CATERPILLAR®

Service Manual

Models
TH336C, TH337C, TH406C, TH407C, TH414C, TH514C, TH417C

SN MJR00150 to Present, SN THM00150 to Present,
SN DJB00150 to Present, SN SXJ00150 to Present,
SN GAT00150 to Present, SN RCH00150 to Present,
SN MLH00150 to Present, SN JJT00150 to Present,
SN KEK00150 to Present, SN RWW00150 to Present,
SN MWC00150 to Present, SN KKW00150 to Present,
SN RRJ00150 to Present, SN RRW00150 to Present

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January 31, 2018

EFFECTIVITY PAGE

DATE	REVISION	DESCRIPTION
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October 8, 2013	C	Revised page 2-11, 2-12, 2-14 thru 2-18, 3-27, 3-54, 3-56, 4-6, 4-7, 5-3, 7-1 thru 7-26, 8-5, 8-16, 8-18, 9-5 thru 9-22, 9-43, 9-44.
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SECTION CONTENTS

Section 1
Safety Practices

Contents

1.1 INTRODUCTION

This service manual provides general directions for accomplishing service and repair procedures. Following the procedures in this manual will help assure safety and equipment reliability.

Read, understand and follow the information in this manual, and obey all locally approved safety practices, procedures, rules, codes, regulations and laws.

These instructions cannot cover all details or variations in the equipment, procedures, or processes described, nor provide directions for meeting every possible contingency during operation, maintenance, or testing. When additional information is desired consult the local Caterpillar dealer.

Many factors contribute to unsafe conditions: carelessness, fatigue, overload, inattentiveness, unfamiliarity, even drugs and alcohol, among others. For optimal safety, encourage everyone to think, and to act, safely.

Appropriate service methods and proper repair procedures are essential for the safety of the individual doing the work, for the safety of the operator, and for the safe, reliable operation of the machine. All references to the right side, left side, front and rear are given from the operator seat looking in a forward direction.

Supplementary information is available from the manufacturer in the form of Service Bulletins, Service Campaigns, Service Training Schools, the service website, other literature, and through updates to the manual itself.

1.2 DISCLAIMER

All information in this manual is based on the latest product information available at the time of publication. The manufacturer reserves the right to make changes and improvements to its products, and to discontinue the manufacture of any product, at its discretion at any time without public notice or obligation.

1.3 OPERATION & MAINTENANCE MANUAL

The mechanic must not operate the machine until the Operation & Maintenance Manual has been read and understood, training has been accomplished and operation of the machine has been completed under the supervision of an experienced and qualified operator.

An Operation & Maintenance Manual is supplied with each machine and must be kept in the manual holder located in the cab. In the event that the Operation & Maintenance Manual is missing, consult the local Caterpillar dealer before proceeding.

1.4 DO NOT OPERATE TAGS

Place Do Not Operate Tags on the ignition key switch and the steering wheel before attempting to perform any service or maintenance. Remove key and disconnect battery leads.

1.5 SAFETY INFORMATION

To avoid possible death or injury, carefully read, understand and comply with all safety messages.

In the event of an accident, know where to obtain medical assistance and how to use a first aid kit and fire extinguisher/ fire suppression system. Keep emergency telephone numbers (fire department, ambulance, rescue squad/ paramedics, police department, etc.) nearby. If working alone, check with another person routinely to help assure personal safety.

1.5.1 Safety Alert System and Signal Words

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

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

CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

1.6 SAFETY INSTRUCTIONS

Following are general safety statements to consider ***before*** performing maintenance procedures on the telehandler. Additional statements related to specific tasks and procedures are located throughout this manual and are listed prior to any work instructions to provide safety information before the potential of a hazard occurs.

For all safety messages, carefully read, understand and follow the instructions ***before*** proceeding.

1.6.1 Personal Hazards

PERSONAL SAFETY GEAR: Wear all the protective clothing and personal safety gear necessary to perform the job safely. This might include heavy gloves, safety glasses or goggles, filter mask or respirator, safety shoes or a hard hat.

LIFTING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist.

1.6.2 Equipment Hazards

LIFTING OF EQUIPMENT: Before using any lifting equipment (chains, slings, brackets, hooks, etc.), verify that it is of the proper capacity, in good working order, and is properly attached.

NEVER stand or otherwise become positioned under a suspended load or under raised equipment. The load or equipment could fall or tip.

Do Not use a hoist, jack or jack stands only to support equipment. Always support equipment with the proper capacity blocks or stands properly rated for the load.

HAND TOOLS: Always use the proper tool for the job; keep tools clean and in good working order, and use special service tools only as recommended.

1.6.3 General Hazards

SOLVENTS: Only use approved solvents that are known to be safe for use.

HOUSEKEEPING: Keep the work area and operator cab clean, and remove all hazards (debris, oil, tools, etc.).

FIRST AID: Immediately clean, dress and report all injuries (cuts, abrasions, burns, etc.), no matter how minor the injury may seem. Know the location of a First Aid Kit, and know how to use it.

CLEANLINESS: Wear eye protection, and clean all components with a high pressure or steam cleaner before attempting service.

When removing hydraulic components, plug hose ends and connections to prevent excess leakage and contamination. Place a suitable catch basin beneath the machine to capture fluid run off.

It is good practice to avoid pressure-washing electrical/ electronic components. In the event pressure-washing the machine is needed, ensure the machine is shut down before pressure-washing. Should pressure-washing be utilized to wash areas containing electrical/electronic components, Caterpillar recommends a maximum pressure of 52 bar (750 psi) at a minimum distance of 30,5 cm (12 in) away from these components. If electrical/electronic components are sprayed, spraying must not be direct and for brief time periods to avoid heavy saturation,

Check and obey all Federal, State and/or Local regulations regarding waste storage, disposal and recycling.

1.6.4 Operational Hazards

ENGINE: Stop the engine before performing any service unless specifically instructed otherwise.

VENTILATION: Avoid prolonged engine operation in enclosed areas without adequate ventilation.

SOFT SURFACES AND SLOPES: **NEVER** work on a machine that is parked on a soft surface or slope. The machine must be on a hard level surface, with the wheels blocked before performing any service.

FLUID TEMPERATURE: **NEVER** work on a machine when the engine, cooling or hydraulic systems are hot. Hot components and fluids can cause severe burns. Allow systems to cool before proceeding.

FLUID PRESSURE: Before loosening any hydraulic or diesel fuel component, hose or tube, turn the engine OFF. Wear heavy, protective gloves and eye protection. **NEVER** check for leaks using any part of your body; use a piece of cardboard or wood instead. If injured, seek medical attention immediately. Diesel fluid leaking under pressure can explode. Hydraulic fluid and diesel fuel leaking under pressure can penetrate the skin, cause infection, gangrene and other serious personal injury.
Refer to the engine manufacturer's manual for specific details concerning the fuel system.

Engine fuel lines are pressurized. Do Not attempt repairs unless specific training has been completed. Refer to the engine manufacturers' manual for specific details concerning the fuel system.

Relieve all pressure before disconnecting any component, part, line or hose. Slowly loosen parts and allow release of residual pressure before removing any part or component. Before starting the engine or applying pressure, use components, parts, hoses and pipes that are in good condition, connected properly and are tightened to the proper torque. Capture fluid in an appropriate container and dispose of in accordance with prevailing environmental regulations.

COOLANT SYSTEM CAP: The cooling system is under pressure, and escaping coolant can cause severe burns and eye injury. To prevent personal injury, NEVER remove the coolant system cap while the cooling system is hot. Wear safety glasses. Turn the coolant system cap to the first stop and allow pressure to escape before removing the cap completely. Failure to follow the safety practices could result in death or serious injury.

FLUID FLAMABILTITY: Do Not service the fuel or hydraulic systems near an open flame, sparks or smoking materials.

Properly disconnect battery(s) prior to servicing the fuel or hydraulic systems.

NEVER drain or store fluids in an open container. Engine fuel and hydraulic fluid are flammable and can cause a fire and/or explosion.

Do Not mix gasoline or alcohol with diesel fuel. The mixture can cause an explosion.

PRESSURE TESTING: When conducting any test, only use test equipment that is correctly calibrated and in good condition. Use the correct equipment in the proper manner, and make changes or repairs as indicated by the test procedure to achieve the desired result.

LEAVING MACHINE: Lower the forks or attachment to the ground before leaving the machine.

TIRES: Always keep tires inflated to the proper pressure to help prevent tipover. Do Not over inflate tires.

NEVER use mismatched tire types, sizes or ply ratings. Always use matched sets according to machine specifications.

MAJOR COMPONENTS: Never alter, remove, or substitute any items such as counterweights, tires, batteries or other items that may reduce or affect the overall weight or stability of the machine.

BATTERY: Do Not charge a frozen battery.Charging a frozen battery may cause it to explode. Allow the battery to thaw before jump starting or connecting a battery charger.

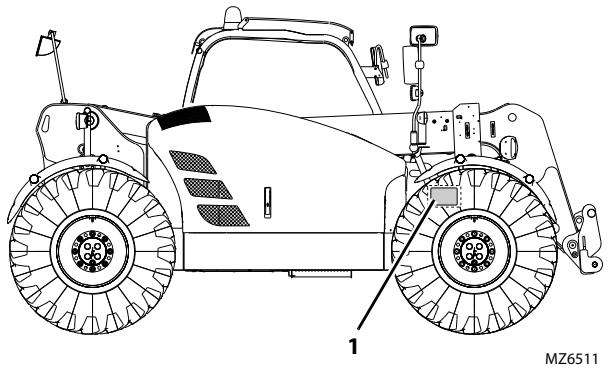
1.7 SAFETY DECALS

Check that all safety decals are present and readable on the machine. Refer to the Operation & Maintenance Manual supplied with machine for information.

Section 2
General Information and Specifications

Contents

2.1 REPLACEMENT PARTS AND WARRANTY INFORMATION



Before ordering parts or initiating service inquiries, make note of the machine serial number. The machine serial number plate (**1**) is located on the frame behind the right front tire.

Note: *The replacement of any part on this machine with any other than factory authorized replacement parts can adversely affect the performance, durability, or safety of the machine, and will void the warranty.* ***JLG*** *disclaims liability for any claims or damages, whether regarding property damage, personal injury or death arising out of the use of unauthorized replacement parts.*

A warranty registration form must be filled out by the local Caterpillar dealer.

Registration activates the warranty period and helps to assure that warranty claims are promptly processed to guarantee full warranty service.

2.2 SPECIFICATIONS

2.2.1 Travel Speeds

Machine	Maximum Travel Speed
TH336C, TH337C, TH406C & TH407C	4 Speed - 32 kph (19.9 mph) 6 Speed - 40 kph (24.9 mph)
TH414C	32 kph (19.9 mph)
TH514C & TH417C	34 kph (21.1 mph)

2.2.2 Hydraulic Cylinder Performance

Note: *Machine with no attachment or load, engine at full throttle, hydraulic oil above 54° C (130° F) minimum, engine at operating temperature.*

FUNCTION	APPROXIMATE TIMES (seconds)						
	TH336C	TH337C	TH406C	TH407C	TH414C	TH514C	TH417C
Boom Extend (Boom Level)	4-6	3-7	4-7	5-8	10-13	16-19	22-26
Boom Retract (Boom Level)	4-6	3-7	4-6	5-7	10-15	18-21	15-25
Boom Lift	5-7	6-10	5-7	6-10	14-18	16-19	15-18
Boom Lower	3-5	5-8	3-6	5-9	8-13	9-12	9-12
Quick Coupler Raise	2-5	2-4	2-4	2-5	2-5	3-5	2-5
Quick Coupler Lower	2-5	2-4	2-4	2-4	2-5	3-5	3-6
Level - Full Right to Left	N/A	N/A	N/A	N/A	7-15	13-19	7-15
Level - Full Left to Right	N/A	N/A	N/A	N/A	7-12	10-16	7-15
Outrigger - Both Down	N/A	N/A	N/A	N/A	5-8	6-10	6-10
Outrigger - Both Up	N/A	N/A	N/A	N/A	4-9	5-9	5-9
Outrigger - Single Down	N/A	N/A	N/A	N/A	3-7	3-6	3-6
Outrigger - Single Up	N/A	N/A	N/A	N/A	3-7	4-6	3-6

2.2.3 Platform Hydraulic Performance Specifications

FUNCTION	APPROXIMATE TIMES (seconds)		
	TH414C	TH514C	TH417C
Platform Lift	31-60	31-60	39-60
Platform Lower	31-60	31-60	39-60
Platform Extend	19-35	19-35	27-43
Platform Retract	19-49	19-40	27-60
Platform Rotate 180°	14-35	14-35	14-35

2.2.4 Cylinder Drift

Cylinder	Maximum Rod Travel (loaded or unloaded)
Lift/Lower Cylinder	3.2 mm (0.125 in) per hour
Extend/Retract Cylinder	3.2 mm (0.125 in) per hour
Attachment Tilt Cylinder	3.2 mm (0.125 in) per hour

2.2.5 Steering Angle Specifications

Model	Angle (in Degree)	
	Minimum	Maximum
TH336C, TH337C, TH406C, TH407C, TH414C, TH514C, TH417C	30°	45°

2.2.6 Electrical System

Description	Standard	Dual
Battery		
Type, Rating	12 V, Negative (-) Ground, Tapered Top Post, Maintenance Free	12 V, Negative (-) Ground, Tapered Top Post, Maintenance Free
Quantity	1	2
Reserve Capacity Minutes @ 80° F (27° C)	160	160
Cold Cranking Amps @ 0° F (-18° C)	900	1800
Group/Series	BCI Group 31	BCI Group 31
Alternator	74.5 kW - 12V, 100 Amps 75 kW, 93.1 kW, 92.6 kW & 106 kW - 12V, 120Amps	74.5 kW - 12V, 100 Amps 75 kW, 93.1 kW, 92.6 kW & 106 kW - 12V, 120Amps
Starter	74.5 kW, 75 kW, 93.1 kW,9 2.6 kW-12V, 4,2 kW, LHS 106 kW - 12V, 4,0 kW, LHS	74.5 kW, 75 kW, 93.1 kW, 92.6 kW-12V, 4,2 kW, LHS 106 kW - 12V, 4,0 kW, LHS

2.2.7 Engine Fan Speed

Fan Type	Fan Speed - High Idle	Fan Hydraulic Pressure	Oil Temperature
Hydraulic	2225 - 2275 RPM	205 - 215 bar (2973 - 3118 psi)	45°- 55°C (113°-131°F)
Belt Driven	2525 - 2575 RPM	N/A	N/A

2.2.8 Engine Performance Specifications

a. SN MJR00150 to Present, DJB00150 to Present, GAT00150 to Present, SN MLH00150 to Present, KEK00150 to Present, MWC00150 to Present, RRJ00150 to Present

Description	75 kW	92.6 kW	106 kW
Engine Make/Model	CAT C3.4	CAT C4.4	CAT C4.4
Displacement	3,4 liters (207 in^3)	4,4 liters (269 in^3)	4.4 liters (269 in^3)
Low Idle	845 - 855 rpm	795 - 805 rpm	795 - 805 rpm
High Idle	2295 - 2345 rpm	2295 - 2345 rpm	2295 - 2345 rpm
Power	75 kW @ 2200 rpm	92,6 kW @ 2200 rpm	106 kW @ 2200 rpm
Peak Torque	410 Nm (302 lb-ft) @ 1400 rpm	530 Nm (365 lb-ft) 1400 rpm	560 Nm (365 lb-ft) @ 1400 rpm
Fuel Delivery	Fuel Injection	Fuel Injection	Fuel Injection
Air Cleaner	Dry Type, Replaceable Primary and Safety Elements	Dry Type, Replaceable Primary and Safety Elements	Dry Type, Replaceable Primary and Safety Elements

b. SN THM00150 to Present, SXJ00150 to Present, RCH00150 to Present, JJT00150 to Present, RWW00150 to Present, KKW00150 to Present, RRW00150 to Present

Description	74,5 kW	93.1 kW
Engine Make/Model	CAT C4.4	CAT C4.4
Displacement	3,4 liters (207 in^3)	4,4 liters (269 in^3)
Low Idle	900 - 1000 rpm	945 - 955 rpm
High Idle	2270 - 2370 rpm	2295 - 2345 rpm
Power	74.5 kW @ 2200 rpm	92,5 kW @ 2200 rpm
Peak Torque	410 Nm (302 lb-ft) @ 1400 rpm	530 Nm (365 lb-ft) @1400 rpm
Fuel Delivery	Fuel Injection	Fuel Injection
Air Cleaner	Dry Type, Replaceable Primary and Safety Elements	Dry Type, Replaceable Primary and Safety Elements

2.2.9 Transmission Performance Specifications

a. SN MJR00150 to Present, DJB00150 to Present, GAT00150 to Present, SN MLH00150 to Present, KEK00150 to Present, MWC00150 to Present, RRJ00150 to Present

Engine	Power	Transmission	Stall Speed	
C3.4	75 kW	4 Speed	1893 rpm	2093 rpm
		6 Speed	1893 rpm	2093 rpm
C4.4	92.6 kW	6 Speed	1839 rpm	2033 rpm
C4.4	106 kW	6 Speed	1916 rpm	2118 rpm

b. SN THM00150 to Present, SXJ00150 to Present, RCH00150 to Present, JJT00150 to Present, RWW00150 to Present, KKW00150 to Present, RRW00150 to Present

Engine	Power	Transmission	Stall Speed	
C3.4	74.5 kW	4 Speed	1872 rpm	2070 rpm
C4.4	93.1 kW	6 Speed	1814 rpm	2004 rpm

2.2.10 Tires

Note: *Standard wheel lug nut torque is 360 ±20 Nm (265 ±15 lb-ft) for TH336C, TH337C, TH406C, TH407C & TH414C machines. Standard wheel lug nut torque for TH514C & TH417C machines is 460 ±20 Nm (340 ±15 lb-ft).*

Note: *Pressures for foam filled tires are for initial fill ONLY.*

a. TH336C, TH337C, TH406C & TH407C

Size	Tire Type	Minimum Ply/ Star Rating	Fill Type	Pressure
15.5-25	L-2	16 Ply	Pneumatic	4,0 Bar (58 psi)
			Foam Filled	Approx 264 kg (582 lb)
			Liquid Filled	Approx 4,6 L (155 oz)
15.5/80-24	TR01	16 Ply	Pneumatic	4,25 Bar (62 psi)
			Liquid Filled	Approx 6,0 L (200 oz)
15.5/80-24	SGI	14 Ply	Pneumatic	4,0 Bar (58 psi)
			Liquid Filled	Approx 6,0 L (200 oz)
460/70R24	XMCL	N/A	Pneumatic	4,0 Bar (58 psi)
			Liquid Filled	Approx 6,4 L (215 oz)
500/70R24 (TH337C & TH407C only)	XMCL	N/A	Pneumatic	3,0 Bar (44 psi)
			Liquid Filled	Approx 6,5 L (220 oz)
400/80-24	Power CL	N/A	Pneumatic	4,0 Bar (58 psi)
			Liquid Filled	Approx 6,0 L (200 oz)
440/80-24 (TH337C & TH407C only)	Power CL	N/A	Pneumatic	3,5 Bar (51 psi)
			Liquid Filled	Approx 6,4 L (215 oz)

b. TH414C

Size	Tire Type	Minimum Ply/ Star Rating	Fill Type	Pressure
15.5/80-24	TR01	16 Ply	Pneumatic	4,25 Bar (62 psi)
			Liquid Filled	Approx 6,0 L (200 oz)
15.5-25	L-2	12 Ply	Pneumatic	4,0 Bar (58 psi)
			Liquid Filled	Approx 4,6 L (155 oz)
400/80-24	Power CL	N/A	Pneumatic	4,5 Bar (65 psi)
			Liquid Filled	Approx 6,0 L (200 oz)
440-80-24	Power CL	N/A	Pneumatic	4,0 Bar (58 psi)
			Liquid Filled	Approx 6,4 L (215 oz)

c. TH514C & TH417C

Size	Tire Type	Minimum Ply/ Star Rating	Fill Type	Pressure
14-24	TG02	16 Ply	Pneumatic	4,25 Bar (61 psi)
			Foam Filled (ANSI only)	Approx 264 kg (582 lb)
			Liquid Filled	Approx 4,6 L (155 oz)
14-24	SGG-2A	16 Ply	Pneumatic	5,25 Bar (76 psi)
			Foam Filled (ANSI only)	Approx 264 kg (582 lb)
			Liquid Filled	Approx 4,6 L (155 oz)

2.3 FLUIDS AND LUBRICANT CAPACITIES

2.3.1 Fluids

SN MJR00150 to Present, DJB00150 to Present, GAT00150 to Present, SN MLH00150 to Present, KEK00150 to Present, MWC00150 to Present, RRJ00150 to Present

Compartment or System	Type and Classification	Viscosities	Ambient Temperature Range			
			°F		°C	
			Min	Max	Min	Max
Engine Crankcase	CAT DEO ULS API CJ-4	SAE 0W-20	-22	50	-30	10
		SAE 0W-30	-22	86	-30	30
		SAE 0W-40	-22	104	-30	40
		SAE 5W-30	-13	86	-25	30
		SAE 5W-40	-13	122	-25	50
		SAE 10W-30	-4	104	-20	40
		SAE 10W-40	-4	122	-20	50
		SAE 15W-40	14	122	-10	50
Hydraulic System	CAT HYDO Advanced	SAE 10W	-4	104	-20	40
		SAE 30	50	122	10	50
Transmission and Transfer Case	CAT TDTO	SAE 10W	0	95	-18	35
		SAE 30	32	95	0	35
		SAE 50	50	122	10	50
		SAE 5W-30	-22	68	-30	20
		SAE 0W-20	-40	68	-40	20
Axle Differential* and Wheel End	CAT TDTO TO-4	SAE 30	-4	104	-20	40
Cylinder, Boom Wear Pad and Axle Grease	CAT Multipurpose Grease	NLGI Grade 2	-22	104	-30	40
Engine Coolant	CAT Extended Life Coolant (ELC)	50/50 Mix				
Fuel	#2 Diesel	Ultra Low Sulfur (S $\leq$ 15 mg/kg)				
Air Conditioning	Refrigerant R-134a	Tetrafluorethane				

Note: **Friction Modifier (197-0017) required for axle differentials, see Section 2.3.2, "Capacities".*

SN THM00150 to Present, SXJ00150 to Present, RCH00150 to Present, JJT00150 to Present, RWW00150 to Present, KKW00150 to Present, RRW00150 to Present

Compartment or System	Type and Classification	Viscosities	Ambient Temperature Range			
			°F		°C	
			Min	Max	Min	Max
Engine Crankcase	CAT DEO API CI-4	SAE 0W-20	-22	50	-30	10
		SAE 0W-30	-22	86	-30	30
		SAE 0W-40	-22	104	-30	40
		SAE 5W-30	-13	86	-25	30
		SAE 5W-40	-13	122	-25	50
		SAE 10W-30	-4	104	-20	40
		SAE 10W-40	-4	122	-20	50
		SAE 15W-40	14	122	-10	50
Hydraulic System	CAT HYDO Advanced	SAE 10W	-4	104	-20	40
		SAE 30	50	122	10	50
Transmission and Transfer Case	CAT TDTO	SAE 10W	0	95	-18	35
		SAE 30	32	95	0	35
		SAE 50	50	122	10	50
		SAE 5W-30	-22	68	-30	20
		SAE 0W-20	-40	68	-40	20
Axle Differential* and Wheel End	CAT TDTO TO-4	SAE 30	-4	104	-20	40
Cylinder, Boom Wear Pad and Axle Grease	CAT Multipurpose Grease	NLGI Grade 2	-22	104	-30	40
Engine Coolant	CAT Extended Life Coolant (ELC)	50/50 Mix				
Fuel	#2 Diesel	Low Sulfur (S $\leq$ 500 mg/kg)				
Air Conditioning	Refrigerant R-134a	Tetrafluorethane				

Note: **Friction Modifier (197-0017) required for axle differentials, see Section 2.3.2, "Capacities".*

2.3.2 Capacities

Engine Crankcase Oil

Capacity with Filter Change	
74.5 kW	8,5 liter (9.0 quart)
75 kW	8,0 liter (8.5 quart)
92.6 kW & 106 kW	8,8 liter (9.3 quart)
93.1 kW	9,5 liter (10.0 quart)

Fuel Tank

Capacity	150 liter (39.6 gallon)

Cooling System

System Capacity	
75 kW &	16,0 liter (16.9 quart)
74.5 kW, 92.6 kW, 93.1 kW & 106 kW	25,0 liter (26.4 quart)

Transmission System

Capacity with Filter Change	14 liters (14.8 quarts)

Transmission Drop Box

Capacity	2,75 liter (2.9 quart)

Hydraulic System

System Capacity	
TH336C, TH337C, TH406C & TH407C	135 liter (35.7 gallon)
TH414C, TH514C & TH417C	145 liter (38.3 gallon)
Reservoir Capacity to Full Mark	90 liter (23.8 gallon)
Auxiliary Hydraulic Circuit Max Flow	80 lpm (21.1 gpm)

Axles

Differential Housing Capacity - Front Axle	
TH336C, TH337C, TH406C & TH407C	10,5 liter (11.1 quart)
TH414C, TH514C & TH417C	11,5 liter (12.2 quart)
Friction Modifier (197-0017) - Front Axle Differential	0,35 liter (0.37 quart)
Wheel End Capacity	
TH336C, TH337C, TH406C & TH407C	0,8 liter (0.8 quart)
TH414C	0,9 liter (1.0 quart)
TH514C & TH417C	1,5 liter (1.5 quart)

Air Conditioning System (if equipped)

System Capacity	1,35 kg (3.0 lb)

2.4 SERVICE AND MAINTENANCE SCHEDULES

2.4.1 Every 10 Hours


OC0880
Check Fuel Level


OC0910
Check Engine Oil Level


OC0920
Check Hydraulic Oil Level

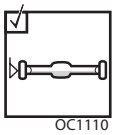

OC0890
Check Tire Condition & Pressure

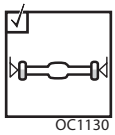

OC0970
Check Engine Coolant Level


OC0930
Check Transmission Oil Level


MAE29820
Check Cab Air Prefilter

2.4.2 First 50 Hours

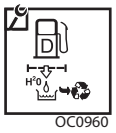

OC1110
Check Axle Differential Oil Level


OC1130
Check Wheel End Oil Level


MAE19460
Check Boom Chain & Tension (TH414C & TH417C)


OC0990
Check Wheel Lug Nut Torque

2.4.3 Every 50 Hours


OC0960
Drain Fuel/Water Separator


OC0950
Check Air Filter


MAE19470
Lubrication Schedule

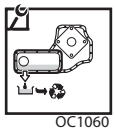

OC1150
Check Battery

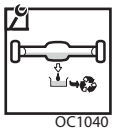

OC1020
Check Washer Fluid Level (if equipped)

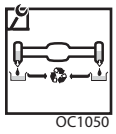

MAE8060
Check Cab Air Filter

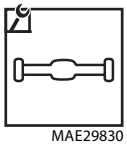
2.4.4 First 250 Hours

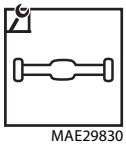

OC1070
Check Transmission Oil & Filter


OC1060
Change Transfer Case Oil

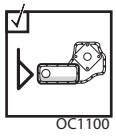

OC1040
Change Axle Differential Oil


OC1050
Change Wheel End Oil


MAE29830
Clean Axle Breather

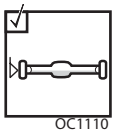

MAE29830
Clean Axle Magnetic Oil Plugs

2.4.5 Every 250 Hours

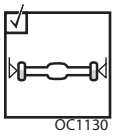


Check Transfer Case Oil Level

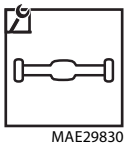
Check Fan Belt



Check Axle Differential Oil Level



Check Wheel End Oil Level



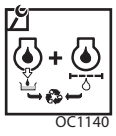
Clean Axle Breather

Check Boom Wear Pads

Check Boom Chain & Tension (TH414C & TH417C)

2.4.6 Every 500 Hours

Change Fuel Filter



Change Engine Oil and Filter

Change Air Filter Elements

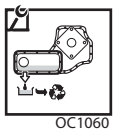
Check Wheel Lug Nut Torque

Lubrication schedule

Check LSI Calibration (CE & AUS)

2.4.7 Every 1000 Hour

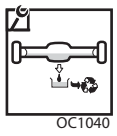
Change Transmission Oil & Filter



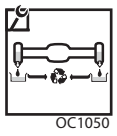
Change Transfer Case Oil

Check Air Intake System

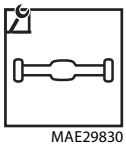
Change Hydraulic Fluid & Filter



Change Axle Differential Oil



Change Wheel End Oil



Clean Axle Magnetic Oil Plugs

2.4.8 Every 1500 Hours

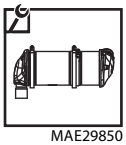

MAE29840

Change Crankcase Vent Filter

2.4.9 Every 3000 Hours


MAE19480

Change Fan Belt


MAE29850

Service Diesel Particulate Filter

(75 kW engine only)


MAE29860

Change Exhaust After Treatment Sensor

(75 kW engine only)

2.4.10 Every 6000 Hours or 3 Years


MAE29870

Add Engine Coolant Extender

2.4.11 Every 12000 Hours or 6 Years

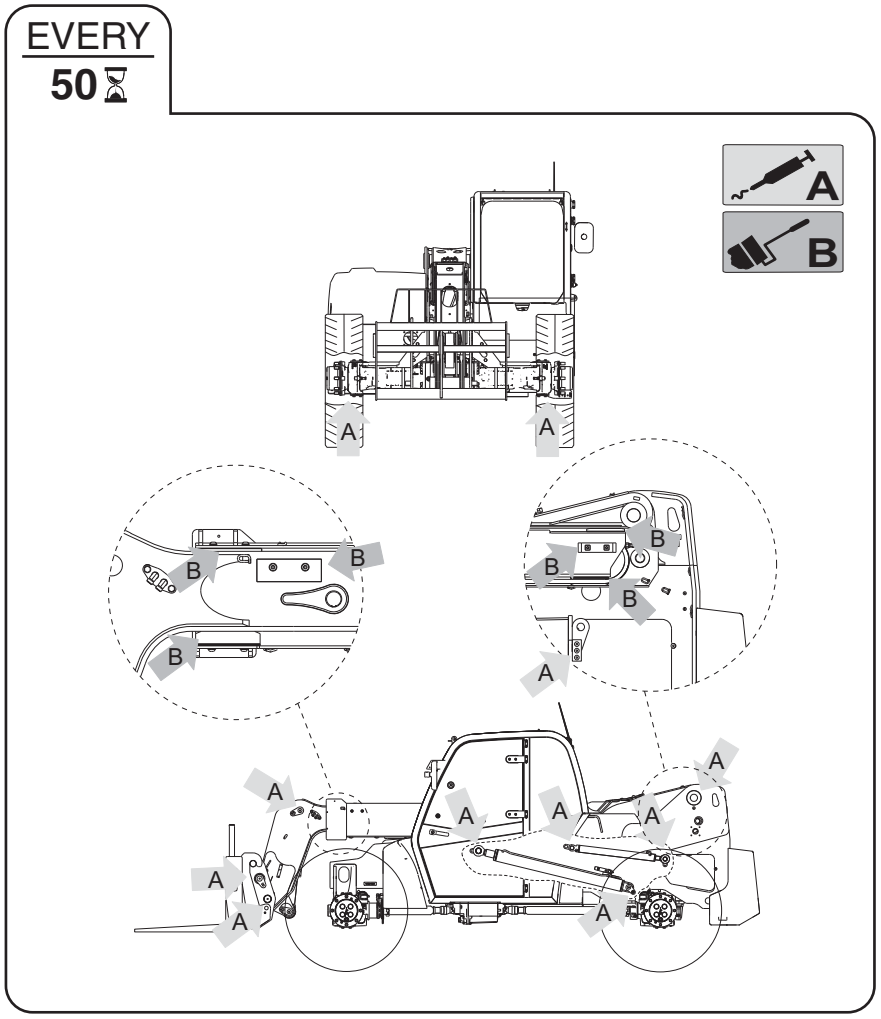

OC1240

Change Engine Coolant

2.5 LUBRICATION SCHEDULES

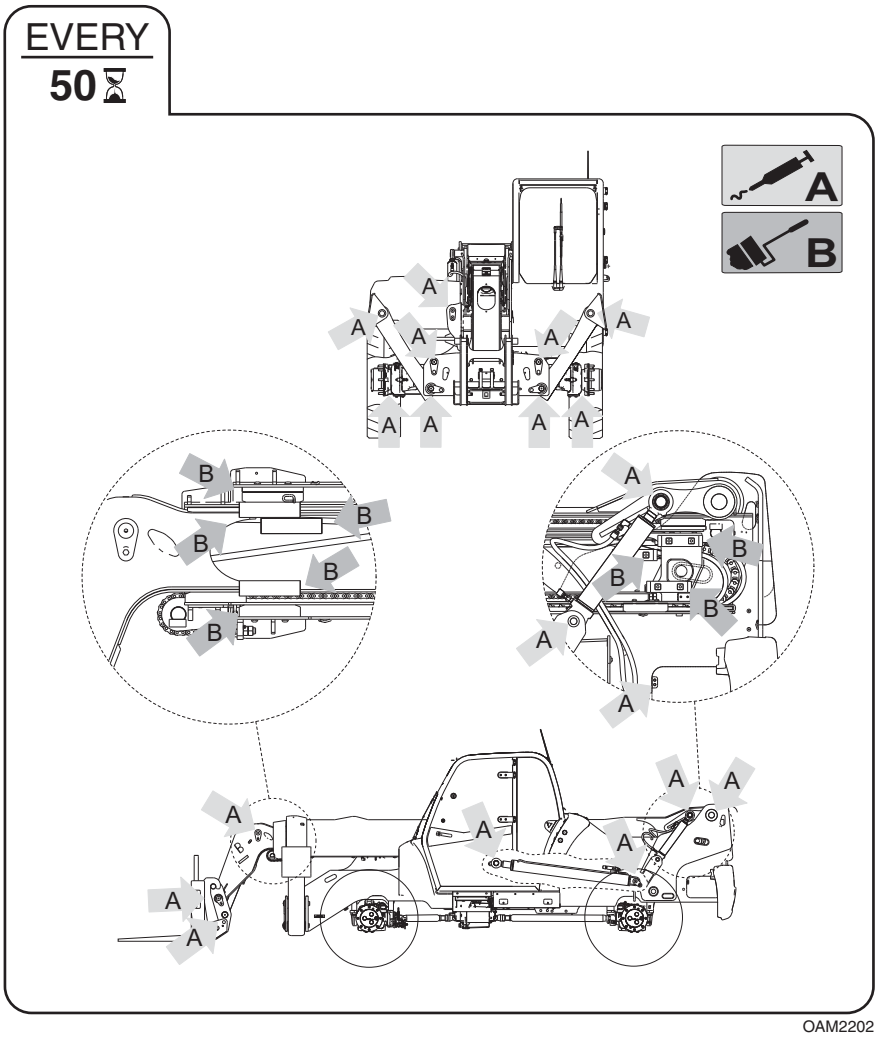
2.5.1 50 Hour Lubrication

a. TH336C, TH337C, TH406C & TH407C

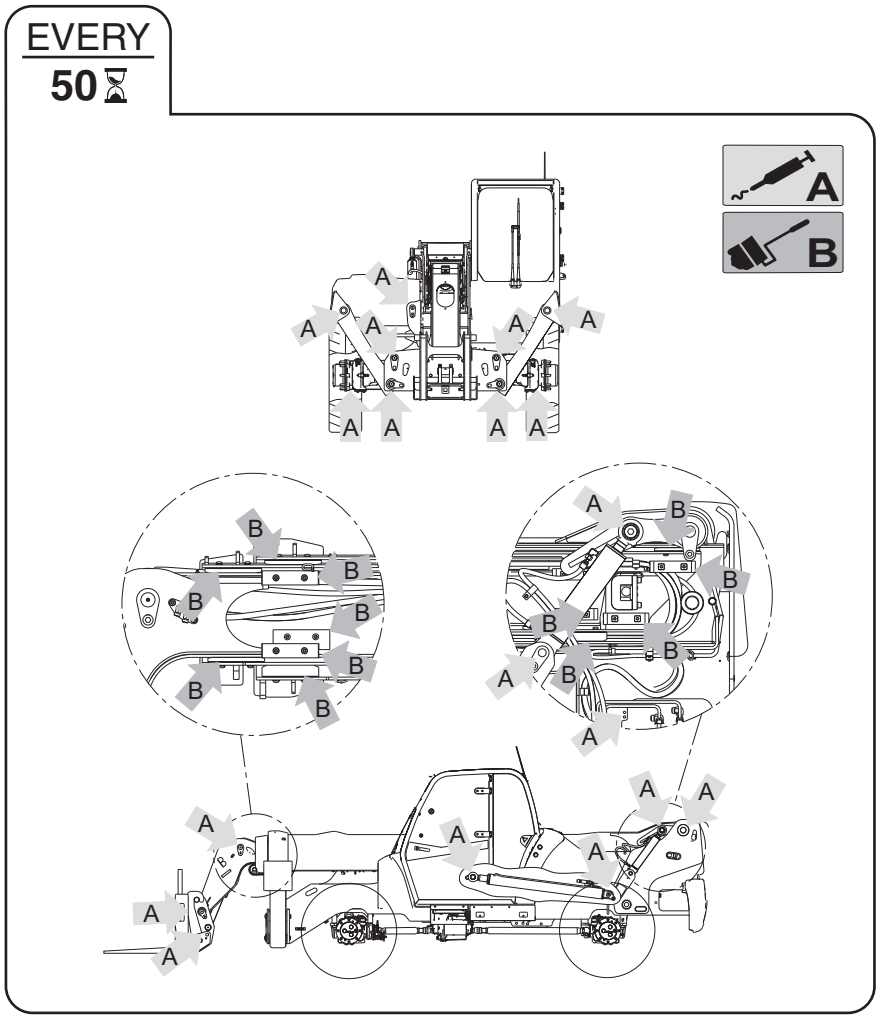


OAM2411

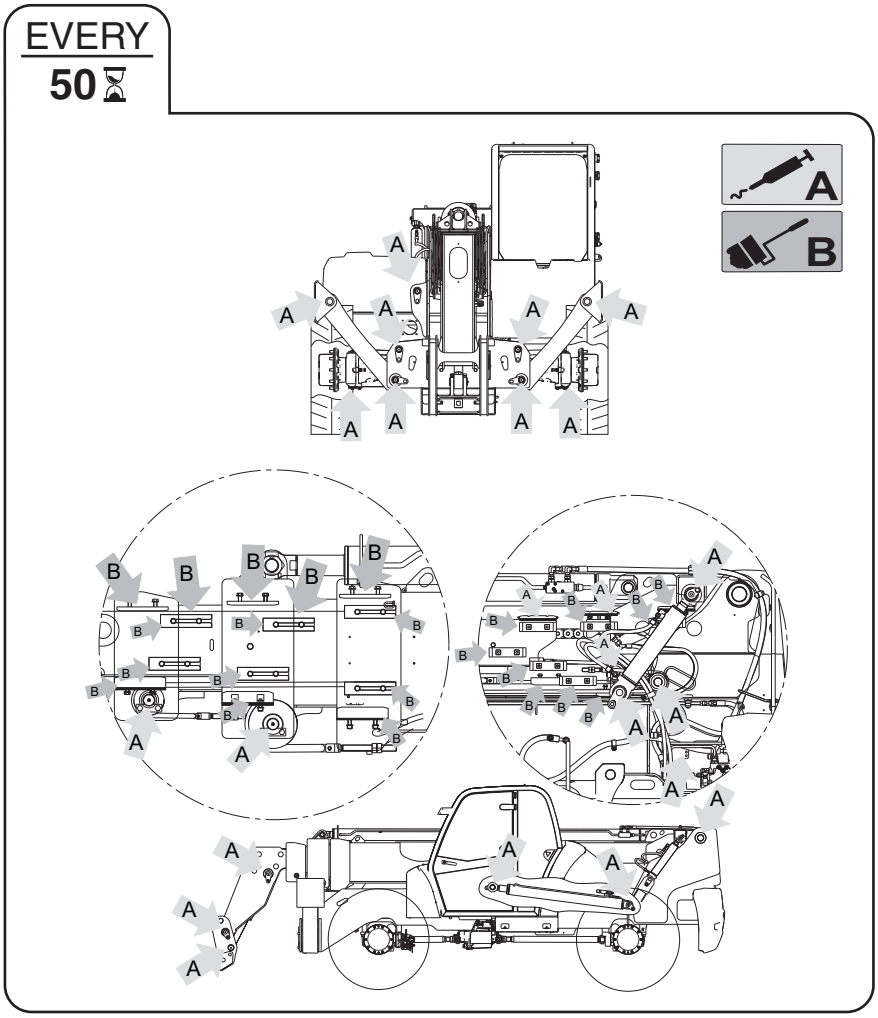
b. TH414C



c. TH514C

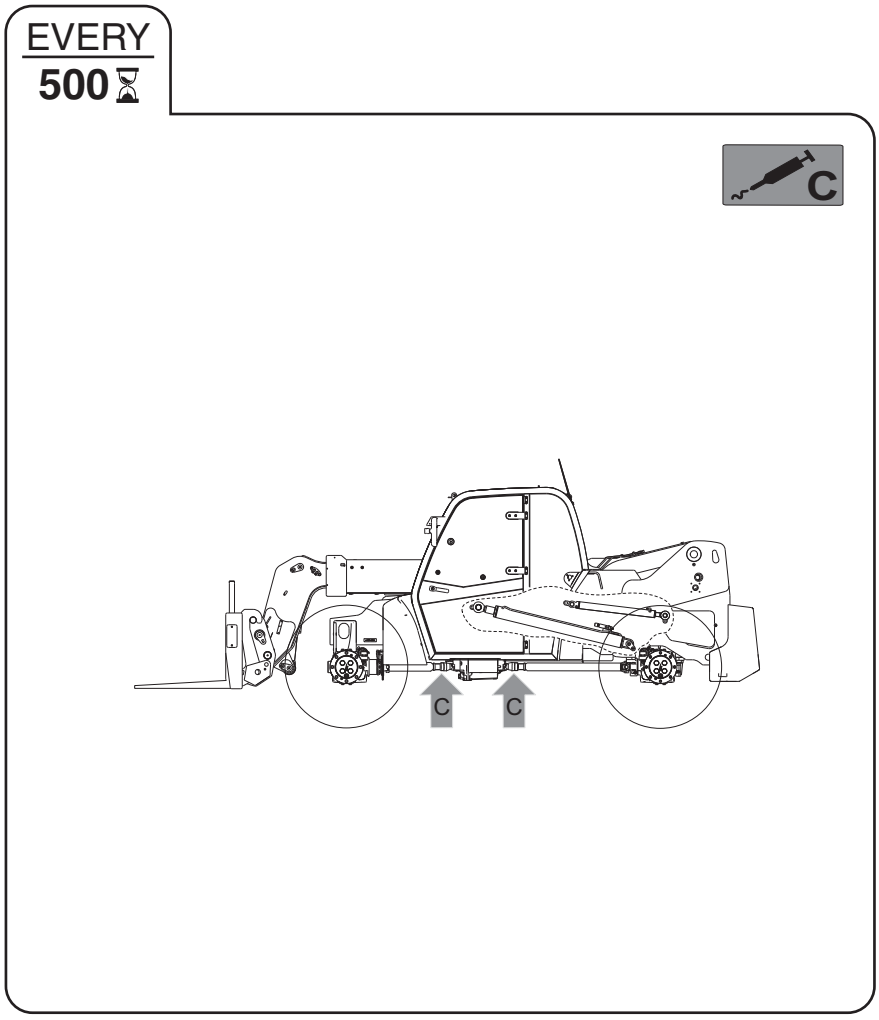


d. TH417C



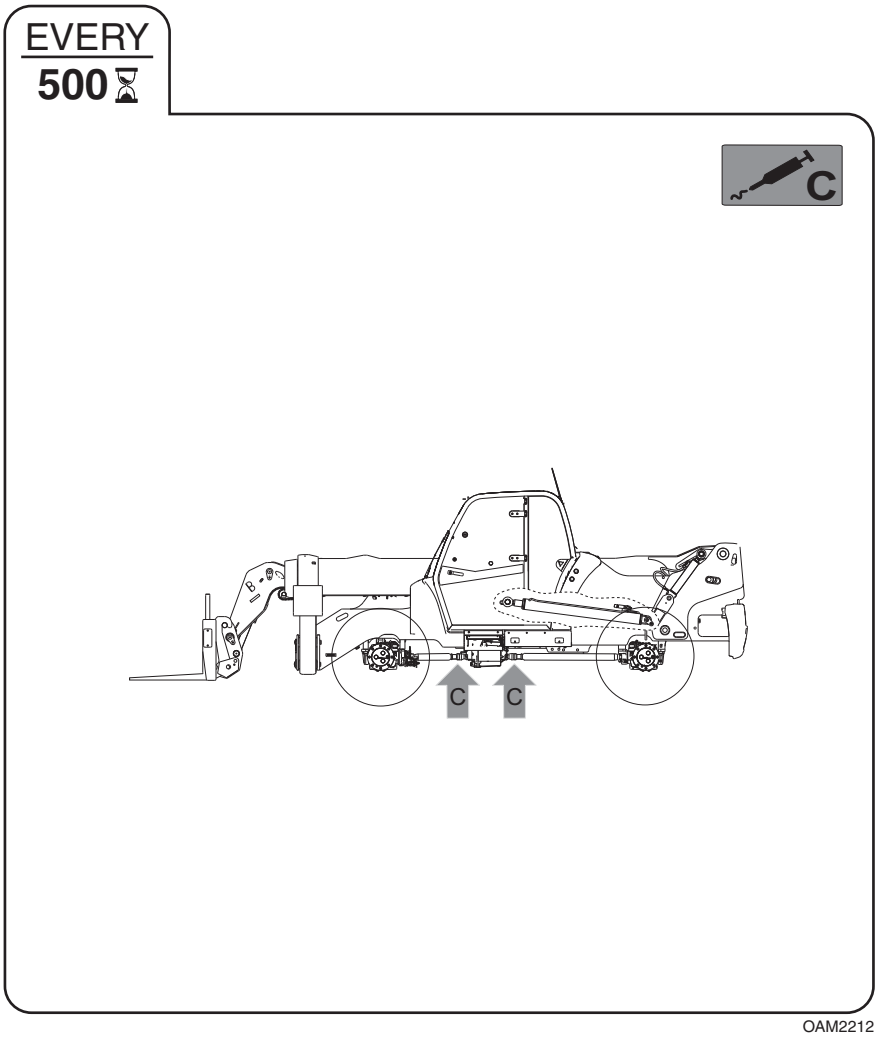
2.5.2 500 Hour Lubrication

a. TH336C, TH337C, TH406C & TH407C



OAM2421

b. TH414C, TH514C & TH417C



OAM2212

2.6 THREAD LOCKING COMPOUND

Loctite®	ND Industries	Description
242™	Vibra-TITE™ 121	Medium Strength (Blue)
243™	Vibra-TITE™ 122	Medium Strength (Blue)
271™	Vibra-TITE™ 140	High Strength (Red)
262™	Vibra-TITE™ 131	Medium - High Strength (Red)

Note: *Loctite® 243™ can be substituted in place of Loctite® 242™. Vibra-TITE™ 122 can be substituted in place of Vibra-TITE™ 121.*

2.7 TORQUE CHARTS

2.7.1 SAE Fastener Torque Chart

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)												
SAE GRADE 5 BOLTS & GRADE 2 NUTS												
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 131)	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	8	0.9	6	0.7				
	48	0.1120	0.00661	420	9	1.0	7	0.8				
6	32	0.1380	0.00909	580	16	1.8	12	1.4				
	40	0.1380	0.01015	610	18	2.0	13	1.5				
8	32	0.1640	0.01400	900	30	3.4	22	2.5				
	36	0.1640	0.01474	940	31	3.5	23	2.6				
10	24	0.1900	0.01750	1120	43	4.8	32	3.5				
	32	0.1900	0.02000	1285	49	5.5	36	4				
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12		
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	17	23	13	18	19	26	16	22
	24	0.3125	0.0580	3700	19	26	14	19	21	29	17	23
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48	28	38
	24	0.3750	0.0878	5600	35	47	25	34	40	54	32	43
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75	45	61
	20	0.4375	0.1187	7550	55	75	40	54	60	82	50	68
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116	68	92
	20	0.5000	0.1599	10700	90	122	65	88	100	136	80	108
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163	98	133
	18	0.5625	0.2030	12950	120	163	90	122	135	184	109	148
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224	135	183
	18	0.6250	0.2560	16300	170	230	130	176	190	258	153	207
3/4	10	0.7500	0.3340	21300	260	353	200	271	285	388	240	325
	16	0.7500	0.3730	23800	300	407	220	298	330	449	268	363
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646	386	523
	14	0.8750	0.5090	32400	470	637	350	475	520	707	425	576
1	8	1.0000	0.6060	38600	640	868	480	651	675	918	579	785
	12	1.0000	0.6630	42200	700	949	530	719	735	1000	633	858
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142	714	968
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258	802	1087
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598	1009	1368
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768	1118	1516
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074	1322	1792
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380	1506	2042
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754	1755	2379
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128	1974	2676

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

2.7.1 SAE Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K=0.20		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474	1320	43	5				
10	24	0.1900	0.01750	1580	60	7				
	32	0.1900	0.02000	1800	68	8				
1/4	20	0.2500	0.0318	2860	143	16	129	15		
	28	0.2500	0.0364	3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	25	35	20	25	20	25
	24	0.3125	0.0580	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	45	60	40	55	35	50
	24	0.3750	0.0878	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	9550	70	95	65	90	50	70
	20	0.4375	0.1187	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	12750	105	145	95	130	80	110
	20	0.5000	0.1599	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	16400	155	210	140	190	115	155
	18	0.5625	0.2030	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	20350	210	285	190	260	160	220
	18	0.6250	0.2560	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	30100	375	510	340	460	280	380
	16	0.7500	0.3730	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	41600	605	825	545	740	455	620
	14	0.8750	0.5090	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	51500	860	1170	770	1045	645	875
	12	1.0000	0.6630	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	142200	3555	4835	3200	4350	2665	3625

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

2.7.1 SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 5 BOLTS & GRADE 2 NUTS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	7	0.8				
	48	0.1120	0.00661	420	8	0.9				
6	32	0.1380	0.00909	580	14	1.5				
	40	0.1380	0.01015	610	14	1.6				
8	32	0.1640	0.01400	900	25	2.8				
	36	0.1640	0.01474	940	26	2.9				
10	24	0.1900	0.01750	1120	36	4.1				
	32	0.1900	0.02000	1285	42	4.7				
1/4	20	0.2500	0.0318	2020	86	9.7	80	9		
	28	0.2500	0.0364	2320	99	11.1	95	11		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20
	24	0.3125	0.0580	3700	15	20	15	21	15	20
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34
	24	0.3750	0.0878	5600	30	40	28	38	25	34
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48
	20	0.4375	0.1187	7550	45	60	44	60	40	54
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75
	20	0.5000	0.1599	10700	75	100	71	97	65	88
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109
	18	0.5625	0.2030	12950	105	145	97	132	90	122
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156
	18	0.6250	0.2560	16300	145	195	136	185	125	170
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272
	16	0.7500	0.3730	23800	255	345	238	324	225	306
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435
	14	0.8750	0.5090	32400	400	545	378	514	355	483
1	8	1.0000	0.6060	38600	545	740	515	700	480	653
	12	1.0000	0.6630	42200	600	815	563	765	530	721
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809
	12	1.1250	0.8560	47500	755	1025	713	969	670	911
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

2.7.1 SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474	1320	37	4				
10	24	0.1900	0.01750	1580	51	6				
	32	0.1900	0.02000	1800	58	7				
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	410	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

2.7.1 SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SOCKET HEAD CAP SCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) or Precoat® 85 K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474							
10	24	0.1900	0.01750							
	32	0.1900	0.02000							
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	415	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

2.7.1 SAE Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*										
SOCKET HEAD CAP SCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) or Precoat® 85 K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474							
10	24	0.1900	0.01750							
	32	0.1900	0.02000							
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	415	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

2.7.2 Metric Fastener Torque Chart

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*							
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS							
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™)	Torque (Lube)	Torque (Loctite® 262™ or 271™ or Vibra-TITE™ 131)	Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 141)
		Sq mm	KN	[N.m]		[N.m]	[N.m]
3	0.5	5.03	2.19	1.3	1.0	1.2	1.4
3.5	0.6	6.78	2.95	2.1	1.6	1.9	2.3
4	0.7	8.78	3.82	3.1	2.3	2.8	3.4
5	0.8	14.20	6.18	6.2	4.6	5.6	6.8
6	1	20.10	8.74	11	7.9	9.4	12
7	1	28.90	12.6	18	13	16	19
8	1.25	36.60	15.9	26	19	23	28
10	1.5	58.00	25.2	50	38	45	55
12	1.75	84.30	36.7	88	66	79	97
14	2	115	50.0	140	105	126	154
16	2	157	68.3	219	164	197	241
18	2.5	192	83.5	301	226	271	331
20	2.5	245	106.5	426	320	383	469
22	2.5	303	132.0	581	436	523	639
24	3	353	153.5	737	553	663	811
27	3	459	199.5	1080	810	970	1130
30	3.5	561	244.0	1460	1100	1320	1530
33	3.5	694	302.0	1990	1490	1790	2090
36	4	817	355.5	2560	1920	2300	2690
42	4.5	1120	487.0	4090	3070	3680	4290

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

2.7.2 Metric Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS, CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M3 - M5*						
Size	**Pitch**	**Tensile Stress Area**	**Clamp Load See Note 4**	**Torque (Dry or Loctite® 263™) K=0.20**	**Torque (Lube or Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.18**	**Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15**
		Sq mm	**KN**	**[N.m]**	**[N.m]**	**[N.m]**
3	0.5	5.03	3.13			
3.5	0.6	6.78	4.22			
4	0.7	8.78	5.47			
5	0.8	14.20	8.85			
6	1	20.10	12.5			
7	1	28.90	18.0	25	23	19
8	1.25	36.60	22.8	37	33	27
10	1.5	58.00	36.1	70	65	55
12	1.75	84.30	52.5	125	115	95
14	2	115	71.6	200	180	150
16	2	157	97.8	315	280	235
18	2.5	192	119.5	430	385	325
20	2.5	245	152.5	610	550	460
22	2.5	303	189.0	830	750	625
24	3	353	222.0	1065	960	800
27	3	459	286.0	1545	1390	1160
30	3.5	561	349.5	2095	1885	1575
33	3.5	694	432.5	2855	2570	2140
36	4	817	509.0	3665	3300	2750
42	4.5	1120	698.0	5865	5275	4395

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

2.7.2 Metric Fastener Torque Chart (Continued)

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube or Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16	Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.1	1.1	1.0
3.5	0.6	6.78	2.95	1.8	1.7	1.5
4	0.7	8.78	3.82	2.6	2.4	2.3
5	0.8	14.20	6.18	5.3	4.9	4.6
6	1	20.10	8.74	9	8.4	7.9
7	1	28.90	12.6	15	14	13
8	1.25	36.60	15.9	22	20	19
10	1.5	58.00	25.2	43	40	38
12	1.75	84.30	36.7	75	70	66
14	2	115	50.0	119	110	105
16	2	157	68.3	186	175	165
18	2.5	192	83.5	256	240	225
20	2.5	245	106.5	362	340	320
22	2.5	303	132.0	494	465	435
24	3	353	153.5	627	590	555
27	3	459	199.5	916	860	810
30	3.5	561	244.0	1245	1170	1100
33	3.5	694	302.0	1694	1595	1495
36	4	817	355.5	2176	2050	1920
42	4.5	1120	487.0	3477	3275	3070

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

2.7.2 Metric Fastener Torque Chart (Continued)

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS, CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE*						
Size	**Pitch**	**Tensile Stress Area**	**Clamp Load See Note 4**	**Torque (Dry or Loctite® 263™) K=0.17**	**Torque (Lube or Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.18**	**Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15**
		Sq mm	**KN**	**[N.m]**	**[N.m]**	**[N.m]**
3	0.5	5.03	3.13			
3.5	0.6	6.78	4.22			
4	0.7	8.78	5.47			
5	0.8	14.20	8.85			
6	1	20.10	12.5	13	12	11
7	1	28.90	18.0	21	20	19
8	1.25	36.60	22.8	31	29	27
10	1.5	58.00	36.1	61	58	55
12	1.75	84.30	52.5	105	100	95
14	2	115	71.6	170	160	150
16	2	157	97.8	265	250	235
18	2.5	192	119.5	365	345	325
20	2.5	245	152.5	520	490	460
22	2.5	303	189.0	705	665	625
24	3	353	222.0	905	850	800
27	3	459	286.0	1315	1235	1160
30	3.5	561	349.5	1780	1680	1575
33	3.5	694	432.5	2425	2285	2140
36	4	817	509.0	3115	2930	2750
42	4.5	1120	698.0	4985	4690	4395

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

3. * ASSEMBLY USES HARDENED WASHER

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

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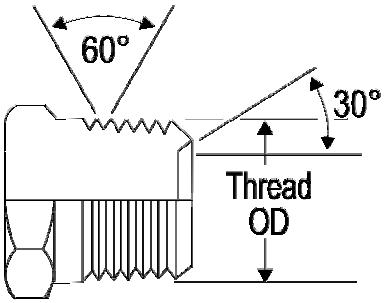
2.8 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION

2.8.1 Definitions

a. Tapered Thread Types

NPTF *- National tapered fuel (dry seal) per SAE J476/J512*



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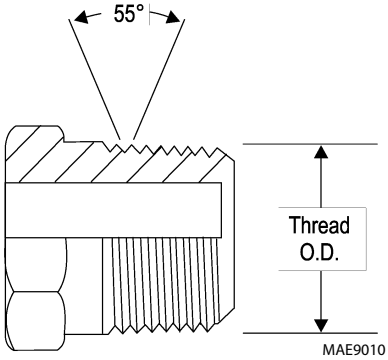
BSPT *- British standard pipe tapered per ISO7-1*



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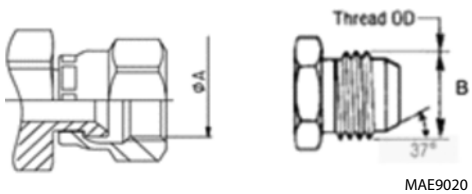
b. Straight Thread Types, Tube and Hose Connections

JIC *- 37° flare per SAE J514*



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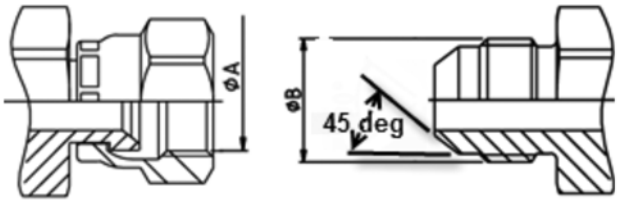
SAE *- 45° flare per SAE J512*



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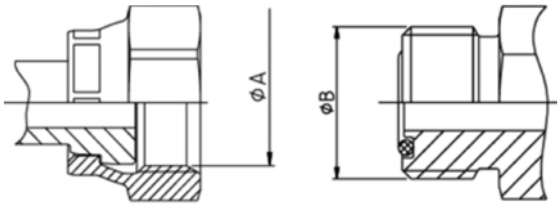
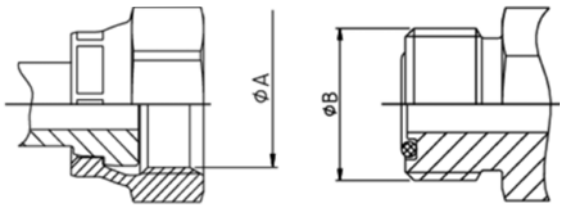
ORFS *- O-ring face seal per SAE J1453*



MAE9040

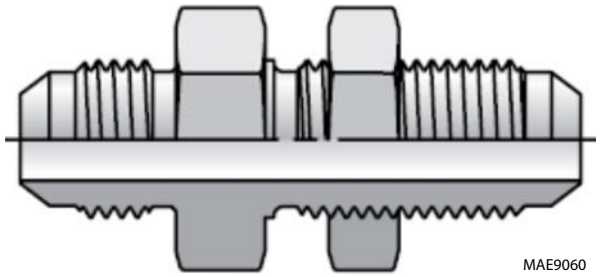
MBTL *- Metric flareless bite type fitting, pressure rating L (medium) per ISO 8434, DIN 2353*

MBTS *- Metric flareless bite type fitting, pressure rating S (high) per ISO 8434, DIN 2353*



MAE9050

BH *- Bulkhead connection – JIC, ORFS, MBTL, or MBTS types*

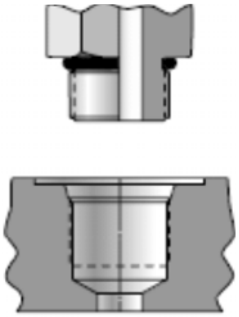


MAE9060

c. Straight Thread Types, Port Connections

ORB *- O-ring boss per SAE J1926, ISO 11926*

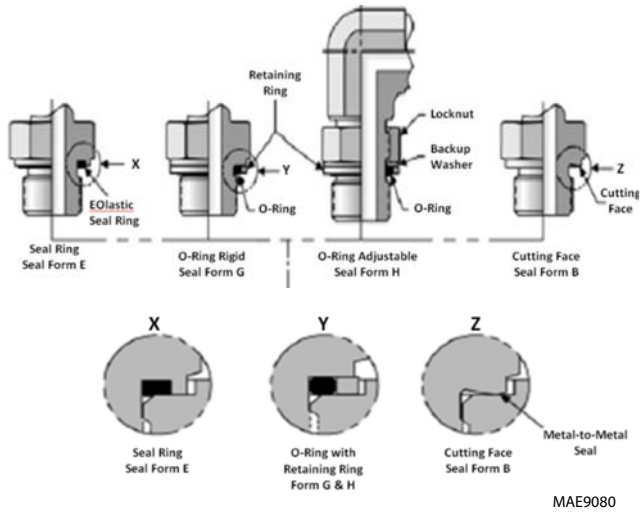
MPP *- Metric pipe parallel o-ring boss per SAE J2244, ISO 6149, DIN 3852*



MAE9070

MFF *- Metric flat face port per ISO 9974-1*

BSPP *- British standard parallel pipe per ISO 1179-1, DIN 3852-2*

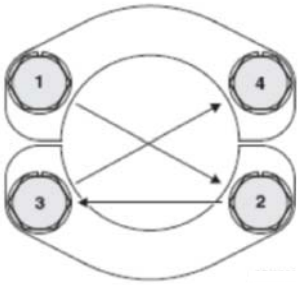


MAE9080

d. Flange Connection Types

FL61 *- Code 61 flange per SAE J518, ISO 6162*

FL62 *- Code 62 flange per SAE J518, ISO 6162*



MAE9090

e. Tightening Methods

Torque - Application of a twisting force to the applicable connection by use of a precise measurement instrument (i.e. torque wrench).

Finger Tight (Hand Tight) - The point where the connector will no longer thread onto the mating part when tightened by hand or fingers. Finger Tight is relative to user strength and will have some variance. The average torque applied by this method is 4 Nm (3 ft-lbs).

TFFT - Turns From Finger Tight; Application of a preload to a connection by first tightening the connection by hand (fingers) and applying an additional rotation counted by a defined number of turns by use of a tool.

FFWR (Flat method) - Flats From Wrench Resistance; Application of a preload to a connection by tightening to the point of initial wrench resistance and turning the nut a described number of flats. A flat is one side of the hexagonal tube nut and equates to 1/6 of a turn.

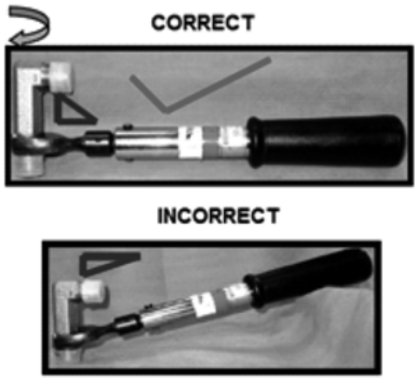
f. Assembly and Torque Specifications

Prior to selecting the appropriate torque from the tables within this section, it is necessary to properly identify the connector being installed.

g. General Tube Type Fitting Assembly Instructions

1. Take precautions to ensure that fittings and mating components are not damaged during storage, handling or assembly. Nicks and scratches in sealing surfaces can create a path for leaks which could lead to component contamination and/or failure.
2. When making a connection to tubing, compression or flare, inspect the tube in the area of the fitting attachment to ensure that the tube has not been damaged.

3. The assembly process is one of the leading causes for contamination in air and hydraulic systems. Contamination can prevent proper tightening of fittings and adapters from occurring.
   a. Avoid using dirty or oily rags when handling fittings.
   b. If fittings are disassembled, they should be cleaned and inspected for damage. Replace fittings as necessary before reinstalling.
   c. Sealing compounds should be applied where specified; however, care should be taken not to introduce sealant into the system.
   d. Avoid applying sealant to the area of the threads where the sealant will be forced into the system. This is generally the first two threads of a fitting.
   e. Sealant should only be applied to the male threads.
   f. Straight thread fittings do not require sealants. O-rings or washers are provided for sealing.
   g. When replacing or installing an o-ring, care is to be taken while transferring the o-ring over the threads as it may become nicked or torn. When replacing an o-ring on a fitting, the use of a thread protector is recommended.
   h. When installing fittings with o-rings, lubrication shall be used to prevent scuffing or tearing of the o-ring. Refer to Section 2.8.17, "O-ring Installation (Replacement)", for procedure.
4. Take care to identify the material of parts to apply the correct torque values.
   a. Verify the material designation in the table headings
   b. If specifications are given only for steel fittings and components, the values for alternate materials shall be as follows:
   Aluminum and Brass - reduce steel values by 35%
   Stainless Steel - Use the upper limit for steel.
5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.



MAE9100

6. Refer to the appropriate section in this manual for more specific instructions and procedures for each type of fitting connection.

2.8.2 Assembly Instructions for American Standard Pipe Thread Tapered Connections

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as Loctite 567, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female

NOTICE

Over tightening may cause deformation of the pipe fitting and damage to the joining fitting, flange or component may occur.

NOTICE

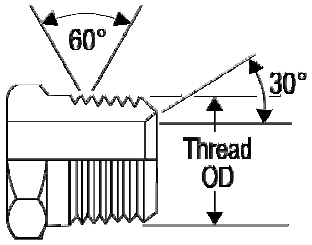
Never back off (loosen) pipe threaded connectors to achieve alignment. Meet the minimum required turns and use the last turn for alignment.

5. Rotate male fitting the number of turns as per below mentioned table. Refer to Section 2.8.15, "FFWR and TFFT Methods", for procedure.

Note: *TFFT values provided in below mentioned table are applicable for the following material configurations:*

   a. Steel fittings with steel mating components
   b. Steel fittings with aluminum or brass mating components
   c. Aluminum or brass fittings with steel mating components
   d. Aluminum or brass fittings with aluminum or brass mating components.

a. NPTF Pipe Thread



ØA dimension is measured on the 4th pitch of the thread

MAE9110

TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size	ØA*		
		(UNF)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8 - 27	0.40	10.24	2 to 3
	4	1/4 - 18	0.54	13.61	2 to 3
	6	3/8 - 18	0.67	17.05	2 to 3
	8	1/2 - 14	0.84	21.22	2 to 3
	12	3/4 - 14	1.05	26.56	2 to 3
	16	1 - 11 1/2	1.31	33.22	1.5 to 2.5
	20	1 1/4 - 11 1/2	1.65	41.98	1.5 to 2.5
	24	1 1/2 - 11 1/2	1.89	48.05	1.5 to 2.5
	32	2 - 11 1/2	2.37	60.09	1.5 to 2.5

NOTE:

* ØA thread dimension for reference only.

** Refer to Section 2.8.15, "FFWR and TFFT Methods", for TFFT procedure requirements.

2.8.3 Assembly Instructions for British Standard Pipe Thread Tapered Connections

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as Loctite 567, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

NOTICE

Over tightening may cause deformation of the pipe fitting and damage to the joining fitting, flange or component may occur.

NOTICE

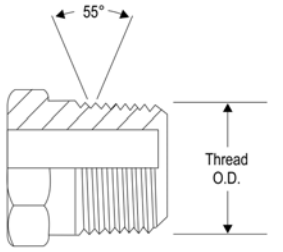
Never back off (loosen) pipe threaded connectors to achieve alignment. Meet the minimum required turns and use the last turn for alignment.

5. Rotate male fitting the number of turns as per below mention table.

Note: *TFFT values provided in below table are applicable for the following material configurations:*

a. Steel fittings with steel mating components
b. Steel fittings with aluminum or brass mating components
c. Aluminum or brass fittings with steel mating components
d. Aluminum or brass fittings with aluminum or brass mating components.

a. BSPT Pipe Thread



MAE9120

TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size	ØA*		
		(BSPT)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8 - 28	0.38	9.73	2 to 3
	4	1/4 - 19	0.52	13.16	2 to 3
	6	3/8 - 19	0.66	16.66	2 to 3
	8	1/2 - 14	0.83	20.96	2 to 3
	12	3/4 - 14	1.04	26.44	2 to 3
	16	1 - 11	1.31	33.25	1.5 to 2.5
	20	1 1/4 - 11	1.65	41.91	1.5 to 2.5
	24	1 1/2 - 11	1.88	47.80	1.5 to 2.5
	32	2 - 11	2.35	59.61	1.5 to 2.5

NOTE:

* ØA thread dimension for reference only.

** Refer to Section 2.8.15, "FFWR and TFFT Methods", for TFFT procedure requirements.

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2.8.4 Assembly Instructions for 37° (JIC) Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure that surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary, replace fitting or adapter.

NOTICE

Do Not force a misaligned or short hose/tube into alignment. It puts undesirable strain onto the joint eventually leading to leakage.

2. Align tube to fitting and start threads by hand.

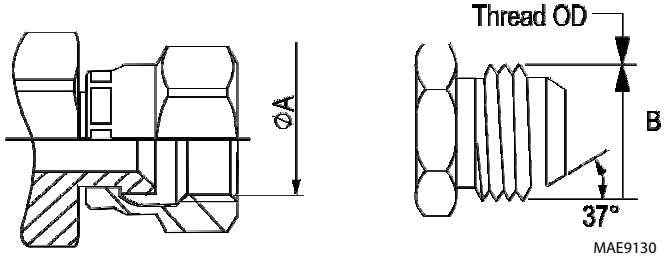
NOTICE

The torque method should NOT be used on lubricated or oily fittings. No lubrication or sealant is required. The lubrication would cause increased clamping force and cause fitting damage.

3. Torque assembly to value listed in below mentioned table while using the Double Wrench Method.

Note: *Torque values provided in below table are segregated based on the material configuration of the connection.*

a. 37° Flare (JIC) Thread - Steel



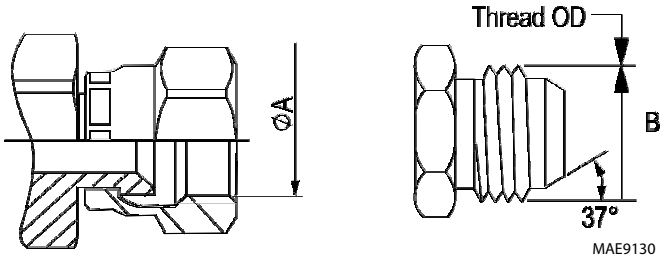
TYPE/FITTING IDENTIFICATION													Flats From Wrench Resistance (F.F.W.R)**
Material	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[Nm]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	7	8	9	10	--
	3	3/8-24	0.34	8.60	0.37	9.50	8	9	10	11	12	14	--
	4	7/16-20	0.39	10.00	0.44	11.10	13	14	14	18	19	19	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	14	15	15	19	20	21	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	22	23	24	30	31	33	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	42	44	46	57	60	63	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	60	63	66	81	85	89	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	84	88	92	114	120	125	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	100	105	110	136	142	149	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	118	124	130	160	168	176	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	168	176	185	228	239	251	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	195	205	215	264	278	291	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	265	278	292	359	377	395	3/4 to 1

NOTE:

* ØA and ØB thread dimensions for reference only.

** Refer to Section 2.8.15, "FFWR and TFFT Methods", for FFWR procedure requirements.

b. 37° Flare (JIC) Thread - Aluminum Brass



TYPE/FITTING IDENTIFICATION													Flats From Wrench Resistance (F.F.W.R)**
Material	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[Nm]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	4	4	5	5	6	7	--
	3	3/8-24	0.34	8.60	0.37	9.50	5	6	7	7	8	9	--
	4	7/16-20	0.39	10.00	0.44	11.10	8	9	9	11	12	13	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	9	10	10	12	13	14	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	14	15	16	19	20	21	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	27	29	30	37	39	41	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	39	41	43	53	56	58	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	55	57	60	74	78	81	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	65	68	72	88	93	97	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	77	81	84	104	109	114	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	172	181	189	234	245	257	3/4 to 1

NOTE:

* ØA and ØB thread dimensions for reference only.

** Refer to Section 2.8.15, "FFWR and TFFT Methods", for FFWR procedure requirements.

2.8.5 Assembly Instructions for 45° SAE Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure that surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary, replace fitting or adapter.

NOTICE

Do Not force a misaligned or short hose/tube into alignment. It puts undesirable strain onto the joint eventually leading to leakage.

2. Align tube to fitting.
3. Tighten fitting by hand until hand tight.

NOTICE

The torque method should NOT be used on lubricated or oily fittings. No lubrication or sealant is required. The lubrication would cause increased clamping force and cause fitting damage.

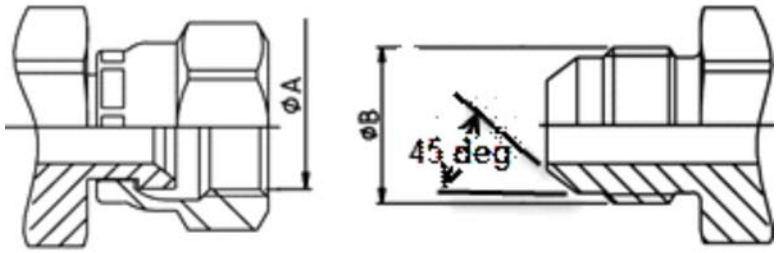
Torque fitting to value listed in below table while using the Double Wrench Method outlined in this section.

Note: *Torque values provided in below table are segregated based on the material configuration of the connection.*

'Aluminum/brass fittings or aluminum/brass mating components' indicate either the following material configurations:

a. Steel fittings with aluminum or brass mating components
b. Aluminum or brass fittings with steel mating components
c. Aluminum or brass fittings with aluminum or brass mating components.

a. 45° Flare (SAE)



MAE9140

STEEL

TYPE/FITTING IDENTIFICATION							TORQUE					
Material	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89
	12	1 1/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125

NOTE: * ØA and ØB thread dimensions for reference only.

ALUMINUM BRASS

TYPE/FITTING IDENTIFICATION							TORQUE					
Material	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	8	9	9	11	12	12
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58
	12	1 1/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83

NOTE: * ØA and ØB thread dimensions for reference only.

2.8.6 Assembly Instructions for O-Ring Face Seal (ORFS) Fittings

1. Ensure proper o-ring is installed. If o-ring is missing install per o-ring Installation (replacement). Refer to Section 2.8.17, "O-ring Installation (Replacement)", for procedure.
2. Ensure that surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary, replace fitting or adapter.

NOTICE

Care to be taken when lubricating o-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

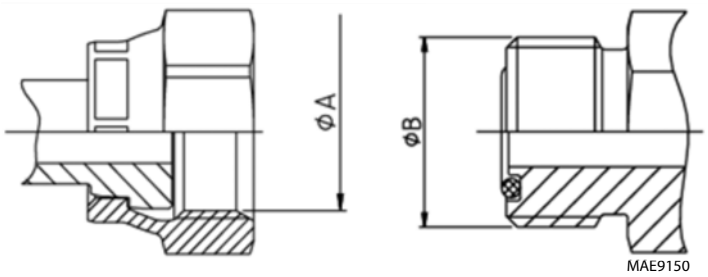
3. Pre-lubricate the o-ring with hydraulic oil.
4. Place the tube assembly against the fitting body so that the flat face comes in contact with the o-ring. Hand thread the nut onto the fitting body.
5. Torque nut to value listed in below mentioned table while using the Double Wrench Method. Refer to Section 2.8.15, "FFWR and TFFT Methods", for procedure if using the FFWR method.

Note: *Torque values provided in below table are segregated based on the material configuration of the connection.*

Aluminum/brass fittings or aluminum/brass mating components' indicate either the following material configurations:

a. Steel fittings with aluminum or brass mating components
b. Aluminum or brass fittings with steel mating components
c. Aluminum or brass fittings with aluminum or brass mating components.

a. O-ring Face Seal (ORFS)



STEEL

TYPE/FITTING IDENTIFICATION							TORQUE							
Material	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[Nm]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	18	19	20	25	26	27	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	30	32	33	40	43	45	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	40	42	44	55	57	60	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	60	63	66	81	85	89	1/4 to 1/2	1/2 to 3/4
	12	1 3/16-12	1.11	28.20	1.19	30.10	85	90	94	115	122	127	1/4 to 1/2	1/2 to 3/4
	16	1 7/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4

NOTE: * ØA and ØB thread dimensions for reference only.

ALUMINUM/BRASS

TYPE/FITTING IDENTIFICATION							TORQUE						FLATS FROM WRENCH RESISTANCE (F.F.W.R)**	
Material	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[Nm]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENT; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	26	28	29	35	38	39	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	39	41	43	53	56	58	1/4 to 1/2	1/2 to 3/4
	12	1 3/16-12	1.11	28.20	1.19	30.10	55	58	61	75	79	83	1/4 to 1/2	1/2 to 3/4
	16	1 7/16-12	1.34	34.15	1.44	36.50	72	76	79	98	103	107	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4

NOTE: * ØA and ØB thread dimensions for reference only.

** Refer to Section 2.8.15, "FFWR and TFFT Methods", for FFWR procedure requirements.

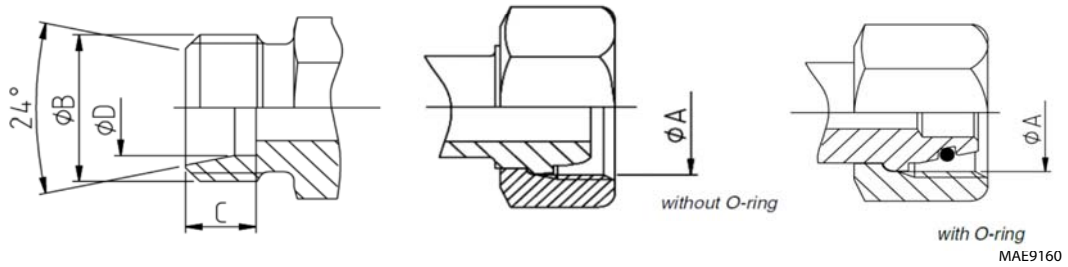
2.8.7 Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

NOTICE

A non-square tube end can cause improperly seated fittings and leakage.

6. Inspect the components to ensure free of contamination, external damage, rust, splits, dirt, foreign matter, or burrs. Ensure tube end is visibly square. If necessary, replace fitting or tube.
7. Lubricate thread and cone of fitting body or hardened pre-assembly tool, as well as the progressive ring and nut threads.
8. Slip nut and progressive ring over tube, assuring that they are in the proper orientation.
9. Push the tube end into the coupling body.
10. Slide collet into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed while using the Double Wrench Method. The tube must not turn with the nut.

a. DIN 24° CONE (MBTL & MBTS)



TYPE/FITTING IDENTIFICATION							DIN 24° CONE FLARELESS BITE FITTING (WITH OR WITHOUT O-RING)							
Material	Type	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [Nm] Min	Torque [Nm] Nom	Torque [Nm] Max	Flats From Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12 x 1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristic of the connection. Consult Engineering on the generation of torque values for the particular application.						1.5 to 1.75
		8	M14 x 1.5	12.50	14.00	7.00	8.20							1.5 to 1.75
		10	M16 x 1.5	14.50	16.00	7.00	10.20							1.5 to 1.75
		12	M18 x 1.5	16.50	18.00	7.00	12.20							1.5 to 1.75
		15	M22 x 1.5	20.50	22.00	7.00	15.20							1.5 to 1.75
		18	M26 x 1.5	24.50	26.00	7.50	18.20							1.5 to 1.75
		22	M30 x 2	27.90	30.00	7.50	22.20							1.5 to 1.75
		28	M36 x 2	33.90	36.00	7.50	28.20							1.5 to 1.75
		35	M45 x 2	42.90	45.00	10.50	35.30							1.5 to 1.75
		42	M52 x 2	49.90	52.00	11.00	42.30							1.5 to 1.75
	Type	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [Nm] Min	Torque [Nm] Nom	Torque [Nm] Max	Flats From Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14 x 1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Consult Engineering on the generation of torque values for the particular application.						1.5 to 1.75
		8	M16 x 1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
		10	M18 x 1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
		12	M20 x 1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
		14	M22 x 1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
		16	M24 x 1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
		20	M30 x 2	27.90	30.00	10.50	20.20							1.5 to 1.75
		25	M36 x 2	33.90	36.00	12.00	25.20							1.5 to 1.75
		30	M42 x 2	39.90	42.00	13.50	30.20							1.5 to 1.75
		38	M52 x 2	49.90	52.00	16.00	38.30							1.5 to 1.75

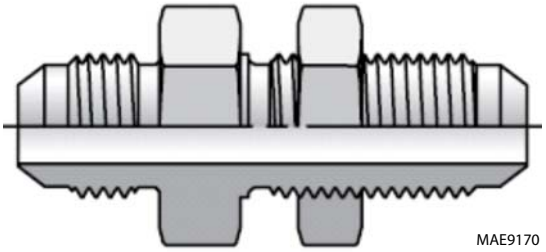
NOTE: * ØA, ØB,C, & ØD thread dimensions for reference only.

** Refer to Section 2.8.15, "FFWR and TFFT Methods", for FFWR procedure requirements.

2.8.8 Assembly Instructions for Bulkhead (BH) Fittings

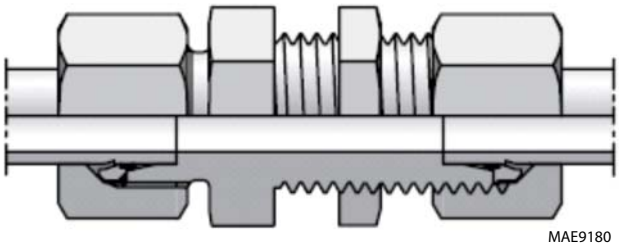
1. Ensure that threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary, replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand thread the locknut onto the bulkhead end of the fitting body.
5. Torque nut onto fitting while using the Double Wrench Method.

a. Bulkhead Fittings (BH) - INCH



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT FOR BULKHEAD CONNECTORS					
Material	Type	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[Nm]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23
		6	11/16-16	25	27	28	34	37	38
		8	13/16-16	55	58	61	75	79	83
		10	1-14	85	90	94	115	122	127
		12	1 3/16-12	135	142	149	183	193	202
		14	1 5/16-12	170	179	187	230	243	254
		16	1 7/16-12	200	210	220	271	285	298
		20	1 11/16-12	245	258	270	332	350	366
		24	2-12	270	284	297	366	385	403
	Type	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[Nm]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
	37° FLARE (JLIC) BULKHEAD FITTING	3	3/8-24	8	9	9	11	12	12
		4	7/16-20	13	14	14	18	19	19
		5	1/2-20	20	21	22	27	28	30
		6	9/16-18	25	27	28	34	37	38
		8	3/4-16	50	53	55	68	72	75
		10	7/8-14	85	90	94	115	122	127
		12	1 1/16-12	135	142	149	183	193	202
		14	1 3/16-12	170	179	187	230	243	254
		16	1 5/16-12	200	210	220	271	285	298
		20	1 5/8-12	245	258	270	332	350	366
		24	1 7/8-12	270	284	297	366	385	403
		32	2 1/2-12	310	326	341	420	442	462

b. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT FOR BULKHEAD CONNECTORS					
Material	Type	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[Nm]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12 x 1.5	14	15	16	19	20	22
		8	M14 x 1.5	17	18	19	23	24	26
		10	M16 x 1.5	22	23	24	30	31	33
		12	M18 x 1.5	35	37	39	47	50	53
		15	M22 x 1.5	44	47	50	60	64	68
		18	M26 x 1.5	70	75	80	95	102	108
		22	M30 x 2	115	120	125	156	163	169
		28	M36 x 2	150	157	164	203	213	222
		35	M45 x 2	155	162	169	210	220	229
		42	M52 x 2	220	230	240	298	312	325
	Type	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[Nm]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	6	M14 x 1.5	17	15	16	23	20	22
		8	M16 x 1.5	22	18	19	30	24	26
		10	M18 x 1.5	35	23	24	47	31	33
		12	M20 x 1.5	40	35	37	54	47	50
		14	M22 x 1.5	44	47	50	60	64	68
		16	M24 x 1.5	70	75	80	95	102	108
		20	M30 x 2	115	120	125	156	163	169
		25	M36 x 2	150	157	164	203	213	222
		30	M42 x 2	155	162	169	210	220	229
		38	M52 x 2	220	230	240	298	312	325

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2.8.9 Assembly Instructions for O-Ring Boss (ORB) Fittings

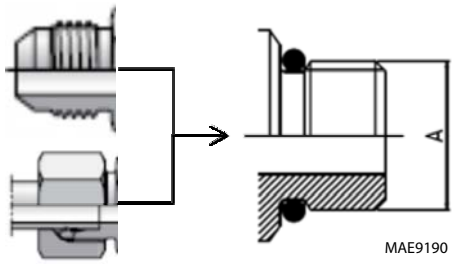
1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Ensure proper o-ring is installed. If o-ring is missing install per o-ring Installation (replacement). Refer to Section 2.8.17, "O-ring Installation (Replacement)", for procedure.

NOTICE

Care to be taken when lubricating o-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

3. Pre-lubricate the o-ring with hydraulic oil.
4. For non-adjustable and plugs, thread the fitting by hand until contact.
5. For adjustable fittings, refer to Section 2.8.16, "Adjustable Stud End Assembly", for proper assembly.
6. Torque the fitting or nut to value while using the Double Wrench Method.
   a. The table headings identify the straight thread o-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread o-ring port.
   b. Torque values are segregated based on the material configuration of the connection. 'Aluminum/brass fittings or aluminum/brass mating components' indicate either the following material configurations:
      - Steel fittings with aluminum or brass mating components
      - Aluminum or brass fittings with steel mating components
      - Aluminum or brass fittings with aluminum or brass mating components.
7. Inspect to ensure the o-ring is not pinched and the washer is seated flat on the counter bore of the port.

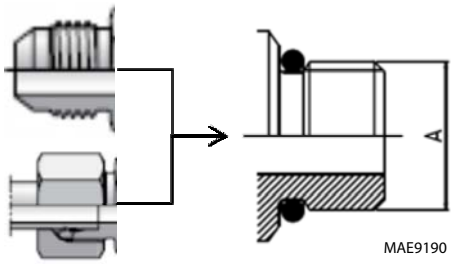
a. O-ring Boss (ORB) - Table 1 of 6



TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END					
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

NOTE: 1. * ØA thread OD dimension for reference only.
2. Removal torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

b. O-ring Boss (ORB) - Table 2 of 6

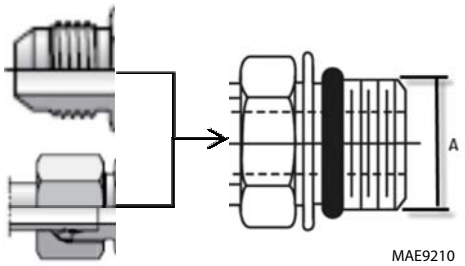


TYPE/FITTING IDENTIFICATION					STUD ENDS WITH (ORFS) OR S ERIES DIN (MBTS) OPPOSITE END					
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

NOTE: 1. * ØA thread OD dimension for reference only.

2. Removal torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

c. O-ring Boss (ORB) - Table 3 of 6

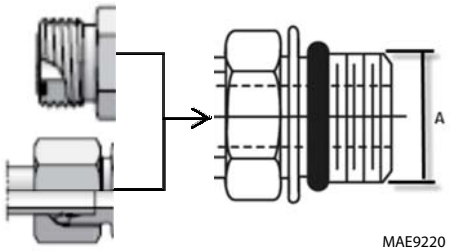


TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END					
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

NOTE: 1. * ØA thread OD dimension for reference only.

2. Removal torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

d. O-ring Boss (ORB) - Table 4 of 6



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END					
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

NOTE:
1. * ØA thread OD dimension for reference only.
2. Removal torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

e. O-ring Boss (ORB) - Table 5 of 6

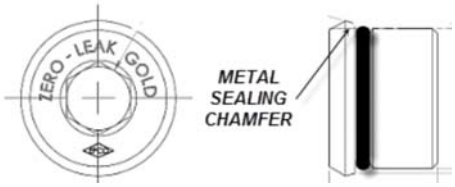
MAE9230

TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

NOTE: 1. * ØA thread OD dimension for reference only.

2. Removal torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

f. O-ring Boss (ORB) - Table 6 of 6



MAE9240

TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on Caterpillar applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						
Material	Dash Size	Thread Size	ØA*		Torque					
					[Ft-Lb]			[Nm]		
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	1 3/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on Caterpillar applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						

NOTE: 1. * ØA thread OD dimension for reference only.

2. Removal torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

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2.8.10 Assembly Instructions for Adjustable Port End Metric Fittings

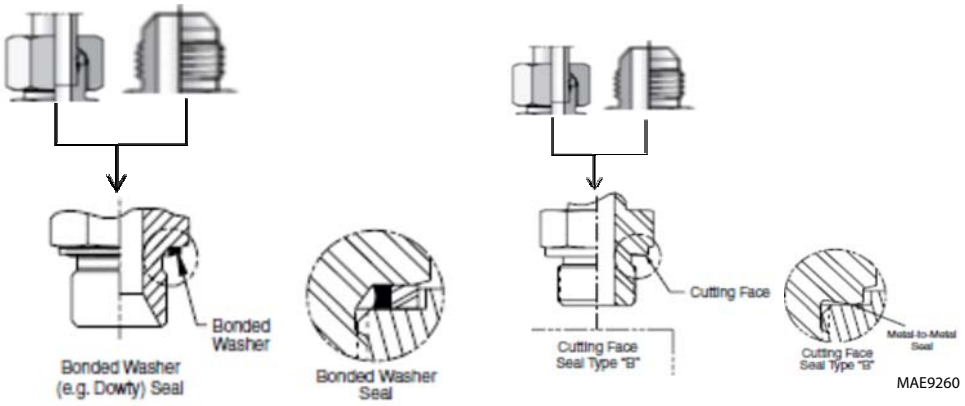
1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If o-ring is not pre-installed, install proper size, taking care not to damage it. Refer to Section 2.8.17, "O-ring Installation (Replacement)", for procedure.

NOTICE

Care to be taken when lubricating o-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

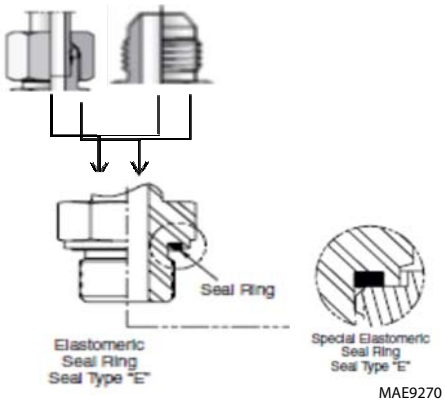
3. Pre-lubricate the o-ring with hydraulic oil.
4. For non-adjustable fittings and plugs, thread the fitting by hand until contact.
5. For adjustable fittings, refer to Section 2.8.16, "Adjustable Stud End Assembly", for proper assembly.
6. Torque the fitting or nut to value while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values are segregated based on the material configuration of the connection. 'Aluminum/brass fittings or aluminum/brass mating components' indicate either the following material configurations:
      - Steel fittings with aluminum or brass mating components
      - Aluminum or brass fittings with steel mating components
      - Aluminum or brass fittings with aluminum or brass mating components.
7. Inspect to ensure the o-ring is not pinched and the washer is seated flat on the counter bore of the port.

a. Metric Flat Face Port (MFF) L Series - Table 1 of 3



TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS WITH 37° (JIC) or L SERIES DIN (MBTL) OPPOSITE END						FORM B (CUTTING FACE) STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END					
Material	Thread M Size	Connecting Tube O.D	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694
Material	Thread M Size	Connecting Tube O.D	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

b. Metric Flat Face Port (MFF) L Series - Table 2 of 3



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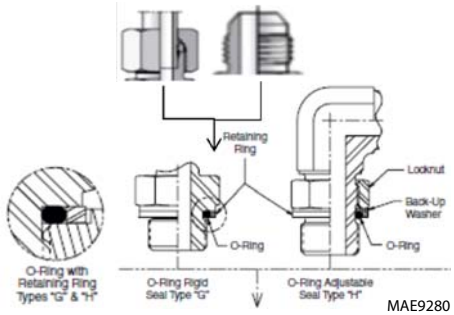
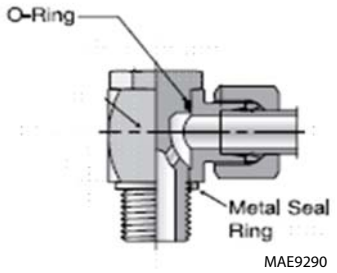


MAE9280

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END						FORM B (CUTTING FACE) STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END					
Material	Thread M Size	Connecting Tube O.D	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
Material	Thread M Size	Connecting Tube O.D	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(UNF)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

c. Metric Flat Face Port (MFF) L Series - Table 3 of 3



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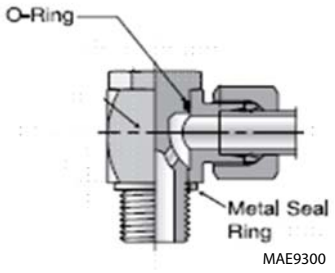
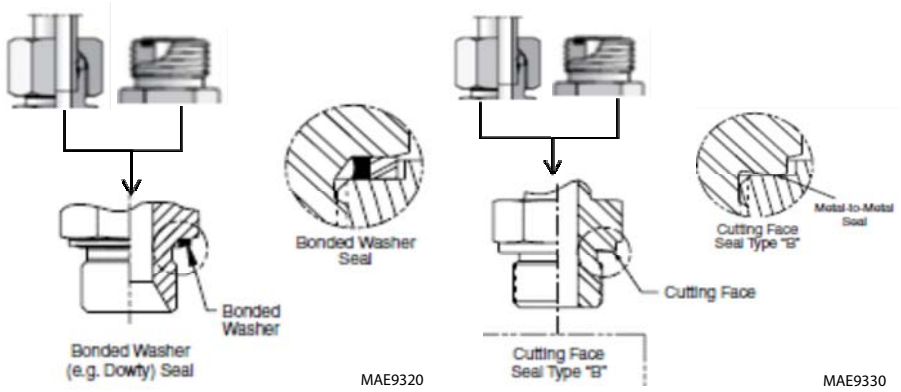


MAE9300

MAE9310

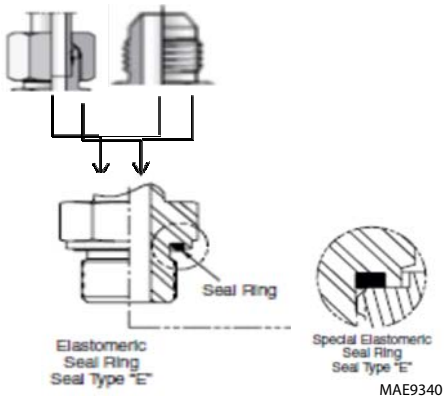
TYPE/FITTING IDENTIFICATION			BANJO FITTINGS WITH L SERIES DIN (MBTL) OPPOSITE END						HIGH PRESSURE BANJO FITTINGS WITH L SERIES DIN (MBTL) OPPOSITE END						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
Material	Thread M Size	Connecting Tube O.D	Torque						Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	166	175	183	225	237	248
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	266	280	293	360	380	397
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	266	280	293	360	380	397
Material	Thread M Size	Connecting Tube O.D	Torque						Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	108	114	119	146	155	161
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	173	182	190	235	247	258
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	173	182	190	235	247	258

d. Metric Flat Face Port (MFF) S Series - Table 1 of 3



TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END						FORM B (CUTTING FACE) STUD ENDS WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END					
Material	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297
	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770
Material	Thread M Size	Connecting Tube O.D	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

e. Metric Flat Face Port (MFF) S Series - Table 2 of 3



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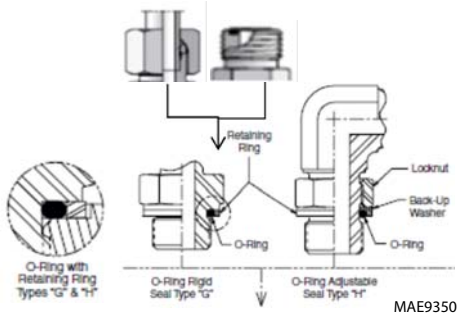
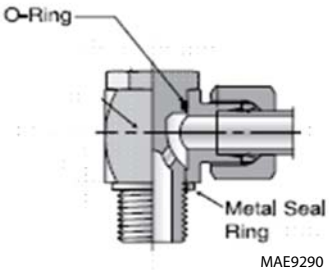


MAE9350

TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END						FORM B (CUTTING FACE) STUD ENDS WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END					
Material	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137
	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
Material	Thread M Size	Connecting Tube O.D	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

f. Metric Flat Face Port (MFF) S Series - Table 3 of 3



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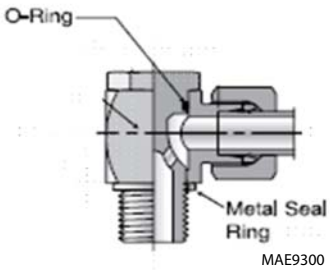

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MAE9310

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS WITH S SERIES DIN (MBTS) OPPOSITE END						HIGH PRESSURE BANJO FITTINGS WITH S SERIES DIN (MBTS) OPPOSITE END						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
Material	Thread M Size	Connecting Tube O.D	Torque						Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	--	--	--	--	--	--
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	--	--	--	--	--	--
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	--	--	--	--	--	--
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	--	--	--	--	--	--
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	--	--	--	--	--	--
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	--	--	--	--	--	--
Material	Thread M Size	Connecting Tube O.D	Torque						Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	--	--	--	--	--	--
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	--	--	--	--	--	--
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	--	--	--	--	--	--
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	--	--	--	--	--	--
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	--	--	--	--	--	--
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	--	--	--	--	--	--

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2.8.11 Assembly Instructions for Metric ISO 6149 Port Assembly Stud Ends

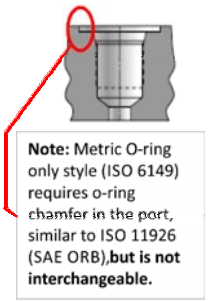
1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If o-ring is not pre installed, install proper size, taking care not to damage it. Refer to Section 2.8.17, "O-ring Installation (Replacement)".

NOTICE

Care to be taken when lubricating o-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

3. Pre-lubricate the o-ring with hydraulic oil.
4. For non-adjustable fittings and plugs, thread the fitting by hand until contact.
5. For adjustable fittings, refer to Section 2.8.16, "Adjustable Stud End Assembly", for proper assembly.
6. Torque the fitting or nut to value while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values are segregated based on the material configuration of the connection. 'Aluminum/brass fittings or aluminum/brass mating components' indicate either the following material configurations:
      - Steel fittings with aluminum or brass mating components
      - Aluminum or brass fittings with steel mating components
      - Aluminum or brass fittings with aluminum or brass mating components.
7. Inspect to ensure the o-ring is not pinched and the washer is seated flat on the counter bore of the port.

a. Metric Pipe Parallel O-Ring Boss (MPP)



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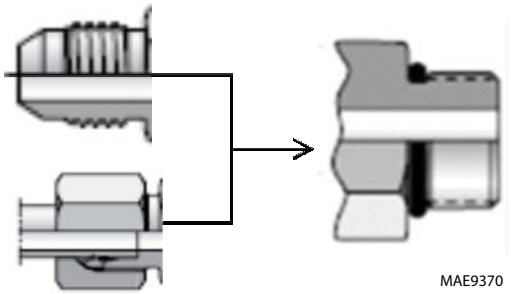
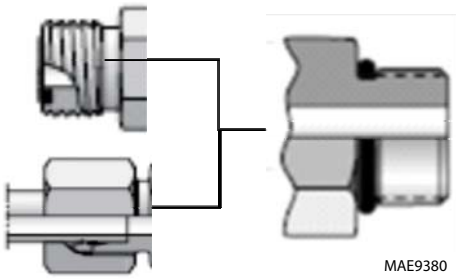

MAE9370


MAE9380

TYPE/FITTING IDENTIFICATION			STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END						STUD ENDS WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END					
Material	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10x1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12x1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18x1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20x1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22x1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27x2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30x2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33x2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38x2	--	135	142	149	183	193	202	235	247	259	319	335	351
	M42x2	30	155	163	171	210	221	232	245	258	270	330	350	366
	M48x2	38	190	200	209	260	271	283	310	326	341	420	442	462
	M60x2	50	230	242	253	315	328	343	370	389	407	500	527	552
Material	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10x1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12x1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18x1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20x1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22x1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27x2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30x2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33x2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38x2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42x2	30	101	106	111	137	144	150	159	168	176	216	228	239
	M48x2	38	124	130	136	168	176	184	202	212	222	274	287	301
	M60x2	50	150	157	164	203	213	222	241	253	265	327	343	359

2.8.12 Assembly Instructions for Adjustable Port End (BSPP) Fittings

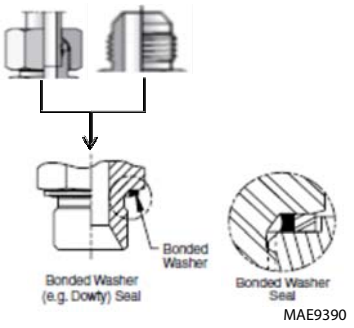
1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If o-ring is not pre installed, install proper size, taking care not to damage it. Refer to Section 2.8.17, "O-ring Installation (Replacement)", for instructions.

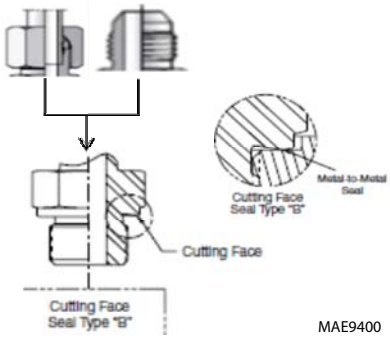
NOTICE

Care to be taken when lubricating o-ring. Avoid adding oil to the threaded connection of the fitting. The lubrication would cause increased clamping force and cause fitting damage.

3. Pre-lubricate the o-ring with hydraulic oil.
4. For non-adjustable fittings and plugs, thread the fitting by hand until contact.
5. For adjustable fittings, refer to Section 2.8.16, "Adjustable Stud End Assembly", for proper assembly.
6. Torque the fitting or nut to value while using the Double Wrench Method.
   a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.
   b. Torque values are segregated based on the material configuration of the connection. 'Aluminum/brass fittings or aluminum/brass mating components' indicate either the following material configurations:
      - Steel fittings with aluminum or brass mating components
      - Aluminum or brass fittings with steel mating components
      - Aluminum or brass fittings with aluminum or brass mating components.
7. Inspect to ensure the o-ring is not pinched and the washer is seated flat on the counter bore of the port.

a. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3

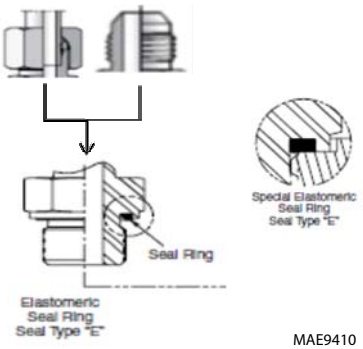




TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS WITH 37° (JIC) or L SERIES DIN (MBTL) OPPOSITE END						FORM B** (CUTTING FACE) STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END					
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G 1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G 1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G 3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G 1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G 1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G 1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G 1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G 3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G 1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G 1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386

NOTE: ** Non typical for Straight Male Stud Fittings, reference only.

b. British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3



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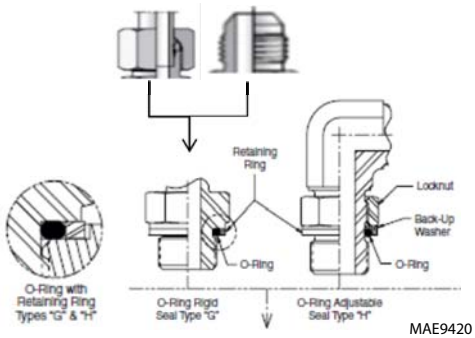
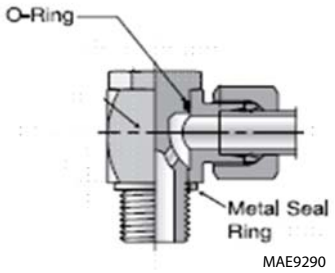


MAE9420

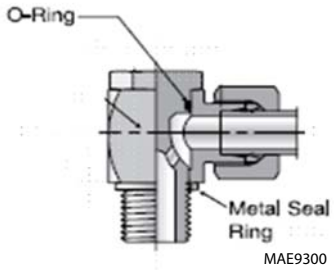
TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END						FORM B** (CUTTING FACE) STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END					
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	52	55	57	70	75	77	52	55	57	70	75	77
	G 1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99
	G 1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99
	G 3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	28	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	42	398	418	438	540	567	594	398	418	438	540	567	594
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	34	36	37	46	49	50	34	36	37	46	49	50
	G 1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64
	G 1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64
	G 3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	28	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321

NOTE: ** Non typical for Straight Male Stud Fittings, reference only.

c. British Standard Parallel Pipe Port (BSPP) L Series - Table 3 of 3



MAE9290

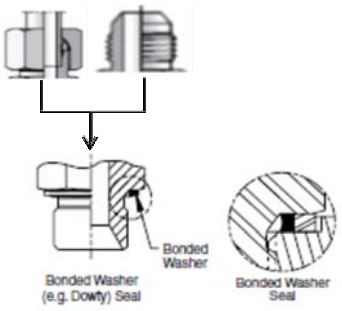


MAE9300

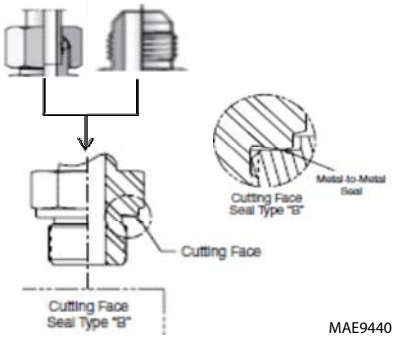
MAE9310

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS WITH S SERIES DIN (MBTS) OPPOSITE END						HIGH PRESSURE BANJO FITTINGS WITH S SERIES DIN (MBTS) OPPOSITE END						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
Material	BSPP Thread G Size	Connecting Tube O.D	Torque						Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G 1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65
	G 1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G 1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G 3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153
	G 1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221
	G 1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450
	G 1-1/2A	42	--	--	--	--	--	--	516	542	568	700	735	770	332	349	365	450	473	495
Material	BSPP Thread G Size	Connecting Tube O.D	Torque						Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	G 1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G 1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42
	G 1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G 1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G 3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99
	G 1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144
	G 1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321
	G 1-1/2A	42	--	--	--	--	--	--	335	352	369	454	477	500	216	227	237	293	308	321

d. British Standard Parallel Pipe Port (BSPP) S Series - Table 1 of 3



MAE9430

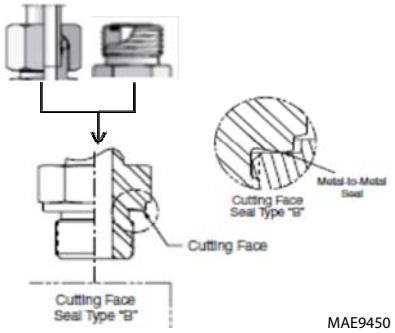


MAE9440

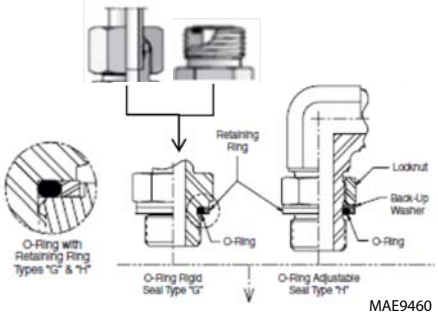
TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END						FORM B** (CUTTING FACE) STUD ENDS WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END					
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	26	28	29	35	38	39	41	43	45	55	58	61
	G 1/4A	8	26	28	29	35	38	39	41	43	45	55	58	61
	G 3/8A	10	33	35	36	45	47	49	66	70	73	90	95	99
	G 3/8A	12	33	35	36	45	47	49	66	70	73	90	95	99
	G 1/2A	14	48	51	53	65	69	72	111	117	122	150	159	165
	G 1/2A	16	48	51	53	65	69	72	96	101	106	130	137	144
	G 3/4A	20	66	70	73	90	95	99	199	209	219	270	283	297
	G 1A	25	111	117	122	150	159	165	251	264	276	340	358	374
	G 1-1/4A	30	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	38	214	225	235	290	305	319	516	542	568	700	735	770
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	17	18	19	23	24	26	27	28	29	37	38	39
	G 1/4A	8	17	18	19	23	24	26	27	28	29	37	38	39
	G 3/8A	10	21	22	23	28	30	31	43	45	47	58	61	64
	G 3/8A	12	21	22	23	28	30	31	43	45	47	58	61	64
	G 1/2A	14	31	33	34	42	45	46	72	76	79	98	103	107
	G 1/2A	16	31	33	34	42	45	46	62	66	69	84	89	94
	G 3/4A	20	43	45	47	58	61	64	129	136	142	175	184	193
	G 1A	25	72	76	79	98	103	107	163	171	179	221	232	243
	G 1-1/4A	30	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	38	139	146	153	188	198	207	335	352	369	454	477	500

NOTE: ** Non typical for Straight Male Stud Fittings, reference only.

e. British Standard Parallel Pipe Port (BSPP) S Series - Table 2 of 3



MAE9450

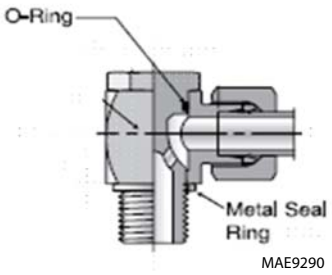


MAE9460

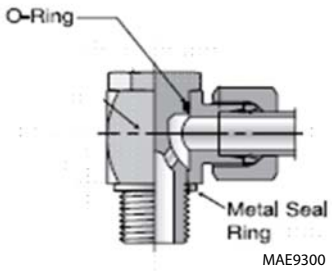
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS WITH (ORFS) or S SERIES DIN (MBTS) OPPOSITE END						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS WITH (ORFS) OR S SERIES DIN (MBTS) OPPOSITE END					
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G 1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G 3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G 3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G 1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G 1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G 3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G 1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G 3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G 3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G 1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G 1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G 3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386

NOTE: * Typical for Straight Male Stud Fittings
***Typical for Adjustable Fittings.

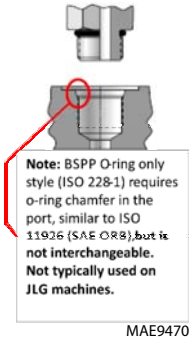
f. British Standard Parallel Pipe Port (BSPP) L Series - Table 3 of 3



MAE9290



MAE9300



MAE9470

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS WITH S SERIES DIN (MBTS) OPPOSITE END						HIGH PRESSURE BANJO FITTINGS WITH S SERIES DIN (MBTS) OPPOSITE END						JIS/BSPP O-RING ONLY					
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on Caterpillar applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G 3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G 1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G 1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G 3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G 1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G 1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G 1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
Material	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/ BRASS FITTINGS OR ALUMINUM/ BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on Caterpillar applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G 3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G 1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G 1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G 3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G 1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G 1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G 1-1/2A	38	--	--	--	--	--	--	335	352	368	454	477	499						

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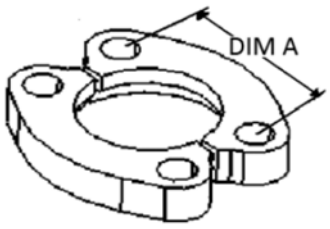
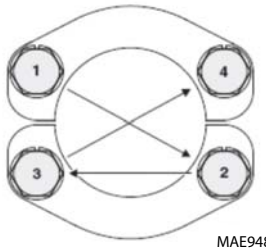
2.8.13 Assembly Instructions for Flange Connections (FL61 and FL62)

1. Ensure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter, or burrs.
2. Pre-lubricate the O-ring with hydraulic oil.
3. Position flange and clamp halves.
4. Place lock washers on bolt and bolt through clamp halves.
5. Tighten all bolts by hand.
6. Torque bolts in diagonal sequence in two or more increments to the torque listed.

a. Flange Code (FL61 & FL62) - Inch Fasteners



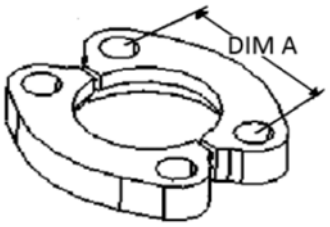


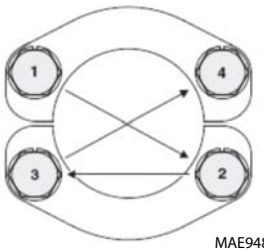
MAE9480

TYPE/FITTING IDENTIFICATION STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)																		
Type	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	5/16-18	18	19	19	24	25	26	24	25	26	32	34	35
	12	0.75	19	1.88	47.75	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	16	1.00	25	2.06	52.32	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	20	1.25	32	2.31	58.67	7/16-14	52	54	57	70	74	77	68	71	75	92	97	101
	24	1.50	38	2.75	69.85	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	32	2.00	51	3.06	77.72	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	40	2.50	64	3.50	88.90	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	48	3.00	76	4.19	106.43	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	56	3.50	89	4.75	120.65	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	64	4.00	102	5.13	130.30	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	80	5.00	127	6.00	152.40	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
Type	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	5/16-18	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	3/8-16	--	--	--	--	--	--	44	46	49	60	63	66
	16	1.00	25	2.25	57.15	7/16-14	--	--	--	--	--	--	68	71	75	92	97	101
	20	1.25	32	2.62	66.55	1/2-13	--	--	--	--	--	--	111	116	122	150	158	165
	20	1.25	32	2.62	66.55	--	--	--	--	--	--	--	--	--	--	--	--	--
	24	1.50	38	3.12	79.25	5/8-11	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	3/4-10	--	--	--	--	--	--	332	348	365	450	473	495

NOTE: * A dimension for reference only.

b. Flange Code (FL61 & FL62) - Metric Fasteners





MAE9480

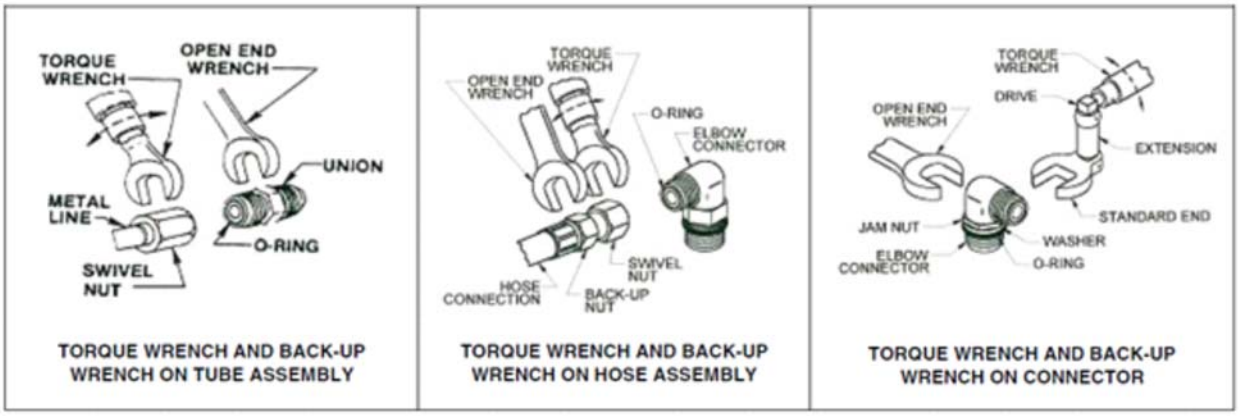
TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)												
Type	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10													
	12	0.75	19	1.88	47.75	M8 x 1.25	18	19	19	24	25	26	18	19	19	24	25	26
	16	1.00	25	2.06	52.32	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	32	2.00	51	3.06	77.72	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.43	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	56	3.50	89	4.75	120.65	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.30	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.40	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
Type	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[Nm]			[Ft-Lb]			[Nm]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	M8 x 1.25	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10 x 1.5	--	--	--	--	--	--	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12 x 1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12 x 1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14 x 2	--	--	--	--	--	--	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16 x 2	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20 x 2.5	--	--	--	--	--	--	406	426	446	550	578	605

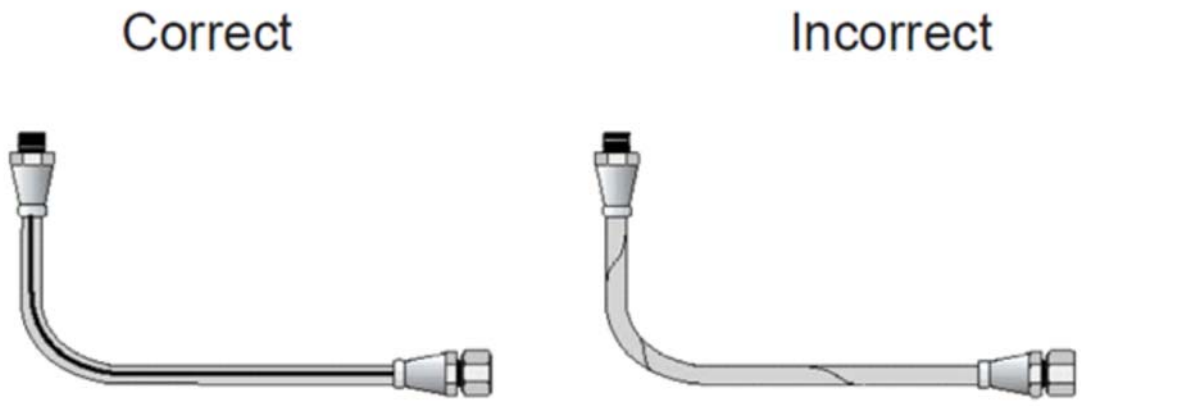
NOTE: * A dimension for reference only.

2.8.14 Double Wrench Method

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one back- up wrench. If two wrenches are not used, inadvertent component rotation may occur which absorbs torque and causes improper joint load and leads to leaks. For hose connections, the 'layline' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted.

Double Wrench Method to Prevent Hose Twist





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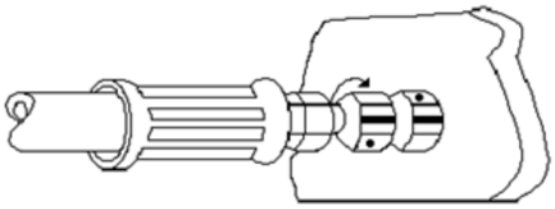
2.8.15 FFWR and TFFT Methods

1. FFWR (Flats from Wrench Resistance Method)
   a. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
   b. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
   c. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of hex flats.
   d. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

FFWR Method



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2. TFFT (Turns from Finger Tight Method)
   a. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
   b. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
   c. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns.
   d. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

2.8.16 Adjustable Stud End Assembly

For Adjustable Stud End Connections; the following assembly steps are to be performed:

a. Lubricate the o-ring with a light coat of hydraulic oil.
b. Position #1 – The o-ring should be located in the groove adjacent to the face of the back-up washer. The washer and o-ring should be positioned at the extreme top end of the groove as shown.
c. Position #2 – Position the locknut to just touch the back-up washer as shown. The locknut in this position will eliminate potential back up washer.

2.8.17 O-ring Installation (Replacement)

Care must be taken when installing o-rings over threads during replacement or installation. O-rings could become nicked or torn. A damaged o-ring could lead to leakage problems.

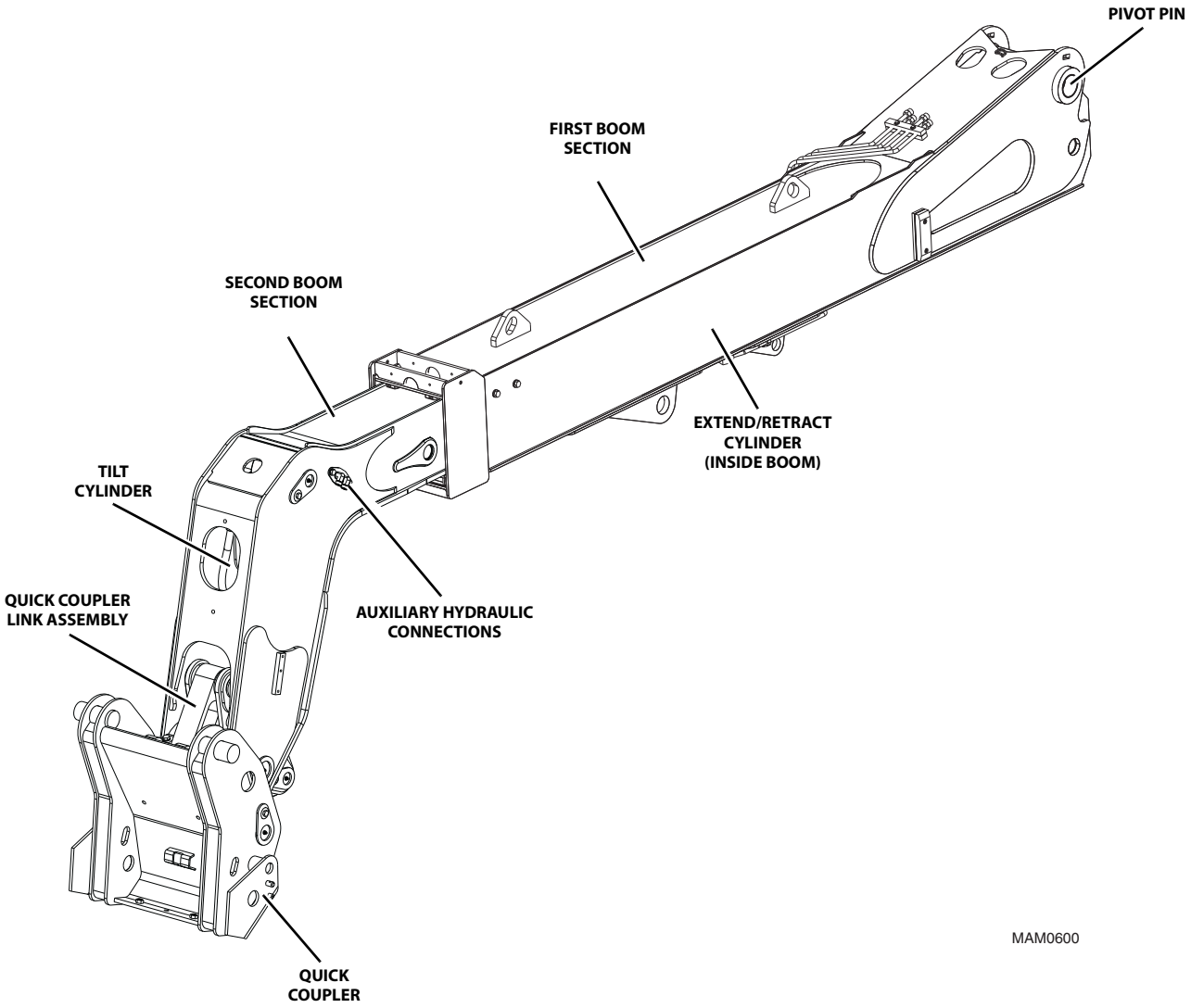
1. Inspect o-ring for tears or nicks. If any are found replace o-ring.
2. Ensure proper o-ring to be installed. Many o-rings look the same but are of different material, different hardness, or are slightly different diameters or widths.
3. Use a thread protector when replacing o-rings on fittings.
4. In ORB; ensure o-ring is properly seated in groove. On straight threads, ensure o-ring is seated all the way past the threads prior to installation.
5. Inspect o-ring for any visible nicks or tears. Replace if found.

Section 3
Boom

Contents

3.1 BOOM SYSTEM COMPONENT TERMINOLOGY - TH336C, TH337C, TH406C & TH407C

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the major assemblies of the boom system. The following illustration identifies the components that are referred to throughout this section.



3.2 BOOM SYSTEM - TWO SECTION

3.2.1 Boom System Operation

The boom operates via an interchange among the electrical, hydraulic and mechanical systems. Components involved include the joystick, tilt cylinder, extend/retract cylinder, lift/lower cylinder, compensating cylinder, various pivots, supporting hardware and other components.

3.3 BOOM ASSEMBLY MAINTENANCE

The boom assembly consists of the first and second section booms and supporting hardware.

Note: *Before removing the boom or boom section, the carriage or any other attachment must be removed from the quick coupler.*

Before beginning, conduct a visual inspection of the machine and work area, and review the task about to be undertaken. Read, understand and follow these instructions.

During service of the boom, perform the following:

1. Check wear pads. (Refer to Section 3.22.1, "Wear Pad Inspection").
2. Apply grease at all lubrication points (grease fittings). Refer to Section 2.5, "Lubrication Schedule".
3. Check for proper operation by operating all boom functions through their full ranges of motion several times.

Depending on your particular circumstance, the following procedures explain the removal/installation of individual boom sections or removal/installation of the complete boom.

⚠ WARNING

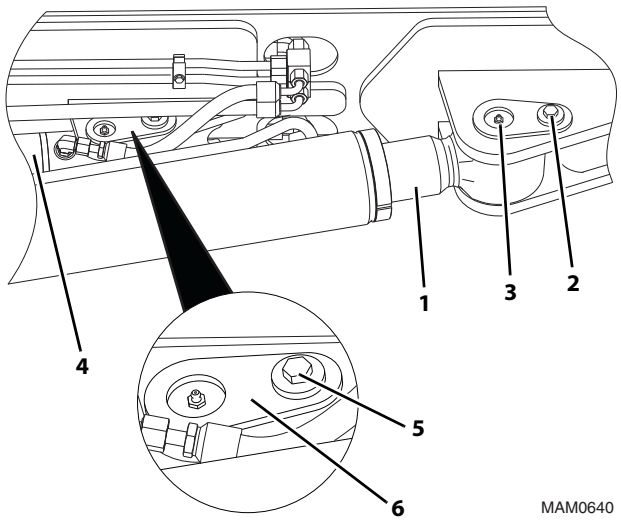
NEVER weld or drill the boom unless approved in writing by **Caterpillar**. The structural integrity of the boom will be impaired if subjected to any repair involving welding or drilling.

3.3.1 Complete Boom Removal

While the boom sections can be separated from each other on the machine, **i**t is much safer, more efficient and more cost- effective to remove the complete boom assembly from the machine and place it on suitable supports for separation. Work can then progress at a normal working height.

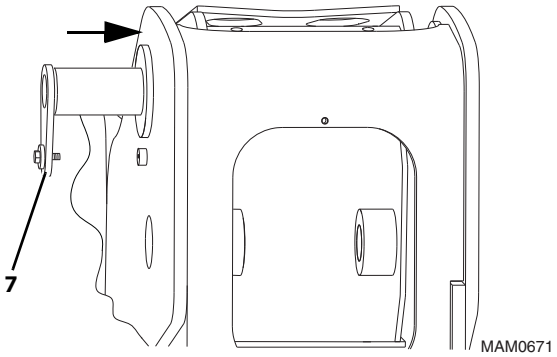
Note: *When removing a complete boom assembly use a hoist or crane with a minimum lift capacity of 2721 kg (6000 lbs).*

1. Remove any attachment from the quick coupler assembly. Refer to the Operation & Maintenance Manual.
2. Park the machine on a hard, level surface, fully retract the boom, raise the boom to allow access to the lift/lower cylinder and the compensation cylinder pivot pins, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Open the engine cover. Allow the system fluids to cool.
6. Remove the quick coupler assembly. Refer to Section 3.23.1, "Quick Coupler Removal (TH336C, TH337C, TH406C & TH407C)".
7. Remove boom angle sensor arm. Refer to Section 9.14.7, "Boom Angle Sensor".



8. Support the boom by placing a sling around the boom head. Support the lift/lower cylinder (**1**) and remove the lock bolt (**2**) and then the rod end pin (**3**). Lower the lift/lower cylinder onto the frame rails.
9. Support the compensating cylinder (**4**) and remove the lock bolt (**5**) and then the barrel end pin (**6**). Lower the compensation cylinder onto the lift/lower cylinder.

10. Label, disconnect and cap the tilt and auxiliary hydraulic hoses attached to the machine at the tubes on top of the boom. Plug and cap the hose ends to prevent dirt and debris from entering the hydraulic system.
11. Label, disconnect and cap the hoses on the extend/retract cylinder.
12. Lower the boom to a level position and place a suitable support under the rear of the boom. Reposition the slings to each end of the boom.



13. Remove the lock bolt and pivot pin (**7**) from rear of first boom section.
14. Lift the complete boom off machine and set on level ground or supports being careful not to damage the tubes on the bottom of the boom.

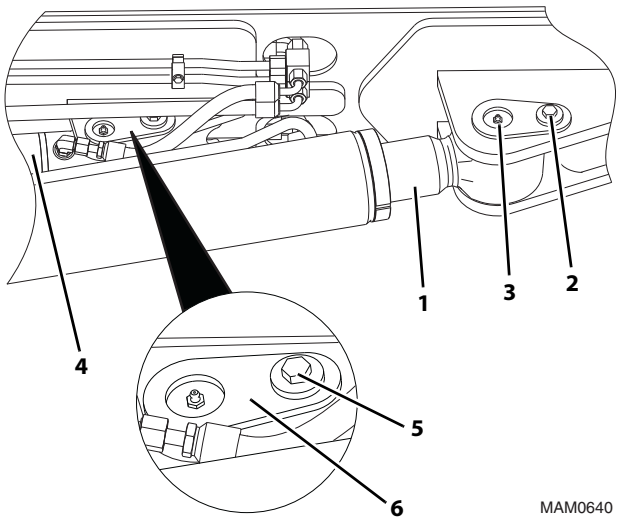
3.3.2 Complete Boom Installation

Note: *Lubrication of the boom wear surfaces with factory authorized grease is recommended to keep the boom wear surfaces lubricated properly. Lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.*

1. Park the machine on a hard, level surface, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.

Note: *Grease the boom pivot bore, compensating cylinder rod ends, lift/lower cylinder rod end and pins before installing.*

4. Using suitable slings, balance the boom assembly, lift and carefully guide the boom into place. Align the frame pivot bore with the boom assembly pivot bore. Install boom pivot pin and lock bolt (**7**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).



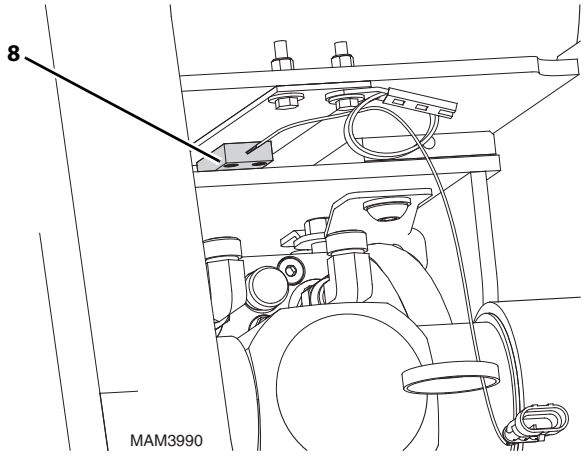
5. With the sling still in place, install the compensating cylinder (**4**), pin (**6**) and lock bolt (**5**). Apply Loctite® 242™and torque to 90 Nm (66 lb-ft).
6. With the sling still in place, install the rod end of the lift/lower cylinder (**1**), pin (**3**) and lock bolt (**2**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).

Note: *Raising the boom up or down with the sling may be necessary so the boom, compensating and lift/lower cylinder bores can be aligned for easier pin installation.*

7. Uncap and connect the previously labeled extend/retract cylinder hoses to the extend/retract cylinder. Refer to Section 2.8, “Hydraulic Connection Assembly and Torque Specification”, for proper hose torque.
8. Uncap and connect the previously labeled tilt hoses and (if equipped) auxiliary hoses to the appropriate cylinder. Refer to Section 2.8, “Hydraulic Connection Assembly and Torque Specification”, for proper hose torque.
9. Install the boom angle sensor arm. Refer to Section 9.14.7, “Boom Angle Sensor”.
10. Start the engine and operate all boom functions several times to bleed any air out of the hydraulic system. Check for fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
11. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.
12. Close and secure the engine cover.
13. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

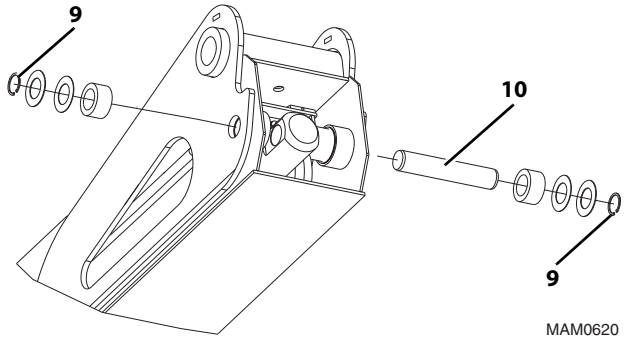
3.3.3 Second Section Boom Removal

1. Remove any attachment from the quick coupler assembly.
2. Be sure there is enough room in front of the machine to allow the boom sections to be removed. Park the machine on a hard, level surface, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Open the engine cover. Allow the system fluids to cool.
6. Remove the quick coupler assembly. Refer to Section 3.23.1, "Quick Coupler Removal (TH336C, TH337C, TH406C & TH407C)".
7. Label, disconnect and cap the tilt hoses and (if equipped) auxiliary hydraulic hoses attached to the machine at the boom head. Plug and cap the hose ends to prevent dirt and debris from entering the hydraulic system.
8. Place a sling around the tilt cylinder and remove the retaining rings and pin at the barrel end of the tilt cylinder. Remove tilt cylinder.



9. Disconnect and remove the boom retract sensor (**8**) from the rear of the first boom section.
10. Label, disconnect and cap the extend/retract hydraulic hoses on the extend/retract cylinder at the rear of the boom. Plug and cap the hose ends to prevent dirt and debris from entering the hydraulic system.
11. Remove the top and side wear pads from the rear of the second boom section.

Note: *Tag each pad, backing plate, shim and bolts from each location.*



12. Remove the retaining rings (**9**) from the rear of the extend/retract cylinder.
13. Remove the extend/retract cylinder mounting pin (**10**).

Note: *Tag each spacer and shim from each side of the extend/retract cylinder.*

14. Support the front of the boom by placing a sling behind the boom head. Pull the second boom section out of the first boom section approximately 15 - 20 cm (6 - 8 in).
15. Pull the tilt hoses and (if equipped) auxiliary hydraulic hoses through the rear of the boom.
16. Remove the top, side and bottom wear pads from the front of the first boom section.

Note: *Tag each pad, backing plate, shim and bolts from each location.*

17. Pull the second boom section halfway out of the first boom section, reposition the sling, balancing the second boom section and remove from the first boom section.
18. Set the second boom section on level ground. Set the complete boom on suitable stands to begin tear down.
19. Inspect the boom and welds. Consult the local Caterpillar dealer if structural damage is detected.
20. Inspect hoses, hardware, wear pads, mounting points and other components visible with the first boom section. Replace any item if damaged.
21. Inspect all wear pads for wear. (Refer to Section 3.22.1, "Wear Pad Inspection").

3.3.4 First Boom Section Removal

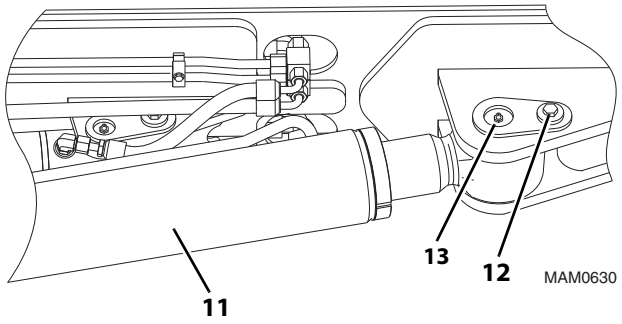
1. Temporarily connect the battery. Refer to Section 9.11, "Battery", for procedure.
2. Remove boom angle sensor arm. Refer to Section 9.14.7, "Boom Angle Sensor".

3. Start the machine and raise the first boom section to gain access to the lift cylinder pin and the compensation cylinder pin.

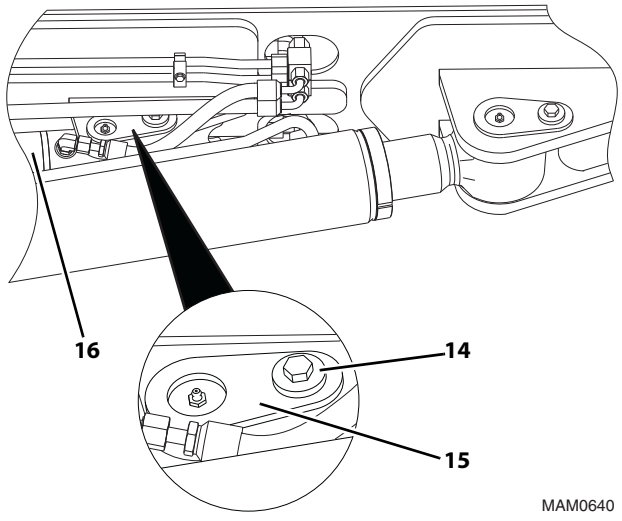
WARNING

Do Not activate ANY boom function other than the boom lift/lower function. Activating the extend/retract, tilt or auxiliary function could cause hydraulic oil to spray onto the machine and/or surrounding areas.

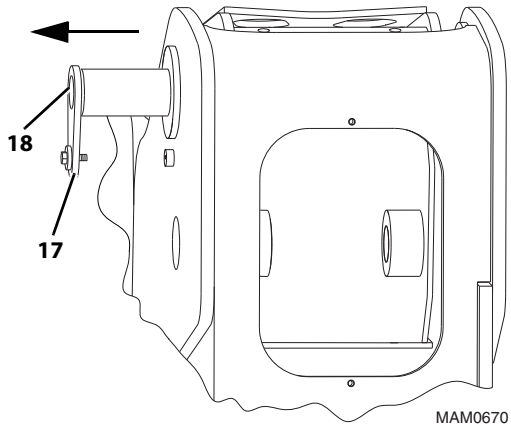
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Support the first boom section by placing a sling at the balance point of the section.



6. Support the lift/lower cylinder (**11**) and remove the lock bolt (**12**) and then the rod end pin (**13**). Lower the lift/lower cylinder onto the frame rails.



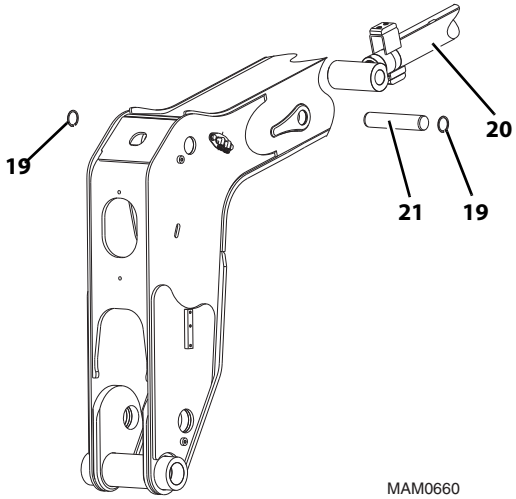
7. Remove the lock bolt (**14**) and pin (**15**) from the barrel end of the compensating cylinder (**16**) on the first boom section. Rest the cylinder on the machine frame.



8. Remove the lock bolt (**17**) and pivot pin (**18**) from rear of first boom section.
9. Lift the first boom section off machine and set on level ground or supports being careful not to damage the tubes on the bottom of the boom.
10. Inspect the boom and welds. Consult the local Caterpillar dealer if structural damage is detected.
11. Inspect hoses, hardware, wear pads, mounting points and other components visible with the first boom section. Replace any item if damaged.
12. Inspect all wear pads for wear. Refer to Section 3.22.1, "Wear Pad Inspection".

3.3.5 Extend/Retract Cylinder Removal

1. Secure the second boom section on suitable supports.

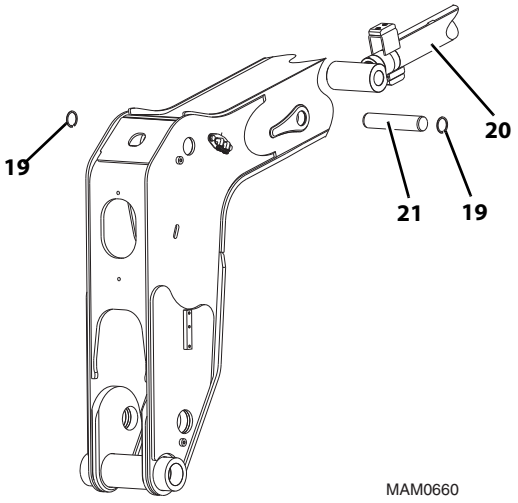


2. Remove the retaining rings (**19**) from the rod end (front) of the extend/retract cylinder (**20**).
3. Remove the extend/retract cylinder mounting pin (**21**).
4. Place a sling around the barrel end of the extend/retract cylinder.

5. Pull the extend/retract cylinder out of the second boom section approximately half way.
6. Support the barrel end of the extend/retract cylinder and reposition the sling toward the center or balancing point of the extend/retract cylinder. Note the location of the sling for installation.
7. Remove the extend/retract cylinder and place on level ground or suitable supports.

3.3.6 Extend/Retract Cylinder Installation

Note: *Grease the boom extend/retract cylinder bore and pins before installing.*



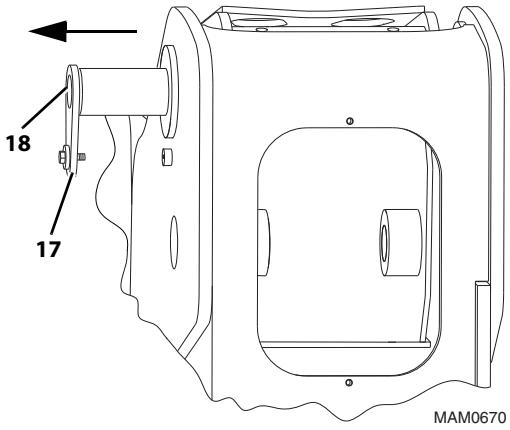
1. Place the sling at the balance point around the extend/retract cylinder barrel (**20**).
2. Install the extend/retract cylinder halfway into the rear of the second boom section.
3. Lower the extend/retract cylinder onto a suitable stand and reposition the sling toward the end of the cylinder.
4. Lift and push the extend/retract cylinder the remainder of the way into the boom section.
5. Align the barrel end of the extend/retract cylinder with the pin bores in the second boom section.
6. Install the extend/retract cylinder mounting pin (**21**).
7. Install the retaining rings (**19**) into the pin bores making sure the rings seat properly within the bore grooves.

3.3.7 First Boom Section Installation

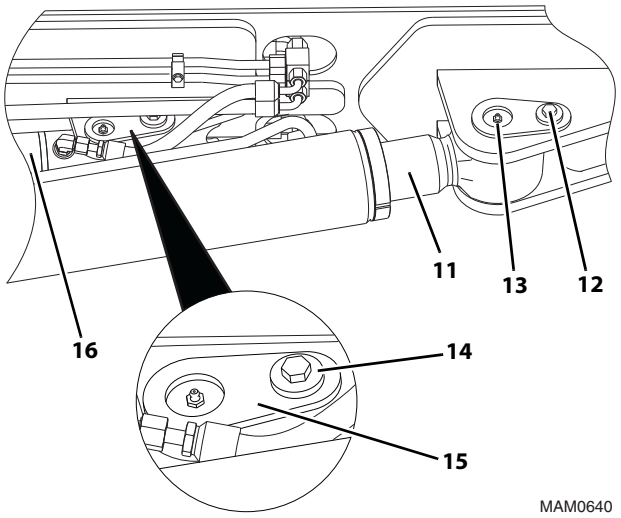
Note: *Lubrication of the boom wear surfaces with factory authorized grease is recommended to keep the boom wear surfaces lubricated properly. Lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.*

1. Park the machine on a hard, level surface, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.

Note: *Grease the boom pivot bore, compensating cylinder rod ends, lift/lower cylinder rod end and pins before installing.*



4. Using suitable slings, balance the first boom section, lift and carefully guide the boom into place. Align the frame pivot bore with the boom assembly pivot bore. Install boom pivot pin (**18**) and lock bolt (**17**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).



5. With a sling in place, raise the compensation cylinder (**16**) into place and install the pin (**15**) and lock bolt (**14**) to the barrel end of the compensating cylinder on the first boom section.
6. With the sling still in place, install the rod end of the lift/lower cylinder (**11**), pin (**13**) and lock bolt (**12**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).

Note: *Raising the boom up or down with the sling may be necessary so the boom, compensating and lift/lower cylinder bores can be aligned for easier pin installation.*

7. Remove sling.
8. Temporarily connect the battery. Refer to Section 9.11, "Battery", for procedure.
9. Start the machine and lower the first boom section to a level position.

⚠ WARNING

Do Not activate ANY boom function other than the boom lift/lower function. Activating the extend/retract, tilt or auxiliary function could cause hydraulic oil to spray onto the machine and/or surrounding areas.

10. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.

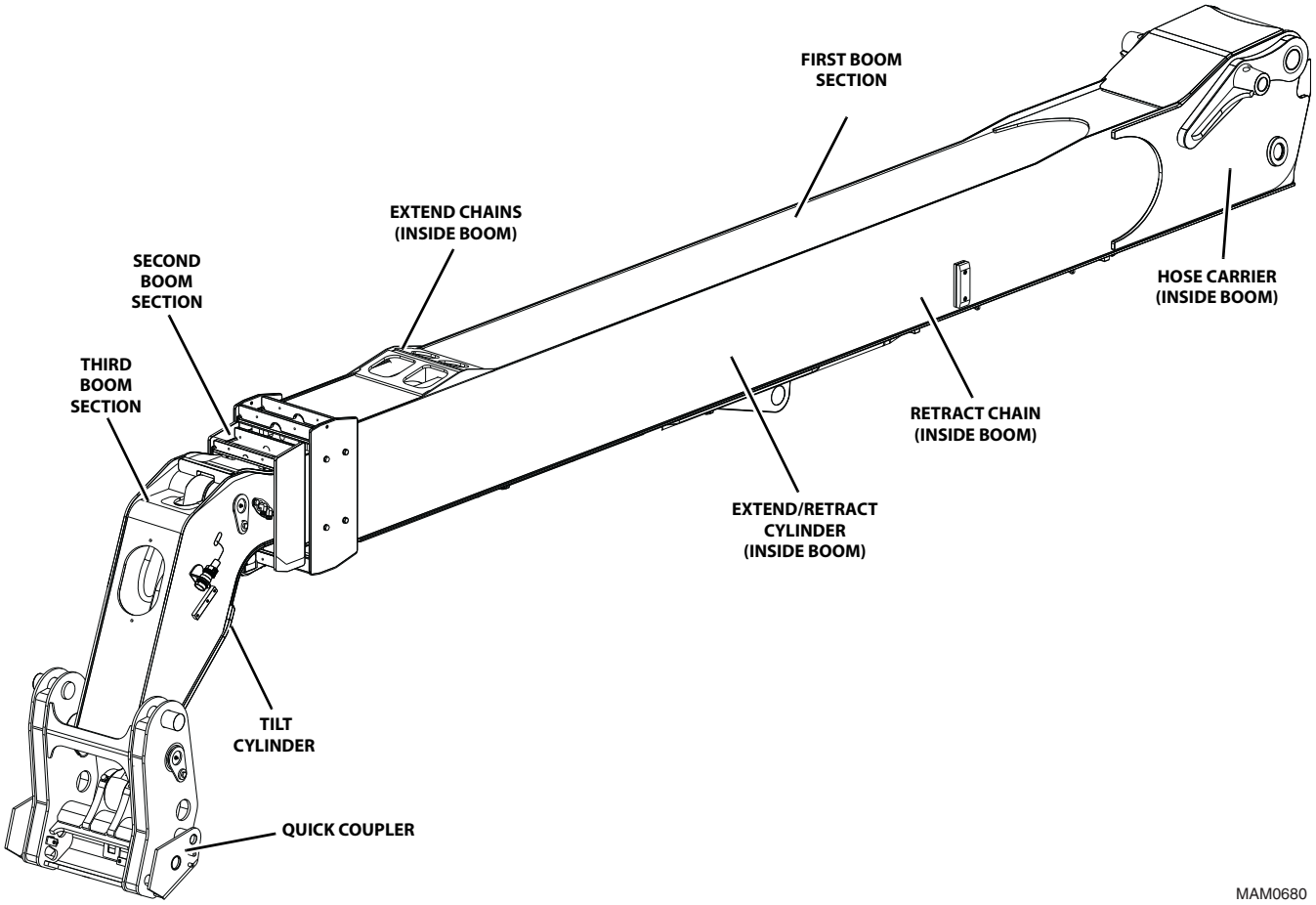
3.3.8 Second Boom Section Installation

Note: *Lubrication of the boom wear surfaces with factory authorized grease is recommended to keep the boom wear surfaces lubricated properly. Lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.*

1. If previously removed, install the extend/retract cylinder into the rear of the second boom section. Refer to Section 3.3.6, "Extend/Retract Cylinder Installation".
2. Using suitable slings, balance the second boom section, lift and carefully guide the boom into place.
3. Install the wear pads, shims and bolts to their proper location at the front inside of the first boom section. Do Not tighten the wear pads at this time.
4. Feed the tilt cylinder hoses and if equipped, the auxiliary hoses through the channel above the extend/retract cylinder.
5. Install the wear pads, shims and bolts previously removed from the rear of the second boom section.Do Not tighten the wear pads at this time.
6. Uncap and connect the previously labeled extend/retract cylinder hoses to the extend/retract cylinder. Refer to Section 2.8, "Hydraulic Connection Assembly and Torque Specification", for proper hose torque.
7. Uncap and connect the previously labeled tilt hoses and (if equipped) auxiliary hoses to the appropriate cylinder. Refer to Section 2.8, "Hydraulic Connection Assembly and Torque Specification", for proper hose torque.
8. Install the boom angle sensor arm. Refer to Section 9.14.7, "Boom Angle Sensor".
9. Install the previously removed boom retract sensor. Refer toSection 3.27, "Boom Retract Sensor Adjustment", for detailed adjustment instructions.
10. Adjust and shim each wear pad as needed. Refer to Section 3.22, "Boom Wear Pads".
11. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
12. Start the engine and operate all boom functions several times to bleed any air out of the hydraulic system. Check for fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
13. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.
14. Close and secure the engine cover.
15. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

3.4 BOOM SYSTEM COMPONENT TERMINOLOGY - TH414C

The following illustrations identify the components that are referred to throughout this section.



3.5 BOOM SYSTEM - THREE SECTION

3.5.1 Boom System Operation

The TH414C three section boom consists of the first, second and third assemblies with first and second section extend chains, and a single first and second section retract chain.

As the extend/retract cylinder, which is anchored at the rear of the second boom section, and the front of the third boom section begins to extend, it pushes the third boom section out of the second boom section.

The boom sections are connected by extend and retract chains. These chains are routed around sheaves on the front and the rear of the second boom section. As the extend/retract cylinder is forced out hydraulically, the second and third boom sections are pulled out by the extend chains.

As hydraulic pressure is applied to the retract port on the extend/retract cylinder, the retract chain pulls the second and third boom sections back into the first boom section.

This mechanical linkage formed by the chains and supporting hardware, extends and retracts the second and third boom sections into the first boom section at the same rate.

The boom section lifts and lowers via action of the lift cylinder.

3.6 BOOM ASSEMBLY MAINTENANCE

These instructions must be completed in sequence. The second and third boom sections are removed from the first boom section.The third boom section is removed from the second boom section or the complete boom assembly can be removed from the machine.

Before beginning, conduct a visual inspection of the machine and work area, and review the task about to be undertaken. Read, understand and follow these instructions.The boom assembly consists of the first, second and third section booms and supporting hardware.

Note: *Before removing the boom or boom section, the carriage or any other attachment must be removed from the quick coupler.*

Before beginning, conduct a visual inspection of the machine and work area, and review the task about to be undertaken. Read, understand and follow these instructions.

During service of the boom, perform the following:

1. Check wear pads. (Refer to Section 3.22.1, “Wear Pad Inspection”).
2. Check hose sheaves and chain rollers.
3. Apply grease at all lubrication points (grease fittings). (Refer to Section 2.5, “Lubrication Schedules”.)
4. Check for proper operation by operating all boom functions through their full ranges of motion several times.

Depending on your particular circumstance, the following procedures explain the removal/installation of individual boom sections or removal/installation of the complete boom.

⚠ WARNING

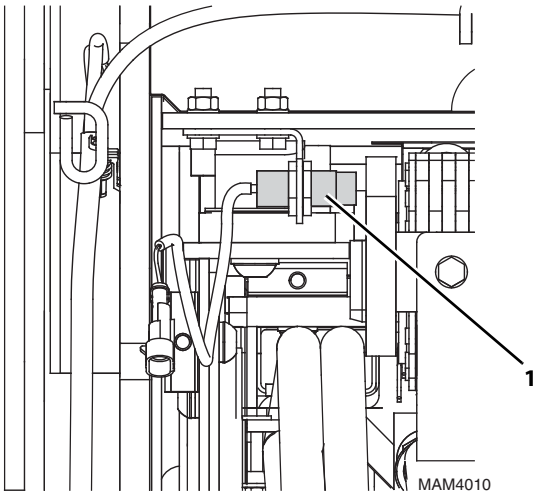
NEVER weld or drill the boom unless approved in writing by **Caterpillar**. The structural integrity of the boom will be impaired if subjected to any repair involving welding or drilling.

3.6.1 Boom Removal

While the boom sections can be separated from each other on the machine, **i**t is much safer, more efficient and more cost- effective to remove the complete boom assembly from the machine and place it on suitable supports for separation. Work can then progress at a normal working height.

Note: *When removing a complete boom assembly use a hoist or crane with a minimum lift capacity of 2721 kg (6000 lbs).*

1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.
2. Park the machine on a hard, level surface, fully retract the boom, raise the boom assembly to access lift/lower cylinder pin, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Open the engine cover. Allow the system fluids to cool.
5. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
6. Remove boom angle sensor arm. Refer to Section 9.14.7, "Boom Angle Sensor".



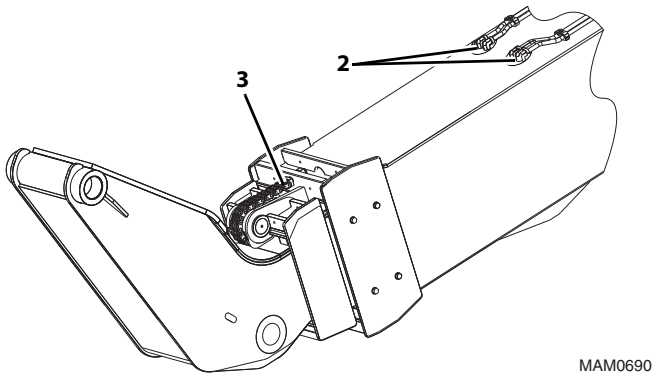
7. Disconnect and remove the boom retract sensor (**1**) from the rear of the first boom section.
8. Place a sling around the first boom section at the balance point.
9. Take the weight off the boom assembly.
10. Label, disconnect and cap all hydraulic hoses attached to the tubes on the bottom of the boom. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
11. Label, disconnect and cap any electrical cables if equipped.
12. Remove the pin from the rod end of each compensation cylinder being careful not to drop the cylinder. Lower each cylinder to a secure position.
13. Remove the pin from the rod end of the lift/lower cylinder being careful not to drop the cylinder. Lower the cylinder to a secure position.
14. Confirm that the boom assembly is balanced with the sling and remove the boom assembly pivot pin.
15. Lift the boom assembly from the machine and lower onto suitable supports.

3.6.2 Second and Third Boom Section Removal

1. Set the complete boom on level ground and by repositioning the slings turn boom over on to the top side. Set the complete boom on suitable stands to begin tear down.

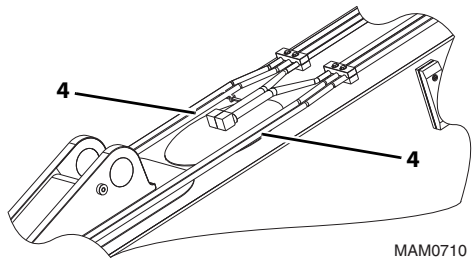
Note: *With the complete boom setting upside down, the removal and replacing of each boom section, tilt cylinder, hoses, extend and retract chains and extend/retract cylinder are made much easier.*

2. Label, disconnect and cap the tilt circuit hoses from the tilt cylinder at the front of the third boom section. Label, disconnect and cap the auxiliary circuit hoses from the quick disconnect fittings at the front of the third boom section. Cap all fittings and openings to prevent dirt and debris from entering the hydraulic system.
3. Place a sling around the tilt cylinder and remove the retaining rings and pin at the barrel end of the tilt cylinder. Remove tilt cylinder.
4. Remove all wear pads, shims and backing plates from the front inside of the first boom section. Label and tag each set of wear pads being removed.

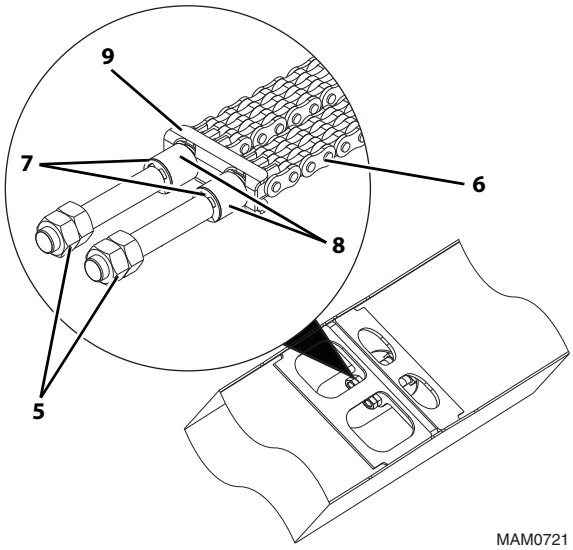


5. Disconnect both tilt hoses and (if equipped) both auxiliary hoses (**2**) at the bottom of the first boom section. Plug the hose ends and cap the tube ends to prevent dirt and debris from entering the hydraulic system. Pull the disconnected hoses from the rear of the boom.

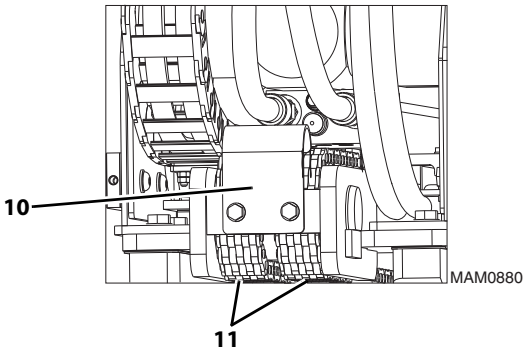
6. Loosen and remove the lock nut and jam nut (**3**) on the retract chain at the front of the first boom section.



7. Disconnect both extend/retract hoses (**4**) at the bottom of the first boom section. Plug the hose ends and cap the tube ends to prevent dirt and debris from entering the hydraulic system. Pull the disconnected hoses from the rear of the boom.



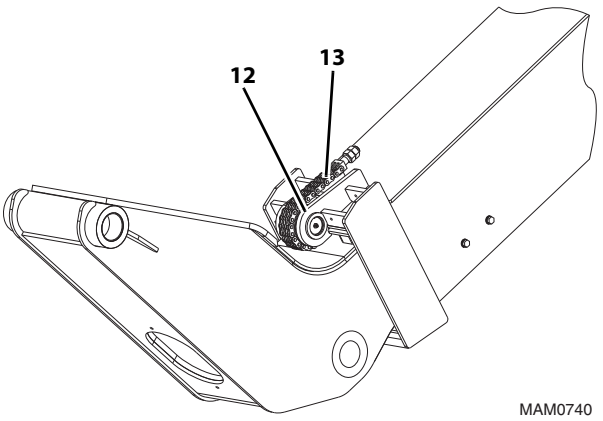
8. Remove the locknuts and jam nuts (**5**) from the extend chains (**6**) at the top of the first boom section.
9. Pull both extend chains (**6**) back to allow the removal of two circlips (**7**), two spacers (**8**) and clevis bracket (**9**).



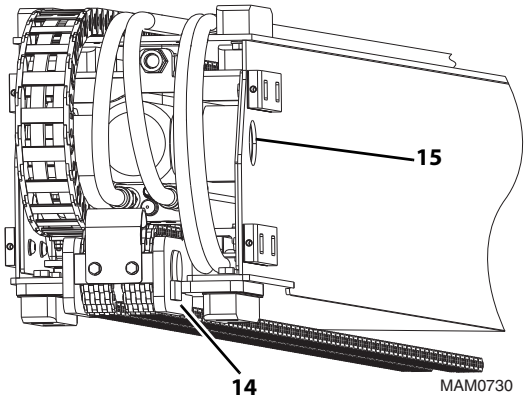
10. Loosen and remove the hose stop bracket (**10**) from the rear of the second boom section.
11. Pull the disconnected extend chains (**11**) from the rear of the boom.
12. Remove both top and one side wear pads, shims and backing plates from the rear inside of the second boom section. Label each set of wear pads being removed.
13. Place a sling around the second boom section, lift and slowly pull the second and third boom section approximately half way out of the first boom section. Lower the second and third boom sections onto a suitable support.
14. Relocate the sling or using two slings for better stability, balance the two boom sections and slowly pull them out of the first boom section being careful not to damage the hydraulic hoses or chains. Lower the second and third boom sections onto suitable supports.

3.6.3 Third Boom Section and Extend/Retract Cylinder Removal

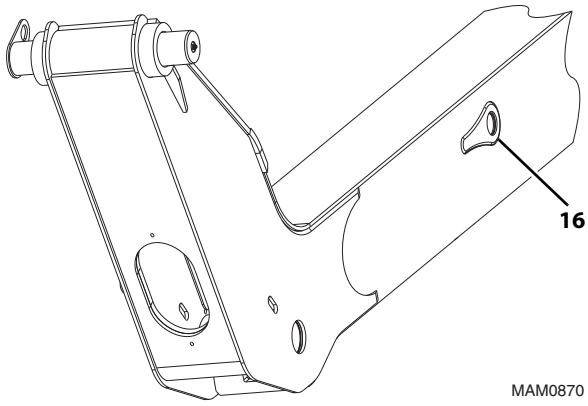
1. Remove all wear pads, shims from the front inside of the second boom section. Label each set of wear pads being removed.



2. Loosen and remove the retract chain sheave components (**12**) from the front of the second boom section.
3. Pull the retract chain (**13**) free of the sheave brackets and lay it on the third boom section.



4. At the rear of the boom, loosen and remove all retract chain sheave components (**14**).
5. Remove the retaining rings and pin from the extend/retract cylinder at the rear of the second boom section (**15**).
6. Secure the hydraulic hoses at the rear of the third boom section.
7. Place a sling around the third boom section, lift and slowly pull the third boom section approximately half way out of the second boom section. Lower the third boom section onto a suitable support.
8. Relocate the sling or using two slings for better stability, balance the third boom section and slowly pull the third boom section out of the second boom section. Lower the third boom section onto suitable supports.
9. Loosen and remove the tilt circuit, auxiliary circuit hoses from the rear of the third boom section.



10. Remove the retaining rings and pin from the extend/retract cylinder at the front of the third boom section (**16**).
11. Place a sling around the rear of the extend/retract cylinder, lift and slowly pull the extend/retract cylinder approximately half way out of the third boom section. Lower the extend/retract cylinder onto a suitable support.
12. Relocate the sling or using two slings for better stability, balance the extend/retract cylinder and slowly pull the extend/retract cylinder out of the third boom section. Lower the extend/retract cylinder onto suitable supports.

3.6.4 Third Boom Section and Extend/Retract Cylinder Installation

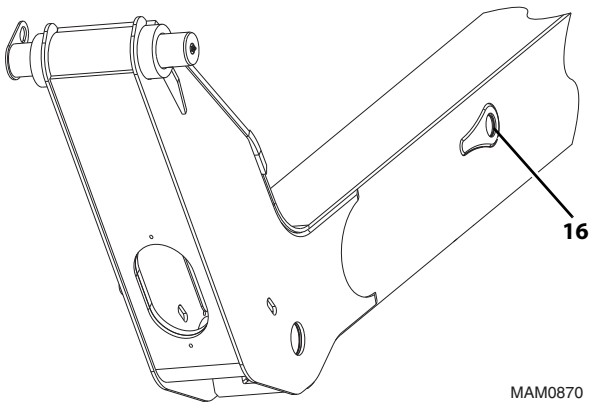
Note: *During reassembly use Loctite® 242™ on all bolt threads and use* Loctite 545™ *on all hydraulic fittings*

Note: *Shim all wear pads. Refer to Section 3.22, "Boom Wear Pads" You may have to final adjust the wear pads after the boom assembly is installed on the machine and hydraulic power is available.*

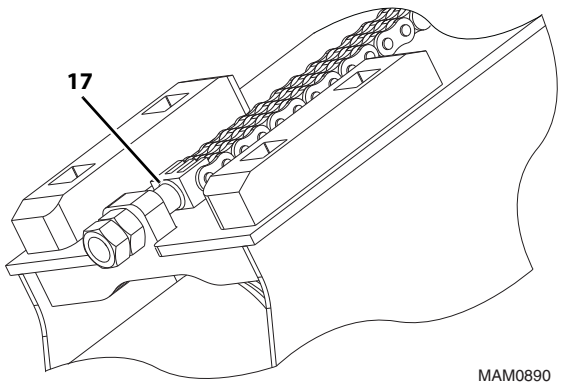
Note: *Coat the interior of all bushings and sheaves with CAT ADVANCED 3MOLY-NLGI Grade 2 prior to the installation of pins and bushings. Wear pads and slide areas must be lubricated with CAT ADVANCED 3MOLY-NLGI Grade 2 or an equivalent.*

1. Place the third boom section upside down on suitable supports.

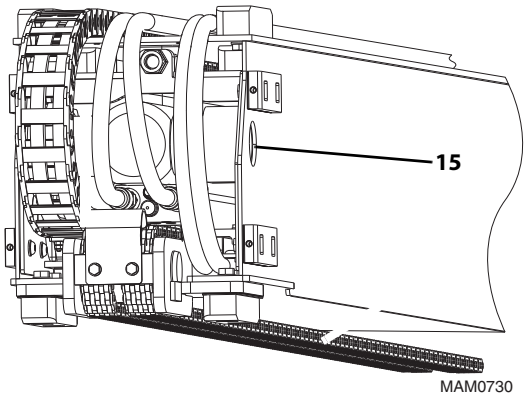
2. Place a sling around the extend/retract cylinder and slowly insert the extend/retract cylinder halfway into the rear of the third boom section. Lower the extend/retract cylinder onto a suitable support.
3. Relocate the sling and install the extend/retract cylinder the remainder of way into the third boom section.



4. Align the rod end of the extend/retract cylinder with the bore in the front of the third boom section and install the pin and retaining rings (**16**).
5. Install the extend/retract hoses to the barrel end of the extend/retract cylinder.
6. Install the tilt circuit hoses, auxiliary/electrical circuit hoses through the channels at the rear of the third boom section and bolt into place.



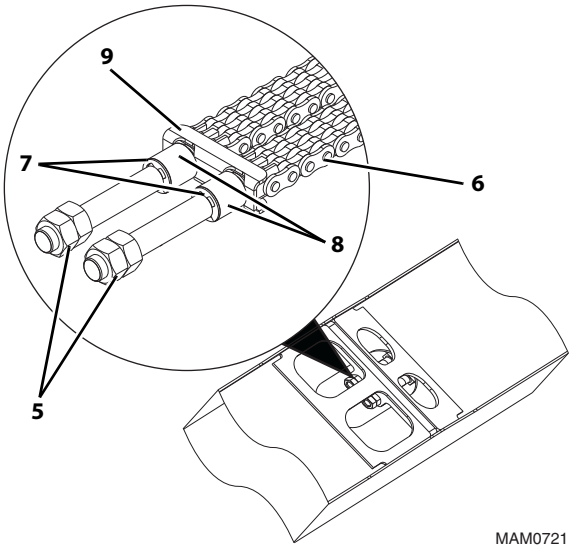
7. Connect the retract chain (**17**) at the rear of the third boom section and lay the chain over the boom.
8. Lubricate wear pad paths and lay the extend/retract cylinder hoses, tilt hoses, auxiliary/electrical hoses behind the third boom section being careful to protect the hoses against being damaged when installing the third boom section into the second boom section.
9. With the extend/retract cylinder installed in the third boom section, the third boom section is ready to be installed into the second boom section.
10. Place the second boom section upside down on suitable supports.
11. Lubricate the inside second boom section on area's where the third boom section wear pads will slide.
12. Using a suitable sling, balance the third boom section and carefully slide the hoses and 1 - 1,2 m (3 - 4 ft) of the third boom section into the front of the second boom section.
13. Set the third boom section onto a suitable support and reset the sling under the boom head of the third boom section. Carefully slide the third boom section into the second boom section.
14. Leave 152 - 203 mm (6 - 8 in) of the third boom section out to be able to install the wear pads in the front of the second boom section.
15. With the sling still under boom head, install the wear pads and spacers in the front of the second boom section.
16. Install the top wear pads and spacers on the top rear of the third boom section.
17. Install the wear pads and spacers on the bottom and both sides at the rear of the second boom section. For ease of installation, Do Not install the top wear pads at this time.
18. Lubricate wear pads, inside sheaves, bores and pins during assembly.
19. Push the third boom section the remainder of the way into the second boom section.



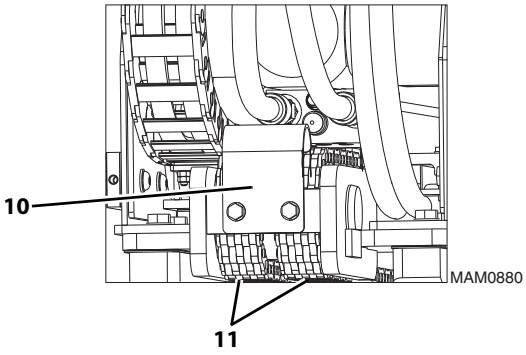
20. Align the barrel end of the extend/retract cylinder with the bore on the rear of the second boom section and install the pin and retaining rings (**15**).

3.6.5 Second and Third Boom Section Installation

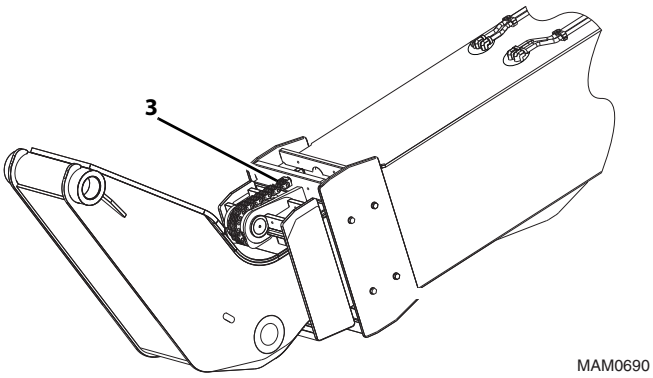
1. Place the first boom section upside down on suitable supports.
2. Lubricate the inside first boom section on area's where the second boom section wear pads will slide.
3. Using a suitable sling, balance the second and third boom sections and carefully slide 0,9 - 1,22 m (3 - 4 ft) into the front of the first boom section.
4. Set the second and third boom sections onto a suitable support and reset the sling under the boom head of the third boom section.



5. Install the clevis bracket (**5**), two spacers (**6**) and two circlips (**7**), previously removed from the extend chains (**8**).
6. Install both extend chains (**8**) to the top of the first boom section
7. Install the locknuts and jam nuts (**9**) to the extend chains (**8**) and allowing the extend chains to hang out over the rear of the first boom section. Do Not tighten the lock nuts and jam nuts at this time.
8. Lay the extend/retract cylinder hoses, tilt hoses, auxiliary/electrical hoses behind the second and third boom sections being careful to protect the hoses against being damaged when installing the second and third boom sections into the first boom section.
9. Carefully slide the hoses and the two boom sections into the first boom section. Leave 152 -203 mm (6 - 8 in) in of the two boom sections out to be able to install the wear pad block and the wear pads in the front of the first boom section.
10. Install the wear pads, spacers and shims at the front of the first boom section. Apply Loctite® 242™ and torque the wear pad mounting bolts to 92 - 106 Nm (68 - 78 lb-ft).



11. Connect both extend chains (**11**) at the rear of the third boom section.
12. Feed the extend/retract hoses, tilt hoses and auxiliary/electrical hoses between the second and first boom sections.
13. Connect the extend/retract hoses, tilt hoses and auxiliary/electrical hoses to the proper tubes on the bottom of the first boom section.
14. Install the hose stop bracket (**10**).
15. Install the previously removed boom retract sensor. Refer to Section 3.27, "Boom Retract Sensor Adjustment", for detailed adjustment instructions.



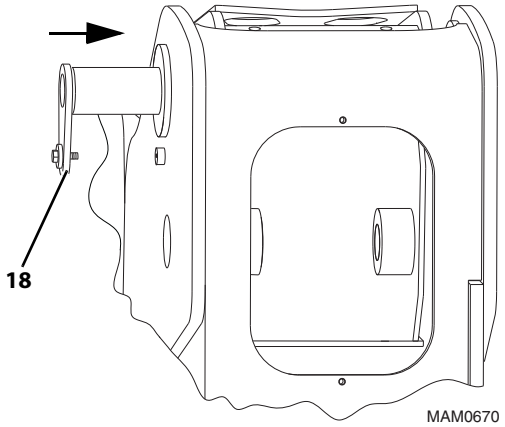
16. Install the lock nut and jam nut (**3**) on the retract chain at the front of the first boom section.
17. Tighten all hose clamps. Connect the auxiliary hoses to the quick disconnects on the side of the boom head. Connect the electrical cable to the plug mounted below the auxiliary quick disconnects if equipped.
18. Install the tilt cylinder in the boom head, install the mounting pin and keeper bolt, locking the mounting pin and tilt cylinder into position.
19. Connect the tilt cylinder hoses to the proper fittings on the tilt cylinder.

3.6.6 Complete Boom Installation

Note: *Lubrication of the boom wear surfaces with CAT Multipurpose Grease is recommended to keep the boom wear surfaces lubricated properly. Lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.*

1. Park the machine on a hard, level surface, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.

Note: *Grease the boom pivot bore, compensating cylinder rod ends, lift/lower cylinder rod end and pins before installing.*



4. Using suitable slings, balance the boom assembly, lift and carefully guide the boom into place. Align the frame pivot bore with the boom assembly pivot bore. Install boom pivot pin and lock bolt (**18**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).
5. With the sling still in place, install the compensating cylinders, pins and lock bolts. Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).
6. With the sling still in place, install the rod end of the lift/lower cylinder, pin and lock bolt. Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).

Note: *Raising the boom up or down with the sling may be necessary so the boom, compensating and lift/lower cylinder bores can be aligned for easier pin installation.*

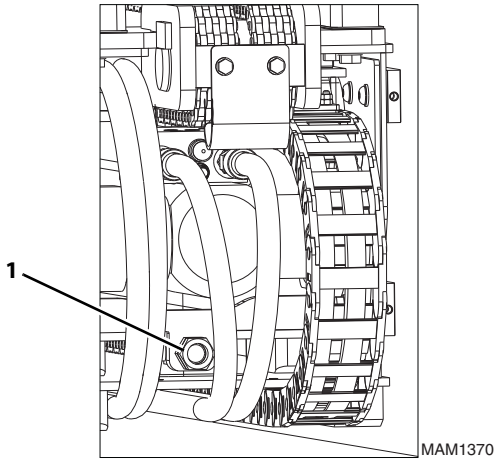
7. Uncap and connect the previously labeled extend/retract cylinder hoses to the extend/retract cylinder.
8. Uncap and connect the previously labeled tilt hoses and (if equipped) auxiliary hoses to the appropriate cylinder.
9. Install the boom angle sensor arm. Refer to Section 9.14.7, “Boom Angle Sensor”.
10. Start the engine and operate all boom functions several times to bleed any air out of the hydraulic system. Check for fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
11. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.
12. Close and secure the engine cover.

3.7 BOOM CHAIN REMOVAL/INSTALLATION

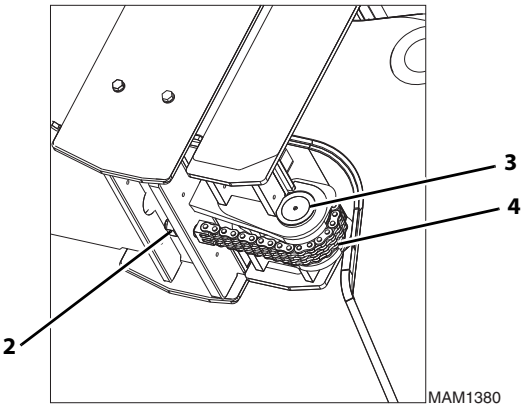
3.7.1 Retract Chain Removal

The removal of the retract chain can be accomplished with out the complete tear down of the boom sections.

1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.
2. Park the machine on a hard, level surface, fully retract the boom, level the boom assembly, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Open the engine cover. Allow the system fluids to cool.
5. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.



6. Remove the retract chain lock nut and adjusting nut (**1**). Fasten a rope/wire to the threaded end of the shackle end to aid in reinstallation.



7. Remove the retract chain lock nut and adjusting nut (**2**) from the bottom front of the first boom section.
8. Remove the retract chain roller (**3**) to allow for retract chain removal.
9. Pull the retract chain (**4**) from between the second and third boom sections below the boom head.
10. Unfasten the rope/wire from the retract chain.

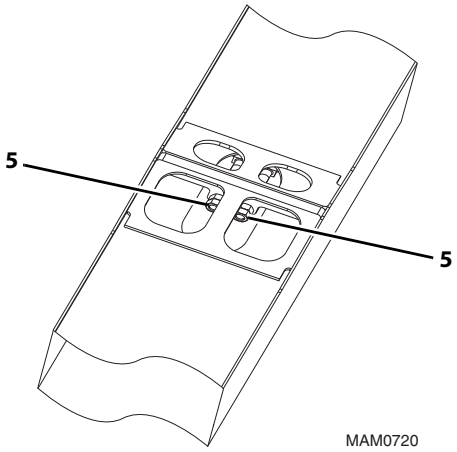
3.7.2 Retract Chain Installation

1. Fasten the rope/wire left in the boom from the retract chain removal to the new retract chain and pull the chain through the boom sections to the approximate final position. Remove the rope/wire.
2. Install the retract chain lock nut and adjusting nut (**1**) at the rear of the third boom section.
3. Install the retract chain roller (**3**) if previously removed.
4. Install the retract chain lock nut and adjusting nut (**2**) at the front of the second boom section below the boom head.
5. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
6. Close and secure the engine cover.
7. For chain adjustments see Section 3.10.1, "Chain Adjustments".

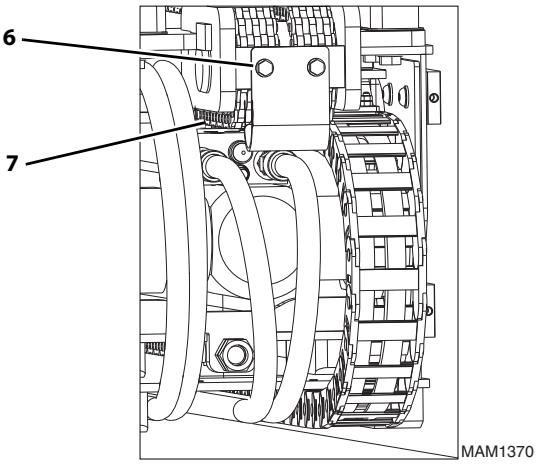
3.7.3 Extend Chain Removal

The removal of the extend chains can be accomplished with out the complete tear down of the boom sections.

1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.
2. Park the machine on a hard, level surface, fully retract the boom, level the boom assembly, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Open the engine cover. Allow the system fluids to cool.
5. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



6. Remove the extend chain lock nuts and adjusting nuts (**5**) from the extend chain at the top of the first boom section. Fasten a rope/wire to the threaded end of the shackle end to aid in reinstallation.



7. Remove the hose guard bracket (**6**) from the rear of the second boom section.
8. Remove the connecting pin (**7**) from the extend chain.
9. Pull the extend chain from between the first and second boom sections at the rear of the machine.
10. Unfasten the rope/wire from the extend chain.
11. Repeat steps 6 through 10 to remove the other extend chain.

3.7.4 Extend Chain Installation

1. Fasten the rope/wire left in the boom from the extend chain removal to the new extend chain and pull the chain through the boom sections to the approximate final position. Remove the rope/wire.
2. Install the extend chain lock nut and adjusting nut (**5**) at the top of the first boom section.
3. Install the extend chain connecting pin (**7**) at the rear of the third boom section.
4. Repeat steps 1 through 3 to install the other extend chain.
5. Install the hose guard bracket (**6**).
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Close and secure the engine cover.
8. For chain adjustments see Section 3.10.1, "Chain Adjustments".

3.8 EXTEND/RETRACT, TILT AND AUXILIARY CIRCUIT HOSE REMOVAL/ INSTALLATION

Hoses that need replaced and are still in one piece can be removed and replaced without removing sections of the boom.

3.8.1 Extend/Retract Hose Removal

1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.
2. Park the machine on a hard, level surface, fully retract the boom, level the boom assembly, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Open the engine cover. Allow the system fluids to cool.
5. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
6. Label, disconnect and cap both hoses from the extend/ retract cylinder at the rear of the boom. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
7. Fasten a rope/wire to the hose end below the first boom section.
8. From the rear of the boom, pull the extend/retract hoses from between the first and second boom sections.
9. Unfasten the rope/wire from the hose end.

Note: *Always check hose sheaves for wear and/or damage. Replace if necessary.*

3.8.2 Extend/Retract Hose Installation

1. Fasten the rope/wire left in the boom from the hose removal to the new hose end at the rear of boom.
2. Slowly pull the rope/wire from below the first boom section until the hose end is visible at the tube connections.
3. Unfasten the rope/wire from the extend/retract hose.
4. Uncap and connect the hoses to the previously labeled tubes under the first boom section.
5. Uncap and connect the hoses to the previously labeled fittings at the rear of the extend/retract cylinder. Refer to Section 2.8, "Hydraulic Connection Assembly and Torque Specification", for proper hose torque.

3.8.3 Tilt/Auxiliary Hose Removal

1. Label, disconnect and cap both hoses from the tilt cylinder or auxiliary fittings at the front of the boom. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
2. Fasten a rope/wire to the hose end at the boom head.
3. Label, disconnect and cap both hoses attached to the tubes on the bottom of the boom. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
4. Fasten a rope/wire to the hose end below the first boom section.
5. Loosen and remove the clamps holding the tilt hoses at the rear of the third boom section.
6. From the rear of the boom, pull the tilt hoses from between the first and second boom sections.
7. Unfasten the rope/wire from each end of the hose assembly.

Note: *Always check hose sheaves for wear and/or damage. Replace if necessary.*

3.8.4 Tilt/Auxiliary Hose Installation

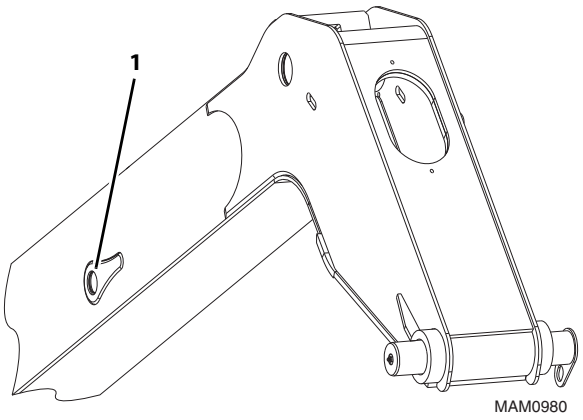
1. Fasten the rope/wire left in the boom from the hose removal to each end of the new hose at the rear of boom.
2. Slowly pull the rope/wire from the boom head until the hose end is visible at the boom head.
3. Slowly pull the rope/wire from below the first boom section until the hose end is visible at the tube connections.
4. Unfasten the rope/wire from each end of the hose.
5. Uncap and connect the hoses to the previously labeled tubes under the first boom section. Refer to Section 2.8, “Hydraulic Connection Assembly and Torque Specification”, for proper hose torque.
6. Uncap and connect the hoses to the previously labeled fittings at the tilt cylinder or the auxiliary fittings. Refer to Section 2.8, “Hydraulic Connection Assembly and Torque Specification”, for proper hose torque.
7. Install and tighten the clamps holding the tilt hoses at the rear of the third boom section.
8. Properly connect the battery. Refer to Section 9.11, “Battery”, for procedure.

3.9 EXTEND/RETRACT CYLINDER REMOVAL/ INSTALLATION

The extend/retract cylinder hydraulically extends and retracts the third boom section.
Seal kits for the extend/retract cylinders are available from the local Caterpillar dealer.

3.9.1 Extend/Retract Cylinder Removal

1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.
2. Park the machine on a hard, level surface, extend the boom to gain access to the extend/retract cylinder pin in the third boom section, level the boom assembly, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.

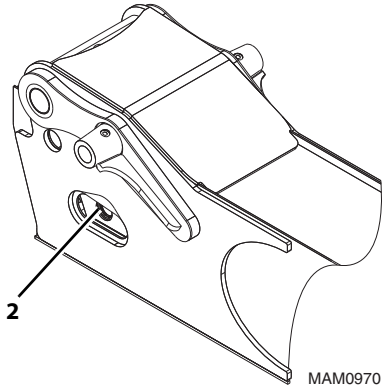


4. Remove the cylinder rod eye mounting pin (**1**) at the side of the third boom section.
5. Start the machine and SLOWLY retract the extend/ retract cylinder and at the same time manually retract the third boom section.
6. Shut the engine OFF.
7. Open the engine cover. Allow the system fluids to cool.
8. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.
9. Loosen and remove the extend/retract cylinder hoses at the rear of the boom assembly. Plug the hose ends to prevent dirt and debris from entering the hydraulic system.
10. Remove the cylinder barrel end pin (**2**). Note the location of the spacers and washers

11. Attach a sling or other suitable lifting device to the extend/retract cylinder and carefully pull the extend/retract cylinder free of the machine through the rear of the boom/chassis assembly.
12. Place the extend/retract cylinder in a designated area for the next operation.

3.9.2 Extend/Retract Cylinder Installation

1. Install the extend/retract cylinder into the rear of the boom and line up the barrel end of the cylinder with the pin bores on the second boom section. Be certain that the wear pads are installed on the cylinder.



2. Install the mounting pin (**2**), spacers and washers through the second boom section bore and cylinder barrel. Secure with retaining clips.
3. Uncap and connect the hoses to the previously labeled fittings at the extend/retract cylinder. Apply Loctite 545™ to the fittings.
4. Manually pull the third and second boom sections out until there is access to the extend/retract cylinder mounting pin bore in the third boom section.
5. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
6. Start the machine and extend the extend/retract cylinder until the rod eye of the cylinder aligns with the pin bore in the third boom section.
7. Shut the engine OFF.
8. Install the mounting pin (**1**) and secure with the retaining clips.
9. Start the machine and cycle the extend/retract cylinder checking for leaks or any alignment problems.

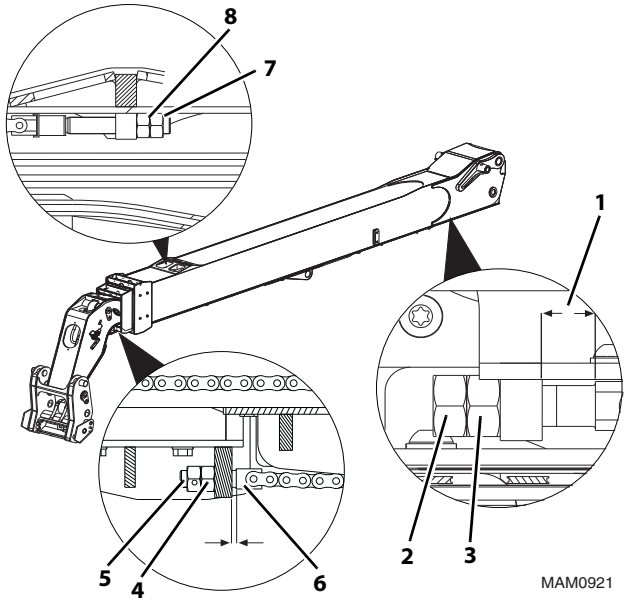
3.10 BOOM SECTIONS ADJUSTMENT

3.10.1 Chain Adjustments

The chains are adjusted by tightening and/or backing off the adjusting nuts at the threaded end of the chains. The opposite chain adjusting nut usually must be loosened whenever this procedure is performed.

The chains are properly adjusted whenever the following parameters are met.

1. Start the machine, level the boom and retract the extend/retract cylinder completely. Turn engine OFF. Suitably support the boom.



2. At the bottom front of the first boom section, tighten the retract chain adjusting nut (**4**) to ensure a gap of 5,0 ± 1,0 mm (0.078 ± 0.016 in) between the clevis shoulder and the face of the third boom section (**6**).
3. Tighten the retract chain lock nut (**5**) to 120 Nm (86 lb-ft) against the adjusting nut.
4. At the rear of the boom, tighten the retract chain adjusting nut (**3**) to ensure a gap of 5,0 ± 1,0 mm (0.078 ± 0.016 in) between the clevis shoulder and the face of the first boom section (**1**).
5. Tighten retract chain lock nut (**2**) to 120 Nm (86 lb-ft) against the adjusting nut.

Note: *Ensure that there is a minimum of one full thread of the clevis showing beyond the lock nut.*

6. Tighten both extend chain adjusting nuts (**7**) until a torque of 60 Nm (44 lb-ft) is obtained.
7. If necessary, repeat step 6 until extend chain tension is equal.

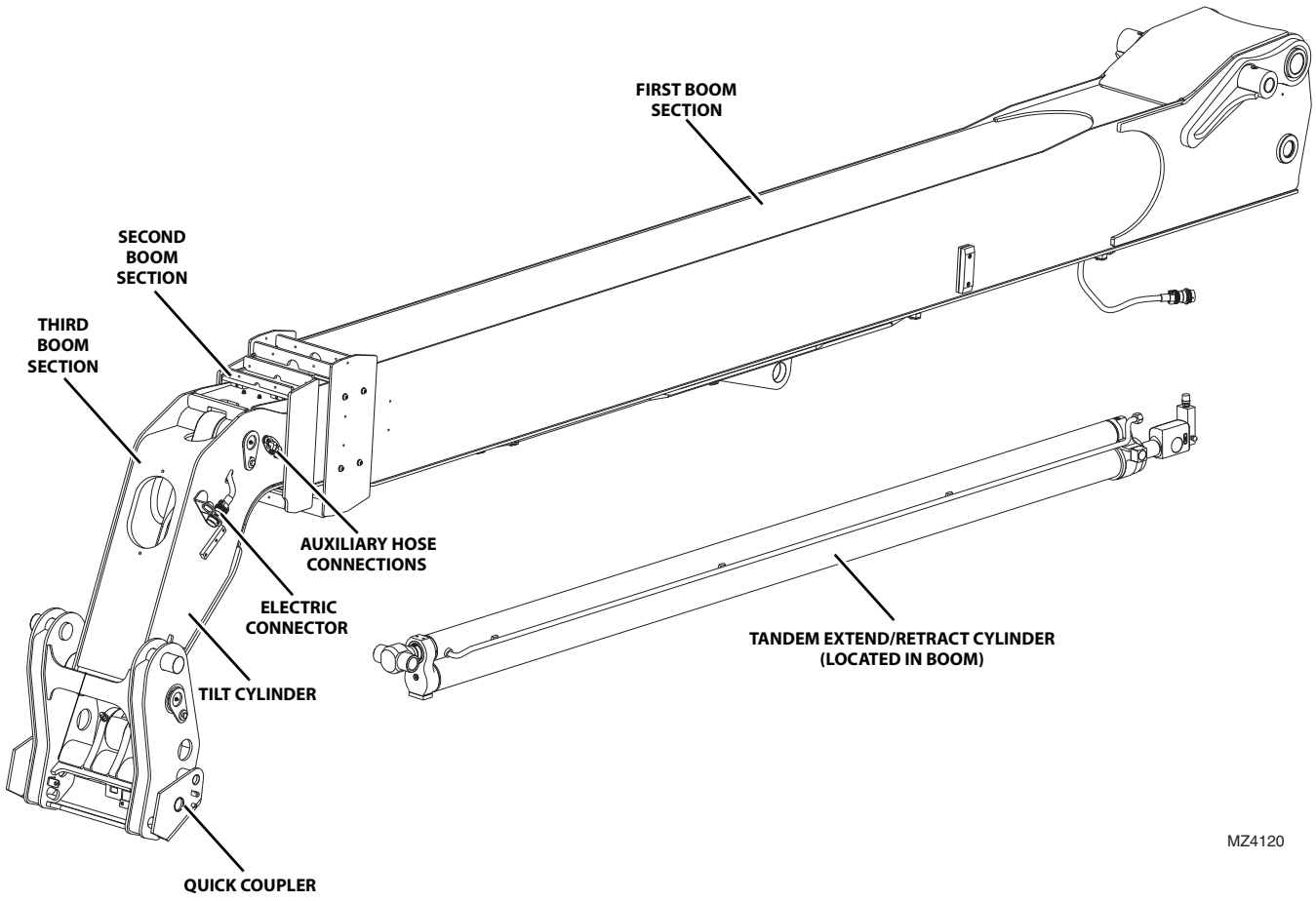
8. Start the machine and slowly extend and retract the boom three times.
9. Retract the extend/retract cylinder completely. Turn OFF engine.
10. Repeat step 6 and 7 if necessary.
11. Tighten both extend chain lock nuts (**8**) to 120 Nm (86 lb-ft) against the adjusting nut.

Note: *Ensure that there is a minimum of one full thread of the clevis showing beyond the lock nut.*

12. Start the machine and cycle the extend/retract cylinder to verify the boom extends and retracts properly.

3.11 BOOM SYSTEM COMPONENT TERMINOLOGY - TH514C

The following illustrations identify the components that are referred to throughout this section.



3.12 BOOM SYSTEM - THREE SECTION

3.12.1 Boom System Operation

The TH514C three section boom consists of the first, second and third assemblies with a tandem extend/retract cylinder connecting the three sections.

As the tandem extend/retract cylinders, which the lower cylinder is anchored at the rear of the first boom section and the rear of the second boon section and the top cylinder is connected near the front of the third boom section begins to extend, it pushes the second boom section out of the first boom section and the third boom section out of the second boom section.

As hydraulic pressure is applied to the retract port on the extend/retract cylinders, the top cylinder pulls the third boom section into the second boom section and bottom cylinder pulls the second boom section into the first boom section.

This hydraulic cylinder linkage formed by the tandem extend/retract cylinder, extends and retracts the second and third boom sections into the first boom section at the same rate.

The boom section lifts and lowers via action of the lift cylinder.

3.13 BOOM ASSEMBLY MAINTENANCE

These instructions must be completed in sequence. The second and third boom sections are removed from the first boom section.The third boom section is removed from the second boom section or the complete boom assembly can be removed from the machine.

Before beginning, conduct a visual inspection of the machine and work area, and review the task about to be undertaken. Read, understand and follow these instructions.The boom assembly consists of the first, second and third section booms and supporting hardware.

Note: *Before removing the boom or boom section, the carriage, any other attachment and the quick coupler must be removed from the boom assembly.*

Before beginning, conduct a visual inspection of the machine and work area, and review the task about to be undertaken. Read, understand and follow these instructions.

During service of the boom, perform the following:

1. Check wear pads. (Refer to Section 3.22.1, “Wear Pad Inspection”).
2. Apply grease at all lubrication points (grease fittings). (Refer to Section 2.5, “Lubrication Schedules”).
3. Check for proper operation by operating all boom functions through their full ranges of motion several times.

Depending on your particular circumstance, the following procedures explain the removal/installation of individual boom sections or removal/installation of the complete boom.

⚠ WARNING

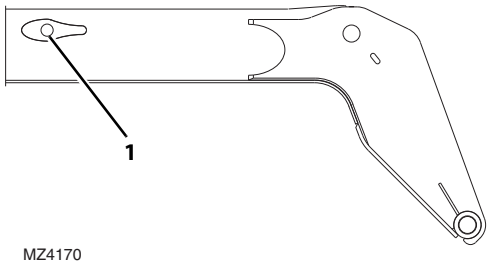
NEVER weld or drill the boom unless approved in writing by **Caterpillar**. The structural integrity of the boom will be impaired if subjected to any repair involving welding or drilling.

3.13.1 Boom Removal

While the boom sections can be separated from each other on the machine, **i**t is much safer, more efficient and more cost- effective to remove the complete boom assembly from the machine and place it on suitable supports for separation. Work can then progress at a normal working height.

Note: *When removing a complete boom assembly use a hoist or crane with a minimum lift capacity of 5000 lbs.*

1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.



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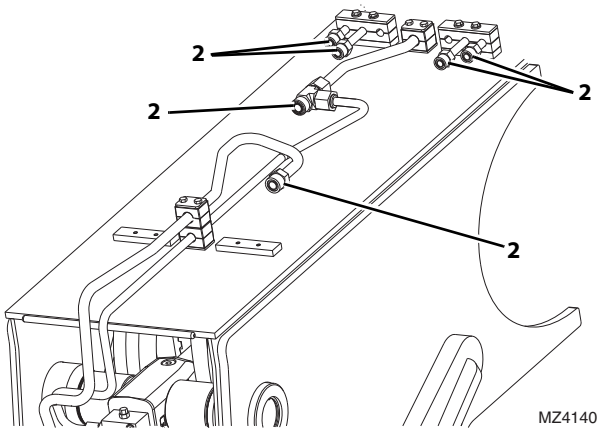
2. Park the machine on a hard, level surface, extend the boom to allow access to the tandem extend/retract cylinder mounting pin in the third boom section (**1**).
3. Remove the retaining rings and mounting pin (**1**).
4. Raise the boom assembly and retract the extend/retract cylinder allowing the third boom section to retract along with the extend/retract cylinder.
5. Keep the boom assembly raised to access lift/lower cylinder pin, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
6. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
7. Open the engine cover. Allow the system fluids to cool.
8. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
9. Remove the quick coupler assembly. Refer to Section 3.23.3, "Quick Coupler Removal (TH414C, TH514C & TH417C)".
10. If equipped, disconnect the boom angle sensor arm. Refer to Section 9.14.7, "Boom Angle Sensor".
11. Place a sling around the front of the first boom section.
12. Take the weight off the boom assembly.



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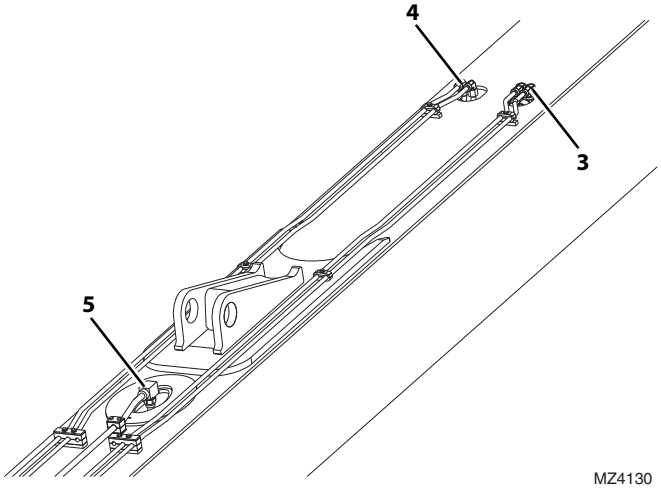
13. Label, disconnect and cap all hydraulic hoses (**2**) attached to the tubes on the bottom of the boom. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
14. Disconnect the electrical cables if equipped.
15. Remove the pin from the rod end of each compensation cylinder being careful not to drop the cylinder. Lower each cylinder to a secure position.
16. Remove the pin from the rod end of the lift/lower cylinder being careful not to drop the cylinder. Lower the cylinder to a secure position.
17. Lower the boom assembly, reposition the slings and confirm that the boom assembly is balanced and remove the boom assembly pivot pin.
18. Lift the boom assembly from the machine and lower onto suitable supports.

3.13.2 Second and Third Boom Section Removal

1. Set the complete boom on level ground and by repositioning the slings turn boom over on to the top side. Set the complete boom on suitable stands to begin tear down.

Note: *With the complete boom setting upside down, the removal and replacing of each boom section, tilt cylinder, hoses and tandem extend/retract cylinder are made much easier.*

2. Label, disconnect and cap the tilt circuit hoses from the tilt cylinder at the front of the third boom section. Disconnect the electrical plug connection from the boom head. Label and remove the electrical plug from the end of the electrical cable. Label, disconnect and cap the auxiliary circuit hoses from the quick disconnect fittings at the front of the third boom section. Cap all fittings and openings to prevent dirt and debris from entering the hydraulic system.
3. Place a sling around the tilt cylinder and remove the retaining rings and pin at the barrel end of the tilt cylinder. Remove tilt cylinder.
4. Remove the side and top wear pads, spacers and shims from the front inside of the first boom section. Label and tag each set of wear pads being removed.



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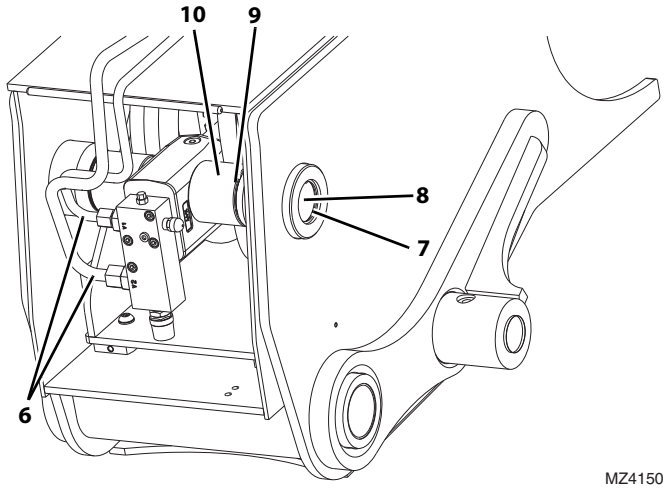
5. Disconnect both tilt hoses (**3**) and (if equipped) both auxiliary hoses (**4**) at the bottom of the first boom section. Disconnect the top tandem extend/retract cylinder hose (**5**) at the bottom of the first boom section. Plug the hose ends with plastic plugs (use plastic plugs for the needed clearance when removing the hoses from between the sections) and cap the tube ends to prevent dirt and debris from entering the hydraulic system.



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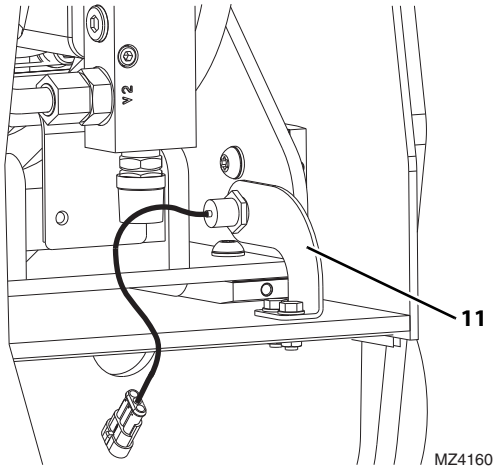
6. Disconnect both extend/retract tubes (**6**) from the tandem cylinder at the rear of the boom. Plug the tube ends and cap the cylinder fittings to prevent dirt and debris from entering the hydraulic system.
7. Remove the circlip (**7**), pin (**8**), shims (**9**) and spacer (**10**) from each side of the rear tandem cylinder rod end. Note the location and number of shims for assembly.
8. Pull the disconnected hoses and electrical cable from the rear of the boom.



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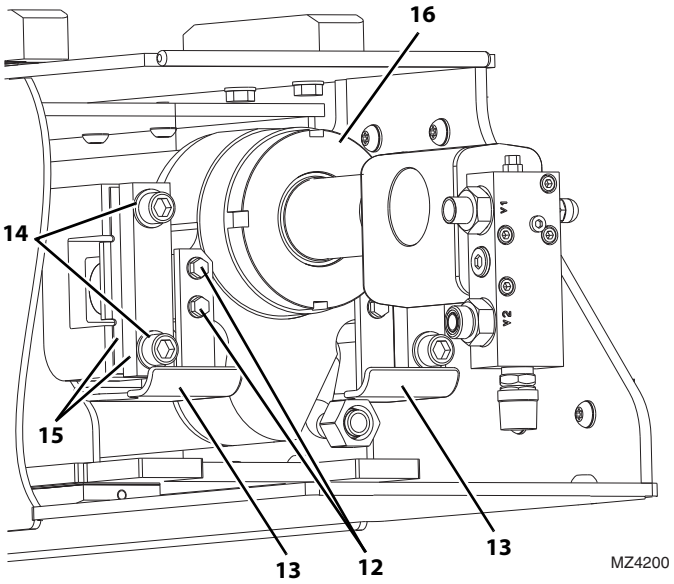
9. Remove the boom retract sensor (**11**) from the rear of the first boom section.
10. Place a sling around the second boom section, lift and slowly pull the second and third boom section approximately half way out of the first boom section. Lower the second and third boom sections onto a suitable support.

11. Relocate the sling or use two slings for better stability, balance the two boom sections and slowly pull them out of the first boom section being careful not to damage the hydraulic hoses. Lower the second and third boom sections onto suitable supports.

3.13.3 Tandem Extend/Retract Cylinder Removal



1. Remove the two hex head bolts and washers (**12**) holding each hose guard (**13**) in place and remove guards.
2. Remove the four socket head bolts and washers (**14**), clamp plate and shim (**15**) holding the extend/retract cylinder (**16**) in place at the rear of the second boom section.
3. Place a sling around the tandem extend/retract cylinder, lift and slowly pull the extend/retract cylinder approximately half way out of the rear of the third boom section. Lower the extend/retract cylinder onto a suitable support.
4. Relocate the sling or using two slings for better stability, balance the extend/retract cylinder and slowly pull the extend/retract cylinder out of the second boom section. Lower the extend/retract cylinder onto suitable supports.

3.13.4 Third Boom Section Removal

1. Remove one side and top wear pads, spacers and shims from the front inside of the second boom section. Label each set of wear pads being removed.
2. Place a sling around the third boom section, lift and slowly pull the third boom section approximately half way out of the second boom section. Lower the third boom section onto a suitable support.
3. Relocate the sling or using two slings for better stability, balance the third boom section and slowly pull the third boom section out of the second boom section. Lower the third boom section onto suitable supports.
4. Relocate the sling or use two slings for better stability, balance the third boom section and slowly pull the third boom section out of the second boom section being careful not to damage the hydraulic hoses. Lower the third boom section onto suitable supports.
5. If required, remove the clamps at the rear of the third boom section holding the tilt/electrical and auxiliary hoses.
6. Remove hoses as needed.

3.13.5 Third Boom Section Installation

Note: *During reassembly use Loctite® 242™ on all bolt threads and use Loctite 545™ on all hydraulic fittings*

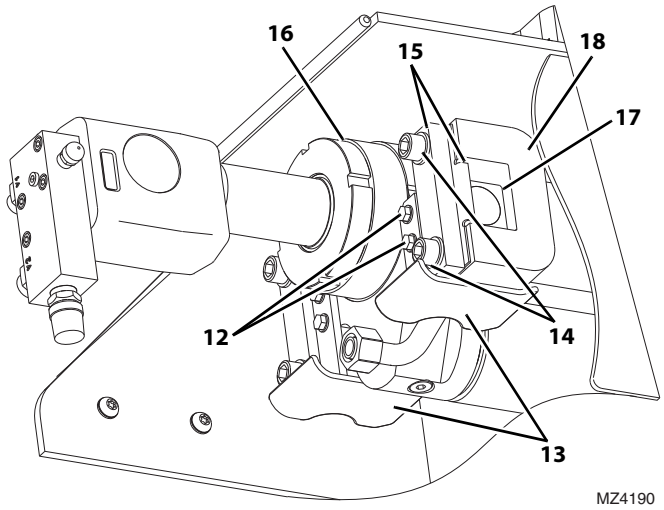
Note: *Shim all wear pads. Refer to Section 3.22, "Boom Wear Pads" You may have to final adjust the wear pads after the boom assembly is installed on the machine and hydraulic power is available.*

Note: *Coat the interior of all bushings and sheaves with CAT ADVANCED 3MOLY-NLGI Grade 2 prior to the installation of pins and bushings. Wear pads and slide areas must be lubricated with CAT ADVANCED 3MOLY-NLGI Grade 2 or an equivalent.*

1. Place the second boom section upside down on suitable supports.
2. Lubricate the inside second boom section on area's where the third boom section wear pads will slide with CAT Advanced 3Moly - NLGI 2.
3. Using a suitable sling, balance the third boom section and carefully slide into the front of the second boom section.
4. Set the third boom section onto a suitable support and reset the sling under the boom head of the third boom section. Carefully slide the third boom section into the second boom section leaving room to install the previously removed wear pads, spacers and shims.
5. Install the previously removed wear pads, spacers and shims on the front inside of the second boom section. Apply Loctite® 242™ and torque the wear pad mounting bolts to 92-106 Nm (68-78 lb-ft).
6. With the third boom section installed in the second boom section, the extend/retract cylinder is ready to be installed into the third boom section.

3.13.6 Tandem Extend/Retract Cylinder Installation

1. Lubricate the inside third boom section on area's where the extend/retract cylinder wear pad will slide with CAT Advanced 3Moly - NLGI 2
2. Apply CAT Multipurpose Grease - NLGI Grade 2 to the trunnion blocks on the extend/retract cylinder and to the trunnion supports at the rear of the second boom section.
3. Connect the extend/retract cylinder hose to the tube connection at the rear of the extend/retract cylinder.
4. Place a sling around the tandem extend/retract cylinder and slowly insert the extend/retract cylinder halfway into the rear of the rear of the third boom section. Lower the extend/retract cylinder onto a suitable support.
5. Relocate the sling and install the extend/retract cylinder the remainder of way into the second boom section.



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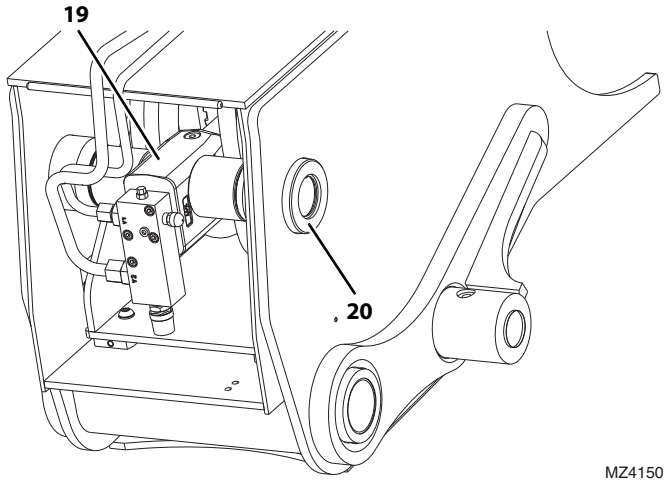
6. Align the trunnion blocks (**17**) of the extend/retract cylinder with each support (**18**) at the rear of the second boom section.
7. Apply Loctite® 242™ to the four socket head bolts (**14**).
8. Install each clamp plate and shim(**15**) holding the extend/retract cylinder (**16**) in place at the rear of the second boom section. Install the four socket head bolts and washers (**14**) and torque to 250 Nm (185 lb-ft).
9. Apply Loctite® 242™ to the four hex head bolts (**12**).
10. Install each hose guard (**13**) to the extend/retract cylinder (**16**). Install the four hex head bolts and washers (**12**) and torque to 28 Nm (21 lb-ft).

3.13.7 Second and Third Boom Section Installation

1. Place the first boom section upside down on suitable supports.
2. Lubricate the inside first boom section on area's where the second boom section wear pads will slide.
3. Using a suitable sling, balance the second and third boom sections and carefully slide into the front of the first boom section.
4. Set the second and third boom sections onto a suitable support and reset the sling under the boom head of the third boom section.



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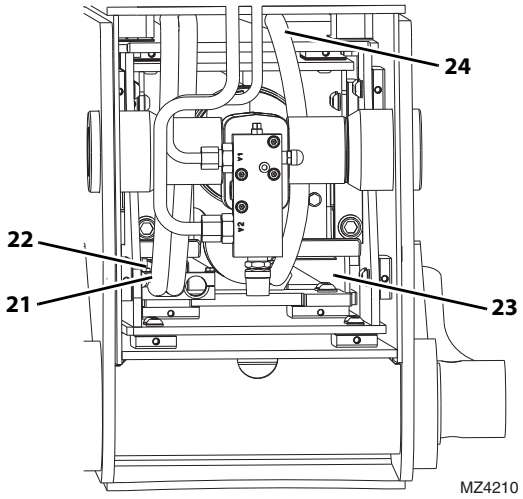
5. Carefully slide the second and third boom sections into the first boom section until the extend/retract cylinder rod (**19**) aligns with the mounting pin bores (**20**) in the rear of the first boom section.



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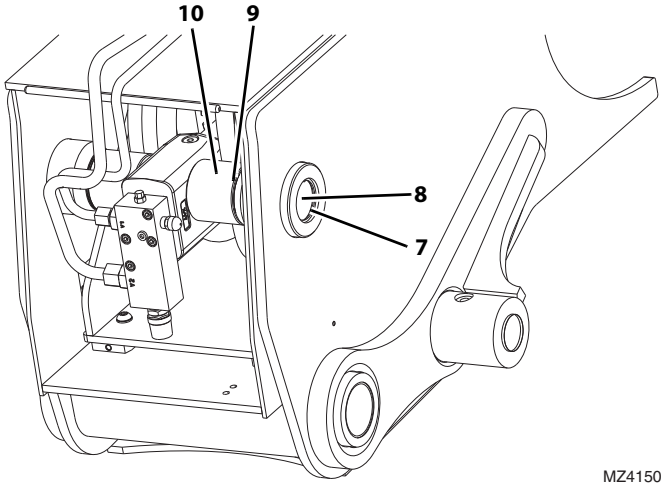
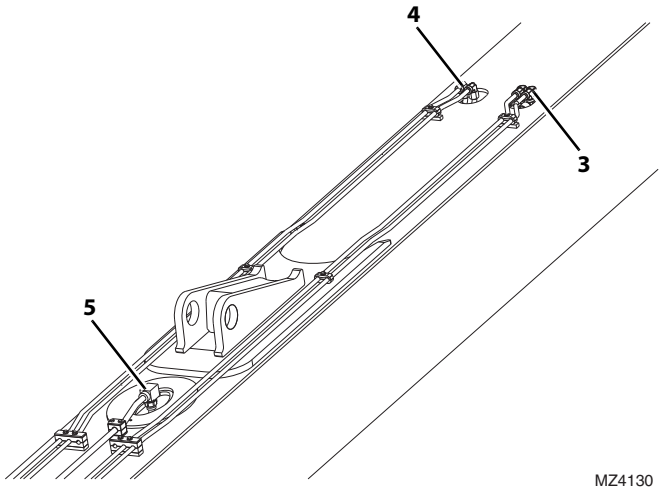
6. Feed the tilt cylinder hoses/electrical cable (**21**) and auxiliary hoses (not shown) through the top left (**22**) (tilt) and top right (**23**) (auxiliary) of the third boom section.

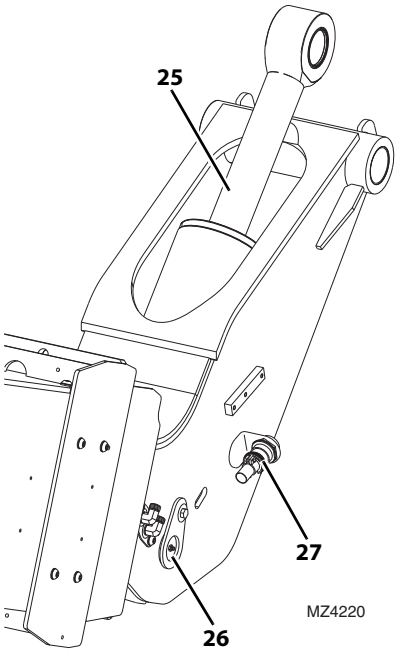
7. Feed the remainder of the tilt cylinder hoses/electrical cable (**21**) (if equipped) and auxiliary hoses between the first and second boom sections.
8. Feed the extend/retract cylinder hose (**24**) between the first and second boom sections.



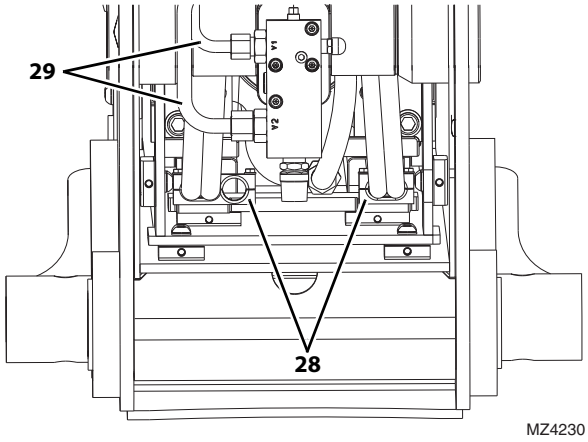
9. Install the extend/retract cylinder pivot pin (**7**), spacers (**10**), shims (**9**) and circlips (**8**).
10. Install the previously removed wear pads, spacers and shims on the front inside of the first boom section. Apply Loctite® 242™ and torque the wear pad mounting bolts to 92 - 106 Nm (68 - 78 lb-ft).



11. Connect the extend/retract cylinder hose (**5**) to the tube fitting on the bottom of the first boom section.
12. Connect the tilt hoses (**3**) and auxiliary hoses (**4**) to the proper tube fittings on the bottom of the first boom section.
13. Connect the auxiliary hoses to the quick disconnects on the side of the boom head.
14. Connect the electrical cable to the plug mounted below the auxiliary quick disconnects if equipped.
15. Secure the electrical cable to the tilt hoses on the bottom of the first boom section.



16. Install the tilt cylinder (**25**) in the boom head, install the mounting pin (**26**) and keeper bolt, locking the mounting pin and tilt cylinder into position.
17. Connect the tilt cylinder hoses to the proper fittings on the tilt cylinder.
18. Connect the electrical plug to the previously labeled electrical cable.
19. Install the electrical plug (**27**) on the side of the boom head.



20. Install the tilt hose and auxiliary hoses clamps (**28**) at the rear of the second boom section.
21. Install both extend/retract cylinder tubes (**29**) to the proper fittings on the extend/retract cylinder and clamp in place on the bottom of the first boom section.

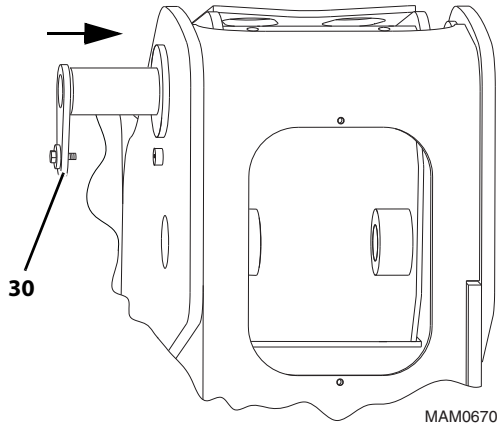
22. Install the previously removed boom retract sensor. Refer to Section 3.27, "Boom Retract Sensor Adjustment", for detailed adjustment instructions.

3.13.8 Complete Boom Installation

Note: *Lubrication of the boom wear surfaces with CAT Multipurpose Grease is recommended to keep the boom wear surfaces lubricated properly. Lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.*

1. Park the machine on a hard, level surface, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.

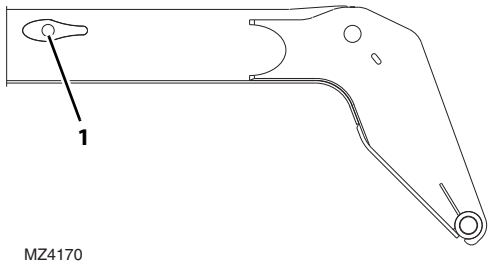
Note: *Grease the boom pivot bore, compensating cylinder rod ends, lift/lower cylinder rod end and pins before installing.*



4. Using suitable slings, balance the boom assembly, lift and carefully guide the boom into place. Align the frame pivot bore with the boom assembly pivot bore. Install boom pivot pin and lock bolt (**30**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).
5. With the sling still in place, install the compensating cylinders, pins and lock bolts. Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).
6. With the sling still in place, install the rod end of the lift/lower cylinder, pin and lock bolt. Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).

Note: *Raising the boom up or down with the sling may be necessary so the boom, compensating and lift/lower cylinder bores can be aligned for easier pin installation.*

7. Uncap and connect the previously labeled extend/retract cylinder hoses to the extend/retract cylinder tubes.
8. Uncap and connect the previously labeled tilt hoses and (if equipped) auxiliary hoses to the appropriate tube fittings.
9. Install the boom angle sensor arm. Refer to Section 9.14.7, "Boom Angle Sensor".
10. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
11. Start the engine and slowly extend boom to allow access to the tandem extend/retract cylinder mounting pin in the third boom section (**1**).
12. Shut engine OFF.



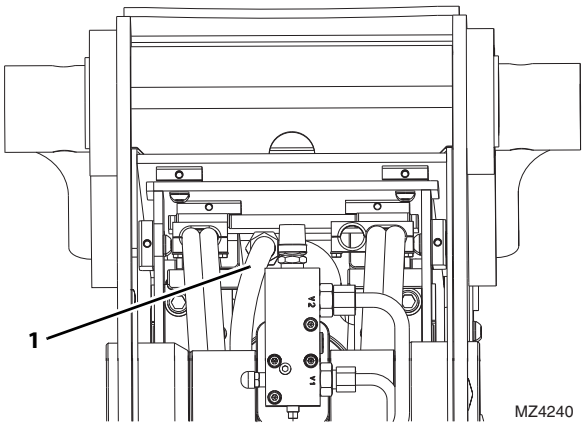
13. Align the tandem extend/retract cylinder rod and install the mounting pin (**1**) and retaining rings.
14. Install the previously removed Quick Coupler. Refer to Section 3.23.4, "Quick Coupler Installation (TH414C, TH514C & TH417C)".
15. Start the engine and operate all boom functions several times to bleed any air out of the hydraulic system. Check for fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
16. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.
17. Close and secure the engine cover.
18. Install previously removed attachment.

3.14 EXTEND/RETRACT, TILT AND AUXILIARY CIRCUIT HOSE REMOVAL/ INSTALLATION

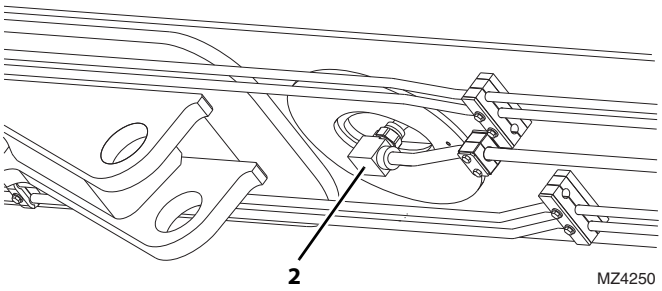
Hoses that need replaced can be removed and replaced without removing sections of the boom.

3.14.1 Extend/Retract Hose Removal

1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.
2. Park the machine on a hard, level surface, fully retract the boom, level the boom assembly, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Open the engine cover. Allow the system fluids to cool.
5. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



6. Label, disconnect and cap the hose from the extend/ retract cylinder tube (**1**) at the rear of the boom. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.



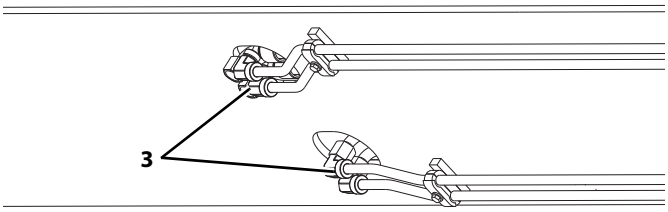
7. Disconnect and cap the hose (**2**) from the extend/ retract cylinder tube at the fitting on the bottom of the boom. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
8. From the rear of the boom, pull the extend/retract hose from between the first and second boom sections.

3.14.2 Extend/Retract Hose Installation

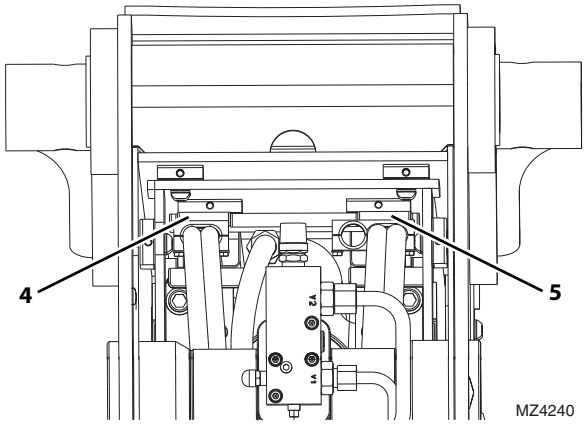
1. Slowly push the new extend/retract hose between the first and second boom sections until the hose end is visible at the tube fitting connection under the first boom section.
2. Uncap and connect the hose to the previously labeled tube under the first boom section.
3. Uncap and connect the hose to the previously labeled tube at the rear of the extend/retract cylinder.
4. Refer to Section 2.8, "Hydraulic Connection Assembly and Torque Specification", for proper hose torque.
5. Tighten the clamp holding the extend/retract hose at the rear of the second boom section.

3.14.3 Tilt-Electrical/Auxiliary Hose Removal

1. Label, disconnect and cap both hoses from the tilt cylinder or auxiliary fittings at the front of the boom. Disconnect the electrical plug connection from the boom head. Label and remove the electrical plug from the end of the electrical cable. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
2. Cut nylon ties securing the electrical cable (if equipped) from the tilt hoses.



3. Label, disconnect and cap both hoses attached to the tubes on the bottom of the boom (**3**). Plug the hose ends with plastic plugs (use plastic plugs for the needed clearance when removing the hoses from between the sections) and cap the tube ends to prevent dirt and debris from entering the hydraulic system.



4. Loosen the clamps holding the tilt (**4**) or auxiliary hoses (**5**) at the rear of the second boom section.
5. From the rear of the boom, pull the tilt (**4**) or auxiliary hoses (**5**) from between the first and second boom sections.
6. Pull the tilt (**4**) or auxiliary hoses (**5**) from the third boom section.

3.14.4 Tilt-Electrical/Auxiliary Hose Installation

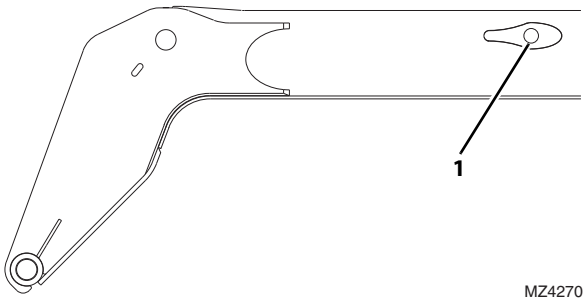
1. Slowly push the new hoses between the first and second boom sections until the hose ends are visible at the tube fitting connections under the first boom section.
2. Uncap and connect the previously remove hoses to the proper fittings and tighten.
3. Feed the remaining tilt cylinder hoses or auxiliary hoses through the top left (tilt) and top right (auxiliary) third boom section.
4. Uncap and connect the tilt hoses or auxiliary hoses to the proper fitting at the boom head.
5. Connect the electrical plug to the previously labeled electrical cable.
6. Install the electrical plug on the side of the boom head.
7. Refer to Section 2.8, “Hydraulic Connection Assembly and Torque Specification”, for proper hose torque.
8. Tighten the clamp holding the tilt hoses or auxiliary hoses at the rear of the second boom section.

3.15 TANDEM EXTEND/RETRACT CYLINDERS REMOVAL/INSTALLATION

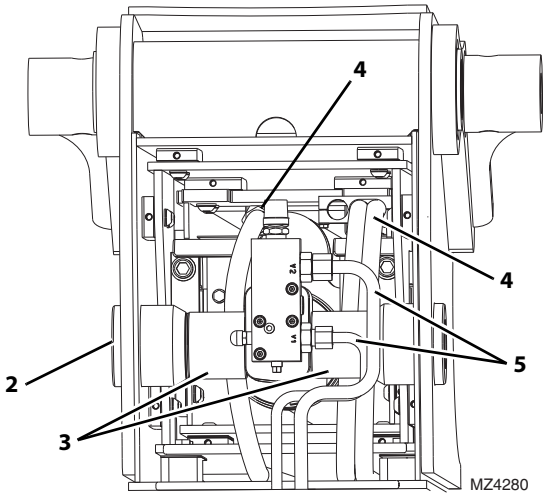
The tandem extend/retract cylinders hydraulically extends and retracts the second and third boom sections.
Seal kits for the extend/retract cylinders are available from the local Caterpillar dealer.

3.15.1 Tandem Extend/Retract Cylinders Removal

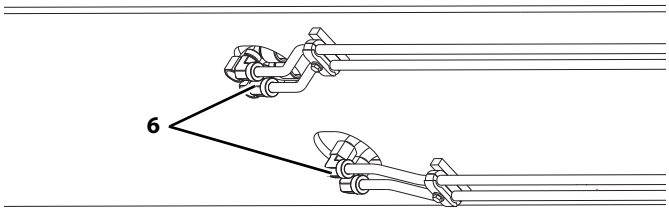
1. Remove any attachment from the quick coupler assembly. Refer to Operation & Maintenance Manual.



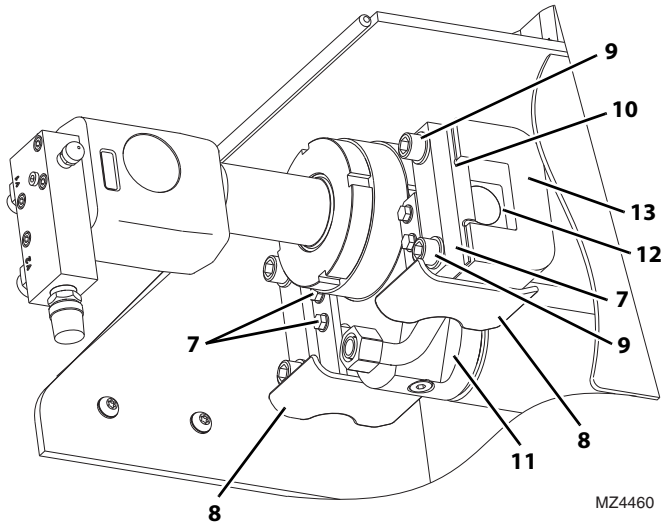
2. Park the machine on a hard, level surface, place the transmission in (N) NEUTRAL, engage the park brake. Extend the boom to allow access to the tandem extend/retract cylinder mounting pin in the third boom section (**1**).
3. Remove the retaining rings and mounting pin (**1**).
4. Raise the boom assembly and retract the extend/retract cylinder allowing the third boom section to retract along with the extend/retract cylinder.
5. Lower the boom assembly to a level position and shut the engine OFF.
6. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
7. Open the engine cover. Allow the system fluids to cool.
8. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.



9. Remove the rod end pin (**2**). Note the location of the spacers and washers (**3**).
10. Loosen and remove the extend/retract cylinder hose (**4**) at the tube fitting on the extend/retract cylinder. Plug the hose end to prevent dirt and debris from entering the hydraulic system.
11. Loosen and remove both tubes (**5**) at the end of the extend/retract cylinder.
12. Remove both clamps under the first boom section holding the extend/retract cylinder tubes.



13. Label, disconnect and cap the tilt circuit and the auxiliary circuit hoses (**6**) at the bottom of the first boom section. Cap all fittings and openings to prevent dirt and debris from entering the hydraulic system.
14. Pull the tilt hoses and/or auxiliary hoses from between the first and second boom sections. Secure the hoses away from the extend/retract cylinder.



15. Remove the two hex head bolts and washers (**7**) holding each hose guard (**8**) in place and remove guards.
16. Remove the four socket head bolts and washers (**9**), clamp plate and shim (**10**) holding the extend/retract cylinder (**11**) in place at the rear of the second boom section.
17. Place a sling around the tandem extend/retract cylinder, lift and slowly pull the extend/retract cylinder approximately half way out of the rear of the boom assembly. Lower the extend/retract cylinder onto a suitable support.
18. Relocate the sling or using two slings for better stability, balance the extend/retract cylinder and slowly pull the extend/retract cylinder free of the machine. Lower the extend/retract cylinder onto suitable supports.

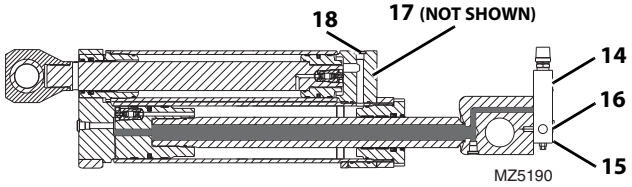
3.15.2 Tandem Extend/Retract Cylinders Bleeding Procedure

This procedure must be followed to assure no air is trapped within the tandem extend/retract cylinders. An auxiliary pump and reservoir must be used to properly fill the tandem extend/retract cylinders.

Port Thread Sizes:
V1 & V2 - 1 1/16-12 SAE UNF/2B
C1 - M16x1,5
C2 - M30x2

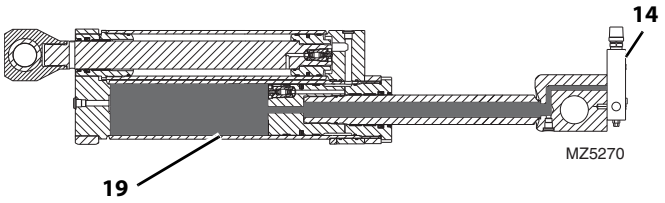
Note: *Use only metal plugs on ports utilized during the procedure.*

Note: *Clean the area around each port before starting the bleeding procedure.*



Note: *Allow adequate space for both cylinder rods when extended.*

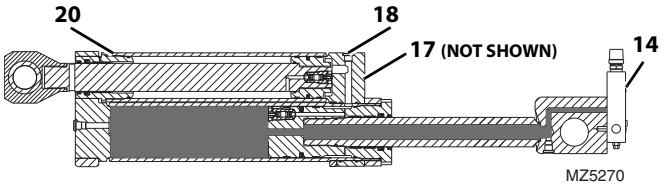
1. Connect the auxiliary pump to the V2 port (**14**) on the (rear) load control valve (**15**). Plug the V1 port (**16**). Plug C1 Port (tube end) (**17**). Remove the plug on the top port C2 (**18**).



2. Slowly fill the bottom tandem cylinder (**19**) using the V2 port (**14**) until the cylinder rod is fully extended.

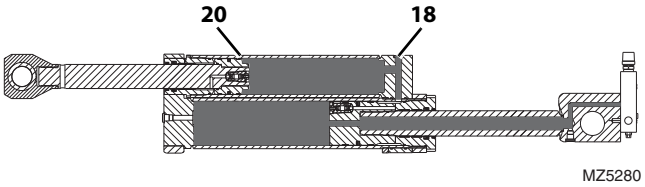
Note: *Fill each cylinder using a maximum of 10 - 20 bar (145 - 290 psi).*

Note: *Approximately 38 liters (10 gal) of hydraulic oil is required to fill the bottom cylinder.*



3. Plug the V2 port (**14**). Connect the auxiliary pump to the C2 port (**18**) on the top cylinder (**20**). Remove plug from C1 port (tube end) (**17**) and connect to reservoir.

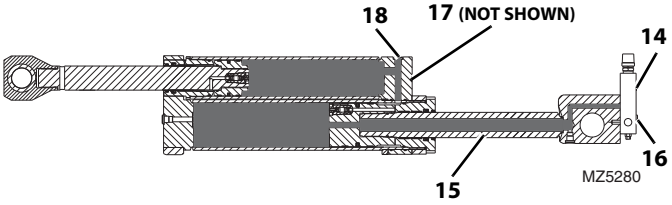
Note: *Use a reservoir with a minimum capacity of 70 liter (18 gal).*



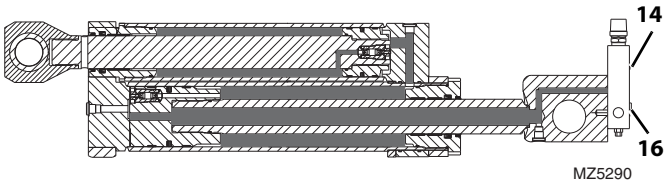
4. Slowly fill the top tandem cylinder (**20**) using the C2 port (**18**) until the cylinder rod is fully extended.

Note: *Approximately 24 liters (6 gal) of hydraulic oil is required to fill the bottom cylinder.*

5. Both tandem extend/retract cylinder rods are now fully extended.



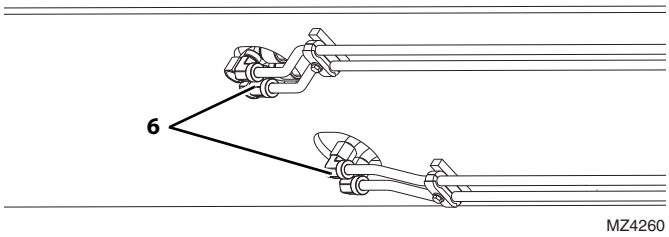
6. Plug C2 port (**18**). Connect C1 port (**17**) to the V1 port (**16**) using a tee fitting and hose. Connect the open end tee fitting to the auxiliary pump. Connect the V2 port (**14**) to reservoir.



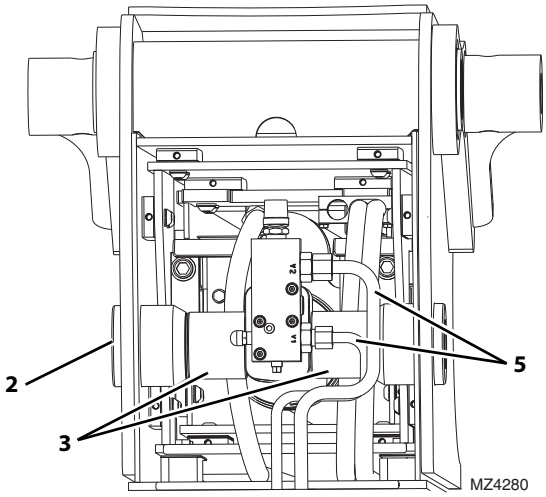
7. Slowly fill the tandem extend/retract cylinders using the V1 port (**16**) until both cylinder rods are fully retracted. Keep the cylinders pressurized for approximately two minutes.
8. Remove the fittings and hose from the V1 (**16**) and V2 (**14**) ports and install plugs.
9. For tandem extend/retract cylinder installation, refer to Section 3.15.3, "Tandem Extend/Retract Cylinders Installation".
10. After tandem extend/retract cylinder installation, start machine and cycle the tandem extend/retract cylinder twice at maximum idle and maximum stroke. Keep the cylinders pressurized for approximately one minute.
11. Shut engine OFF. Verify the tandem extend/retract cylinder is leak free. Check hydraulic fluid level and add if necessary.

3.15.3 Tandem Extend/Retract Cylinders Installation

1. Using two slings for better stability, balance the extend/retract cylinder and slowly push the extend/retract cylinder approximately half way into the rear of the boom assembly. Lower the extend/retract cylinder onto a suitable support.
2. Align the trunnion blocks (**12**) of the extend/retract cylinder (**11**) with each support (**13**) at the rear of the second boom section.
3. Apply Loctite® 242™ to the four socket head bolts (**9**).
4. Install each clamp plate and shim (**10**) holding the extend/retract cylinder (**11**) in place at the rear of the second boom section. Install the four socket head bolts and washers (**9**) and torque to 250 Nm (185 lb-ft).
5. Apply Loctite® 242™ to the four hex head bolts (**7**).
6. Install each hose guard (**8**) to the extend/retract cylinder (**11**). Install the four hex head bolts and washers (**7**) and torque to 28 Nm (21 lb-ft).

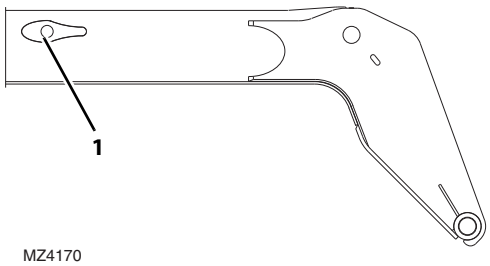


7. Install the tilt hoses and auxiliary hoses (**6**) between the first and second boom sections.



8. Align the rod end of the tandem extend/retract cylinder and the mounting bore at the rear of the first boom section. Install the rod end pin (**2**), spacers and shims (**3**). Secure with the retaining clips.
9. Connect both tubes (**5**) to the appropriate locations at the end of the extend/retract cylinder.

10. Install both clamps under the first boom section holding the extend/retract cylinder tubes.
11. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
12. Close and secure the engine cover.



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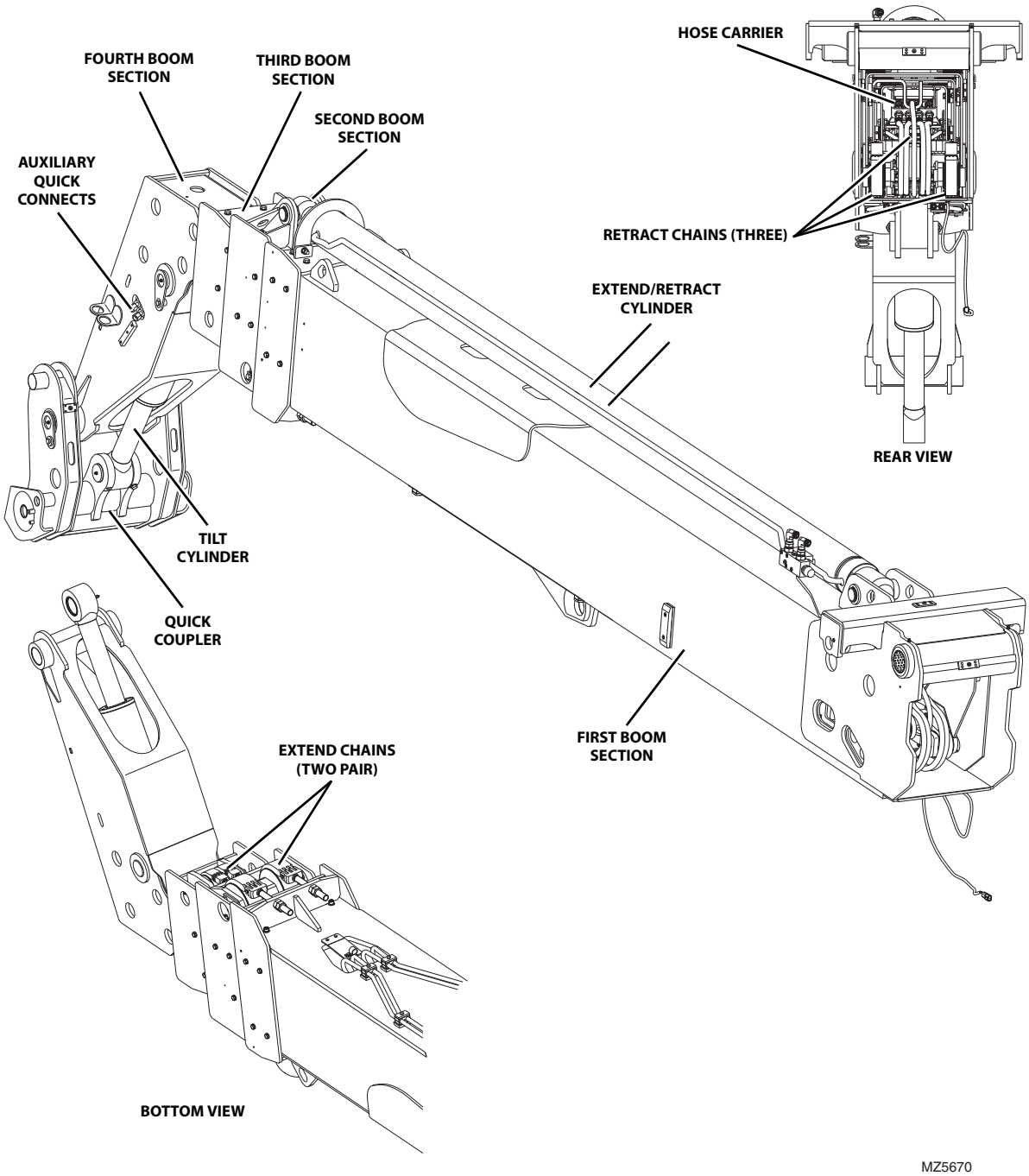
13. Start the engine and slowly extend boom to allow access to the tandem extend/retract cylinder mounting pin in the third boom section (**1**).
14. Shut engine OFF.
15. Align the tandem extend/retract cylinder rod and install the mounting pin (**1**) and retaining rings.
16. Start the engine and operate all boom functions several times to bleed any air out of the hydraulic system. Check for fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
17. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.

3.16 BOOM SYSTEM COMPONENT TERMINOLOGY - TH417C

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the name and location of the major assemblies of the boom system. The following illustration identifies the components that are referred to throughout this section.



3.17 BOOM SYSTEM - FOUR SECTION BOOM

3.17.1 Boom System Operation

The four section boom consists of the first, second, third and fourth assemblies with double third and fourth section extend chains, a double third section retract chains and a single fourth section retract chain.

As the extend/retract cylinder, which is anchored at the front of the second boom section, and the rear of the first boom section begins to extend, it forces the second boom section out of the first boom section.

The first, second, third and fourth boom sections are connected by extend and retract chains. These chains are routed around sheaves on the second and third boom sections. As the second and third boom sections are forced out, the extend chain pulls the fourth boom section out of the third boom section.

As hydraulic pressure is applied to the retract port on the extend/retract cylinder, the second boom section is pulled back into the first boom section, and the retract chain pulls the third and fourth boom sections back into the second boom section.

This mechanical linkage formed by the chains and supporting hardware, extends and retracts the third and fourth boom sections at the same rate.

The first boom section does not extend or retract, but lifts and lowers via action of the lift cylinder.

3.18 BOOM ASSEMBLY MAINTENANCE

These instructions must be completed in sequence. The second, third and fourth boom sections are removed from the first boom section.The third and fourth boom sections are removed from the second boom section.The fourth boom section is removed from the third boom section.

Before beginning, conduct a visual inspection of the machine and work area, and review the task about to be undertaken. Read, understand and follow these instructions.

3.18.1 Boom Removal

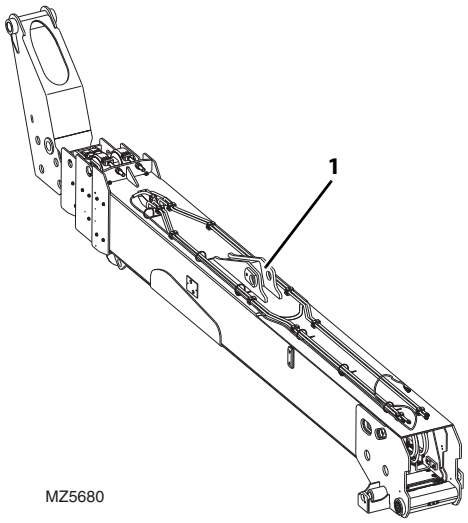
1. Remove any attachment from the quick coupler assembly.

Note: *If replacing the innermost boom section, remove the quick coupler assembly. Refer to Section 3.23.3, "Quick Coupler Removal (TH414C, TH514C & TH417C)".*

2. Park the machine on a firm, level surface. Be sure there is enough room in front of the machine to allow the boom sections to be removed. Fully retract the boom then raise the boom to access the rod end pin of lift cylinder. Place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Open the engine cover. Allow the system fluids to cool.
5. Label, disconnect and cap both hoses from the Extend/Retract cylinder.
6. Label, disconnect and cap both hoses from the tilt hoses and auxiliary hoses from tubes at the bottom rear of the first boom section. Cap all fittings to prevent dirt and debris from entering the hydraulic system.
7. Remove the Extend/Retract cylinder support at the top front of the first boom section.
8. Support the Extend/Retract cylinder and remove the clip and pin from rod end of extend/retract cylinder. Remove the clip and pin from barrel end of extend/retract cylinder and remove the extend/retract cylinder.
9. Disconnect the boom angle indicator rod from the switch at the inside left rear corner of the main boom section and frame.
10. Support the front of the boom by placing a sling behind the boom head. Support the Lift/Lower cylinder and remove the lock bolt and then the rod end pin. Lower the Lift/Lower cylinder onto the frame rails.
11. Remove the lock bolt and pin from Compensation cylinder on each side of first boom section. Remove the lock bolt and pivot pin from rear of first boom section.

12. Lower the boom to a level position and place a suitable support under the boom head. Reposition the slings to each end of the boom.
13. Lift the complete boom off machine and set on level ground or supports being careful not to damage the tubes on the left side of boom.

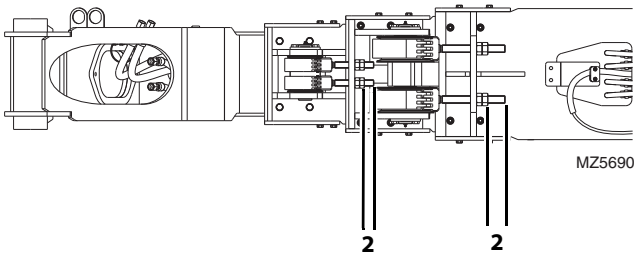
3.18.2 Second, Third and Fourth Boom Section Removal



1. Set the complete boom on level ground and by repositioning the slings turn boom over on to the top side. Set the complete boom (**1**) on suitable stands to begin tear down.

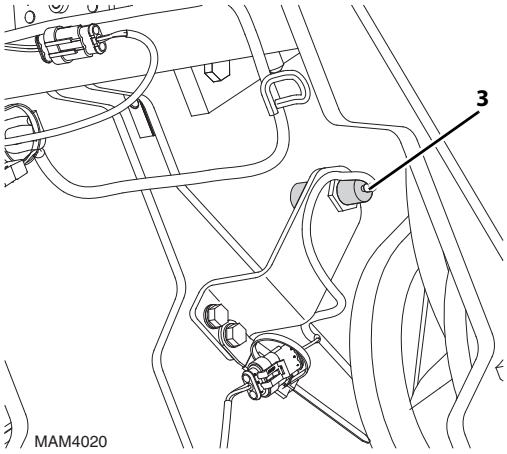
Note: *With the complete boom setting upside down, the removal and replacing of each boom section, tilt cylinder, hoses, extend and retract chains and hose carrier are made much easier.*

2. At the boom head attach a sling through rod end of tilt cylinder. Label, disconnect and cap both hoses from tilt cylinder. Plug the cap all fittings to prevent dirt and debris from entering the hydraulic system. Remove the clip from barrel end of tilt cylinder pin. Remove the tilt cylinder pin and lift the tilt cylinder out of the boom head.
3. Use a suitable sling around the third section boom to take any pressure off of wear pads to make pad removal easier.



Note: *Before removing the extend chains, measure the distance (**2**) between the face of the jam nut to the end of the chain clevis on all four extend chains. This measurement will be used when reassembling the boom.*

4. At the bottom front of the first boom section, remove the jam nuts and nuts and washers from the two extend chain clevises. Remove clips and pins from the two clevises and remove clevis from each chain.
5. At the bottom front of the second boom section remove the jam nuts and nuts and washers from the two extend chain clevises. Remove clips and pins from the two clevises and remove clevis from each chain.



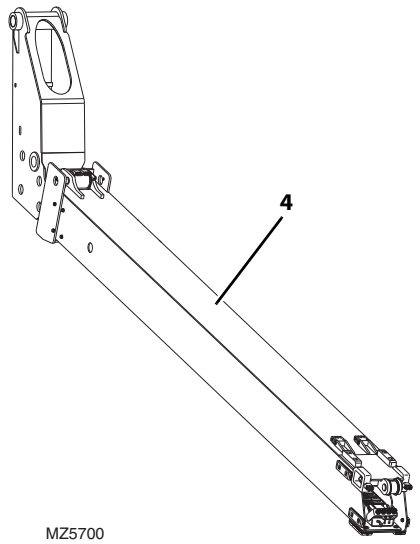
6. Disconnect and remove the boom retract sensor (**3**) from the rear of the first boom section.
7. At the rear of the boom, label, disconnect and cap both tilt hoses and both auxiliary hoses from the bulkhead on the hose carrier. Cap all fittings to prevent dirt and debris from entering the hydraulic system.
8. Remove the clip and pin from both retract chain clevises that are attached to the rear of the third section boom. The pins can be removed through the access holes at the bottom left and right sides of the first section boom. Do not remove the clevises.

9. Remove the clip and pin from the retract chain clevis that is attached to the rear of the fourth boom section. Do not remove the clevis.
10. Pull the second section boom out 152 - 203 mm (6 - 8 in) and remove all the wear pads from the front inside of the first section boom. Label all parts for installation.
11. Pull the third boom section out 152 - 203 mm (6 - 8 in). Remove the top left and right side wear pads from the second boom section. Loosen the bottom rear wear pad bolts and remove the shims from the second boom section to gain the necessary clearance to be able to remove the second boom section from the first boom section. Label all parts for installation.
12. Using a sling around the front of the second boom section, lift and slide the three boom sections 75% of the way out of the first boom section. Set the boom head down on a suitable support, then center the sling to be able to balance the three boom sections being removed. Carefully pull the three boom sections the remainder of the way out of the first boom section and set the three boom sections down on suitable supports.
13. Remove the clip and pin holding each retract chain from the inside of the first boom section. Clean and inspect chains. Replace if damaged.
14. Label, disconnect and cap the Tilt and Auxiliary hydraulic hoses from tubes at bottom front of first boom section. Plug all fittings to prevent dirt and debris from entering hydraulic system. Clean and inspect the hoses. Replace if damaged.
15. Inspect the boom and welds. Consult your local authorized service distributor if structural damage is detected.
16. Inspect hoses, hardware, wear pads, mounting points, chains and other components visible with the first boom section. Replace any item if damaged. (Refer to Section 3.21, "Boom Extend and Retract Chains - TH414C & TH417C", and Section 3.22.1, "Wear Pad Inspection").

Note: *It is recommended that if any chain or hose is damaged that ALL chains or hoses are replaced.*

3.18.3 Third and Fourth Boom Section Removal

1. With the three boom sections setting on suitable supports remove bolts, keeper and pin from both sheaves on the bottom front of the second boom section. Remove sheaves. Remove all wear pads on the front inside of the second boom section. Label all parts for installation.
2. Remove the bolts, keeper and pin from center sheave on the bottom rear of the third boom section. Remove the sheave.
3. Remove the top left and right side rear wear pads on the third boom section. Loosen the bottom rear wear pad bolts and remove the shims from the third boom section to gain the necessary clearance to remove the third boom section from the second boom section. Label all parts for installation.

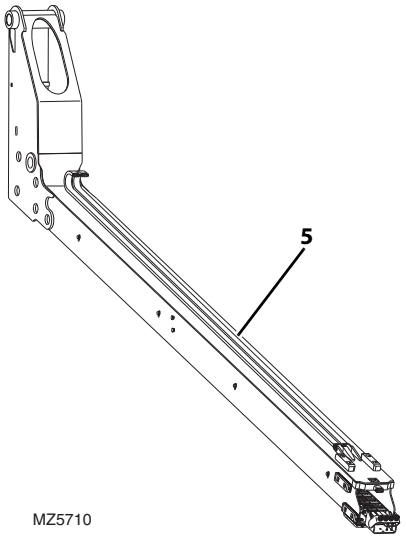


4. Place a sling around the front of the third boom section. Lift and slide the two boom sections 75% of the way out of the second boom section. Set the boom head down on a suitable support, then center the sling to be able to balance the two boom sections being removed. Carefully pull the two boom sections (**4**) the remainder of the way out of the second boom section and set the two boom sections down on suitable supports.
5. Remove the lock bolts, keeper and pin from both sheaves at bottom rear of the second section boom. Remove the sheaves.
6. Remove the clip and pin holding retract chain from bottom front of second boom section. Clean and inspect chain. Replace if damaged.
7. Inspect the boom and welds. Consult your local authorized service distributor if structural damage is detected.
8. Inspect hoses, hardware, wear pads, mounting points, chains and other components visible with the first boom section. Replace any item if damaged. (Refer to Section 3.21, "Boom Extend and Retract Chains - TH414C & TH417C", and Section 3.22.1, "Wear Pad Inspection").

9. It is recommended that if any chain or hose is damaged that ALL chains or hoses are replaced.

3.18.4 Fourth Boom Section Removal

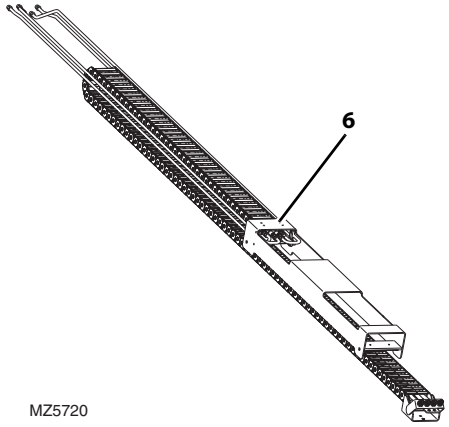
1. With the two boom sections setting on suitable supports remove the bolts, keeper and pin from sheave on the front of the third boom section. Remove the sheaves. Remove all wear pads, from the front inside of the third boom section. Label all parts for installation.
2. Remove the top left and right side rear wear pads on the fourth boom section. Loosen the bottom rear wear pad bolts and remove the shims from the fourth boom section to gain the necessary clearance to be able to remove the fourth boom section from the third boom section. Label all parts for installation.
3. Loosen and remove the two bolts holding the rear of the hose carrier to the top of the third boom section. Lift and push rear of hose carrier into the fourth boom section.



4. Place a sling around the front of the fourth boom section (**5**). Lift and slide the fourth boom section 3/4 of the way out of the third boom section. Set the boom head down on a suitable support, then center the sling to be able to balance the fourth boom section being removed. Carefully pull the fourth boom section the remainder of the way out of the third boom section and set the fourth boom section down on suitable supports.
5. Remove the clip and pin holding both extend chains from bottom of third and fourth boom sections. Clean and inspect chains. Replace if damaged.
6. Inspect the boom and welds. Consult your local authorized service distributor if structural damage is detected.
7. Inspect hoses, hardware, wear pads, mounting points, chains and other components visible with the first boom section. Replace any item if damaged. (Refer to Section 3.21, “Boom Extend and Retract Chains - TH414C & TH417C”, and Section 3.22.1, “Wear Pad Inspection”).
8. It is recommended that if any chain or hose is damaged that ALL chains or hoses are replaced.

3.18.5 Hose Carrier Removal

1. Label, disconnect and cap both auxiliary hydraulic hoses in the boom head. Cap all fittings to prevent dirt and debris from entering hydraulic system.
2. With fourth boom section setting on suitable supports loosen and remove the six bolts (three per side) on the fourth boom section.

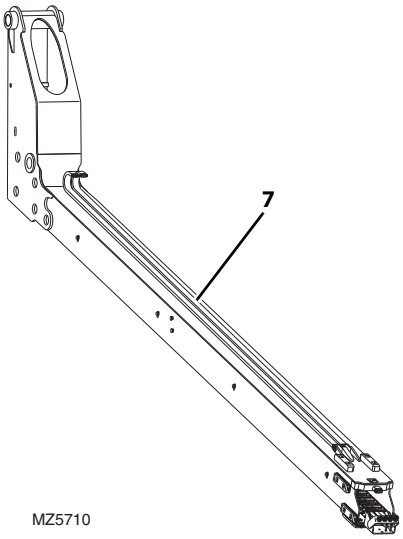


3. Pull the hose carrier (**6**) halfway out of fourth boom section by hand and set on a suitable support. Place a sling around the center of the hose carrier to be able to balance the hose carrier while being removed. Carefully slide the hose carrier the remainder of the way out of the fourth boom section and set down on suitable supports.

3.18.6 Hose Carrier Installation

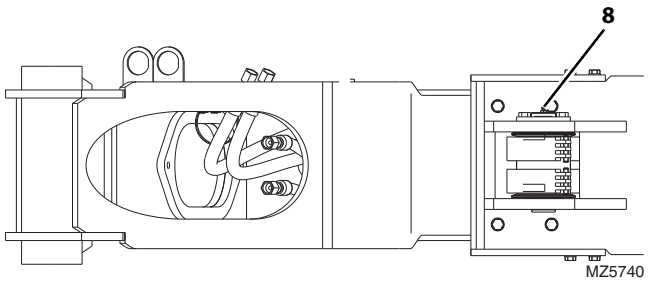
1. Install the hose carrier into the fourth boom section. Using a suitable sling, place the sling under the center of the hose carrier and guide the front of hose carrier into the rear of the fourth boom section. Set the rear of the hose carrier on a suitable support. Remove the sling and slide the remainder of the hose carrier into the fourth boom section by hand.
2. Apply Loctite® 242™ to the hose carrier bolts. Install the bolts through the three holes on each side of the fourth boom section. Install the front two bolts first. Install the middle two next. Then the rear two bolts last. Torque to all six bolts to 90 Nm (66 lb-ft).

3.18.7 Fourth Boom Section Installation



1. Apply Loctite® 242™ to the wear pad mounting bolts. Install the bottom, left right and top wear pads. Do not shim or tighten the side and top wear pad bolts at this time. Install both extend chains (**7**) on bottom rear of fourth boom section. Lay extend chains the length of fourth boom section.
2. Grease the inside third boom section on area's where the fourth boom section wear pads will slide.
3. Using a suitable sling, balance the fourth boom section and carefully slide 914 - 1219 mm (3 - 4 ft) into the front of the third boom section. Set the fourth boom section head onto suitable support and reset sling under the boom head of the fourth boom section. Carefully slide the fourth boom section into the third boom section. Leave 1829 - 2438 mm (6 - 8 ft) of the fourth boom section out to be able to install wear pads in front of the third boom section.
4. With the sling still under boom head install the top wear pads. Lower the fourth boom section and install the bottom, left and right side wear pads. Do not shim or tighten bolts at this time.

Note: *Grease wear pads, inside sheaves, bores and pins during assembly.*



5. Apply Loctite® 242™ to the sheave mounting bolts, Install the sheave (**8**), pin, lock plate and bolts at the bottom front of the third boom section. Torque bolts to 90 Nm (66 lb-ft). Grease the sheave using the grease fitting in the pin. Spin the sheave by hand to ensure the sheave spins freely on the pin and to distribute grease evenly. Pull both extend chains from the fourth boom section around the front and over the sheave. Install both chain clevises, pins and clips.
6. Retract the fourth boom section the remainder of the way into the third boom section and install the wear pads at the rear of third and fourth boom sections.
7. Apply Loctite® 242™ to the wear pad mounting bolts and install the bottom left and right side wear pads, backing plates, shims and bolts. Shim the top wear pads on the rear of the fourth boom section. Shim the top left and right wear pads on the rear of the fourth boom section. Torque bolts to 90 Nm (66 lb-ft). Torque grease fitting bolts to 45 Nm (33 lb-ft).

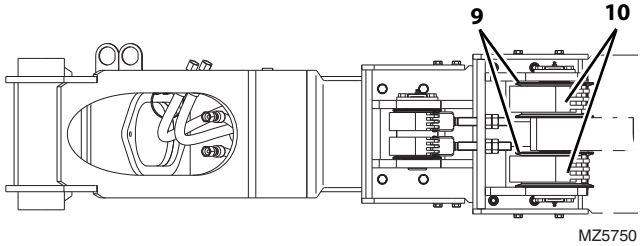
3.18.8 Third and Fourth Boom Section Installation

1. At the rear of the third boom section apply Loctite® 242™ to the wear pad mounting bolts and install the bottom rear wear pads, washers and bolts. Torque to 90 Nm (66 lb-ft). Install the bottom rear left and right side wear pads, backing plate and bolts (do not shim or tighten bolts). Install the top rear wear pads, backing plates and bolts (front bolts are drilled and tapped for grease fittings. do not shim or tighten bolts). Install both extend chains on the bottom rear of the third boom section. Lay extend chains the length of third boom section.
2. Grease the inside second boom section on areas where the third boom section wear pads will slide.
3. Install retract chain, pin and clip to bottom front inside of the second boom section.

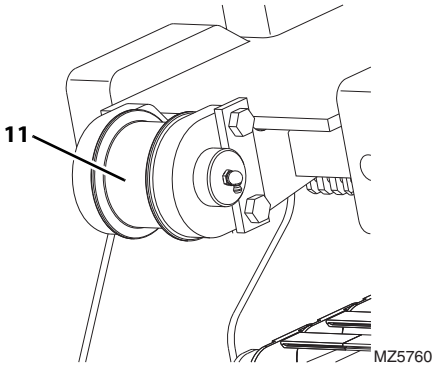
Note: *Keep the retract chain centered on bottom of the third boom section while installing the third boom section into the second boom section.*

4. Using a suitable sling, balance third and fourth boom sections and carefully slide 914 - 1219 mm (3 - 4 ft) into the front of second boom section. Set the third and fourth boom sections onto a suitable support and reset the sling under boom head of the fourth boom section. Carefully slide the third and fourth boom sections into the second boom section. Leave 152 - 203 mm (6 - 8 in) of the third boom section out to be able to install the wear pads in the front of the second boom section.
5. With the sling still under boom head, Apply Loctite® 242™ to the wear pad mounting bolts and install the top wear pads, washers and bolts in the front of the second boom section. Torque to 90 Nm (66 lb-ft). Lower the third and fourth boom section and apply Loctite® 242™ to the wear pad mounting bolts and install bottom wear pads, backing plates, shims, and the allen head cap bolts in the front of the second boom section. Torque to 90 Nm (66 lb-ft). Install both left side and right side front wear pads, backing plates, shims and bolts in the front of the second boom section. Torque to 90 Nm (66 lb-ft).

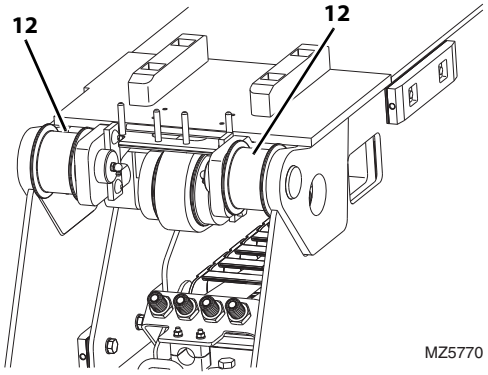
Note: *Grease wear pads, inside sheaves, bores and pins during assembly.*



6. Install both sheaves (**9**), pins, lock plates and bolts at the bottom front of the second boom section. Apply Loctite® 242™ and torque bolts to 90 Nm (66 lb-ft). Grease the sheaves using the grease fitting in the pin. Spin the sheaves by hand to ensure the sheaves spin freely on the pin and to distribute grease evenly. Pull both extend chains from the third boom section around the front and over the sheaves. Install both chain clevises, pins and clips (**10**).
7. Apply Loctite® 242™ to the wear pad mounting bolts and install the bottom left and right side wear pads, backing plates, shims and bolts.Shim the top wear pads on the rear of the third boom section. Shim the top left and right wear pads on the rear of the third boom section.Torque bolts to 90 Nm (66 lb-ft). Torque grease fitting bolts to 45 Nm (33 lb-ft).



8. Install the retract chain sheave (**11**), pin, keeper and bolts to bottom rear of third boom section. Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft). Grease the sheaves using the grease fitting in the pin. Spin the sheaves by hand to ensure the sheaves spin freely on the pin and to distribute grease evenly.

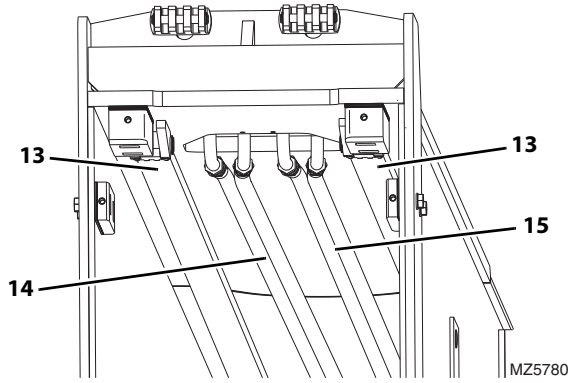


9. Install both retract chain sheaves (**12**), pin, keeper and bolts to bottom rear of second boom section. Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft). Grease the sheaves using the grease fitting in the pin. Spin the sheaves by hand to ensure the sheaves spin freely on the pin and to distribute grease evenly.

3.18.9 Second, Third and Fourth Boom Section Installation

Note: *Light lubrication of the boom wear surfaces with a factory authorized grease is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.*

1. Apply Loctite® 242™ to the wear pad mounting bolts. At the rear of the second boom section, install the bottom rear wear pads, washers and bolts. Torque to 90 Nm (66 lb-ft). Install the bottom rear left and right side wear pads, backing plate and bolts (do not shim or tighten bolts). Install top rear wear pads, backing plates and bolts (front bolts are drilled and tapped for grease fittings. do not shim or tighten bolts).



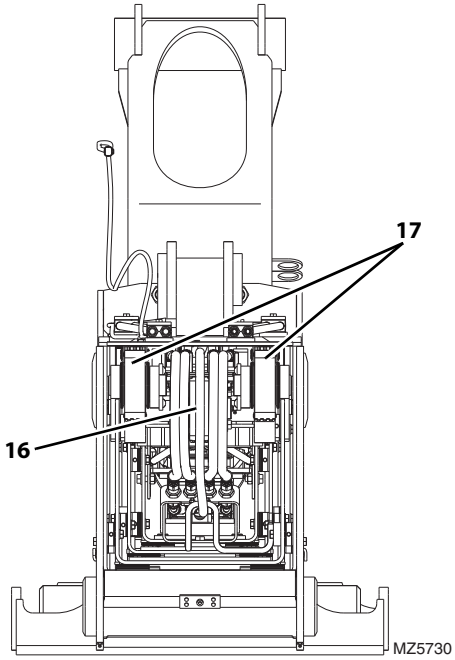
2. Grease the inside first boom section on area's where the second boom section wear pads will slide.
3. Install the retract chains (**13**), pins and clips to bottom front inside of the first boom section.
4. Install both tilt hoses (**14**) and both auxiliary hoses (**15**) to the tubes mounted at the bottom front of the first boom section. Make sure both sets of hoses are run through the opening at the bottom front of the first boom section and run down the inside center of the boom section

Note: *Keep the retract chains, tilt and auxiliary hoses centered in the first boom section while installing the second boom section into the first boom section.*

5. Using a suitable sling, balance the second, third and fourth boom sections and carefully slide 914 - 1219 mm (3 - 4 ft) into the front of the first boom section. Set the second, third and fourth boom sections onto a suitable support and reset sling under the boom head of the fourth boom section. Carefully slide the second, third and fourth boom sections into the first boom section. Leave 152 - 203 mm (6 - 8 in) of the second boom section out to be able to install wear pads in front of the first boom section.
6. With sling still under boom head, Apply Loctite® 242™ to the wear pad mounting bolts. Install the top wear pads, washers and bolts in the front of the first boom section. Torque to 90 Nm (66 lb-ft). Lower the second, third and fourth boom sections and apply Loctite® 242™ to the wear pad mounting bolts, Install bottom wear pads, backing plates, shims, and bolts in the front of the first boom section. Torque to 90 Nm (66 lb-ft). Install both left side and right side front wear pads, backing plates, shims and bolts in the front of the second boom section. Torque to 90 Nm (66 lb-ft).

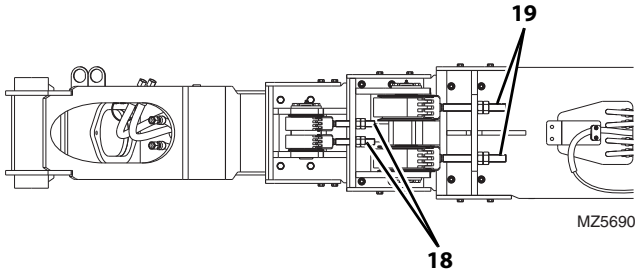
Note: *Shim ALL side wear pads as needed to maintain a minimum gap 1.6 mm (1/16 in) the horizontal direction or a snug fit. The number of shims can vary at each shim point.*

7. Install the bottom left and right side wear pads, backing plates, shims and bolts at the rear of the second boom section.Shim the top wear pads on the rear of the second boom section. Shim the top left and right wear pads on the rear of the second boom section. Apply Loctite® 242™ and torque bolts to 90 Nm (66 lb-ft).
8. Retract the second, third and fourth boom sections the remainder of the way into the first boom section.



9. Attach the retract chain (**16**), pin and clip to the clevis at the rear of the fourth boom section.
10. Attach the retract chains (**17**), pins and clips to the clevises at the rear of the third boom section.
11. Install the previously removed boom retract sensor. Refer to Section 3.27, "Boom Retract Sensor Adjustment", for detailed adjustment instructions.

Note: *Installing the clevis pins in the third boom section can only be done when the first boom section and the second boom section access holes are aligned.*



12. Attach both extend chain clevises (**18**) through the holes in the bottom front of the first boom section. Install the washers, adjustment nut and jam nut to the clevises.
13. Attach both extend chain clevises (**19**) through the holes in the bottom front of the second boom section. Install the washers, adjustment nut and jam nut to the clevises.

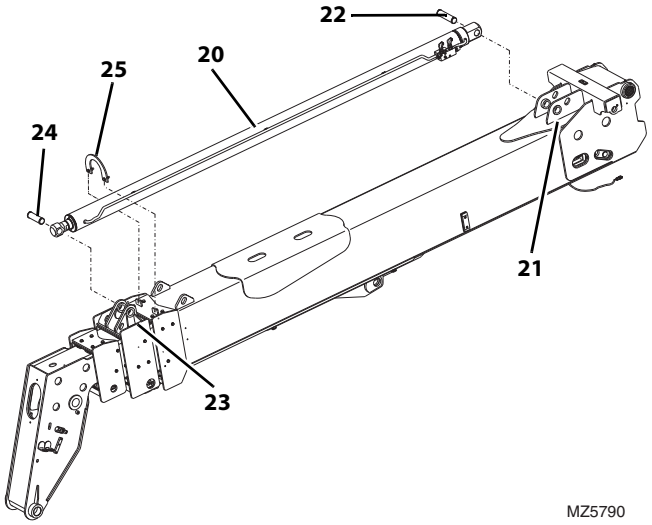
Note: *Adjust all four extend chains using the measurement taken in the beginning of the tear down procedure. Depending on the extent of the parts being replaced, the above measurement is to be used as a starting point ONLY.*

14. Pull the rear of the hose carrier over the rear of the fourth boom section and set onto the rear of the third boom section. Using the two bolts, washers and nuts, bolt the rear of the hose carrier to the rear of the third boom section. Apply Loctite® 242™ and torque the two bolts to 90 Nm (66 lb-ft).
15. Remove the caps from the fittings on the hose carrier bulkhead and the plugs from the tilt and auxiliary hoses. Install all four hoses and tighten until wrench-tight. Mark the hose fitting then tighten each hose firmly 1 to 1 1/2 flats.
16. Remove the caps from the Auxiliary hoses in the boom head and install the Auxiliary hoses from the front of the hose carrier to the Auxiliary bulkhead. Tighten each hose wrench-tight. Mark the hose fitting then tighten each hose firmly 1 to 1 1/2 flats. Bolt the auxiliary hose bulkhead to the side of the boom head and torque the two bolts to 90 Nm (66 lb-ft).
17. Using a suitable sling through the rod end of the Tilt cylinder, lower the Tilt cylinder into boom head. Align the Tilt cylinder barrel end bore with the boom head bore and install the Tilt cylinder pin and retaining clip.

Note: *Grease Tilt cylinder barrel end bore and pin before installing.*

18. Remove the caps from the fittings on the Tilt cylinder and the plugs from the Tilt hoses from the hose carrier. Install both Tilt hoses and tighten until wrench-tight. Mark the hose fitting then tighten each hose firmly 1 to 1 1/2 flats.
19. Using suitable slings, lift complete boom off supports and set on level ground. It will be necessary to place a block under the rear of the boom to keep the tilt and auxiliary tubes from being damaged.
20. Turn the boom over being careful not to damage the Tilt and Auxiliary tubes mounted on the side and rear of boom.
21. After boom is turned upright, place a suitable support under the rear of the boom.
22. Attach a sling around a balance point on the Extend/Retract cylinder and carefully set on top of the first boom section.

Note: *Grease Extend/Retract cylinder barrel end bore and rod end bore and pins before installing.*

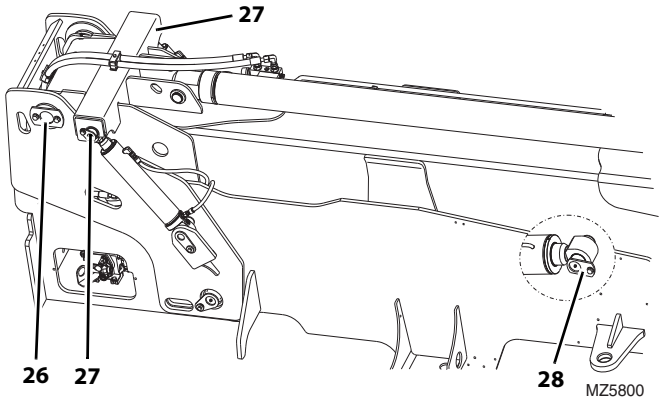


23. Align the Extend/Retract cylinder barrel end (**20**) with bore at rear of the first boom section (**21**). Install the pin and retaining clip (**22**).
24. Align the Extend/Retract cylinder rod end with bore at front of the second boom section (**23**). Install the pin and retaining clip (**24**).
25. Install Extend/Retract cylinder support (**25**). Apply Loctite® 242™ and torque bolts to 90 Nm (66 lb-ft).

3.18.10 Complete Boom Installation

Note: *Light lubrication of the boom wear surfaces with a factory authorized grease is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.*

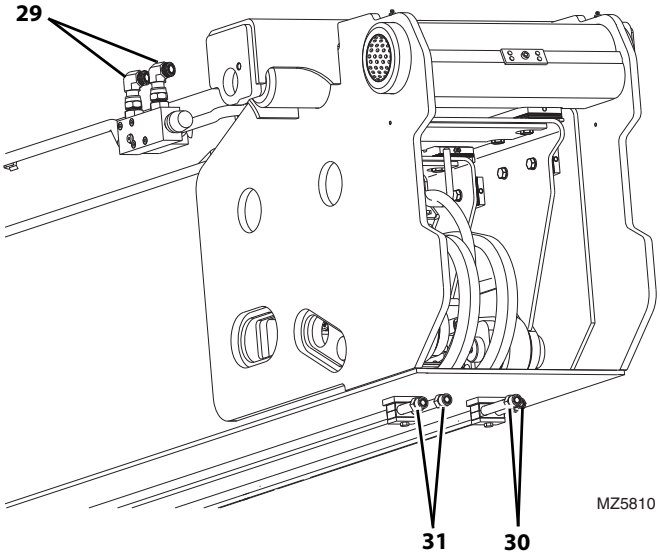
1. Park the machine on a hard, level surface. Make sure park brake is set, key is removed from the ignition and "Do Not Operate" tag is placed in clear view in the cab.



2. Using suitable slings, balance the boom assembly, lift and carefully guide the boom into place. Align the frame pivot bore with the boom assembly pivot bore. Install boom pivot pin (**26**). Apply Loctite® 242™ and torque lock bolts to 90 Nm (66 lb-ft).
3. With the sling still in place, install both Compensation cylinders, pins and lock bolts (**27**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).
4. With the sling still in place, install the rod end of the Lift/Lower cylinder, pin and lock bolt (**28**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).

Note: *Raising the boom up or down with the sling maybe necessary so the boom, Compensation and Lift/Lower cylinder bores can be aligned for easier pin installation.*

Note: *Grease the boom pivot bore, compensation cylinder rod ends, lift/lower cylinder rod end and pins before installing.*



5. Remove the caps from Extend/Retract cylinder fittings and plugs from Extend/Retract cylinder hoses. Attach each hose to the Extend/Retract cylinder fittings (**29**) and tighten until wrench-tight. Mark the hose fitting then tighten each hose firmly 1 to 1 1/2 flats.
6. Remove the caps from both Tilt tubes (**30**) and Auxiliary tubes (**31**) and plugs from both Tilt hoses and both Auxiliary hoses. Attach both sets of hoses to the Tilt tubes and the Auxiliary tubes and tighten until wrench-tight. Mark the hose fitting then tighten each hose firmly 1 to 1 1/2 flats.
7. Connect the boom angle indicator rod to the switch at the inside left rear corner of the main boom section and frame. Refer to Section 9.14.7, "Boom Angle Sensor", for adjustment information.
8. Start the engine and operate all boom functions several times. Check for leaks, and check the hydraulic fluid level in the reservoir; add fluid if required.
9. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.

3.19 BOOM CHAIN REMOVAL/INSTALLATION

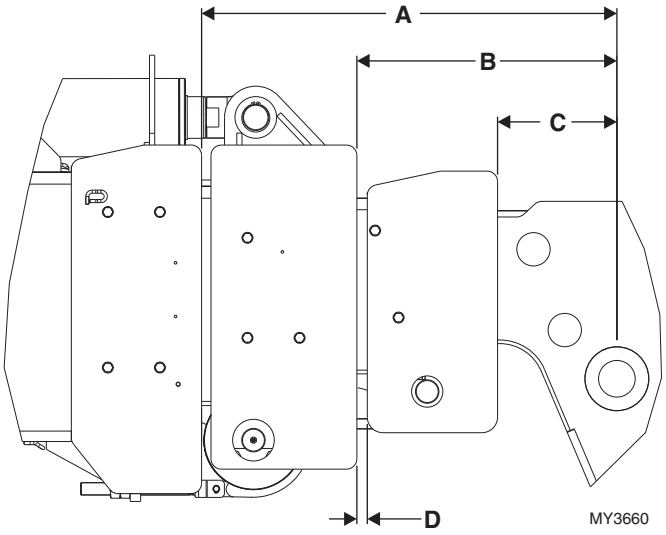
The removal of the extend and/or retract chain can only be accomplished with the complete tear down of the boom.

3.20 BOOM SECTIONS ADJUSTMENT

3.20.1 Chain Adjustments

The chains are adjusted by tightening and/or backing off the adjusting nuts at the threaded end of the chains. The opposite chain adjusting nut usually must be loosened whenever this procedure is performed.

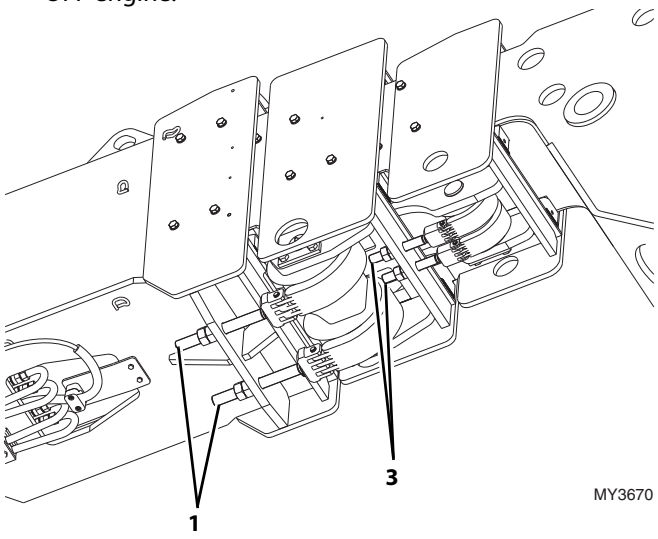
Fully retract and level the boom.

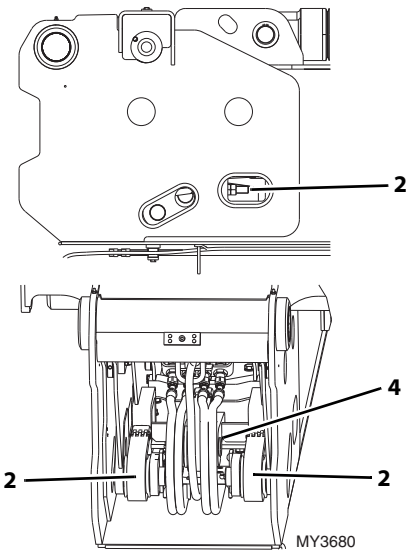


The boom is properly adjusted whenever the following parameters are met.

A. 797 ± 3 mm (31.0 ± 0.12 in)
B. 499 ± 3 mm (19.9 ± 0.12 in)
C. 229 ± 3 mm (9.0 ± 0.12 in)
D. 20 mm (0.80in)

1. If adjustments are needed: Start the machine, level the boom and extend the boom 0,91 - 1,2 m (3 - 4 ft). Turn OFF engine.



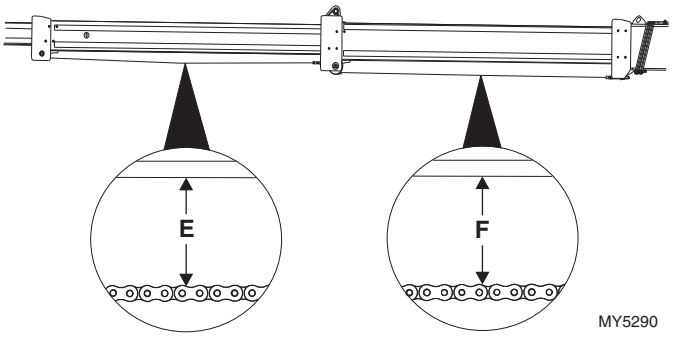


2. Loosen the locknuts on the extend and retract chains.
3. Adjust extend chains (**1**) and retract chains (**2**) to ensure a gap of (**D**) between the face of the second boom section and the shoulder of the third boom section. The retract chains (**2**) are accessible from the side of the boom.
4. Adjust extend chains (**3**) and retract chain (**4**) to ensure a gap of (**C**) between the face of the third boom section and the center of the tilt cylinder pin on the fourth boom section. The retract chain (**4**) is accessible from the rear of the boom.
5. Adjust extend chains (**1** and **3**) and retract chain(s) (**2** and **4**) to ensure a gap of (**A** and **B**) for the overall boom section adjustment.

6. Tighten the extend and retract chain lock nuts to 120 Nm (86 lb-ft) against the adjusting nut.

Note: *Ensure that there is a minimum of one full thread of the clevis showing beyond the lock nut.*

7. Start the machine and slowly extend and retract the boom three times.
8. Retract the extend/retract cylinder completely. Turn OFF engine.
9. Verify boom section dimensions. Repeat steps 1 thru 7 if necessary.
10. Start the machine, lower the out riggers if necessary and extend the boom to maximum extension, then retract 51 - 76 mm (2 - 3 in). Shut machine off.



11. Measure the distance between the top of both extend chains and the bottom of the second and third boom sections at the center of each section.
12. The distance between the top of the extend chains and the bottom of the third boom section (**E**) should measure 120 mm ± 2 mm (4.724 in ± 0.078 in).
13. The distance between the top of the extend chains and the bottom of the second boom section (**F**) should measure 180 mm ± 2 mm (7.0 in ± 0.078 in).
14. Loosen the locknuts on the extend chains and adjust if necessary. Tighten locknuts to 120 Nm (86 lb-ft).
15. Start the machine and cycle the extend/retract cylinder to verify the boom extends and retracts properly.

3.21 BOOM EXTEND AND RETRACT CHAINS - TH414C & TH417C

3.21.1 Boom Chain Inspection

⚠ WARNING

Worn pins, stretched or cracked links or corrosive environments can cause chain failure. A chain failure could result in uncontrolled boom movement, loss of load or machine instability.

Under normal operating conditions the boom chains will need to be inspected every 250 hours of operation. The retract chains need to be exposed and inspected every 1000 hours of operation. Refer to the Service Manual for the proper procedure. Environmental conditions and dynamic impulse/shock loads can drastically affect normal operating conditions and require more frequent inspection intervals.

Environments in which material handling vehicles operate can vary widely from outdoor moisture to temperature to mildly corrosive or highly corrosive industrial atmospheres, in addition to abrasive exposures such as sand and grit. Some effects can be as follows:

- Moisture - Corrosive rusting reduces chain strength by pitting and cracking.
- Temperature - Low temperature reduces chain strength by embrittlement. Going in and out of cold storage results in moisture from condensation.
- Chemical Solutions or Vapors - Corrosive attack on the chain components and/or the mechanical connections between the chain components. Cracking can be (and often is) microscopic. Going from microscopic cracking to complete failure can be either abrupt or may require an extended period of time.
- Abrasives - Accelerated wearing and scoring of the articulating members of the chain (pins and plates), with a corresponding reduction in chain strength. Due to the inaccessibility of the bearing surfaces (pin surfaces and plate apertures), wear and scoring are not readily noticeable to the naked eye.

Following are some examples of dynamic shock loading which can impose abnormal loads above the endurance limit of a leaf chain.

- High velocity movement of load, followed by sudden, abrupt stops.
- Carrying loads in suspension over irregular surfaces such as railroad tracks, potholes, and rough terrain.
- Attempting to "inch" loads which are beyond the rated capacity of the vehicle.

The above load cycles and environmental conditions make it impossible to predict chain life. It is therefore necessary to conduct frequent inspections until replacement life can be predicted.

The boom chain's normal life expectancy can be expressed as a maximum percent of elongation. This is generally 3%. As the chain flexes back and forth over the sheave, the bearing joints (pins and inside link plates) gradually incur wear due to articulation.

3.21.2 Inspection Guidelines - TH414C

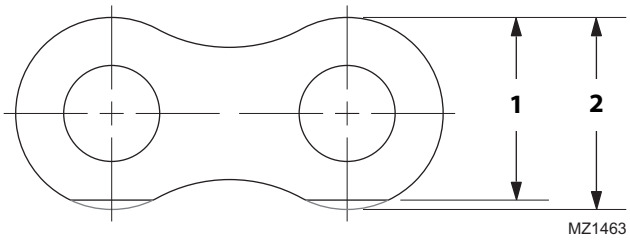
a. Retract Chain

1. Park the machine on a firm, level surface, raise the boom to a horizontal (level) position, place the transmission in (N) NEUTRAL, engage the park brake switch.
2. Fully extend the boom until the retract chain is taut. Shut the engine off.
3. The retract chain will be visible for inspection with the vehicle in this state.
4. While doing the chain inspection, check all chain clevis ends, pins for distortion or cracking and sheaves for bearing wear or grooving from the chain.

b. Extend Chains

1. Park the machine on a firm, level surface, raise the boom to a horizontal (level) position, place the transmission in (N) NEUTRAL, engage the park brake switch.
2. Fully retract the boom. Shut the engine off.
3. Both extend chain clevises and pins will be visible for inspection with the vehicle in this state.
4. Limited visual inspection of the extend chains is possible. For complete extend chain inspection, the extend chains must be removed from the boom. For extend chain removal, refer to Section 3.7.3, "Extend Chain Removal", and Section 3.7.4, "Extend Chain Installation".
5. Inspect the extend and retract chains every 250 hours of operation.
6. Inspect the chains for the following conditions:

Edge Wear

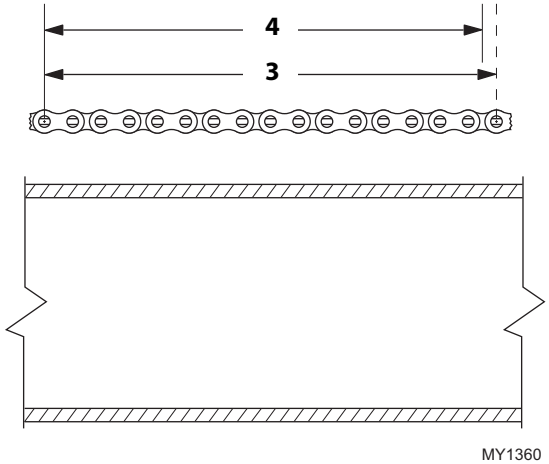


Check the chain for wear on the link plate edges caused by running back and forth over the sheave. The maximum reduction of material should not exceed 5%. Measure and compare to a normal link plate height by measuring a portion of chain that does not run over the sheave. If the measured plate height (**1**) is 5% less than the normal plate height (**2**), discard and replace the chain.

Elongation

It is important to measure the chain in the section that moves over the sheaves because it receives the most frequent articulation. Measuring the chain near its clevis terminals could give an inaccurate reading. The ends of the chains, near the clevis terminal, will not have flexed as frequently, if at all, as the middle of the chains.

It is best to measure in 12 pin increments from pin center to pin center. For example, if the links are 25 mm (1 in) from pin center to pin center, the distance should be 305 mm (12 in). If the links are 19 mm (.75 in) apart, the distance after 12 pins should be 229 mm (9 in).



If the distance measured (**3**) is 3% greater than the normal length (**4**), discard and replace the chain.

3.21.3 Inspection Guidelines - TH417C

1. Park the machine on a firm, level surface, raise the boom to a horizontal (level) position, place the transmission in (N) NEUTRAL, engage the park brake switch.
2. Fully extend the boom until the extend chain is taut. Shut the engine off.
3. The extend chains will be visible for inspection with the vehicle in this state.
4. While doing the chain inspection, check all chain clevis ends for distortion or cracking and sheaves for bearing wear or grooving from the chain.
5. Inspect the retract chains every 1000 hours of operation. Refer to the Service Manual for proper procedure.
6. Inspect the chains for the following conditions:

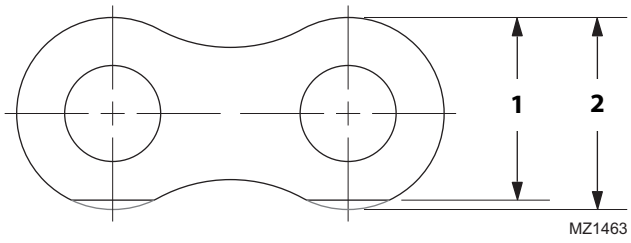
Edge Wear

Check the chain for wear on the link plate edges caused by running back and forth over the sheave. The maximum reduction of material should not exceed 5%. This can be compared to a normal link plate height by measuring a portion of chain that does not run over the sheave.

a. Extend Chains (fourth to third section)

The extend chains between the fourth and third boom sections measures 18 mm (.713 in) (**1**). If the measurement of the worn chain is less than 17 mm (.677 in) (**2**), the chain should be replaced.

b. Extend Chains (third to second section)

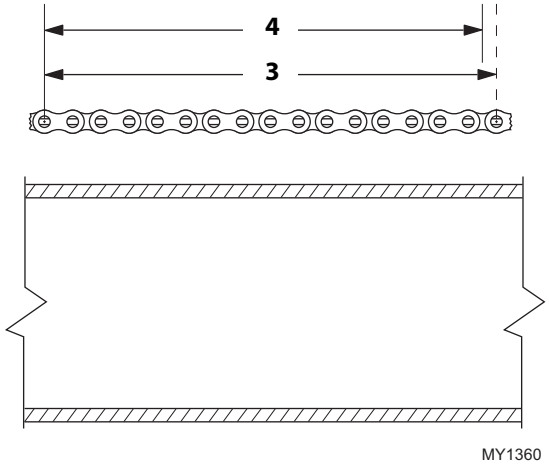


The extend chains between the third and second boom sections measures 29,6 mm (1.2 in) (**2**). If the measurement of the worn chain is less than 28,6 mm (1.1 in) (**1**), the chain should be replaced.

Elongation

It is important to measure the chain in the section that moves over the sheaves because it receives the most frequent articulation. Measuring the chain near its clevis terminals could give an inaccurate reading. The ends of the chains, near the clevis terminal, will not have flexed as frequently, if at all, as nearer the middle of the chains.

a. Extend Chains (fourth to third section)



When the original length (**3**) of 305 mm (12.00 in) per foot of extend chain between the fourth and third boom sections has elongated from wear to a length (**4**) of 313 mm (12.36 in), the chain should be discarded and replaced.

Measure across a span of **16** pins at the center of the extend chain. Measure from pin center to pin center. Because the retract chain is inside the boom you will not be able to measure the chain.

The maximum measurement allowed is 313 mm(12.36 in). If the measurement is more than 313 mm (12.36 in), the chain should be replaced.

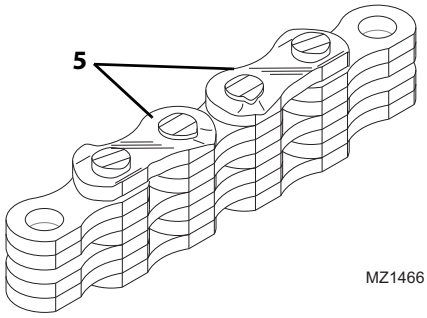
b. Extend Chains (third to second section)

When the original length (**3**) of 317 mm (12.5 in) per foot of extend chain between the third and second boom sections has elongated from wear to a length (**4**) of 325 mm (12.8 in), the chain should be discarded and replaced.

Measure across a span of **10** pins at the center of the extend chain. Measure from pin center to pin center. Because the retract chain is inside the boom you will not be able to measure the chain.

The maximum measurement allowed is 325 mm (12.8 in). If the measurement is more than 325 mm (12.8 in), the chain should be replaced.

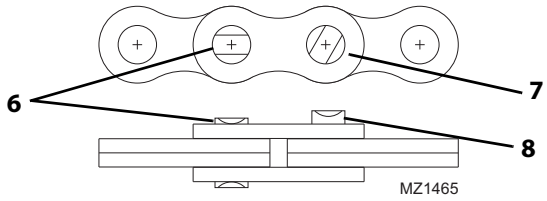
Distorted or Battered Link Plates



Distorted or battered link plates (**5**) on a leaf chain can cause tight joints and prevent flexing.

Turning or Protruding Pins

Highly loaded chain, operating with inadequate lubrication can generate abnormal frictional forces between pin and link plates. When chain is allowed to operate in this condition, a pin or series of pins, can begin to twist out of a chain, resulting in failure.



Examine the pin head rivets to determine if the "VEE" flats are still in correct alignment (**6**). Chain with rotated/displaced heads (**7**) or abnormal pin protrusion (**8**) should be replaced immediately.

Do Not attempt to repair the chain by welding or driving the pin(s) back into the chain. Once the press fit integrity between outside plates and pins has been altered, it cannot be restored.

Any wear pattern on the pin heads or the sides of the link plates indicates misalignment in the system. This condition damages the chain as well as increases frictional loading and should be corrected.

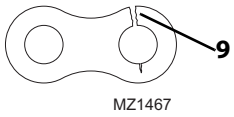
Cracked Plates

Inspect the chains very carefully, front and back as well as side to side, for any evidence of cracked plates. If any one crack is discovered, the chain should be replaced in its entirety.

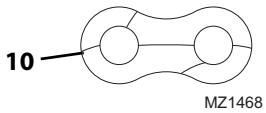
It is important, however to determine the cause of the crack before installing a new chain so the condition does not repeat itself.

The types of cracks are:

- **Fatigue Cracking** - Fatigue cracks (**9**) are a result of repeated cyclic loading beyond the chain's endurance limit.



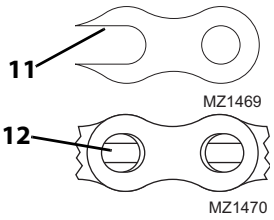
- **Stress Corrosion Cracking** - The outside link plates are particularly susceptible to stress corrosion cracking (**10**).



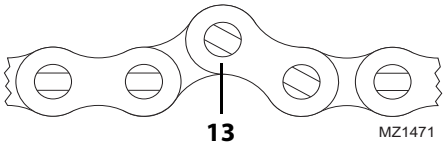
- **Corrosion Fatigue Cracking** - Corrosion fatigue cracks are very similar to fatigue cracks in appearance. Corrosion fatigue is the combined action of an aggressive environment and cyclic stress.

Other Modes of Failure

- **Ultimate Strength Failure** - These types of failures are caused by overloads far in excess of the design load. Either fractured plates (**11**) or enlarged holes (**12**) can occur. If either of these failures occurs, the chain should be replaced immediately.



- **Tight Joints** - All joints in the chain should flex freely. Tight joints (**13**) resist flexing.



If the problem is caused by dirt or foreign substance packed in the joints, clean and lubricate thoroughly before re-installing the chain.
If the problem is caused by corrosion and rust or bent pins, replace the chain.

3.21.4 Expose Chains for Inspection

c. Retract Chain

1. Park the machine on a firm, level surface. Place the transmission in (N) NEUTRAL, engage the park brake switch and raise the boom to a horizontal (level) position.
2. Fully extend the boom until the retract chain is taut. Shut the engine OFF.

The retract chain will be visible for inspection with the machine in this state.

While doing the chain inspection, check all chain clevis ends for distortion or cracking and sheaves for bearing wear or grooving from the chain.

If during the inspection, if any chain is found to be damaged or stretched, the chain must be replaced. It is recommended that when any chain is replaced, that all the chains and clevises be replaced at the same time.

d. Extend Chains

The extend chains are only partially visible through the rear of the boom with all the sections retracted. It is possible to see a section of the extend chain as the boom is slowly extended. If there is ANY question that one or both extend chains are damaged, the extend chains should be removed, inspected and replaced if necessary.

Refer to Section 3.21, "Boom Extend and Retract Chains - TH414C & TH417C".

Note: *Do Not attempt to repair a chain. Replace a stretched or damaged chain with a new part. Always replace both the chain and the clevis. It is recommended that when any chain is replaced, that all chains and clevis' be replaced at the same time.*

3.21.5 Chain Lubrication

After inspection and before being returned to service, chains must be lubricated with CAT Multipurpose Grease-NLGI Grade 2.

The lubricant must penetrate the chain joint to prevent wear. Applying lubricant to the external surfaces will prevent rust, but the chains should be articulated to make sure the lubricant penetrates to the working surfaces between the pins and links.

To prepare the chain for lubrication, the chain plates should be brushed with a stiff brush or wire brush to clear the space between the plates so that lubricant can penetrate to the working surfaces.

Lubricant may be applied with a narrow paint brush or directly poured on, but the chain should be well flooded with lubricant and the boom should be extended and retracted to be sure that the lubricant penetrates to the working surfaces. All surplus lubricant should be wiped away from the external surfaces. Do Not use a solvent for this wiping operation.

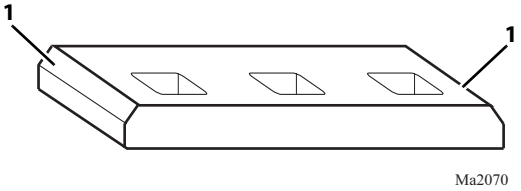
Regular application of lubricant is necessary to make sure that all working surfaces are adequately lubricated. In extremely dusty conditions, it may be necessary to lubricate the chains more often. Refer to Section 2.4, "Service and Maintenance Schedules", and Section 2.5, "Lubrication Schedules", for detailed information.

Lubrication of chains on vehicles working consistently in extreme hot or cold conditions requires special consideration. Contact the Caterpillar dealer for guidance.

3.22 BOOM WEAR PADS

The boom wear pads are flat rectangular plastic blocks with metal inserts.

3.22.1 Wear Pad Inspection



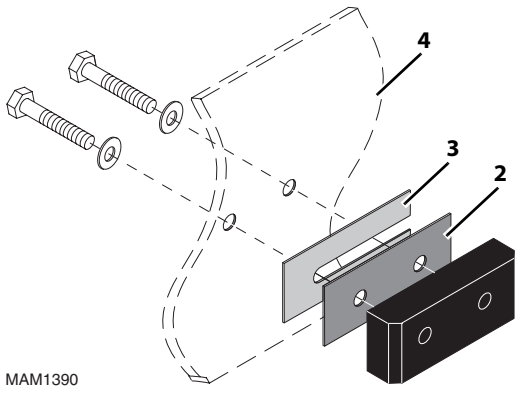
Inspect all wear pads for wear. If the angle indicators (**1**) on the ends of the wear pads are visible, the wear pads can be reused. If the pads show uneven wear (front to back), they should be replaced. Replace pads as a set if worn or damaged.

3.22.2 Boom Wear Pad Installation/Lubrication

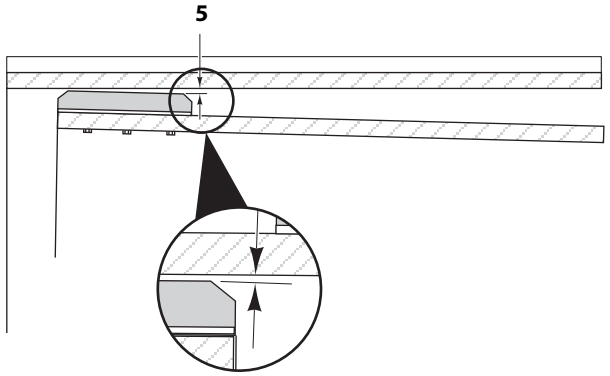
The boom has been factory lubricated for proper wear pad break-in and will normally require minor further lubrication. However, after replacing any wear pad(s), or after prolonged periods of inoperation, lubrication of the boom wear surfaces with CAT Multipurpose Grease is recommended to keep the boom wear surfaces lubricated properly. Lubrication of the boom wear surfaces is also recommended when the machine is stored, to help prevent rusting.

The following wear pad procedure must be followed to insure the proper wear pad installation:

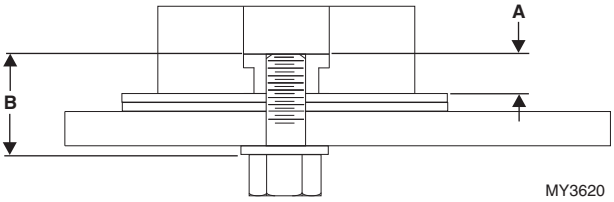
- The wear pad inserts and mounting bolts MUST be clean before mounting bolts are installed.
- Apply Loctite® 242™ to all wear pad mounting bolts.



- A spacer (**2**) with holes must be used before any shim (**3**) is used.
- A shim (**3**) must inserted between the spacer (**2**) and wear pad support plate, block or boom section (**4**).
- The number of shims can vary at each shim point.
- The bottom wear pads must be shimmed equally on each side.



- Maintain a total boom section clearance of 1,77 - 3,30 mm (0.070 - 0.130 in) both the horizontal and vertical directions.



- The length of the wear pad bolt depends on the number of shims, spacers and washers being used.
- The thickness of each threaded wear pad insert is 7,9 mm (0.312 in) (**A**).
- The bolt length should be determined by measuring the distance from the face of the insert to the face of the boom (**B**) including any spacer, shim(s) and washer(s).
- Bolt thread engagement in the wear pad insert should be 6,98 mm ± 1,52 mm (0.275 ± 0.060 in).
- One or two hardened washers are to be used on each wear pad bolt except where noted otherwise. Do Not use more than two hardened washers.
- Use only one hardened washer if mounting bolts are recessed.
- Wear Pad Bolt Torque:
  3/8 - 24 Bolt, 43 - 50 Nm (32 - 37 lb-ft).
  3/8 - 24 Hollow Bolt, 20 - 23 Nm (15 - 17 lb-ft).
  1/2 - 20 Bolt, 103 - 117 Nm (76 - 86 lb-ft).
  1/2 - 20 Hollow Bolt, 61 - 68 Nm (45 - 50 lb-ft).
- Lubricate the face and pockets of each wear pad after being installed.

Boom Section Wear Pad Pathway Lubrication:

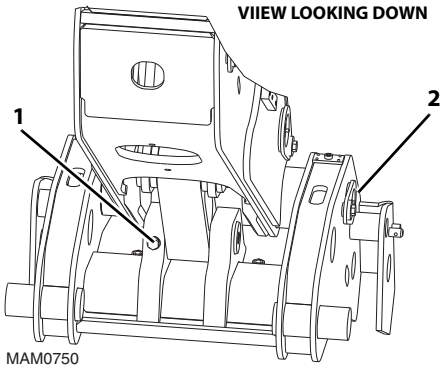
- Clean and lightly grease all wear pad pathways with CAT Multipurpose Grease.
- Clean and lightly grease the hose carrier guide bar pathway with CAT Multipurpose Grease.

3.23 QUICK COUPLER

Note: *The following procedures covers all styles of quick couplers.*

3.23.1 Quick Coupler Removal (TH336C, TH337C, TH406C & TH407C)

1. Lower attachment to ground, tilt forward to access coupler pin, set park brake and turn off engine.
2. If equipped with a hydraulic quick coupler device, refer to Operation & Maintenance Manual.



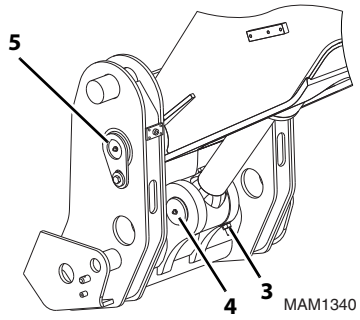
3. Remove the lock bolt (**1**) holding the coupler pin to the tilt cylinder lever assembly. Remove the coupler pin.
4. Support the quick coupler assembly. Remove the pivot pin (**2**) from the quick coupler assembly.
5. Inspect the above pin for nicks or surface corrosion. Use fine emery cloth to fix minor nicks or corrosion. If damaged or if it cannot be repaired the pin must be replaced.
6. Inspect the coupler and lever assembly pins for nicks or surface corrosion. Use fine emery cloth to fix minor nicks or corrosion. If damaged or if it cannot be repaired the pin must be replaced.

3.23.2 Quick Coupler Installation (TH336C, TH337C, TH406C & TH407C)

1. Assemble the quick coupler to the boom head. Line up the quick coupler between the mounts on the boom head. The quick coupler should be centered in the boom head.
2. Coat the quick coupler pivot pin with CAT Thread Lubricant. Insert the quick coupler pivot pin (**2**) through the boom head and the lever assembly.
3. Align the quick coupler with the lever assembly and insert the coupler pin (**1**) and replace the lock bolt assembly. Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).
4. If equipped, reconnect the hydraulic quick coupler device hoses to the quick disconnect fittings on the left side of the boom head.

3.23.3 Quick Coupler Removal (TH414C, TH514C & TH417C)

1. Lower attachment to ground, tilt forward to access coupler pin, set park brake and turn off engine.
2. If equipped with a hydraulic quick coupler device, refer to Operation & Maintenance Manual.



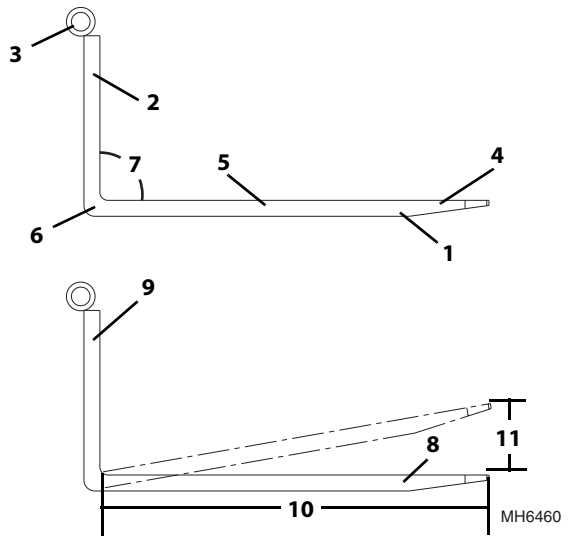
3. Remove the lock bolt (**3**) holding the rod end tilt cylinder pin to the quick coupler assembly. Remove the rod end pin (**4**).
4. Support the quick coupler assembly. Remove the pin from the quick coupler assembly (**5**).
5. Inspect the above pins for nicks or surface corrosion. Use fine emery cloth to fix minor nicks or corrosion. If damaged or if it cannot be repaired the pin must be replaced.

3.23.4 Quick Coupler Installation (TH414C, TH514C & TH417C)

1. Assemble the quick coupler to the boom head. Line up the quick coupler between the mounts on the boom head. The quick coupler should be centered in the boom head.
2. Coat the quick coupler pivot pin with CAT Thread Lubricant. Insert the quick coupler pivot pin (**5**) through the quick coupler and boom head.
3. Align the quick coupler with the rod end tilt cylinder and insert the coupler pin (**4**) and replace the lock bolt assembly (**3**). Apply Loctite® 242™ and torque to 90 Nm (66 lb-ft).
4. If equipped, reconnect the hydraulic attachment hoses to the quick disconnect fittings on the left side of the boom head.

3.24 FORKS

Forks should be cleaned and inspected prior to being attached to carriage. If the following criteria is not met, forks must be removed from service immediately.



Daily Inspection

1. Inspect forks (**1**) for cracks, paying special attention to heel (**2**) and mounting tubes (**3**).
2. Inspect forks for broken or bent tips (**4**) and twisted blades (**5**) and shanks (**6**).

Yearly Inspection

1. Straightness of the upper face of blade (**5**) and the front face of shank (**6**) should not exceed 0.5 percent of the length of blade or height of shank.
2. Angle (**7**) between upper face of blade and front face of shank should not exceed 93 degrees.
3. Thickness of blade (**8**) and shank (**9**) should not be reduced to 90 percent of original thickness.

Note: *Contact the local Caterpillar dealer with the fork part number to find the manufactured dimensions of the fork blade.*

4. Ensure fork length (**10**) is adequate for intended loads.
5. Fork markings should be legible, re-stamp if required.
6. Compare fork tips (**11**) when mounted on a carriage. Maximum difference in height of fork tips is 3 percent of the length of the blade (**8**).

3.25 BOOM PROP (IF EQUIPPED)

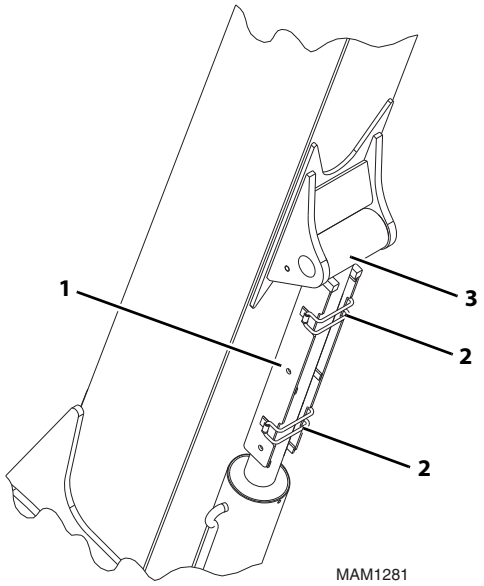
WARNING

A raised boom can fall if a hydraulic component is removed. Remove any load, retract the boom and install the boom prop or a suitable supporting stand before working under a raised boom.

3.25.1 Installation and Removal Procedures

a. Prop Installation

1. Park the machine on a firm, level surface. Place the transmission in (N) NEUTRAL, engage the park brake switch.
2. Raise the boom to an angle of approximately 20 degrees. Stop engine.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
4. Before installing the boom prop, inspect the prop for damage. Do not use if the prop is damaged or if the o-rings are damaged or missing.



5. Install the boom prop (**1**) onto the lift/lower cylinder. Install o-rings (**2**). Align lift cylinder lock so the o rings are on the bottom side of the lift/lower cylinder rod.
6. Start the engine and SLOWLY lower the boom until there is a clearance of 6 mm (0.25 in) between the end of the boom prop and the lift/lower cylinder rod end (**3**).

NOTICE

EQUIPMENT DAMAGE. Do Not operate with the boom prop in place. Damage to the boom prop and/or the lift/lower cylinder could occur.

7. Shut engine OFF.

b. Prop Removal

1. If needed, start machine and slowly raise the boom until the boom prop is clear of the lift/lower rod end.
2. Remove the o-rings (**3**) and boom prop (**1**) from the cylinder. Return the boom prop to the proper location and secure.
3. Lower boom, shut engine OFF.

3.26 EMERGENCY BOOM LOWERING PROCEDURE

WARNING

To avoid instability of the machine, the extend/retract cylinder **MUST BE** fully retracted prior to retracting the lift cylinder. If circumstances prevent retraction of the extend/retract cylinder first, lower the lift cylinder the minimum amount necessary and resume retraction of the extend/retract cylinder as soon as possible.

3.26.1 Equipment and Supplies Required

Auxiliary Hydraulic Power Supply:

- Portable hydraulic unit or another machine with an auxiliary hydraulic power supply with a capacity to hold up to 35 L (9 gal) of hydraulic oil from the machine during lowering process.

NOTICE

EQUIPMENT DAMAGE. Auxiliary Hydraulic Power Supply hydraulic oil must be compatible with hydraulic oil shown in Section 2.3, “Fluids and Lubricant Capacities”

Hoses:

- Two Hydraulic Hoses - Approximately 3,0 m (10 ft) each, with a minimum I.D. of 9,5 mm (0.375 in) and a minimum rating of 275,8 bar (4000 psi).

Fittings:

- Two -8 ORFS Caps
- Two -8 ORFS Plugs

Adaptors:

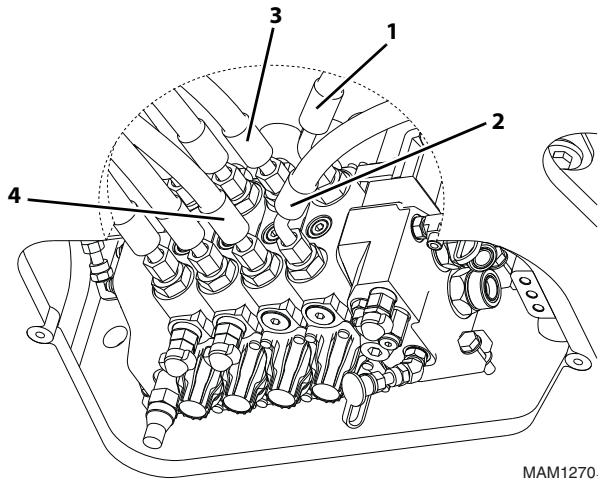
- Two -8 ORFS Adaptors

Note: *Machine extend/retract and lift/lower hoses are -8 ORFS. The adaptor size may vary depending on the hose ends of the auxiliary hydraulic power supply.*

3.26.2 Lowering Procedure

a. Retract the boom as follows:

1. Place a suitable receptacle under the main control valve.



VIEW FROM RIGHT SIDE

2. Label and disconnect the extend/retract cylinder hoses (**1** and **2**) from the main control valve. Install plugs in hoses to prevent fluid loss. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.

Note: *Loss of hydraulic oil is limited to the amount trapped within each hose.*

3. Using the hoses and fittings specified, connect the hoses between the auxiliary hydraulic power supply and the hoses removed from the main control valve extend/retract section of the affected machine. Retract hose (**2**) is the supply and extend hose (**1**) is the return. Connect the hoses in the proper order to ensure that the cylinder is retracted, not extended.
4. Use the auxiliary power supply to retract the extend/retract cylinder.
5. Loosen and remove the jumper hoses and reconnect the extend/retract cylinder hoses.
6. Transfer any hydraulic oil into a suitable, covered container, and label the container as "Used Oil". Dispose of used oil at an approved recycling facility.
7. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.

b. Lower the boom as follows:

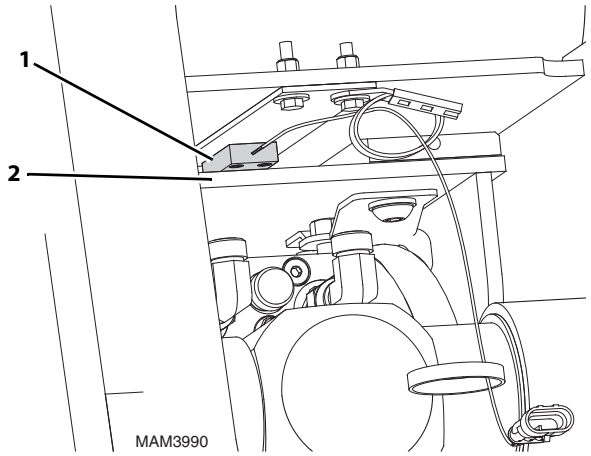
1. Place a suitable receptacle under the main control valve.
2. Label and disconnect lift/lower cylinder hoses (**3** and **4**) from the main control valve. Install plugs in hoses to prevent fluid loss. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.

Note: *Loss of hydraulic oil is limited to the amount trapped within each hose.*

3. Using the hoses and fittings specified, connect the hoses between the auxiliary hydraulic power supply and the hoses removed from the main control valve lift/lower section of the affected machine. Hose (**4**) is the supply (lower) and hose (**3**) is the return. Connect the hoses in the proper order to ensure that the boom is lowered, not raised.
4. Use the auxiliary power supply to lower the boom.
5. Loosen and remove the jumper hoses and reconnect the lift/lower cylinder hoses.
6. Transfer any hydraulic oil into a suitable, covered container, and label the container as "Used Oil". Dispose of used oil at an approved recycling facility.
7. Clean up all debris, hydraulic fluid, etc., in, on, near and around the machine.

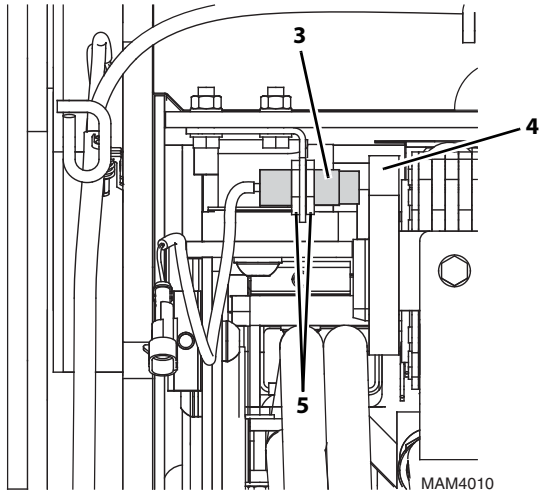
3.27 BOOM RETRACT SENSOR ADJUSTMENT

a. TH336C, TH337C, TH406C & TH407C



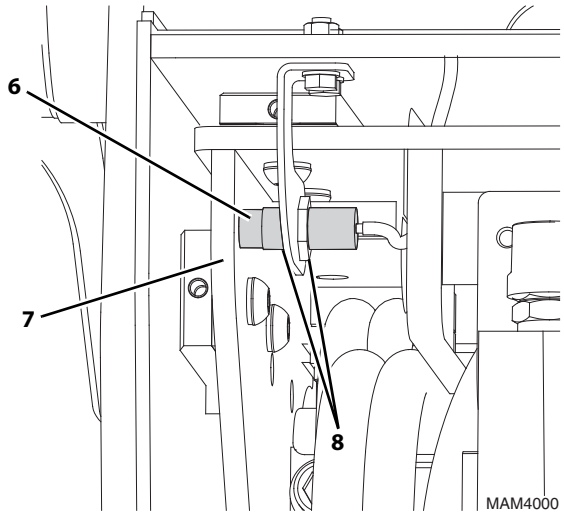
1. Level and fully retract the boom.
2. Measure the distance between the face of the sensor (**1**) and the top of the inner boom section (**2**).
3. A distance of 2 - 4mm (0.08 - 0.15 in) is required.
4. Use the appropriate shim(s) to achieve the proper clearance between the face of the sensor (**1**) and the top of the inner boom section (**2**) if required.

b. TH414C



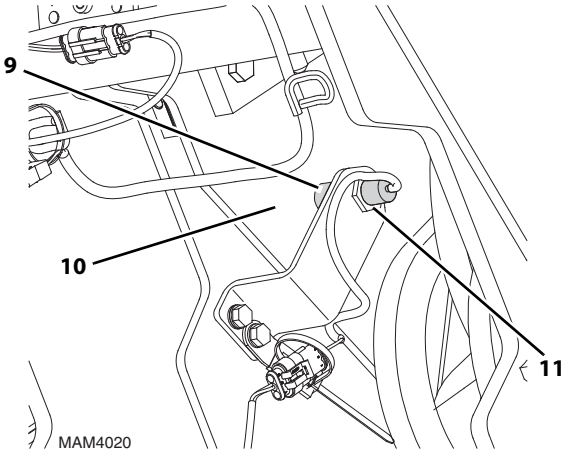
1. Level and fully retract the boom.
2. Measure the distance between the face of the sensor (**3**) and the side of the inner boom section (**4**).
3. A distance of 4 - 6 mm (0.15 - 0.23 in) is required.
4. Loosen the turn the lock nuts (**5**) to achieve the proper clearance between the face of the sensor (**3**) and the side of the inner boom section (**4**) if required.
5. Torque the locknuts to 18 - 22 Nm (13 - 16 lb-ft).

c. TH514C



1. Level and fully retract the boom.
2. Measure the distance between the face of the sensor (**6**) and the side of the inner boom section (**7**).
3. A distance of 4 - 6 mm (0.15 - 0.23 in) is required.
4. Loosen the turn the lock nuts (**8**) to achieve the proper clearance between the face of the sensor (**6**) and the side of the inner boom section (**7**) if required.
5. Torque the locknuts to 18 - 22 Nm (13 - 16 lb-ft).

d. TH417C



1. Level and fully retract the boom.
2. Measure the distance between the face of the sensor (**9**) and the side of the inner boom section (**10**).
3. A distance of 4 - 6 mm (0.15 - 0.23 in) is required.

4. Loosen the turn the lock nuts (**11**) to achieve the proper clearance between the face of the sensor (**9**) and the side of the inner boom section (**10**) if required.
5. Torque the locknuts to 18 - 22 Nm (13 - 16 lb-ft).

Note: *If adding Boom Retract Switch follow the software instructions below.*

1. Access the machine setup menu using the cab display or the analyzer.
2. Enter Access code for level 1 Access.
3. Navigate to Boom Retract Switch.
4. Navigate to "Yes".

Note: *If switch is being installed on a platform machine, the boom retract switch will default to "Yes".*

3.28 TROUBLESHOOTING

This section provides an easy reference guide covering the most common problems that occur during operation of the boom.

Problem	Possible Causes	Remedy
1. Boom will not extend or retract	1. Broken hydraulic hose(s) or tube(s) and/or connections leaking.	1. Locate break, replace hose(s) or tube(s), tighten connections.
	2. Extend/retract hydraulic system not operating properly.	2. Refer to Section 8.5, "Hydraulic Circuits".
	3. Faulty extend/retract cylinder.	3. Repair cylinder. Refer to Section 8.12.1, "General Cylinder Removal Instructions".
2. Boom shifts to right or left when extending.	1. Boom side wear pads improperly shimmed or worn.	1. Shim wear pads to correct gap. Replace wear pads as needed. Refer to Section 3.22, "Boom Wear Pads".
3. Excessive pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. Refer to Section 2.5, "Lubrication Schedules". Replace worn pins as needed.
	2. Worn bearing(s).	2. Replace bearing(s) and lubricate at regular intervals Refer to Section 2.5, "Lubrication Schedules".
4. Excessive Compensation cylinder pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. Refer to Section 2.5, "Lubrication Schedules". Replace worn pins as needed.
	2. Worn bushing(s).	2. Replace bushing(s) and lubricate at regular intervals.
5. Boom will not raise or lower.	1. Broken hydraulic hoses or tubes and/or connection leaks.	1. Locate break, replace hose(s) or tube(s), tighten connections.
	2. Lift/lower hydraulic system not operating properly.	2. Refer to Section 8.5, "Hydraulic Circuits".
	3. Faulty lift/lower cylinder.	3. Repair cylinder. Refer to Section 8.12.1, "General Cylinder Removal Instructions".
	4. Seized boom pivot pin bushing.	4. Replace bushing.

Problem	Possible Causes	Remedy
6. Drooping chain, or jerky boom extend or retract functions.	1. Chain(s) tension not properly adjusted.	1. Adjust chain(s).
	2. Chain(s) stretched or binding.	2. Replace chains as needed. Refer to Section 3.10, "Boom Sections Adjustment".
	3. Wear pads loose, contaminated, excessively worn or damaged.	3. Replace wear pad. Refer to Section 3.22, "Boom Wear Pads".
	4. Contaminated, corroded or rusted wear pad sliding surfaces.	4. Remove contamination and/or corrosion from wear pad sliding surfaces and lubricate. If the surfaces cannot be reconditioned, replace the boom section(s).
	5. Extend/Retract hydraulic system not operating properly.	5. Refer to Section 8.5, "Hydraulic Circuits".
	6. Damaged boom section.	6. Replace the damaged boom section.
7. Excessive Lift/Lower cylinder pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. Refer to Section 2.4, "Service and Maintenance Schedules". Replace worn pins as needed. Refer to Section 8.12.1, "General Cylinder Removal Instructions".
	2. Worn self-aligning bushing(s).	2. Replace bushing(s) and lubricate at regular intervals. Refer to Section 2.5, "Lubrication Schedules".
8. Rapid boom pad wear.	1. Incorrect wear pad gap.	1. Check wear pad gaps and correct as needed. Refer to Section 3.22, "Boom Wear Pads".
	2. Rapid cycle times with heavy loads.	2. Reduce cycle times.
	3. Contaminated, corroded or rusted wear pad sliding surfaces.	3. Remove contamination and/or corrosion from wear pad sliding surfaces and lubricate. If the surfaces cannot be reconditioned, replace the boom section(s).
	4. Operating in extremely dusty/ abrasive conditions.	4. Clean equipment frequently.
9. Auxiliary hydraulics will not operate.	1. Auxiliary hydraulic system not operating properly.	1. Refer to Section 8.5, "Hydraulic Circuits".

Problem	Possible Causes	Remedy
10. Excessive chain wear.	1. Improper chain adjustment.	1. Adjust to correct tension. Refer to Section 3.21, "Boom Extend and Retract Chains - TH414C & TH417C". Replace chains as needed.
	2. Chain sheave(s) not properly lubricated.	2. Lubricate chain sheave. Refer to Section 2.4, "Service and Maintenance Schedules".
	3. Chain sheave(s) not rotating freely.	3. Lubricate chain sheave. Refer to Section 2.4, "Service and Maintenance Schedules". Repair or replace chain sheave(s) as needed.
	4. Improper chain lubrication.	4. Lubricate at regular intervals. Refer to Section 2.4, "Service and Maintenance Schedules". Replace chains as needed.

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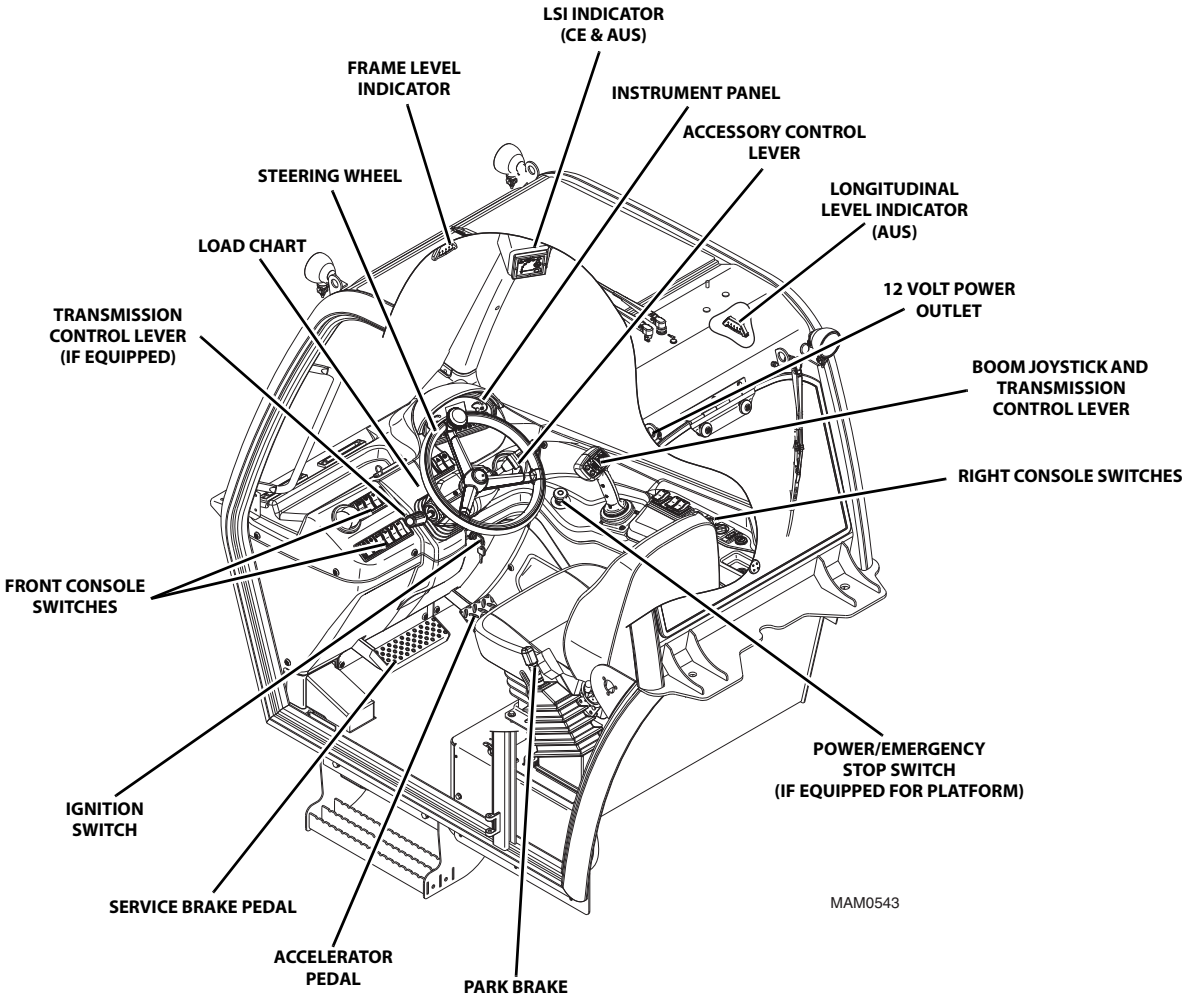
Section 4
Cab

Contents

4.1 OPERATOR CAB AND COVERS COMPONENT TERMINOLOGY

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the major assemblies of the machine cab and covers. The following illustration identifies the components that are referred to throughout this section.



4.2 OPERATOR CAB

WARNING

Do Not service the machine without following all safety precautions as outlined in Section 1, “Safety Practices”, of this manual.

4.2.1 Operator Cab Safety

WARNING

The protection offered by this ROPS/FOPS will be impaired if subjected to any modification or structural damage, at which time replacement is necessary. ROPS/FOPS must be properly installed using fasteners of correct size, grade, and torqued to their specified value.

WARNING

Do Not weld, grind, drill, repair or modify the cab in any way. Any modification or damage to cab structural components requires cab replacement.

Refer to the appropriate parts manual for ordering information.

4.2.2 Serial Number Plate

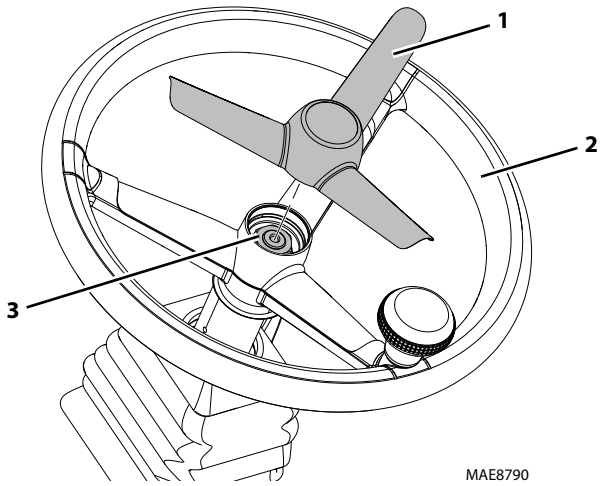
The cab serial number plate is located on the left side of the cab, below the seat. Information specified on the serial number plate includes the cab model number, the cab serial number and other data. Write this information down in a convenient location to use in cab correspondence.

4.3 CAB COMPONENTS

4.3.1 Steering Wheel

a. Steering Wheel Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine covers. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.



5. Remove steering insert (**1**) out of steering wheel.
6. Mark steering wheel (**2**) and shaft to ensure proper installation. Remove nut and washer (**3**) securing the steering wheel (**2**) to splined steering column shaft.
7. Use a steering wheel puller to remove steering wheel (**2**) from splined shaft.

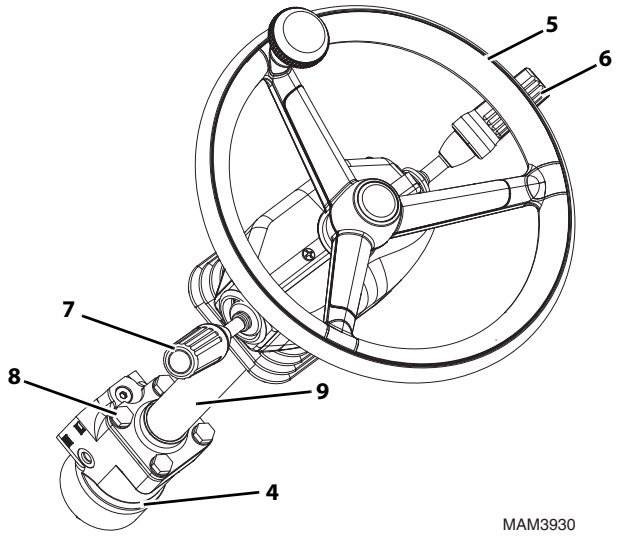
b. Steering Wheel Installation

1. Install steering wheel (**2**) onto splined steering column shaft.
2. Secure steering wheel with previously removed nut and washer (**3**). Torque as required.
3. Install steering insert (**1**) on the steering wheel (**2**).
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Close and secure the engine covers.
6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

4.3.2 Steering Column/Orbital Valve

a. Steering Column and Orbital Valve Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the parking brake and turn the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the lower dash panel in the cab.
6. Remove the protective cover from the front of the cab.



7. Label, disconnect and cap the hydraulic hoses attached to the orbital valve (**4**).
8. Remove the steering wheel (**5**). Refer to Section 4.3.1, "Steering Wheel".
9. Disconnect and remove the accessory control lever (**6**), and if equipped, transmission control lever (**7**). Disconnect the control lever(s) harness from the main cab harness.
10. Have an assistant hold the orbital valve from the outside of the cab. Remove the four bolts (**8**) securing the orbital valve to the cab.
11. Remove the steering column (**9**) through the dash panel opening.

Note: *Do Not disassemble the orbital valve. The orbital valve is not serviceable and must be replaced in its entirety, if defective.*

b. Steering Column and Orbital Valve Installation

1. Install the steering column to its original orientation in the cab.
2. Have an assistant hold the orbital valve in its original orientation from outside the cab. Install the steering column to the valve with the previously removed hardware.
3. Install the accessory control lever, and if equipped, transmission control lever. Connect the control lever(s) harness connector to the main cab harness and install the steering wheel assembly.
4. Uncap and connect the previously labeled hydraulic hoses to the orbital valve.
5. Carefully examine all connections one last time before engine start-up. Rectify any faulty conditions.
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Start the engine and check the operation of steering system. Check for hydraulic fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
8. Install the protective cover to the front of the cab.
9. Install the lower dash panel in the cab.
10. Close and secure the engine cover.
11. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

c. Steering Test

Conduct a pressure check of the steering hydraulic circuits at the main control valve. Refer to Section 8.4.1, "Pressure Checks and Adjustments".

4.3.3 Service Brake

a. Brake Valve Removal

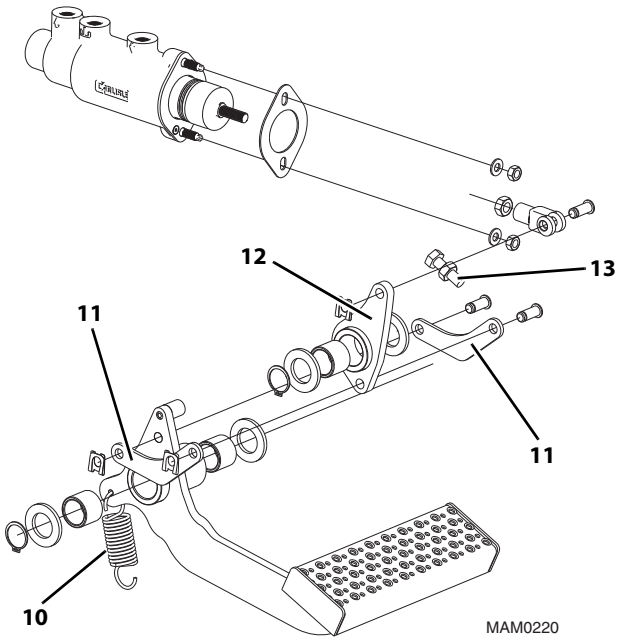
Refer to Section 8.10.3, "Service Brake Valve", for removal information.

b. Brake Valve Installation

Refer to Section 8.10.3, "Service Brake Valve", for installation information.

c. Service Brake Pedal Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the parking brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



5. Remove the tension spring (**10**) from the brake pedal.
6. Remove the clips securing the brake pedal and linkage to the service brake valve.
7. Remove the connecting plates (**11**) between the pedal and the lever assembly (**12**).
8. Remove the two snap rings.
9. Remove the pedal and lever assembly keeping note of location of all washers, bushings, etc.

d. Service Brake Pedal Installation

1. Install the brake pedal and lever assembly (**12**) onto their mounting posts with the previously used washers, bushings etc.
2. Install the two snap rings.
3. Install the connecting plates (**11**) between the pedal and the lever assembly with the previously used clips.
4. Install the pedal tension spring (**10**).
5. Be sure the brake pedal has the correct range of motion. If the pedal requires adjustment, refer to Section 4.3.3. e. "Service Brake Pedal Adjustment".
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Close and secure the engine cover.
8. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

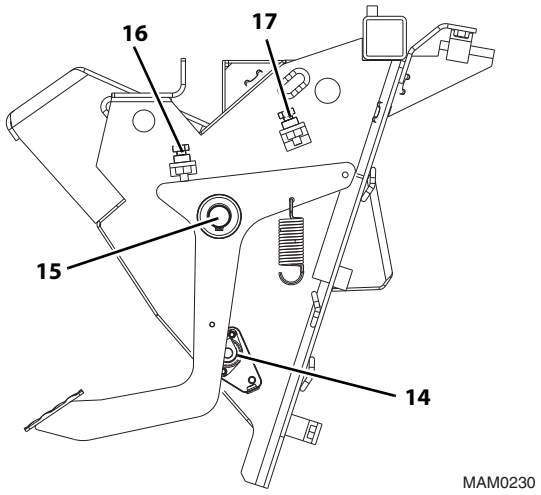
e. Service Brake Pedal Adjustment

1. Loosen the pedal adjustment bolt. The adjustment bolt cannot contact the linkage during adjustment.
2. Remove the master cylinder dust cover to gain access to the master cylinder plunger.
3. Rotate the master cylinder push rod clockwise until the push rod bottoms in the plunger. Rotate the push rod a quarter turn counterclockwise and tighten the adjustment bolt locknut. There should be 0,6 - 1,2 mm (0.2 - 0.8 in) of axial play between the push rod and plunger.
4. Screw in the adjustment bolt (**13**) by hand until the bolt makes contact with the linkage. Turn the bolt an additional one turn and secure with the locknut.
5. Verify that the pedal height is no less than 134 mm (5.3 in) from cab floor (mat included).
6. Verify that the master cylinder plunger is flush with master cylinder body.
7. Install the master cylinder dust cover.

4.3.4 Electronic Throttle Pedal

a. Throttle Pedal Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the parking brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.
4. Remove the tension spring from the pedal.



5. Disconnect the sensor linkage from the pedal (**14**).
6. Remove the snap ring (**15**) securing the throttle pedal to the mounting post.
7. Remove the throttle pedal assembly from the cab.

b. Throttle Pedal Installation

1. Position the throttle pedal in its mounting location within the cab.
2. Secure the throttle pedal into position with the previously used snap ring.
3. Install the pedal tension spring.
4. Install the sensor linkage to the pedal.
5. Properly connect the battery. Refer to Section 9.11, “Battery”, for procedure.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

c. Throttle Pedal Adjustment

The throttle pedal provides analog position feedback (APS OUT), and switches to confirm idle pedal position.

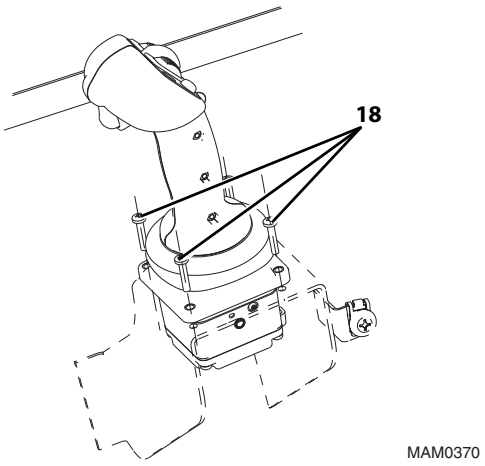
Pin	Functionality
A	APS OUT
B	Ground
C	VCC
D	IVS1
E	IVS2
F	Reserved (do not connect)

1. Loosen the lock nuts on each stop bolts (**16** and **17**).
2. Connect multimeter to wires connected to pins “B” and “C” on the wire harness connection at the throttle pedal.
3. Turn ignition to the ON position.
4. Adjust closed throttle stop adjustment bolt (**16**) to 0.65 - 0.85V.
5. Depress the throttle pedal and adjust open throttle stop adjustment bolt (**17**) to 3.65 - 3.85V.
6. Tighten lock nuts on each stop bolts (**16** and **17**).
7. Verify the above readings are correct and adjust if necessary.

4.3.5 Joystick Assembly

a. Joystick Assembly Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL position, engage the parking brake and turn the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.



4. Remove the bolts securing the boom joystick to the cab (**18**).
5. Lift the joystick from its mounting position.
6. Label and disconnect the electrical connectors attached to the joystick.
7. Remove the joystick assembly.

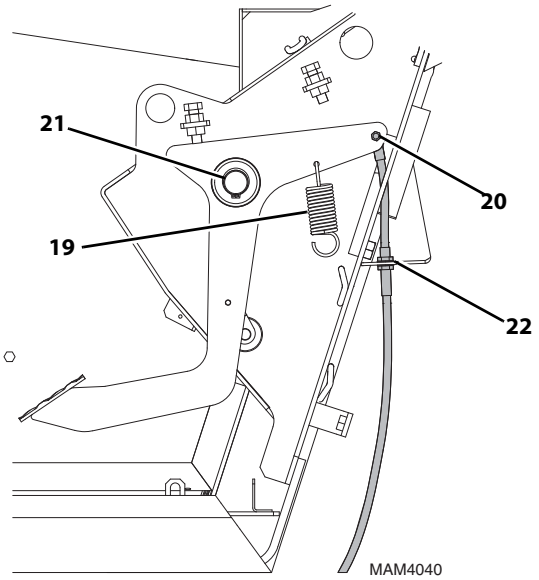
b. Joystick Assembly Installation

1. Connect the previously labeled electrical connectors to the joystick.
2. Install the bolts securing the joystick to the cab.
3. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
4. Test the joystick functions.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

4.3.6 Mechanical Throttle Pedal

a. Mechanical Throttle Pedal Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the travel select lever in the (N) NEUTRAL position, engage the parking brake and turn the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



4. Remove the tension spring (**19**) from the pedal.
5. Disconnect the nut securing the throttle cable end (**20**) to the throttle pedal.
6. Remove the snap ring (**21**) securing the throttle pedal to the mounting post.
7. Remove the throttle pedal assembly from the cab.

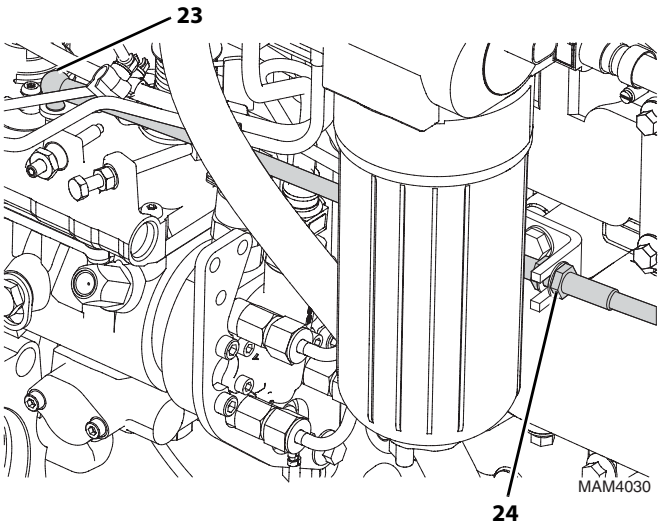
b. Mechanical Throttle Pedal Installation

1. Position the throttle pedal in its mounting location within the cab.
2. Secure the throttle pedal into position with the previously used snap ring.
3. Install the throttle cable to the throttle pedal.
4. Refer to Section b, "Mechanical Throttle Pedal Cable Installation"for detailed cable installation and adjustments.
5. Install the pedal tension spring.
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Close and secure the engine cover.
8. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

4.3.7 Mechanical Throttle Pedal Cable

a. Mechanical Throttle Pedal Cable Removal

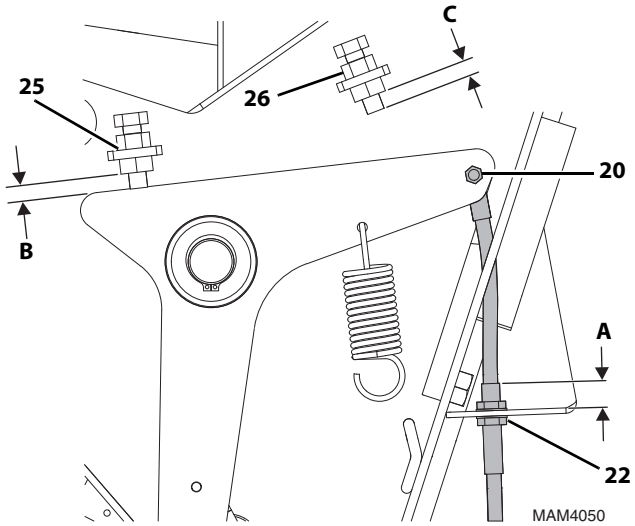
1. Disconnect the throttle cable from the throttle pedal (**20**).
2. Loosen the lock nuts (**22**) on the base of the throttle pedal.



3. Disconnect the throttle cable (**23**) from the engine.
4. Loosen the lock nuts (**24**) on the throttle cable engine bracket.
5. Cut all cable nylon ties securing the throttle cable.
6. Remove the throttle cable noting the routing location of the throttle cable.

b. Mechanical Throttle Pedal Cable Installation

1. Install the throttle cable following the routing location of the previously removed cable.



2. Connect the throttle cable to the throttle pedal (**20**).
3. Hand tighten the lock nuts (**22**) on the base of the throttle pedal.
4. Adjust the throttle cable to 12 - 14 mm (0.47 - 0.55 in)(**A**) and tighten locknuts (**22**).
5. Adjust throttle pedal stop (**25**) to 4 - 6 mm (0.15 - 0.23 in).
6. Adjust throttle pedal stop (**26**) to 10 - 12mm (0.39 - 0.47 in).
7. Connect the throttle cable (**23**) to the engine.
8. Tighten the lock nuts (**24**) on the throttle cable engine bracket.
9. Secure the throttle cable with nylon ties as needed.
10. Start the machine and verify low idle (900 - 100 RPM) and high idle (2300 - 2400 RPM). Adjust if required.

4.3.8 Window Wiper Assembly

Refer to Section 9.13, “Window Wiper System (if equipped)”, for removal and installation information.

4.3.9 Heater System (if equipped)

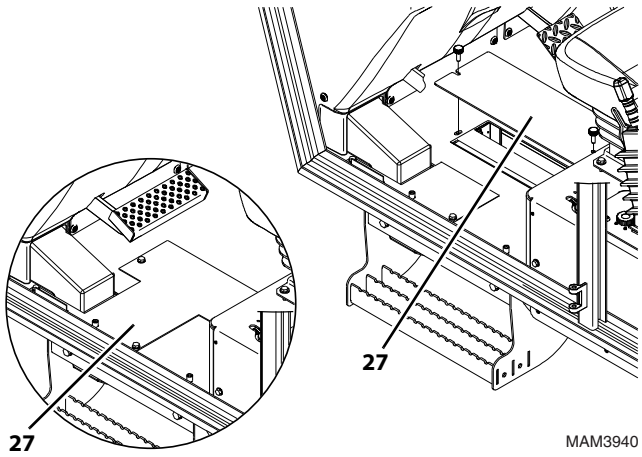
a. Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.

⚠ CAUTION

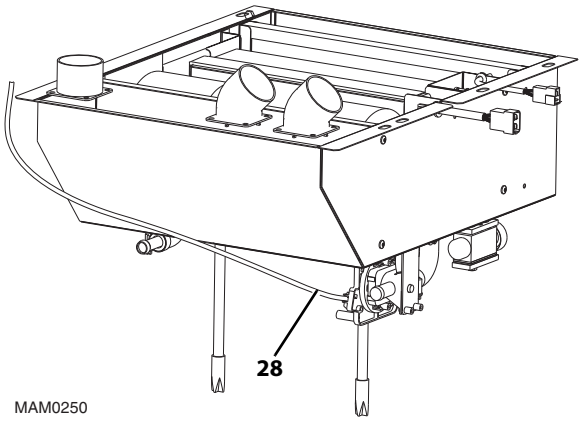
The cooling system is under pressure. NEVER remove the radiator cap while the cooling system is hot. Wear safety glasses. Turn the radiator cap to the first stop and allow pressure to escape before removing the cap completely.

5. Place a suitable container beneath the radiator. Slowly turn the radiator cap to the first stop, and allow any pressure to escape. Remove the radiator cap.
6. Place a funnel at the base of the radiator to channel the drained coolant into the container. Remove the drain plug and allow the coolant to drain.
7. Transfer the coolant to a container with a cover, and label as "Used Antifreeze". Dispose of the used coolant at an approved recycling facility.
8. Tighten the radiator drain plug.
9. From under the cab, remove the protective cover to the heater assembly.
10. Remove the cab floor mat.



EARLY PRODUCTION

11. Remove the small cab floor plate (**27**).
12. Remove the four bolts securing the intake box to the heater box.
13. Label and disconnect the electrical connections to the heater assembly.



14. Disconnect the cable (**28**) for the heater control knob from the water valve.
15. Support the heater assembly from under the cab
16. Remove the bolts securing the heater assembly to the cab. Remove the heater assembly.

b. Installation

1. Position the heater assembly to its original orientation under the cab. Secure with the previously used hardware.
2. Connect the cable for the heater control knob to the water valve.
3. Connect the previously labeled electrical connectors to the heater assembly.
4. Replace the heater assembly filter if needed, refer to Section 4.3.9. c. "Heater Assembly Filter Replacement".
5. Fill the cooling system completely with coolant, allowing time for the coolant to fill the engine block. The cooling system capacity is listed in Section 2.3, "Fluids and Lubricant Capacities".
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Start the engine, run it briefly at low idle and check the machine for any visual sign of fluid leakage.

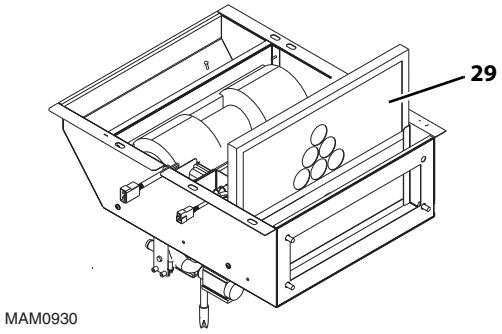
Note: *STOP the engine immediately if any leakage is noted, and make any necessary repairs before continuing.*

8. Wait for the engine to cool and check the coolant level. Add coolant as required to bring the coolant to the proper level.

9. Install the protective cover to the heater assembly.
10. Install the intake box to the heater box.
11. Install the small cab floor plate.
12. Install the plastic side cover in the cab.
13. Install the cab floor mat.
14. Close and secure the engine cover.
15. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

c. Heater Assembly Filter Replacement

1. Remove the cab floor mat.
2. Remove the small cab floor plate (**27**).
3. Remove the four bolts securing the intake box to the heater box.



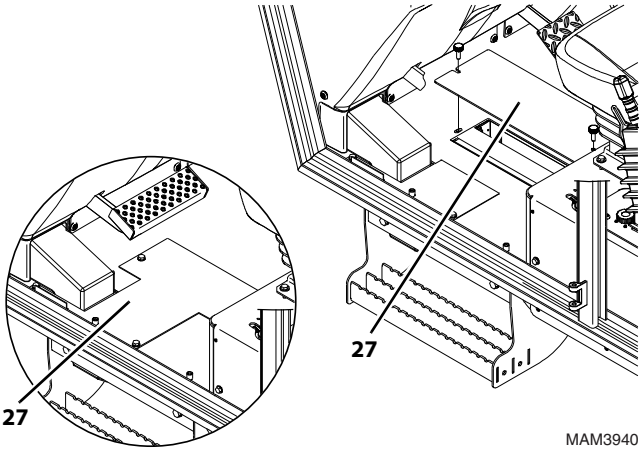
4. Remove the heater assembly filter (**29**) and replace with a new filter.
5. Install the intake box to the heater box.
6. Install the small cab floor plate.
7. Install the cab floor mat.

4.3.10 Heater and Air Conditioning System (if equipped)

a. Removal

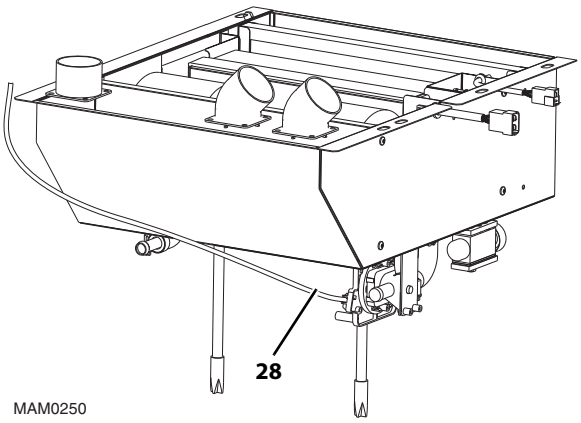
1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage park brake and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine covers. Allow system fluids to cool.
4. Properly disconnect the battery. Refer Section 9.11, "Battery", for procedure.
5. Place a suitable container beneath the radiator. Slowly turn the radiator cap to the first stop, and allow any pressure to escape. Remove the radiator cap.
6. Place a funnel at the base of the radiator to channel the drained coolant into the container. Remove the drain plug and allow the coolant to drain.
7. Transfer the coolant to a container with a cover, and label as "Used Antifreeze". Dispose of the used coolant at an approved recycling facility.
8. Tighten the radiator drain plug.

Note: *The local Caterpillar dealer or certified air conditioning service center or personnel to perform the refrigerant removal from the system.*



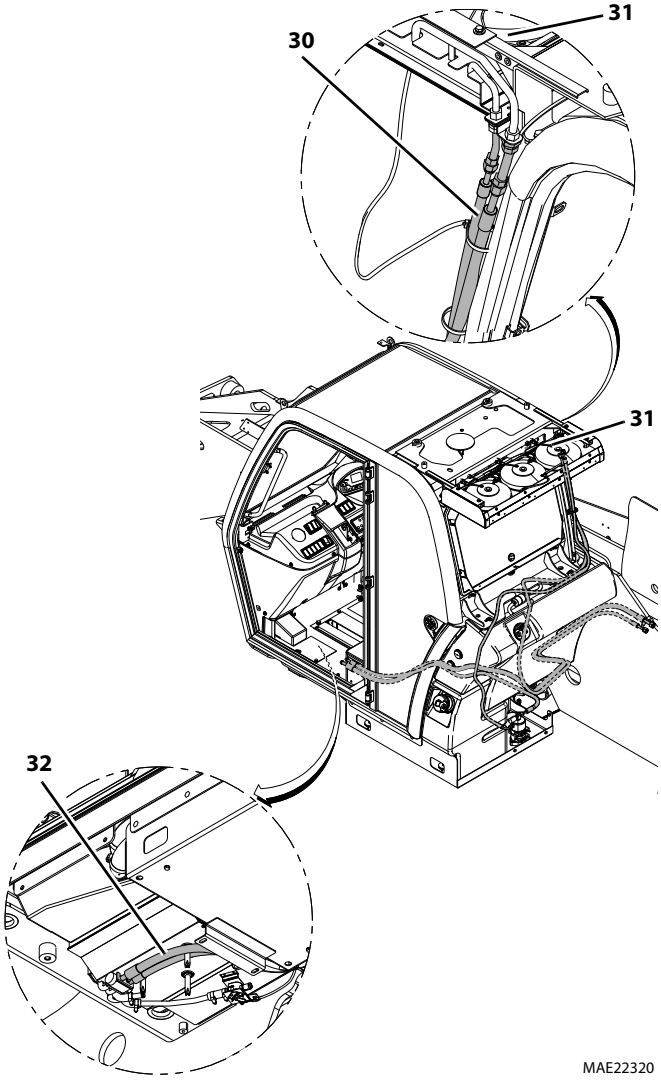
EARLY PRODUCTION

9. From under the cab, remove the protective cover to the heater and air conditioning assembly.
10. Remove the cab floor mat.
11. Remove the small cab floor plate (**27**).
12. Remove the four bolts securing the intake box to the heater box.



13. Label and disconnect the electrical connections to the heater and air conditioning assembly.
14. Disconnect the cable (**28**) for the heater control knob from the water valve.

15. Support the heater and air conditioning assembly from under the cab.



16. Label and disconnect hoses (**30**) attached to the condenser assembly (**31**).
17. Label and disconnect all electrical connections attached to the condenser assembly.
18. Remove bolts securing the condenser assembly (**31**) to cab roof. Remove condenser assembly from rear of the cab roof.
19. Label and disconnect air conditioning hoses (**32**) attached to heater and air conditioning assembly.
20. Remove bolts securing heater and air conditioning assembly to cab. Remove heater and air conditioning assembly.

b. Installation

1. Install cab condenser assembly (**31**) to cab roof. Secure with previously removed hardware.
2. Connect previously labeled electrical connections to the condenser assembly.
3. Connect previously labeled hoses (**30**) to condenser assembly (**31**).
4. Position heater and air conditioning assembly to original orientation under the cab. Secure with previously removed hardware.
5. Connect previously labeled electrical connections to heater and air conditioning assembly.
6. Connect cable (**28**) the heater control knob to the water valve.
7. Connect the previously labeled electrical connectors to the heater assembly.
8. Connect previously labeled air conditioning hoses (**32**) to appropriate locations.
9. Replace the heater assembly filter if needed, refer to Section 4.3.9. c. “Heater Assembly Filter Replacement”.
10. Fill cooling system completely with coolant, allowing time for the coolant to fill the engine block. The cooling system capacity is listed in Section 2.3, “Fluids and Lubricant Capacities”.

Note: *The local Caterpillar dealer or certified air conditioning service center or personnel to perform the refrigerant installation to the system.*

11. Properly connect the battery. Refer Section 9.11, “Battery”, for procedure.
12. Start engine, run it briefly at low idle and check machine for any visual sign of fluid leakage.

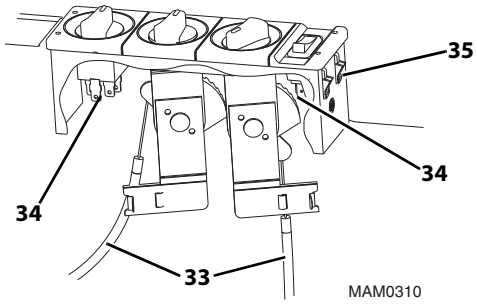
Note: *STOP engine immediately if any leakage is noted, and make any necessary repairs before continuing.*

13. Wait for engine to cool and check coolant level. Add coolant as required to bring coolant to proper level.
14. Install the protective cover to the heater and air conditioning assembly.
15. Install the intake box to the heater box.
16. Install the small cab floor plate.
17. Install the cab floor mat.
18. Close and secure the engine cover.
19. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

4.3.11 Heater/Air Conditioning Controls

a. Heater Controls Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the plastic side cover in the cab to gain access to the control cables and electronics. If necessary, remove the seat for more accessibility.



6. Label and disconnect the control cables (**31**) attached to the control knob mechanisms.
7. Label and disconnect the electrical connectors (**33**) attached to the control box.
8. Depress the side clips (**35**) and push the control box through the dash panel.

b. Disassembly

Do Not disassemble the cab heater and fan controls. The controls are not serviceable. Replace controls if found to be defective.

c. Installation and Testing

1. Install the control box into the dash panel until the side clips firmly hold the box.
2. Connect the previously labeled electrical connectors to the appropriate locations.
3. Connect the previously labeled control cables to the appropriate control knob mechanisms.
4. Verify the water valve on the bottom of the heater assembly opens completely.
5. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
6. Turn the ignition key to the ON position and check the control functions.
7. Start the machine and allow engine to warm to operating temperature. Check heat control at different levels.
8. Install the plastic side cover. If necessary, install the seat.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

4.4 CAB REMOVAL

WARNING

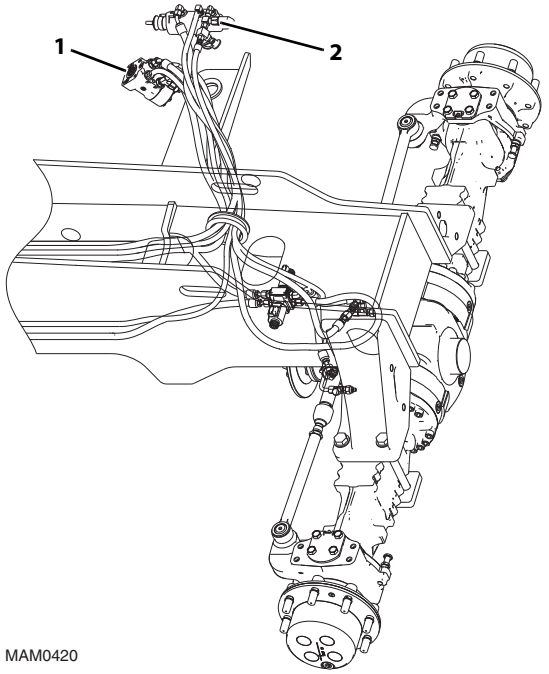
The protection offered by this ROPS/FOPS will be impaired if subjected to any modification or structural damage, at which time replacement is necessary. ROPS/FOPS must be properly installed using fasteners of correct size and grade, and torqued to their specified value.

Note: *To help ensure safety and optimum performance, replace the cab if it is damaged. Refer to the appropriate parts manual for ordering information.*

Inspect the cab, its welds and mounts. If modification, damage, a cracked weld and/or fatigued metal is discovered, replace the cab. Contact the local Caterpillar dealer with any questions about the suitability or condition of a cab.

Note: *Remove and label cab components as needed before removing the cab from the machine. Label, disconnect and cap hydraulic hoses. Transfer cab parts to the replacement cab after the replacement cab is securely mounted on the machine.*

1. Park the machine on a firm, level surface. Allow sufficient overhead and side clearance for cab removal. Level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Block all four wheels to help prevent the machine from moving. Assure that there is sufficient overhead and side clearance for cab removal.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.
5. Place a funnel at the base of the radiator to channel the drained coolant into the container. Remove the drain plug and allow the coolant to drain.
6. Transfer the coolant to a container with a cover, and label as “Used Antifreeze”. Dispose of the used coolant at an approved recycling facility.
7. Tighten the radiator drain plug.
8. Label and disconnect the cab heater hoses. Refer to Section 4.3.9, “Heater System (if equipped)” and Section 4.3.10, “Heater and Air Conditioning System (if equipped)”.
9. Remove the protective cover from the front of the cab.



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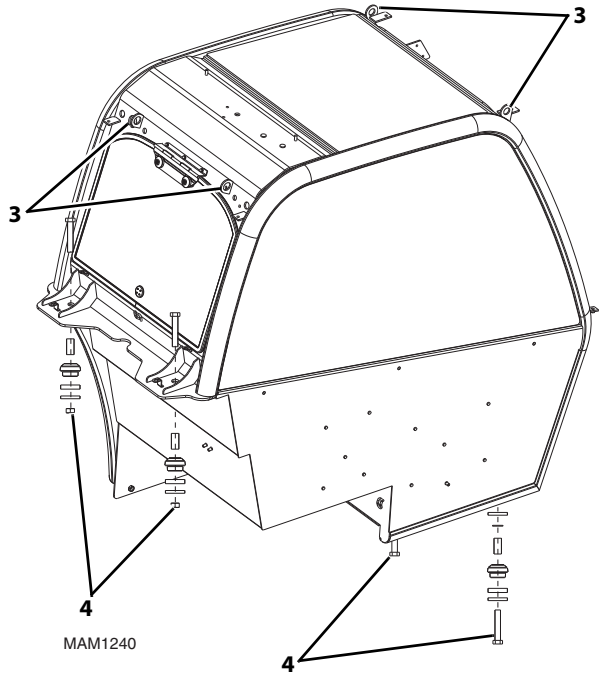
10. Label, disconnect and cap all hydraulic hoses attached to the steering orbital valve (**1**). Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
11. Label, disconnect and cap all hydraulic hoses attached to the service brake valve (**2**). Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
12. Disconnect the cab ground strap.
13. Remove the hydraulic oil reservoir. Refer to Section 8.7.3, “Hydraulic Oil Reservoir Removal/Installation”.
14. Remove the fuel tank. Refer to Section 7.6.2, “Fuel Tank”.
15. Label and disconnect the cab harness connectors. Move the harnesses clear of the cab to prevent damage during cab removal.



16. Install four lifting eye bolts with a minimum lifting capacity of 363 kg (800 lb) in the existing lifting holes at the top corners of the cab (**3**).
17. Use a hoist or overhead crane and sling with a minimum lifting capacity of 363 kg (800 lb) attached to the four eye bolts. Do Not attempt to lift the cab at this point.
18. Remove the four bolts (**4**) securing the cab to the frame.
19. Remove the mirrors and all other cab components as needed, if not previously removed.
20. When all wiring, hydraulic hoses and fasteners are disconnected or removed, carefully and slowly lift the cab and remove it from the frame. Readjust the position of the sling as needed to help balance the cab during removal.
21. When the cab is completely clear of the machine, carefully lower it to the ground. Block up or support the cab so that it does not move or fall. Assure that no personnel enter the cab while it is being removed from the machine.
22. Inspect and replace other machine parts that are exposed with the cab removed. Repair or replace as required.

4.5 CAB INSTALLATION

1. Block all four wheels to help prevent the machine from moving. Assure that there is sufficient overhead and side clearance for cab installation.
2. Attach a sling with a minimum lifting capacity of 363 kg (800 lb) through the lifting eyes of the cab.
3. Use a hoist or overhead crane and sling attached to the cab. Carefully begin to align the cab with the mounting holes in the frame. Stop and check that wiring, hydraulic hoses, cables, etc., will not be pinched or damaged as the cab is positioned. Readjust the position of the sling as needed to help balance the cab during installation.
4. Install the four cab to frame mount bolts, washers and nuts to 150 Nm (111 lb-ft).
5. Connect the previously labeled cab harness connectors to their appropriate locations.
6. Install the fuel tank. Refer to Section 7.6.2, “Fuel Tank”.
7. Install the hydraulic oil reservoir. Refer to Section 8.7.3, “Hydraulic Oil Reservoir Removal/Installation”.
8. Reconnect the cab ground strap.
9. Uncap and reconnect the previously labeled hydraulic hoses to their appropriate locations.
10. Reconnect any remaining electrical connections to their appropriate locations.
11. Reconnect the heater hoses to the cab heater. Refer to Section 4.3.9, “Heater System (if equipped)”.
12. Fill the cooling system completely with coolant, allowing time for the coolant to fill the engine block.The cooling system capacity is listed in Section 2.3, “Fluids and Lubricant Capacities”.
13. Properly connect the battery. Refer to Section 9.11, “Battery”, for procedure.
14. Carefully examine all cab components, fasteners, etc., one last time before engine start-up. Rectify any faulty conditions.

15. Start the engine and check the operation of all controls. Check for hydraulic fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.

Note: *When the engine is initially started, run it briefly at low idle and check the machine for any visual sign of fluid leakage. STOP the engine immediately if any leakage is noted, and make any necessary repairs before continuing.*

16. Wait for the engine to cool and check the coolant level. Add coolant to the overflow bottle as required to bring the coolant to the proper level.
17. Install the protective cover to the front of the cab.
18. Install the mirrors and all other cab components as needed, if removed.
19. Unblock the wheels.
20. Close and secure the engine cover.
21. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

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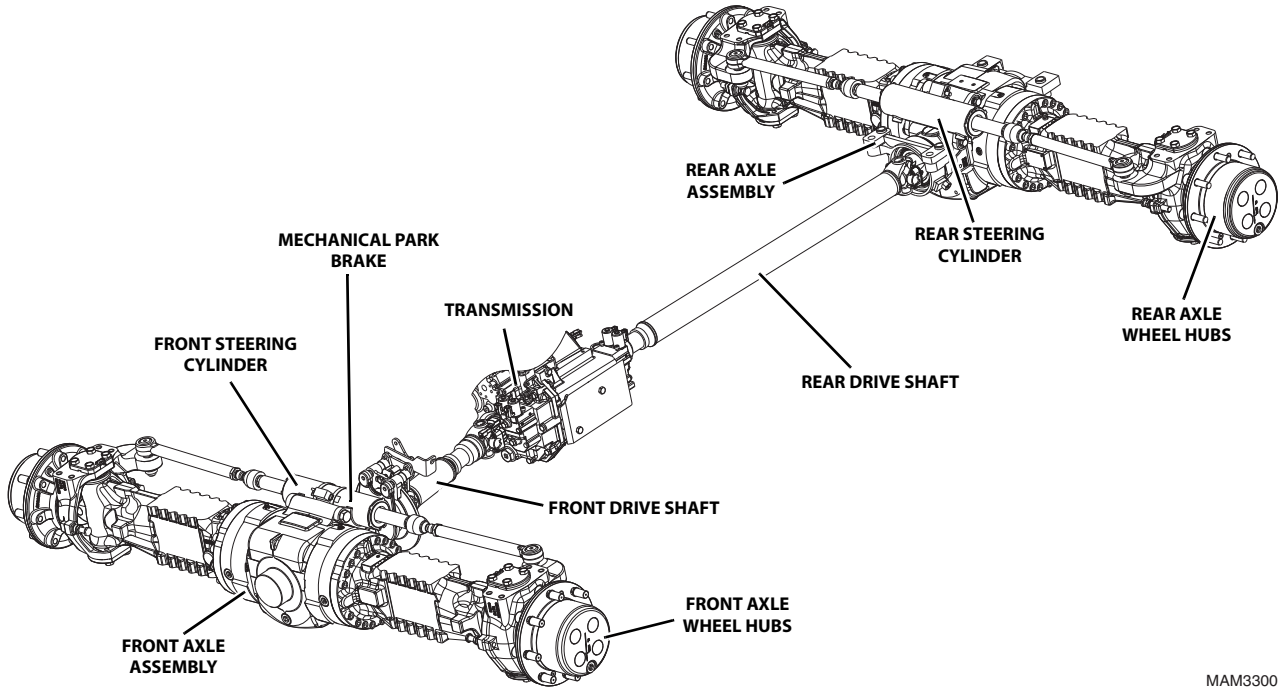
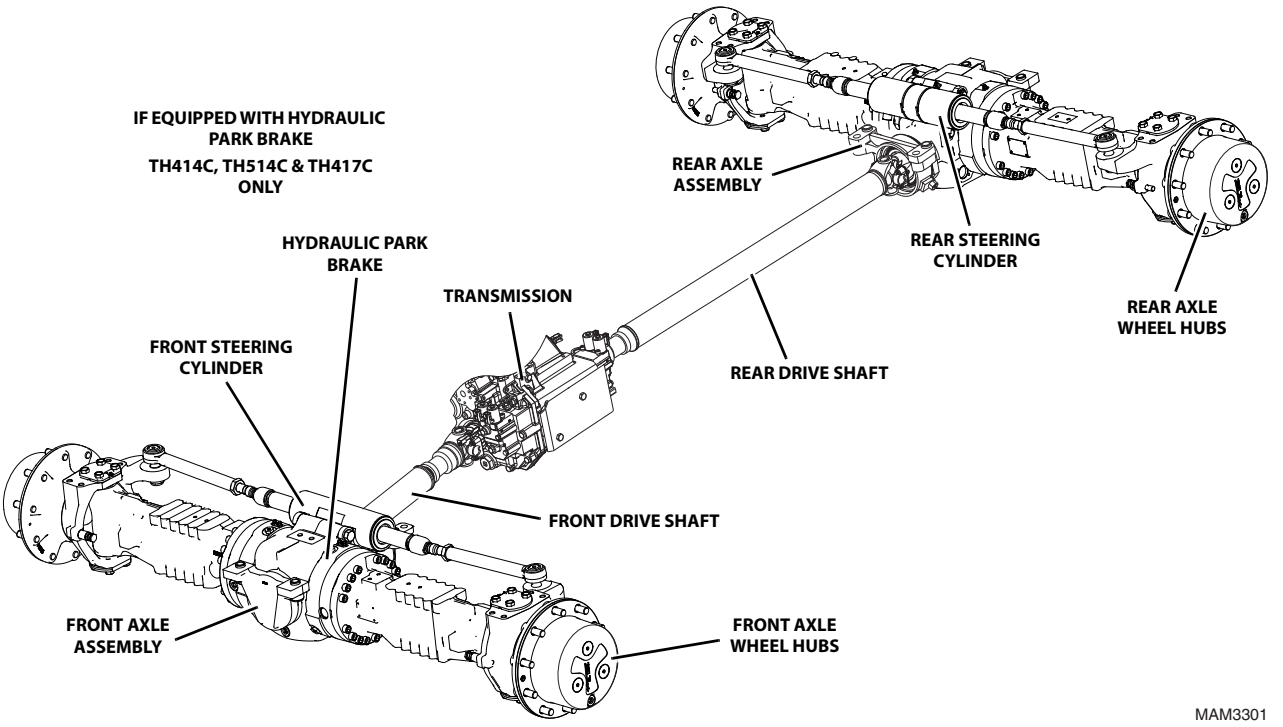
Section 5
Axles, Drive Shafts, Wheels and Tires

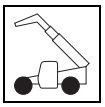
Contents

5.1 AXLE, DRIVE SHAFT AND WHEEL COMPONENT TERMINOLOGY

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the major assemblies of the axles, drive shafts, wheels and tires. The following illustration identifies the components that are referred to throughout this section.







WARNING

Do Not service the machine without following all safety precautions as outlined in Section 1, “Safety Practices”, of this manual.

5.2 AXLE SERIAL NUMBER

The front and rear axle serial number plate is located on the inside of each axle on the right side of the center section. Information on the serial number plate is required in correspondence regarding the axle.

Supply information from the axle serial number plate when communicating about an axle assembly or axle components.

5.3 AXLE SPECIFICATIONS AND MAINTENANCE INFORMATION

For axle, oil specifications and maintenance information, refer to Section 2.3, “Fluids and Lubricant Capacities”.

Detailed axle service instructions are provided in the following publications:

Refer to SIS Web for detailed axle service instructions.

5.4 AXLE REPLACEMENT

5.4.1 Axle Removal

WARNING

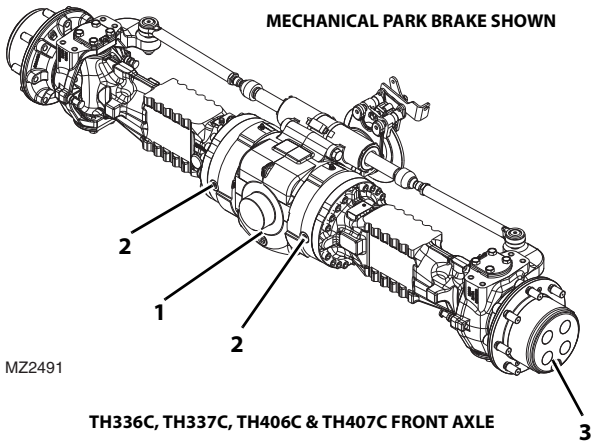
An improperly supported machine can fall. Safely raise and adequately support the machine so that it will remain stable and in place before attempting to remove an axle.

The front and rear axle assemblies differ in that the front axle assembly is equipped with a parking brake mechanism and a limited slip feature; the rear axle has neither. The following steps outline a typical axle removal procedure, suitable for either the front or the rear axle assembly.

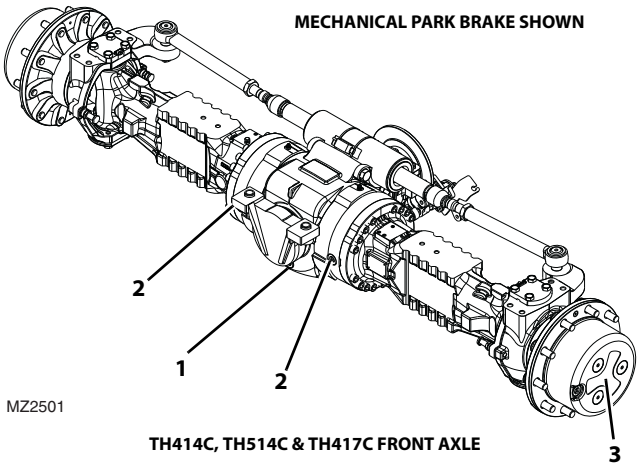
Cleanliness is extremely important. Before attempting to remove the axle, thoroughly clean the machine. Avoid spraying water or cleaning solution on electrical components. If using a steam cleaner, seal all openings before steam cleaning.

Note: *Clear the work area of all debris, unnecessary personnel, etc. Allow sufficient space to raise the machine and to remove the axle.*

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the parking brake, straighten all wheels and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.
5. Remove the bolts securing the fender assembly to the axle.



TH336C, TH337C, TH406C & TH407C FRONT AXLE



TH414C, TH514C & TH417C FRONT AXLE

6. Loosen and remove the axle oil fill plug (**2**). If the axle will be disassembled after removal, place a suitable receptacle under the axle (**1**) and wheel hubs (**3**) drain plugs. Remove the drain plugs and allow the oil to drain into the receptacle. Transfer the used oil into a suitable covered container, and label the container as "Used Oil". Dispose of the used oil at an approved recycling facility.
7. Label, disconnect and cap the steering and brake lines at the axle. Wipe up any spilled oil.
8. Block the front and rear of both tires on the axle that is not being removed. Ensure that the machine will remain in place during axle removal before proceeding.
9. Raise the machine using a suitable jack or hoist. Place suitable supports under both sides of the frame and lower the machine onto the supports. Ensure that the machine will remain in place during axle removal.
10. Support the axle that is being removed with a suitable jack, hoist or overhead crane and sling. Do Not raise the axle or the machine.
11. Remove both wheel and tire assemblies from the axle that is being removed. Refer to Section 5.11.1, "Removing Wheel and Tire Assembly from Machine".

Note: *The wheel and tire assemblies must be re-installed later with the directional tread pattern "arrows" facing in the direction of forward travel.*

12. Remove the drive shaft assembly. Refer to Section 5.10.3, "Drive Shaft Removal".
13. **TH414C, TH514C & TH417C Only:** On the front axle, remove the lower position cylinder mount pin for the front cylinder. Tap the cylinder mount pin out, and move the cylinder to prevent it from interfering with axle removal. If a new axle will be installed, remove the frame level mounting plate from the axle.
14. Remove the bolts and locknuts securing the axle to the frame.
15. Remove the axles from the machine using the jack, hoist or overhead crane and sling supporting the axle. Do Not raise or otherwise disturb the machine while removing the axle. Balance the axle and prevent it from tipping, turning or falling while removing it from beneath the machine. Place the axle on a suitable support or holding stand.

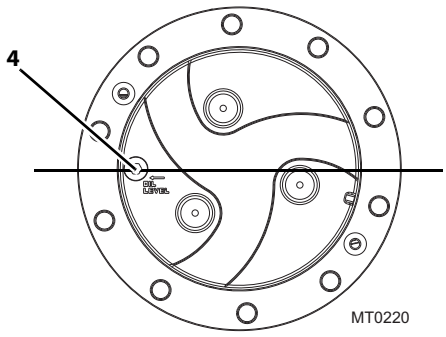
5.4.2 Axle Installation

1. Before proceeding, ensure that the machine will remain in place during axle installation. Block the front and rear of both tires on the axle that is already installed on the machine.
2. If applicable, raise the machine using a suitable jack or hoist. Place suitable supports beneath the frame and lower the machine onto the supports, allowing enough room for axle installation. Ensure that the machine will remain in place during axle installation.
3. Using a suitable jack, hoist or overhead crane and sling, remove the axle from its support or holding stand. Balance the axle and prevent it from tipping, turning or falling while positioning it beneath the machine. Do Not raise or otherwise disturb the machine while installing the axle. Keep the axle supported and balanced on the jack, hoist or overhead crane and sling throughout the installation procedure.
4. Position the axle under the frame, and align the axle housings with the holes in the frame.
5. Apply Loctite® 271™ to each mounting bolt.

6. Install the axle mounting bolts and nuts. Tighten and torque as required:

Machine	Front Axle Bolts Torque	Rear Axle Bolts Torque
TH336C, TH337C, TH406C, TH407C	780 - 820 Nm (575 - 605 lb-ft)	550 Nm (406 lb-ft)
TH414C, TH514C, TH417C	550 Nm (406 lb-ft)	550 Nm (406 lb-ft)

7. **TH414C, TH514C & TH417C Only:** Install the frame level mount to the front axle (if necessary). Move the cylinder into position on the axle cylinder anchor. Insert a cylinder mount pin through the cylinder and cylinder anchor. Secure the cylinder mount pin.
8. Apply multi purpose grease through the self tapping lube fitting to lubricate the self align bearing and the cylinder mount pin.
9. Install the drive shaft assemblies. Refer to Section 5.10.5, "Drive Shaft Installation".
10. If reinstalling an axle previously removed from the machine, position the driveshaft yoke on the axle according to the alignment marks made earlier. If installing a new axle, note the position of the driveshaft yoke at the transmission. Align the driveshaft yoke on the axle in the same plane as the yoke on the transmission.
11. Tighten the axle oil drain plug (**1**), loosen and remove the axle oil fill plug (**2**). Refer to Section 2.3, "Fluids and Lubricant Capacities", for proper oil and capacities.



12. Rotate wheel hubs 90 degrees so the drain plug becomes the fill plug (**4**). Refer to Section 2.3, "Fluids and Lubricant Capacities", for proper oil and capacities.
13. Install the wheel and tire assemblies. Refer to Section 5.11.2, "Installing Wheel and Tire Assembly onto Machine".
14. Carefully remove the jack, hoist or overhead crane and sling supporting the axle.
15. Carefully raise the machine using a suitable jack or hoist. Remove the supports from beneath the frame and lower the machine to the ground.
16. Remove the blocks from the front and rear of both tires on the other axle.

Note: *ALWAYS use new o-rings when servicing the machine.*

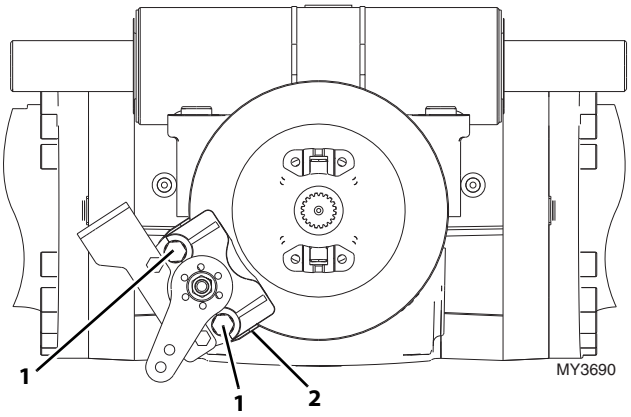
17. Install new o-rings into the fittings. Lubricate the o-rings with clean hydraulic oil.
18. Uncap and connect the steering and brake lines at their axle fittings.
19. Check the hydraulic reservoir oil level.
20. Start the engine. Turn the steering wheel several times lock to lock, operate the frame tilt function several times in both directions and check the function of the brakes. Check for hydraulic leaks, and tighten or repair as necessary.
21. Install the fender assembly. Torque the mounting bolts to 241 Nm (178 lb-ft).
22. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
23. Close and secure the engine cover.
24. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

Note: *The service brake circuit will need to bled after axle installation. Refer to Section 8.10.4, "Service Brake Bleeding".*

5.5 MECHANICAL PARK BRAKE

5.5.1 Mechanical Park Brake Removal

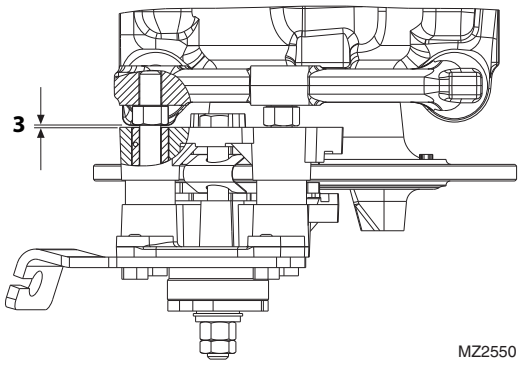
1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the parking brake, straighten all wheels and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.
5. Remove park brake cable from park brake lever.



6. Remove bracket (**2**) from park brake.
7. Remove the bolts (**1**) securing the park brake to the axle. Remove the park brake off the brake disc.

5.5.2 Mechanical Park Brake Installation

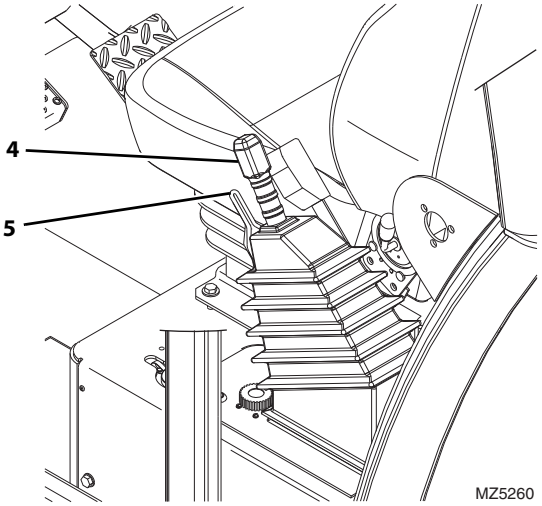
1. Slide park brake onto brake disc and secure with the previously used hardware. Do Not tighten the bolts at this time.



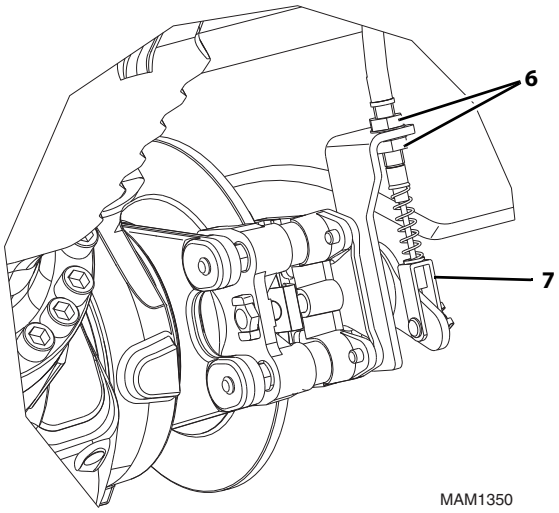
2. Use a feeler gauge to measure the distance (**3**) between locknuts and spacers. Set the gap to 1 ± 0.5 mm (0.040 ± 0.020 in) before tightening the two bolts. Torque bolts to 115 Nm (85 lb-ft).
3. Install bracket onto park brake. Install park brake cable.
4. Properly connect the battery. Refer to Section 9.11, “Battery”, for procedure.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

5.5.3 Mechanical Park Brake Adjustment

1. Chock all wheels to prevent machine from moving.



2. Place the park brake in the disengaged position. Depress the release lever (**5**) and push the park brake lever (**4**) downward.



3. Adjust lock nuts (**6**) to remove any slack in the park brake cable (**7**).
4. Sitting in the operators seat, adjust the park brake cable by turning the adjuster knob (**4**) clockwise to increase park brake force. Turn the adjuster knob counterclockwise to decrease park brake force.

5.6 HYDRAULIC PARK BRAKE

For detailed hydraulic park brake removal, Refer to Section 5.3, "Axle Specifications and Maintenance Information".

5.6.1 Park Brake Test

The following procedure is used in order to determine if the parking brake is functional. This procedure is not intended to measure the maximum brake performance.

Note: *Refer to Section 9.4.1, "Keypad", for additional information.*

Note: *The hand held Analyzer can also be used if desired.*

1. Verify the machine is on a dry, level surface and the test area is clear of personnel and obstacles.
2. Engage the park brake and start the machine.
3. Access Level 3 on the display screen.
4. Select PARK BRAKE TEST from the calibration menu.
5. The operator will be asked: PERFORM PARK BRAKE TEST? To begin the test, press the Enter button.

Note: *Pressing the ESC button will return the operator back to the CALIBRATIONS menu.*

Note: *If there is an active fault pertaining to a drive direction or gear selection inputs, the analyzer will not permit the test to be run and show PARK BRAKE TEST FAILED.*

6. With the park brake test now running, the analyzer will prompt the operator to SET PARK BRAKE.

Note: *If J4-5 is LOW when the operator presses the Enter button, the control system will respond with a PARK BRAKE TEST FAILED message and any concluding button press will return the analyzer back to CALIBRATION: PARK BRAKE TEST menu screen.*

7. If J4-5 is HIGH when the operator presses the Enter button, the analyzer will prompt the operator to Shift To Second Gear.

Note: *If J4-11 is LOW or J4-11 is HIGH and one of the other gear select inputs is HIGH when the operator presses the Enter button, the control system will respond with a PARK BRAKE TEST FAILED message and any concluding button press will return the analyzer back to CALIBRATION: PARK BRAKE TEST menu screen.*

8. If J4-11 (connector on the UGM) is HIGH when operator presses the Enter button, the analyzer will provide the following information: WARNING: DRIVE WILL BE ENGAGED for a period of 2 seconds and then display the following information: FORWARD TO START (first line) NEUTRAL TO PAUSE (second line).
9. If the control system receives a valid drive FORWARD signal in this test mode, the transmission neutralize state will be overridden (act as the park brake is not set) and drive will be engaged. If the control system receives a valid drive NEUTRAL signal in this test mode, the transmission neutralize state will be engaged (normal operation).
10. Gradually increase the engine speed to high idle. The machine should not move.
11. Reduce engine speed to low idle. Move transmission to the neutral position.

⚠ WARNING

If the machine begins to move during the PARK BRAKE TEST, reduce engine speed to low idle and apply the service brakes.

Note: *If the machine moved during the PARK BRAKE TEST, refer to Section 5.5.3, "Mechanical Park Brake Adjustment", and re-test.*

Note: *If J4-5 goes LOW or J4-11 goes LOW or an active fault pertaining to the drive direction or gear selection inputs become active in this test mode, the test will be stopped and the control system will respond with a PARK BRAKE TEST FAILED message and any concluding button press will return the analyzer back to CALIBRATION:PARK BRAKE TEST menu screen.*

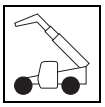
12. If the ESC or Enter button is pressed at this stage, the control system will stop the test and respond with a PARK BRAKE TEST COMPLETE message and any concluding button press will return the analyzer back to CALIBRATION: PARK BRAKE TEST menu screen.
13. With the PARK BRAKE TEST complete, engage the park brake, shut engine OFF.

5.7 BRAKE INSPECTION

Detailed axle service instructions are provided in the appropriate Axle Disassembly & Assembly Manual, refer to Section 5.3, "Axle Specifications and Maintenance Information".

5.8 STEERING ANGLE ADJUSTMENT

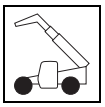
Detailed axle service instructions are provided in the appropriate Axle Disassembly & Assembly Manual, refer to Section 5.3, "Axle Specifications and Maintenance Information".



5.9 AXLE ASSEMBLY AND DRIVE SHAFT TROUBLESHOOTING

Problem	Possible Causes	Remedy
1. Excessive axle noise while driving.	1. Oil level too low.	1. Fill oil to correct level. Refer to Section 2.3, "Fluids and Lubricant Capacities".
	2. Axle and/or wheel end housings filled with incorrect oil or oil level low.	2. Drain axle and/or wheel end housings and fill to correct level. Refer to Section 2.3, "Fluids and Lubricant Capacities".
	3. Incorrect alignment of ring and pinion gears.	3. Correct alignment by adding or removing shims as needed.
	4. Incorrect pinion (input) shaft bearing preload.	4. Correct bearing preload by adding or removing shims as needed.
	5. Worn or damaged bearings.	5. Replace bearings as needed.
	6. Worn or broken gear teeth.	6. Replace gears as needed.
	7. Contamination in the axle.	7. Drain axle and/or wheel end housings and fill to correct level. Refer to Section 2.3, "Fluids and Lubricant Capacities".
	8. Axle housing damaged.	8. Replace damaged parts.
2. Intermittent noise when traveling.	1. Universal joint(s) worn or damaged.	1. Repair or replace universal joints as needed.
	2. Differential ring and/or pinion gears damaged.	2. Determine cause and repair as needed.
3. Vibration or intermittent noise when traveling.	1. Drive shaft universal joint assembly(ies) incorrectly tightened.	1. Tighten capscrews to correct torque.
	2. Drive shaft universal joint(s) worn or damaged.	2. Repair or replace universal joints as needed.
	3. Drive shaft(s) damaged/ unbalanced.	3. Replace drive shaft(s) as needed.

Problem	Possible Causes	Remedy
4. Oil leaking from axle (differential housing and/or axle housings).	1. Drain and/or inspection plugs loose and/or o-rings damaged or missing.	1. Replace o-rings as needed and tighten plugs to 130 Nm (96 lb-ft).
	2. Hose fittings loose.	2. Tighten fittings.
	3. Axle shaft seal damaged or missing and/or worn or damaged shaft sealing surfaces.	3. Replace seal and/or joint coupling fork shaft (axle shaft).
	4. Input shaft multi-seal ring damaged or missing and/or worn or damaged pinion (input) shaft sealing surfaces.	4. Replace multi-seal ring and/or input shaft. Adjust ring and pinion alignment and bearing preload as described in the CAT Repair Manuals.
	5. Axle casing to brake housing and/or brake housing to differential assembly o-rings and/or seals worn or damaged.	5. Replace o-rings and seals.
	6. Axle housing mounting nuts and capscrews loose.	6. Tighten housing nuts and capscrews to 390 Nm (288 lb-ft).
	7. Differential and/or axle housing(s) damaged.	7. Replace housing(s) as needed.
5. Oil leaking from wheel end housing (planet carrier).	1. Oil level plugs loose and/or o-rings damaged or missing.	1. Replace o-rings as needed and tighten plugs to 60 Nm (44 lb-ft).
	2. O-ring between hub and housing (planet carrier) damaged or missing.	2. Replace o-ring.
	3. Shaft seal damaged or missing and/or worn or damaged shaft sealing surfaces.	3. Replace seal and/or fork joint shaft.
	4. Housing capscrews loose.	4. Tighten housing capscrews to 55 Nm (41 lb-ft).
	5. Housing (planet carrier) damaged.	5. Replace housing (planet carrier).
6. Oil leaking from steering cylinder.	1. Hose fittings loose.	1. Tighten fittings.
	2. Steering cylinder o-rings and/or seals worn or damaged.	2. Replace o-rings and seals.
	3. Piston rod seal worn or damaged.	3. Replace piston rod seal.
	4. Cylinder tube damaged.	4. Replace cylinder tube.



Problem	Possible Causes	Remedy
7. Axle overheating.	1. Oil level too high.	1. Fill oil to correct level. Refer to Section 2.3, “Fluids and Lubricant Capacities”.
	2. Axle and/or wheel end housings filled with incorrect oil or oil contaminated or oil level low.	2. Drain axle and fill to correct level. Refer toSection 2.3, “Fluids and Lubricant Capacities”.
	3. Dragging park brake.	3. Adjust park brake cable as needed. Refer to Section 5.5, “Mechanical Park Brake”.
8. High steering effort required.	1. Steering (hydraulic) system not operating properly.	1. Refer to Section 8.5, “Hydraulic Circuits”.
	2. Excessive joint housing swivel bearing preload.	2. Correct bearing preload by adding or removing shims as needed.
	3. Worn or damaged swivel bearings.	3. Replace swivel bearings as needed.
9. Slow steering response.	1. Steering (hydraulic) system not operating properly.	1. Refer to Section 8.5, “Hydraulic Circuits”.
	2. Steering cylinder leaking internally.	2. Repair or replace steering cylinder as needed.
10. Excessive noise when brakes are engaged.	1. Brake discs worn.	1. Check brake discs for wear. Refer to Section 5.7, “Brake Inspection”.
	2. Brake discs damaged.	2. Replace brake discs.
11. Brakes will not engage.	1. Brake (hydraulic) system not operating properly.	1. Refer to Section 8.5, “Hydraulic Circuits”.
	2. Brake piston o-rings and seals damaged (leaking).	2. Replace o-rings and seals.
12. Brakes will not hold the machine or braking power reduced.	1. Brake discs worn.	1. Check brake discs for wear. Refer to Section 5.7, “Brake Inspection”.
	2. Brake (hydraulic) system not operating properly.	2. Refer to Section 8.10.4, “Service Brake Bleeding”.
	3. Brake piston o-rings and seals damaged (leaking).	3. Replace o-rings and seals.

5.10 DRIVE SHAFTS

5.10.1 Drive Shaft Inspection

Inspect areas where the drive shaft flange yokes and slip yokes mount to the drive shafts. Attempt to turn each drive shaft in both directions. Look for excessive looseness, missing parts, cracks or other damage. Worn or damaged drive shafts and cross and bearing assemblies may cause an excessive amount of vibration or noise.

Note: *To ensure optimum performance, the driveshaft assemblies are specially balanced as a unit at the factory. When servicing any flange yoke, slip yoke or drive shaft tube, order a complete assembly if components are bent or damaged. Refer to the appropriate parts manual for ordering information.*

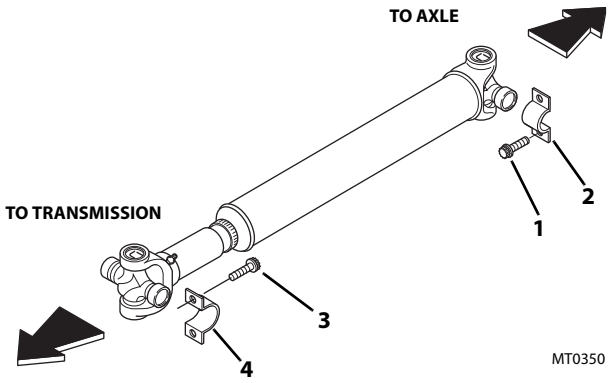
Note: *Any bolt removed from the drive shaft assembly MUST be replaced. Do Not re-torque.*

5.10.2 Drive Shaft Maintenance

Refer to Section 2.3, "Fluids and Lubricant Capacities", for information regarding the lubrication of the grease fittings on the drive shafts.

5.10.3 Drive Shaft Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Block the wheels.
6. The drive shaft assembly is a balanced assembly. Mark the yoke and axle, transmission and the shaft and slip yoke so that these components can be returned to their original positions when reinstalled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.



7. Remove the four bolts (**1**) and two straps (**2**) securing the bearing cross to the transmission output shaft flange.Discard the bolts.
8. Remove the four bolts (**3**) and two straps (**4**) securing the bearing crosses to the axle.
9. Remove the drive shaft assembly.
10. Repeat the above procedure on the rear drive shaft.

5.10.4 Drive Shaft Cleaning and Drying

1. Disassemble and clean all parts using an approved cleaning fluid. Allow to dry.
2. Remove any burrs or rough spots from all machined surfaces. Re-clean and dry as required.

5.10.5 Drive Shaft Installation

1. Raise the drive shaft assembly into position. The slip yoke end of the drive shaft mounts toward the axle. If reinstalling a drive shaft previously removed, align the flange yokes according to the alignment marks made during removal.

Note: *Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.*

2. Apply Loctite® 243™ to all mounting bolts.
3. Install the two straps (**2**) and four new bolts (**1**) securing the bearing crosses to the transmission. Torque capscrews to 38 Nm (lb-ft).
4. Install the two straps (**4**) and four new bolts (**3**) securing the bearing crosses to the axle. Torque capscrews to 38 Nm (lb-ft).
5. Repeat the above procedure on the rear drive shaft.
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Close and secure the engine cover.
8. Unblock the wheels.
9. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

5.11 WHEELS AND TIRES

WARNING

Mismatched tire sizes, ply ratings or mixing of tire types (radial tires with bias-ply tires) may compromise machine stability and may cause machine to tip over.

It is recommended that a replacement tire to be the same size, ply and brand as originally installed. Refer to the appropriate parts manual for ordering information. If not using an approved replacement tire, It is recommended that replacement tires have the following characteristics:

- Equal or greater ply/load rating and size of original.
- Tire tread contact width equal or greater than original.
- Wheel diameter, width and offset dimensions equal to the original.
- Approved for the application by the tire manufacturer (including inflation pressure and maximum tire load).

The rims installed have been designed for stability requirements which consist of track width, tire pressure and load capacity. Size changes such as rim width, center piece location, larger or smaller diameter, etc., without written factory recommendations, may result in unsafe condition regarding stability.

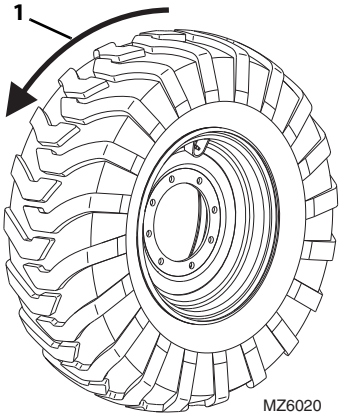
Foam filled tires have a positive effect on the weight, stability and handling characteristics of the machine, especially under load. The use of hydrofill as a tire-fill substance is not recommended because of possible environmental impact.

Large-bore valve stems are used to help expedite tire inflation and deflation. An inner tube may be used if a tire does not provide an airtight seal. Check tire inflation pressures when the tires are cold. When mounting a tire on the wheel, the tire must be mounted on the wheel respective of the directional tread pattern of the tire; this produces a left or right tire and wheel assembly.

5.11.1 Removing Wheel and Tire Assembly from Machine

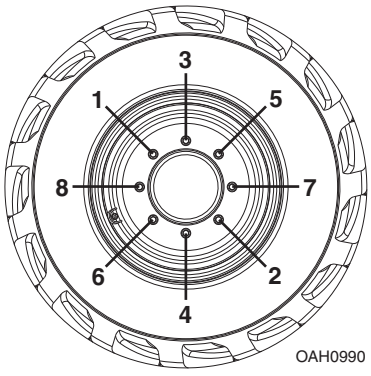
1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
3. Loosen but Do Not remove the lug nuts on the wheel and tire assembly to be removed.
4. Place a suitable jack under the axle pad closest to the wheel being removed. Raise the machine and position a suitable support beneath the axle. Allow sufficient room to lower the machine onto the support and to remove the wheel and tire assembly.
5. Lower the machine onto the support.
6. Remove lug nuts and washers in an alternating pattern.
7. Remove the wheel and tire assembly from the machine.

5.11.2 Installing Wheel and Tire Assembly onto Machine



Note: *The wheel and tire assemblies must be installed with the directional tread pattern "arrows" facing in the direction of forward travel.*

1. Position wheel onto studs on wheel end of axle.
2. Install wheel washers onto studs.
3. Start all lug nuts by hand to prevent cross threading. Apply one drop of lubrication oil.



4. Tighten lug nuts in an alternating pattern as indicated in the previous figure.

   TH336C, TH337C, TH406C, TH407C & TH414C
   340-380 Nm (251-280 lb-ft)

   TH514C & TH417C
   440-480 Nm (324-354 lb-ft)

5. Remove machine from supports.

6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

5.12 TOWING A DISABLED MACHINE

Towing a disabled machine should only be attempted after exhausting all other options. Make every effort to repair the machine and move it under its own power.

1. Fully retract the boom. Position attachment approximately 610 mm (24 in) above the ground.

Note: *If total loss of power has occurred, refer to Section 3.26, "Emergency Boom Lowering Procedure".*

WARNING

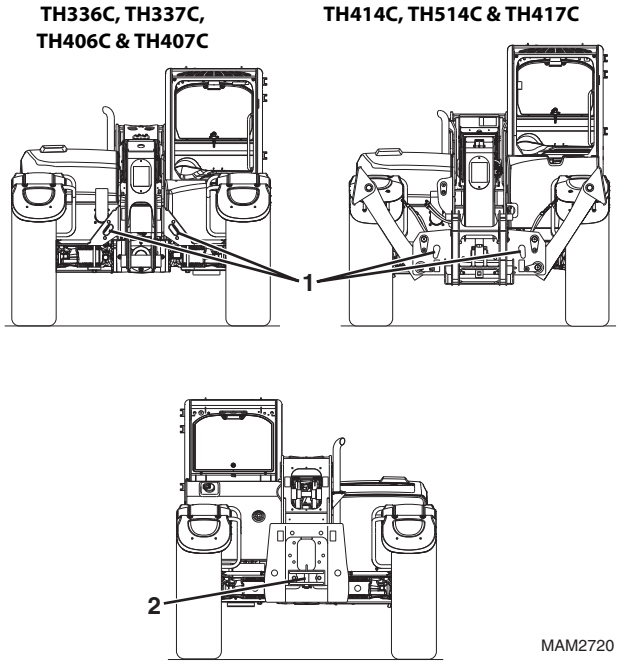
Do not attempt to tow a machine that is loaded or the boom/attachment is raised more than approximately 610 mm (24 in).

2. Remove load from the machine.
3. Place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
4. Block all four wheels.

WARNING

Block all four wheels when preparing the machine for towing to prevent any unexpected movement.

5. Remove the front and rear drive shafts. Refer to Section 5.10, "Drive Shafts".



6. Secure the machine to a suitable towing vehicle.
   a. For towing or retrieval from front of machine, attach towing equipment to lifting points (**1**).
   b. For towing or retrieval from rear of machine, attach towing equipment to the retrieval hitch (**2**).

WARNING

Use a vehicle of sufficient capacity to tow the machine. Tow vehicle must be capable of providing braking for both vehicle and machine.

7. Clear the area of any unnecessary personnel.
8. Have an operator seated in the machine operator cab.
9. Remove the blocks from all four wheels.
10. Disengage the machine park brake.
11. Tow the machine to a secure location.

Note: *Tow the machine at a very slow speed.*

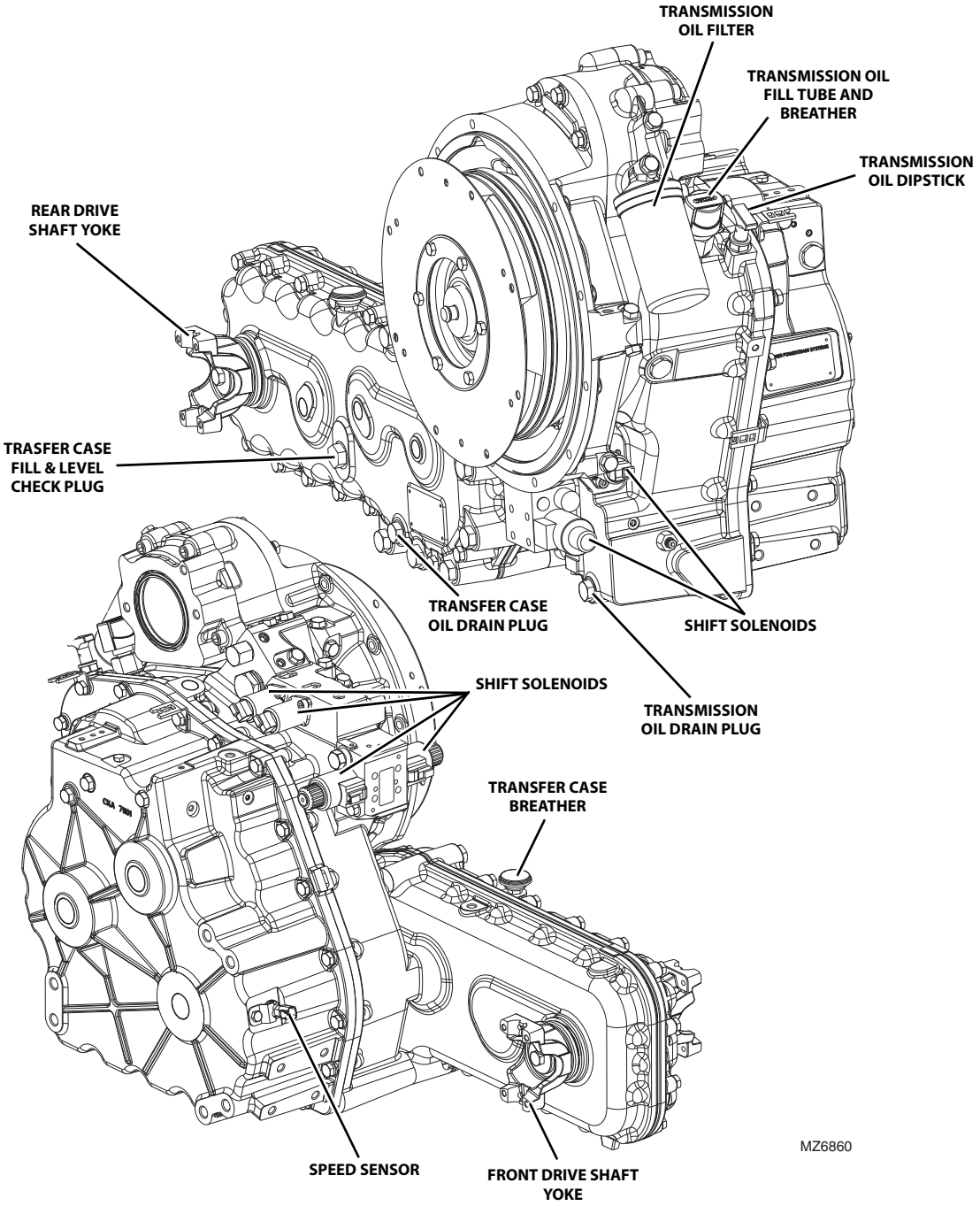
12. After towing is complete, engage the park brake.
13. Block all four wheels.
14. Reinstall the front and rear drive shafts. Refer toSection 5.10, "Drive Shafts".
15. Repair machine as necessary.

Section 6
Transmission

Contents

6.1 TRANSMISSION ASSEMBLY COMPONENT TERMINOLOGY

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the major assemblies of the transmission. The following illustration identifies the components that are referred to throughout this section.

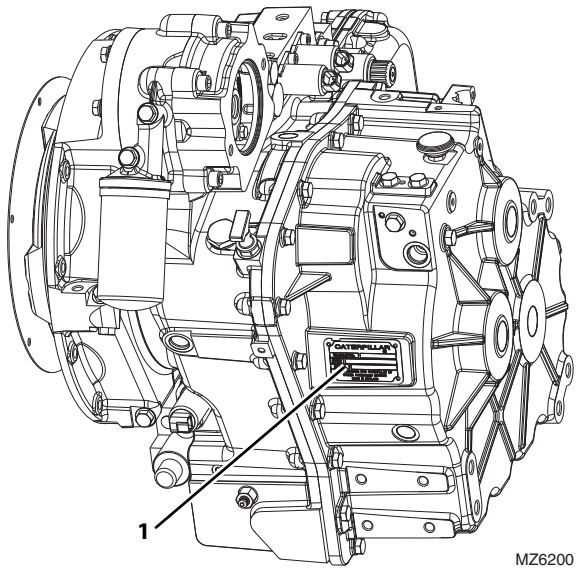


WARNING

Do Not service the machine without following all safety precautions as outlined in Section 1, "Safety Practices", of this manual.

Note: *These instructions cover only the routine maintenance, removal, installation and troubleshooting of the transmission. Refer to the local Caterpillar dealer and the applicable Transmission Service Manual for assistance with comprehensive transmission diagnosis, repair and component replacement.*

6.2 TRANSMISSION SERIAL NUMBER



The transmission serial number plate (**1**) is located on the front of the transmission case behind the oil dipstick. Information contained in the serial number is required in correspondence with the transmission manufacturer.

6.3 SPECIFICATIONS AND MAINTENANCE INFORMATION

For transmission, oil specifications and maintenance information, refer to Section 2, "General Information and Specifications".

Detailed transmission parts and service information can be found in SIS Web.

6.4 TRANSMISSION REPLACEMENT

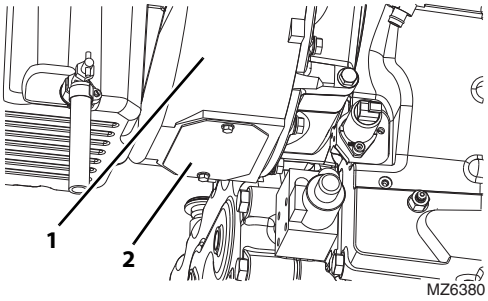
Cleanliness is of extreme importance. Before attempting to remove the transmission, thoroughly clean the exterior of the transmission to help prevent dirt from entering during the replacement process. Avoid spraying water or cleaning solution onto or near the transmission shift solenoids and other electrical components.

6.4.1 Transmission Removal

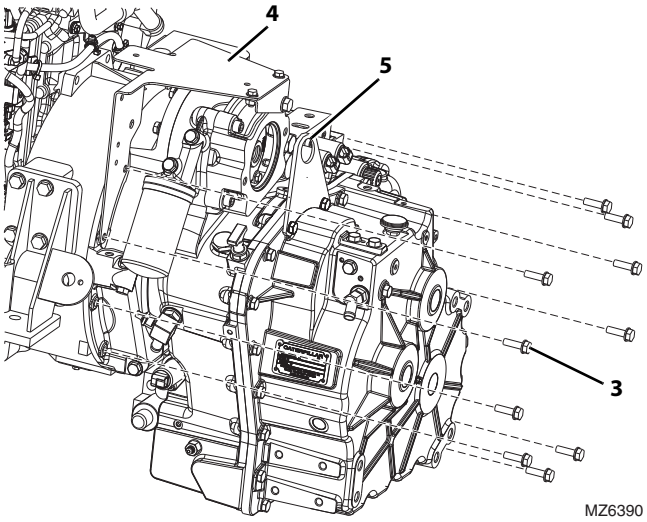
WARNING

NEVER lift a transmission alone; enlist the help of at least one assistant or use a suitable hoist or overhead crane and sling with a minimum lifting capacity of 454 kg (1000 lb).

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery(s). Refer to Section 9.11, "Battery", for procedure.
5. Drain the hydraulic oil reservoir. Refer to Section 8.7.1, "Hydraulic Oil Reservoir Draining".
6. If not previously removed, remove the implement pump. Refer to Section 8.8.1, "Pump Replacement".
7. Refer to Section 7.9, "Engine Replacement", for detailed removal instructions.
8. Thoroughly clean the transmission and surrounding area, including all hoses and fittings, before proceeding.
9. Place a suitable receptacle under the transmission/ transfer case drain plugs. Remove the transmission drain plug, and allow the transmission oil to drain into the receptacle.
10. Remove the transmission transfer case drain plug, and allow the transfer case oil to drain into the receptacle.
11. Transfer the used transmission oil into a suitable, covered container, and label the container as "Used Oil". Dispose of used oil at an approved recycling facility. Clean and reinstall the transmission and transfer case drain plugs.



12. Remove the access cover (**2**) from the engine bell housing (**1**). This will allow access to remove the six torque convertor flex plate bolts and washers from the engine flywheel.
13. Turn the engine over slowly by hand and align each of the torque convertor flex plate bolts to be accessed. Remove them one at a time.



14. Remove the ten bolts and washers (**3**) holding the transmission to the engine.
15. Remove the air cleaner mounting bracket (**4**).
16. Use a suitable hoist or overhead crane, secure the transmission with a lifting strap or chain to the transmission lifting bracket (**5**).

Note: *The lifting bracket (**5**) is NOT included with the transmission.*

17. Carefully remove the transmission from the machine. Avoid causing damage to the transmission or surrounding parts.
18. Lift the transmission clear of the machine, and lower it onto suitable supports or secure it to a stand built especially for transmission or engine service. Secure the transmission so that it will not move or fall.
19. Remove any external transmission components as required. Cover all transmission openings.

6.4.2 Transmission Installation.

WARNING

NEVER lift a transmission alone; enlist the help of at least one assistant or use a suitable hoist or overhead crane and sling.

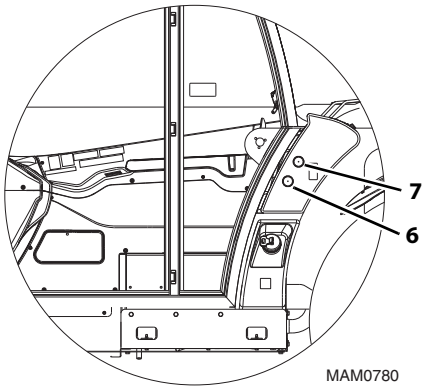
Note: *Apply Loctite® 243™ to all transmission bolts before installation.*

1. Use a suitable hoist or overhead crane, secure the transmission with a lifting strap or chain to the transmission lifting bracket (**5**).
2. Install the air cleaner mounting bracket (**4**) with the previously removed hardware.
3. Install the transmission to the engine and secure with the ten bolts and washers (**3**) previously removed. Torque to 55 Nm (41 lb-ft).
4. Remove the hoist or overhead crane and sling.
5. Turn the engine over slowly by hand and align and install each of the torque convertor flex plate bolts and washers to the engine flywheel through the access opening on the engine bell housing. Install them one at a time. Do Not fully tighten until all of the bolts are in place.
6. Torque each flex plate bolt to 26 Nm (19 lb-ft).
7. Install the hydraulic pump. Refer to Section 8.8.1, “Pump Replacement”.
8. Refer to Section 7.9.4, “Engine/Transmission Installation”, for detailed engine/transmission installation instructions.

6.4.3 After Transmission Service or Replacement

In general:

1. Disconnect and clean all transmission hoses. When possible, remove transmission lines from the machine for cleaning
2. Properly clean the transmission oil cooler.
3. Install a new hydraulic filter.
4. Check the transfer case oil level and add oil as required.
   - Transfer Case: Remove the transfer case fill plug and verify oil is at the thread opening. Add oil if required and torque plug to 46 - 60 Nm (34 - 44 lb-ft).
5. Check the transmission oil level and add oil as required.
   - Transmission: With engine runningat low idle and the transmissiom cold, check the oil level. Verify oil level is at the “Max” mark on the dipstick. Add oil if required.
6. Check the torque on the drive shaft yoke capscrews.



7. Reassemble all components and check the level of hydraulic oil in the hydraulic oil reservoir. If required fill with clean, fresh oil until oil level is visible in the lower gauge window (**6**). Do Not overfill.
8. Run the engine for two minutes at idle to help prime the transmission oil lines.
9. Recheck the level of the fluid in the hydraulic oil reservoir with the engine running at idle.
10. Add oil as necessary until oil level is visible in the upper gauge window (**7**). Recheck the oil level when it reaches operating temperature 83 - 94° C (180 - 200° F).
11. Recheck all drain plugs, lines, connections, etc., for leaks, and tighten where necessary.

6.4.4 Transmission Torque Converter Stall Test

1. Start the machine and bring engine to normal operating temperature.
   Engine - 75° ± 5° C (167° ± 40° F)
   Hydraulic Oil - 60° ± 5° C (140° ± 40° F)
   Torque Converter - 80° ± 5° C (176° ± 40° F)
2. Ensure that the transmission neutralizer switch is in the OFF position.
3. With the engine at high idle and the service brake fully depressed, shift the transmission into the highest forward gear.
4. With the transmission in the stall condition, the torque converter speed output should be 0 rpm.
5. Record the stall speed at a steady state condition after 10 seconds in the stall state.
6. Shift the transmission back to neutral after completion of the test. Allow engine to idle for two minutes to allow transmission to return to normal operating temperatures.
7. Refer to Section 2.2.9, “Transmission Performance Specifications”, for detailed stall speed information.

6.5 TORQUE CONVERTOR DIAPHRAGM

6.5.1 Torque Convertor Diaphragm Removal/ Installation

Refer to Section 6.3, “Specifications and Maintenance Information”, for detailed Torque Convertor Information.

6.6 TROUBLESHOOTING

Refer to Section 6.3, “Specifications and Maintenance Information”, for detailed Torque Convertor Information.

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Section 7
Engine

Contents

7.1 INTRODUCTION

WARNING

Do Not service the machine without following all safety precautions as outlined in Section 1, “Safety Practices”, of this manual.

WARNING

Engine fuel lines are pressurized. Do Not attempt repairs unless specific training has been completed.

7.1.1 Disclaimer and Scope

These instructions are written for worldwide use. In territories where legal requirements govern engine smoke emission, noise, safety factors, etc., apply all instructions, data and dimensions provided herein in such a way that after maintenance, service and repair of the engine, engine operation does not violate local regulations.

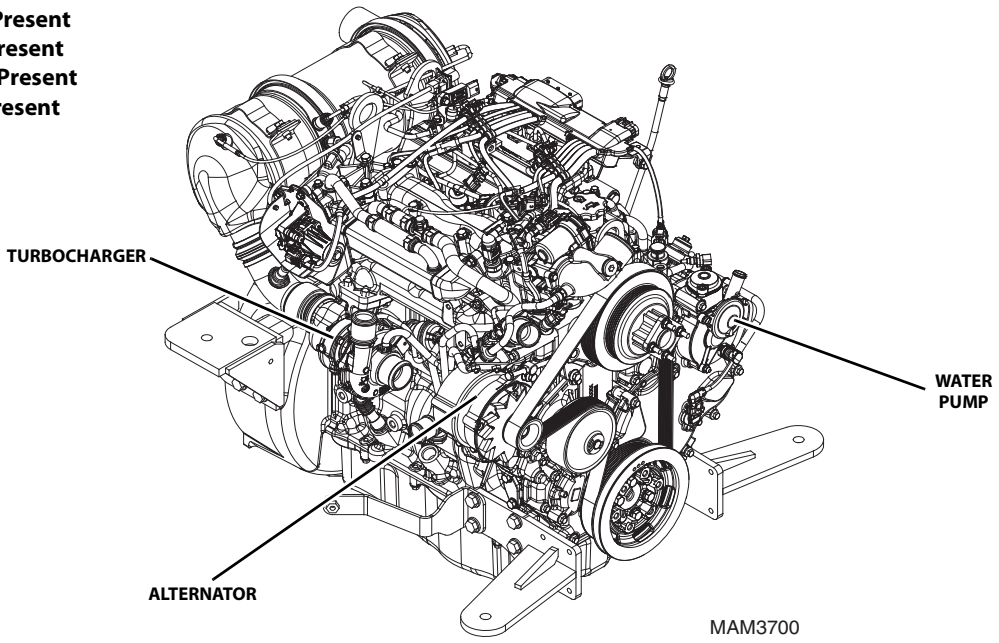
Note: *Detailed engine service instructions (covering disassembly, inspection, internal repair, assembly, adjustment and troubleshooting information) are provided in appropriate engine service manual. A gradual running-in (break-in) of a new engine is not necessary. Full load can be applied to a new engine as soon as the engine is put into service and the coolant temperature is at least 60° C (140° F). Extended light-load operation during the early life of the engine is not recommended. Do Not run the engine at high, no-load speeds. Do Not apply an overload to the engine.*

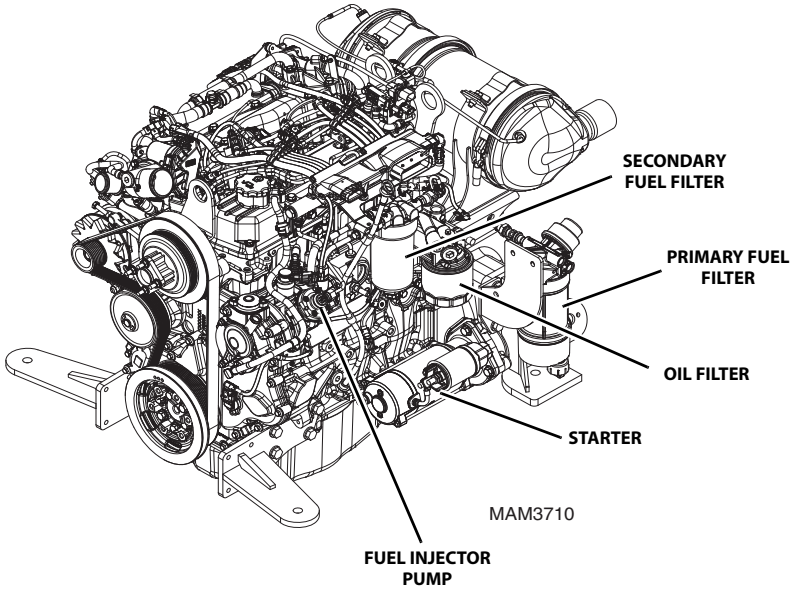
7.1.2 Component Terminology

To understand the safety, operation and maintenance information presented in this section, it is necessary that the operator/mechanic be familiar with the names and locations of the engine components. The following illustration identifies the components that are referred to throughout this section.

SN MJR00150 to Present
SN DJB00150 to Present
SN GAT00150 to Present
SN MLH00150 to Present
SN KEK00150 to Present
SN MWC00150 to Present
SN RRJ00150 to Present

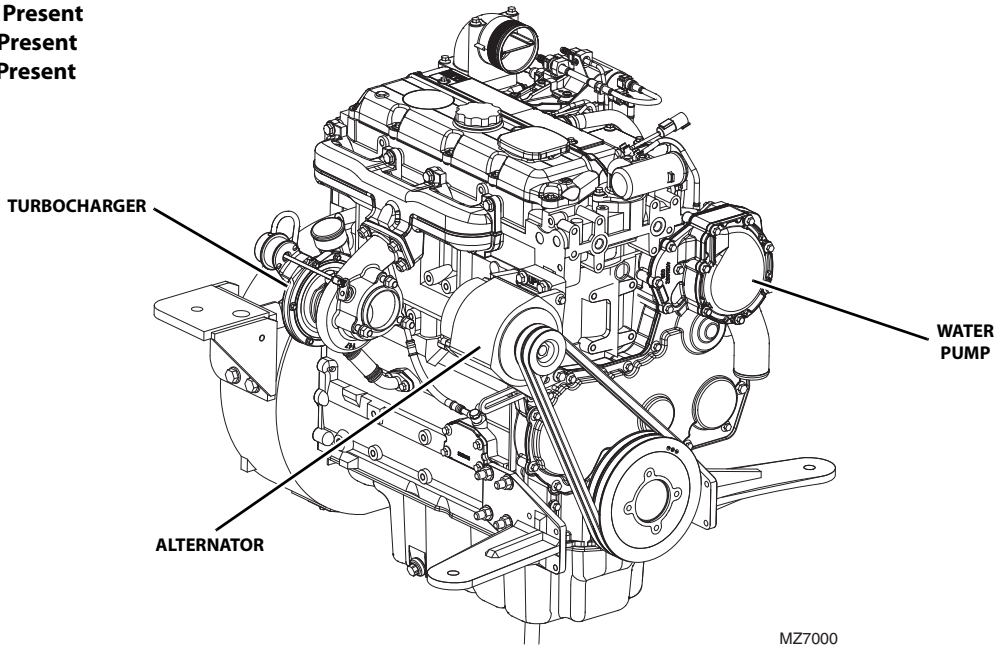
75 kW

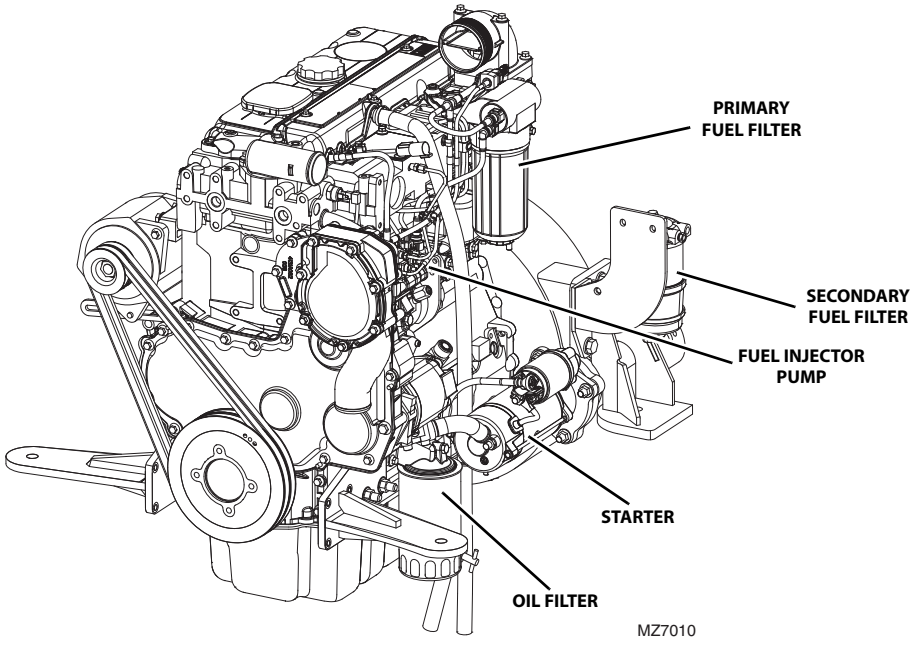




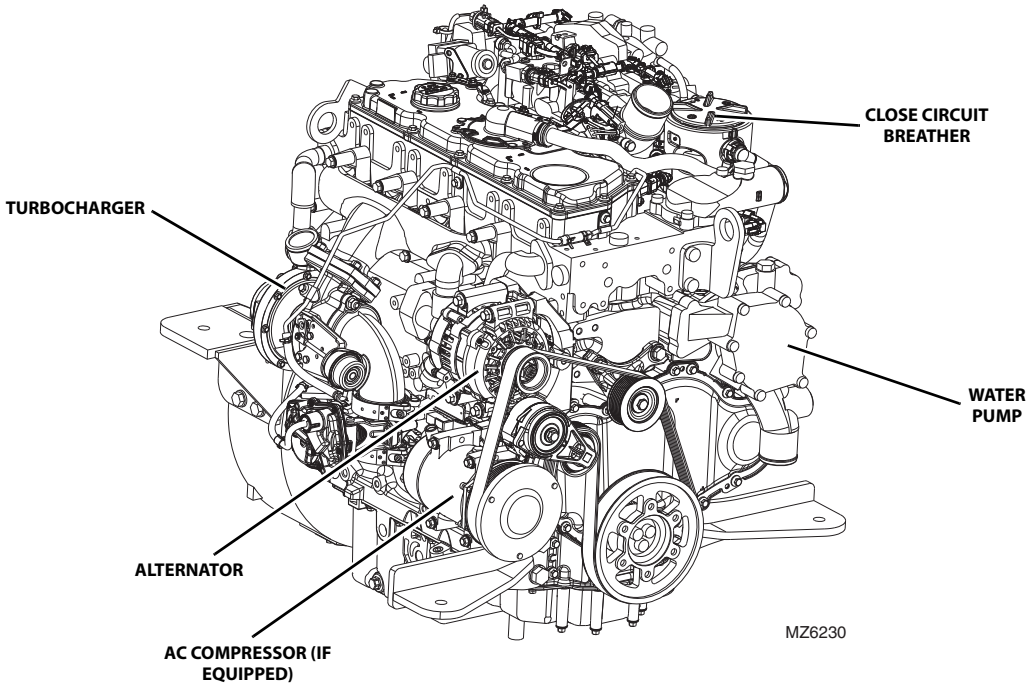
SN THM00150 to Present
SN SXJ00150 to Present
SN RCH00150 to Present
SN JJT00150 to Present
SN RWW00150 to Present
SN KKW00150 to Present
SN RRW00150 to Present

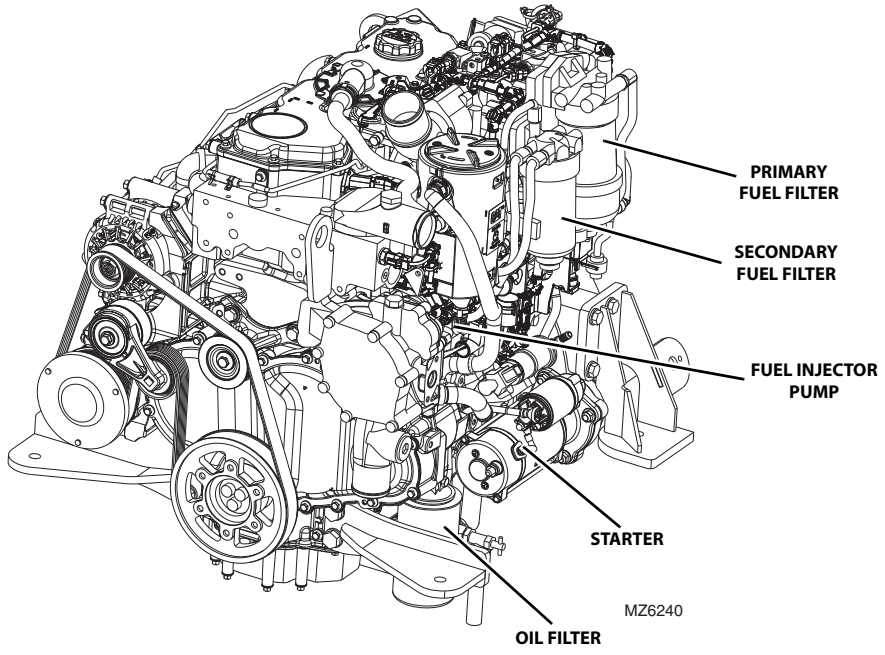
74,5 kW





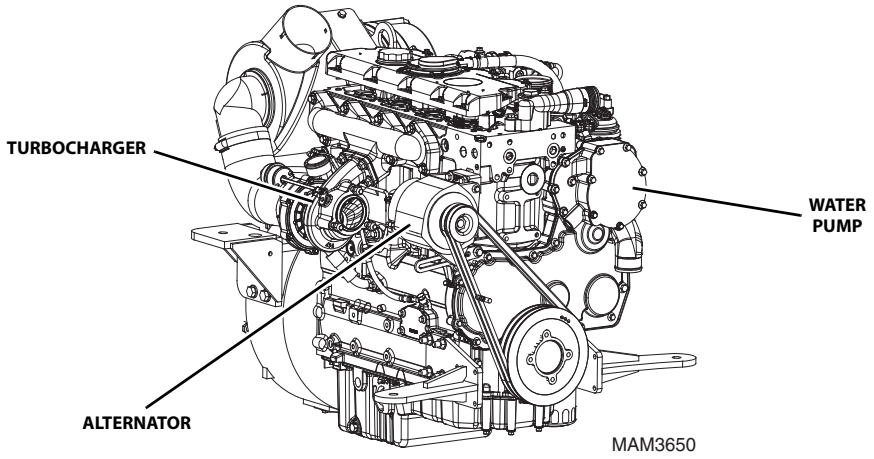
SN MJR00150 to Present **92,6 kW**
SN DJB00150 to Present **106 kW**
SN GAT00150 to Present
SN MLH00150 to Present

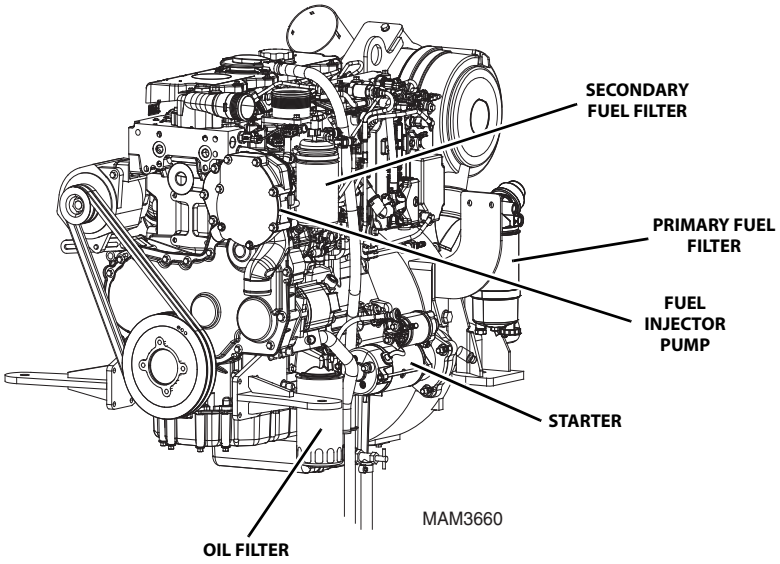




SN THM00150 to Present
SN SXJ00150 to Present
SN RCH00150 to Present
SN JJT00150 to Present

93,1 kW





7.2 ENGINE SERIAL NUMBER

The engine serial number is stamped on the engine block and is included on a decal attached to the side of the radiator. Information contained in the serial number is required in correspondence with the engine manufacturer.

7.3 SPECIFICATIONS AND MAINTENANCE INFORMATION

For engine, coolant and oil specifications, and maintenance information, refer to Section 2, "General Information and Specifications".

Refer to SIS Web for detailed engine service instructions.

7.4 ENGINE COOLING SYSTEM

7.4.1 Surge Tank Cap

A 1 Bar (14.5 psi) cap is used on the surge tank. An incorrect or malfunctioning cap can result in the loss of coolant and a hot running engine.

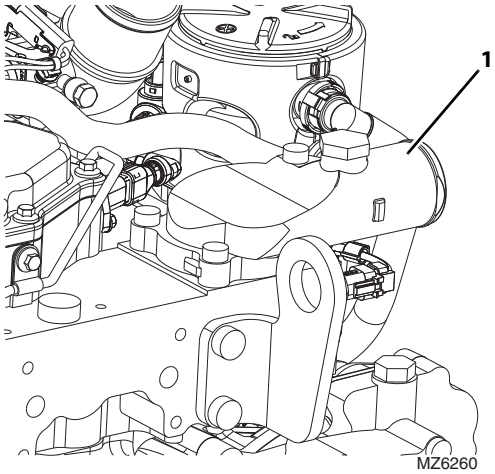
7.4.2 Thermostat Replacement

Before considering thermostat replacement, check the coolant level, fan belt tension and instrument cluster temperature indicator.

- If engine seems to take a long time to warm up, thermostat may be stuck in open position and requires replacement.
- If engine runs hot, check temperature of upper radiator hose.
- If hose is not hot, thermostat may be stuck in closed position.
- If engine has overheated, performance may suffer, indicating other damage including a leaking cylinder head gasket, cracked cylinder head or block, and/or other internal engine damage.

a. Thermostat Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the parking brake, and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Slowly turn surge tank cap to the first stop and allow any pressure to escape. Remove surge tank cap.
6. Place a funnel at the base of the radiator to channel the drained coolant into the container. Loosen the drain plug and slowly remove to allow the coolant to drain. Transfer the coolant into a properly labeled container. Dispose of properly if coolant needs to be replaced. Replace the radiator drain plug.



TYPICAL ILLUSTRATION

7. Remove capscrews securing thermostat housing (**1**) to the engine.
8. Remove the thermostat housing, old gasket and thermostat. Clean all gasket surfaces. Do Not let any debris into the thermostat opening.

Note: *ALWAYS use the correct thermostat and install a new gasket.* ***NEVER*** *operate the engine without a thermostat, or engine damage will result.*

b. Thermostat Installation

1. Install the engine thermostat, thermostat gasket and thermostat housing. Secure with the previously removed capscrews.
2. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
3. Open the surge tank cap, and fill system completely with CAT extended life coolant (ELC). Add coolant at a maximum rate of 1.3 gallons per minute (5 liters per minute) to full cold level with coolant.
4. Add coolant to the surge tank until 1/4 to 1/2 full. This overfilling will compensate for any air trapped in cooling system. Replace and tighten surge tank cap.
5. Run engine to operating temperature. Visually check for leaks with engine running. Check coolant level in surge tank and fill, or drain, as necessary.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

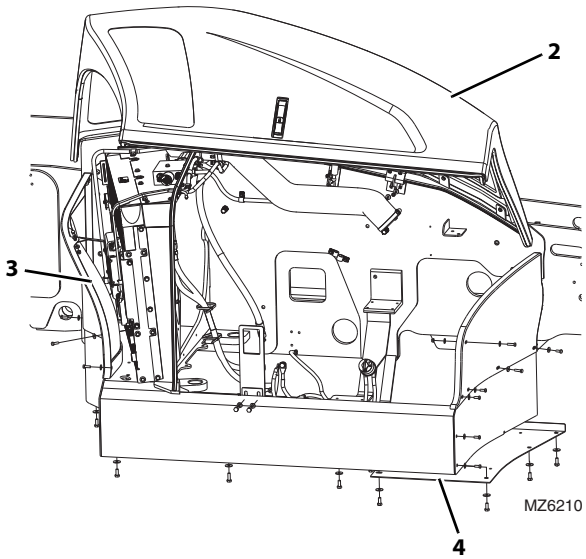
7.4.3 Radiator Assembly Removal - 75 kW

SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present, SN KEK00150 to Present, SN MWC00150 to Present, SN RRJ00150 to Present

Before considering radiator assembly replacement for other than obvious damage, conduct a cooling system pressure test check the coolant specific gravity, coolant level, fan belt tension, excess debris that would hinder engine cooling and dash panel temperature indicator.

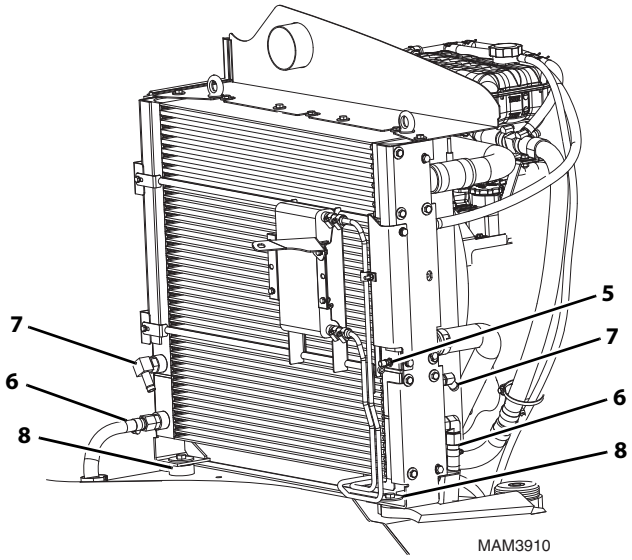
- If engine runs hot, check temperature of upper radiator hose.
- If hose is not hot, thermostat may be stuck in the closed position.
- If engine has overheated, performance may suffer, indicating other damage including a leaking cylinder head gasket, cracked cylinder head or block, and/or other internal engine damage.

1. Park machine on a firm, level surface, level machine, fully retract the boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery.Refer to Section 9.11, "Battery", for procedure.

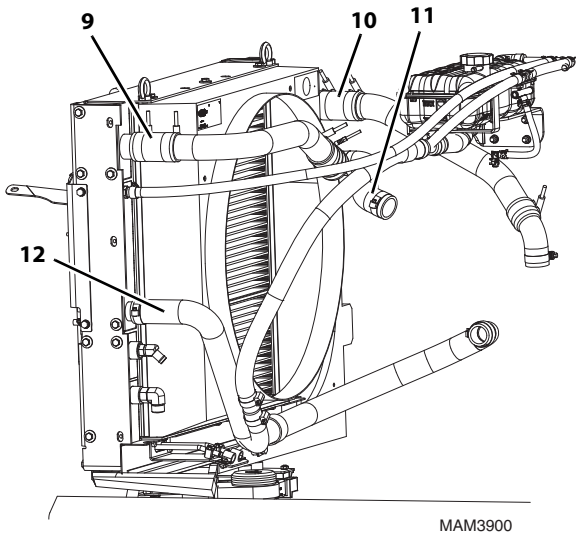


5. Remove the hood (**2**), end cover (**3**) and belly pans (**4**) from the engine compartment.
6. Remove air cleaner assembly, Refer to Section 7.8.1, "Air Cleaner Assembly Removal - 75 kW".

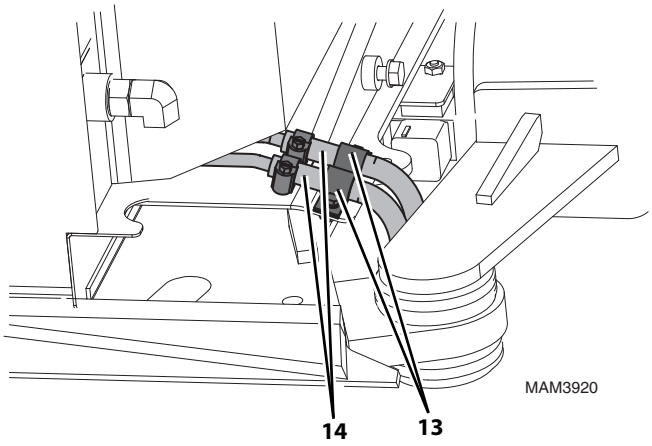
7. Place a suitable receptacle under transmission drain plug. Remove the transmission drain plug, and allow the transmission oil to drain into the receptacle.
8. Transfer used transmission oil into a suitable, covered container, and label container as “Used Oil”. Dispose of used oil at an approved recycling facility. Clean and reinstall the transmission drain plug
9. Drain the hydraulic oil reservoir. Refer to Section 8.7.1, “Hydraulic Oil Reservoir Draining”.
10. Slowly turn surge tank cap to first stop and allow any pressure to escape. Remove the surge tank cap.
11. Place a suitable container beneath radiator drain.



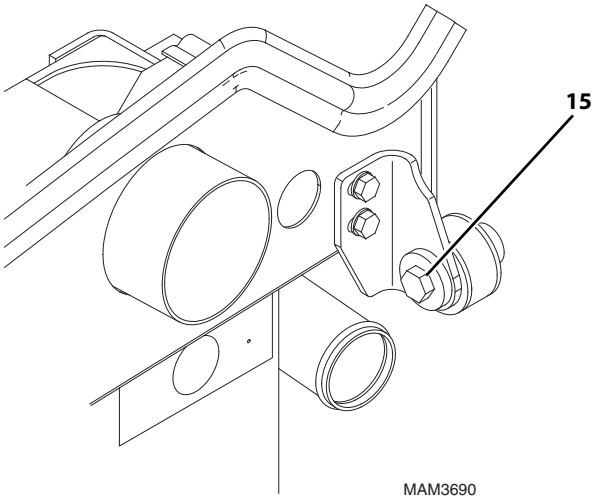
12. Place a funnel at base of radiator to channel drained coolant into a container. Open drain plug (**5**) and slowly remove to allow coolant to drain. Transfer the coolant into a properly labeled container. Dispose of properly if coolant needs to be replaced. Close the radiator drain plug.
13. Label and disconnect both transmission cooler hoses (**6**). Cap all fittings and openings to prevent dirt and debris from entering the hydraulic system.
14. Label and disconnect the outer hydraulic cooler hose (**7**). Cap all fittings and openings to prevent dirt and debris from entering the hydraulic system.
15. Loosen and remove radiator assembly mounting bolts, washers and (if equipped) shims (**8**). Note the number of shims being used and there location.



16. Loosen and remove the outer air intercooler tube (**9**) from the radiator assembly.
17. Loosen and remove the inner air intercooler tube (**10**) from the radiator assembly.
18. Loosen and remove the top radiator hose (**11**) from the radiator assembly.
19. Loosen and remove the bottom radiator hose (**12**) from the radiator assembly.



20. Loosen and remove clamps (**13**) securing fuel inlet hose to radiator shroud.
21. Loosen and disconnect fuel hoses (**14**) from radiator assembly. Plug and cap hoses and fittings to prevent dirt and debris from entering fuel system.



22. Loosen and remove radiator assembly mounting bolt, washer and (if equipped) shims (**15**). Note number of shims being used and there location.
23. Carefully lift the radiator assembly out of engine compartment.

Note: *Fuel Cooler, Fan Shrouding, Fan Guard and Fan Assembly can be removed and/or disassembled after radiator assembly is removed and placed in a secure location.*

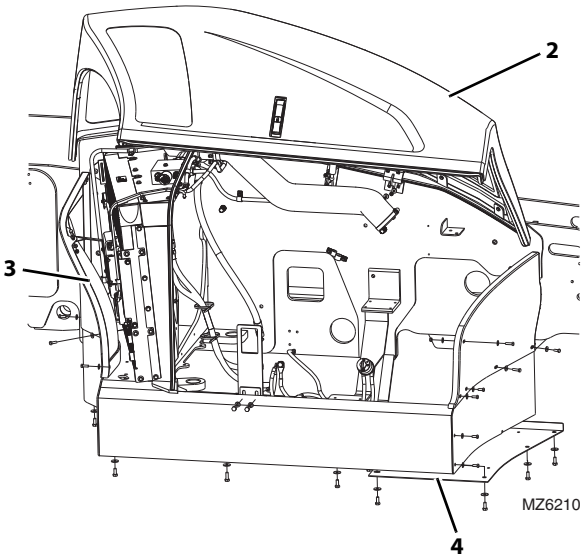
7.4.4 Radiator Assembly Removal - 74.5, 92.6, 93.1 and 106 kW

SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present, SN KEK00150 to Present, SN MWC00150 to Present, SN RRJ00150 to Present, SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present, SN RWW00150 to Present, SN KKW00150 to Present, SN RRW00150 to Present

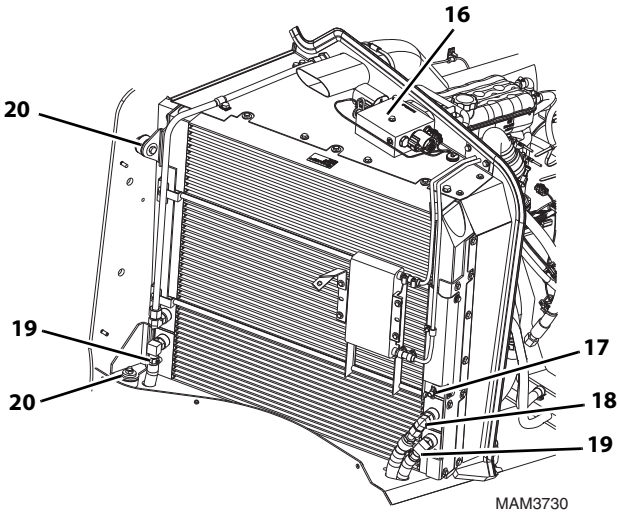
Before considering radiator assembly replacement for other than obvious damage, conduct a cooling system pressure test check the coolant specific gravity, coolant level, fan belt tension, excess debris that would hinder engine cooling and dash panel temperature indicator.

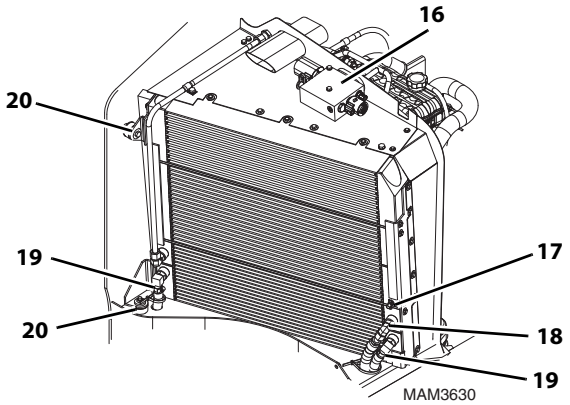
- If engine runs hot, check temperature of upper radiator hose.
- If hose is not hot, thermostat may be stuck in the closed position.
- If engine has overheated, performance may suffer, indicating other damage including a leaking cylinder head gasket, cracked cylinder head or block, and/or other internal engine damage.

1. Park machine on a firm, level surface, level machine, fully retract the boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.

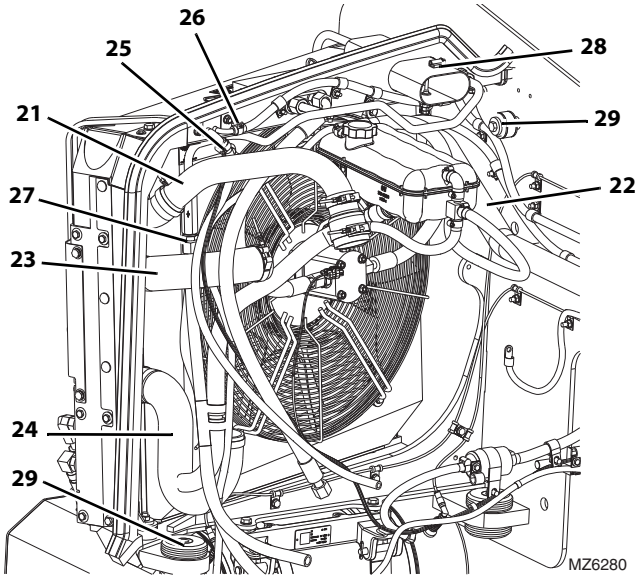


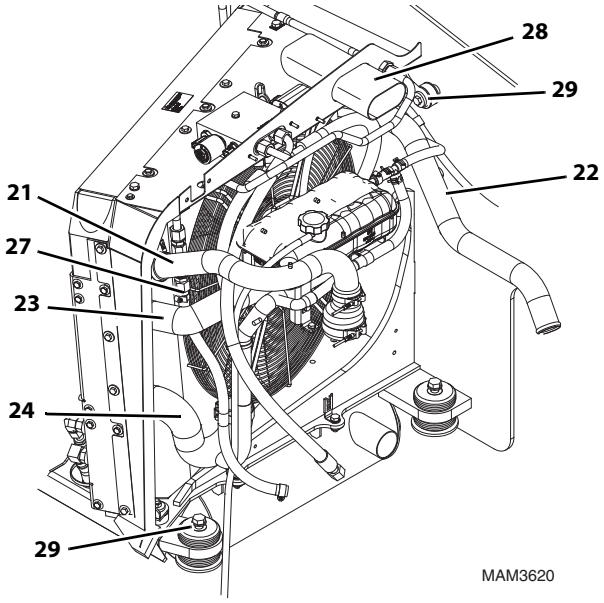
5. Remove the hood (**2**), end cover (**3**) and belly pans (**4**) from the engine compartment.
6. Place a suitable receptacle under transmission drain plug. Remove the transmission drain plug, and allow the transmission oil to drain into the receptacle.
7. Transfer used transmission oil into a suitable, covered container, and label container as “Used Oil”. Dispose of used oil at an approved recycling facility. Clean and reinstall the transmission drain plug
8. Drain the hydraulic oil reservoir. Refer to Section 8.7.1, “Hydraulic Oil Reservoir Draining”.
9. Slowly turn surge tank cap to first stop and allow any pressure to escape. Remove the surge tank cap.
10. Place a suitable container beneath radiator drain.





11. Place a funnel at base of radiator to channel drained coolant. Open drain plug (**17**) and slowly remove to allow coolant to drain into a properly labeled container. Dispose of properly if coolant needs to be replaced. Close drain plug.
12. Label and disconnect electrical connectors at hydraulic reversing fan valve (**16**). Remove grommet from fan shroud and pull wire harness/connectors through fan shroud opening and place on engine.
13. Label and disconnect both transmission cooler hoses (**19**). Cap all fittings and openings to prevent dirt and debris from entering the hydraulic system.
14. Label and disconnect the outer hydraulic cooler hose (**18**). Cap all fittings and openings to prevent dirt and debris from entering the hydraulic system.
15. Loosen and remove two radiator assembly mounting bolts, washers and shims (**20**) (if equipped). Note the number of shims being used and there location.





16. Loosen and remove the outer air intercooler tube (**21**) from the radiator assembly.
17. Loosen and remove the inner air intercooler tube (**22**) from the radiator assembly.
18. Loosen and remove the top radiator hose (**23**) from the radiator assembly.
19. Loosen and remove the bottom radiator hose (**24**) from the radiator assembly.

Note: *Not all models equipped with fuel cooler assembly.*

20. Loosen and disconnect the fuel outlet hose (**25**) from radiator assembly. Plug and cap hose and fitting to prevent dirt and debris from entering the fuel system.

21. Loosen and disconnect fuel inlet hose (**26**) from radiator assembly. Loosen and remove four clamps securing fuel inlet hose to radiator shroud. Plug and cap hose and fitting to prevent dirt and debris from entering fuel system.
22. Loosen and disconnect hydraulic hose (**27**) from radiator assembly. Plug and cap hose and fitting to prevent dirt and debris from entering fuel system.
23. Loosen and remove air inlet tube (**28**).
24. Loosen and remove two radiator assembly mounting bolts, washers and shims (**29**) (if equipped). Note number of shims being used and there location.
25. Carefully lift assembly out of engine compartment.

Note: *Fuel Cooler, Fan Shrouding, Fan Guard, Fan Assembly, Fan Reversing Valve Assembly can be removed and/or disassembled after radiator assembly is removed and placed in a secure location.*

7.4.5 Radiator Assembly Installation

1. Place radiator assembly in engine compartment at original orientation. Secure with previously used hardware.
2. If equipped, uncap and connect previously labeled fuel hoses to fuel cooler tube connections. Secure fuel inlet hose with previously removed clamps.
3. Uncap and connect the previously labeled hoses to the radiator, transmission cooler and oil cooler.
4. If equipped, connect electrical connecter to reversing valve.
5. Fill the hydraulic oil reservoir. Refer to Section 8.7.2, “Hydraulic Oil Reservoir Filling”.
6. Fill transmission. Refer to Section 2.3, “Fluids and Lubricant Capacities”.
7. Open surge tank cap and fill the radiator completely with coolant. Replace and tighten cap. Refer to Section 2.3, “Fluids and Lubricant Capacities”, for proper capacities.
8. Properly connect the battery. Refer to Section 9.11, “Battery”, for procedure.
9. Run engine to operating temperature. Visually check for leaks with engine running. Check all fluid levels for correct levels.
10. Install the end cover, hood and belly pans on the engine compartment.
11. Close and secure the engine cover.
12. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

7.5 ENGINE ELECTRICAL SYSTEM

The engine electrical system, including the starter, alternator and primary wiring, is described in Section 9.8, “Electrical System Schematics”.

7.6 FUEL SYSTEM

7.6.1 Diesel Fuel

Fuel represents a major portion of machine operating costs and therefore must be used efficiently. ALWAYS use a premium brand of high quality, clean diesel fuel. Low cost, inferior fuel can lead to poor performance and expensive engine repair.

Refer to Section 2.3, “Fluids and Lubricant Capacities”, for proper oil and capacities.

7.6.2 Fuel Tank

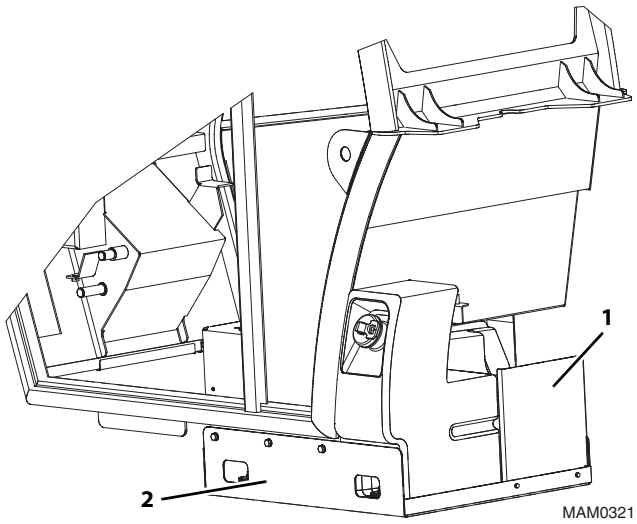
Note: *Fuel tank is a one piece unit. It is located on rear of cab. If it is determined that fuel tank must be removed, fuel must be drained before tank removal. Always dispose of fuel properly.*

a. Fuel Tank Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the parking brake, and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect battery. Refer to Section 9.11, “Battery”, for procedure.

Note: *If replacing tank, remove all internal and external components from old tank, and retain for use on the replacement tank.*

Note: *Have a dry chemical (Class B) fire extinguisher near the work area.*



5. Remove lower cover (**1**) of fuel tank.
6. Remove hydraulic oil reservoir. Refer to Section 8.7.3, “Hydraulic Oil Reservoir Removal/Installation”.
7. Remove fuel tank drain plug, and drain fuel into an approved container. Dispose of fuel properly.
8. Label, disconnect and cap fuel lines of fuel tank. Disconnect fuel sender.
9. Support fuel tank with a floor jack or suitable supports. Remove bolts securing fuel tank support (**2**) to cab.
10. Lower fuel tank and support bracket away from cab being careful to minimize fluid spillage.
11. If replacing fuel tank, remove bolts and washers securing support bracket to fuel tank.

b. Disassembly

Fuel tank is a one-piece unit and cannot be disassembled. Fuel level indicator can be removed and reused on new replacement tank. Dispose of old tank according to local regulations concerning hazardous materials disposal.

c. Cleaning and Drying

If contaminated fuel or foreign material is in the tank, the tank can usually be cleaned.

To clean the fuel tank:

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Remove fuel or oil tank drain plug, and safely drain fuel into an approved container. Dispose of fuel properly.
3. Clean fuel tank with a high pressure washer, or flush tank with hot water for five minutes and drain water. Dispose of contaminated water properly.
4. Add a diesel fuel emulsifying agent to tank. Refer to manufacturer’s instructions for correct emulsifying agent-to-water mixture ratio. Refill tank with water, and agitate mixture for 10 minutes. Drain tank completely. Dispose of contaminated water properly.
5. Refill fuel tank with water until it overflows. Completely flush tank with water. Empty fuel tank, and allow it to dry completely.

d. Assembly

Fuel level indicator can be removed and reused on new tank. Dispose of old tank according to local regulations concerning hazardous materials disposal regulations.

e. Inspection

1. Inspect fuel tank thoroughly for any cracks, slices, leaks or other damage.
2. With fuel tank removed from machine, plug all openings except one elbow fitting. Install elbow fitting, and apply approximately 7 - 10 kPa (1 - 1.5 psi) of air pressure through elbow. Check reservoir for leaks by applying a soap solution to exterior and look for bubbles to appear at cracked or damaged area.

f. Fuel Tank Installation

1. If necessary, install fuel tank to support bracket with previously used hardware.
2. Using a floor jack, lift fuel tank and support bracket to their original orientation on cab. Install with previously used hardware. Remove floor jack.
3. Install fuel tank to machine with previously used hardware. Remove floor jack.
4. Connect previously labeled fuel hoses to their appropriate locations. Secure with clamps. Connect fuel sender.
5. Fill fuel tank according to specifications.Refer to Section 2.3, “Fluids and Lubricant Capacities”.
6. Check fuel tank for leaks.
7. Install hydraulic oil reservoir. Refer to Section 8.7.3, “Hydraulic Oil Reservoir Removal/Installation”.
8. Install lower cover of fuel tank.
9. Properly connect battery. Refer to Section 9.11, “Battery”, for procedure.
10. Close and secure the engine cover.
11. Remove Do Not Operate Tag from ignition key switch and steering wheel.

7.6.3 After Fuel System Service

1. Drain and flush the fuel tank if it was contaminated.
2. Vent air from fuel system in accordance with instructions found in appropriate Engine Operation & Maintenance Manual.
3. Fill fuel tank with fresh, clean diesel fuel as required.

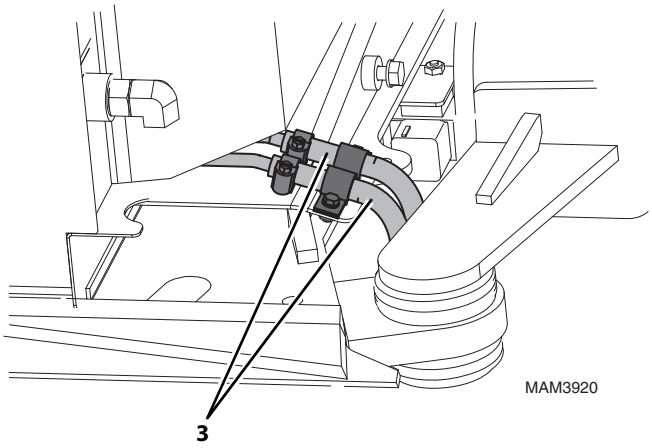
7.6.4 Fuel Cooler

Note: *Not all models equipped with fuel cooler assembly.*

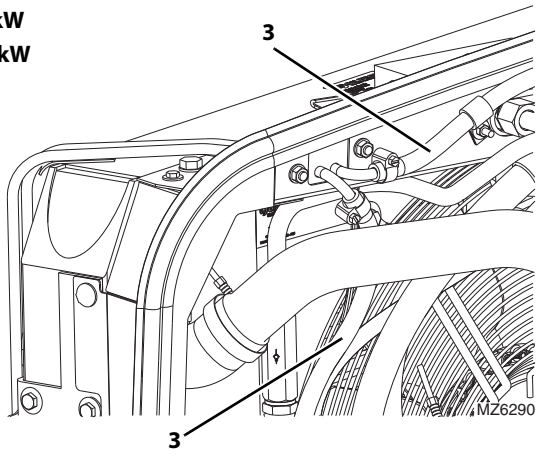
a. Fuel Cooler Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL position, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery.

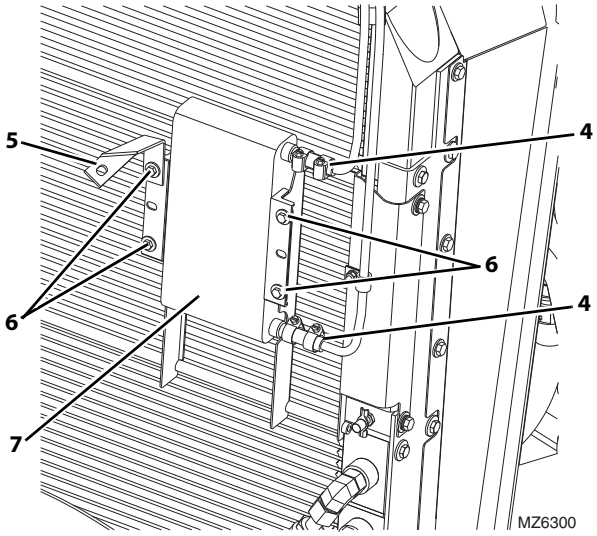
75kW



74,5kW
92,6kW
106kW
93,1kW



5. Temporarily clamp both fuel lines (**3**) before removing the fuel cooler.



6. Loosen fuel hose clamps (**4**) noting the orientation.
7. Loosen the hood mounting bracket bolt (**5**).
8. Loosen and remove the four fuel cooler mounting bolts (**6**). Remove the fuel cooler (**7**).
9. Safely drain any fuel into a suitable container. Dispose of fuel properly.

b. Fuel Cooler Installation

1. Apply Loctite® 242™ to all mounting bolts.
2. Install fuel cooler to the mounting brackets with the previously removed bolts. Torque to 28 Nm (21 lb-ft).
3. Tighten the hood mounting bracket bolt. Torque to 28 Nm (21 lb-ft).
4. Install previously removed fuel lines and secure with clamps. Torque clamps to 5 Nm (44 lb-in).
5. Remove both clamps on each fuel line.
6. Start the machine and verify no fuel leakage.
7. Shut machine OFF.
8. Close and secure the engine cover.
9. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

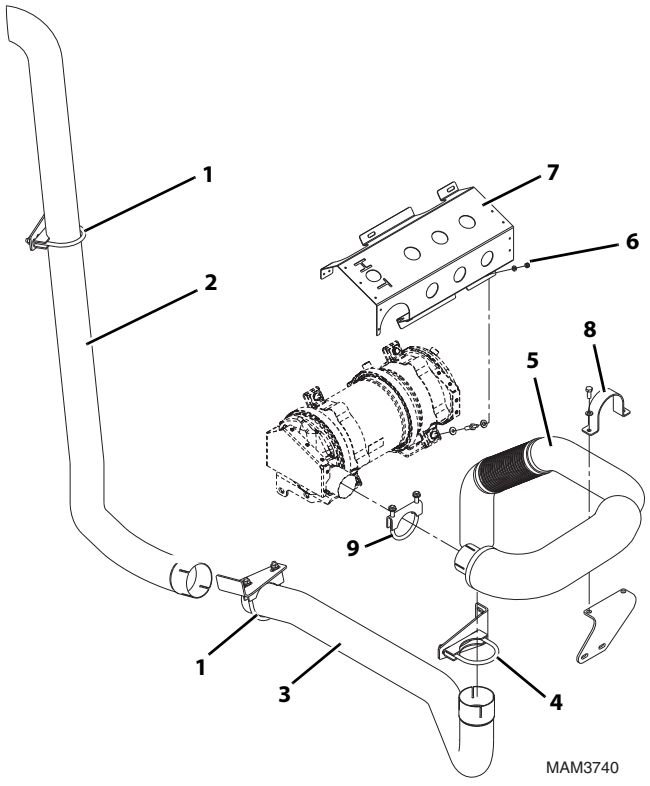
7.7 ENGINE EXHAUST SYSTEM

Note: *Emission Sensitive Exhaust. Assembly must be replaced exactly as removed. Contact your local Caterpillar dealer before removing the muffler system.*

7.7.1 Exhaust System Removal - 75 kW

SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present, SN KEK00150 to Present, SN MWC00150 to Present and SN RRJ00150 to Present

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect battery. Refer to Section 9.11, “Battery”, for procedure.
5. Remove belly pan.



6. Loosen and remove tail pipe clamps (**1**) securing tail pipe (**2**) to exhaust pipe (**3**).
7. Loosen and remove clamp (**4**) securing exhaust pipe (**3**) to exhaust pipe (**5**).

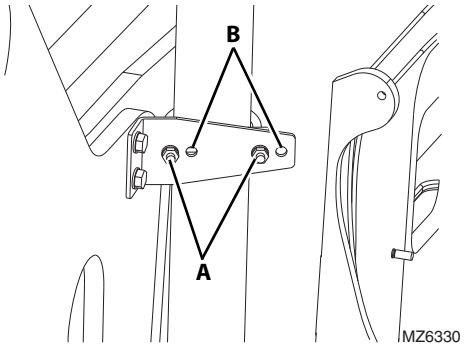
8. Remove and retain all hardware (**6**) securing heatshield (**7**). Remove heatshield.
9. Remove clamps (**8** and **9**) that secure exhaust pipe (**5**).
10. Remove exhaust pipe (**5**).

7.7.2 Exhaust System Installation - 75 kW

SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present, SN KEK00150 to Present, SN MWC00150 to Present and SN RRJ00150 to Present

Note: *Keep all clamps loosened until entire exhaust system is in place.*

1. Install exhaust pipe (**5**).
2. Secure with new clamps (**8** and **9**). Do Not tighten.
3. Install exhaust pipe (**3**).
4. Secure with new clamp (**4**). Do Not tighten.
5. Install the tail pipe (**2**).
6. Secure with new clamps (**1**). Do Not tighten.



TH336C, TH337C, TH406C & TH407C -
Use mounting holes "**A**".

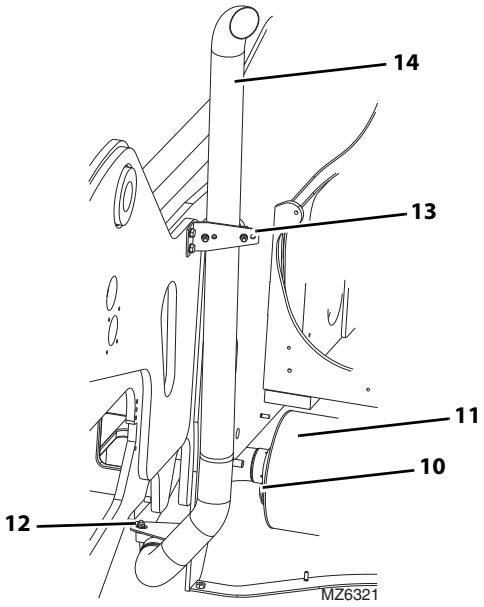
TH414C, TH514C & TH417C -
Use mounting holes "**B**".

7. Adjust exhaust and tail pipes for proper clearance then tighten all clamps. Torque to 12 Nm (9 lb-ft).
8. Re-Install the heatshield (**7**) with hardware (**6**) removed earlier.
9. Properly connect battery. Refer to Section 9.11, "Battery", for procedure.
10. Start engine and check for exhaust leaks at all exhaust connections. Adjust or repair as needed.
11. Install the belly pan.
12. Close and secure the engine cover.
13. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

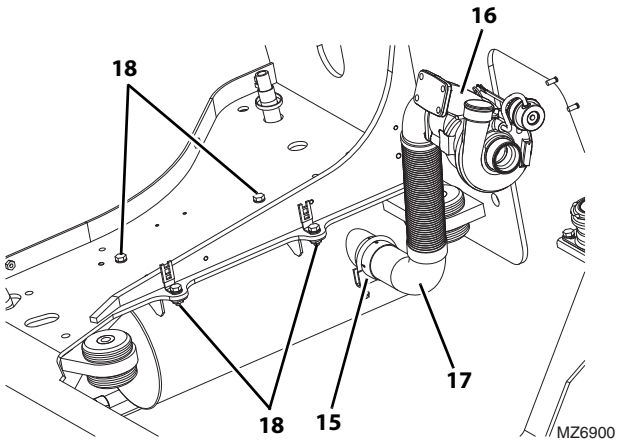
7.7.3 Exhaust System Removal - 74.5 kW

SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present, SN RWW00150 to Present, SN KKW00150 to Present, SN RRW00150 to Present

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect battery.Refer to Section 9.11, "Battery", for procedure.
5. Remove belly pan.



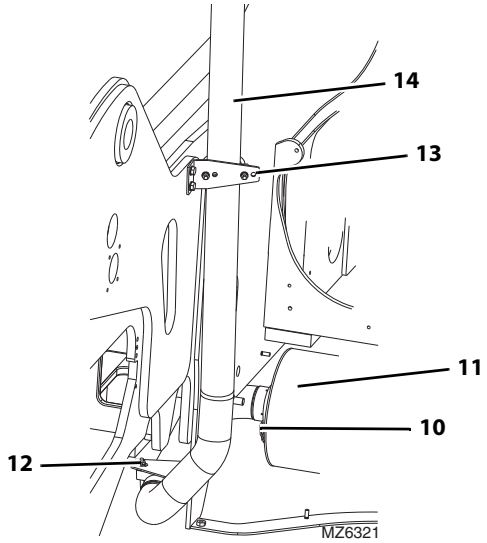
6. Loosen and remove tail pipe clamp (**10**) at muffler (**11**).
7. Loosen and remove two clamps (**12** and **13**) securing tail pipe (**14**) to muffler (**11**).
8. Remove tail pipe (**14**) from muffler (**11**).



9. Loosen and remove clamp (**15**) and hardware (**16**) securing exhaust pipe (**17**).
10. Remove hardware (**18**) securing muffler and carefully lower muffler from machine.
11. Remove exhaust pipe (**17**).

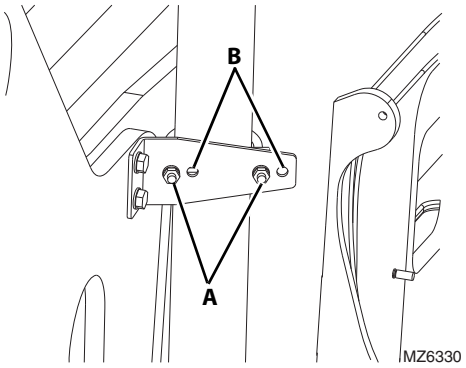
7.7.4 Exhaust System Installation - 74.5 kW

SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present, SN RWW00150 to Present, SN KKW00150 to Present, SN RRW00150 to Present



Note: *Keep all clamps loosened until entire exhaust system is in place.*

1. Install muffler (**11**) and with hardware (**18**) removed earlier. Do Not tighten.
2. Install exhaust pipe (**17**). Secure with new clamp. Do Not tighten.
3. Install the tail pipe (**14**) to the muffler (**11**) with previously used clamp (**10**). Do Not tighten.
4. Install clamps (**12** and **13**). Do Not tighten.



TH336C, TH337C, TH406C & TH407C -
Use mounting holes "**A**".

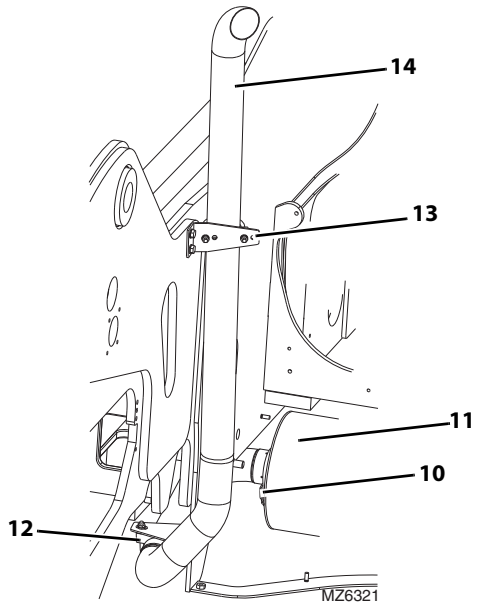
TH414C, TH514C & TH417C -
Use mounting holes "**B**".

5. Adjust muffler, exhaust and tail pipes for proper clearance then tighten all clamps. Torque to 12 Nm (9 lb-ft).
6. Properly connect battery.Refer to Section 9.11, "Battery", for procedure.
7. Start engine and check for exhaust leaks at all exhaust connections. Adjust or repair as needed.
8. Install the belly pan.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

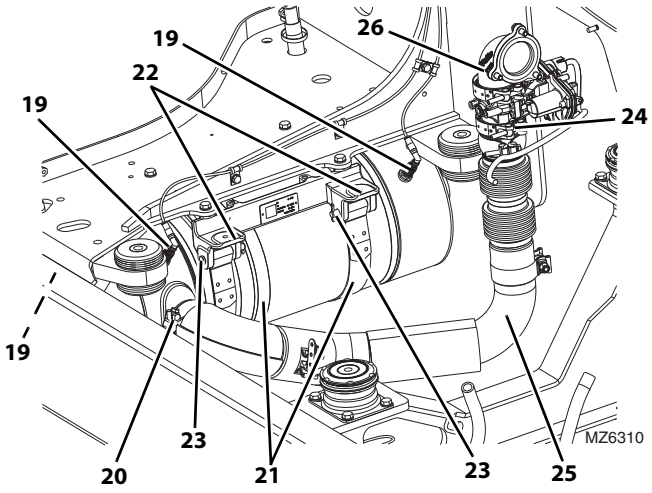
7.7.5 Exhaust System Removal - 92.6 & 106 kW

SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery.Refer to Section 9.11, “Battery”, for procedure.
5. Remove belly pan.



6. Loosen and remove the tail pipe clamp (**10**) at muffler (**11**).
7. Loosen and remove two clamps (**12** and **13**) securing tail pipe (**14**) to muffler (**11**).
8. Remove tail pipe (**14**) from muffler (**11**).



9. Label, loosen and disconnect three muffler sensors (**19**). Only two sensors shown. One is located behind muffler.
10. Loosen and remove muffler ball clamp (**20**).
11. At bottom of muffler, loosen muffler hangars (**21**).
12. Remove cotter keys (**22**), pins (**23**) and carefully lower muffler from machine.

Note: *Remove exhaust pipe between muffler and back pressure valve as an assembly.*

13. Loosen and remove V-band clamp (**24**) securing exhaust pipe (**25**) to back pressure valve (**26**).
14. Remove exhaust pipe assembly.

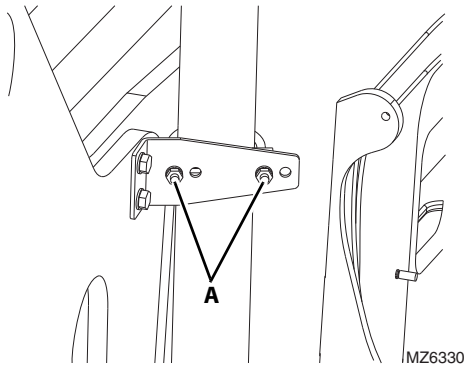
7.7.6 Exhaust System Installation - 92.6 & 106 kW

SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present

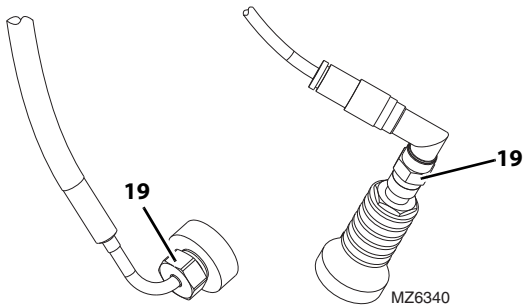
Note: *Keep all clamps loosened until entire exhaust system is in place.*

1. Install muffler and secure with hangars, pins and cotter keys. Do not tighten hangars.
2. Install exhaust pipe between the muffler and back pressure valve. Secure with new clamps (**20** and **24**). Do Not tighten.
3. Tighten and torque muffler hangars (**21**) to 47 - 63 Nm (35 - 63 lb-ft).
4. Tighten and torque V-band clamp (**24**) to 11 - 13 Nm (8 - 9.5 lb-ft).
5. Tighten and torque ball clamp (**20**) to 33 - 37 Nm (24 - 26.5 lb-ft).
6. Install the pipe (**14**) to muffler (**11**) with previously used clamp (**10**). Do Not tighten.

7. Install clamps (**12** and **13**). Do Not tighten.



8. **TH336C, TH337C, TH406C & TH407C** - Use mounting holes "**A**".
9. Adjust muffler (**11**), exhaust (**25**) and tail pipes (**14**) for proper clearance then tighten all clamps. Torque to 12 Nm (9 lb-ft).

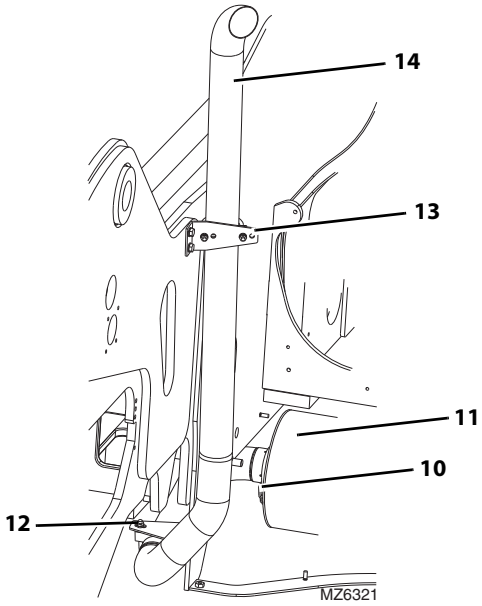


10. Install previous labeled sensor connectors (**19**). Torque to 1,5 - 1,7 Nm (13.2 - 15 in-lb).
11. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
12. Start engine and check for exhaust leaks at all exhaust connections. Adjust or repair as needed.
13. Install the belly pan.
14. Close and secure the engine cover.
15. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

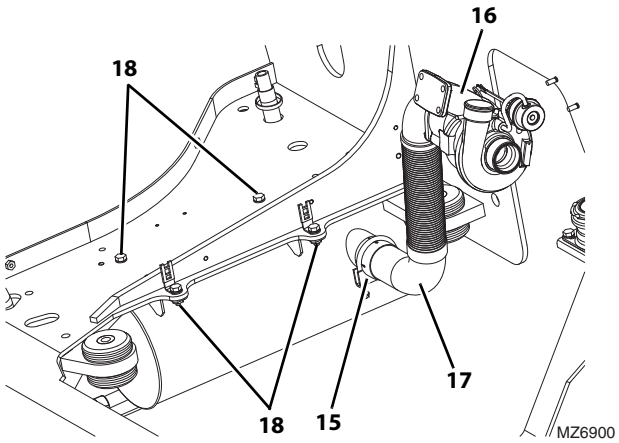
7.7.7 Exhaust System Removal - 93.1 kW

SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove belly pan.



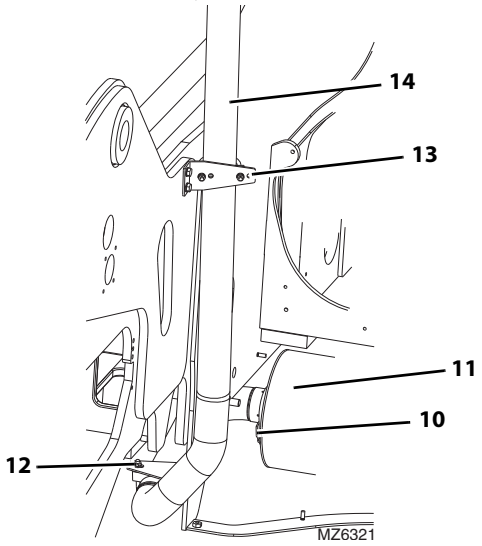
6. Loosen and remove tail pipe clamp (**10**) at muffler (**11**).
7. Loosen and remove two clamps (**12** and **13**) securing tail pipe (**14**) to muffler (**11**).
8. Remove tail pipe (**14**) from muffler (**11**).



9. Loosen and remove clamp (**15**) and hardware (**16**) securing exhaust pipe (**17**).
10. Remove hardware (**18**) securing muffler (**18**) and carefully lower muffler from machine.
11. Remove exhaust pipe (**17**).

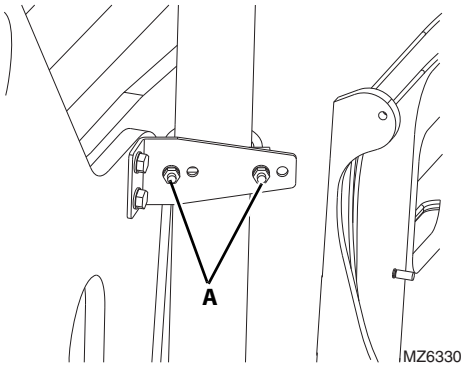
7.7.8 Exhaust System Installation - 93.1 kW

SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present



Note: *Keep all clamps loosened until entire exhaust system is in place.*

1. Install muffler (**11**) and with hardware (**18**) removed earlier. Do Not tighten.
2. Install exhaust pipe (**17**). Secure with new clamp. Do Not tighten.
3. Install the tail pipe (**14**) to the muffler (**11**) with previously used clamp (**10**). Do Not tighten.
4. Install clamps (**12** and **13**). Do Not tighten.



TH336C, TH337C, TH406C & TH407C -
Use mounting holes "**A**".

5. Adjust muffler (**11**), exhaust (**17**) and tail pipes (**14**) for proper clearance then tighten all clamps. Torque to 12 Nm (9 lb-ft).
6. Properly connect battery. Refer to Section 9.11, "Battery", for procedure.
7. Start engine and check for exhaust leaks at all exhaust connections. Adjust or repair as needed.
8. Install the belly pan.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

7.8 AIR CLEANER ASSEMBLY

NOTICE

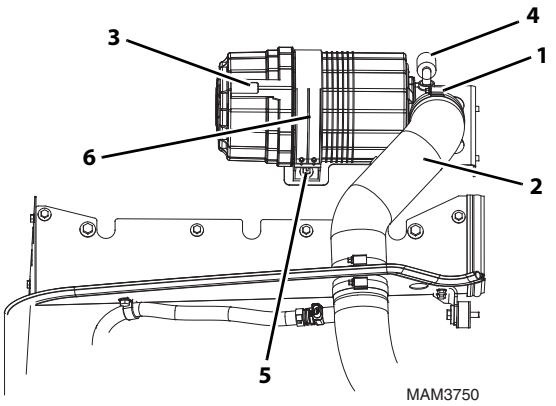
NEVER run the engine with only the inner safety element installed.

Note: *Refer to the appropriate machine Operation & Maintenance Manual for the correct element change procedure.*

7.8.1 Air Cleaner Assembly Removal - 75 kW

SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present, SN KEK00150 to Present, SN MWC00150 to Present, SN RRJ00150 to Present

1. Park machine on a firm, level surface, level machine, fully retract the boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the battery.Refer to Section 9.11, “Battery”, for procedure.



5. Loosen and remove clamp (**1**) securing air intake hose (**2**) to air cleaner (**3**). Remove air intake hose.
6. Label and disconnect air pressure switch (**4**).
7. Remove the two bolts (**5**) securing the air cleaner strap (**6**) to the air cleaner (**3**). Remove the air cleaner assembly.

7.8.2 Air Cleaner Assembly Installation - 75 kW

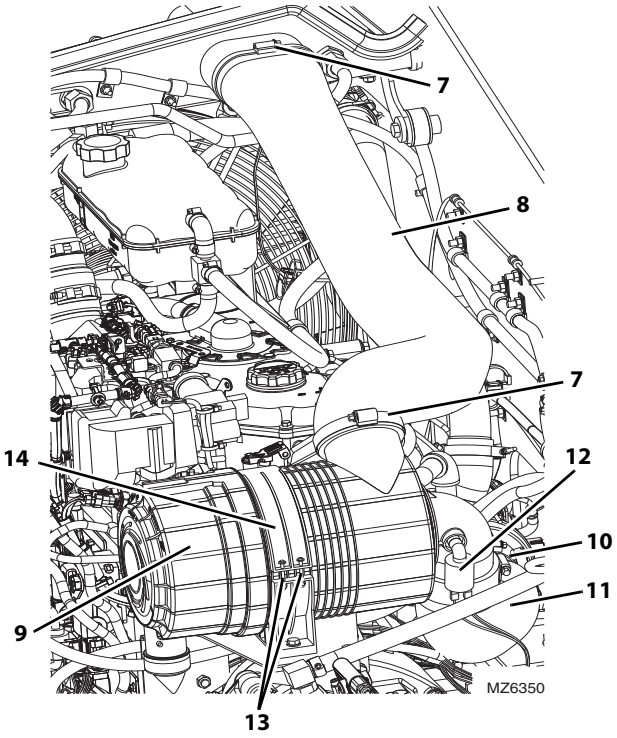
SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present, SN KEK00150 to Present, SN MWC00150 to Present, SN RRJ00150 to Present

1. Install air cleaner (**3**) to air cleaner mounting plate and secure with previously used hardware.
2. Place loosened clamp (**1**) over air intake hose (**2**) and install the hose on the air cleaner assembly. Tighten clamps.
3. Connect previously labeled wire connections to air pressure switch (**4**).
4. Properly connect battery.Refer to Section 9.11, “Battery”, for procedure.
5. Close and secure engine cover.
6. Remove Do Not Operate Tag from ignition key switch and steering wheel.

7.8.3 Air Cleaner Assembly Removal - 74.5 kW

SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present, SN RWW00150 to Present, SN KKW00150 to Present and SN RRW00150 to Present

1. Park machine on a firm, level surface, level machine, fully retract the boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



5. Loosen and remove clamps (**7**) securing air intake hose (**8**) to air cleaner (**9**). Remove air intake hose.
6. Remove clamp (**10**) securing air inlet hose (**11**) between air cleaner assembly and engine. Pull air inlet hose off air cleaner.
7. Label and disconnect air pressure switch (**12**).
8. Remove the two bolts (**13**) securing the air cleaner strap (**14**) to the air cleaner (**9**). Remove the air cleaner assembly.

7.8.4 Air Cleaner Assembly Installation - 74.5 kW

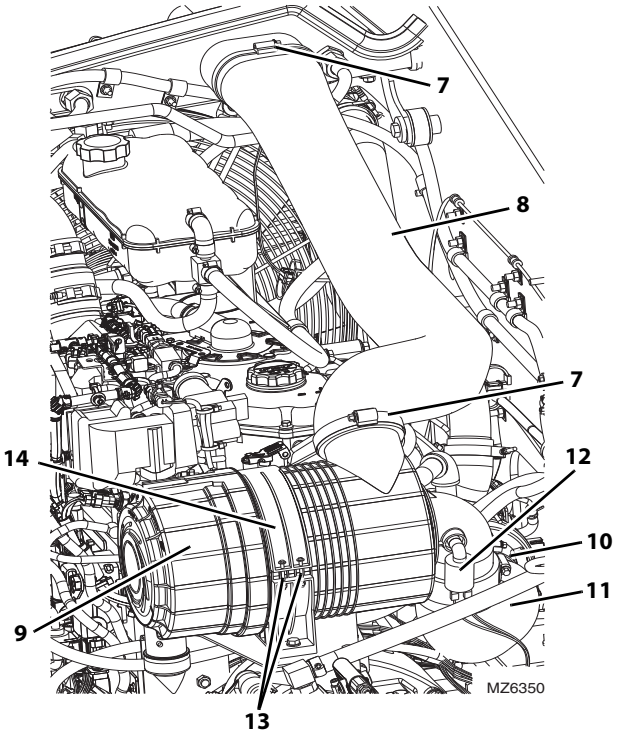
SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present, SN RWW00150 to Present, SN KKW00150 to Present and SN RRW00150 to Present

1. Install air cleaner (**9**) to air cleaner mounting plate and secure with previously used hardware.
2. Place loosened clamp (**10**) over the air inlet hose (**11**) and install hose on the air cleaner assembly. Tighten clamp.
3. Place loosened clamps (**7**) over air intake hose (**8**) and install the hose on the air cleaner assembly. Tighten clamps.
4. Connect previously labeled wire connections to air pressure switch (**12**).
5. Properly connect battery. Refer to Section 9.11, "Battery", for procedure.
6. Close and secure engine cover.
7. Remove Do Not Operate Tag from ignition key switch and steering wheel.

7.8.5 Air Cleaner Assembly Removal - 92.6 & 106 kW

SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present

1. Park machine on a firm, level surface, level machine, fully retract the boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



5. Loosen and remove clamps (**7**) securing air intake hose (**8**) to air cleaner (**9**). Remove air intake hose.
6. Remove clamp (**10**) securing air inlet hose (**11**) between air cleaner assembly and engine. Pull air inlet hose off air cleaner.
7. Label and disconnect air pressure switch (**12**).
8. Remove the two bolts (**13**) securing the air cleaner strap (**14**) to the air cleaner (**9**). Remove the air cleaner assembly.

7.8.6 Air Cleaner Assembly Installation - 92.6 & 106 kW

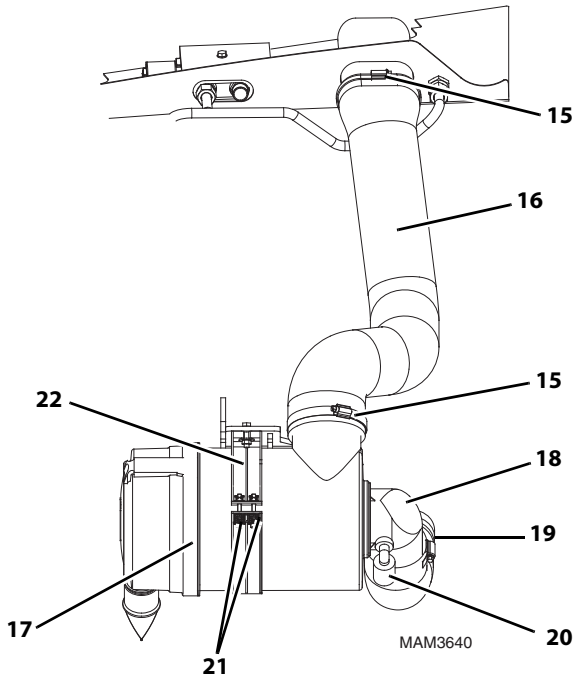
SN MJR00150 to Present, SN DJB00150 to Present, SN GAT00150 to Present, SN MLH00150 to Present

1. Install air cleaner (**9**) to air cleaner mounting plate and secure with previously used hardware.
2. Place loosened clamp (**10**) over the air inlet hose (**11**) and install hose on the air cleaner assembly. Tighten clamp.
3. Place loosened clamps (**7**) over air intake hose (**8**) and install the hose on the air cleaner assembly. Tighten clamps.
4. Connect previously labeled wire connections to air pressure switch (**10**).
5. Properly connect battery. Refer to Section 9.11, "Battery", for procedure.
6. Close and secure engine cover.
7. Remove Do Not Operate Tag from ignition key switch and steering wheel.

7.8.7 Air Cleaner Assembly Removal - 93.1 kW

SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present

1. Park machine on a firm, level surface, level machine, fully retract the boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



5. Loosen and remove clamps (**15**) securing air intake hose (**16**) to air cleaner (**17**). Remove air intake hose.
6. Remove clamp (**18**) securing air inlet hose (**19**) between air cleaner assembly and engine. Pull air inlet hose off air cleaner.
7. Label and disconnect air pressure switch (**20**).
8. Remove the two bolts (**21**) securing the air cleaner strap (**22**) to the air cleaner (**17**). Remove the air cleaner assembly.

7.8.8 Air Cleaner Assembly Installation - 93.1 kW

SN THM00150 to Present, SN SXJ00150 to Present, SN RCH00150 to Present, SN JJT00150 to Present

1. Install air cleaner (**17**) to air cleaner mounting plate and secure with previously used hardware.
2. Place loosened clamp (**18**) over the air inlet hose (**19**) and install hose on the air cleaner assembly. Tighten clamp.
3. Place loosened clamps (**15**) over air intake hose (**16**) and install the hose on the air cleaner assembly. Tighten clamps.
4. Connect previously labeled wire connections to air pressure switch (**20**).
5. Properly connect battery. Refer to Section 9.11, "Battery", for procedure.
6. Close and secure engine cover.
7. Remove Do Not Operate Tag from ignition key switch and steering wheel.

7.9 ENGINE REPLACEMENT

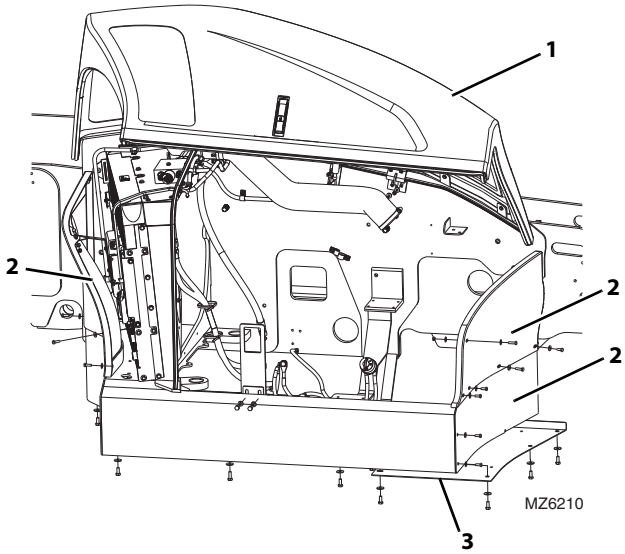
7.9.1 Engine/Transmission Removal

WARNING

NEVER lift engine/transmission alone; enlist the help of at least one assistant. Use a suitable hoist or overhead crane and sling with a minimum lifting capacity of 2000 lb (454 kg).

Note: *The radiator assembly must be removed from the machine before engine/transmission removal. Refer to Section 7.4.3, "Radiator Assembly Removal - 75 kW". Several additional components must be removed before engine/transmission removal. They will be addressed in the following procedures.*

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake, and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect and remove the battery(s). Refer to Section 9.11, "Battery", for procedure.
5. Properly drain hydraulic oil system. Refer to Section 8.7, "Hydraulic Reservoir", for detailed instructions.
6. Properly drain the transmission. Refer to Section 6.4.1, "Transmission Removal", for detailed instructions.
7. Mark position of cover to help with cover adjustment when being reinstalled.



8. Remove the hood (**1**), end covers (**2**) and belly pans (**3**) from the engine compartment.
9. Remove the heater and cooling hoses attached to the engine.
10. Label, disconnect and cap/plug all hydraulic connections on the engine/transmission.

Note: *The engine/transmission harness is routed and attached to the engine/transmission using hold-down clamps and plastic wire ties at various places on the engine. Before removing engine/transmission, ensure that the harness has been completely separated (disconnected) from the engine/transmission. Move the harness clear of the engine/transmission, and with the help of an observer, ensure that the engine/transmission clears the harness during removal.*

11. Label and disconnect all electrical wire connections on the engine/transmission.
12. Label and disconnect all hoses on the engine and transmission. Plug and/or cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
13. Label, disconnect and cap fuel lines.
14. Label and remove all clamps securing any fuel line on engine.
15. Remove exhaust pipe from exhaust manifold. Refer to Section 7.7, "Engine Exhaust System".

Note: *Emission Sensitive Exhaust. Assembly must be replaced exactly as removed.*

16. Remove air cleaner assembly. Refer to Section 7.8, "Air Cleaner Assembly".
17. Remove the drive shaft assemblies.Refer to Section 5.10.3, "Drive Shaft Removal".
18. Secure the engine with a lifting strap or chain from the appropriate lifting points. Use a suitable hoist or overhead crane.

Note: *Not all engines are equipped with lifting brackets.*

19. Loosen and remove the four engine/transmission mounting bolts and washers securing the engine to the frame.
20. Slightly lift and pull the engine/transmission out of the machine. Have an assistant ensure that the engine/transmission clears all frame components during removal.
21. Place engine/transmission on a flat, level surface.

7.9.2 Transmission Removal/Installation

Refer to Section 6.4, "Transmission Replacement", for detailed transmission removal and installation instructions.

7.9.3 Engine Disassembly, Inspection and Service

Engine disassembly, internal inspection, service, repair and assembly procedures are covered in the CAT service manual. Several special engine service tools are required to properly service the CAT engine. Contact the local Caterpillar dealer for further information.

Note: *If engine is being replaced, there may be external components that will be required to be transferred from original engine to replacement engine depending upon who you purchase new engine from and configuration of your replacement engine. Refer to appropriate CAT user manual for detailed procedures that cover transfer of original engine components to replacement engine.*

7.9.4 Engine/Transmission Installation

1. Attach a lifting chain to front and rear engine lift brackets, and lift engine/transmission clear of ground.

Note: *Apply Loctite® 243™ to engine mount bracket bolts before installation.*

2. Lift engine/transmission and slowly push and lower into engine compartment. Have an assistant ensure that engine/transmission clears frame, hose and harness components during engine/transmission installation. Position engine/transmission brackets over frame mounts.
3. Align motor mount holes and install front mounting bolts and washers.
4. Align motor mount holes and install rear mounting bolts and washers.
5. Lower the engine onto the mounts and remove the lifting chains.
6. Install flat washer, lock washer and nut on front two mounting bolts.
7. Torque engine/transmission mounting bolts to mounts to 241 Nm (178 lb-ft).
8. Install air cleaner. Refer to Section 7.8, “Air Cleaner Assembly”.
9. Install exhaust pipe. Refer to Section 7.7, “Engine Exhaust System”.
10. Install radiator assembly. Refer to Section 7.4.3, “Radiator Assembly Removal - 75 kW”.
11. Install the drive shaft assemblies. Refer to Section 5.10.5, “Drive Shaft Installation”.
12. Connect and secure all the previously labeled hydraulic hoses, fuel lines and electrical wire connections on the engine and transmission.
13. Install heater and cooling hoses to the engine and tighten clamps (if equipped).
14. Install hood (**1**), end covers (**2**) and belly pans (**3**) from engine compartment. and adjust if necessary.
15. Install and properly connect battery(s). Refer to Section 9.11, “Battery”, for procedure.
16. Check that all hydraulic system, electrical system, cooling system, fuel system and exhaust system connections are correct and connected tightly.

Note: *Have an assistant stand by with a Class B fire extinguisher.*

17. Check for proper fluid levels prior to startup. Refer to Section 2.3, “Fluids and Lubricant Capacities”.
18. Start engine and run to normal operating temperature then shut off engine. While engine is cooling, check for leaks.
19. Allow engine to cool. Check radiator coolant level, and top off with coolant.
20. Check for leaks from engine, main hydraulic pump and lines, transmission, hydraulic reservoir and fuel tank. Check levels of all fluids and lubricants. Fill as required.

Note: *During full throttle check:*

- Do Not operate any hydraulic function.
- Do Not steer or apply any pressure to the steering wheel.
- Keep transmission in (N) NEUTRAL.

21. Check engine rpm at full throttle.
22. Purge hydraulic system of air by operating all boom functions through their entire range of motion several times.
23. Check hydraulic oil level. If oil is warm, oil level should be visible in upper gauge window.
24. Check for proper operation of all components.
25. Turn engine OFF
26. Install the oil pan cover underneath the engine compartment.
27. Close and secure engine cover.
28. Remove Do Not Operate Tag from ignition key switch and steering wheel.

7.10 ENGINE TROUBLESHOOTING

Refer to Section 7.3, “Specifications and Maintenance Information”, for detailed engine service information.

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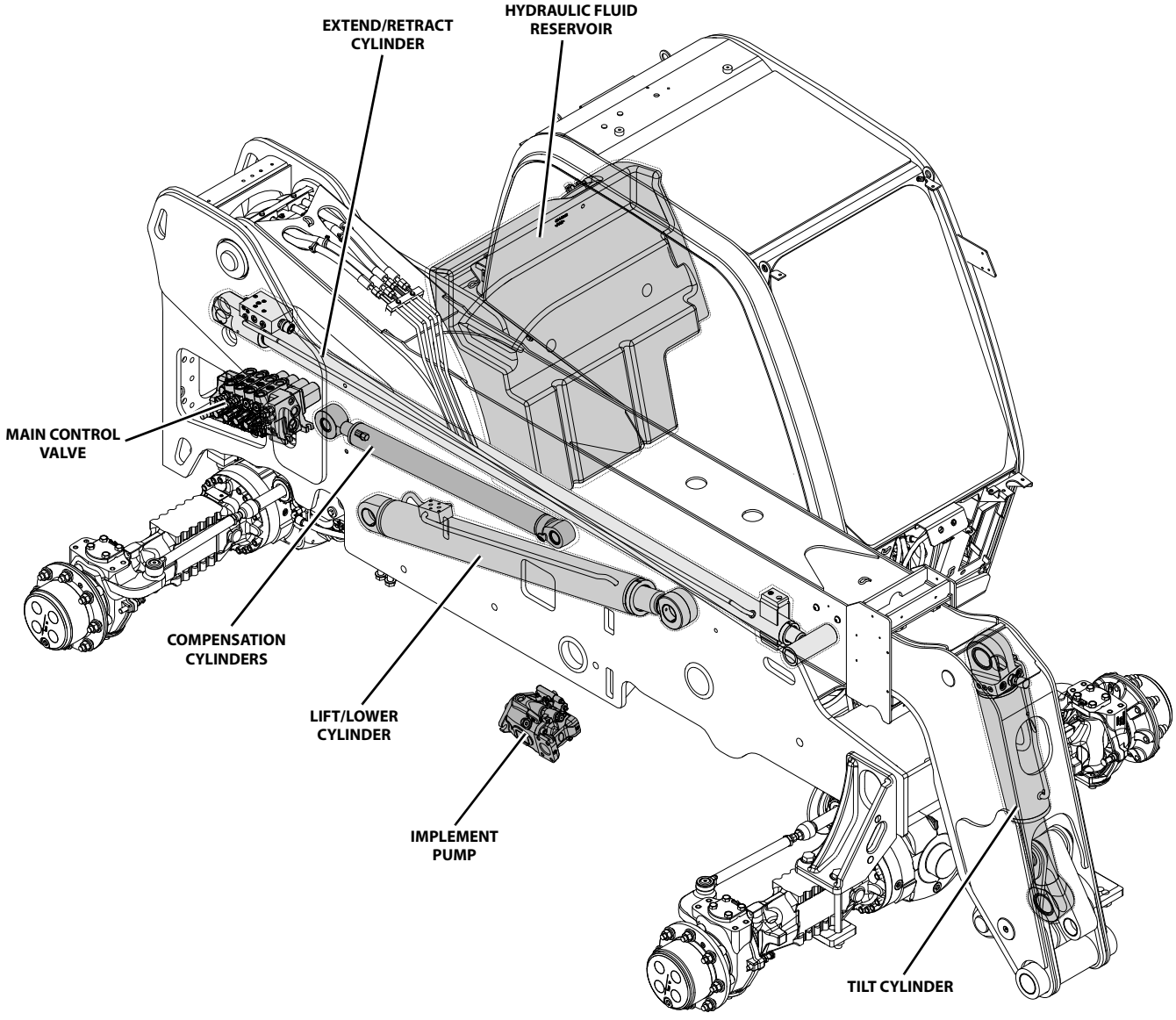
Section 8
Hydraulic System

Contents

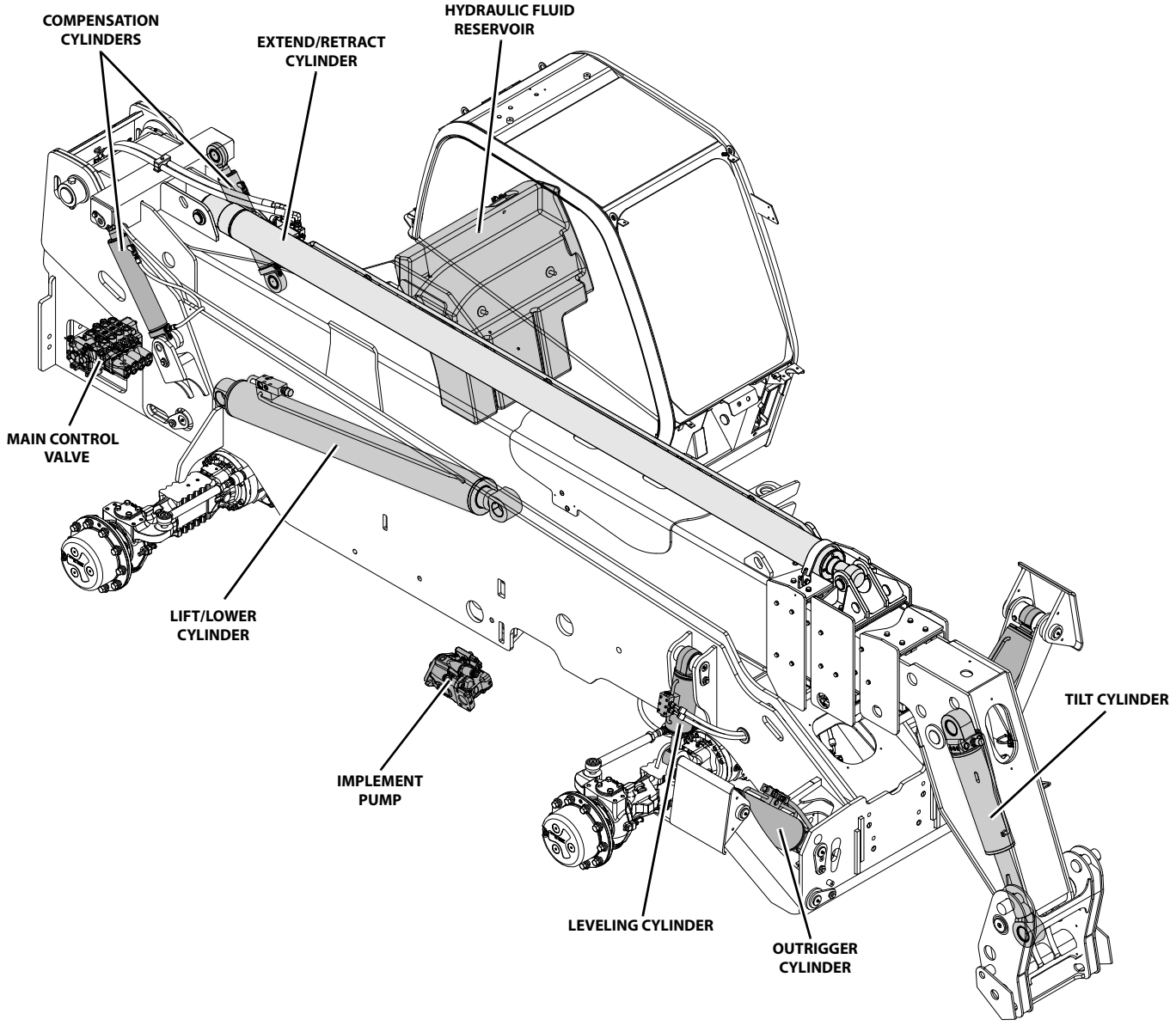
8.1 HYDRAULIC COMPONENT TERMINOLOGY

To understand the safety, operation and service information presented in this section, it is necessary that the operator/ mechanic be familiar with the name and location of the hydraulic components of the machine. The following illustration identifies the components that are referred to throughout this section.

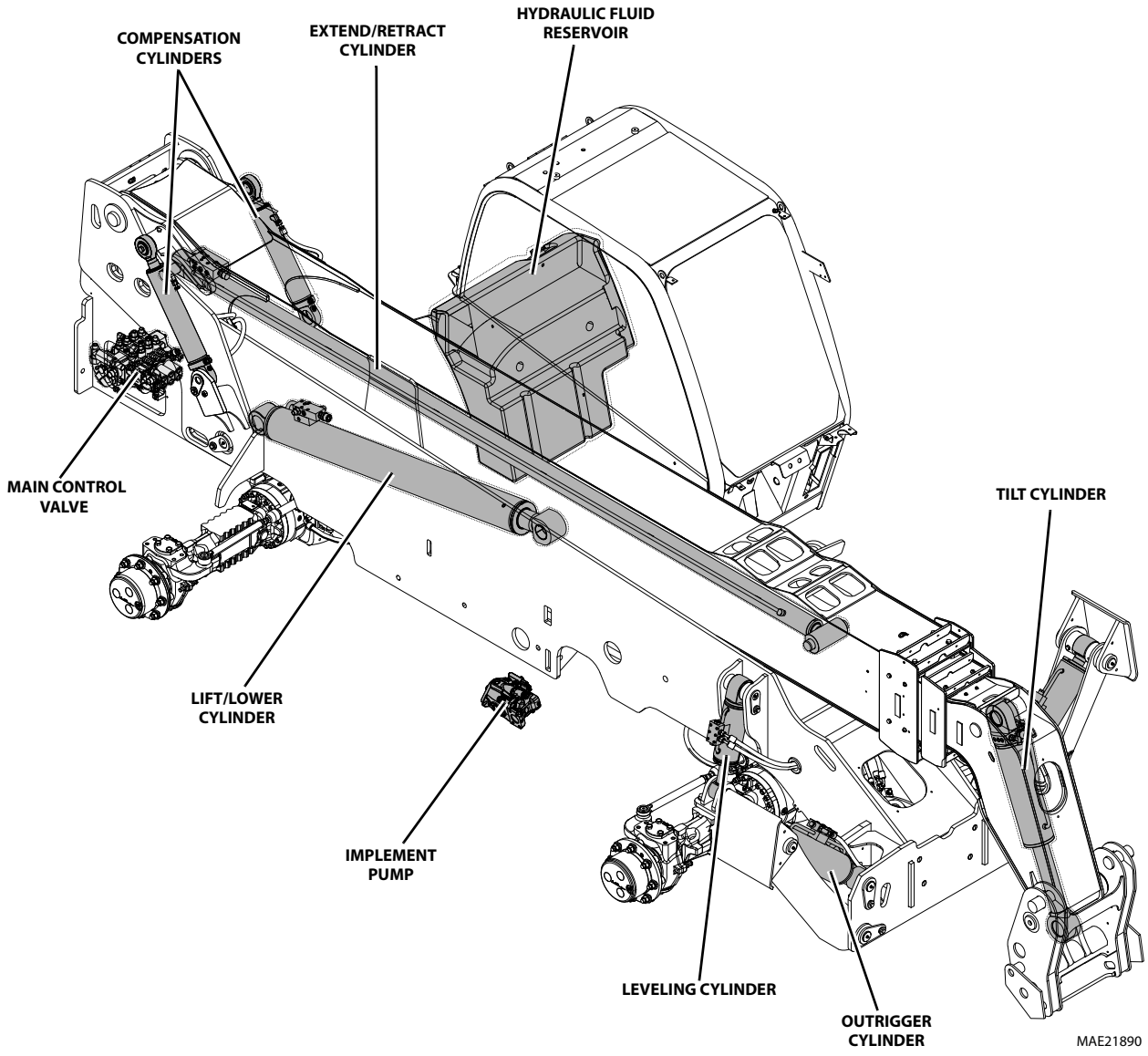
8.1.1 TH336C, TH337C, TH406C and TH407C



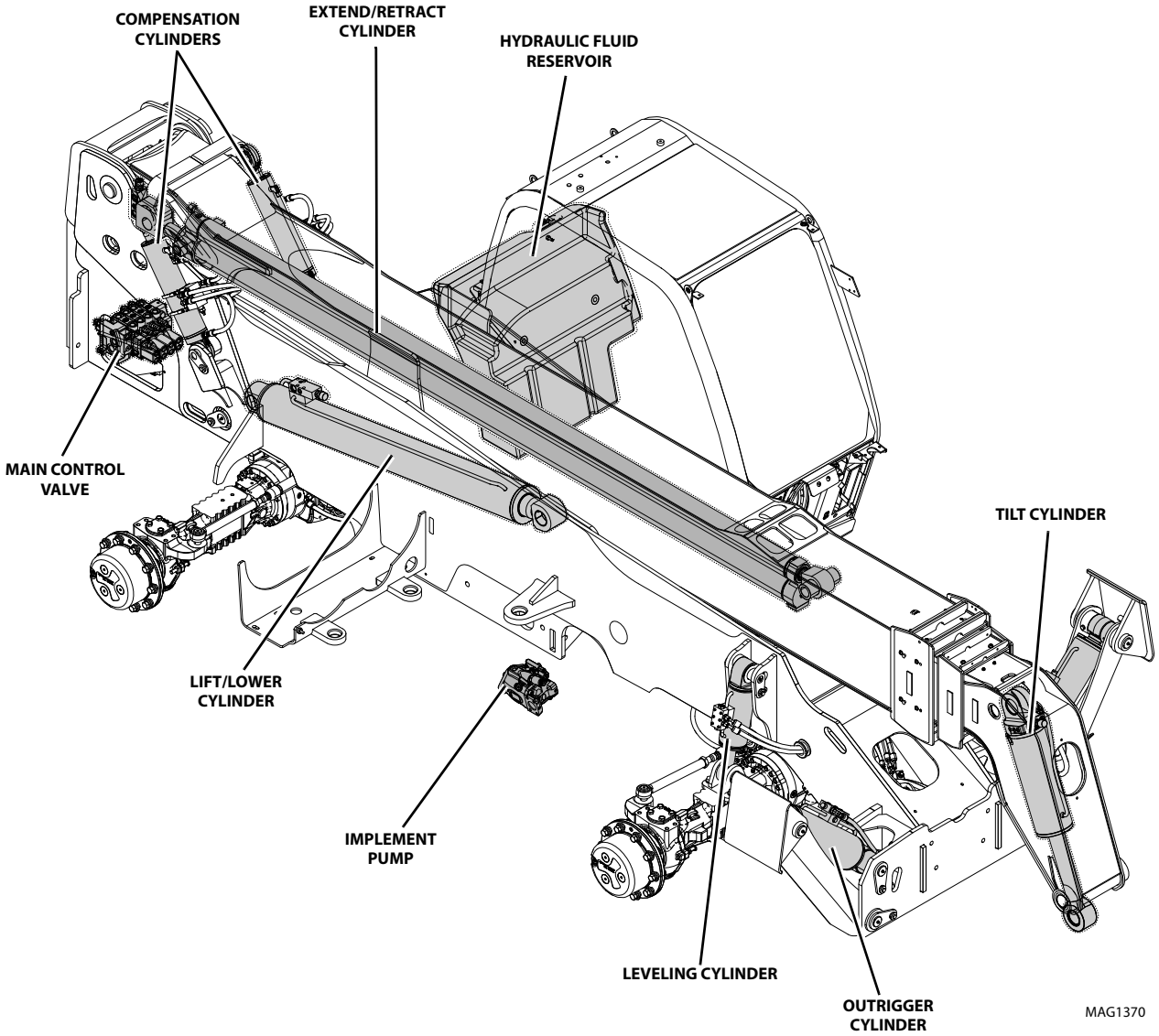
8.1.2 TH417C


COMPENSATION CYLINDERS
EXTEND/RETRACT CYLINDER
HYDRAULIC FLUID RESERVOIR
MAIN CONTROL VALVE
LIFT/LOWER CYLINDER
IMPLEMENT PUMP
TILT CYLINDER
LEVELING CYLINDER
OUTRIGGER CYLINDER
MAE21980

8.1.3 TH414C


COMPENSATION CYLINDERS
EXTEND/RETRACT CYLINDER
HYDRAULIC FLUID RESERVOIR
MAIN CONTROL VALVE
TILT CYLINDER
LIFT/LOWER CYLINDER
IMPLEMENT PUMP
LEVELING CYLINDER
OUTRIGGER CYLINDER
MAE21890

8.1.4 TH514C


COMPENSATION CYLINDERS
EXTEND/RETRACT CYLINDER
HYDRAULIC FLUID RESERVOIR
MAIN CONTROL VALVE
TILT CYLINDER
LIFT/LOWER CYLINDER
IMPLEMENT PUMP
LEVELING CYLINDER
OUTRIGGER CYLINDER
MAG1370

8.2 SAFETY INFORMATION

⚠ WARNING

Do Not service the machine without following all safety precautions as outlined in Section 1, "Safety Practices", of this manual.

Petroleum-based hydraulic fluids are used in this machine. The temperature of hydraulic fluid increases during the operation of various hydraulic functions. A heated petroleum-based hydraulic fluid presents a fire hazard, especially when an ignition source is present.

Accordingly, periodically inspect all hydraulic system components, hoses, tubes, lines, fittings, etc. Carefully examine any deterioration and determine whether any further use of the component would constitute a hazard. If in doubt, replace the component.

Whenever you disconnect a hydraulic line, coupler, fitting or other component, slowly and cautiously loosen the part involved. A hissing sound or slow seepage of hydraulic fluid may occur in most cases. After the hissing sound has ceased, continue removing the part. Any escaping oil should be directed into an appropriate container. Cap or otherwise block off the part to prevent further fluid seepage.

Hydraulic system maintenance will, at times, require that the engine be operated. Always follow safety precautions.

A major cause of hydraulic component failure is contamination. Keeping the hydraulic fluid as clean as possible will help avoid downtime and repairs. Dirty or contaminated hydraulic oil can damage internal components and void the manufacturer's warranty. When servicing the system, cap or plug hydraulic fittings, hoses and tube assemblies. Plug all cylinder ports, valves and the hydraulic reservoir, and pump openings until installation occurs. Protect threads from contamination and damage.

Manufacture's recommended hydraulic oil cleanliness levels are based on the three digit ISO code for 4 micron/6 micron/ 14 micron particle sizes found in one ml of fluid (reference ISO 4406: 199(E). The acceptable level is 19/17/14 or below; anything higher requires system cleaning and filter replacement.

Note: *The human eye can only distinguish particles down to 40 microns.*

Reference Section 2.4, "Service and Maintenance Schedules", for the appropriate maintenance intervals based on hours of operation, but if your equipment is exposed to extremely dirty or hostile conditions service may be required more frequently. Always use OEM filters to assure the necessary filtration requirements are met.

Some hydraulic functions are actuated by interfacing with electrical system components (switches, solenoids and sensors). When the hydraulic system is not functioning properly, check the electrical aspect of the malfunctioning circuit also. Refer to Section 9.8, "Electrical System Schematics", in this manual.

8.3 SPECIFICATIONS

Refer to Section 2.2, "Specifications", for hydraulic system specifications.

8.4 HYDRAULIC PRESSURE DIAGNOSIS

8.4.1 Pressure Checks and Adjustments

When diagnosing trouble in the hydraulic system, use the hydraulic testing information in Section 8.5.1, "Hydraulic Pressures".

In general, follow the steps below whenever conducting pressure checks and performing adjustments:

1. Park the machine on a firm, level surface. Engage the park brake, place transmission in (N) NEUTRAL, level the boom and turn the engine OFF.
2. At the proper test port, install a pressure gauge capable of measuring at least 10% more pressure than that which the circuit being checked operates under.
3. Start the engine. Operate machine functions several times to allow hydraulic oil to reach operating temperature. The hydraulic oil temperature should be between 38-49° C (100-120° F). If a temperature gauge or thermometer is unavailable, the hydraulic oil reservoir should be warm to the touch.
4. Refer to Section 8.5.1, "Hydraulic Pressures", for testing procedures.
5. Fully depress the accelerator pedal if required. Place and hold the joystick in the position needed to operate the particular machine function being checked. Continue holding the joystick in position until pressure readings are taken.
6. Check the pressure gauge reading. It should read as specified in the Pressure Readings column of the charts found in Section 8.5.1, "Hydraulic Pressures". If the reading is not as specified, turn the engine OFF and check other components in the system. Verify that all related hydraulic components and electrical switches, sensors, solenoids, etc. are operating correctly.
7. Adjust the appropriate relief valve by turning the adjustment screw. Turning clockwise will increase the pressure; turning the screw counterclockwise will decrease the pressure.

8. Start the engine and check the pressure again. Turn the engine OFF. If there is pressure reading in the gauge, bleed it off then disconnect or remove the pressure gauge from the machine.

8.5 HYDRAULIC CIRCUITS

This section covers the hydraulic circuits and includes listings for all hydraulic function pressures, where and how to check those pressures and a hydraulic schematic.

Electrical and hydraulic functions are often related. Verify that the electrical components of the circuit are functioning properly whenever troubleshooting the hydraulic circuit.

Always check the following before beginning to troubleshoot a circuit that is not functioning correctly.

1. Check the hydraulic oil level in the reservoir. If oil is cold, oil level should be visible in the lower gauge window with all cylinders retracted.
2. Check hoses, tubes, fittings and other hydraulic components for leaks, bends, kinks, interference, etc.
3. Check for air in the hydraulic system. Erratic machine performance and/or spongy cylinder operation are signs of air in the hydraulic system.

   If air in the hydraulic system is suspected, you will hear air leakage when hydraulic fittings are loosened and see air bubbles in the hydraulic fluid.

   Loose fittings, faulty o-rings or seals, trapped oil, leaks, system opened for service, etc., can cause air in the system. Determine what is causing air to enter the system and correct it. Bleed air from the system.

8.5.1 Hydraulic Pressures

a. Checking Pressure

1. Start the machine and warm the hydraulic system to operating temperature.
2. Shut off the machine and install a digital or a 345 bar (5000 psi) gauge to the appropriate test port on the hydraulic manifold.
3. Start the machine, run the engine at idle and bottom the appropriate hydraulic function. Refer to Section 8.5.1. c. "Pressure Specifications", for the correct pressure rating.

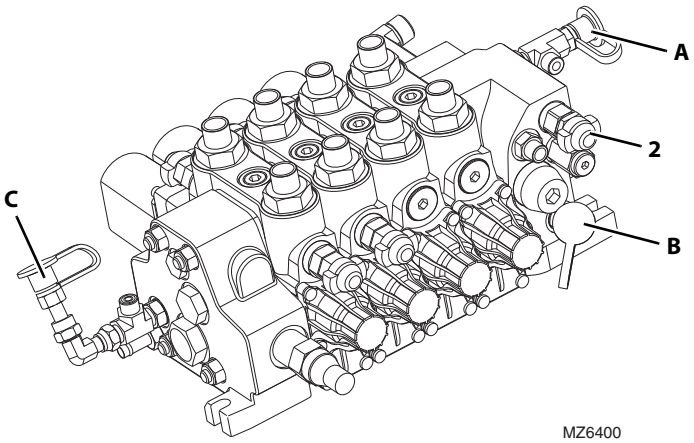
b. Adjusting Hydraulic Pressures

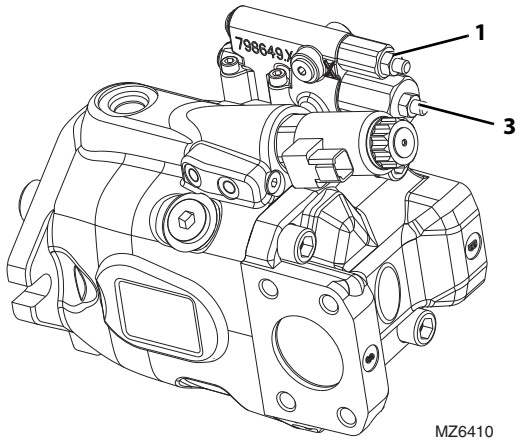
1. Shut the machine off.
2. Start the machine and loosen the jam nut on the relief. Turn the relief clockwise to increase pressure or counter-clockwise to decrease pressure. Set to the correct pressure.
3. Tighten the jam nut and recheck the pressure. If the reading is within specification, shut the machine off, install the safety cap and remove the gauge from the test port.
4. If the proper pressure cannot be set, use the accompanying hydraulic schematic and/or the electrical schematic to help troubleshoot and correct the problem.

Note: *Do Not operate any other function while checking steering pressure.*

Note: *The steering pressure is pre-set from the manufacturer and cannot be adjusted.*

c. Pressure Specifications





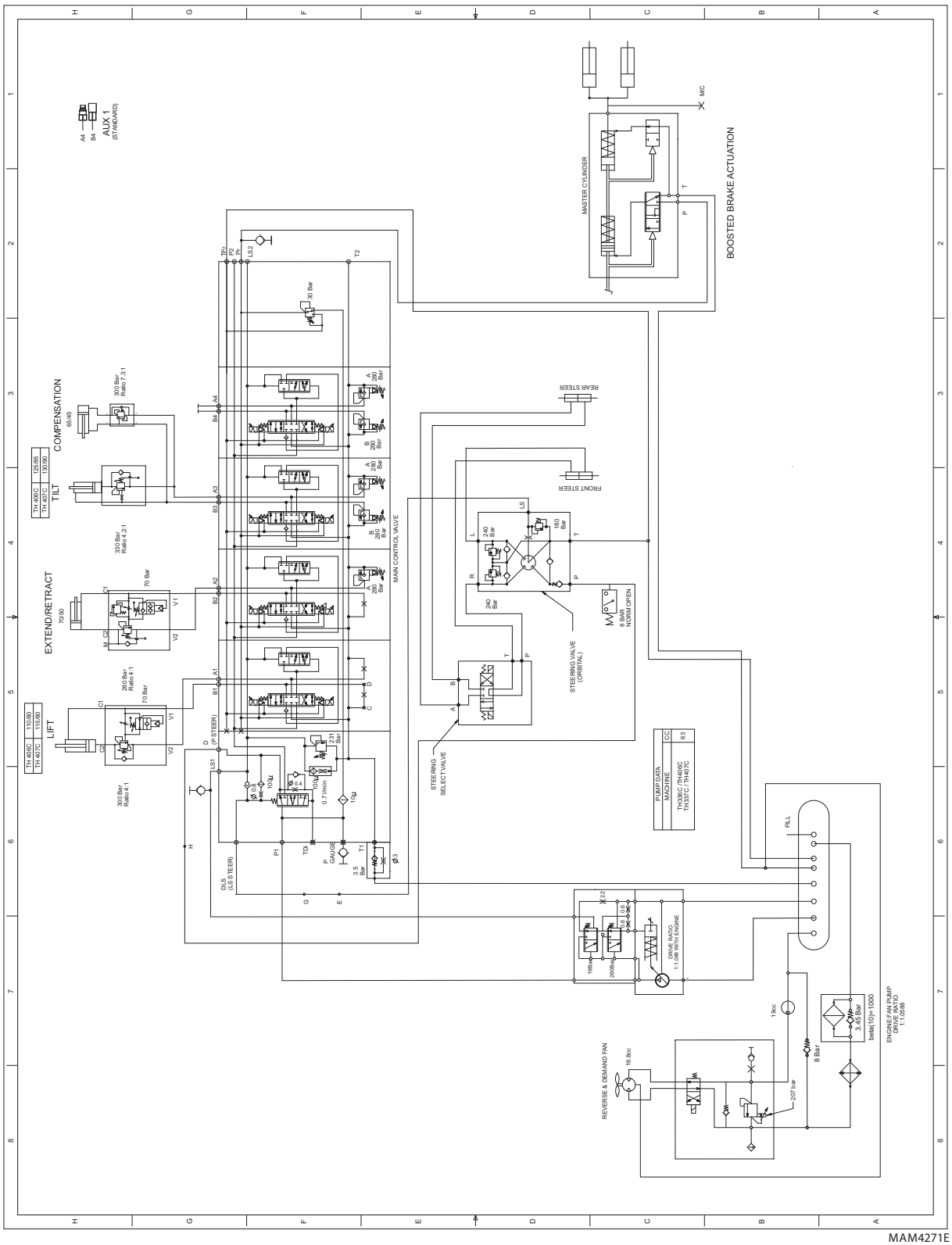
Note: *All pressure check are to be performed at High Idle unless noted.*

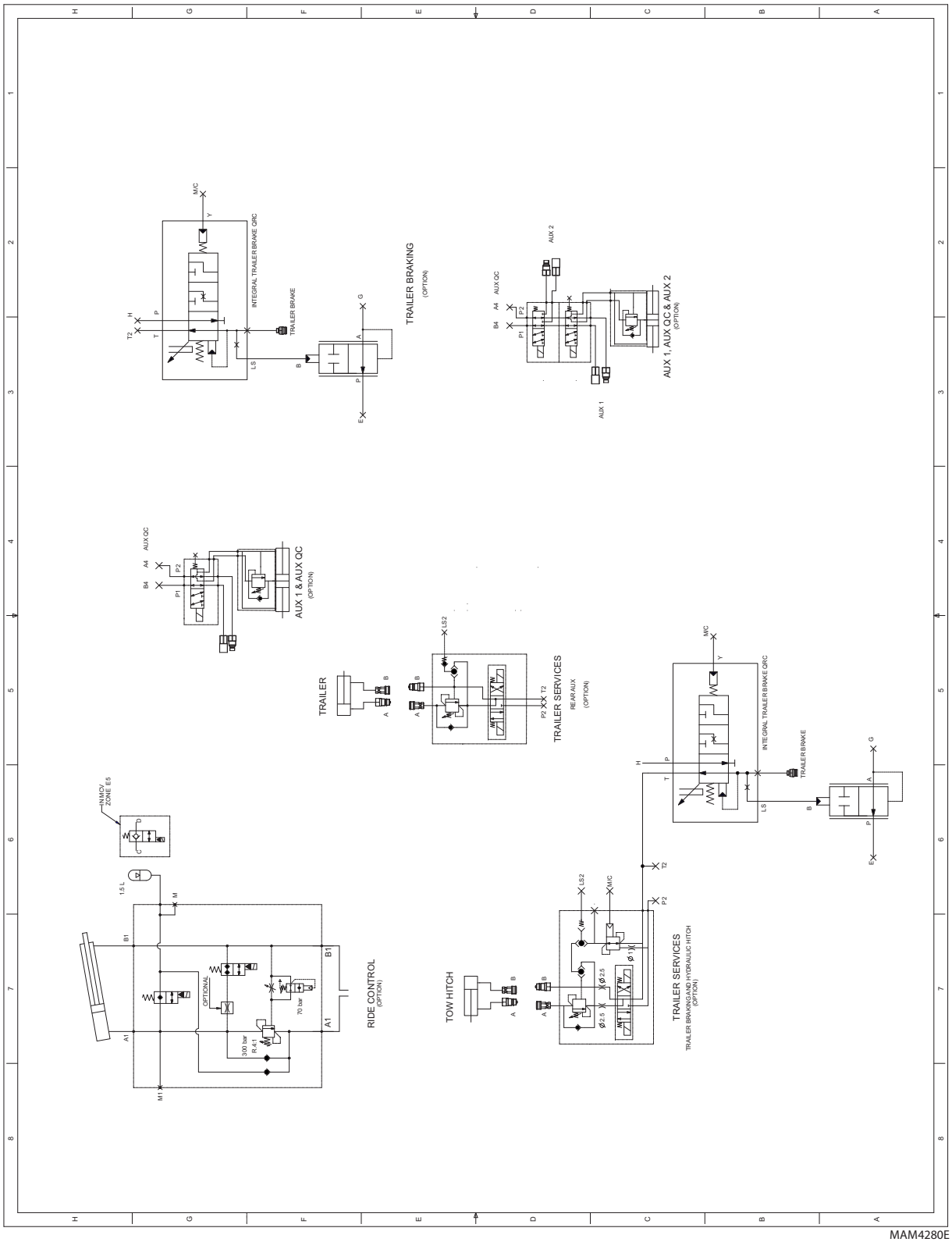
	Hydraulic Circuit	Test Port	Procedure	Adjustment Location	Pressure Range
1	Steer Pressure	LS1 (**A**)	Connect gauge to LS1 port, select 2 wheel steer, run engine at high idle, turn steering wheel one direction to lock. Hold and check pressure. Note: Do not operate any other function while checking pressure.	N/A	168 - 178 Bar 2467 - 2582 psi
2	Pump Margin	LS1 (**A**) & P (**B**)	Connect one gauge to LS1 port, and connect one gauge to P port, select 2 wheel steer, run engine at high idle, turn steering wheel one direction to lock. Hold and check pressure. The margin pressure is the difference between the pressures measured at the LS1 Port and the P Port.	1	18,5 - 23,5 Bar 269 - 340.8 PSI
3	Load Sense	LS1 (**A**)	Connect gauge to LS1 port, level boom and bottom boom retract.	2	225 - 235 Bar 3263 - 3408 PSI
4	Maximum Pump Pressure	P (**B**)	Connect gauge to P port, level boom and bottom boom retract.	3	245 - 255 Bar 3553 - 3698 PSI
5	Stand-By Pressure	P (**B**)	Connect gauge to P port, check pressure at Low idle with no function.	N/A	15 - 35 Bar 218 - 508 PSI
6	Pilot Pressure	PR (**C**)	Connect gauge to PR port, check pressure with no function.	N/A	25 - 30 Bar (362 - 435 PSI)
7	Auxiliary Pressure	Auxiliary Port	Connect gauge to Auxiliary Coupling, check pressure at coupling.	N/A	245-255 Bar 3553 - 3698 PSI

8.6 HYDRAULIC SCHEMATICS

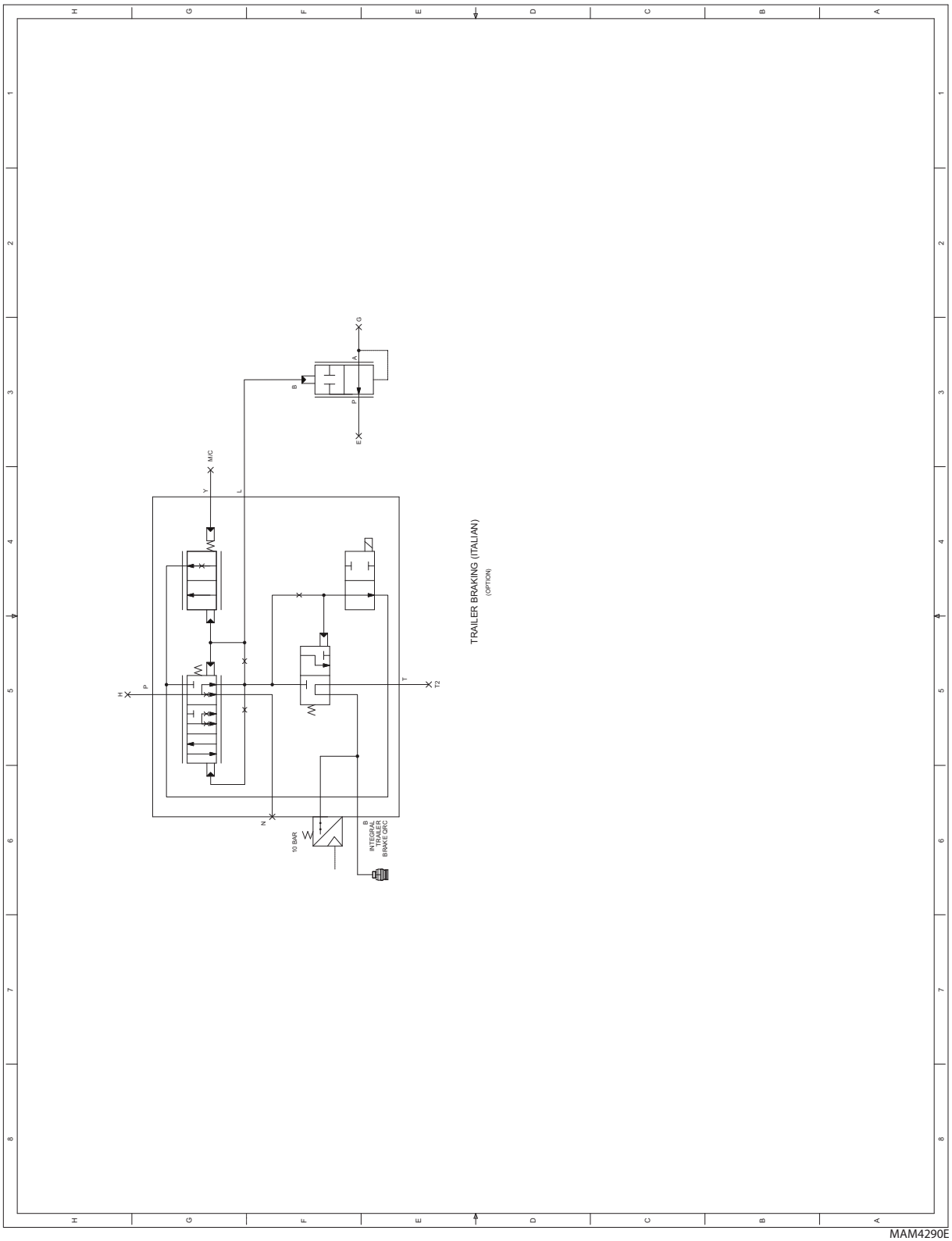
Refer to Hydraulic Schematic Package (PN 31200831)

8.6.1 TH336C, TH337C, TH406C & TH407C




TRAILER BRAKING
(OPTION)
INTEGRAL TRAILER BRAKE QRC
TRAILER BRAKE
AUX 1, AUX QC & AUX 2
(OPTION)
AUX 1 & AUX QC
(OPTION)
TRAILER
TRAILER SERVICES
REAR AUX
(OPTION)
RIDE CONTROL
(OPTION)
TOW HITCH
TRAILER SERVICES
TRAILER BRAKING AND HYDRAULIC HITCH
(OPTION)

MAM4280E


TRAILER BRAKING (ITALIAN)
(OPTION)
MIC
Y
L
G
A
B
P
E
H
P
T
T2
N
10 BAR
B
INTEGRAL TRAILER BRAKE OPC

MAM4290E

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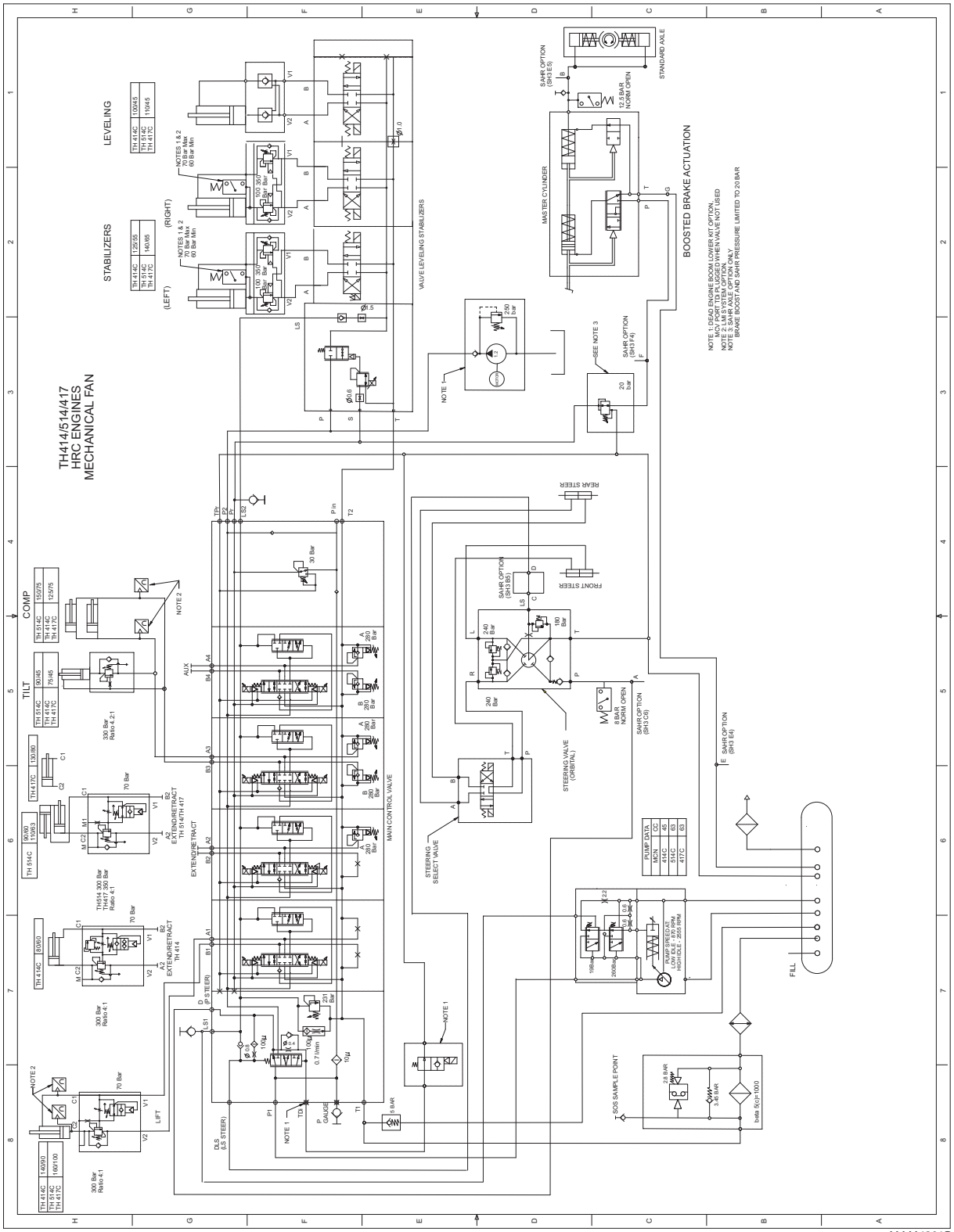
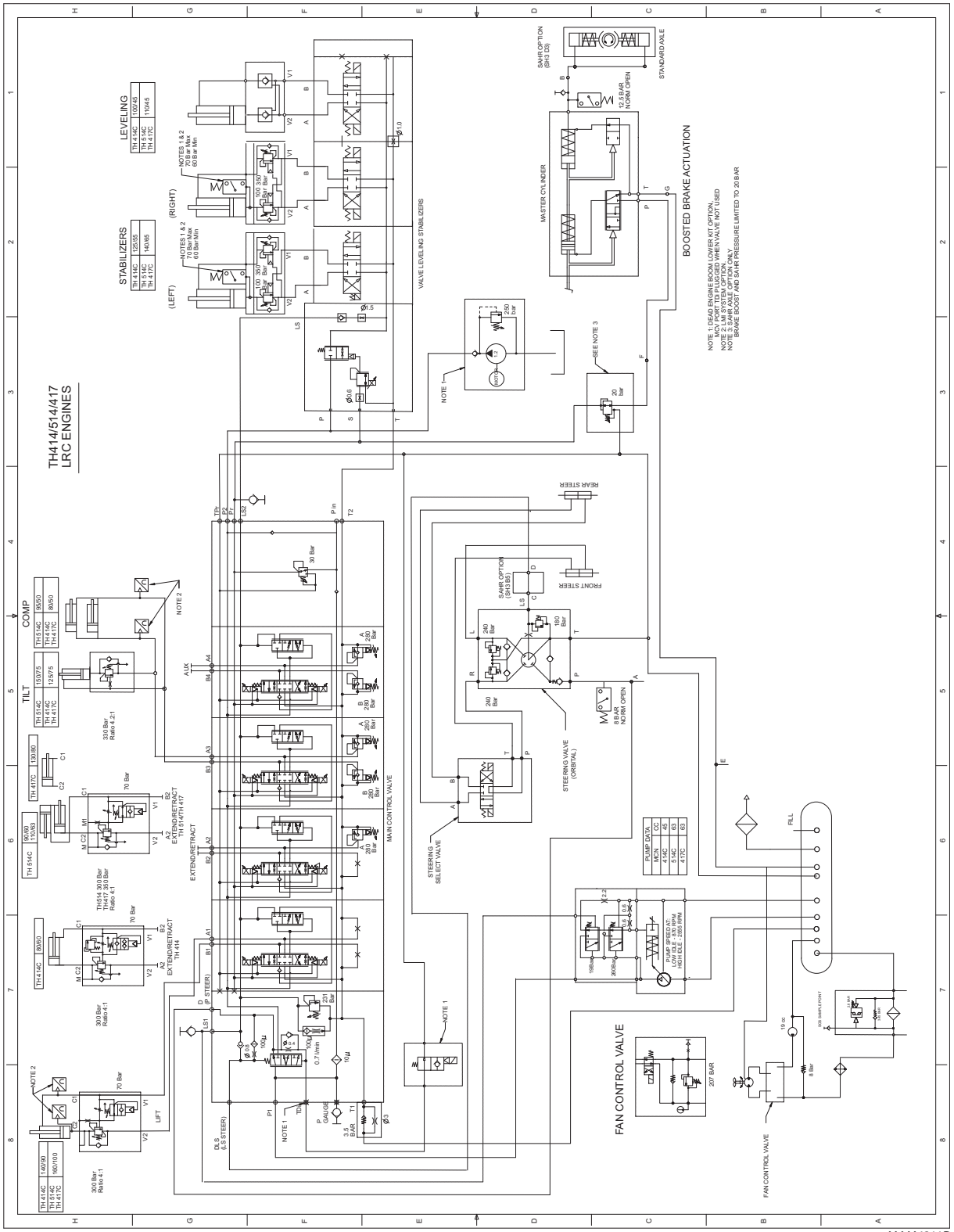
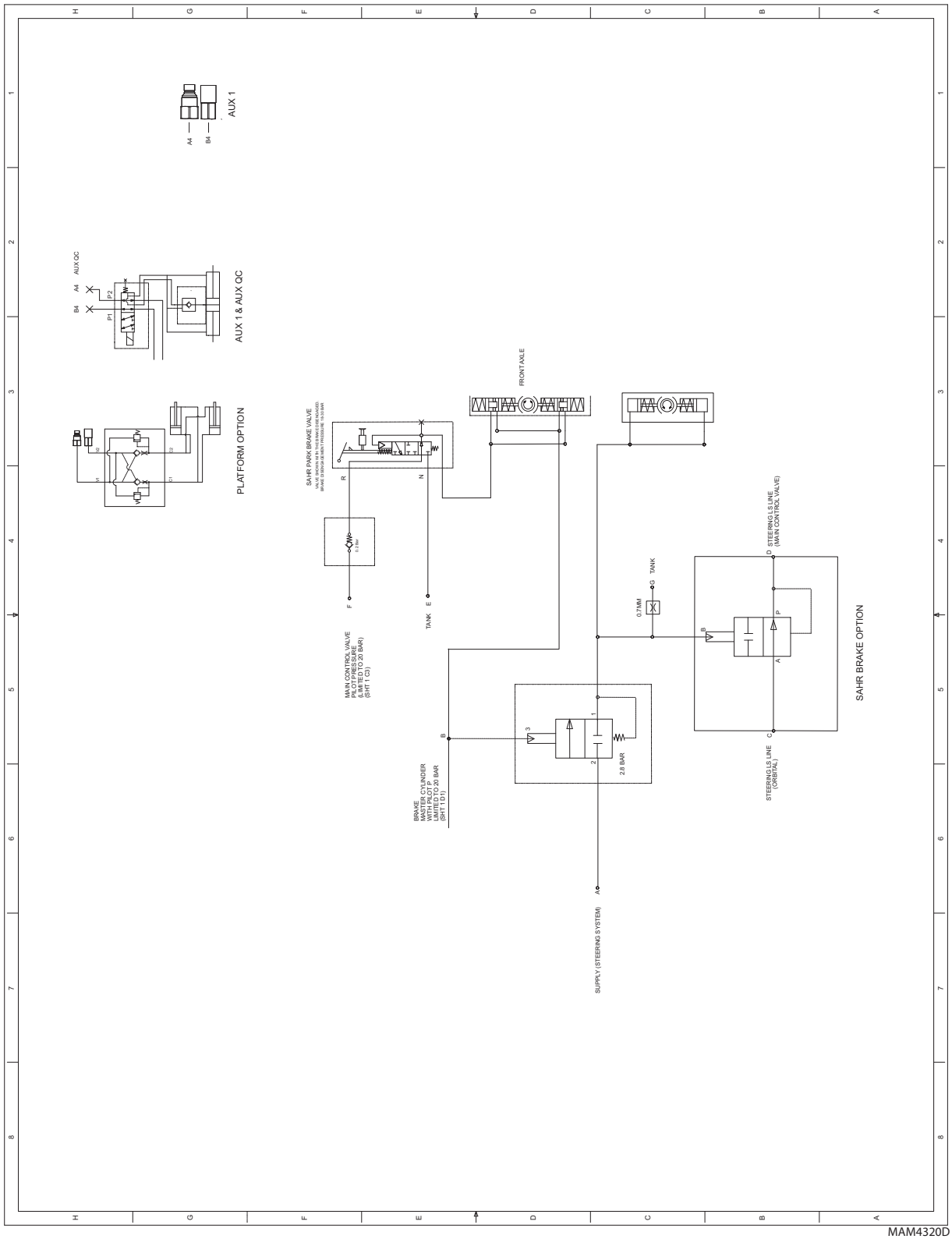
8.6.2 TH414C, TH514C & TH417C



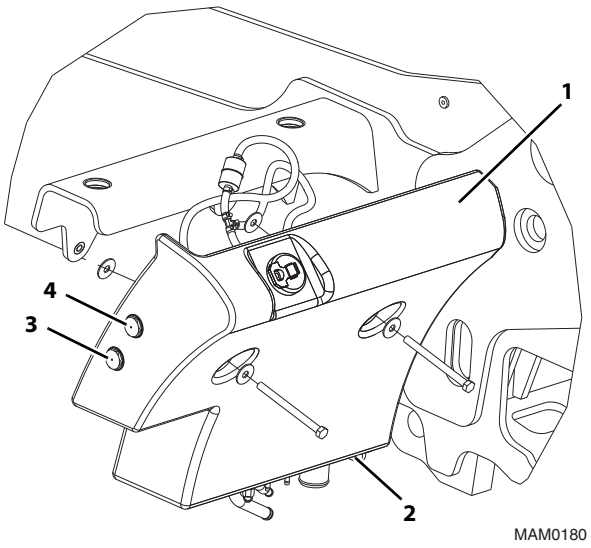

TH414/514/417
LRC ENGINES
LEVELING
STABILIZERS
(RIGHT)
(LEFT)
VALVE LEVELING STABILIZERS
MASTER CYLINDER
BOOSTED BRAKE ACTUATION
STANDARD AXLE
SAHR OPTION (SH18 DS)
REAR STEER
FRONT STEER
SAHR OPTION (SH18 BS)
STEERING VALVE (ORBITAL)
STEERING SELECT VALVE
MAIN CONTROL VALVE
TILT
COMP
LIFT
EXTEND/RETRACT
AUX
FAN CONTROL VALVE
PUMP DATA
FILL
NOTE 1: DEAD ENGINE BOOM LOWER KIT OPTION.
MCV PORT TO PLUGGED WHEN VALVE NOT USED
NOTE 2: LIFT CYLINDER OPTION ONLY
NOTE 3: SAHR AXLE OPTION ONLY
BRAKE BOOST AND SAHR PRESSURE LIMITED TO 20 BAR

MAM4311D


AUX 1
A4
B4
AUX QC
P2
P1
AUX 1 & AUX QC
PLATFORM OPTION
SAHR PARK BRAKE VALVE
FRONT AXLE
R
N
F
TANK
E
MAIN CONTROL VALVE
PILOT PRESSURE
(LIMITED TO 20 BAR)
(SHUTTLE)
0.71MM
TANK
D
STEERING LS LINE
(MAIN CONTROL VALVE)
P
B
A
C
STEERING LS LINE
(ORBITAL)
SAHR BRAKE OPTION
BRAKE
MASTER CYLINDER
PRESSURE
LIMITED TO 20 BAR
(SHUTTLE)
2.8 BAR
SUPPLY (STEERING SYSTEM)

MAM4320D

8.7 HYDRAULIC RESERVOIR



The hydraulic reservoir (**1**) is located on the rear of the cab.

8.7.1 Hydraulic Oil Reservoir Draining

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N)NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the lower cover of the reservoir.
6. Open the filler cap on the hydraulic oil reservoir. Remove the drain plug (**2**) on the bottom of the hydraulic oil reservoir.
7. Transfer the used hydraulic oil into a suitable covered container, and label as "Used Oil". Dispose of used oil at an approved recycling facility. Clean and reinstall the drain plug. Torque drain plug to 35 Nm (25 lb-ft).
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine and the work area.

8.7.2 Hydraulic Oil Reservoir Filling

1. Be sure the reservoir is clean and free of all debris.
2. Install a new hydraulic oil filter.
3. Fill the reservoir with oil until oil level is visible in the lower gauge window (**3**). Refer to Section 2.3, "Fluids and Lubricant Capacities".
4. Install the lower cover of the reservoir.
5. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
6. Close and secure the engine cover.
7. Start machine and check all hydraulic functions for proper operation. Check for any hydraulic oil leaks. Shut machine OFF and check hydraulic oil level. If oil is warm, oil level should be visible in the upper gauge window (**4**). Add hydraulic oil if necessary.
8. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

8.7.3 Hydraulic Oil Reservoir Removal/ Installation

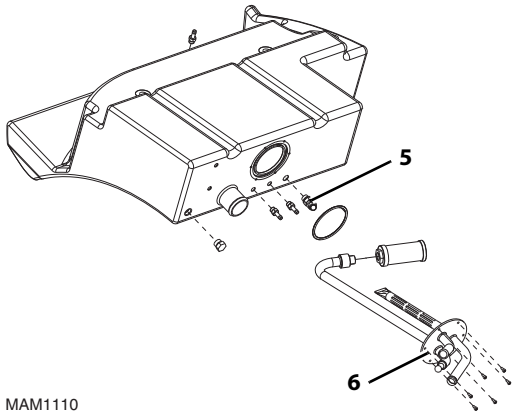
If it is determined that the hydraulic oil reservoir must be removed, the hydraulic oil must be drained before the reservoir is removed. Always dispose of hydraulic oil properly.

a. Reservoir Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the lower cover of the reservoir.
6. Drain the hydraulic oil reservoir. Refer to Section 8.7.1, "Hydraulic Oil Reservoir Draining".
7. Label, disconnect and cap all hydraulic hoses attached to the hydraulic oil reservoir. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
8. Remove the bolts securing the hydraulic oil reservoir to the frame.
9. Remove the hydraulic oil reservoir.

b. Disassembly

Dispose of the old reservoir according to local regulations concerning hazardous materials disposal.



1. Remove the adapters (**5**) from the bottom of the tank.
2. Remove the screws securing the hydraulic manifold (**6**) to the tank.
3. Pull the hydraulic manifold out of the hydraulic tank.

c. Assembly

1. Install the hydraulic manifold in the hydraulic tank using a new o-ring. Torque the six screws to 2,25 ±0,25 Nm (19.9 ±2 lb-in).
2. Install the adapters to the bottom of the tank. Torque to 23 ±3 Nm (17 ±2 lb-ft).

d. Cleaning and Drying

If contaminated hydraulic oil or foreign material is in the tank, the tank can usually be cleaned.

To clean the hydraulic oil reservoir:

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Remove the hydraulic oil reservoir drain plug, and safely drain any hydraulic oil into a suitable container. Dispose of hydraulic oil properly.
3. Clean the hydraulic oil reservoir with a high-pressure washer, or flush the tank with hot water for five minutes and drain the water. Dispose of contaminated water properly.

e. Inspection

1. Inspect the hydraulic oil reservoir thoroughly for any cracks, slices, leaks or other damage.
2. With the hydraulic oil reservoir removed from the machine, plug all openings except one elbow fitting. Install the elbow fitting, and apply approximately 7 - 10 kPa (1 - 1.5 psi) of air pressure through the elbow. Check the reservoir for leaks by applying a soap solution to the exterior and look for bubbles to appear at the cracked or damaged area.

f. Reservoir Installation

1. Place the hydraulic oil reservoir into its original orientation.
2. Secure the hydraulic oil reservoir to the frame with the previous mounting hardware.
3. Uncap and connect the previously labeled hydraulic hoses to their appropriate locations. Be sure all lines are free of kinks and sharp bends.
4. Install hydraulic filter bracket and hydraulic filter.
5. Fill the reservoir with oil until oil level is visible in the lower gauge window. Refer to Section 2.3, “Fluids and Lubricant Capacities”.
6. Check the hydraulic oil reservoir for leaks.
7. Install the lower reservoir cover.
8. Properly connect the battery. Refer to Section 9.11, “Battery”, for procedure.
9. Close and secure the engine cover.
10. Start machine and check all hydraulic functions for proper operation. Check for any hydraulic oil leaks. Shut machine OFF and check hydraulic oil level. If oil is warm, oil level should be visible in the upper gauge window. Add hydraulic oil if necessary.
11. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

8.8 ENGINE IMPLEMENT PUMP

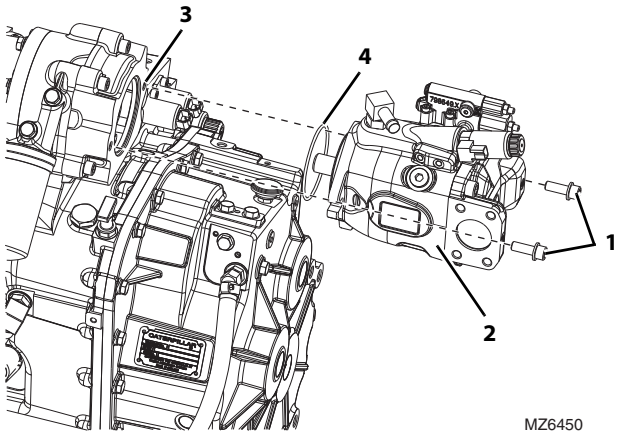
8.8.1 Pump Replacement

a. Pump Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Drain the hydraulic reservoir. Refer to Section 8.7.1, "Hydraulic Oil Reservoir Draining".
6. Remove the engine compartment belly pan.
7. Thoroughly clean the pump and surrounding area, including all hoses and fittings before proceeding.

Note: *Cap all hoses as you remove them to prevent unnecessary fluid spillage.*

8. Label, disconnect and cap the hydraulic hoses attached to the pump.

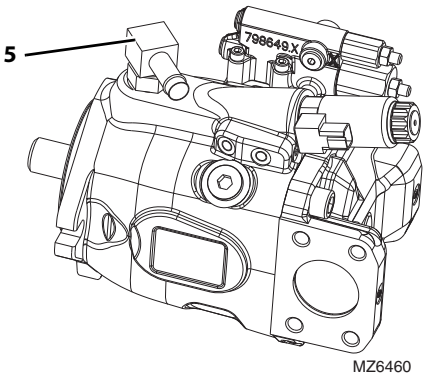


9. Remove the two bolts and two lockwashers (**1**) securing the pump (**2**) to the adapter plate (**3**). Remove the o-ring (**4**) located between the plate and the pump. Wipe up any hydraulic oil spillage.
10. If necessary, remove the four bolts securing the adapter plate to the transmission. Remove the adapter plate.
11. If a new pump will be installed, remove all hose fittings from the pump.

Note: *Do Not disassemble the operating pump. The pump is pre-set from the manufacturer.*

b. Pump Installation

1. Apply Loctite® 243™ to all mounting bolts.
2. If the adapter plate was removed, place into position with a new, oiled o-ring on the engine. Secure with the previously used hardware.
3. Place the pump and a new, oiled o-ring into position on the adapter plate. Align the pump shaft with the internal gear, so that the machined teeth mesh together.
4. Align the bolt holes with the pump mount holes. Secure the pump to the adapter plate with the two bolts and washers. Torque as required.
5. Uncap and connect the previously labeled hydraulic hoses to their appropriate locations.
6. Fill the hydraulic reservoir. Refer to Section 8.7.2, "Hydraulic Oil Reservoir Filling".



7. Prime the pump by filling the case with fresh, filtered hydraulic oil from a clean container through the 45° elbow fitting (**5**) port.
8. Remove the fitting noting the orientation. Fill the pump, install and tighten the 45° elbow fitting.
9. Check all routing of hoses and tubing for sharp bends or interference with any rotating members.
10. Inspect for leaks and check all fluid levels. The hydraulic reservoir oil level must be to the middle of the sight gauge.
11. Install the belly pan.
12. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
13. Close and secure the engine cover.
14. Start machine and verify proper operation.
15. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

c. Implement Pump Test

Refer to Section 8.4.1, "Pressure Checks and Adjustments".

8.9 AUXILIARY PUMP (PLATFORM EQUIPPED MODELS ONLY)

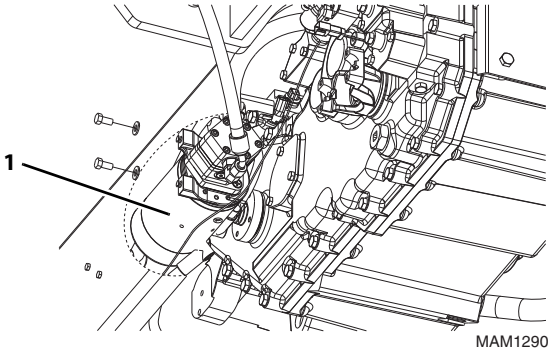
8.9.1 Auxiliary Pump Description

The auxiliary pump works as a safety back up for the platform in case of engine stalling. The pump will allow the platform to lower without the engine running.

8.9.2 Auxiliary Pump Replacement

a. Auxiliary Pump Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



5. Thoroughly clean the auxiliary pump (**1**) and surrounding area, including all hoses and fittings, before proceeding.
6. Place a suitable container to catch hydraulic fluid drainage beneath the frame.
7. Label, disconnect and cap the hydraulic hoses attached to the auxiliary pump. Slowly turn hose fittings to allow any trapped pressure in the hydraulic system to escape. Call all fittings to prevent dirt and debris from entering the hydraulic system.
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine and work area.
9. Label and disconnect the electrical connections to the auxiliary pump.
10. Support the valve and remove the bolts securing the pump to the engine pod.
11. Remove the pump.

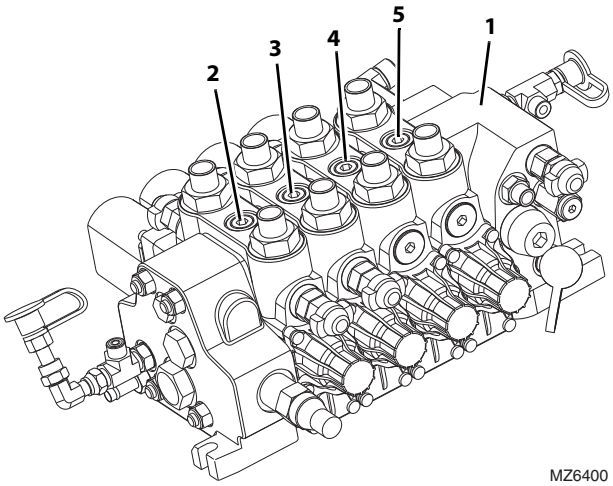
b. Auxiliary Pump Installation

1. Install the pump to its original orientation and secure in place with the previously used hardware.
2. Connect the previously labeled electrical connections to the pump.
3. Uncap and connect the previously labeled hydraulic hoses to the auxiliary pump.
4. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Test the pump functions.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

8.10 CONTROL VALVES

8.10.1 Main Control Valve

The main control valve is mounted at the rear of the machine inside the frame.



The main control valve assembly (**1**) consists of working sections with their own valve assemblies, each providing a specific hydraulic function. Those functions are: lift/lower (**2**), extend/retract (**3**), tilt (**4**) and auxiliary (**5**).

a. Main Control Valve Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Thoroughly clean the main control valve and surrounding area, including all hoses and fittings, before proceeding.
6. Place a suitable container to catch hydraulic fluid drainage beneath the frame.
7. Drain the hydraulic oil reservoir. Refer to Section 8.7.1, "Hydraulic Oil Reservoir Draining".
8. Label, disconnect and cap all the hydraulic hoses, tubes and wires at the main control valve. Slowly turn hose fittings to allow any trapped pressure in the hydraulic system to escape.
9. Wipe up any hydraulic fluid spillage in, on, near and around the machine and the work area.
10. Support the valve and remove the four bolts securing the main control valve to the frame. Remove the main control valve.

b. Main Control Valve Disassembly

Disassemble the Main Control Valve

1. To disassemble the individual sections of the main control valve, remove the nuts from one end of the tie rods.
2. Disassemble each section assembly as required.

Some sections include a pre-adjusted relief valve that regulates pressure in a specific circuit.

Note: *Do Not adjust any of the relief valve assemblies. Tampering with a relief valve will irrevocably alter pressure in the affected circuit, requiring recalibration or a new relief valve.*

Disassemble each Valve Section

1. Carefully separate the load sense outlet section from the next section.
2. Remove the o-rings from between the two sections.
3. Carefully separate each remaining section.
4. Remove any check valves, compensator valves, anti-cavitation valves or shock valves from individual valve section if equipped.
5. Keep all parts being removed from individual valve sections tagged and kept together.

c. Main Control Valve Parts Cleaning

Clean all components with a suitable cleaner, such as triclorethylene, before continuing. Blow dry.

d. Main Control Valve Parts Inspection

Inspect all parts and internal passageways for wear, damage, etc. If inner surfaces of any component Do Not display an ultra-smooth, polished finish, or are damaged in any way, replace the damaged part. Often, dirty hydraulic fluid causes failure of internal seals, damage to the polished surfaces within the component, and wear of and/or harm to other parts.

e. Main Control Valve Assembly

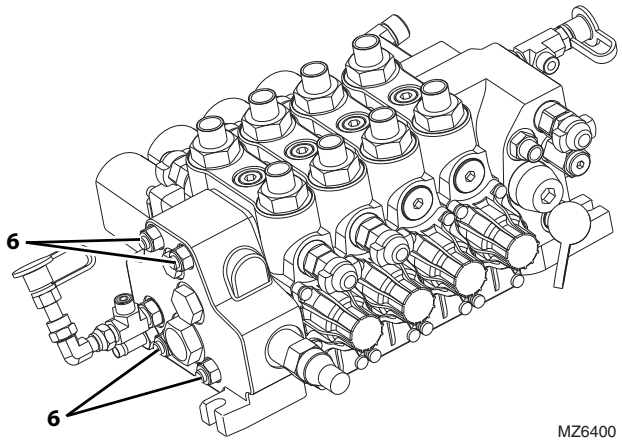
Note: *ALWAYS replace seals, o-rings, gaskets, etc., with new parts to help ensure proper sealing and operation. Lubricate seals and o-rings with clean hydraulic oil.*

Assemble each Valve Section

1. Reassemble any check valves, compensator valves, anti-cavitation valves or shock valves from each individual valve sections if equipped.
2. Install the end caps on each end of the valve section.

Assemble the Main Control Valve

1. If removed, install all four tie rods into the end main control valve section.
2. Stand the end main control valve section on end.
3. Install the proper o-rings and load sense shuttle on the inner face of the end main control valve section. Align the next valve section over the three tie rods and slide onto the end main control valve section.
4. Using the proper o-rings and load sense shuttle, repeat step three for the remaining valve sections and lastly the inlet end valve section.



5. Install the nuts on the tie rods (**6**) and torque to 25 Nm (18.5 lb-ft).

f. Main Control Valve Installation

1. Install the main control valve onto the frame, aligning the bolts with the holes in the end sections of the main control valve. Slide the main control valve into position, and tighten the bolts.
2. Prime the main control valve by filling the inlet openings with fresh, filtered hydraulic oil from a clean container, before attaching the hoses.
3. Use new oiled o-rings as required. Uncap and connect all hoses, clamps, etc. to the main control valve.
4. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.
5. Fill the hydraulic oil reservoir. Refer to Section 8.7.2, "Hydraulic Oil Reservoir Filling".
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the machine or operating any hydraulic functions.
8. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF.
9. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
10. Close and secure the engine cover.
11. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

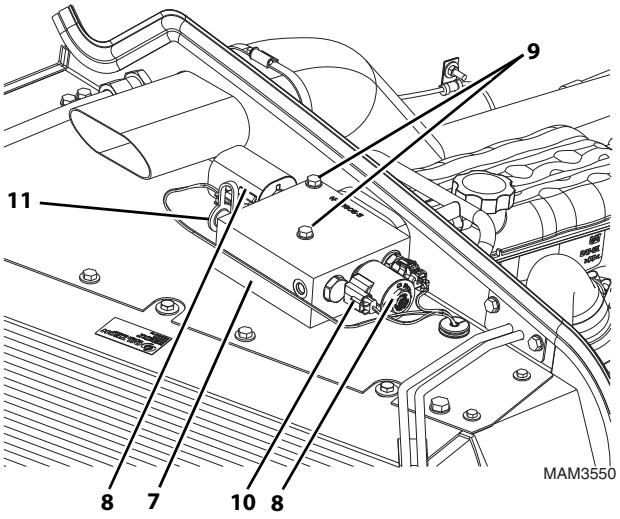
g. Main Control Valve Test

Conduct a pressure check of the hydraulic system in its entirety. Adjust pressure(s) as required. Refer to Section 8.5.1, "Hydraulic Pressures".

8.10.2 Reversing Fan Valve

a. Reversing Fan Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



5. Label and disconnect the electrical connectors (**8**) on each end of the reversing fan valve (**7**).
6. Thoroughly clean the reversing fan valve and surrounding area, including all hoses and fittings, before proceeding.
7. Place a suitable container to catch hydraulic fluid drainage beneath the reversing fan valve.
8. Label, disconnect and cap the four hydraulic hoses attached to the back and bottom of the reversing fan valve.
9. Loosen and remove the two mounting bolts, washers and nuts (**9**) from the reversing fan valve.

b. Reversing Fan Installation

1. Apply Loctite® 243™ to all mounting bolts.
2. Install the reversing fan valve (**7**) with the previously removed mounting bolts, washers and nuts (**9**). Torque as required.
3. Connect the previous labeled connectors (**8**) to the proper solenoids (**8**).
4. Connect the previous labeled four hydraulic hoses to the fittings on the side and bottom of the reversing fan valve.
5. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.
6. If required, fill the hydraulic oil reservoir. Refer to Section 8.7.2, "Hydraulic Oil Reservoir Filling".
7. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
8. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the machine or operating any hydraulic functions.
9. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF.
10. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
11. Close and secure the engine cover.
12. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

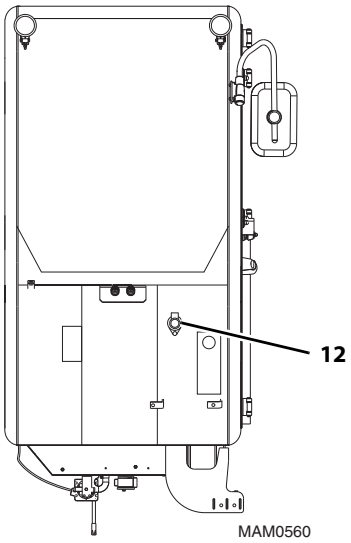
c. Reversing Fan Test

1. Disconnect solenoid connector HV747 (**10**).
2. Start the machine and warm the hydraulic system to operating temperature.
3. Shut off the machine and install a digital or a 34,5 bar (500 psi) gauge to test port (**11**) on the reversing fan manifold.
4. Start the machine, run the engine at idle and bottom the appropriate hydraulic function. Refer to Section 2.2.7, "Engine Fan Speed", for the correct pressure rating.

8.10.3 Service Brake Valve

a. Service Brake Valve Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the protective cover from the front of the cab.



6. Label, disconnect and cap all hoses attached to the service brake valve (**12**).
7. Remove the lower dash panel in the cab.
8. Disconnect the service brake pedal linkage from the valve rod.
9. Remove the two nuts securing the service brake valve to the cab.
10. Remove the valve through the front of the cab.

Note: *Do Not disassemble the service brake valve. The service brake valve is not serviceable and must be replaced in its entirety, if defective.*

b. Service Brake Valve Installation

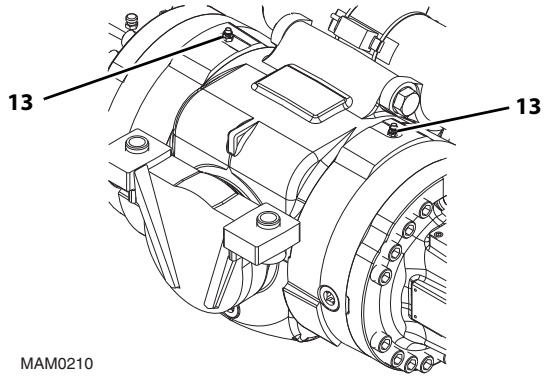
1. Install the service brake valve to its original orientation in the cab. Secure with the previously used hardware.
2. Install the service brake pedal linkage to the valve rod.
3. Uncap and connect the previously labeled hydraulic hoses to the service brake valve.

4. Check the routing of all hoses, and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.
5. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
6. Start the engine and run at approximately one-third to one-half throttle for about one minute, without moving the machine or operating any hydraulic functions.
7. Inspect the service brake valve and connections for leaks, and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF.
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
9. Install the lower dash panel in the cab.
10. Install the protective cover to the front of the cab.
11. Close and secure the engine cover.
12. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

8.10.4 Service Brake Bleeding

Carefully bleed the brake lines as soon as the brake valve is installed in the machine. Air in the system will not allow the brakes to apply properly. There are two brake bleeder locations on the front axle. Work with an assistant to perform this procedure.

1. Place transmission in (N) NEUTRAL, engage the park brake, and start the engine.

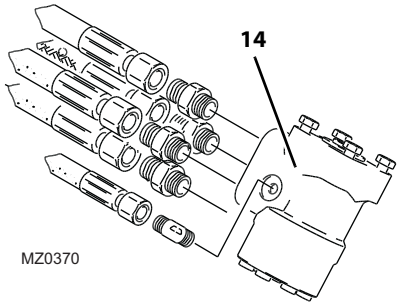


2. Remove the plastic cap from the left brake bleeder (**13**). Attach one end of a length of transparent tubing over the brake bleeder. Place the other end of this tubing in a suitable transparent container that is partially filled with hydraulic oil. The end of the tubing must be below the oil level in the container.
3. Do Not open the brake bleeder without holding the tubing firmly on the bleeder. There is pressure at the brakes. Carefully open the bleeder. Have the assistant depress the brake pedal. Close the brake bleeder when air bubbles no longer appear in the oil. Release the brake pedal. Remove the tubing from the brake bleeder.
4. Repeat steps 2 and 3 for the right brake bleeder.

8.10.5 Service Brake Test

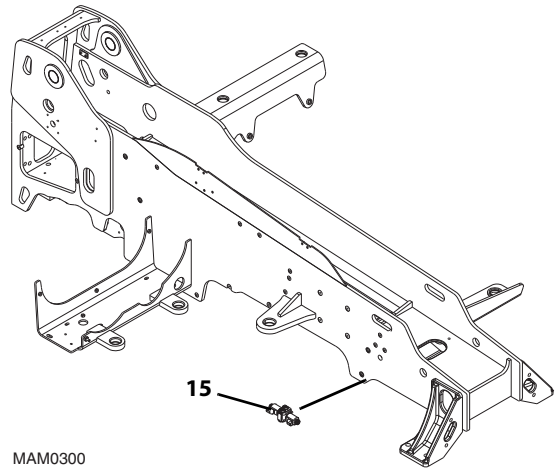
1. Install a digital or a 70 bar (1000 psi) gauge to the test port on the brake valve (behind the front cover of the cab).
2. Start the machine and apply pressure to the service brake pedal. A maximum pressure of 44 bar (638 psi) should be achieved.
3. If further testing is required, refer to Section 8.5.1, "Hydraulic Pressures".

8.10.6 Steering Orbital Valve



The steering orbital valve (**14**) is located at the base of the steering wheel shaft, concealed by the lower dash cover. The valve is not serviceable and must be replaced in its entirety if defective. For detailed information refer to Section 4.3.2, "Steering Column/Orbital Valve".

8.10.7 Steer Select Valve



TH406C FRAME SHOWN

The machine can be used in the front-wheel, four-wheel or crab steering mode. The steer select valve (**15**) controls the direction of hydraulic fluid flow to the steering cylinder mounted on each axle. The steer select valve is attached inside the frame near the front axle.

Verify the correct operation of the steer select valve solenoids before considering replacement of the valve. Refer to Section 9.8, "Electrical System Schematics". The housing of the steer select valve is not serviceable and must be replaced if defective.

a. Steer Select Manifold and Valve Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Label, disconnect and cap the hydraulic hoses and the electrical plugs connected to the steering select valve.
6. Remove the bolts holding the steer select valve to the mounting plate on the frame.
7. Remove the steer select valve from the machine. Wipe up any hydraulic fluid spillage in, on, near and around the machine.

b. Steer Select Manifold and Valve Disassembly, Cleaning, Inspection and Assembly

1. Place the steer select assembly on a suitable work surface.
2. Separate the steer select solenoids from the spool. Discard the o-rings.
3. Clean all components with a suitable cleaner before inspection.
4. Inspect the solenoid cartridges for proper operation. Check by shifting the spool to ensure that it is functioning properly. Check that the spring is intact. Inspect the cartridge interior for contamination.
5. Inspect internal passageways of the steer select valve for wear, damage, etc. If inner surfaces of the manifold Do Not display an ultra-smooth, polished finish, or components are damaged in any way, replace the manifold or appropriate part. Often, dirty hydraulic fluid causes failure of internal seals and damage to the polished surfaces within the secondary function manifold.

Note: *ALWAYS replace seals, o-rings, gaskets, etc., with new parts to help ensure proper sealing and operation. Lubricate seals and o-rings with clean hydraulic oil.*

6. Install the solenoids in the steer select housing.

c. Steer Select Valve and Manifold Installation

1. Install the steer select valve to the mounting plate under the left front side of the frame using the two bolts.
2. Connect all the hydraulic hoses, fittings, solenoid wire terminal leads, etc., to the steer select valve
3. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all hose clamps.
4. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Start the engine and run at approximately 1/3-1/2 throttle for about one minute without moving the machine or operating any hydraulic functions.
6. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF.

Note: *Check for leaks and repair as required before continuing. Add hydraulic fluid to the reservoir as needed.*

7. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
8. Close and secure the engine cover.

9. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

d. Steering Test

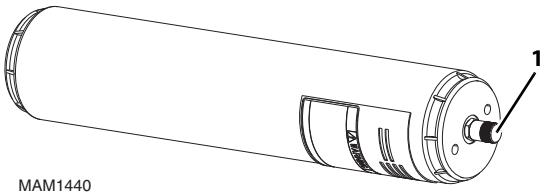
Refer to Section 8.5.1, "Hydraulic Pressures".

1. Conduct a pressure check of the steering hydraulic circuit.
2. Check each steering mode for proper function.

8.11 BOOM RIDE CONTROL (TH336C, TH337C, TH406C, TH407C - IF EQUIPPED)

8.11.1 General Accumulator Information

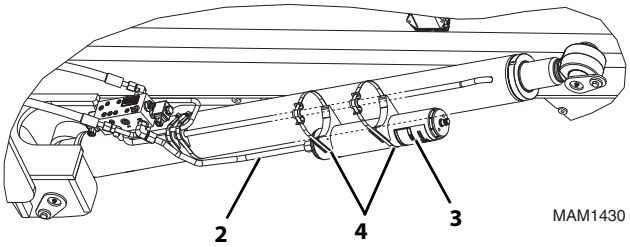
The accumulator is a 275 bar (3988 psi) piston type accumulator.
The pneumatic accumulator is operated by compressed gas. Gas and hydraulic oil occupy the same container. When oil pressure rises, incoming oil compresses the gas. When oil pressure drops, the gas expands, forcing the oil out into the lift side of the lift/lower cylinder.
The gas is separated from the oil by a piston. This prevents the mixing of gas and oil and keeps gas out of the hydraulic system.



The accumulator must be "pre-charged" with gas before use in the hydraulic system. This is done by filling the gas chamber with dry nitrogen to a pressure of 35 bar (507 psi). The schrader valve is located under the protective cap (**1**) at the top of the accumulator. The schrader valve is used for pre-charging and testing the accumulator.

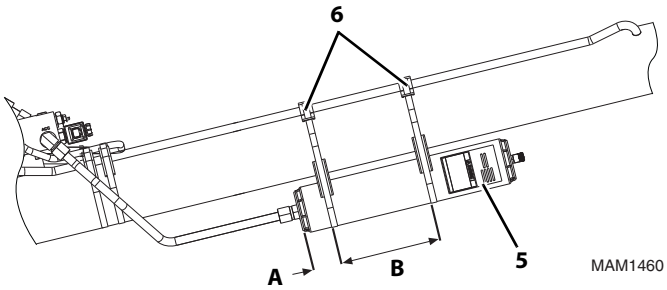
a. Accumulator Removal

1. Remove any attachment from the machine. Park the machine on a firm level surface and fully retract the boom. Raise the boom to allow sufficient work space around the lift/lower cylinder to allow the accumulator to be removed. Support the boom. Place transmission in (N) NEUTRAL, engage the park brake, shut the engine OFF and chock wheels.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



5. Disconnect and cap or plug the hydraulic tube (**2**) at the accumulator (**3**).
6. Remove the two straps (**4**) securing the accumulator to the lift/lower cylinder.
7. Remove the accumulator.
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.

b. Accumulator Installation



1. Secure the accumulator (**5**) to the lift/lower cylinder with the two straps (**6**) to the proper dimensions:
   A. 57,0 ± 10 mm (2.25 ± 0.375 in)
   B. 200,0 ± 10 mm (7.875 ± 0.375 in)
2. Uncap and connect the hydraulic tube to the accumulator.
3. Remove the boom support.
4. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.
7. Refer to Section 8.11.3, "Pre-Charging Accumulator", for Accumulator pre-charging instructions.

8.11.2 Accumulators

This section covers the charging of the accumulator system.

The accumulator is located and mounted under the lift/lower cylinder. The internal parts of the accumulator are not serviceable. If the internal piston is leaking, or the seals on the top or bottom cap are leaking, the accumulator requires replacement.

The accumulator pre-charge pressure will vary depending on the ambient temperature that the accumulator was pre-charged at and the actual operating temperature of the accumulator.

8.11.3 Pre-Charging Accumulator

Note: *Replacement accumulators are not pre-charged when shipped.*

WARNING

NEVER fill an accumulator with oxygen! An explosion could result if oil and oxygen are mixed under pressure. Only fill accumulator with dry nitrogen.

Pre-charged the accumulator with nitrogen gas only. Nitrogen gas is free of water vapor and oxygen which makes it harmless to internal parts and will not react if mixed with oil under pressure.

NOTICE

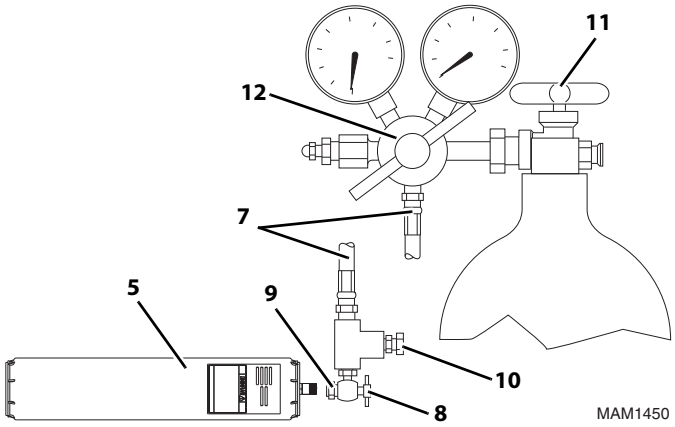
Never fill an accumulator with air. Air contains moisture which can cause corrosion. This corrosion may damage seals and ruin the accumulator.

Never charge an accumulator to a pressure more than specified. The proper pressure for the accumulator is 35 bar (507 psi).

Note: *Make sure the nitrogen bottle, as well as the charging and gauge assembly used is compatible with the schrader valve assembly on the accumulator. The nitrogen bottle and all components must be rated for a pressure at least as high as the nitrogen source. It is strongly recommended that the nitrogen bottle has a high pressure regulator.*

You will require an accumulator fill kit to properly charge the accumulators. Refer to the parts manual or contact the local Caterpillar dealer.

Use the following steps to properly pre-charge each accumulator:

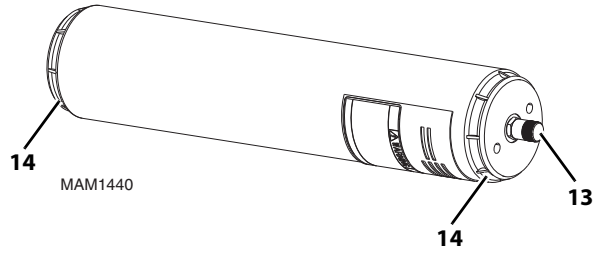


1. Thoroughly clean the top of each accumulator (**5**).
2. Make sure the nitrogen supply is shut off.
3. Attach the accumulator fill kit (**7**) to the nitrogen bottle.
4. Remove the protective cap from the gas valve on the accumulator.
5. Back the "T" handle (**8**) on the accumulator fill kit all the way out (counter-clockwise). Attach the schrader adaptor (**9**) to the gas valve on the accumulator. Tighten securely.
6. Turn the gas valve/bleed valve (**10**) on the accumulator fill kit all the way in.
7. Turn the "T" handle (**8**) all the way in to open the valve core on the accumulator.
8. Open the valve (**11**) on the nitrogen bottle.
9. Slowly adjust the regulator (**12**) on the nitrogen bottle to read 35 bar (507 psi).
10. Close the main valve (**11**) on the nitrogen bottle.
11. Back the "T" handle (**8**) on the accumulator fill kit all the way out (counter-clockwise).
12. Let the pre-charge on the accumulator set for 10-15 minutes. This will allow the gas temperature to stabilize. If the desired pre-charged range is exceeded, turn the "T" handle (**8**) all the way in. With the main valve (**11**) closed on the nitrogen bottle, turn the gas valve/ bleeder valve (**10**) out to bleed pressure off the accumulator. Turn the valve all the way in and check the pressure reading on the regulator gauge.
13. When the correct pressure is reached, back the "T" handle (**8**) on the accumulator fill kit all the way out (counter-clockwise). Bleed the pressure from the hose by turning the gas valve/bleed valve out to relieve the pressure.

14. Turn the gas valve/bleed valve (**10**) all the way in and remove the schrader adapter (**9**) from the valve on the accumulator.
15. Reassemble the protective cap onto the gas valve on the accumulator.

8.11.4 Checking Pre-Charge

a. Gas Leaks

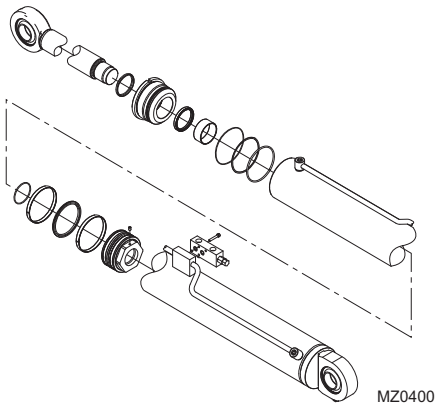


1. If an external leak is suspected, apply soapy water to the gas valve (**13**) and the seams of the gas bottle (**14**). If bubbles form, the accumulator has to be replaced.
2. If an internal leak is suspected, check for foaming oil in the hydraulic reservoir and/or no accumulator action. If any of these signs are evident, the accumulator has to be replaced.

8.12 HYDRAULIC CYLINDERS

8.12.1 General Cylinder Removal Instructions

1. Remove any attachment from the machine. Park the machine on a firm level surface and fully retract the boom. Allow sufficient work space around the hydraulic cylinder being removed. Support the boom if the lift/lower cylinder is being removed. Place transmission in (N) NEUTRAL, engage the park brake, shut the engine OFF and chock wheels.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open the engine cover. Allow the system fluids to cool.
4. Label, disconnect and cap or plug hydraulic hoses in relation to the cylinder.
5. Attach a suitable sling to an appropriate lifting device and to the cylinder. Make sure the device used can actually support the cylinder.
6. Remove the lock bolt and/or any retaining clips securing the cylinder pins. Remove the cylinder pins.
7. Remove the cylinder.
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.



a. General Cylinder Disassembly

1. Clean the cylinder with a suitable cleaner before disassembly. Remove all dirt, debris and grease from the cylinder.
2. Clamp the barrel end of the cylinder in a soft-jawed vise or other acceptable holding equipment if possible.

⚠ WARNING

Significant pressure may be trapped inside the cylinder. Exercise caution when removing a counterbalance valve or a pilot-operated check valve from a cylinder.

Note: *Avoid using excessive force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube.*

3. If applicable, remove the counterbalance valve from the side of the cylinder barrel.

Note: *Do Not tamper with or attempt to adjust the counterbalance valve cartridge. If adjustment or replacement is necessary, replace the counterbalance valve with a new part.*

4. Extend the rod as required to allow access to the base of the cylinder.

Note: *Protect the finish of the rod at all times. Damage to the surface of the rod can cause seal failure.*

5. Using a pin spanner wrench, unscrew the head gland from the tube. A considerable amount of force will be needed to remove the head gland. Carefully slide the head gland down along the rod toward the rod eye, away from the cylinder barrel.

Note: *When sliding the rod and piston assembly out of the barrel, prevent the threaded end of the barrel from damaging the piston. Keep the rod centered within the barrel to help prevent binding.*

6. Carefully pull the rod assembly along with the head gland out of the cylinder barrel.
7. Fasten the rod eye in a soft-jawed vise, and place a padded support under and near the threaded end of the rod to prevent any damage to the rod.
8. Remove the set screw from the piston head.

Note: *It may be necessary to apply heat to break the bond of the sealant between the piston and the rod before the piston can be removed.*

Some cylinder parts are sealed with a special organic sealant and locking compound. Before attempting to disassemble these parts, remove any accessible seals from the area of the bonded parts. Wipe off any hydraulic oil, then heat the part(s) uniformly to break the bond. A temperature of 149 - 204° C (300 - 400° F) will destroy the bond. Avoid overheating, or the parts may become distorted or damaged. Apply sufficient torque for removal while the parts are still hot. The sealant often leaves a white, powdery residue on threads and other parts, which must be removed by brushing with a soft brass wire brush prior to reassembly.

9. Remove the piston head from the rod and carefully slide the head gland off the end of the rod.
10. Remove all seals, back-up rings and o-rings from the piston head and all seals, back-up rings and o-rings from the head gland.

Note: *The head gland bearing will need to be inspected to determine if replacement is necessary.*

Do Not attempt to salvage cylinder seals, sealing rings or o-rings. ALWAYS use a new, complete seal kit when rebuilding hydraulic components. Consult the parts catalog for ordering information.

b. Cylinder Cleaning Instructions

1. Discard all seals, back-up rings and o-rings. Replace with new items from seal kit to ensure proper cylinder function.
2. Clean all metal parts with an approved cleaning solvent such as trichlorethylene. Carefully clean cavities, grooves, threads, etc.

Note: *If a white powdery residue is present on threads or parts, it can be removed by using a soft brass wire brush. Wipe clean with Loctite® Cleaner prior to reassembly.*

c. Cylinder Inspection

1. Inspect internal surfaces and all parts for wear, damage, etc. If the inner surface of the cylinder barrel does not display a smooth finish, or is scored or damaged in any way, replace the barrel.
2. Remove light scratches on the piston, head gland, rod or inner surface of the cylinder barrel with a 400-600 grit emery cloth. Use the emery cloth in a rotary motion to polish out and blend the scratch(es) into the surrounding surface.
3. Check the piston rod assembly for run-out. If the rod is bent, it must be replaced.

d. General Cylinder Assembly Instructions

1. Use the proper tools for specific installation tasks. Clean tools are required for installation.
2. Install new seals, back-up rings and o-rings on the piston and new seals, back-up rings, o-rings and bearing on the head gland.

Note: *The extend/retract cylinder has a spacer that MUST be installed over the rod AFTER the head gland and BEFORE the piston head.*

3. Fasten the rod eye in a soft-jawed vise, and place a padded support under and near the threaded end of the rod to prevent any damage to the rod.

Note: *Protect the finish on the cylinder rod at all times. Damage to the surface of the rod can cause seal failure.*

4. Lubricate and slide the head gland over the cylinder rod. Install the piston head on to the end of the cylinder rod. Apply Loctite® 243™ and install the set screw in the piston head. Refer to Section 8.12.4, "Cylinder Torque Specifications", for torque specifications for the piston head and the set screw.

Note: *Avoid using excess force when clamping the cylinder barrel in a vise. Apply only enough force to hold the cylinder barrel securely. Excessive force can damage the cylinder barrel.*

5. Place the cylinder barrel in a soft-jawed vise or other acceptable holding devise.

Note: *When sliding the rod and piston assembly into the cylinder barrel, prevent the threaded end of the cylinder barrel from damaging the piston head. Keep the cylinder rod centered within the barrel to prevent binding.*

6. Carefully insert the cylinder rod assembly into the cylinder barrel.
7. Screw the head gland into the cylinder barrel and tighten with a spanner wrench. Refer to Section 8.12.4, "Cylinder Torque Specifications" for torque specifications for the head gland.
8. If applicable, install new counter balance valve into block on the cylinder barrel.

e. General Cylinder Installation

1. Grease the bushings at the ends of the hydraulic cylinder. Using an appropriate sling, lift the cylinder into it's mounting position.
2. Align cylinder bushing and install pin, lock bolt or retaining clip.
3. Connect the hydraulic hoses in relation to the labels or markings made during removal.
4. Before starting the machine, check fluid level of the hydraulic fluid reservoir and if necessary fill to full mark with oil.
5. Start the machine and run at low idle for about one minute. Slowly activate hydraulic cylinder function in both directions allowing cylinder to fill with hydraulic oil.
6. Inspect for leaks and check level of hydraulic fluid in reservoir. Add hydraulic fluid if needed. Shut the engine OFF.
7. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
8. Close and secure the engine cover.

8.12.2 Cylinder Pressure Checking

Attach a 345 bar (5000 psi) gauge to the test port on the P1 port on the hydraulic manifold to check the system pressure. For more information, refer to Section 8.4.1, "Pressure Checks and Adjustments".

Note: *If a hydraulic cylinder pressure is greater than the main control valve pressure, increase the main control valve pressure by adjusting the main relief. Generally, one half turn clockwise will be adequate to check an individual circuit. Activate the circuit and if pressure is obtained turn the main relief counter clockwise one half turn. Re-check the main relief setting and adjust if necessary.*

8.12.3 Steering Cylinders

Refer to Section 5.3, "Axle Specifications and Maintenance Information", for detailed service information.

8.12.4 Cylinder Torque Specifications

a. Lift/Lower Cylinder

Model	Head	Piston	Set Screw
TH336C, TH337C, TH406C, TH407C	400 Nm (295 lb-ft)	1540 Nm (1136 lb-ft)	10 Nm (7 lb-ft)
TH414C	400 Nm (295 lb-ft)	2460 Nm (1814 lb-ft)	10 Nm (7 lb-ft)
TH514C, TH417C	400 Nm (295 lb-ft)	3420 Nm (2522 lb-ft)	10 Nm (7 lb-ft)

b. Extend/Retract Cylinder

Model	Head	Piston	Set Screw
TH336C, TH337C, TH406C, TH407C	300 - 350 Nm (221 - 258 lb-ft)	540 - 590 Nm (398 - 435 lb-ft)	20 - 25 Nm (15 - 18 lb-ft)
TH414C	320 - 370 Nm (236 - 273 lb-ft)	815 - 865 Nm (601 - 638 lb-ft)	20 - 25 Nm (15 - 18 lb-ft)
TH514C	Top: 380 - 430 Nm (280 - 317 lb-ft) Bottom: 480 - 530 Nm (354 - 391 lb-ft)	1070 - 1120 Nm (789 - 826 lb-ft)	20 - 25 Nm (15 - 18 lb-ft)
TH417C	320 - 370 Nm (236 - 273 lb-ft)	815 - 865 Nm (601 - 638 lb-ft)	20 - 25 Nm (15 - 18 lb-ft)

c. Tilt Cylinder

Model	Head	Piston
All machines	1500 Nm (1106 lb-ft)	3000 Nm (2212 lb-ft)

d. Compensation Cylinder

Model	Head	Piston
TH336C, TH337C, TH406C, TH407C	800 Nm (590 lb-ft)	1100 Nm (811 lb-ft)
TH414C, TH417C	1000 Nm (737 lb-ft)	1100 Nm (811 lb-ft)
TH514C	1200 Nm (885 lb-ft)	1000 Nm (737 lb-ft)

e. Frame Level Cylinder

Model	Head	Piston	Set Screw
TH414C	400 Nm (295 lb-ft)	740 Nm (545 lb-ft)	10 Nm (7 lb-ft)
TH514C, TH417C	400 Nm (295 lb-ft)	855 Nm (630 lb-ft)	10 Nm (7 lb-ft)

f. Outrigger Cylinder

Model	Head	Piston	Set Screw
TH414C	400 Nm (295 lb-ft)	1330 Nm (981 lb-ft)	10 Nm (7 lb-ft)
TH514C, TH417C	400 Nm (295 lb-ft)	2160 Nm (1593 lb-ft)	10 Nm (7 lb-ft)

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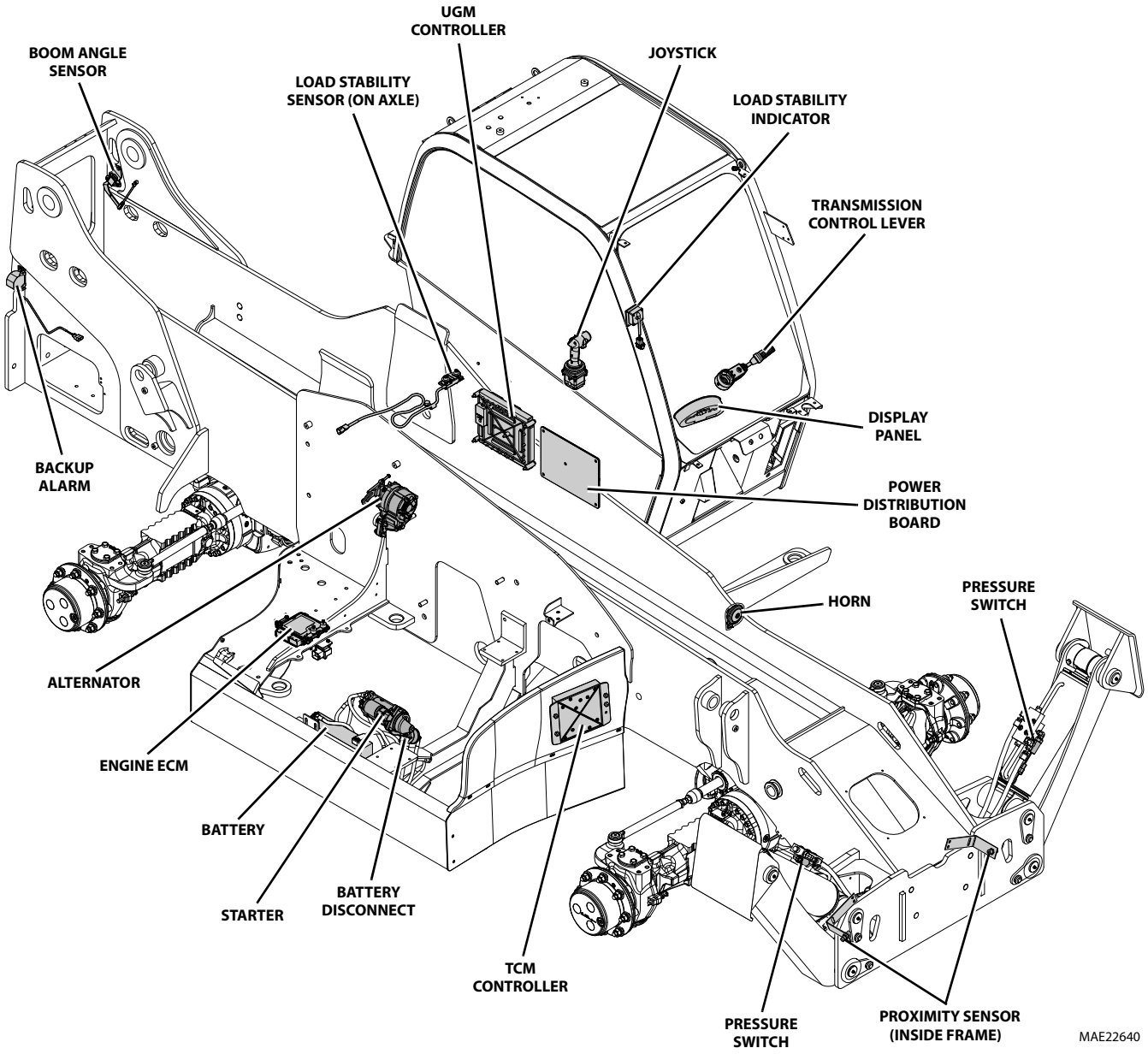
Section 9
Electrical System

Contents

9.1 ELECTRICAL COMPONENT TERMINOLOGY

To understand the safety, operation, and service information presented in this section, it is necessary that the operator/ mechanic be familiar with the name and location of the electrical components of the machine. The following illustration identifies the components that are referred to throughout this section.

9.1.1 General Overview



9.2 SPECIFICATIONS

Electrical system specifications are listed in Section 2, “General Information and Specifications”.

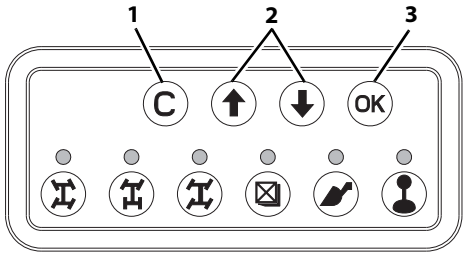
9.3 SAFETY INFORMATION

WARNING

Do Not service the machine without following all safety precautions as outlined in Section 1, “Safety Practices”, of this manual.

9.4 KEYPAD AND DISPLAY SCREEN

9.4.1 Keypad



OAM2600

Depress the C and OK buttons on the keypad to access the menu.

1. C (Clear or Escape): Use in conjunction with display screen. Returns user interface one level during navigation. If at top of the menu, depress and hold for one second to exit.
2. Up/Down Arrows: Use in conjunction with display screen. Navigate menu selections and change adjustable values.
3. OK (Enter): Use in conjunction with display screen. Confirms user interface inputs.

9.4.2 Display Screen

The display screen is located in the center of the instrument panel and can display the following information with activation of the menu screen.

OAM2610

a. Help - Displays active fault code. Depress OK button again and use keypad arrows to cycle through the last 25 fault codes. Active fault codes are denoted with an asterisk. Refer to Section 9.23, “Machine Fault Codes”, for the complete list of codes.

b. Operator Tools - Speed, Temperature and Oil Pressure units and Steer Mode can be modified by the operator. Customer Service level access code is required to view other items.

c. Personalities - Customer or Service level access code required.

d. Access Level - Code entry determines access level.
   - Operator (Level 3) - No code required.
   - Customer (Level 2) - Refer to Section 9.5, “Software Level 2 Accessibility”.
   - Service (Level 1) - Manufacturer service representative only.

e. Diagnostics - View diagnostic information.

f. System Test - Performs test of all system inputs and outputs.

g. Machine Setup - Service level access code required.

h. Calibrations - Customer or Service level access code required.

9.5 SOFTWARE LEVEL 2 ACCESSIBILITY

The following parameters can be altered in the 2nd level of access to the machine's software.

Refer to Section 9.21.2, "Analyzer Software Version PX.XX", for detailed software information.

9.5.1 Operator Tools

Menu	Setting/Submenu	Visible	Comment
Change Anti-theft Code?	Enter Current Code: 0000 Enter New Code: 0000	Access Levels 1, 2	Requires the existing code to be entered before a new one
Perform Hardware Exchange?	Transfer From Display->UGM Transfer From UGM->display Transfer Status: In Progress… Transfer Status: Cycle Power Now Transfer Failed: Cycle Power Now	Access Levels 1, 2	Initiates Transfer Of Non-volatile Memory Settings Between The Cabin Display And UGM; Displays Progress And Final Status For The Technician
Confirm Machine Service?	Service Complete? Yes: Enter, No: ESC	Access Levels 1, 2	Records that preventive maintenance has been performed
Review Service History?	Service History 1:0h 0m	Access Levels 1, 2	Displays the engine operating hours for the past fifteen service confirmations
Set Service Interval:500h	N/A	Access Levels 1, 2	Increment/decrement the engine operating hours before the next service interval
Review LMI Shutoff History	LMI History 1:0H 0M	Access Level 1; Machine Setup's MARKET is CE or AUSTRALIA	Displays the engine operating hours for the past fifteen LMI shutoff (cancel) incidents
Vehicle Speed Units: Kph	KPH MPH	Access Levels 1, 2, 3	Selects units for vehicle speed display; default to KPH when Machine Setup's MARKET is CE or AUSTRALIA; default to MPH when MARKET is ANSI
Temperature: Celsius	Celsius Fahrenheit	Access Levels 1, 2, 3	Selects units for temperature display; default to CELSIUS when Machine Setup's MARKET is CE or AUSTRALIA; default to FAHRENHEIT when MARKET is ANSI
Oil Pressure: Bar	BAR PSI	Access Levels 1, 2, 3	Select units for oil pressure display; default to BAR when Machine Setup's MARKET is CE or AUSTRALIA; default to PSI when MARKET is ANSI

Menu	Setting/Submenu	Visible	Comment
Cabin Joystick: Telescope: X-AXIS	X-AXIS ROLLER	Access Levels 1, 2, 3	Selects the cabin joystick resource that will be used to control telescope; fork tilt is controlled by the opposite
Steer Mode: Automatic	Automatic Manual	Access Levels 1, 2, 3	Selects steering mode preference
Revise Engine Hours?	Set Engine On Hours: 0H	Access Level 1; Mechanical Engine	Used to update engine on data log for service (rebuild or replacement); mechanical engine only
LSI-CAN SYSTEM CHECK:	Perform LSI-CAN System Check? No	Access Levels 1,2; Machine Setup's LOAD MONITORING is LSI-CAN or LSI-CAN + LMI; CALIBRATION LSI-CAN SYSTEM CHECK completed	The technician will press the UP / DOWN arrow keys to select YES. When set to YES and ENTER button is pressed, the control system will provide the following directions
	Remove Weights And Attachments.		The following directions will be displayed and when the operator presses the ENTER button, the control system will advance to the next menu screen
	Fully Deploy Stabilizers		Display when Machine Setup's MODEL is TH414C, TH417C, or TH514C; the following directions will be displayed and when the operator presses the ENTER button, the control system will advance to the next menu screen
	Telescope In And Fully Lift Up.		The following directions will be displayed and when the operator presses the ENTER button, the control system will advance to the next menu screen
	**** Stop **** Wait 1 Minute		The following directions will be displayed and when the operator presses the ENTER button, the control system will advance to the next menu screen
	Press Enter To Start Test: Pass		The technician will press the ENTER button to start the control system comparative check of the LSI System load sensor raw counts; PASS (within +/- 20 counts) or FAIL will be indicated; the ESC button will used to exit
Review LSI Suspended Log?	LSI Suspend Log NN: XXH YYM - On	Access Level 1	Displays UGM operating hours and minutes when the LSI-CAN suspended vehicle operation; ON during passive mode and OFF otherwise (last ten events)
Fan Reverse Timer: 2sec	2sec To 10sec	Access Level 1, 2, or 3; Hydraulic Variable Speed Fan or Reversing Fan configured	Sets the length of time that the fan will be reversed (cycling or demand)
Fan Reverse Interval: 20min	5min To 60min		Sets the interval between cycling fan reversals
Tyre Selection:		Access Level 1, 2, or 3	Selects the tyre fitted for proper vehicle speed calibration (refer to Vehicle Speed Calculation)
Default Gear Selection: 2	1, 2, 3, 4	Access Levels 1, 2, 3	Sets the default transmission gear at power-up

Menu	Setting/Submenu	Visible	Comment
ECM Service Tool Access?	ECM Tool Access? Yes: Enter, No: ESC	Access Level 1	When YES, the UGM shall not transmit CANbus messages. This will allow maximum bandwidth for Caterpillar and Deutz service tools during re-programming. Power cycle is required to resume normal operation.

9.5.2 Personalities

Function	Description	Default Value
Main Lift	Allows the owner to adjust the Max Lift Up and Max Lift Down function speeds	1400 mA (up) 1600 mA (down)
Soft Lift	Allows the owner to adjust the derate value when the boom enters the soft lift zone	40% (TH336C & TH406C) 45% (TH337C & TH407C) 35% (TH414C)
Telescope	Allows the owner to adjust the Max Retract and Max Extend function speeds	1300 mA
Fork Tilt	Allows the owner to adjust the Max Fork Tilt Up and Max Fork Tilt Down function speeds	1150 mA
Platform Level	Allows the owner to adjust the Max Platform Level Up and Max Platform Level Down function speeds	800 mA
Platform Rotate	Allows the owner to adjust the Max Platform Left and Max Platform Right function speeds	1000 mA
Platform Lift	Allows the owner to adjust the Max Platform Lift Up and Max Platform Lift Down function speeds	1020 mA (up) 960 mA (down)
Platform Telescope	Allows the owner to adjust the Max Platform Retract and Max Platform Extend function speeds	1000 mA (in) 1080 mA (out)
Outriggers	Allows the owner to adjust the Max Outrigger Up and Max Outrigger Down function speeds	1000 mA
Frame Level	Allows the owner to adjust the Max Frame Level Left and Max Frame Level Right function speeds	1000 mA
Bucket Lift	Allows the owner to adjust the Max Bucket Up and Max Bucket Down function speeds	1400 mA (up) 1600 mA (down)
Bucket Telescope	Allows the owner to adjust the Max Bucket Retract and Max Bucket Extend function speeds	1300 mA
Bucket Tilt	Allows the owner to adjust the Max Bucket Tilt Up and Max Bucket Tilt Down function speeds	1400 mA (up) 1600 mA (down)
Auxiliary Function	Allows the owner to adjust the Accel, Decel, and Max Function Coil A and Max Function Coil B function speeds	1500 mA

9.5.3 Calibration

Menu	SubMenu	Visible	Comment
Calibrations: Tilt Sensor	Calibrate Tilt Sensor?	Access Levels 1, 2; Machine Setup's PLATFORM OPTION is ENABLED	Used by technicians to calibrate the tilt sensor (integral to UGM); press ENTER to confirm; ESC to exit
	Tilt Calibration Set Stabilizers		Displayed when Machine Setup's STABILIZERS is EQUIPPED and at least one stabilizer is not deployed; press ENTER or ESC to exit
	Tilt Sensor Calibrating...		Displayed while control system averages readings
	Calibration Complete		Calibration offset was within +/- 8.0 degrees; press ENTER or ESC to exit
	Calibration Failed		Calibration offset was outside +/- 8.0 degrees; press ENTER or ESC to exit
Calibrations: Boom Angle	Calibrate Boom Angle Sensor?	Access Levels 1, 2; Platform Not Attached	Used by technicians to calibrate the boom angle sensor; press ENTER to confirm; ESC to exit
	Press Enter At Lowest Position.		Technician must lower boom to mechanical stop, press ENTER to confirm
	Boom Angle: Calibrating...		Displayed while control system averages readings
	Lift Up. Press Enter At Top.		Technician must raise boom to mechanical stop, press ENTER to confirm.
	Boom Angle: Calibrating...		Displayed while control system averages readings
	Calibration: Complete		Calibration was successful; press ESC key to exit
	Calibration: Remove Platform		The platform was attached when the calibration was initiated; press ESC key to exit
	Calibration: Failed		The minimum or maximum boom angle sensor counts were improper for this vehicle; press ESC key to exit; press LEFT or RIGHT for the BOOM ANGLE RAW COUNTS display
	Calibration: Sensor Fault		DTC 2344, 2345, 2346, 2353, or 6621 was active and calibration could not succeed; press ESC key to exit; press LEFT or RIGHT for the BOOM ANGLE RAW COUNTS display
	Boom Angle Raw: Counts: xxxx	Access Levels 1, 2; Machine Setup's MODEL is TH414C, TH417C, or TH514C; platform is not attached	Displays the raw ADC counts for the CANbus boom angle sensor after a SENSOR FAULT or FAILED event
	Boom Angle Raw: Counts: xxxx	Access Levels 1, 2; Machine Setup's MODEL is TH406C or TH407C	Displays the raw ADC counts for the boom angle sensor from UGM J7-4 after a SENSOR FAULT or FAILED event

Menu	SubMenu	Visible	Comment
Calibrations: LSS	Platform Type: 350-extendable	Access Levels 1, 2; Machine Setup's LOAD SENSING is WARN ONLY or PLATFORM CUTOUT	Used by technicians to calibrate the platform load sensing system; use LEFT, RIGHT, UP, DOWN to select 350-EXTENDABLE or 450-FIXED; press ENTER to continue or ESC to exit
	Stabilizers Not Deployed		Displayed when Machine Setup's STABILIZERS is EQUIPPED and at least one stabilizer is not deployed; press ENTER or ESC to exit
	Confirm Platform Is Empty: No		Use LEFT, RIGHT, UP, DOWN to select YES; press ENTER to continue or ESC to exit
	Calibration In Progress		Displayed while control system averages readings
	Calibration Complete		The 350-EXTENDABLE was 850-1300LBS empty; the 450-FIXED was 176-375LBS empty; calibration was successful; press ESC to exit
	Calibration Failed		The platform was outside weight limits or the reading could not be recorded in the LSS Module
Calibrations: Stabilizers	Press Enter To Use Stabilizers	Access Level 1; Machine Setup's MODEL is TH414C, TH417C, or TH514C	Used by technicians during the manufacturing process to move the stabilizers before the boom is fitted and the boom angle sensor is calibrated; interlocks that prevent stabilizer movement while the boom is elevated are ignored; press ENTER to continue or ESC to exit
	Warning Safeties Offline		
	Press ESC Button When Test Done		
Calibrations: Boom Ride Test	Confirm Boom Ride Test: No	Access Level 1; Machine Setup's BOOM RIDE is YES	UP and DOWN select NO or YES; press ENTER while YES to energize boom ride valves with the vehicle stationary; interlocks that prevent boom ride while stationary are ignored
	Press Enter When Test Done		Press ENTER to complete test

Menu	SubMenu	Visible	Comment
Calibrations: Park Brake Test	Perform Park Brake Test?	Access Levels 1, 2, 3	Used by customers (mining) as part of a daily safety verification that the vehicle cannot drive through the parking brake in second gear; interlocks that prevent gear engagement while the parking brake is set are ignored; press ENTER to continue or ESC to exit
	Set Park Brake		Prompt user to apply the park brake; brake must remain applied during test unless shifter returns to neutral
	Shift To Second Gear		Prompt user to select second gear
	Warning: Drive Will Be Engaged		Prompt user that the vehicle will engage the transmission (attempt to drive through park brake) during the next step
	Forward To Start Neutral To Pause		Prompt user to select forward direction for evaluation
	Park Brake Test Complete		The evaluation was successful; press ESC to exit
	Park Brake Test Failed		The CABIN JOYSTICK – FNR SWITCH FAULT (23115) fault was active and the test could not proceed; press ESC to exit
Calibrations: Trans Service	Confirm Trans Service: No	Access Levels 1, 2	UP and DOWN select NO or YES; default to NO at power-up
	Confirm Trans Service: Yes		When YES, allow Direction Selection despite faults detected so a technician can diagnose or transport a vehicle
Calibrations: Fan Speed Test	Perform Fan Speed Test?	Access Levels 1,2; Hydraulic Variable Speed Fan Configured	Used by technicians at the factory for noise testing; press ENTER to begin or ESC to exit
	Fan Speed Valve 0 Ma		UP and DOWN keys directly adjust fan speed valve current with 50mA increments (3000mA maximum); default is 0mA (highest fan speed) to start test; fan reversing is prevented once test begins; selected fan speed valve current is retained until power is cycled

9.6 OPERATOR TOOLS

9.6.1 Resetting the Anti theft Code

To reset the anti theft code:

1. Turn the engine to the ON position.
2. Press the “C” and “OK” buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to “Access Level Code”. Enter the code “33271” to go into access level 2.
4. Scroll to and select the “Operator Tools” screen.
5. Scroll to and select the “Change Anti Theft Code” screen.
6. Enter the current anti theft code.

Note: *If a machine does not have an anti theft code set, the default code is “00000”.*

7. Enter the new code.

9.6.2 Hardware Exchange

After the replacement of either the display or UGM (Controller) the machine software will indicate a Hardware Exchange fault. To correct this fault:

1. Turn the engine to the ON position.
2. Press the “C” and “OK” buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to “Access Level Code”. Enter the code “33271” to go into access level 2.
4. Scroll to and select the “Operator Tools” screen.
5. Scroll to and select the “Perform Hardware Exchange” screen.
6. Scroll to and select the proper screen for hardware exchange. The screen will show either “DISPLAY -> UGM” or “UGM -> DISPLAY”. The new component should be listed second.

9.6.3 Confirm Machine Service

To log the machine service into the software:

1. Turn the engine to the ON position.
2. Press the “C” and “OK” buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to “Access Level Code”. Enter the code “33271” to go into access level 2.
4. Scroll to and select the “Operator Tools” screen.
5. Scroll to and select the “Confirm Machine Service” screen.
6. If service is complete, press ENTER for YES. Otherwise, press ESC for NO.

9.6.4 Review Service History

To view the last 15 machine service instances:

1. Turn the engine to the ON position.
2. Press the “C” and “OK” buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to “Access Level Code”. Enter the code “33271” to go into access level 2.
4. Scroll to and select the “Operator Tools” screen.
5. Scroll to and select the “Review Service History” screen.
6. Scroll through the screens to view the last 15 times the machine was serviced.

9.6.5 Set Service Interval

To set the machine recommended service interval:

1. Turn the engine to the ON position.
2. Press the “C” and “OK” buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to “Access Level Code”. Enter the code “33271” to go into access level 2.
4. Scroll to and select the “Operator Tools” screen.
5. Scroll to and select the “Set Service Interval” screen.
6. Enter a new service interval.

9.6.6 Cabin Joystick Telescope: X-Axis/Roller

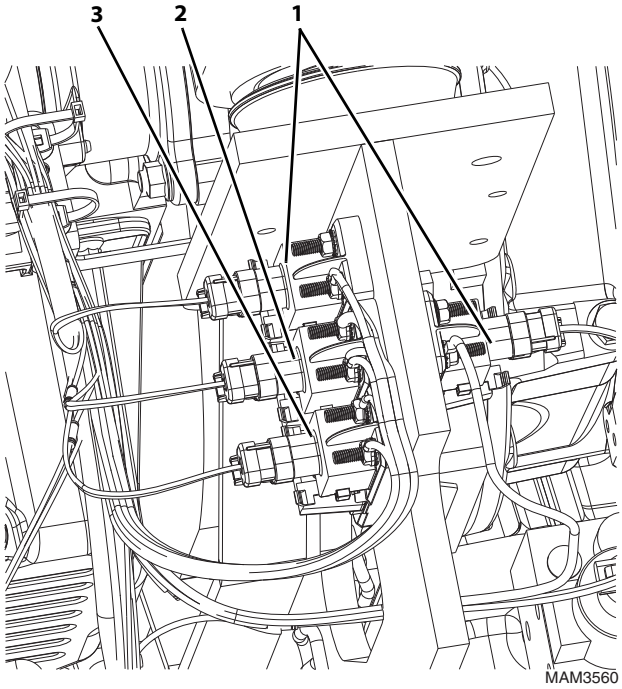
To change the joystick telescope function on the joystick:

1. Turn the engine to the ON position.
2. Press the “C” and “OK” buttons on the dash simultaneously to enter the analyzer mode.
3. Scroll to “Access Level Code”. Enter the code “33271” to go into access level 2.
4. Scroll to and select the “Operator Tools” screen.
5. Scroll to and select the “Cabin Joystick Telescope” screen.
6. Select either X-AXIS or ROLLER.

When changing the joystick function, ensure the correct joystick operation decal is installed. Contact the local Caterpillar dealer.

9.7 FUSES AND RELAYS

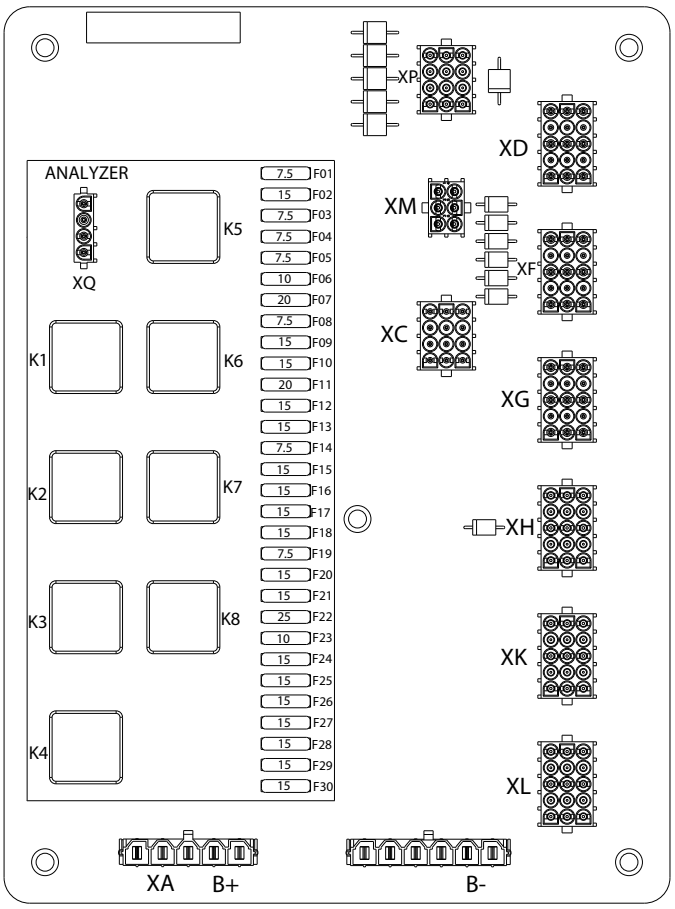
9.7.1 Engine Compartment



The starter relay (**1**), glow plug relay (**2**),fuel shutoff relay (**3**) are located beside the battery mounted on the frame in the engine compartment.

9.7.2 Power Distribution Board

The power distribution board is located in the cab. For access, remove the screws securing the small side panel to the cab.



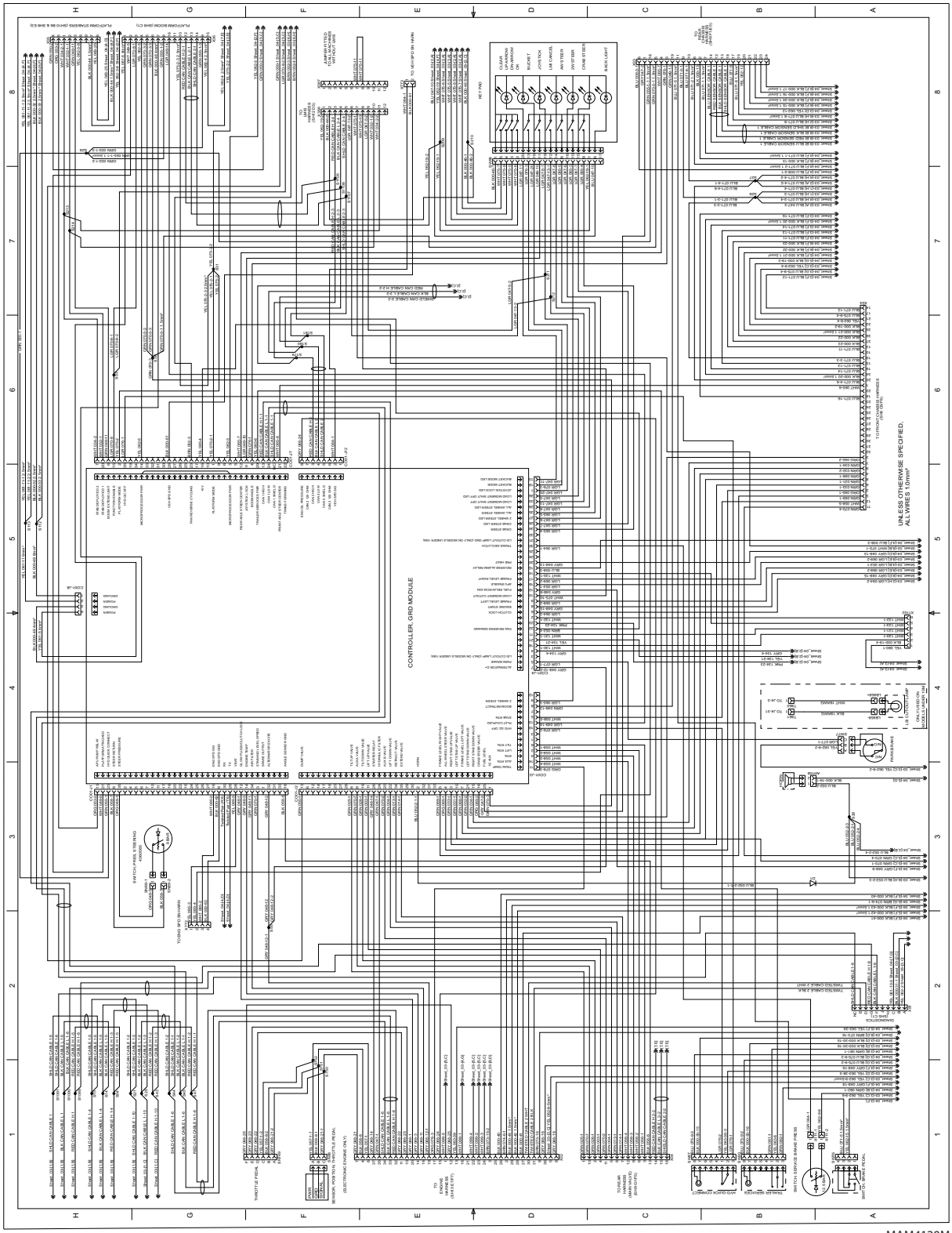
Fuse/Relay	Function	Amp Rating
F1	Right Headlight Low	7.5
F2	Rear Wiper	15
F3	Right Headlight High	7.5
F4	Left Headlight Low	7.5
F5	Left Headlight High	7.5
F6	Radio	10
F7	Front Wiper	20
F8	A/C	7.5

Fuse/Relay	Function	Amp Rating
F9	Key 2	15
F10	Key 1	15
F11	Fan	20
F12	Lights Bat 1	15
F13	Lights Bat 2	15
F14	Left Marker Lights	7.5
F15	Boom Worklights	15
F16	Brake Lights	15
F17	Front Worklights	15
F18	Flasher	15
F19	Right Marker Lights	7.5
F20	Beacon	15
F21	Rear Worklights	15
F22	Controller	25
F23	Display/Joystick	10
F24	Fuel	15
F25	Power Socket	15
F26	Seat	15
F27	Key Bat	15
F28	DPF Soot Sensor	15
F29	Reverse Alarm	15
F30	Aux Function Power	15
K1	Reverse Alarm	
K2	Start	
K3	Flasher	
K4	Ignition Power 1	
K5	Ignition Power 2	
K6	Work Lights	
K7	Ignition Power 3	
K8	Fuel	

9.8 ELECTRICAL SYSTEM SCHEMATICS

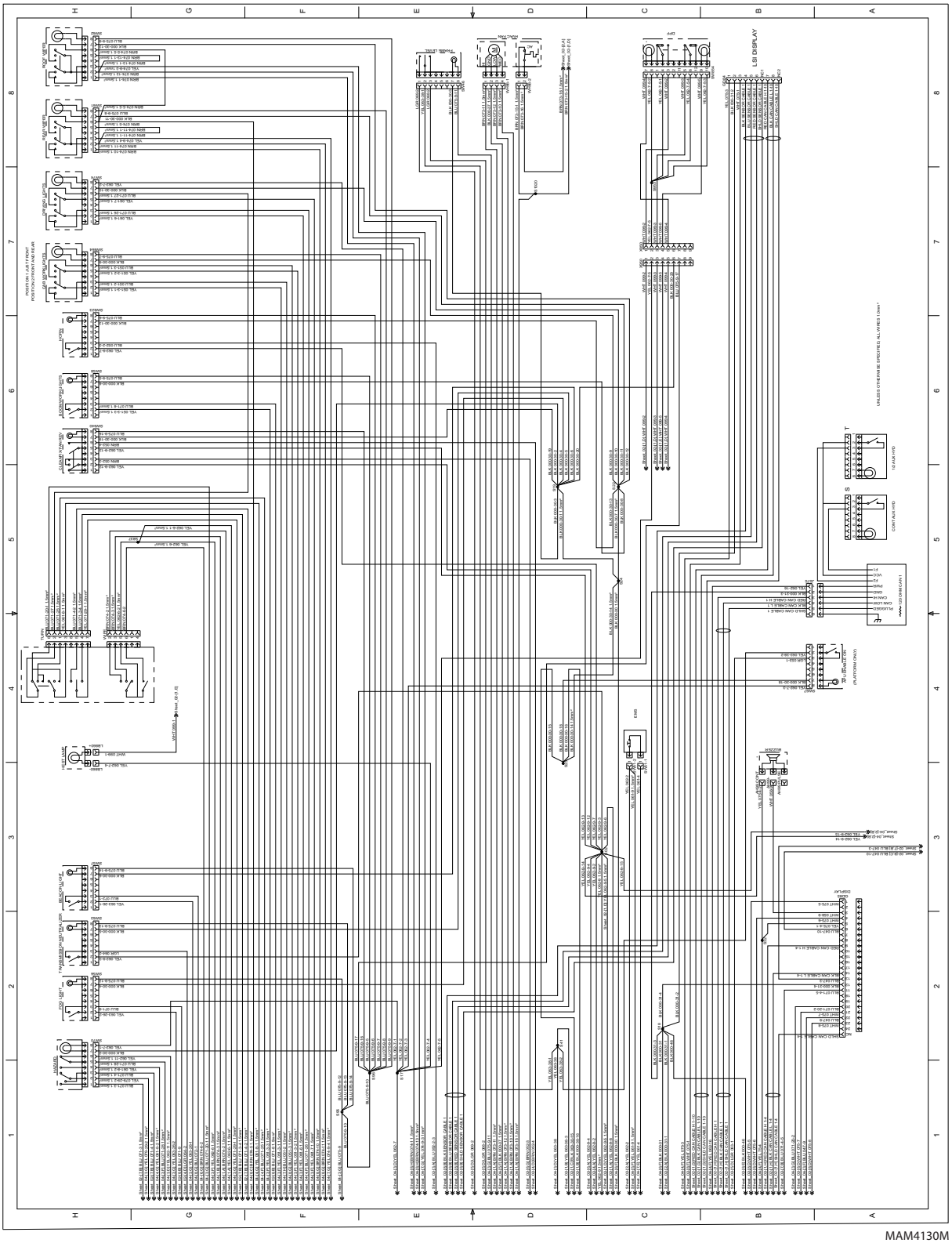
Refer to Electrical Schematic Package (PN 31200832)

9.8.1 Cab Harness Electrical Schematic 1 of 3



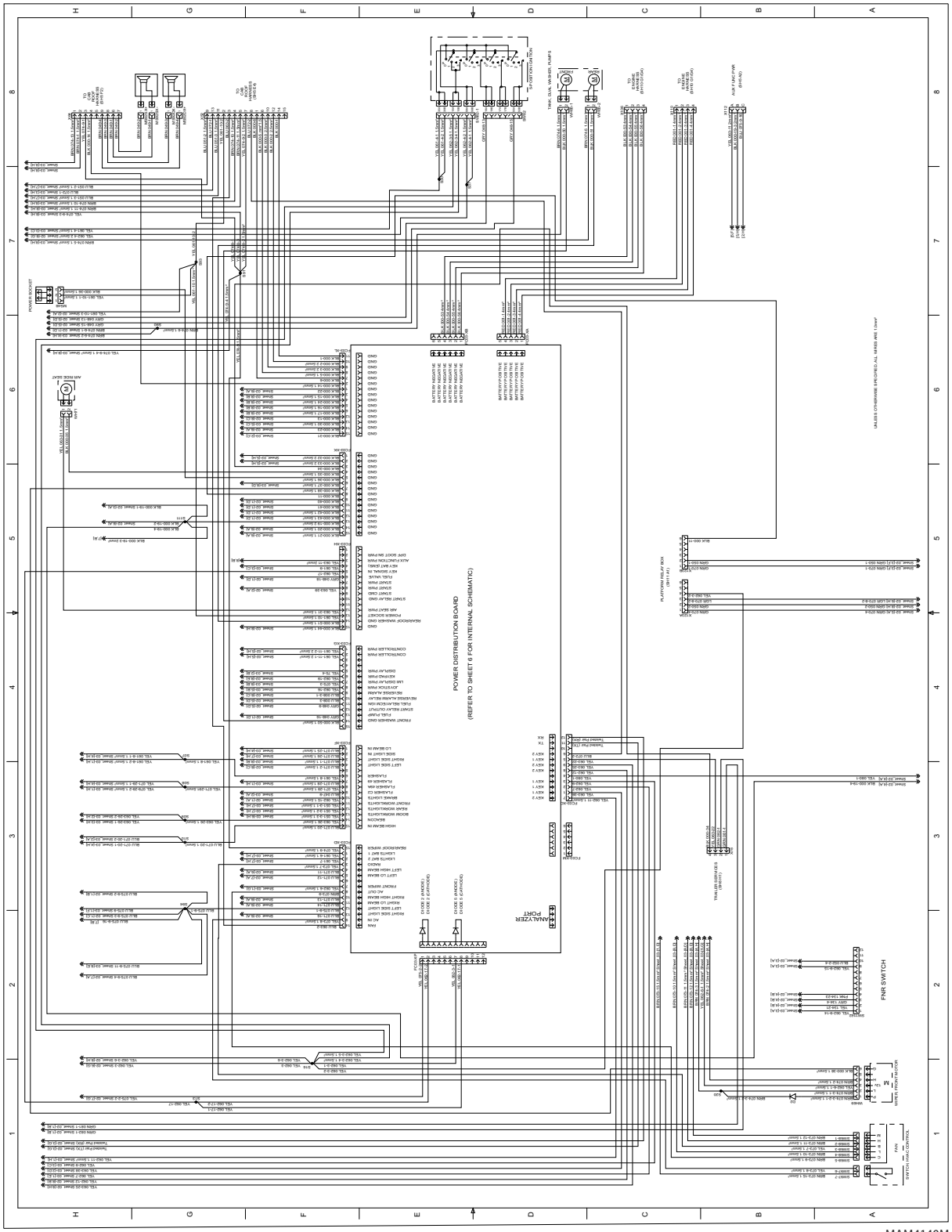
MAM4120M

9.8.2 Cab Harness Electrical Schematic 2 of 3



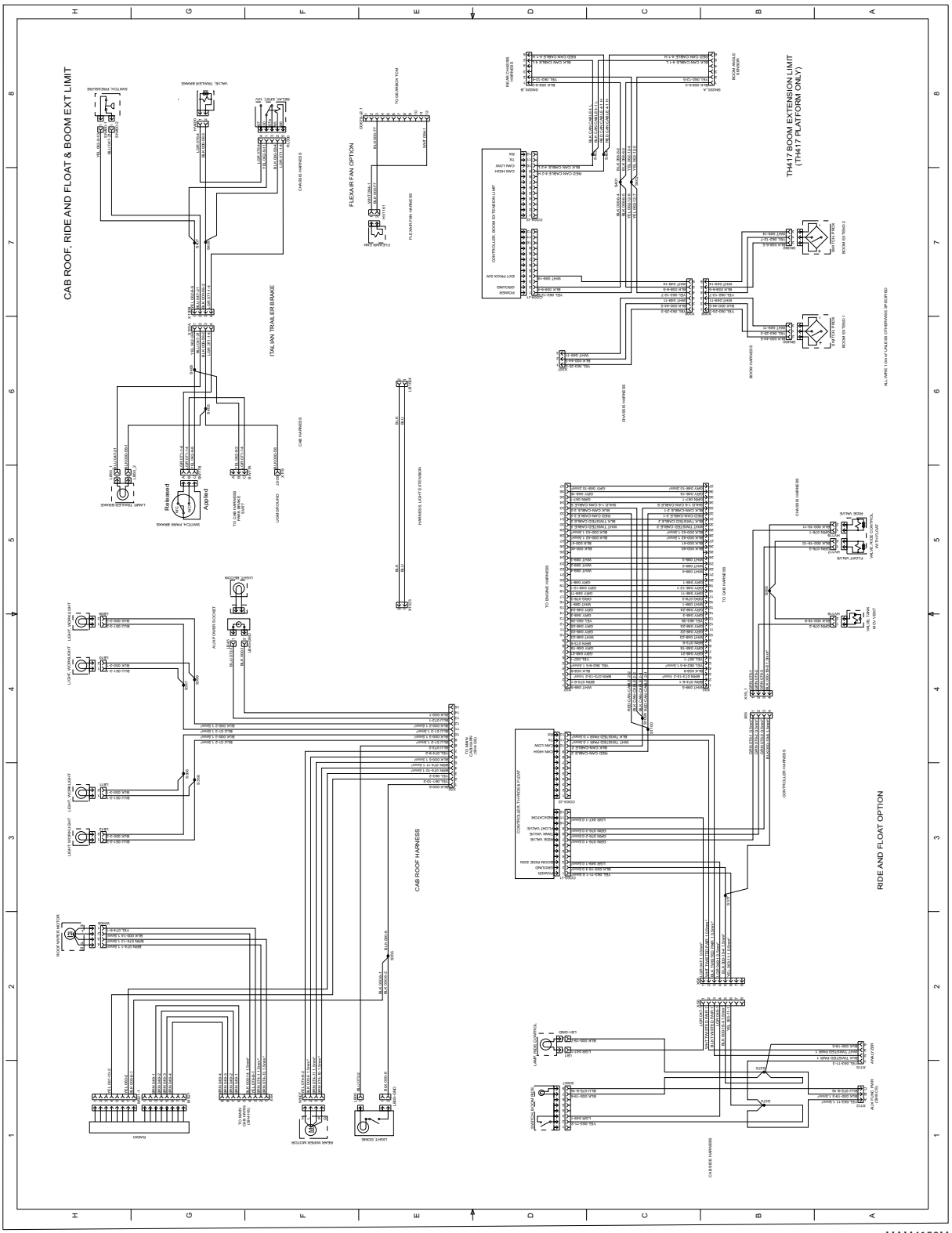
MAM4130M

9.8.3 Cab Harness Electrical Schematic 3 of 3



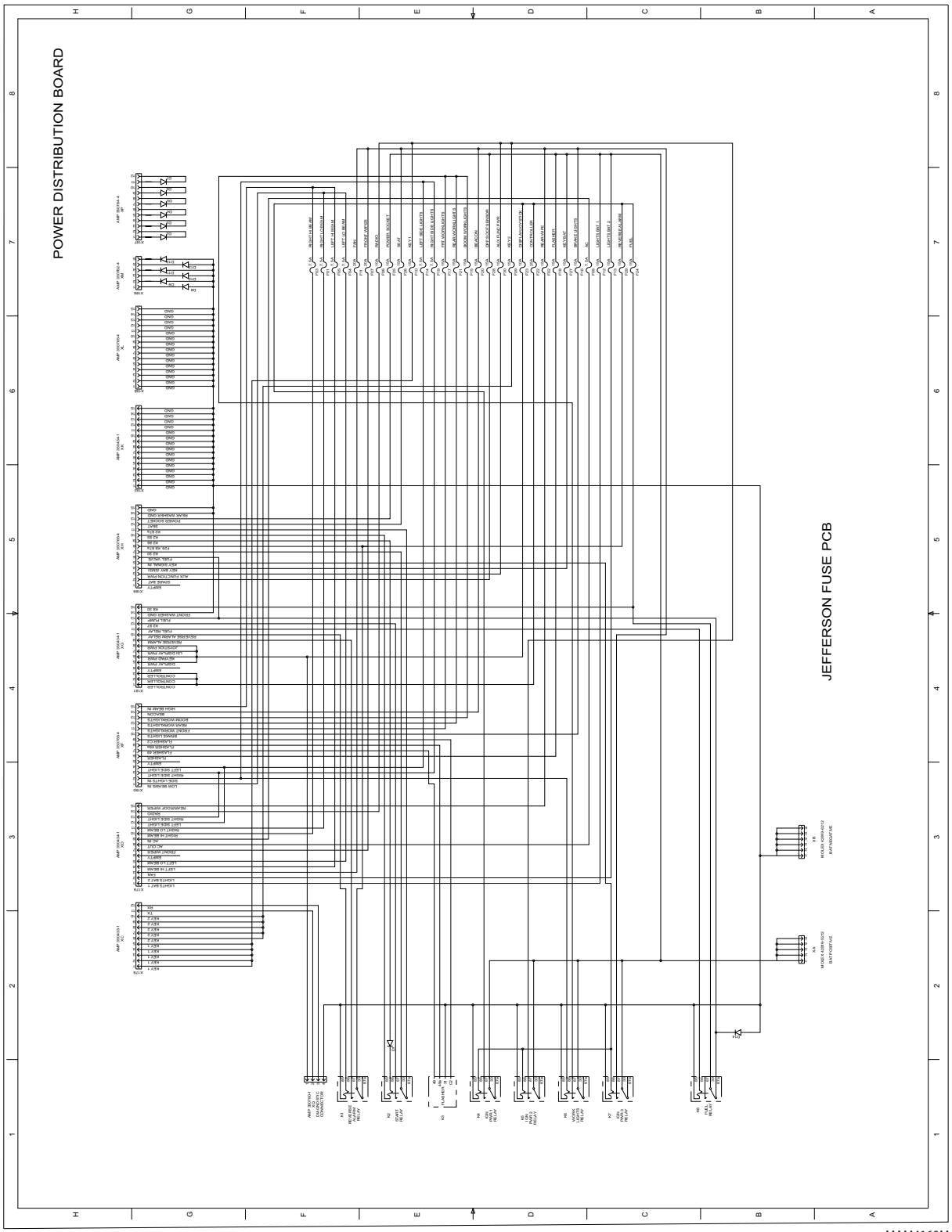
MAM4140M

9.8.4 Cab Roof, Ride, Float and Boom Extend LImit



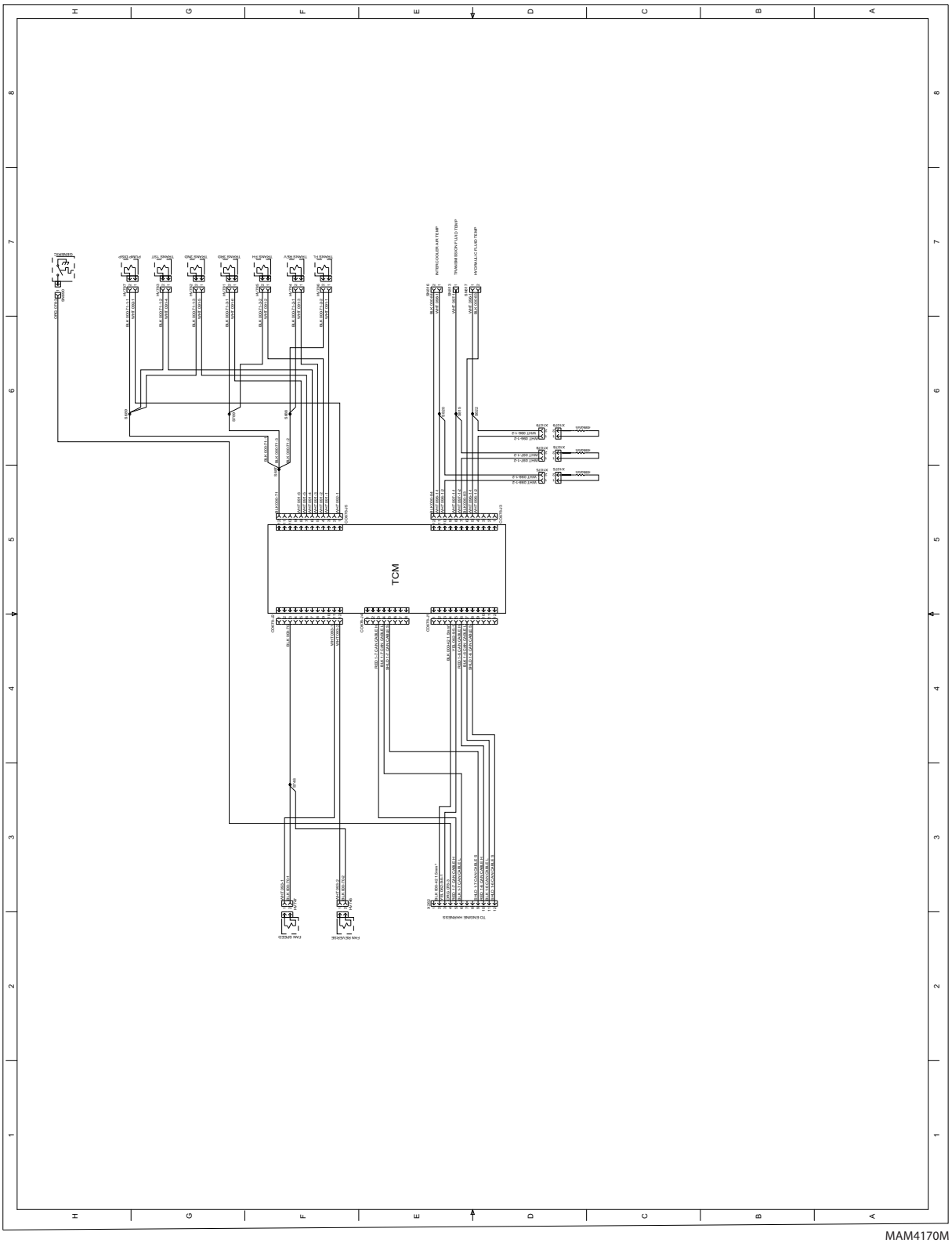
MAM4150M

9.8.5 Power Distribution Board



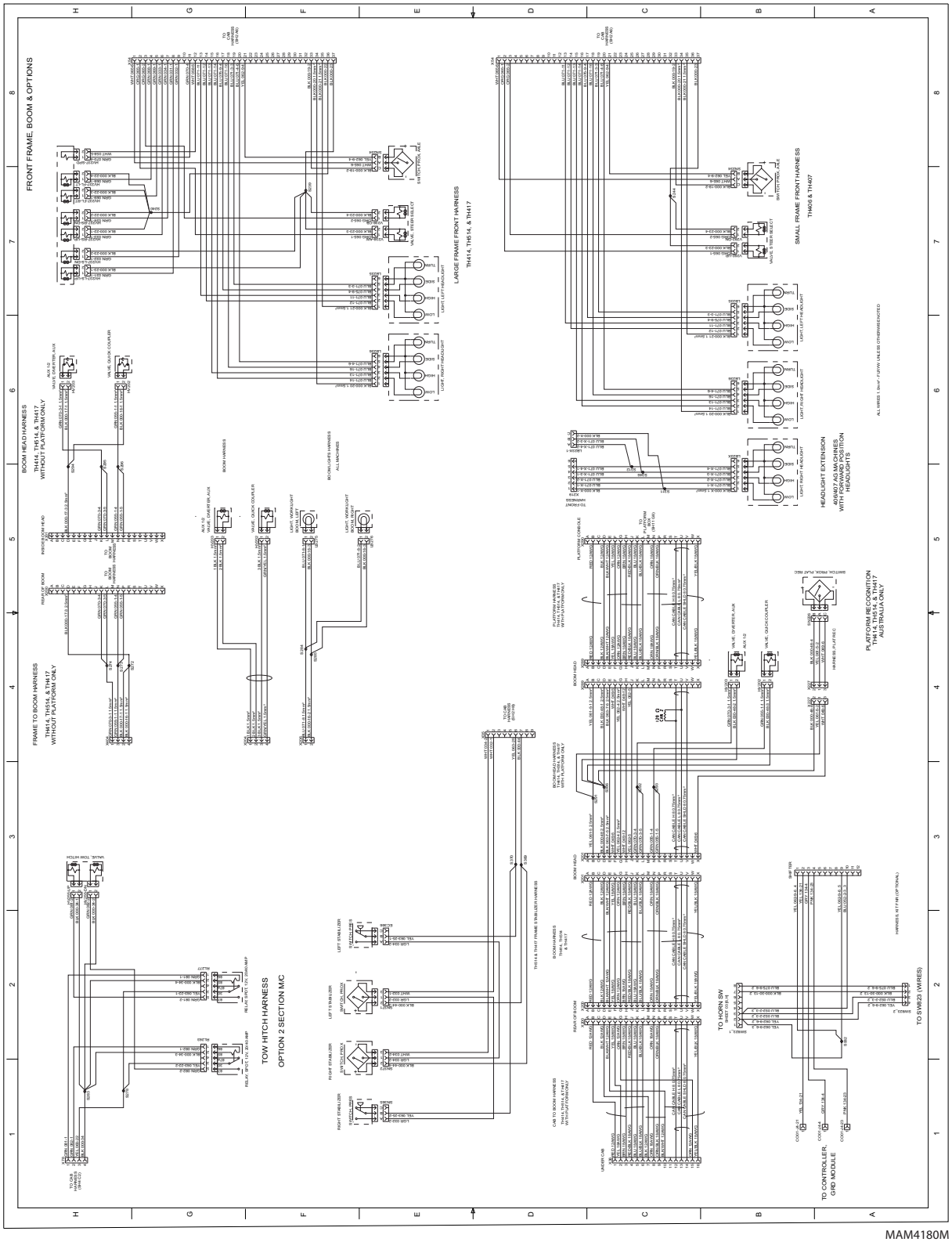
MAM4160M

9.8.6 Transmission and Reverse Fan

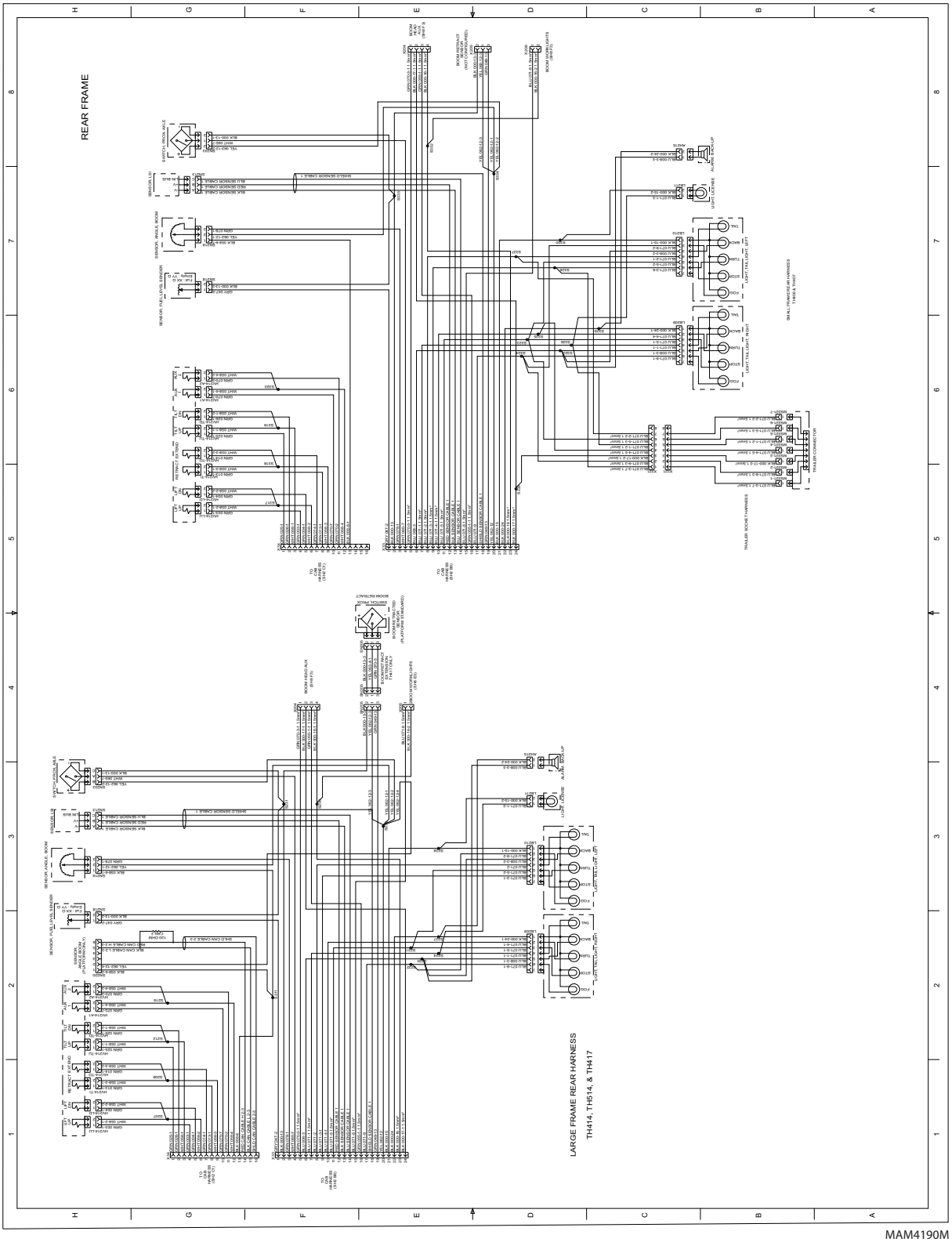


MAM4170M

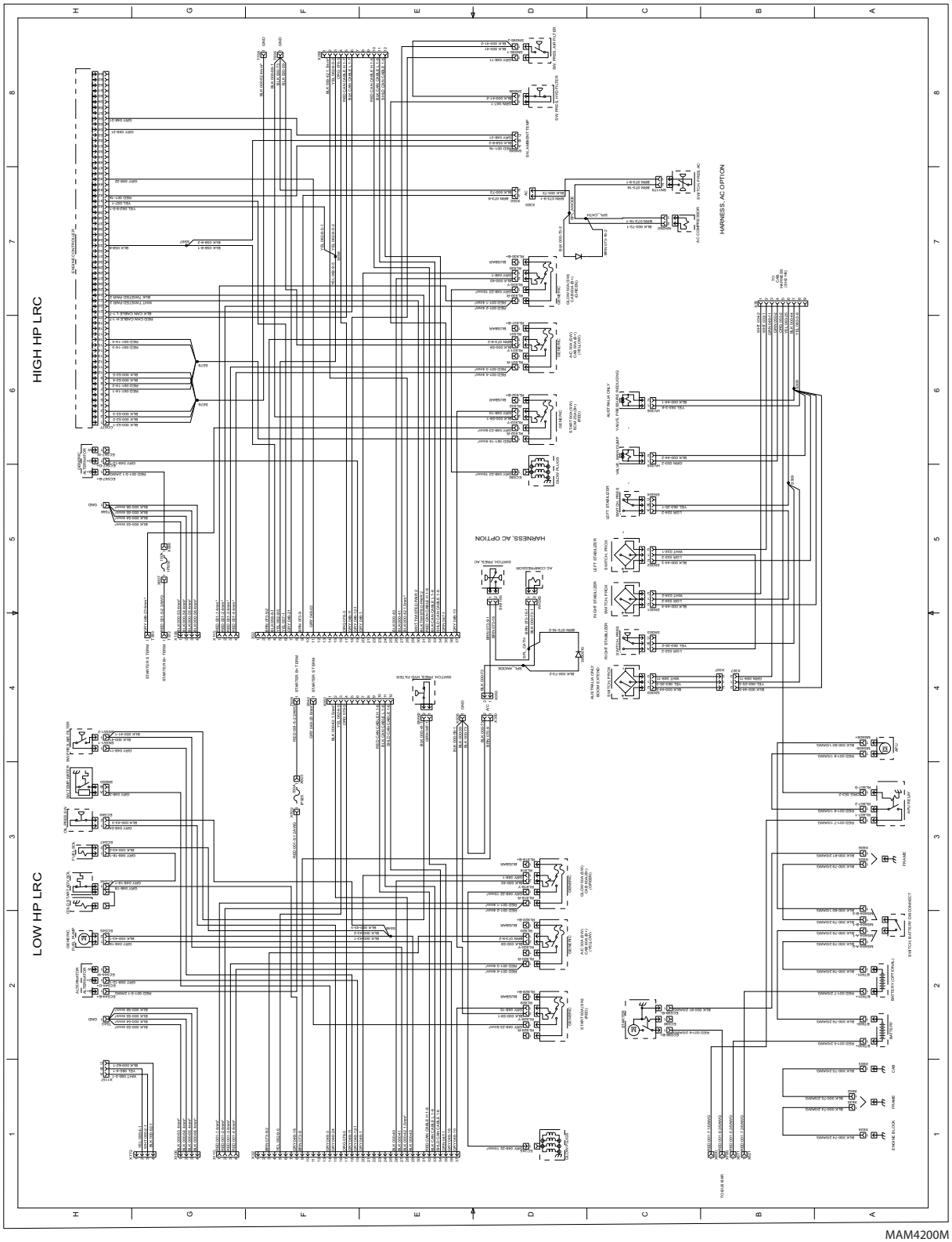
9.8.7 Front Frame, Boom and Options



9.8.8 Rear Frame

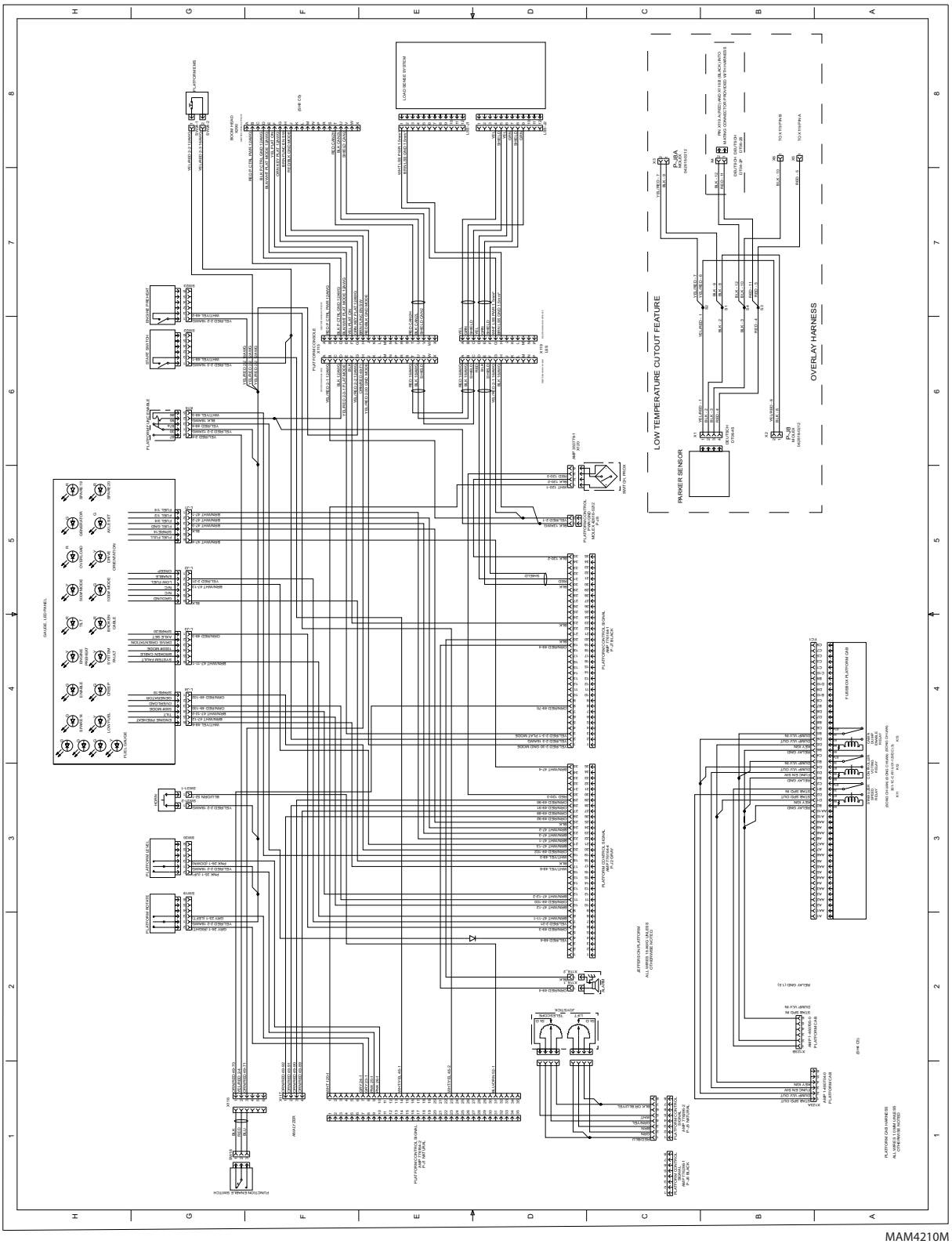


9.8.9 LRC Engine, Battery & Platform Stabs



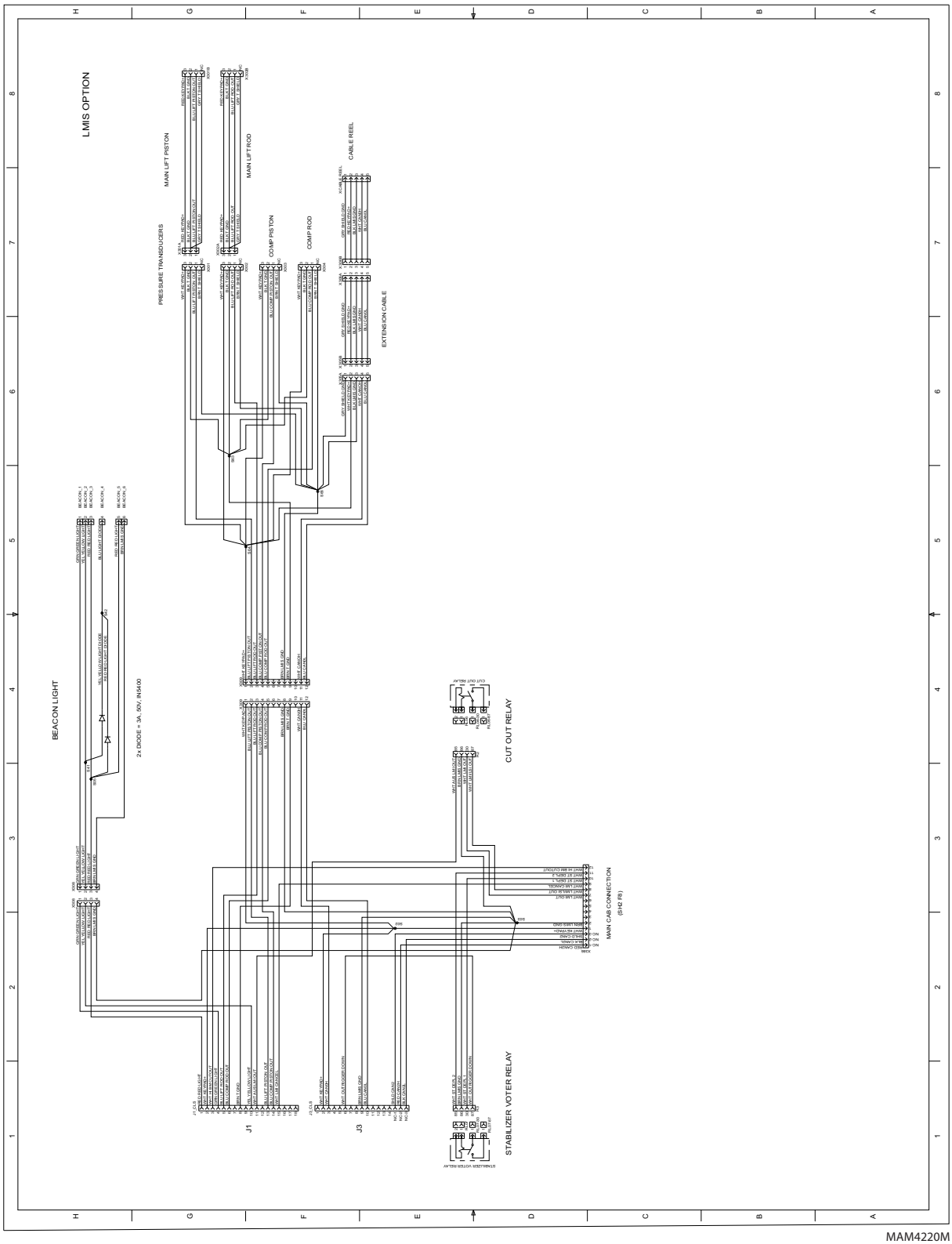
MAM4200M

9.8.10 Platform Box



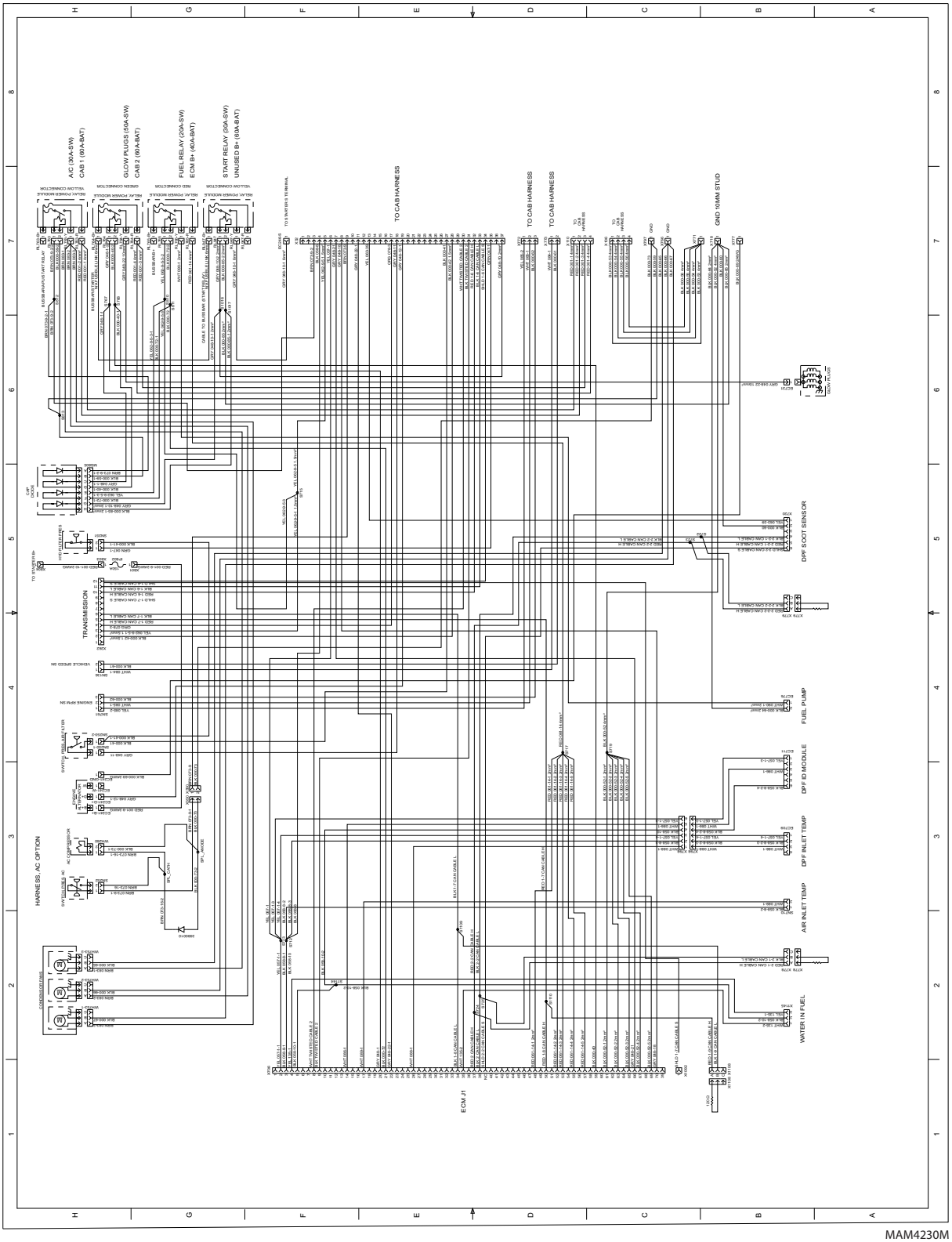
MAM4210M

9.8.11 LMIS Option

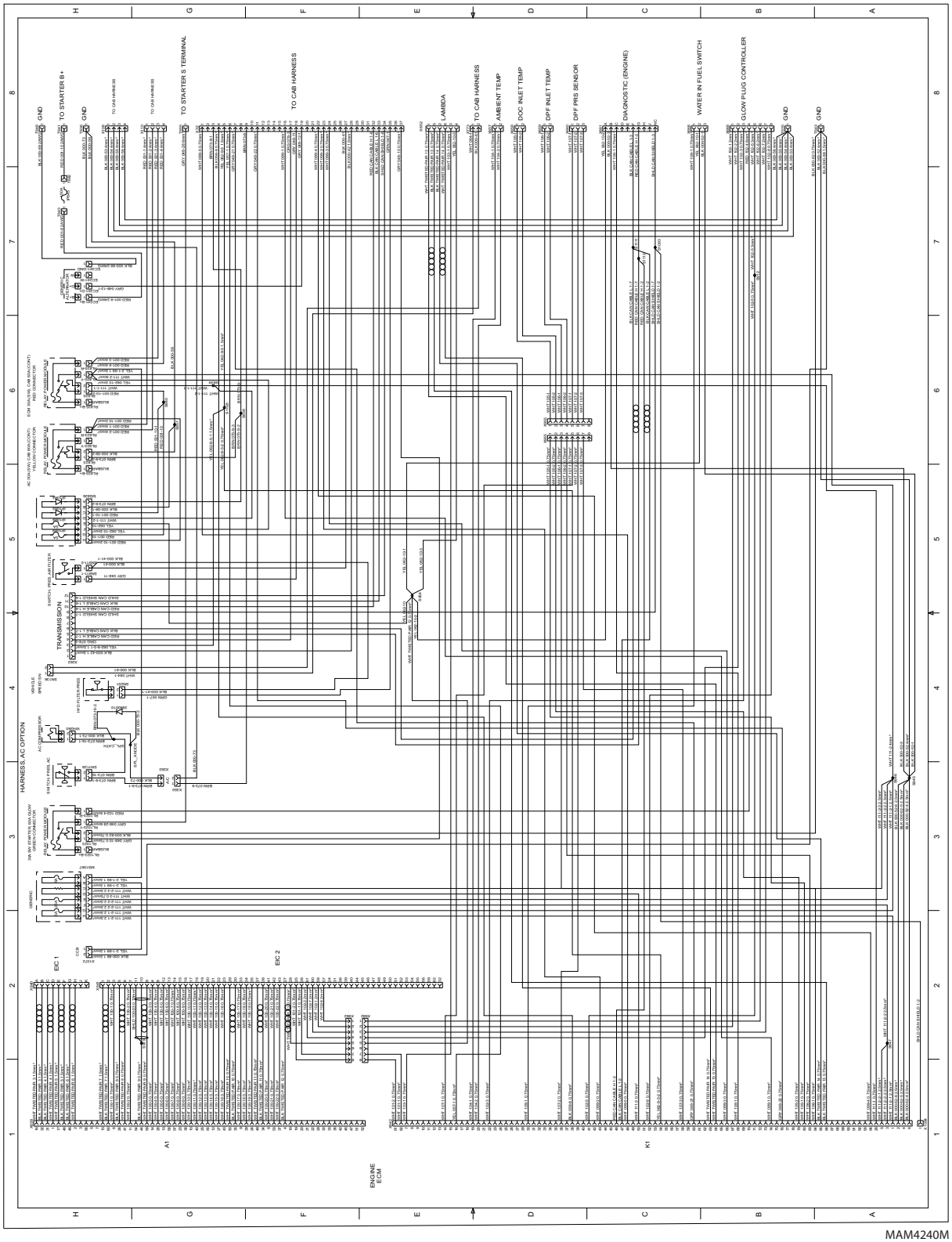


MAM4220M

9.8.12 CAT C4.4 Engine

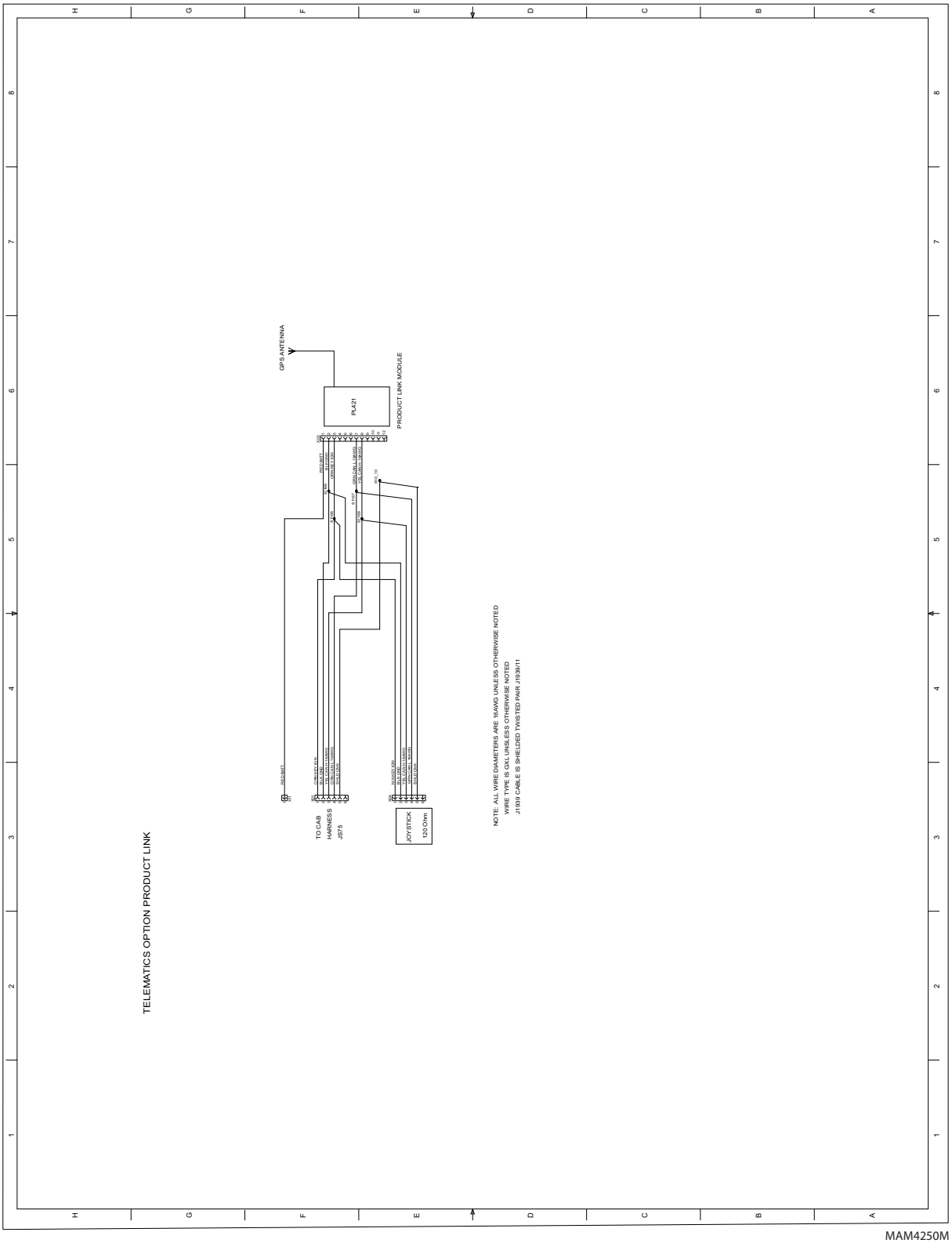


9.8.13 CAT C3.4 Engine



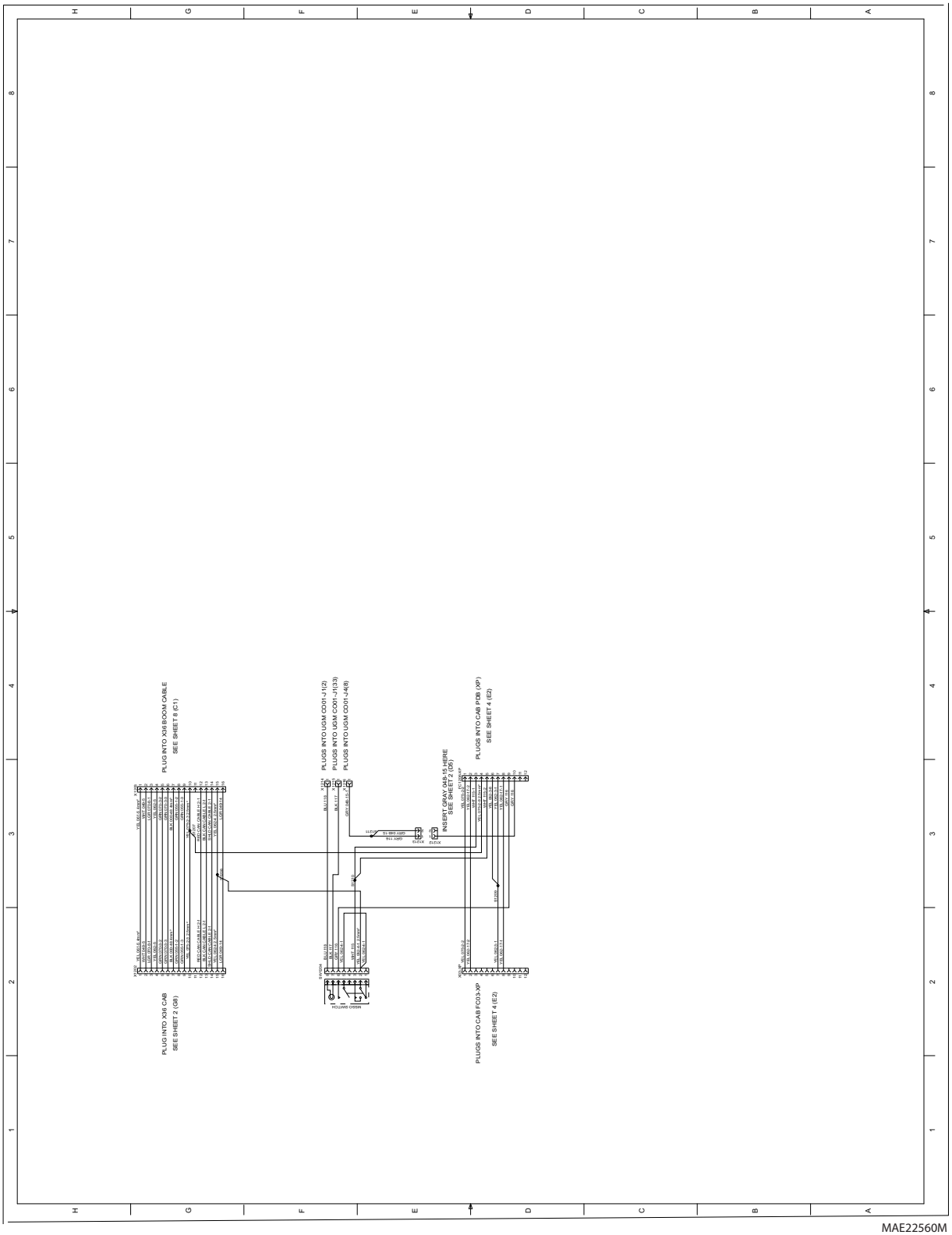
MAM4240M

9.8.14 CAT Product Link



MAM4250M

9.8.15 Platform MSSO Harness

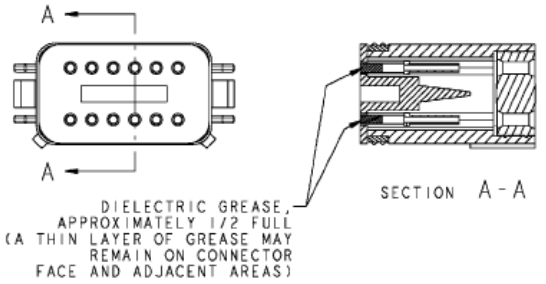


MAE22560M

9.9 DIELECTRIC GREASE APPLICATION

Dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from the application of dielectric grease.

9.9.1 Installation



MAE3230

1. Apply dielectric grease to plug/male connector housing which typically contains sockets contact/female terminals.

Note: *Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.*

2. Leave a thin layer of dielectric grease on the face of the connector.
3. Assemble the connector system immediately to prevent moisture ingress or dust contamination.
4. Pierce one of the unused wire seals prior to assembly if the connector system tends to trap air (i.e. AMP Seal) and then install a seal plug.

The following connector systems are specifically addressed because of their widespread use. However, this guidance may be applied to similar devices:

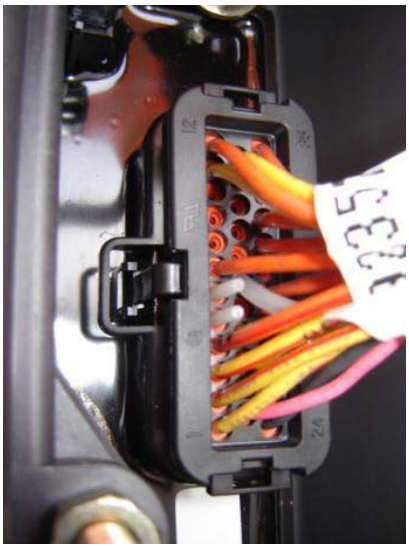
1. Deutsch HD, DT, DTM, DRC Series

MAE3240

The Deutsch connector system is widely used for harsh environment interconnect. Follow the general guidance for installation.

2. AMP Seal

MAE3250

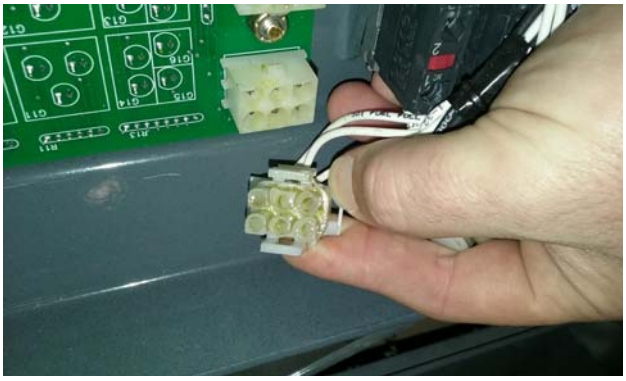


MAE3260

The AMP Seal connector system is used on the Control ADE Platform and Ground Modules.
Apply dielectric grease to the plug/male connector housing which typically contains socket contacts/female terminals. If trapped air prevents the connector from latching, pierce one of the unused wire seals. After assembly, install a seal plug in that location to prevent moisture ingress.

Note: *Seal plugs may be installed by the wire harness manufacturer if an unused wire seal becomes compromised (wire inserted in the wrong cavity during assembly and the corrected).*

3. AMP Mate-N-Lok



MAE3270

This connector system is widely used inside enclosures for general-purpose interconnect. Follow the general guidance for installation.

4. DIN Connectors

MAE3280

This connector system is typically used on hydraulic valves at Caterpillar. Follow the general guidance for installation.

9.9.2 Exclusions

1. **M12 with Gold Contact Material:**

MAE3290

MAE3300

The connector uses gold contact material to resist corrosion and an o-ring seal for moisture integrity. If dielectric grease is mistakenly applied to this connector system, the low-force contacts cannot displace the grease to get electrical contact. Once contaminated, there is no practical way to remove the dielectric grease (replacement of female contacts required). The Caterpillar Load Sensing System and 1250AJP Rotary Angle Sensors are examples of components with the M12 connector system.

2. Engine Control Unit Connectors

MAE3310

Many times, these types of connectors use back-seals for moisture integrity. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease.

3. Sealed Enclosures

MAE3320

Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP66 (dust tight; protected from powerful jets of water). The enclosure must be fitted with a high quality, continuous gasket and all wiring must pass through cable entrances.

4. **MIL-C-5015 Spec Connector's**

MAE3330

The dielectric grease is not recommended for this series connector. For similar model series connectors, the manufacturer should be contacted for confirmation before applying dielectric grease.

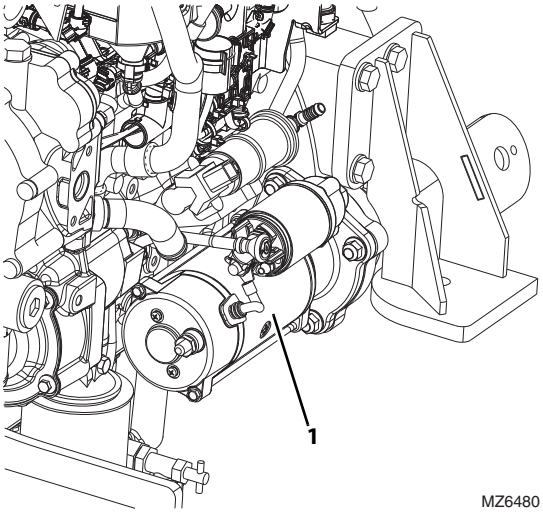
5. CMC Series Connectors

MAE3340

The CMC connector family is a sealed, high-density connection system using matte-seal technology for CP 0.635 and 1.50mm terminals. To guarantee IP6K7 and IP6K9 sealing, a seal plug option is used. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease.

9.10 ENGINE START CIRCUIT

9.10.1 Starter



The starter (**1**) is located on the left side of the engine (the right side of the machine).

a. Testing the Starter on the Engine

If the starter does not engage when the ignition key switch is turned, check the following:

1. The main fuse may be blown, requiring replacement. Check for the cause of the blown fuse.
2. There may be a defect in the ignition key switch, ignition wiring or starter solenoid.
3. Check battery condition. Clean the battery posts and the connectors at each end of the battery cables.
4. Check for broken wiring and damaged insulation on the wiring. Replace all broken or damaged wiring.
5. Check all connections at the starter solenoid, key switch and wiring harness plugs. Clean and tighten all connections.
6. If the starter still does not operate after these checks have been performed, check the starting circuit.

b. Starter Circuit Checks

1. Check wires and connections for looseness, corrosion, damage, etc.
2. If a "whirring" noise is heard but the engine does not turn over, the starter is spinning but not engaging the flywheel. The starter drive or solenoid that pushes the drive forward to engage the flywheel may be defective. Missing or damaged teeth on the flywheel can also prevent the starter from cranking the engine.
3. If the starter only "clicks" it may indicate that the battery is discharged, or that there is a loose or corroded battery cable connection. Check the battery state of charge and battery condition first, then check the cables and cable connections.
4. For additional information on the starting circuit, refer to Section 9.8, "Electrical System Schematics".

c. Starter Removal

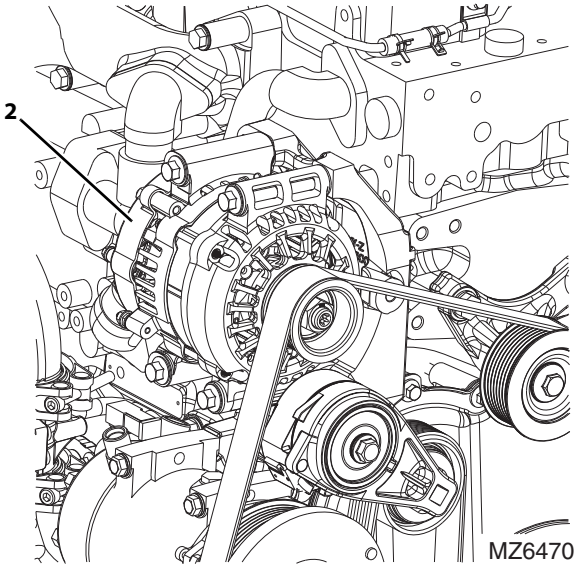
Remove the starter only if it fails. To remove the starter:

1. Park the machine on a firm, level surface with the machine level, retract and level the boom. Place transmission in (N) NEUTRAL and engage the parking brake. Shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Allow the engine and all system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the wires from the solenoid stud. Remove the positive (+) battery cable from the starter. Label and disconnect the wire from the starter solenoid housing stud. Record how the wires are installed to ensure correct installation later.
6. Loosen, but Do Not remove, the fasteners securing the starter to the flywheel housing. Support the starter securely, as it is relatively heavy and will fall if not supported.
7. Support the starter and remove the fasteners securing the starter to the engine. Remove the negative (-) ground cable from its starter mounting bolt.
8. Remove the starter from the machine.

d. Starter Installation

1. Position the starter in its mounting opening on the flywheel housing. Position the ground cable over the correct starter mounting bolt. Secure the starter with the previously used hardware.
2. Connect the positive (+) battery cable to the upper solenoid stud. Install the wires to the upper solenoid stud, and secure with lock washer and nut.
3. Connect the wire to the solenoid mounting stud.
4. Connect the battery negative (-) cable to the battery negative (-) terminal.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.10.2 Charging Circuit



Before using a battery charger, an attempt can be made to recharge the battery by jump-starting the machine (Refer to the appropriate Operation & Maintenance Manual). Allow the engine to run, which will enable the alternator (**2**) to charge the battery.

If the engine alternator charging warning indicator illuminates, perform the following checks:

1. Check all battery cable connections at the battery, and verify that they are clean and tight.
2. Check the external alternator wiring and connections, and verify that they are in good condition.
3. Check the fan belt condition and tension.
4. Run the engine and check the alternator for noise. A loose drive pulley, loose mounting hardware, worn or dirty internal alternator bearings, a defective stator or defective diodes can cause noise. Replace a worn or defective alternator.

9.10.3 Alternator

a. Alternator Removal

1. Park the machine on a firm, level surface with the machine level, retract and level the boom. Place transmission in (N) NEUTRAL and engage the parking brake. Shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Allow the engine and all system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Install a drive ratchet into the square hole in the serpentine belt tensioner bracket.
6. While lifting the automatic belt tensioner away from the belt, remove the fan serpentine belt.

Note: *Record how the alternator is installed to ensure correct installation later.*

7. Label and disconnect the wire leads attached to the alternator.
8. Remove the lower mounting capscrew securing the alternator to the lower mounting hole on the engine.
9. While supporting the alternator with one hand, remove the upper (longer) mounting hardware from the upper alternator mount. Remove the alternator from the machine.

b. Alternator Installation

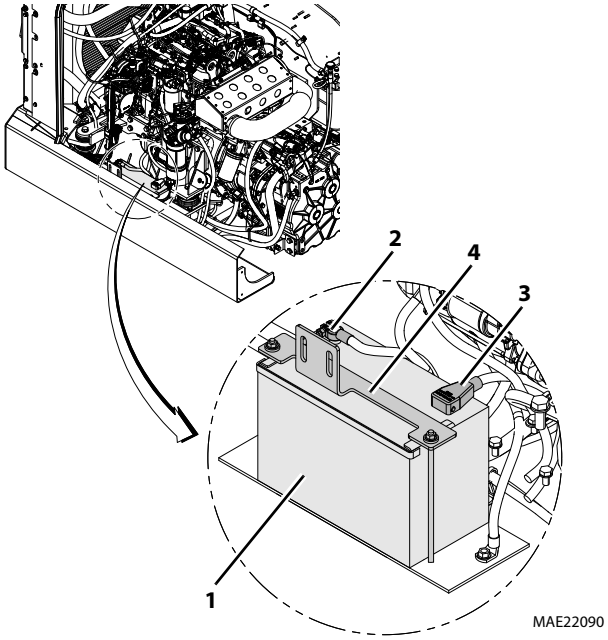
1. Position the alternator and align with the upper alternator mount on the engine bracket. Insert the upper (longer) mounting hardware through the alternator mount. Thread the longer capscrew into the alternator front mount. Do Not tighten completely at this time.
2. Align the lower alternator mount hole with the lower mounting bracket on the engine, and insert the lower mounting capscrew. Tighten the lower capscrew and upper capscrew securely.
3. Place a drive ratchet into the square hole on the serpentine belt tensioner bracket. Apply pressure against the tensioner bracket and route the serpentine belt onto the alternator and engine pulleys. Release and check the tensioner pulley to verify that it is pivoting freely in order to provide the proper tension on the belt. Check for proper belt alignment. (Refer to the appropriate Operation & Maintenance Manual.)
4. Connect the previously labeled wire leads to the alternator.
5. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.11 BATTERY

Note: *Eye protection is recommended before inspecting and/or replacing the battery.*

9.11.1 Battery Inspection

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.



4. Visually inspect the battery (**1**).
5. Check terminals for corrosion.
6. Replace the battery if it has a cracked, melted or damaged case.
7. Close and secure engine cover.
8. Remove boom support.
9. Remove Do Not Operate Tag from ignition key switch and steering wheel.

9.11.2 Battery Removal/Installation

a. Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lift boom, place transmission in (N) NEUTRAL, engage parking brake and shut engine OFF.
2. Properly support the boom.
3. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
4. Open engine cover. Allow system fluids to cool.
5. Turn OFF electrical master switch.
6. Disconnect Negative battery cable (**2**).
7. Disconnect Positive battery cable (**3**).
8. Loosen and remove clamp (**4**) securing battery.
9. Remove battery (**1**).

b. Installation

1. Properly install battery (**1**) and secure in place with previously removed clamp (**2**).
2. Connect Positive battery cable (**3**).
3. Connect Negative battery cable (**2**).
4. Turn ON electrical master switch.
5. Close and secure engine cover.
6. Properly remove the support for the boom.
7. Remove Do Not Operate Tag from ignition key switch and steering wheel.

9.11.3 Battery Disconnect/Connect

a. Disconnect

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Remove bolts securing access panel (**1**) and remove panel.
5. Disconnect Negative battery cable (**3**).
6. Disconnect Positive battery cable (**4**).

b. Connect

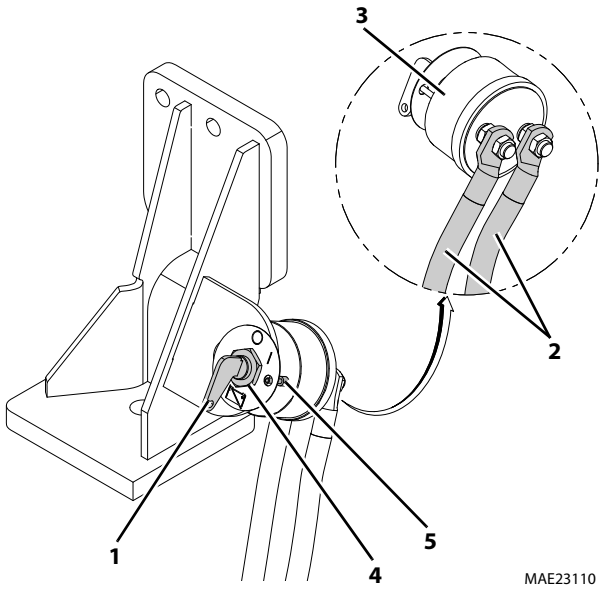
1. Connect Positive battery cable (**4**).
2. Connect Negative battery cable (**3**).
3. Install access cover (**1**) and secure with previously removed bolts.
4. Close and secure engine cover.
5. Remove Do Not Operate Tag from ignition key switch and steering wheel.

9.12 ELECTRICAL MASTER SWITCH

The electrical master switch cuts off all power to the machine without the need to disconnect the electrical cables from the battery.

9.12.1 Electrical Master Switch Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission in (N) NEUTRAL, engage parking brake and shut engine OFF.
2. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the battery. Refer Section 9.11, “Battery”, for procedure.



5. Remove master electrical switch key (**1**).
6. Label and disconnect the cables (**2**) on the rear of the master electrical switch (**3**).
7. Loosen and remove the nut (**4**) securing the key switch to the mounting bracket.
8. Remove the master switch (**3**).

9.12.2 Electrical Master Switch Installation

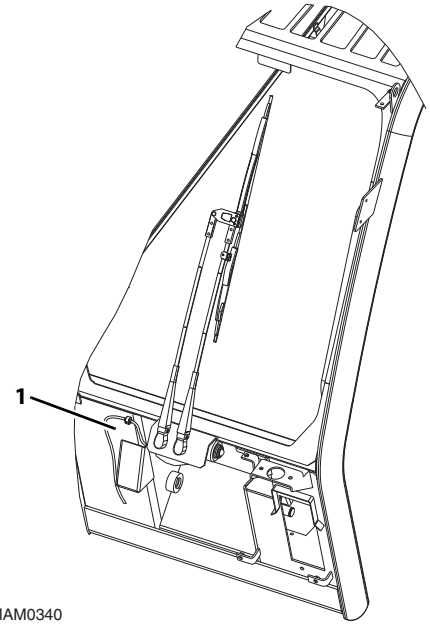
1. Install the master electrical switch (**3**) to the mounting bracket and align the switch locator pin (**5**) in the mounting bracket.
2. Install previously removed master electrical switch mounting nut (**4**) and torque to 14 - 20 lb-ft (19 - 27 Nm).
3. Connect previously labeled electrical cables (**2**). Secure cables if required.
4. Properly connect the battery. Refer Section 9.11, "Battery", for procedure.
5. Close and secure engine cover.
6. Remove Do Not Operate Tag from ignition key switch and steering wheel.
7. Verify proper operation of the electrical master switch.

9.13 WINDOW WIPER SYSTEM (IF EQUIPPED)

9.13.1 Front Windshield Wiper Motor

a. Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the cab cover.
6. Disconnect the cab harness connectors from the wiper motor.



7. Disconnect the reservoir hose attached to the wiper motor (**1**).
8. Remove the linkage attached to the wiper motor.
9. Loosen and remove the bolts holding the wiper motor to the mounting bracket.

Note: *Retain all hardware removed from the wiper assembly for possible reuse on the replacement motor housing.*

10. Remove the motor from the front of the cab.

b. Disassembly

Do Not disassemble the motor. The motor is not serviceable. Replace motor if found to be defective.

c. Inspection and Replacement

Inspect the motor terminals for continuity. Replace motor if continuity is not found.

d. Installation and Testing

1. Align motor with the mounting holes and bolt the motor to the mounting bracket.
2. Connect the wiper linkage to the wiper motor shaft.

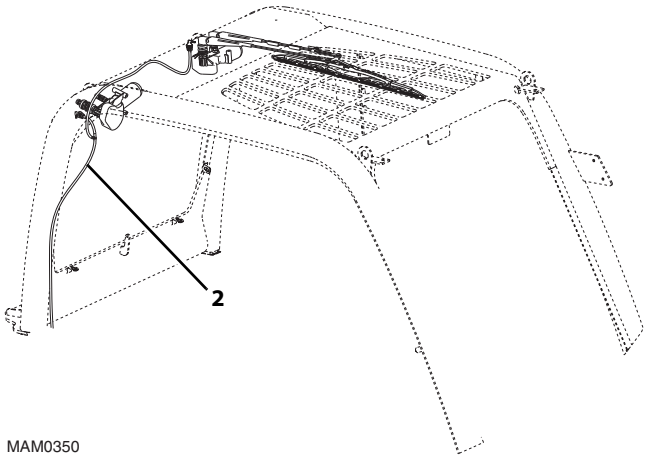
Note: *Align the wiper linkage arm with the flat on the motor shaft to ensure wiper stroke covers window area, and it does not swipe past the glass area.*

3. Connect the reservoir hose to the wiper motor.
4. Connect the cab harness connectors to windshield wiper motor connectors.
5. Turn ignition key switch to the RUN position, and operate windshield wiper in both LOW and HIGH speeds to ensure proper operation and that correct wiper travel is achieved.
6. Install the cab cover.
7. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
8. Close and secure the engine cover.
9. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.13.2 Rear Window Wiper Motor

a. Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the cab ceiling cover to gain access to the wiper motor.
6. Disconnect the cab harness connector(s) from the wiper motor.



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7. Disconnect the reservoir hose (**2**) attached to the wiper motor.
8. From outside the cab, remove the wiper arm from the wiper motor post.
9. Remove the hardware securing the wiper motor to the cab.
10. Remove the wiper motor from inside the cab.

b. Disassembly

Do Not disassemble the motor. The motor is not serviceable. Replace motor if found to be defective.

c. Inspection and Replacement

Inspect the motor terminals for continuity. Replace motor if continuity is not found.

d. Installation and Testing

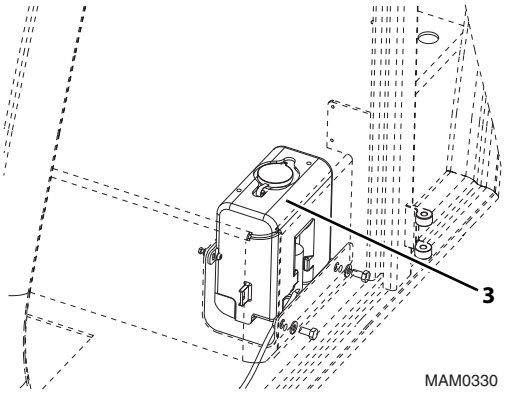
1. Align motor with the mounting holes from inside the cab. Secure the motor with the previously used hardware.
2. Install the wiper arm to the wiper motor shaft.

Note: *Align the wiper arm on the motor shaft to ensure wiper stroke covers window area, and it does not swipe past the glass area.*

3. From inside the cab, connect the reservoir hose to the wiper motor.
4. Connect the cab harness connector(s) to wiper motor connector(s).
5. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.

6. Turn ignition key switch to the RUN position, and operate wiper in both LOW and HIGH speeds to ensure proper operation and that correct wiper travel is achieved.
7. Install the cab ceiling cover.
8. Close and secure the engine cover.
9. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.13.3 Washer Fluid Reservoir



The washer motor and reservoir (**3**) is located in the cab underneath the seat. It is labeled as a unit and cannot be serviced separately.

a. Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the hydraulic oil reservoir from back of the cab. Refer to Section 8.7.3, "Hydraulic Oil Reservoir Removal/ Installation".
6. Remove the fuel tank. Refer to Section 7.6.2, "Fuel Tank".
7. Label and disconnect the cab harness connectors from the washer reservoir connectors.
8. Remove the washer hoses from the reservoir.
9. Remove the bolts securing the reservoir to the mounting bracket.
10. Remove the reservoir from the cab.

b. Disassembly

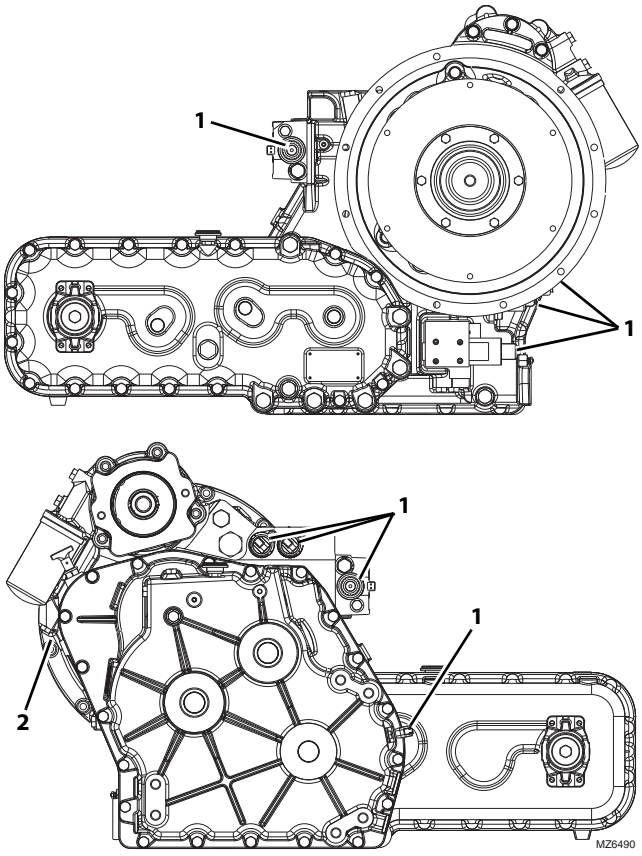
Do Not disassemble the pump. The pump is not serviceable. Replace pump if found to be defective.

c. Installation and Testing

1. Install the reservoir into the mounting bracket. Secure with the previously used hardware.
2. Connect the windshield washer hoses to the reservoir.
3. Connect the cab wiring harness connectors to the reservoir connectors.
4. Fill the washer fluid reservoir with washer fluid.
5. Install the fuel tank. Refer to Section 7.6.2, "Fuel Tank".
6. Install the hydraulic oil reservoir. Refer to Section 8.7.3, "Hydraulic Oil Reservoir Removal/Installation".
7. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
8. Turn the ignition key switch to the RUN position and press the washer switch. Verify that fluid is sprayed on the windshield, roof and rear glass.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.14 SOLENOIDS, SENSORS AND SENDERS

9.14.1 Transmission Solenoid Valves



Note: If the transmission is not shifting properly, the transmission wiring harness or transmission shift solenoids (**1**) should be checked in order to determine which component is defective. Specific information to determine which travel position and corresponding component is not responding can be found in the detailed transmission service instructions (covering repair, disassembly, reassembly and adjustment information) are provided in the following publications:

Detailed transmission parts and service information can be found in SIS Web.

The transmission should be checked, serviced and repaired only by experienced service technicians who are aware of all safety instructions and particular component features.

Note: *Contact the local Caterpillar dealer if internal transmission repair is required during the warranty period.*

9.14.2 Transmission Oil Temperature Switch

a. Transmission Oil Temperature Switch Removal

The transmission oil temperature switch (**2**) is located at the left side of the forward/reverse solenoid housing.

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, “Battery”, for procedure.
5. Unplug the transmission oil temperature switch connector from the wiring harness connector.
6. The switch is threaded into the transmission housing. Remove the switch.

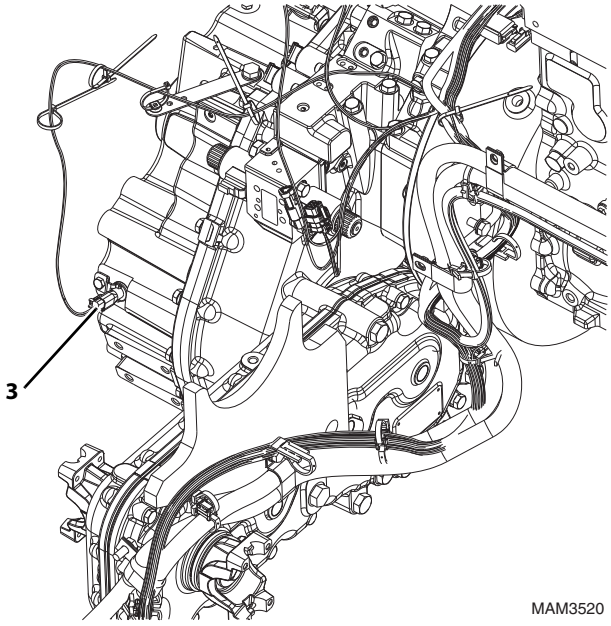
b. Transmission Oil Temperature Switch Inspection and Replacement

Inspect the switch and the wiring harness connector terminals for continuity. Replace a defective or faulty switch with a new part.

c. Transmission Oil Temperature Switch Installation and Testing

1. Thread the transmission oil temperature switch into the transmission housing snugly, then connect the switch connector to the wiring harness connector.
2. Properly connect the battery. Refer to Section 9.11, “Battery”, for procedure.
3. Check for proper fluid level.
4. Start the engine, allow it to reach operating temperature and observe the operator display cluster for warning indication. If the switch is not defective, the problem could be elsewhere; possibly in a shorted wire, damaged transmission, improper or low fluid, etc.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.14.3 Transmission Mounted Speed Sensor



The transmission speed sensor (**3**) is located on the side of the transmission bell housing.

a. Transmission Mounted Speed Sensor Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the engine to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the battery cutoff switch from the air filter bracket.
6. Remove the fuel filter from the air filter bracket.
7. Remove the electrical relays and fuses from the air filter bracket.
8. Remove the air cleaner assembly. Refer to Section 7.8.3, "Air Cleaner Assembly Removal - 74.5 kW".
9. Remove the air cleaner bracket.
10. Unplug the speed sensor connector from the wiring harness connector.
11. Loosen the screw holding the clamp and remove the sensor.

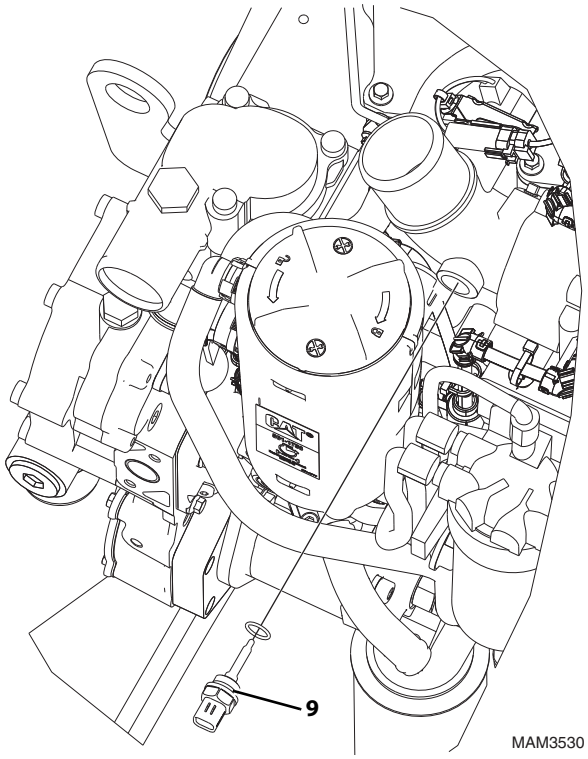
b. Transmission Mounted Speed Sensor Inspection and Replacement

Inspect the sensor and the wiring harness connector terminals for continuity. Replace a defective or faulty sensor with a new part.

c. Transmission Mounted Speed Sensor Installation and Testing

1. Install sensor in transmission, install clamp on sensor.
2. Connect the sensor plug to the wire harness.
3. Install the air cleaner bracket.
4. Install the air cleaner. Refer to Section 7.8.4, "Air Cleaner Assembly Installation - 74.5 kW".
5. Install the electrical relays and fuses to the air filter bracket.
6. Install the fuel filter to the air filter bracket.
7. Install the battery cutoff switch to the air filter bracket.
8. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.14.4 Engine Coolant Temperature Sensor



The engine coolant temperature sensor (**9**) is located behind the fuel filter.

a. Engine Coolant Temperature Sensor Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Unplug the engine coolant temperature sensor connector from the wiring harness connector.
6. Loosen and remove the engine coolant temperature sensor from the engine block.

b. Engine Coolant Temperature Sensor Inspection and Replacement

Inspect the sensor and the wiring harness connector terminals for continuity. Replace a defective or faulty sensor with a new part.

c. Engine Coolant Temperature Sensor Installation and Testing

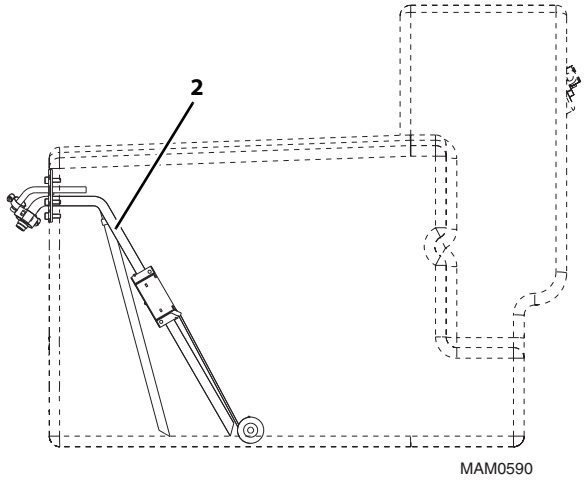
1. Apply a lubricate to the o-ring on the water temperature sensor.
2. Thread the engine coolant temperature sensor into the engine block. Tighten and torque the sensor to 17 - 23 Nm (12.5 - 17 lb-ft).
3. Connect the sensor connector to the wiring harness connector.
4. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Check for proper coolant level.
6. Start the engine, allow it to reach operating temperature and observe the operator instrument cluster for warning indication. If the sensor is not defective, the problem could be elsewhere; possibly in a shorted wire, improper-running engine, improper or low coolant, obstructed or faulty radiator, coolant pump, loose fan belt, defective instrument display, etc.
7. Close and secure the engine cover.
8. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.14.5 Fuel Level Sender

a. Fuel Level Indicator Testing

1. The fuel level sender wiring harness leads can be accessed from the side of the fuel tank. Disconnect the fuel level sender wiring harness leads. With the help of an assistant, touch both harness leads together.
2. From the operator cab, have the assistant turn the ignition key switch to the RUN position. Do Not start the engine. Observe the fuel level indicator needle on the operator instrument cluster. The reading must be at the FULL mark.
3. Turn the ignition key switch to the OFF position. The fuel level indicator needle should return to the EMPTY position.

b. Fuel Level Circuit Tests



If the fuel level sender (**2**) is suspected of giving a false reading, perform the following checks:

1. If the fuel level indicator needle does not move, check the fuel tank for fuel.
2. Check for loose or defective wiring, faulty ground connections, and corrosion on the fuel tank sender and wiring lead.
3. If the fuel level indicator needle does not move after the ignition key switch is turned to the RUN position, use a test lamp to determine whether current is flowing from the ignition switch to the fuel level sender.
4. If the fuel level indicator does not move and a faulty or defective fuel level sender in the fuel tank has been ruled out, and in addition, wiring and connectors have been checked and ruled out, the fuel level indicator is defective and must be replaced.

5. Check that the ignition terminal has current and that the fuse in the fuse panel is not blown.
6. Check for broken, shorted, frayed, disconnected or damaged wiring between the fuel level indicator wiring at the cab, fuse and relay panel, ignition key switch, and from the fuel level sender on the fuel tank through the wiring in the cab.
7. Check the fuel level sender. A defective fuel level sender in the fuel tank may also prevent the fuel level indicator from moving. Refer to Section 9.8, "Electrical System Schematics", for further information.

9.14.6 Front and Rear Axle Steering Sensors

The sensors used on each axle allow the steering to be changed to one of three different settings. The sensors will not allow the change to be completed unless both axles are in the central location.

Each sensor is mounted on each steer cylinder.

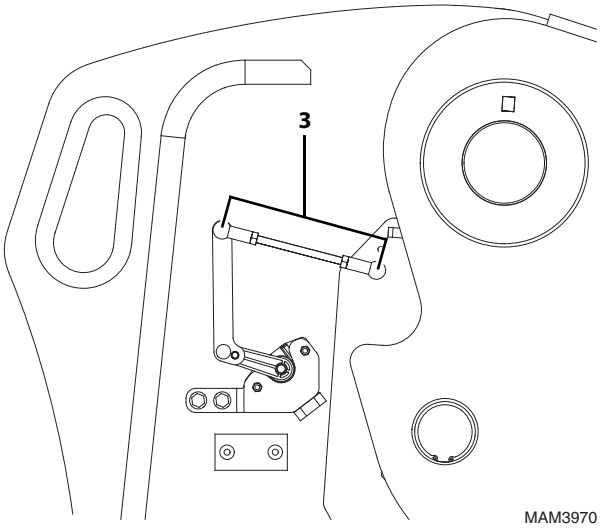
9.14.7 Boom Angle Sensor

The boom angle sensor is located at the top left inside rear of the boom.

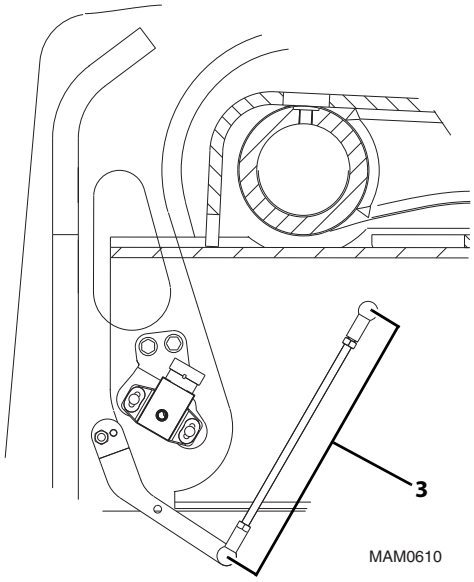
a. Boom Angle Sensor Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the engine to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Disconnect the boom angle sensor electrical connector.

TH336C, TH406C, TH337C & TH407C



TH414C, TH514C & TH417C



6. Loosen and remove the nut holding the rod assembly (**3**) to the sensor arm.
7. Loosen and remove the two bolts holding the sensor to the sensor bracket.
8. Remove the sensor assembly.
9. If necessary, remove the sensor bracket.

b. Boom Angle Sensor Inspection and Replacement

Inspect the sensor and the wiring harness connector terminals for continuity. Replace a defective or faulty sensor with a new sensor.

c. Boom Angle Sensor Installation

1. If necessary, install the sensor bracket.
2. Install the sensor assembly to the sensor seat and tighten both bolts.
3. Install the rod end to the sensor arm and tighten nut.
4. If necessary, measure and set the rod length (**3**) as required.

Machine	Rod Length
TH336C, TH406C, TH337C, TH407C	132.0 ± 2 mm (5.2 ± 0.07 in)
TH414C, TH514C, TH514C Platform & TH417C	220.0 ± 1 mm (8.7 ± 0.04 in)
TH414C Platform & TH417C Platform	215.0 ± 1 mm (8.5 ± 0.04 in)

5. Plug the electrical connector into the sensor assembly.
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Close and secure the engine cover.
8. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

d. Boom Angle Sensor Adjustment

1. Access Level 2 can be reached by pressing buttons **C** and **OK** at the same time.
2. Enter Access Level 2 password 33271.
3. Choose Calibration menu and select "Boom Angle".
4. Press **OK** button when asked "Calibrate Boom Angle Sensor?".
5. Follow prompts. First move boom to lowest position, press **OK** button.
6. Follow prompts. Move boom to highest position, press **OK** button.
7. If calibration is successful, Analyzer will indicate "Calibration: Complete".
   If calibration fails, Analyzer will indicate "Calibration Failed". The boom angle sensor position may need to be adjusted or the boom sensor rod may need adjusted.

9.14.8 Back-up Alarm

The back-up alarm is located at the rear of the machine.

When the transmission is shifted to the (R) REVERSE position, the back-up alarm will automatically sound.

Place the transmission in (R) REVERSE to test the back-up alarm. The back-up alarm must not sound when the transmission is in (N) NEUTRAL or (F) FORWARD.
Also, with the ignition key switch in the RUN position, the back-up alarm will sound when the transmission is shifted into the (R) REVERSE position.

a. Disassembly

Do Not disassemble the back-up alarm. Replace a defective or faulty alarm with a new part.

9.15 DASH SWITCHES

Note: *For information on the front windshield wiper, rear window wiper and washer systems, refer to Section 9.13, "Window Wiper System (if equipped)".*

9.15.1 Ignition Key Switch

a. Ignition Key Switch Removal

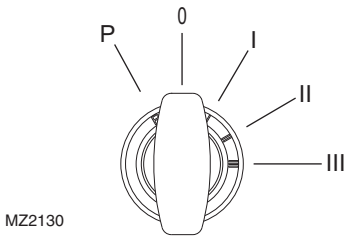
1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the engine to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Remove the screws securing the lower dash panel.
6. Remove the hex nut securing the ignition key switch to the dash.
7. Lower the dash panel to gain access to the rear of the ignition switch. Push the switch through the panel.
8. Label and disconnect the electrical connections attached to the switch.
9. Remove the switch from the machine.

b. Disassembly

Do Not disassemble the ignition key switch. Replace a defective switch with a new part.

c. Inspection and Replacement

To determine the proper operation of the ignition key switch, using the following chart, test the wires on the back of the switch for continuity with an ohmmeter.



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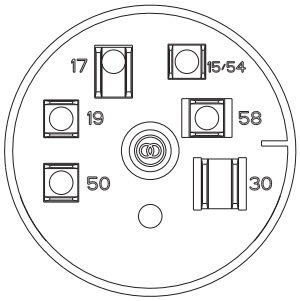

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Test the ignition key switch for continuity, by checking from the power (**#30**) wire to each of the following wires in each switch position. Continuity should be present as indicated in the following chart:

Switch Position	Test for Continuity Between Wire #30 and wires:
P	#58
I	#15
II	#15 & #19
III	#15, #17 & #50

If all connections do not show proper continuity, replace the ignition switch.

d. Ignition Key Switch Installation

1. Connect the previously labeled electrical connections to the ignition key switch.
2. Push the ignition key switch through the hole in the dash.
3. Secure the switch to the dash with the previously used hex nut.
4. Verify that each ignition position is properly connected.
5. Install the lower dash panel.
6. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
7. Close and secure the engine cover.
8. Start engine to verify proper operation of the ignition switch.
9. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.15.2 Dash Switches

a. Switch Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
3. Open the engine cover. Allow the system fluids to cool.
4. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.
5. Pull the frame out of the dash, disconnect the harness connector to the switch in question and push the switch out of the frame.

b. Disassembly

Do Not disassemble the dash switch. Replace a defective switch with a new part.

c. Inspection and Replacement

Inspect the switch terminals for continuity and shorting in both the engaged and disengaged positions. Replace a defective or faulty switch with a new switch.

d. Switch Installation

1. Connect the switch to the cab harness connector.
2. Position the switch over the rectangular switch bezel and snap into position.
3. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
4. Start the machine and check the replaced switch for proper function.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.

9.16 PLATFORM INTERLOCK CHECKS

To check the platform interlock, turn the ignition key to position I and be sure the following are set:

- Park brake is applied
- Transmission is in the (N) NEUTRAL
- Machine outriggers are fully lowered
- Machine is level
- Quick Coupler locking pin is installed

It is now possible to check the platform interlock.

1. Disengage the park brake. Turn the ignition key to the platform position. The machine should not engage in platform mode. Reapply the park brake.
2. Shift the transmission into (F) FORWARD or (R) REVERSE. The machine should not engage in platform mode. Shift the transmission back to the (N) NEUTRAL.
3. Raise the outriggers. The machine should not engage in platform mode. Lower the outriggers.
4. Unlevel the machine. The machine should not engage in platform mode. Level the machine.
5. Remove the quick coupler locking pin from the boom head. The machine should not engage in platform mode. Install the quick coupler locking pin.

With all the above conditions met for the machine to go into platform mode, turn the ignition key to the platform position.

1. Disengage the park brake. The machine should disable platform functions. Engage the park brake.
2. Shift the transmission to (F) FORWARD or (R) REVERSE. The machine should not drive in platform mode. Shift the machine to (N) NEUTRAL.
3. Raise the outriggers. The outriggers should NOT raise in platform mode.
4. Unlevel the machine. The machine should disable platform functions if the machine is not level. Level the machine.
5. Have an assistant remove the quick coupler locking pin. The machine should disable platform functions.

⚠ WARNING

While an assistant raises the boom. Do Not leave the cab unattended.

9.17 PLATFORM LOAD SYSTEM CHECK

Verify proper operation of the Load Sensing System (LSS).

1. Verify platform interlock works properly. Refer to Section 9.16, “Platform Interlock Checks”.
2. Apply park brake, shift transmission into (N) NEUTRAL, fully retract and lower the boom below 10 degrees.
3. Fully lower outriggers, lifting the front tires and ensure that the machine is level.
4. Shut off engine and rotate key to Platform position.
5. Remove key and ensure power/emergency stop switch is pulled up.
6. Exit cab and lock door.
7. Load a total weight of 450 - 540 kg (992 - 1,190 lb) including the operator weight into the platform and secure.
8. Enter platform, push and hold start switch. Release start switch after engine starts.
9. The platform overload indicator should be illuminated.
10. Hold trigger on the function enable control joystick.
11. Actuate the boom joystick.
12. If the LSS will not allow any platform movement, the system is working properly.
13. If platform moves the LSS is not working properly.
14. STOP and lower the platform. Shut engine off.
15. Place a Do Not Operate Tag on both the ignition key switch and steering wheel, stating that the machine should not be operated.
16. Contact the local Caterpillar dealer for assistance.

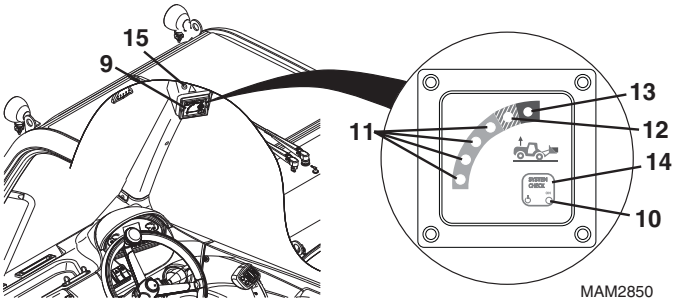
9.18 LOAD STABILITY INDICATOR (LSI) (CE & AUS)

9.18.1 Load Stability Indicator

WARNING

TIP OVER HAZARD. The LSI considers only longitudinal stability limitations, observe all operating parameters. Failure to follow operating parameters of the telehandler could damage the equipment and/or cause tip over.

Note: *The Load Stability Indicator is NOT a serviceable item. The LSI must be inspected and/or replaced by the local Caterpillar dealer.*



The LSI (**9**) provides visual and audible indication of forward stability limitations when machine is static on firm, level surface.

- Green LED (**10**) will illuminate when LSI power is on.
- When approaching forward stability limitations LEDs progressively illuminate, green (**11**), then orange (**12**) and finally red (**13**).
- If the red LED iluminates, the warning buzzer also sounds.

The LSI has two modes:

Active Mode (TH336C, TH337C, TH406C, TH407C, TH414C, TH514C & TH417C)

- As the telehandler reaches forward stability limitations and the red LED (**13**) illuminates, the automatic function cut-out is activated. All boom, frame level and outrigger functions are disabled except boom retract (CE & AUS) and boom lift (CE). Retract boom to fully re-enable functions.
- In some instances the LSI system may slow down or stop boom functions if operated close to forward stability limitations. When LEDs begin to flash, certain functions can not be operated. Retract boom and/or return the joystick to neutral position for a short period to allow system to reset and LEDs to stop flashing before proceeding with operation.

Passive Mode (TH336C, TH337C, TH406C & TH407C)

- The orange LED (**15**) illuminates when either of the following occurs:
  - The boom is fully retracted.
  - The park brake is not applied and transmission is in the forward or reverse position.
- When approaching forward stability limitations, visual and audible indication is provided and the automatic function cut-out and/or slow down feature is disabled.
- Travel in accordance with the requirements set forth in Section 1 - General Safety Practices.
- When placing a load, ensure axles are not fully steered in either direction.

WARNING

TIP OVER HAZARD. If the green, orange and red LEDs flash and warning buzzer sounds, retract and lower boom immediately. Determine cause and correct before continued use.

- Test the LSI (**14**) at the beginning of each work shift.

1. Fully retract and level the boom, with no load. Do not raise the boom during this test.
2. Level frame using level in cab.
3. Press the system check button on the LSI display. This will cause all LEDs to flash on and an audible warning to sound. This indicates that the system is functioning properly. If the test gives a different result, the system is not functioning properly and the machine must be removed from service and repaired before continued operation.

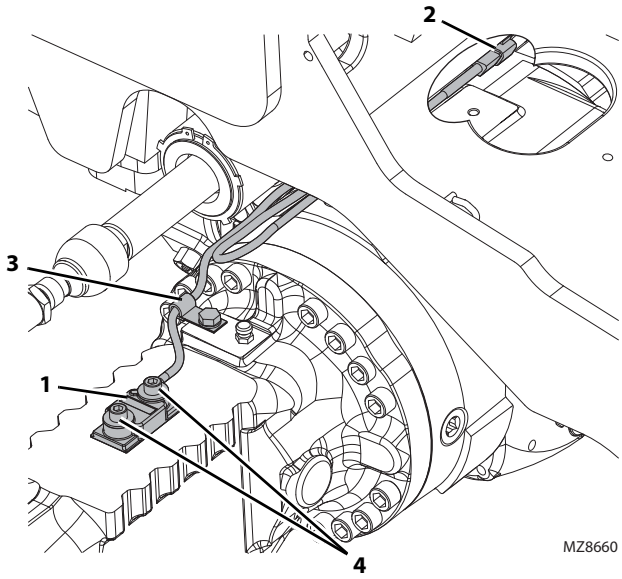
9.19 LSI SENSOR

The LSI sensor (**1**) is bolted on the top left of the rear axle.

Note: *If the rear axle is removed or replaced, the LSI Sensor must be installed AFTER the rear axle assembly is installed and setting on all four wheels.*

9.19.1 LSI Sensor Removal

1. Remove any attachment from the machine.
2. Park the machine on a firm, level surface, straighten all four wheels and drive the machine in a straight line for approximately 2 m (6.5 ft), level the machine using the cab mounted level, fully retract the boom, fully raise the boom, place the transmission in (N) NEUTRAL, engage the park brake and shut the engine OFF.
3. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel, stating that the machine should not be operated.
4. Open the engine cover. Allow the engine to cool.
5. Properly disconnect the battery. Refer to Section 9.11, "Battery", for procedure.



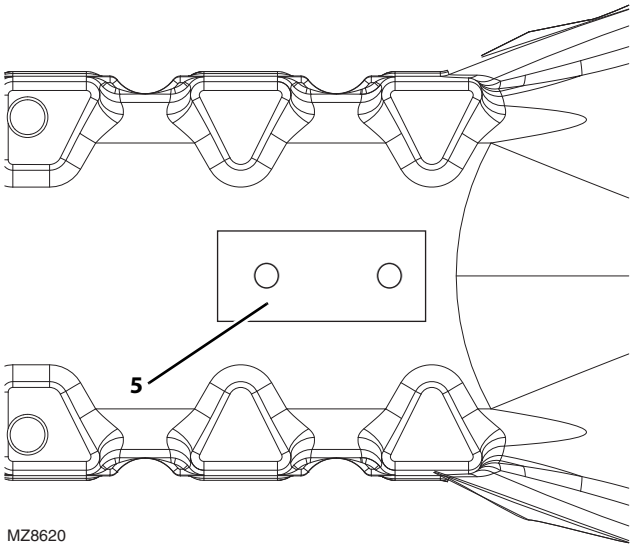
6. Disconnect the LSI sensor (**1**) at the electrical connection (**2**).
7. Loosen and remove P-Clamp (**3**).
8. Loosen, remove and discard the two bolts (**4**) holding the LSI assembly to the rear axle.
9. Remove and discard the sensor assembly.

9.19.2 LSI Sensor Installation

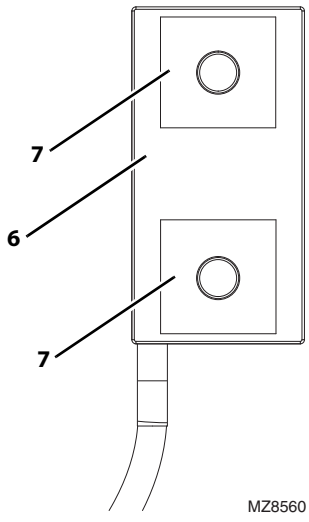
Note: *The machine **MUST** remain stationary for a minimum of two (2) hours.*

Note: *If there is any difficulty preparing the axle surface to mount the sensor, contact your local Caterpillar Dealer.*

1. Remove any adhesive and/or rust from the mounting area.
2. Ensure threads of both bolt holes are clean and free from rust, water and debris. If necessary, thread anM10 bottom tap through each hole. Verify holes are clean.



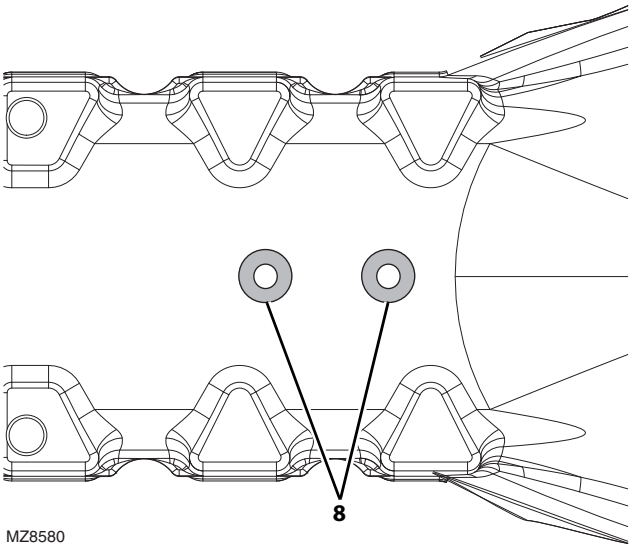
3. Clean the bare metal with degreasing agent, Loctite® 7063. Only use the necessary amount of degreasing agent to clean the mounting area (**5**).
4. Remove any excess degreasing agent and allow to dry.



5. Inspect the bottom of the new LSI sensor (**6**) to ensure the mounting area is clean.

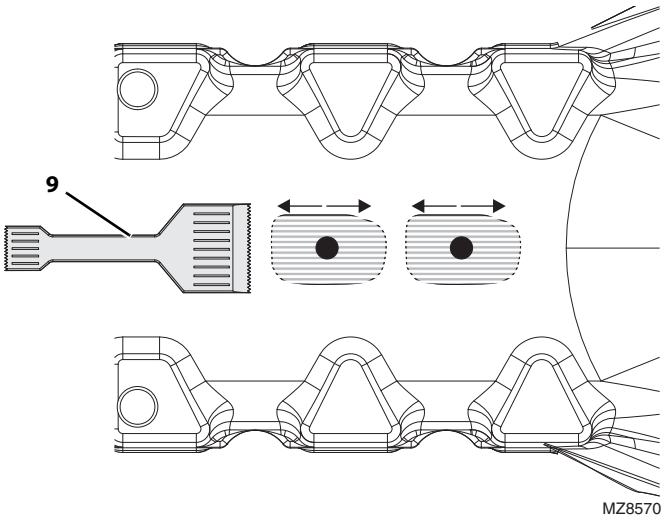
Note: *Install the sensor to the axle within one minute of applying activator and adhesive for optimum adhesion.*

6. Apply a thin film of Loctite® Initiator #1 (may also be denoted as Initiator #5) activator approximately 6 cm^2 (1 in^2) to each of the metallic surfaces of the sensor, ensuring the adhesive is spread evenly over the entire surface (**7**).



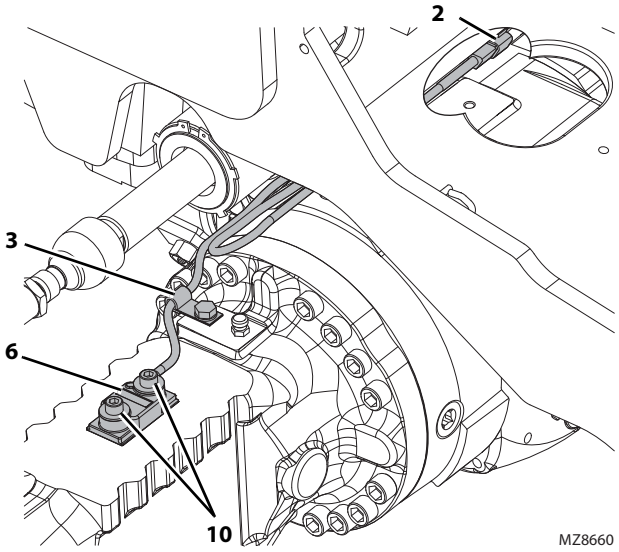
7. Apply an 3mm (0.125 in) bead of Loctite® A2460™ (F246) Adhesive to the axle surface area (**8**) around each mounting hole.

Note: *Follow manufacturer's recommendations for storage life. Other adhesives must NOT be used as a substitute for Loctite® A2460™ (F246).*



8. Use a spatula (**9**) to evenly distribute the adhesive over the axle surface area. Use the following sequence to minimize the amount of adhesive entering into the threaded holes and to distribute the adhesive properly.

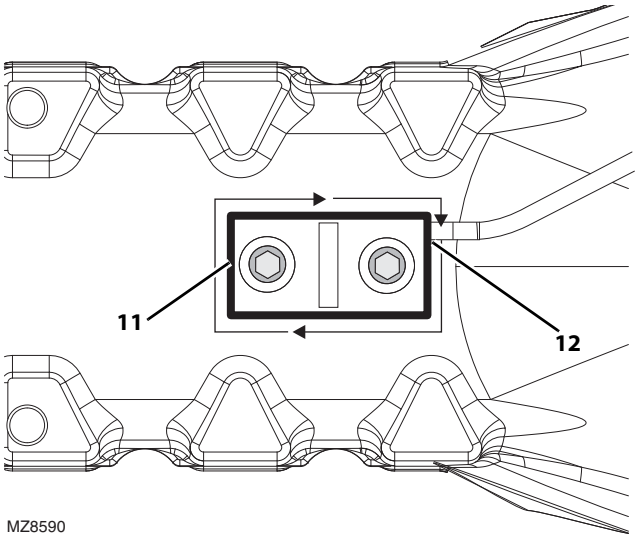
   A. Position the spatula (**9**) over the threaded hole.
   B. Move the spatula from the center of the hole to the left.
   C. Remove the excess adhesive from the spatula.
   D. Move the spatula from the center of the hole to the right.
   E. Repeat steps **A** thru **D** on remaining hole.



9. Fit the sensor (**6**) ensuring the lead exits in the corner direction. Secure with two new Bolts (**10**) in the following sequence:

   A. Tighten each bolt finger tight.
   B. Tighten each bolt to 30 - 35 Nm (22 - 26 lb-ft).
   C. Tighten each bolt to 70 - 80 Nm (51 - 59 lb-ft).

10. Scribe a permanent mark from each bolt head onto the sensor
11. Connect the LSI sensor (**6**) at the electrical connection (**2**).
12. Install the previously removed P-Clamp (**3**).



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13. Apply a Sealant (**11**) around the perimeter sensor in the following sequence:

    A. Start by positioning the nozzle under the harness lead (**12**) and apply a large bead of sealant (**11**) around the sensor.
    B. Ensure that you end the bead Over The Starting Point.
14. Using a spatula and soapy water, smooth the silicone around the sensor.
15. Plug the electrical connector into the sensor assembly.

Note: *Do Not move the machine for a minimum of 1 hour.*

16. Properly connect the battery. Refer to Section 9.11, "Battery", for procedure.
17. Close and secure the engine cover.
18. Remove the Do Not Operate Tag from the ignition key switch and the steering wheel.
19. Calibrate the LSI system, refer to Section 9.20, "LSI System Calibration".

9.20 LSI SYSTEM CALIBRATION

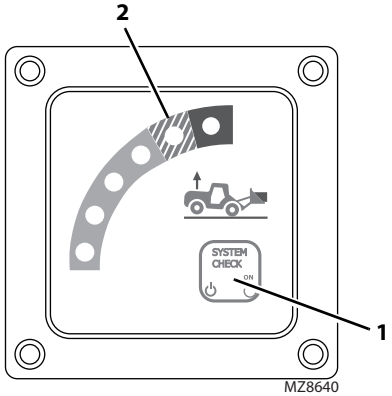
9.20.1 Standard Calibration

To calibrate the LSI, certain conditions must be met:

- The sensor must be installed according to Section 9.19, "LSI Sensor".
- The machine control system must be powered on for at least 3 minutes before calibration.
- The operator must remain in the cab.
- The calibration shall be conducted with the standard carriage and forks attached and weights as necessary (a range of 60 - 80% of maximum weight capacity).
- The machine must be on a level surface with the wheels steered straight and park brake off. drive the machine a distance of at least 2 m (6.5 ft) before entering the calibration point.
- Position the rear tires centrally on the scales.
- The calibration must be completed within 30 minutes after starting procedure.

Calibration Procedure:

1. Start and position the machine to perform the calibration procedure.
2. Remove the standard carriage and weight assembly.
3. Level and fully retract the boom and if equipped, fully lower the outriggers. Shut the machine OFF.



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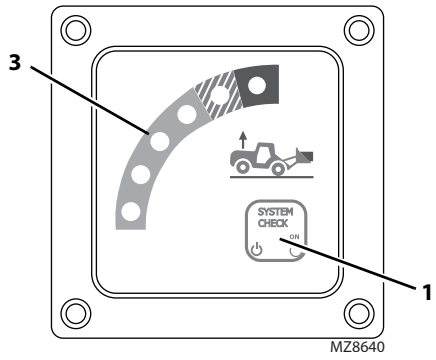
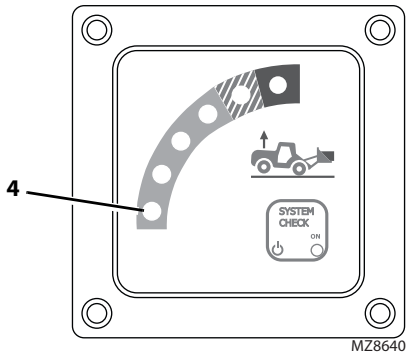
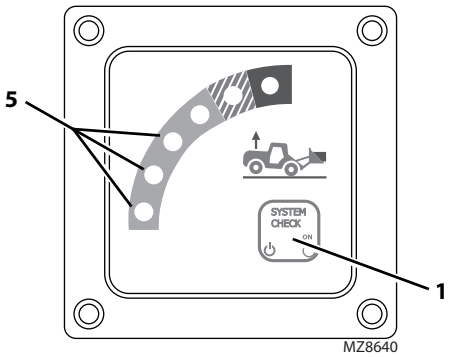
4. With ignition key in OFF position, press and hold SYSTEM CHECK button (**1**) on LSI display and turn ignition key to engine START position. Release the ignition key when engine start is achieved, but continue to hold SYSTEM CHECK button on LSI display until the orange LED (**2**) on LSI display goes out and buzzer sounds (approximately 3 seconds). Release SYSTEM CHECK button (**1**).



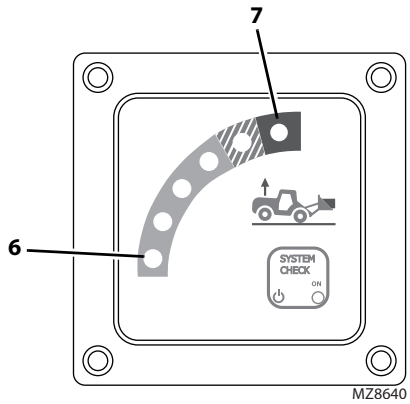
5. The LEDs will perform a rolling sequence. When only the third green LED illuminates (**3**), press the SYSTEM CHECK button (**1**).



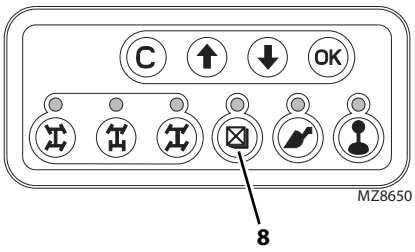
6. The first green LED then illuminates (**4**). With no attachment, outriggers fully down (if equipped) and boom fully retracted, lift boom to maximum boom angle.



7. Press the SYSTEM CHECK button (**1**) on the LSI display and release. The first 3 green LEDs will illuminate (**5**). The third then second green LEDs will go out as the calibration point is recorded.

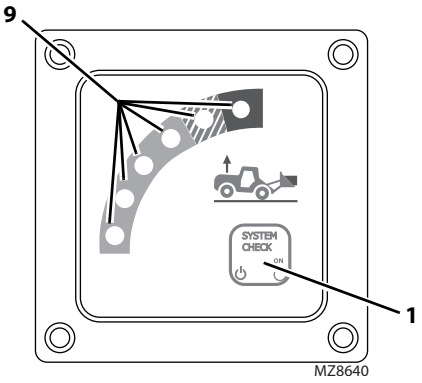


8. The first green LED goes out (**6**) and buzzer sounds then the red LED illuminates (**7**).



9. Lower boom until level. If equipped, fully raise outriggers. Pressing the LSI Override button (**8**) may be required to lower the boom.
10. Attach the previously removed standard carriage, forks and weight.
11. Slowly extend the boom until the rear axle weight in the following table is achieved.

Model	Weight on Rear Axle
TH336C	500 kg (1102 lb)
TH337C, TH406C, TH407C	600 kg (1323 lb)
TH414C, TH514C, TH417C	1000 kg (2205 lb)



12. Press the SYSTEM CHECK button (**1**) on the LSI display and release. As the calibration point is recorded, buzzer sounds and the LEDs (**9**) will flash and perform a sequence until all are flashing.
13. Turn engine Off. LSI is now calibrated.
14. Perform the LSI- CAN Check PT to finalize the calibration. Refer to Section 9.20.3, “LSI-CAN Check PT”.

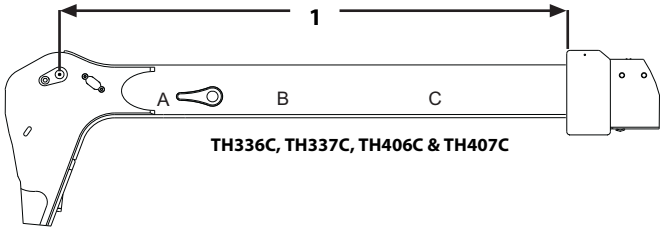
9.20.2 Field Calibration

Model	Market	Test Weight (W)	X Tip (1)	X Cal (2)	X Place (3)
TH336C	CE	3000 kg (6614 lb)	1228 mm (48 in)	918 mm (36 in)	NA
TH337C	CE	3000 kg (6614 lb)	1484 mm (58 in)	1082 mm (43 in)	NA
TH406C	CE, AUS	3000 kg (6614 lb)	1879 mm (74 in)	1476 mm (58 in)	NA
TH407C	CE, AUS	3000 kg (6614 lb)	1968 mm (77 in)	1586 mm (62 in)	NA
TH414C	CE	1000 kg (2205 lb)	2509 mm (99 in)	1916 mm (75 in)	1500 mm (59 in)
TH414C	AUS		2050 mm (81 in)	2259 mm (89 in)	1500 mm (59 in)
TH514C	CE	1000 kg (2205 lb)	3139 mm (124 in)	2592 mm (102 in)	1500 mm (59 in)
TH514C	AUS	2100 kg (4630 lb)	1942 mm (76 in)	1545 mm (61 in)	1500 mm (59 in)
TH417C	CE, AUS	1000 kg (2205 lb)	2050 mm (81 in)	1713 mm (67 in)	1500 mm (59 in)

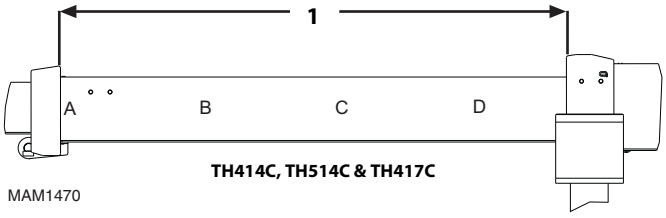
To calibrate the LSI, certain conditions must be met:

- The sensor must be installed according to Section 9.19, "LSI Sensor".
- The test weight matches the model being calibrated in the table shown above.
- The calibration shall be conducted with standard carriage and forks attached to the machine.

Note: *If the test weight is not known, follow steps 1 and 2.*



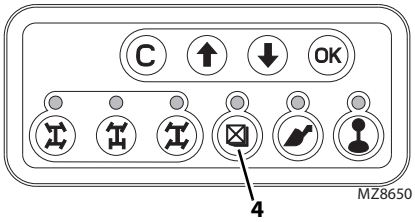
TH336C, TH337C, TH406C & TH407C



TH414C, TH514C & TH417C

MAM1470

1. With the estimated test weight on the forks, start the machine and extend the boom horizontally until the machine starts to tip. This point should be at an extension of X Tip (**1**) of the second boom section. If the machine is not tipping at this extension, weight needs to be added or removed from the forks.



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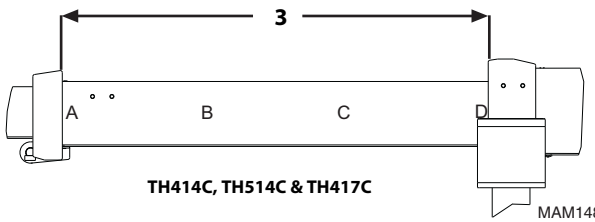
Pressing the LSI override button (**4**) up to 30 seconds may be required to reach tipping point.

2. By confirming that the machine tips at this point, the correct amount of weight is now on the forks.
3. The machine control system must be powered on for at least 3 minutes before calibration.
4. The machine must be on a level surface with the wheels steered straight, boom fully retracted, level and park brake OFF, with standard carriage, forks and test weight attached to the machine.
5. Drive the machine forward over a distance of at least 2 m (6.5 ft) before starting the calibration procedure.
6. Apply park brake.

Note: *If machine is equipped with outriggers, continue to step 7. If machine is NOT equipped with outriggers, proceed to step 8.*



TH414C, TH514C & TH417C

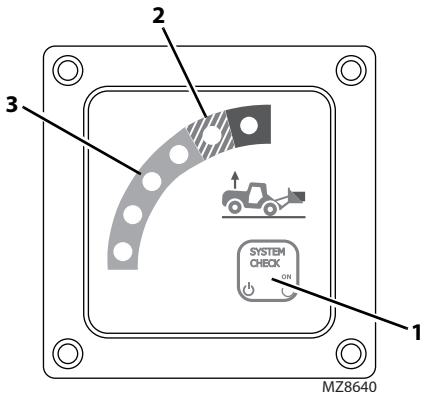
MAM1480

7. Detach standard carriage, forks and test weight at a minimum of distance of X Place (**3**) in front of the machine. Pressing the LSI override button (**4**) may be required.

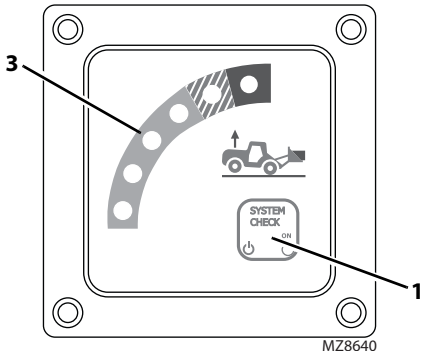
8. Fully retract and level the boom. Fully lower the outriggers (if equipped) and shut engine OFF. Pressing the LSI override button (**4**) may be required. Do Not move machine.

a. Field Calibration Procedure:

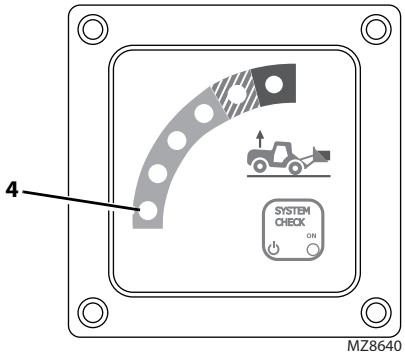
Note: *The following procedure must be completed within 30 minutes of starting the procedure.*



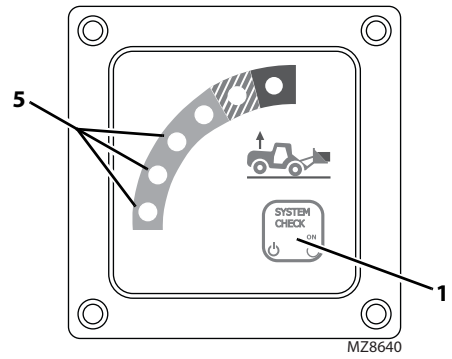
1. With ignition key in OFF position, press and hold SYSTEM CHECK button (**1**) on LSI display and turn ignition key to engine START position. Release the ignition key when engine start is achieved, but continue to hold SYSTEM CHECK button on LSI display until the orange LED (**2**) on LSI display goes out and buzzer sounds (approximately 3 seconds). Release SYSTEM CHECK button.



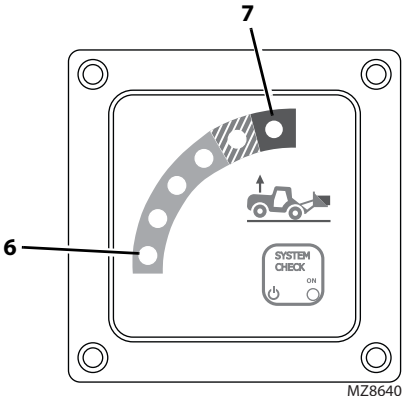
2. The LEDs will perform a sequence. When only the third green LED (**3**) illuminates, press the SYSTEM CHECK button (**1**).



3. The first green LED (**4**) then illuminates. With no attachment and boom retracted, lift boom fully to maximum boom angle.

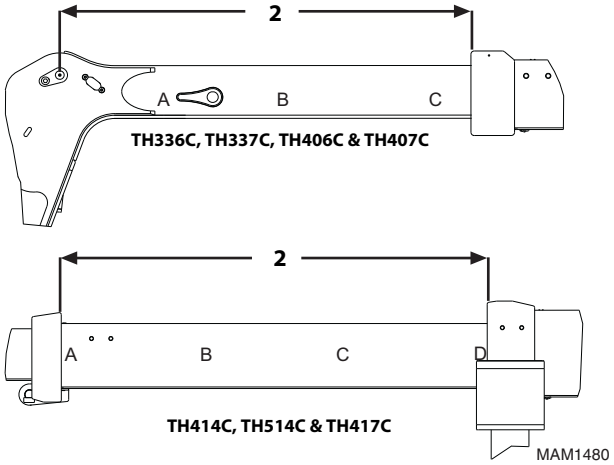


4. Press the SYSTEM CHECK button (**1**) on the LSI display and release. The first 3 green LEDs (**5**) will illuminate. The third then second green LEDs will go out as the calibration point is recorded.

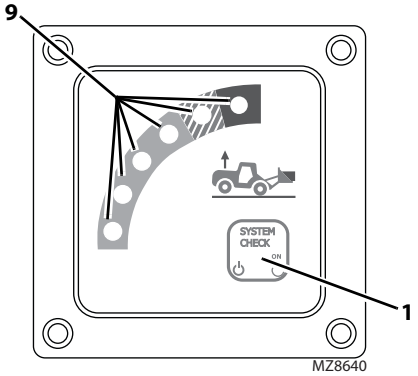


5. The first green LED (**6**) goes out and buzzer sounds then the red LED illuminates (**7**).

6. Lower boom and without moving the machine, attach standard carriage, forks and test weight (**W**) listed in the table. Pressing the LSI Override button (**4**) may be required to lower the boom.
7. Fully raise the outriggers (if equipped).



8. With the boom level, slowly extend the boom to a distance of X Cal (**2**). The proper calibration weight is now on the rear axle and the LSI can now be calibrated.



9. Press the SYSTEM CHECK button (**1**) on the LSI display and release. As the calibration point is recorded, buzzer sounds and the LEDs (**9**) will flash and perform a sequence until all are flashing.
10. Turn engine Off. LSI is now calibrated.
11. Perform the LSI- CAN Check PT to finalize the calibration. Refer to Section 9.20.3, "LSI-CAN Check PT".

9.20.3 LSI-CAN CHECK PT

With the LSI calibrated, the UGM also needs to be calibrated and verified.

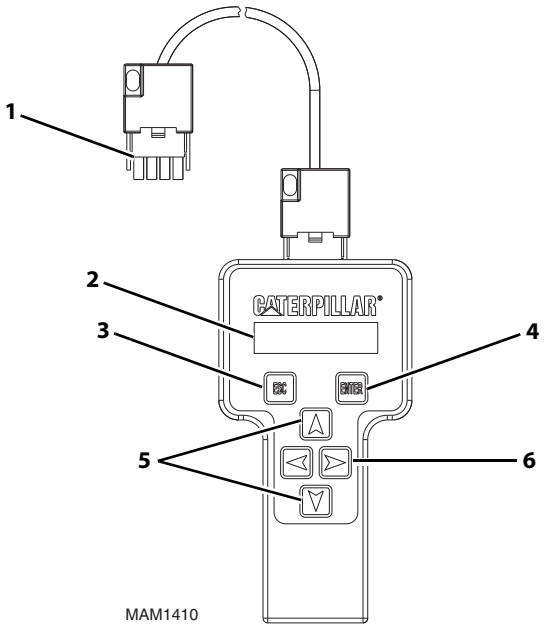
1. The machine must be on a level surface, wheels steered straight and park brake ON.
2. Start the machine.
3. Press the "C" and "OK" buttons simultaneously on the keypad or the analyzer.
4. Go to "ACCESS LEVEL 3" and press "OK".
5. Enter the proper access code and press "OK".
6. "ACCESS LEVEL 2" is now visible.
7. Go to "CALIBRATIONS" menu, press "OK".
8. Scroll to "LSI_CAN CHECK PT".
9. "SET LSI_CAN CHECK POINT", use the arrow keys to change "NO" to "YES".
10. Follow and execute the screen instructions:
    a. "Remove Weights and Attachments", press "OK".
    b. TH414C, TH514C and TH417C ONLY: "Fully deploy stabilizers", press "OK".
    c. "TELESCOPE IN and FULLY LIFT UP", press "OK".
    d. "STOP, WAIT ONE MINUTE", wait at least one minute and press "OK".
    e. "PRESS ENTER TO SET CHECK POINT", press "OK"
    f. Screen defaults back to "CALIBRATIONS: LSI_CAN CHECK POINT".
    g. Press "C" for approximate two seconds to return to normal display screen.
    h. LSI Can Check is now complete.
11. Return machine to service.

9.20.4 500 Hour - LSI UGM Calibration Check

1. The machine must be on a level surface, wheels steered straight and park brake ON.
2. Start machine
3. Press the "C" and "OK" buttons simultaneously on the keypad or the analyzer.
4. Go to "ACCESS LEVEL 3" and press "OK".
5. Enter the proper access code and press "OK".
6. "ACCESS LEVEL 2" is now visible.
7. Go to "OPERATOR TOOLS" menu, press "OK".
8. Scroll to "LSI_CAN SYSTEM CHECK".
9. "PERFORM LSI_CAN SYSTEM CHECK?", use the arrow keys to change "NO" to "YES".
10. Follow and execute the screen instructions:
    a. "Remove Weights and Attachments", press "OK".
    b. TH414C, TH514C and TH417C ONLY: "Fully deploy stabilizers", press "OK".
    c. "TELESCOPE IN and FULLY LIFT UP", press "OK".
    d. "STOP, WAIT ONE MINUTE", wait at least one minute and press "OK".
    e. "PRESS ENTER TO START TEST", press "OK".
    f. Screen will show: "PRESS ENTER TO START TEST: PASS".
    g. Must receive a "PASS".
    h. Press "C" for approximate two seconds to return to normal display screen.
    i. LSI UGM Calibration Check is now complete.
11. Return machine to service.

9.21 HAND HELD ANALYZER

The hand held analyzer can be used in place of the cab display panel.



1. Cable Connector.
2. Analyzer Display Screen.
3. Escape Key: To return home or access previous menu.
4. Enter Key: Stores and selects Top Level, Sub Level and Items Menus.
5. Up/Down Arrow Keys: Change adjustable values.
6. Left and Right Arrow Keys: Used to move between Top Level, Sub Levels and Item Menus.

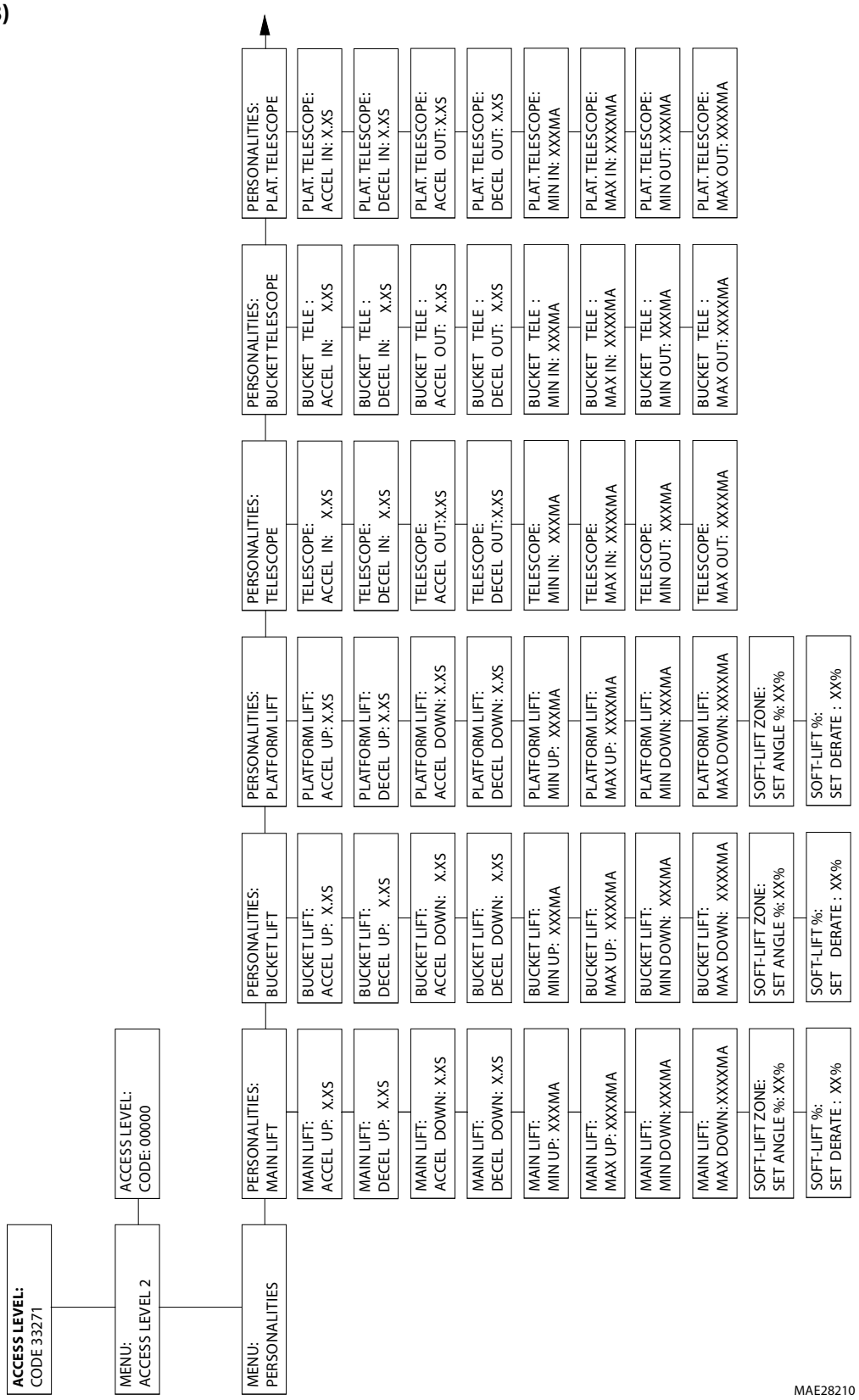
9.21.1 Analyzer Usage

Help messages can be viewed using the Analyzer (PN 330-5251). The Help messages can be accessed by pressing the ENTER key while viewing the current Help message. The Help message shall be EVERYTHING OK when no fault is present. The Analyzer cable plugs into the XQ connector of the PCB board located beside the operator seat.

For more information, contact the local Caterpillar dealer.

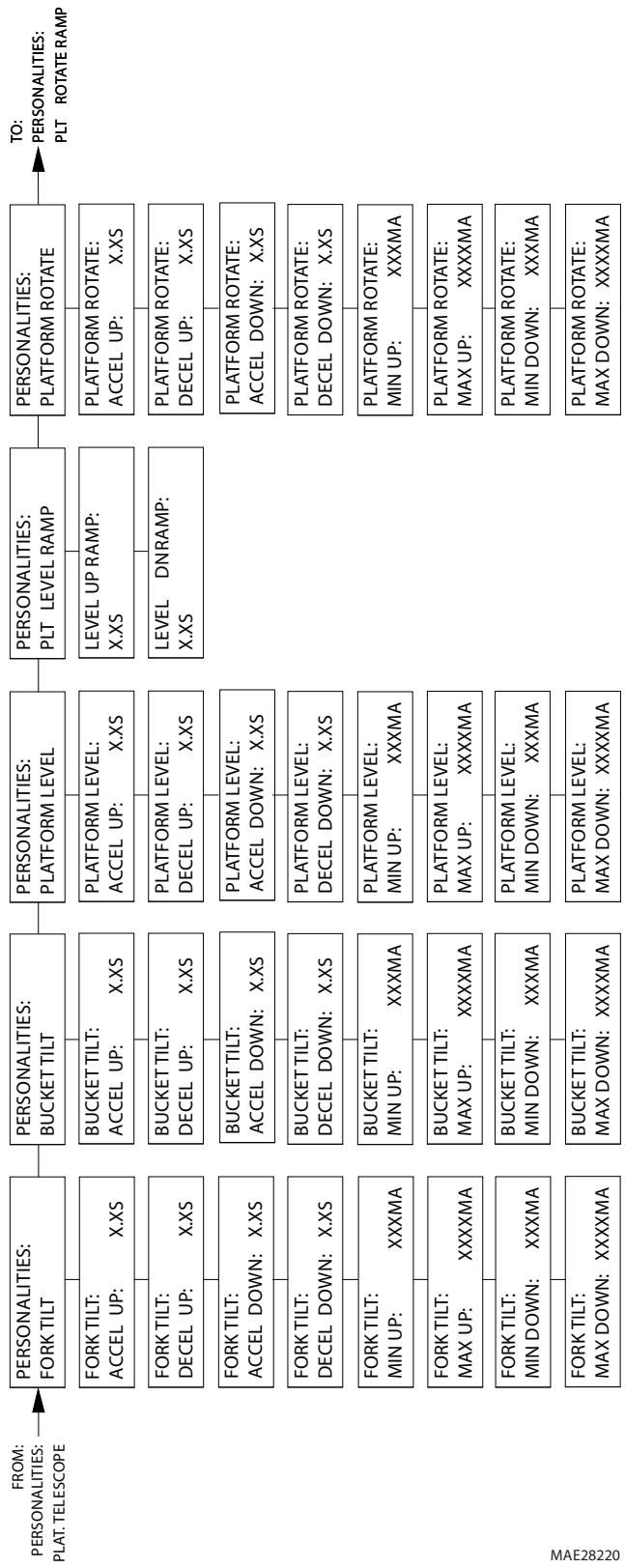
9.21.2 Analyzer Software Version P4.5

(Sheet 1 of 8)

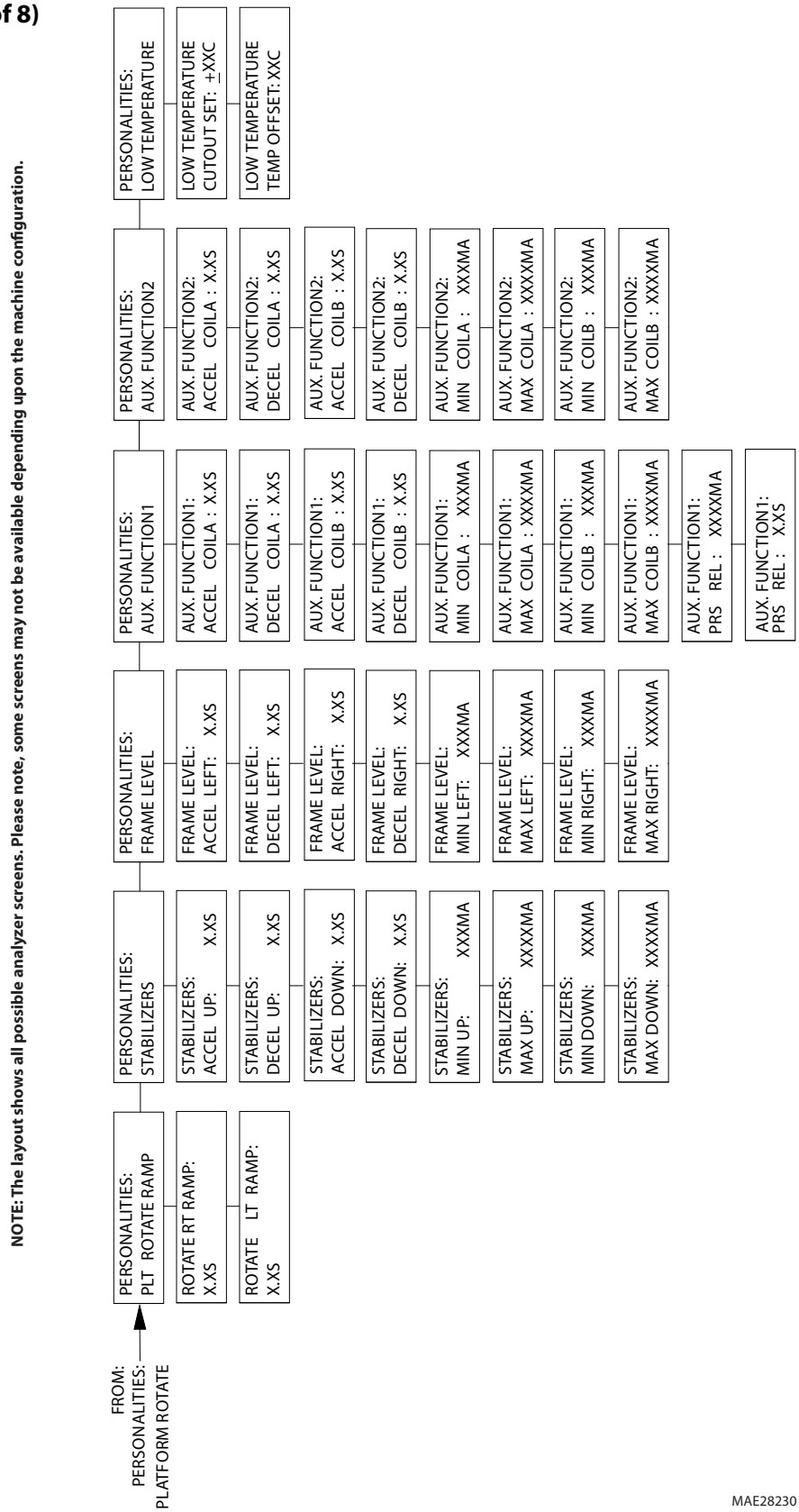


(Sheet 2 of 8)

NOTE: The layout shows all possible analyzer screens. Please note, some screens may not be available depending upon the machine configuration.



(Sheet 3 of 8)


NOTE: The layout shows all possible analyzer screens. Please note, some screens may not be available depending upon the machine configuration.
FROM: PERSONALITIES: PLATFORM ROTATE
PERSONALITIES: PLT ROTATE RAMP
ROTATE RT RAMP: X.XS
ROTATE LT RAMP: X.XS
PERSONALITIES: STABILIZERS
STABILIZERS: ACCEL UP: X.XS
STABILIZERS: DECEL UP: X.XS
STABILIZERS: ACCEL DOWN: X.XS
STABILIZERS: DECEL DOWN: X.XS
STABILIZERS: MIN UP: XXXMA
STABILIZERS: MAX UP: XXXXMA
STABILIZERS: MIN DOWN: XXXMA
STABILIZERS: MAX DOWN: XXXXMA
PERSONALITIES: FRAME LEVEL
FRAME LEVEL: ACCEL LEFT: X.XS
FRAME LEVEL: DECEL LEFT: X.XS
FRAME LEVEL: ACCEL RIGHT: X.XS
FRAME LEVEL: DECEL RIGHT: X.XS
FRAME LEVEL: MIN LEFT: XXXMA
FRAME LEVEL: MAX LEFT: XXXXMA
FRAME LEVEL: MIN RIGHT: XXXMA
FRAME LEVEL: MAX RIGHT: XXXXMA
PERSONALITIES: AUX. FUNCTION1
AUX. FUNCTION1: ACCEL COILA : X.XS
AUX. FUNCTION1: DECEL COILA : X.XS
AUX. FUNCTION1: ACCEL COILB : X.XS
AUX. FUNCTION1: DECEL COILB : X.XS
AUX. FUNCTION1: MIN COILA : XXXMA
AUX. FUNCTION1: MAX COILA : XXXXMA
AUX. FUNCTION1: MIN COILB : XXXMA
AUX. FUNCTION1: MAX COILB : XXXXMA
AUX. FUNCTION1: PRS REL : XXXXMA
AUX. FUNCTION1: PRS REL : X.XS
PERSONALITIES: AUX. FUNCTION2
AUX. FUNCTION2: ACCEL COILA : X.XS
AUX. FUNCTION2: DECEL COILA : X.XS
AUX. FUNCTION2: ACCEL COILB : X.XS
AUX. FUNCTION2: DECEL COILB : X.XS
AUX. FUNCTION2: MIN COILA : XXXMA
AUX. FUNCTION2: MAX COILA : XXXXMA
AUX. FUNCTION2: MIN COILB : XXXMA
AUX. FUNCTION2: MAX COILB : XXXXMA
PERSONALITIES: LOW TEMPERATURE
LOW TEMPERATURE CUTOUT SET: ±XXC
LOW TEMPERATURE TEMP OFFSET: XXC
MAE28230

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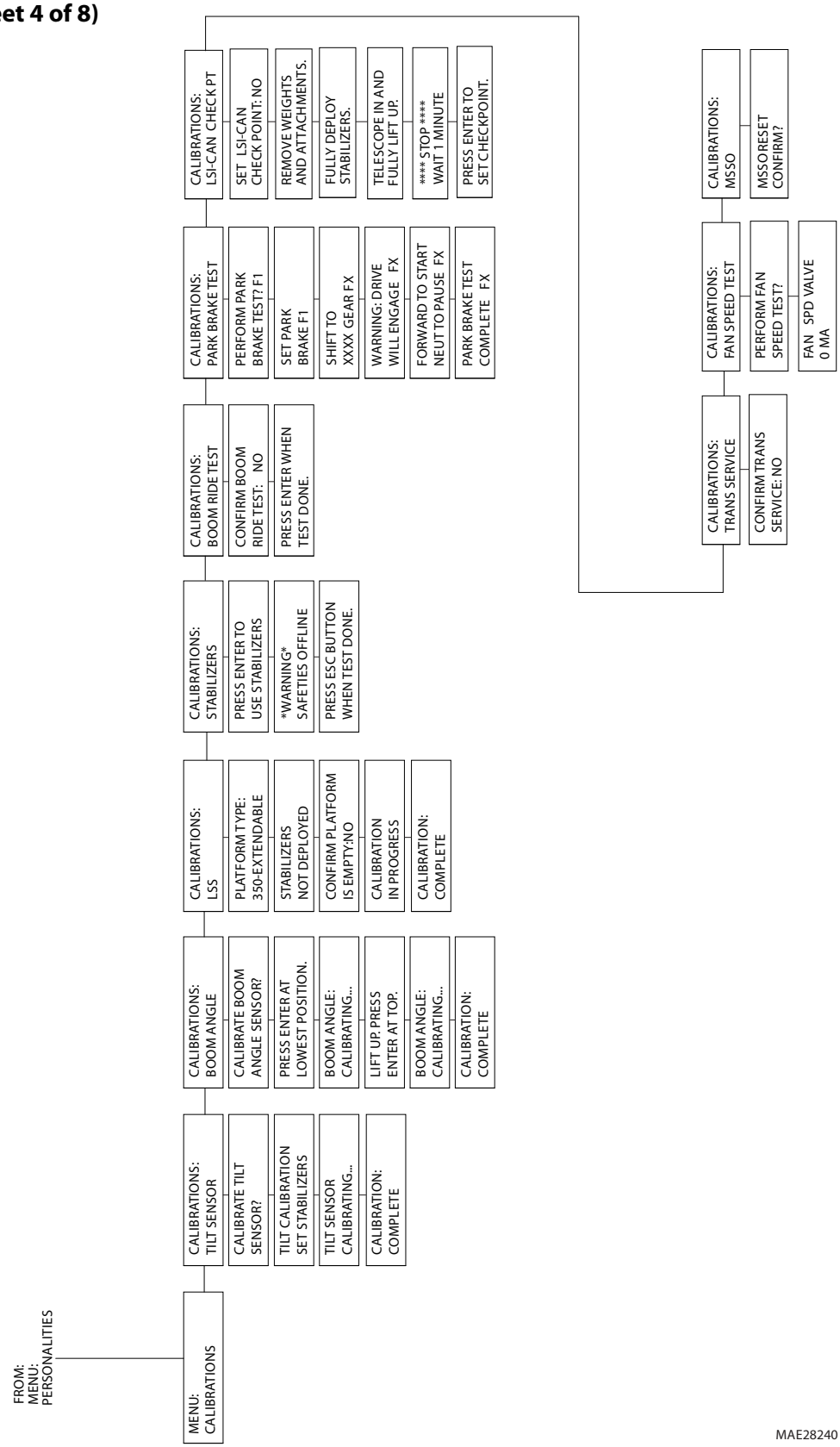
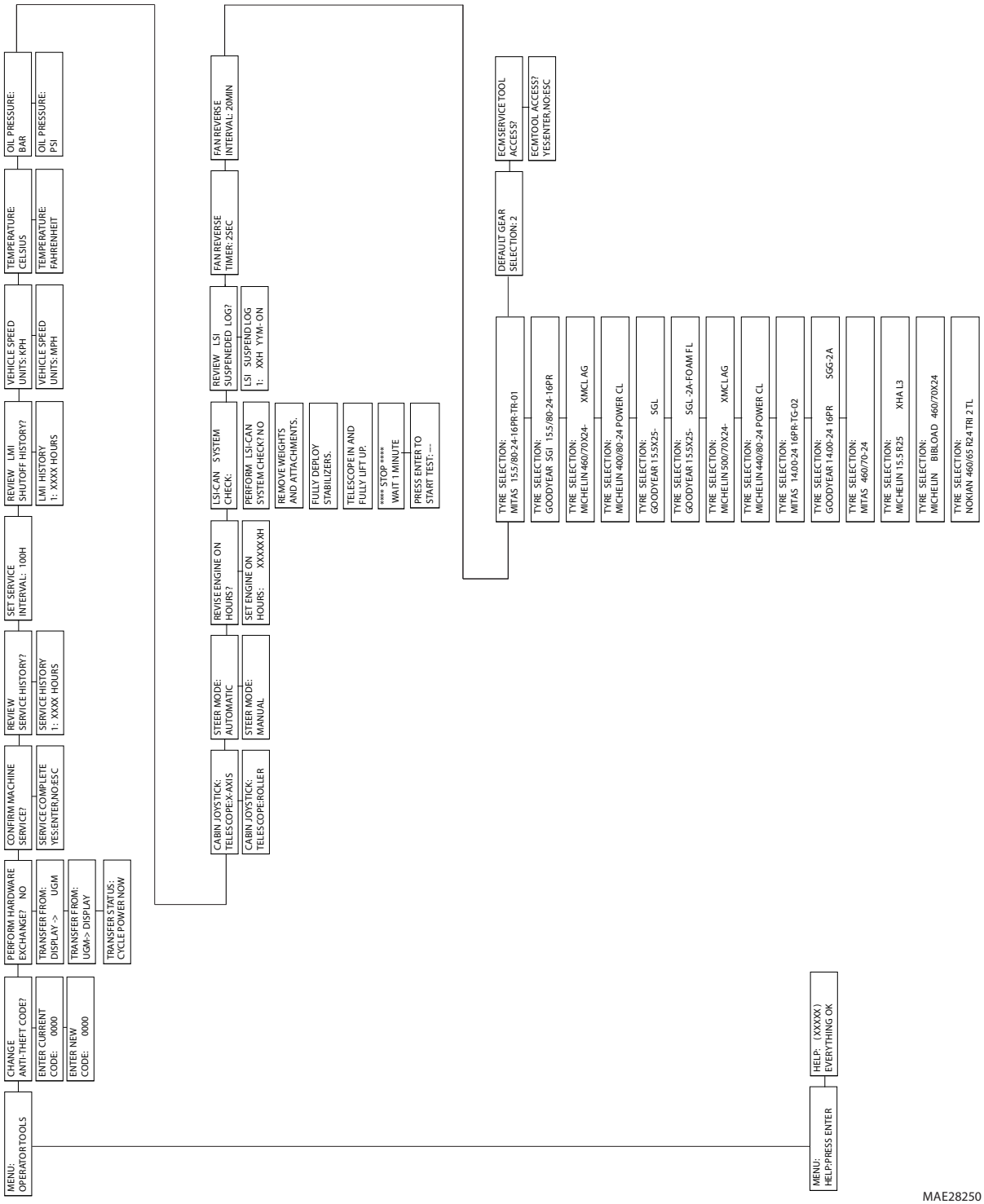
NOTE: The layout shows all possible analyzer screens. Please note, some screens may not be available depending upon the machine configuration.



MAE28240

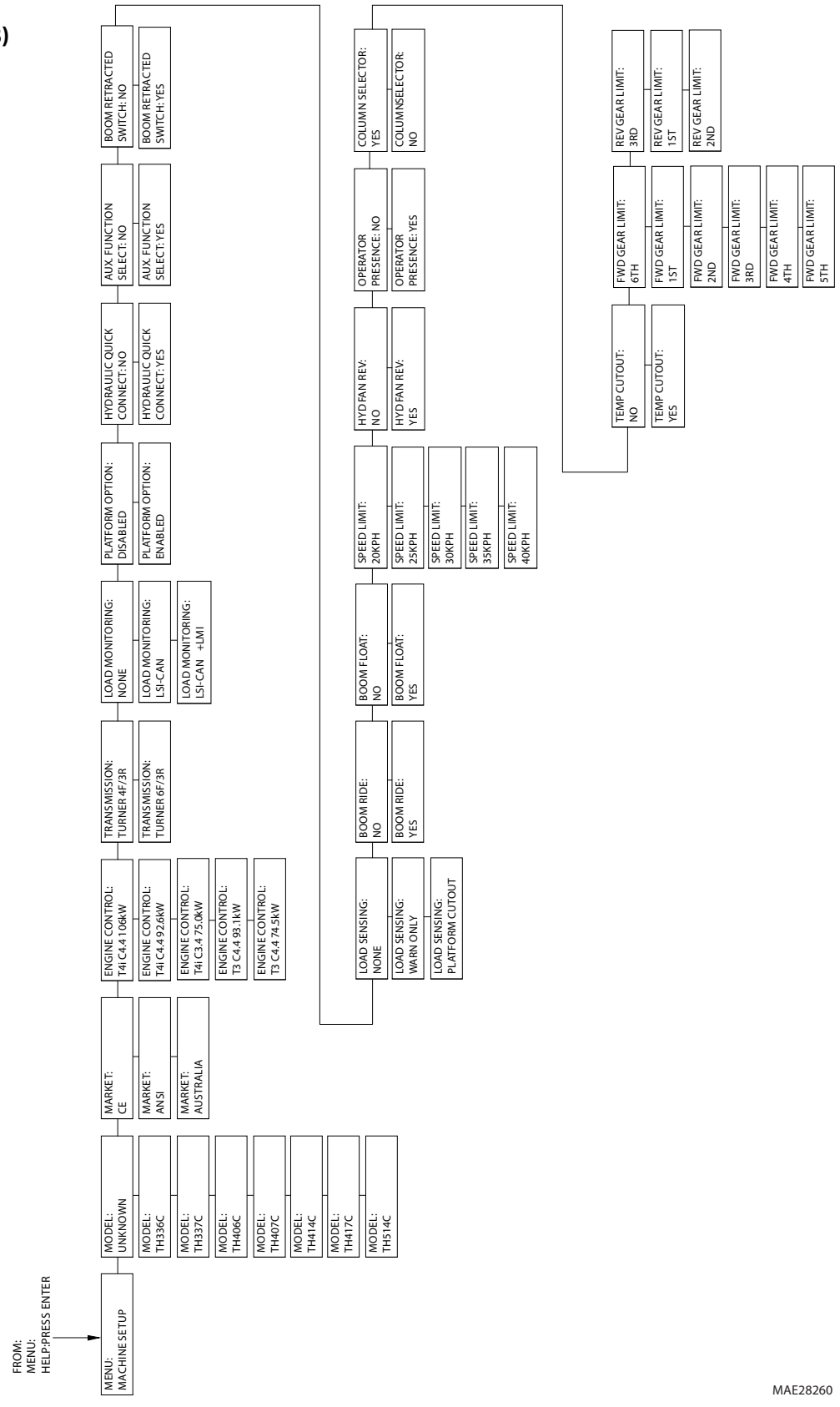
(Sheet 5 of 8)

NOTE: The layout shows all possible analyzer screens. Please note, some screens may not be available depending upon the machine configuration.



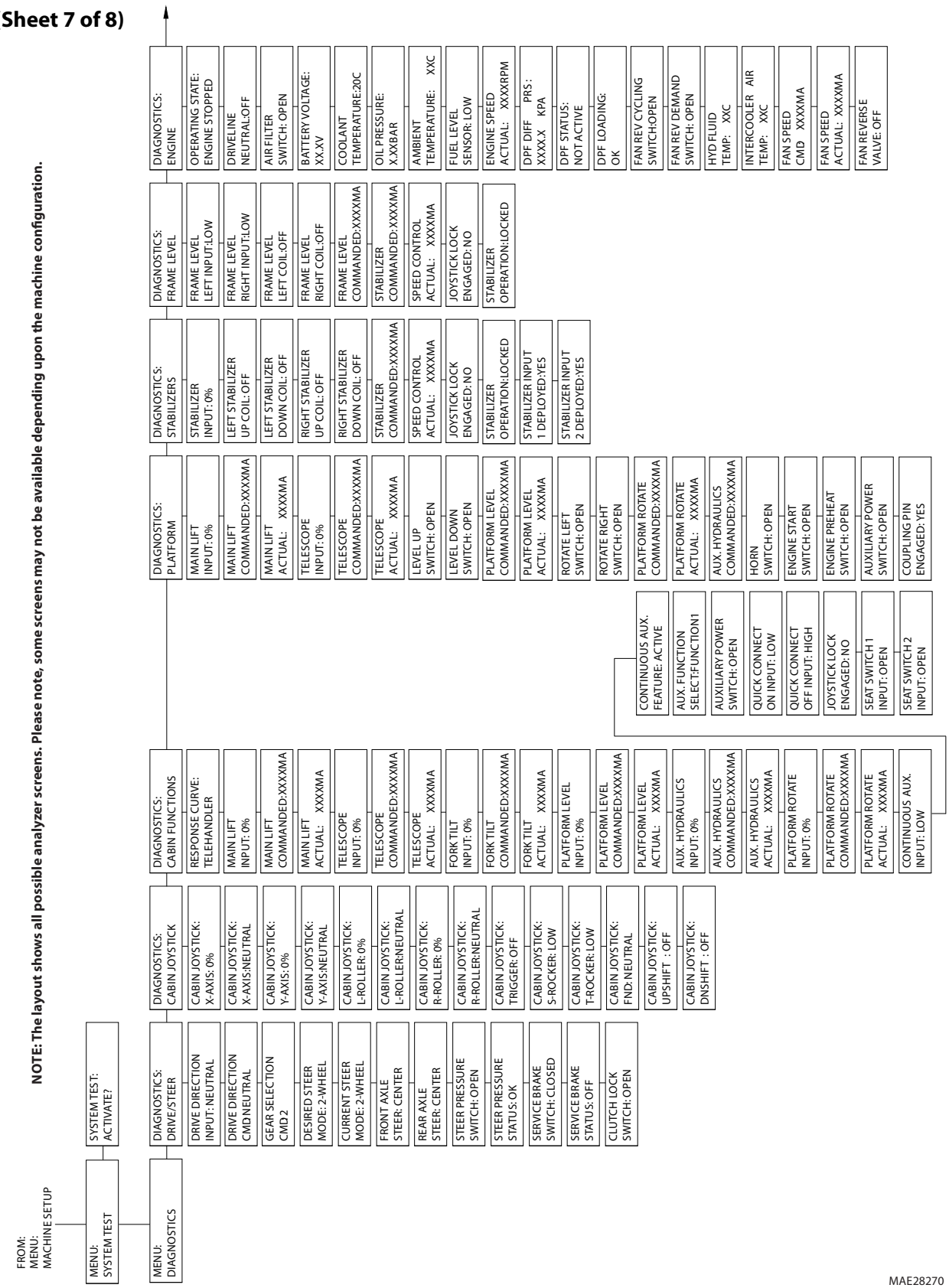
(Sheet 6 of 8)

NOTE: The layout shows all possible analyzer screens. Please note, some screens may not be available depending upon the machine configuration.



MAE28260

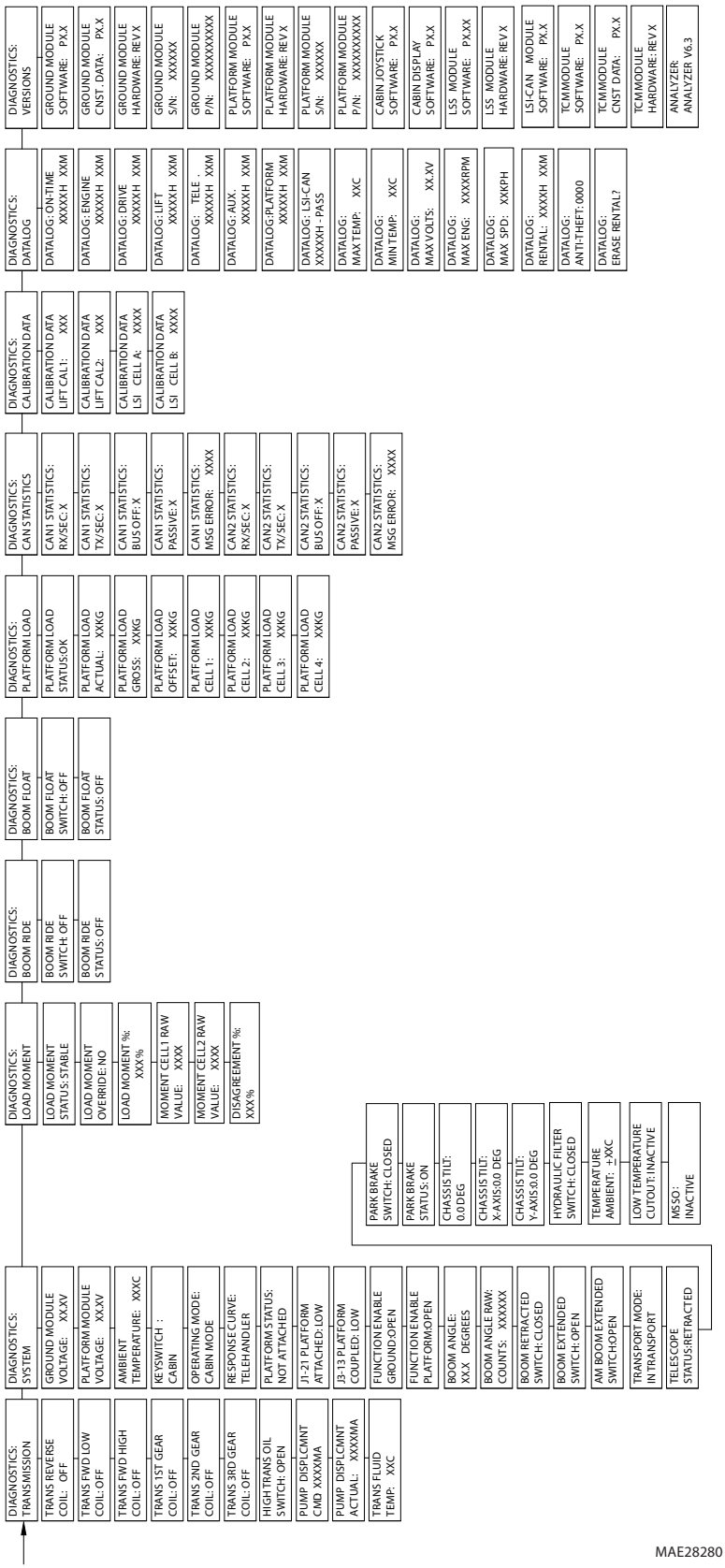
(Sheet 7 of 8)



MAE28270

(Sheet 8 of 8)

NOTE: The layout shows all possible analyzer screens. Please note, some screens may not be available depending upon the machine configuration.

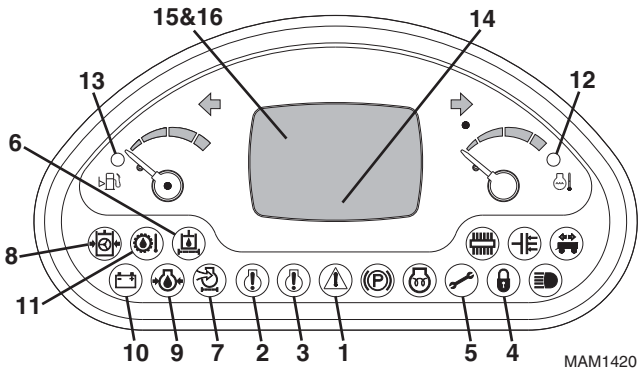


MAE28280

9.22 FAULT CODES

Active faults and fault memory will be displayed at the operator level of access. Active faults will also be displayed as a blink code at the controller on-board LED. The 25 previous faults are logged in fault memory, which can be accessed by choosing ENTER while viewing active fault messages.

9.22.1 Indicator Cross Reference Table



Indicator	Assignment
1	Machine System Distress
2	Engine Fault Warning
3	Engine Fault Critical
4	Machine Locked
5	Service
6	Hydraulic Filter Restriction
7	Air Filter Restriction
8	Low Steer Pressure
9	Low Engine Oil Pressure
10	Battery Low or Not Charging
11	High Transmission Oil Temperature
12	High Engine Coolant Temperature
13	Low Fuel Level
14	Platform Overloaded
15	Outriggers Not Deployed (Platform)
16	Chassis Not Level

9.23 MACHINE FAULT CODES

a. Help Comment

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
EVERYTHING OK	001	-	-	The system detects no problems exist.	-

b. Power-Up

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
POWER CYCLE	211	-	-	Power was cycled ON.	-
FUNCTION ENABLE INPUTS – INVALID SIGNAL STATES	214	Continuously	PLT J2-19 Function Enable Relay shall be de-energized Platform controls shall be prevented	Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; Keys witch Platform; PLT J2-19 Function Enable Relay is energized; PLT J7-8 & UGM J7-15 Function Enable Switch digital inputs are not complementary for 1000mS Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; Keys witch Platform; power-up; PLT J7-8 Function Enable Switch digital input is energized	Power cycled
JOYSTICK AXES NOT IN NEUTRAL POSITION AT POWER UP	215	5000mS	The cabin joystick X & Y axis input shall be ignored	The cabin joystick's X or Y axis is not neutral at power-up	The cabin joystick's X and Y axis return to neutral
JOYSTICK S1 BUTTON ACTIVE AT POWER UP	217	5000mS	The cabin joystick S1 push button (downshift) is prevented	The cabin joystick's S1 push button (downshift) is pressed at power-up	The push button is released
JOYSTICK S2 BUTTON ACTIVE AT POWER UP	218	5000mS	The cabin joystick S2 push button (upshift) is prevented	The cabin joystick's S2 push button (upshift) is pressed at power-up	The push button is released
ENGINE START PREVENTED – PLATFORM START SWITCH HIGH AT POWER UP	2111	5000mS	Platform Engine Start is prevented	Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; PLT J1-14 Engine Start Switch is closed at power-up	The switch is open momentarily
PLATFORM ROTATE LEFT PREVENTED – INPUT HIGH AT POWER UP	2112	5000mS	Platform Rotate Left & Right are prevented	Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; PLT J1-8 Platform Rotate Left Switch is closed at power-up	Power cycled
PLATFORM ROTATE RIGHT PREVENTED – INPUT HIGH AT POWER UP	2113	5000mS	Platform Rotate Left & Right are prevented	Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; PLT J1-7 Platform Rotate Right Switch is closed at power-up	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
PLATFORM LEVEL UP PREVENTED – INPUT HIGH AT POWER UP	2114	5000mS	Platform Level Up & Down are prevented	Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; PLT J1-9 Platform Level Up Switch is closed at power-up	Power cycled
PLATFORM LEVEL DOWN PREVENTED – INPUT HIGH AT POWER UP	2115	5000mS	Platform Level Up & Down are prevented	Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; PLT J1-10 Platform Level Down Switch is closed at power-up in platform mode	Power cycled
APU SWITCH INPUT INVALID – INPUT HIGH AT POWER UP	2116	5000mS	APU functionality is prevented Lift Up is prevented above +10° Telescope Out is prevented once the boom is fully retracted	Machine Setup's PLATFORM OPTION is ENABLED; Platform Attached; PLT J4-16 APU Enable Switch is closed at power-up	The switch is open momentarily (1,000mS)
PLATFORM JOYSTICK NOT IN NEUTRAL POSITION AT POWER UP	2117	5000mS	Main Lift and Telescope functions are prevented	Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; platform joystick is not in neutral position at power-up	The platform joystick returns to the neutral position
ENGINE PRE-HEAT PREVENTED – INPUT HIGH AT POWER UP	2118	5000mS	Engine pre-heat is prevented	Cabin Mode is active; UGM J4-20 Engine Pre-Heat is energized at power-up Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode is active; PLG J1-23 Engine Pre-Heat is energized at power-up	The switch is open momentarily (1,000mS)
FRAME LEVEL RIGHT INPUT – INVALID SIGNAL	2119	5000mS	Frame Level Left & Right are prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C and the UGM J4-17 Frame Leveling Right Switch is closed at power-up	Power cycled
FRAME LEVEL LEFT INPUT – INVALID SIGNAL	2120	5000mS	Frame Level Left & Right are prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C and the UGM J4-9 Frame Leveling Left Switch is closed at power-up	Power cycled
HYDRAULIC QUICK CONNECT INPUT – INVALID SIGNAL	2121	5000mS	Hydraulic Quick Connect is prevented	Machine Setup's HYDRAULIC QUICK CONNECT is YES; UGM J7-35 Hydraulic Quick Connect On is high at power-up Machine Setup's HYDRAULIC QUICK CONNECT is YES; UGM J3-10 Hydraulic Quick Connect Off is low at power-up Machine Setup's HYDRAULIC QUICK CONNECT is YES; UGM J7-35 Hydraulic Quick Connect On and UGM J3-10 Hydraulic Quick Connect Off are the same state for 500mS	Power cycled
CONTINUOUS AUXILIARY HYDRAULICS SWITCH HIGH AT POWER UP	2122	5000mS	Continuous Auxiliary Hydraulics are prevented	The cabin joystick's S switch is closed at power-up	The switch is open momentarily (1,000mS)

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
JOYSTICK TRIGGER SWITCH ACTIVE AT POWER UP	2123	5000mS	The cabin joystick trigger is prevented (Stabilizers, Boom Float)	The cabin joystick's trigger is pressed at power-up	The push button is released (150mS)
JOYSTICK LEFT ROLLER NOT IN THE NEUTRAL POSITION AT POWER UP	2124	5000mS	The ARF roller is prevented (Fork Tilt or Telescope)	The cabin joystick's left roller (ARF) is not neutral at power-up	The roller returns to neutral (150mS)
JOYSTICK RIGHT ROLLER NOT IN THE NEUTRAL POSITION AT POWER UP	2125	5000mS	The ARR roller is prevented (Auxiliary Hydraulics, Hydraulic Quick Connect)	The cabin joystick's right roller (ARR) is not neutral at power-up	The roller returns to neutral (150mS)
BOOM RIDE ENABLE SWITCH NOT IN THE OFF POSITION AT POWER UP	2130	5000mS	Boom Ride is prevented	Machine Setup's BOOM RIDE is YES; AM J1-3 Boom Ride Switch is closed at power-up	The switch is open momentarily (500mS)

c. Platform Controls

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
PLATFORM LEVEL - CONFLICTING INPUT SIGNALS	2225	5000mS	Platform Level Up & Down are prevented	Platform Mode; PLT J1-9 Platform Level Up Switch and PLT J1-10 Platform Level Down Switch are closed at the same time	Power cycled
PLATFORM ROTATE - CONFLICTING INPUT SIGNALS	2226	5000mS	Platform Rotate Left & Right are prevented	Platform Mode; PLT J1-8 Platform Rotate Left Switch and PLT J1-7 Platform Rotate Right Switch are closed at the same time	Power cycled
FUNCTION ENABLE INTERLOCK - ENABLE SWITCH NOT SELECTED FIRST	2227	5000mS	Platform controls are prevented	Platform Mode; Function Enable Switch is engaged after any of the following: Platform Level Down Switch (PLT J1 10) is closed Platform Rotate Left Switch (PLT J1-8) is closed Platform Rotate Right Switch (PLT J1-7) is closed Platform Lift Joystick (PLT J5-3) is not neutral Platform Telescope Joystick (PLT J5-4) is not neutral	The platform switch is opened and the platform joystick returns neutral
FUNCTION ENABLE INTERLOCK - NOT SELECTED IN TIME	2228	-	Platform controls are prevented	Platform Mode; Function Enable Switch is engaged (PLT J7-8 Function Enable Switch is open; UGM J7-15 Function Enable Switch is closed); 7,000mS expired before a hydraulic function was activated	Function Enable Switch is not engaged

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
ENGINE START PREVENTED - FUNCTION ENABLE SWITCH ENGAGED	2229	5000mS	Engine Start is prevented	Platform Mode; Function Enable Switch is engaged; Engine Start Switch (PLT J1-14) is closed	Function Enable Switch is not engaged; Engine Start Switch is open
PLATFORM JOYSTICK - OUT OF RANGE HIGH	2230	5000mS	Main Lift Up, Lift Down, Telescope In, and Telescope Out are prevented	Platform Mode; PLT J5-3 Main Lift Joystick wiper is out of range Platform Mode; PLT J5-4 Main Telescope Joystick wiper is out of range	Power cycled
PLATFORM JOYSTICK - CENTER TAP BAD	2231	5000mS	Main Lift Up, Lift Down, Telescope In, and Telescope Out are prevented	Platform Mode; PLT J5-2 Platform Lift Joystick center tap is out of range Platform Mode; PLT J5-5 Platform Telescope Joystick center tap is out of range	Power cycled
FUNCTION ENABLE RELAY - INVALID SIGNAL	2233	Continuously	PLT J2-19 Function Enable Relay shall be de-energized Engine Start is prevented Platform controls are prevented	Platform Mode; power-up; PLT J7-8 Function Enable Switch is energized or PLT J2-4 Function Integrity Signal is de-energized Platform Mode; 600mS after PLT J2-19 Function Enable Relay is energized; PLT J7-8 Function Enable Switch is de-energized or PLT J2-4 Function Integrity Signal is energized	Power cycled

d. Cab Controls

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
OPERATING MODE INTERLOCK – SHIFTER NOT IN NEUTRAL	239	5000mS	Engine Start is prevented Platform controls are prevented	Transition from Cabin to Platform Mode; cabin joystick's FNR switch is not in the neutral position	Cabin joystick's FNR switch is set to neutral
PLATFORM OPTION NOT CONFIGURED	2311	Continuously	Platform controls shall be prevented	Machine Setup's PLATFORM OPTION is DISABLED; UGM J1-21 Platform Attached is grounded, Platform Module CAN bus is detected, or keys witch is in Platform Mode	Power cycled
OPERATING MODE INTERLOCK – STABILIZERS NOT DEPLOYED	2315	5000mS	Lift Up and Telescope Out are prevented when the boom angles is greater than +10° (after power-up) Lift Down is prevented when the boom angle is greater than +10° and the Boom Retracted Switch is open (not fully retracted; after power-up)	Keys witch Platform; Stabilizer Deployed 1 Switch is not deployed Keys witch Platform; Stabilizer Deployed 2 Switch is not deployed	Stabilizer Deployed 1 and 2 are deployed

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
OPERATING MODE INTERLOCK – PLATFORM NOT ATTACHED	2316	5000mS	Platform controls are prevented Engine start is prevented	Keys witch Platform; Machine Setup's PLATFORM OPTION is ENABLED; Platform Attached (UGM J1-21) is not grounded	Platform Attached UGM J2-21 is grounded
OPERATING MODE INTERLOCK – CHASSIS NOT LEVEL	2317	5000mS	Main Lift Up, Lift Down, Telescope In, and Telescope Out function speeds are reduced when the chassis is tilted and the engine is running (after power-up) Telescope Out is prevented when the chassis is excessively tilted (after power-up) *Refer to Chassis Tilt Sensor functionality*	Keys witch Platform; chassis is tilted or excessively tilted (refer to Chassis Tilt Sensor functionality)	Cabin mode is selected The chassis tilt is within acceptable limits
OPERATING MODE INTERLOCK – BOOM ANGLE TOO HIGH	2318	5000mS	Engine start is prevented	Machine Setup's PLATFORM OPTION is ENABLED; boom angle is greater than +10°; a transition from cabin to platform or platform to cabin is in progress	Boom angle is less than +10°
OPERATING MODE INTERLOCK – BOOM NOT FULLY RETRACTED	2319	5000mS	Engine start is prevented	Machine Setup's PLATFORM OPTION is ENBALED; the boom is not retracted; a transition from cabin to platform or platform to cabin is in progress	Boom is fully retracted
OPERATING MODE INTERLOCK – PARK BRAKE NOT SET	2320	5000mS	Engine start is prevented Hydraulic functions are prevented	Machine Setup's PLATFORM OPTION is ENABLED; the Park Brake Switch UGM J4-5 is open (released); a transition from cabin to platform or platform to cabin is in progress	Park Brake is applied
ERRATIC PLATFORM ATTACHED SIGNAL	2321	5000mS	The control system shall assume that the platform is attached	Machine Setup's PLATFORM OPTION is ENABLED; Platform Attached UGM J1-21 detects three signal transitions with 5,000mS	Power cycled
CONFLICTING FRAME LEVEL SIGNALS	2322	5000mS	Frame Level Left and Frame Level Right are prevented	UGM J4-9 Frame Level Left and UGM J4-17 Frame Level Right digital inputs are energized together	Power cycled
CABIN JOYSTICK – X AXIS FAULT	2323	Continuously	Cabin joystick X-axis is prevented	Cabin joystick transmits a DM1 (SPN:FMI) with 2660:14, 520196:3, 520196:4, 520197:3, 520197:4 Cabin joystick transmit 1022 as the X-Axis position Cabin joystick transmits Error (1:0) for the X-Axis Neutral, Left, or Right Position	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
CABIN JOYSTICK – Y AXIS FAULT	2324	Continuously	Cabin joystick Y-axis is prevented	Cabin joystick transmits a DM1 (SPN:FMI) with 2661:14, 520198:3, 520198:4, 520199:3, 520199:4 Cabin joystick transmits 1022 as the Y-Axis position Cabin joystick transmits Error (1:0) for the Y-Axis Neutral, Forward, or Backward Position	Power cycled
CABIN JOYSTICK – S1 BUTTON FAULT	2326	Continuously	S1 & S2 buttons are prevented (downshift & upshift)	Cabin joystick transmits Error (1:0) for the S1 (downshift) button	Power cycled
CABIN JOYSTICK – S2 BUTTON FAULT	2327	Continuously	S1 & S2 buttons are prevented (downshift & upshift)	Cabin joystick transmits Error (1:0) for the S2 (upshift) button	Power cycled
CABIN JOYSTICK – S SWITCH FAULT	2330	Continuously	S switch function requests will be ignored by the UGM (Continuous Auxiliary; Auxiliary Pressure Release)	Cabin joystick transmits Error (1:0) for the S switch (Continuous Auxiliary; Auxiliary Pressure Release) button	Power cycled
CABIN JOYSTICK – T SWITCH FAULT	2331	Continuously	Auxiliary 1 / 2 Select Valve is de-energized	Cabin joystick transmits Error (1:0) for the T switch (Auxiliary 1 / 2) button	Power cycled
HYDRAULIC FILTER RESTRICTION	2332	5000mS	–	Ten minutes after power-up, UGM J2-24 Hydraulic Filter Restriction Switch digital input is grounded for 3,000mS	UGM J2-24 Hydraulic Filter Restriction Switch digital input is not grounded for 1,000mS
ALL WHEEL STEER INPUT – INVALID SIGNAL	2333	5000mS	All Wheel Steer Mode Switch is ignored	UGM J4-35 All Wheel Steer digital input is energized at power up or for 7,000mS	Power cycled
CRAB STEER INPUT – INVALID SIGNAL	2334	5000mS	Crab Steer Mode Switch is ignored	UGM J4-34 Crab Steer digital input is energized at power up or for 7,000mS	Power cycled
JOYSTICK LOCK INPUT – INVALID SIGNAL	2335	5000mS	Joystick Lock Switch is ignored	Machine Setup's MARKET is CE or AUSTRALIA; UGM J7-11 Joystick Lock digital input is energized at power up or for 7,000mS	Power cycled
LOAD MOMENT SHUTOFF INPUT – INVALID SIGNAL	2336	5000mS	Load Moment Shutoff Switch is ignored	Machine Setup's MARKET is CE or AUSTRALIA; UGM J4-33 Load Moment Shutoff digital input is energized at power up or for 40 Seconds	Power cycled
BUCKET MODE INPUT – INVALID SIGNAL	2337	5000mS	Bucket Mode Switch is ignored Fork Tilt Mode is engaged	UGM J4-19 Bucket Mode digital input is energized at power up or for 7,000mS	Power cycled
2–WHEEL STEER INPUT – INVALID SIGNAL	2338	5000mS	2-Wheel Steer Switch is ignored	UGM J3-9 2-Wheel Steer digital input is energized at power up or for 7,000mS	Power cycled
KEYPAD OK BUTTON – INVALID SIGNAL	2339	5000mS	Keypad OK button is ignored	The keypad OK button is closed at power up or for 7,000mS	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
KEYPAD CANCEL BUTTON – INVALID SIGNAL	2340	5000mS	Keypad Cancel button is ignored	The keypad Cancel button is closed at power up or for 7,000mS	Power cycled
KEYPAD UP BUTTON – INVALID SIGNAL	2341	5000mS	Keypad Up button is ignored	The keypad Up button is closed at power up or for 7,000mS (except in Analyzer Mode)	Power cycled
KEYPAD DOWN BUTTON – INVALID SIGNAL	2342	5000mS	Keypad Down button is ignored	The keypad Down button is closed at power up or for 7,000mS (except in Analyzer Mode)	Power cycled
BOOM ANGLE SENSOR – NOT CALIBRATED	2343	5000mS	Boom angle sensor reading is +99° Lift Up is de-rated to 60% (Constant Data) of the maximum personality for Cabin Mode Lift Up is de-rated to 20% (Constant Data) of the maximum personality for Platform Mode Hydraulic Quick Connect is allowed despite boom angle (DFM) Platform controls shall be prevented	The UGM detects that a valid boom angle sensor calibration has not been performed	The Boom Angle Sensor Calibration procedure is performed successfully
BOOM ANGLE SENSOR – OUT OF RANGE HIGH	2344	5000mS	Boom angle sensor reading is +99° Lift Up is de-rated to 60% (Constant Data) of the maximum personality for Cabin Mode Lift Up is de-rated to 20% (Constant Data) of the maximum personality for Platform Mode	Machine Setup's PLATFORM OPTION is DISABLED; UGM J7-4 Boom Angle Sensor analog input is more than 4.5V	Power cycled
BOOM ANGLE SENSOR – OUT OF RANGE LOW	2345	5000mS	Boom angle sensor reading is +99° Lift Up is de-rated to 60% (Constant Data) of the maximum personality for Cabin Mode Lift Up is de-rated to 20% (Constant Data) of the maximum personality for Platform Mode	Machine Setup's PLATFORM OPTION is DISABLED; UGM J7-4 Boom Angle Sensor analog input is less than 0.6V	Power cycled
BOOM ANGLE SENSOR – NOT RESPONDING	2346	5000mS	Boom angle sensor reading is +99° Lift Up is de-rated to 60% (Constant Data) of the maximum personality for Cabin Mode Lift Up is prevented if the platform is attached in Cabin Mode All functions are prevented in Platform Mode	Main Lift Up or Down valve current greater than 900mA; the engine is running; BOOM ANGLE SENSOR – NOT CALIBRATED (2342) not active; BOOM ANGLE SENSOR – OUT OF RANGE HIGH (2344) not active; BOOM ANGLE SENSOR – OUT OF RANGE LOW (2345) not active; LIFT – CURRENT FEEDBACK READING TOO LOW (33287) not active; boom not within +3.0° of mechanical stop; boom angle > +10° (for bucket tear out capability); boom angle sensor does not change at least 0.5° in 4,000mS; DEBUG à BOOM NR is NO	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
SYSTEM INTERLOCK – SET JOYSTICK INPUTS TO NEUTRAL	2347	-	The cabin joystick's X-Axis, Y-Axis, ARL roller, and ARR roller are prevented	Engine is running, cabin mode, the cabin joystick is not neutral, and one of the following situations occurs. Hydraulic Quick Connect functionality is activated or de-activated Auxiliary Pressure Release (S Switch) is closed but the function is not activated Bucket mode is active and Platform becomes attached or coupled BUCKET MODE INPUT – INVALID SIGNAL (2337) fault becomes active Joystick Lock is initiated CANBUS FAILURE – CABIN JOYSTICK (6617) fault becomes active	Entire cabin joystick is neutral momentarily
ENGINE START INPUT – INVALID SIGNAL	2348	5000mS	Engine Start is prevented	UGM J4-8 Engine Start digital input energized after the engine is running for more than 7,000mS	The switch is open momentarily (1,000mS)
LIFT ANGLE DERATED – STABILIZERS NOT DEPLOYED	2349	5000mS	Lift Up is prevented	Machine Setup's MODEL is TH417C; Cabin Mode; at least one Stabilizer is not deployed; platform is not attached; Lift Up attempted; boom angle > +60° Machine Setup's MODEL is TH514C; Cabin Mode; at least one Stabilizer is not deployed; platform is not attached; Lift Up attempted; boom angle > +70° Refer to Stabilizer Deployed Switch 1 & 2 functionality	Stabilizer 1 and 2 are deployed (250mS)
CABIN JOYSTICK – LEFT ROLLER FAULT	2350	Continuously	Left Roller shall be prevented (Fork Tilt / Telescope)	Cabin joystick transmits a DM1 (SPN:FMI) with 2662:14, 520210:3, 520210:4 Cabin joystick transmits Error (1:0) for the Telescope / Tilt Roller Neutral, Backward, or Forward position Cabin joystick transmits 1022 as the Telescope / Tilt Roller position	Power cycled
CABIN JOYSTICK – RIGHT ROLLER FAULT	2351	Continuously	Right Roller shall be prevented (Auxiliary Hydraulics)	Cabin joystick transmits a DM1 (SPN:FMI) with 2663:14, 520211:3, 520211:4 Cabin joystick transmits Error (1:0) for the Auxiliary Roller Neutral, Backward, or Forward position Cabin joystick transmits 1022 as the Auxiliary Roller position	Power cycled
CABIN JOYSTICK – TRIGGER SWITCH FAULT	2352	Continuously	Trigger shall be prevented (Boom Float / Stabilizers)	Cabin joystick transmits Error (1:0) for the Trigger switch	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
CABIN JOYSTICK – FNR SWITCH FAULT	23115	Continuously	Direction Selection shall be Neutral	Cabin joystick transmits Error (1:0) for the Forward, Neutral, or Reverse switches Cabin joystick transmits Switch Closed (0:1) for more than one position (Forward, Neutral, Reverse) for 500mS Cabin joystick transmit Switch Open (0:0) for all position (Forward, Neutral, Reverse) for 500mS	Power cycled
BOOM ANGLE SENSOR – INTERNAL FAILURE	2353	Continuously	Boom angle sensor reading is +99° Lift Up is de-rated to 60% (Constant Data) of the maximum personality for Cabin Mode Lift Up is prevented if the platform is attached in Cabin Mode All functions are prevented in Platform Mode Hydraulic Quick Connect is prevented	Machine Setup's PLATFORM OPTION is ENABLED; the primary and backup sensor readings disagree by more than 7 counts (2.5°) for 1,000mS Machine Setup's PLATFORM OPTION is ENABLED; the primary or backup sensor reading was greater than 250 counts (out of range)	Power cycled
OPERATING INTERLOCK – ATTACHMENT COUPLING PIN NOT ENGAGED	2354	5000mS	Main Lift Up, Lift Down, Telescope In, and Telescope Out function speeds are reduced (same as chassis is tilted) when the engine is running in Cabin Mode Transition from Cabin to Platform Mode is prevented Main Lift Up, Lift Down, Telescope In, and Telescope Out function speeds are reduced (same as chassis is tilted) when the engine is running in Platform Mode after power-up	Machine Setup's PLATFORM OPTION is ENABLED; the platform is attached; the hydraulic coupling pin not engaged (PLT J1-1 digital input low)	Hydraulic coupling pin is engaged for at least 3,000mS
OPERATING INTERLOCK – PLATFORM NOT COUPLED	2384	5000mS	Engine Start is prevented	Machine Setup's PLATFORM OPTION is ENABLED; Machine Setup's MARKET is AUSTRALIA; Keys witch Platform; platform is attached; platform is not coupled	Platform is coupled for at least 2,000mS
ERRATIC PLATFORM COUPLED SIGNAL	2385	5000mS	Assume that platform is coupled	Machine Setup's PLATFORM OPTION is ENABLED; Machine Setup's MARKET is AUSTRALIA; UGM detects three signal transitions on the platform coupled signal within 5,000mS	Power cycled
LOSS OF PLATFORM COUPLED SIGNAL	2386	5000mS	–	Machine Setup's PLATFORM OPTION is ENABLED; Machine Setup's MARKET is AUSTRALIA; Keys witch Cabin; platform is attached; platform is not coupled	Power cycled
FAN REVERSE DEMAND SWITCH - PERMANENTLY SELECTED	23118	5000mS	Fan Reversing is prevented	Hydraulic Variable Speed Fan is configured; Fan Reverse Demand Switch is closed at power-up or more than 10,000mS	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
OPERATING MODE INTERLOCK - OPERATOR PRESENCE	23120	Continuously	-	Cabin Mode; Machine Setup's OPERATOR PRESENCE is YES; operator is not present (refer to Operator Presence functionality); and one of the following conditions is present: Park Brake is released Cabin joystick is not neutral Machine Setup's MODEL is TH414C, TH417C, or TH514C and the UGM J4-9 Frame Leveling Left Switch is closed Machine Setup's MODEL is TH414C, TH417C, or TH514C and the UGM J4-17 Frame Leveling Right Switch is closed UGM J4-8 Engine Start digital input energized	Trigger conditions are removed

e. Other Inputs

Help Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW	241	Continuously	Platform Lift Up and Telescope Out prevented Platform Lift Down, Telescope In, Level, and Rotate function speeds de-rated to 60% (Constant Data)	Machine Setup's TEMP CUTOUT is YES; Platform Mode; Ambient Temperature Sensor < -40°C (Constant Data)	Ambient Temperature Sensor > -40°C
AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH	242	Continuously	Platform Lift Up and Telescope Out prevented Platform Lift Down, Telescope In, Level, and Rotate function speeds de-rated to 60% (Constant Data)	Machine Setup's TEMP CUTOUT is YES; Platform Mode; Ambient Temperature Sensor > +55°C (Constant Data)	Ambient Temperature Sensor < +55°C

f. Function Prevented

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
MODEL CHANGED – HYDRAULICS SUSPENDED – CYCLE EMS	259	Continuously	Hydraulic functions are prevented Engine Start is prevented	Machine Setup's MODEL was changed	Power cycle
FUNCTIONS LOCKED OUT – CONSTANT DATA VERSION IMPROPER	2520	Continuously	Hydraulic functions are prevented Engine Start is prevented	UGM Constant Data version does not agree with Application	Re-program UGM; Power cycled
ENGINE START PREVENTED – PARK BRAKE NOT SET	2525	5000mS	Engine Start is prevented	UGM J4-8 Engine Start digital input is high (key in start position) and UGM J4-5 Park Brake is low (not set).	UGM J4-5 Park Brake is high (set; 250mS).

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
BOOM EXTENDED SWITCH – CONFLICTING STATE	2526	5000mS	–	Machine Setup's MODEL is TH414C or TH514C; PLATFORM OPTION is ENABLED; UGM J7-8 Boom Extension Switch indicates critical (de-energized); UGM J3-8 Boom Retracted Switch indicates retracted (energized)	Power cycle
EXCESSIVE BOOM ANGLE FOR HYDRAULIC QUICK CONNECT OPERATION	2527	5000mS	Hydraulic Quick Connect is prevented	Machine Setup's HYDRAULIC QUICK CONNECT is YES; boom angle is greater than +20°; Hydraulic Quick Connect Switch is pressed	Hydraulic Quick Connect Switch is released; boom angle is reduced
PLATFORM ATTACHED – HYDRAULIC QUICK CONNECT CUTOUT	2528	5000mS	Hydraulic Quick Connect is prevented	Machine Setup's HYDRAULIC QUICK CONNECT is YES; Cabin Mode; platform is attached; Hydraulic Quick Connect Switch is pressed	Hydraulic Quick Connect Switch is released; disconnect platform cable before using hydraulic quick connect to release the attachment
ENGINE START PREVENTED – SHIFT LEVER NOT IN NEUTRAL	2529	5000mS	Engine Start is prevented	Cabin Mode; UGM J4-8 Engine Start digital input is energized; the cabin joystick's FNR switch is set to forward or reverse	Cabin joystick's FNR switch is set to neutral
PLATFORM ATTACHED ANGLE LIMIT EXCEEDED	2533	Continuously	Lift Up is prevented	Machine Setup's PLATFORM OPTION is ENABLED; platform is attached; Platform Module detected that the boom angle exceed the Overshoot Angle	UGM and Platform Module confirm the boom angle is less than the Cutout Angle for 1,000mS
SYSTEM TEST MODE ACTIVE	2548	5000mS	Boom functions, Stabilizer, and Frame Leveling are prevented Engine Start is prevented	System Test has been activated using the Analyzer or Cabin Display	Power cycle
BOOM EXTENSION LIMIT SWITCHES – CONFLICTING STATES	2557	5000mS	Telescope Out is prevented in Platform Mode Lift Down is prevented until the boom is fully retracted (UGM J3-8) in Platform Mode Platform Mode is prevented	Machine Setup's PLATFORM OPTION is ENABLED; MODEL is TH417C; Boom Extension Limit Switch 1 (UGM J7-8) and Switch 2 (AM J1-4) disagree for more than 500mS while Telescope is active	Power cycle

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
TELESCOPE POSITION SWITCHES – CONFLICTING STATES	2558	5000mS	Platform Mode is prevented	Machine Setup's PLATFORM OPTION is ENABLED; platform attached; MODEL is TH417C; Boom Extension Limit Switch 1 (UGM J7-8) and Switch 2 (AM J1-4) indicate Critical (de-energized); Boom Retracted Switch (UGM J3-8) indicates Retracted (energized)	Power cycle
BOOM RETRACTED SENSOR FAULTY – SENSING INVALID	2560	Continuously	Boom extended (ignore J3-8 Boom Retracted Switch)	Machine Setup's BOOM RETRACT is YES and the J3-8 Boom Retracted Switch becomes unhealthy	Power cycled or boom retracted switch becomes healthy
FUNCTIONS LOCKED OUT – TCM CONSTANT DATA VERSION IMPROPER	2562	Continuously	Boom functions, Auxiliary A/B, Stabilizer, and Frame Leveling are prevented Engine Start is prevented	TCM Constant Data version does not agree with Application	Re-program TCM; Power cycled
TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW	2568	Continuously	Platform Lift, Telescope, Level, and Rotate prevented until Function Enable Switch is open Platform Lift, Telescope, Level, and Rotate function speeds de-rated to 60% (Constant Data) Refer to Low Temperature Cutout functionality	Machine Setup's TEMP CUTOUT is YES; Platform Mode; Low Temperature Cutout active; DTC 6649 is not active	Low Temperature Cutout inactive and Trigger Switch is open

g. Output Drivers

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
MAIN LIFT UP VALVE – OPEN CIRCUIT	33181	5000mS	Lift Up is prevented	Open-circuit is detected on UGM J2-11	Power cycled
MAIN LIFT VALVES – SHORT TO BATTERY	33182	Continuously	Lift Up is prevented Lift Down is prevented UGM J3-2 Lift Return is disabled	Short to battery is detected on UGM J2-11 or UGM J2-22	Power cycled
MAIN LIFT UP VALVE – SHORT TO GROUND	33183	Continuously	Lift Up is prevented Lift Down is prevented UGM J3-2 Lift Return is disabled	Short to ground is detected on UGM J2-11	Power cycled
MAIN LIFT DOWN VALVE – OPEN CIRCUIT	33184	5000mS	Lift Down is prevented	Open-circuit is detected on UGM J2-22	Power cycled
MAIN LIFT DOWN VALVE – SHORT TO GROUND	33185	Continuously	Lift Up is prevented Lift Down is prevented UGM J3-2 Lift Return is disabled	Short to ground is detected on UGM J2-22	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
MAIN TELESCOPE OUT VALVE – OPEN CIRCUIT	33186	5000mS	Telescope Out is prevented	Open-circuit is detected on UGM J2-35	Power cycled
MAIN TELESCOPE VALVES – SHORT TO BATTERY	33187	Continuously	Telescope Out is prevented Telescope In is prevented UGM J3-4 Telescope Return is disabled	Short to battery is detected on UGM J2-34 or UGM J2-35	Power cycled
MAIN TELESCOPE OUT VALVE – SHORT TO GROUND	33188	Continuously	Telescope Out is prevented Telescope In is prevented UGM J3-4 Telescope Return is disabled	Short to ground is detected on UGM J2-35	Power cycled
MAIN TELESCOPE IN VALVE – OPEN CIRCUIT	33189	5000mS	Telescope In is prevented	Open-circuit is detected on UGM J2-34	Power cycled
MAIN TELESCOPE IN VALVE – SHORT TO GROUND	33190	Continuously	Telescope Out is prevented Telescope In is prevented UGM J3-4 Telescope Return is disabled	Short to ground is detected on UGM J2-34	Power cycled
FORK TILT UP VALVE – OPEN CIRCUIT	33191	5000mS	Fork Tilt Up is prevented	Fork Tilt Mode is active; Open-circuit is detected on UGM J2-8	Power cycled
FORK TILT VALVES – SHORT TO BATTERY	33192	Continuously	Fork Tilt Up is prevented Fork Tilt Down is prevented UGM J3-6 Tilt Return is disabled	Short to battery is detected on UGM J2-8 or J2-19	Power cycled
FORK TILT UP VALVE – SHORT TO GROUND	33193	Continuously	Fork Tilt Up is prevented Fork Tilt Down is prevented UGM J3-6 Tilt Return is disabled	Fork Tilt Mode is active; Short to ground is detected on UGM J2-8	Power cycled
FORK TILT DOWN VALVE – OPEN CIRCUIT	33194	5000mS	Fork Tilt Down is prevented	Fork Tilt Mode is active; Open-circuit is detected on UGM J2-19	Power cycled
FORK TILT DOWN VALVE – SHORT TO GROUND	33195	Continuously	Fork Tilt Up is prevented Fork Tilt Down is prevented UGM J3-6 Tilt Return is disabled	Fork Tilt Mode is active; Short to ground is detected on UGM J2-19	Power cycled
AUXILIARY FUNCTION-A VALVE – OPEN CIRCUIT	33196	5000mS	Auxiliary Function-A is prevented Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Open-circuit is detected on UGM J2-9	Power cycled
AUXILIARY FUNCTION-A/B VALVES – SHORT TO BATTERY	33197	Continuously	Auxiliary Function-A is prevented Auxiliary Function-B is prevented UGM J3-14 Aux Return is disabled Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Short to battery is detected on UGM J2-9 or UGM J2-20	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
AUXILIARY FUNCTION-A VALVE – SHORT TO GROUND	33198	Continuously	Auxiliary Function-A is prevented Auxiliary Function-B is prevented UGM J3-14 Aux Return is disabled Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Short to ground is detected on UGM J2-9	Power cycled
AUXILIARY FUNCTION-B VALVE – OPEN CIRCUIT	33199	5000mS	Auxiliary Function-B is prevented Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Open-circuit is detected on UGM J2-20	Power cycled
AUXILIARY FUNCTION-B VALVE – SHORT TO GROUND	33200	Continuously	Auxiliary Function-A is prevented Auxiliary Function-B is prevented UGM J3-14 Aux Return is disabled Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Short to ground is detected on UGM J2-20	Power cycled
STABILIZER/FRAME LEVEL SPEED VALVE – OPEN CIRCUIT	33201	5000mS	Stabilizers are prevented Frame Level is prevented	Cabin Mode; Machine Setup's MODEL is TH414C, TH417C, or TH514C; open-circuit is detected on UGM J1-3	Power cycled
STABILIZER/FRAME LEVEL SPEED VALVE – SHORT TO BATTERY	33202	Continuously	Stabilizers are prevented Frame Level is prevented UGM J3-5 Stabilizer / Frame Level Speed Return is disabled	Cabin Mode; Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to battery is detected on UGM J1-3	Power cycled
STABILIZER/FRAME LEVEL SPEED VALVE – SHORT TO GROUND	33203	Continuously	Stabilizers are prevented Frame Level is prevented UGM J3-5 Stabilizer / Frame Level Speed Return is disabled	Cabin Mode; Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to ground is detected on UGM J1-3	Power cycled
HYDRAULIC QUICK CONNECT SELECT – OPEN CIRCUIT	33204	5000mS	Hydraulic Quick Connect is prevented	Machine Setup's HYDRAULIC QUICK CONNECT is YES; open-circuit is detected on UGM J1-23	Power cycled
HYDRAULIC QUICK CONNECT SELECT – SHORT TO BATTERY	33205	Continuously	Auxiliary Function-A is prevented Auxiliary Function-B is prevented UGM J3-14 Aux Return is disabled Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Machine Setup's HYDRAULIC QUICK CONNECT is YES; short to battery is detected on UGM J1-23	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
HYDRAULIC QUICK CONNECT SELECT – SHORT TO GROUND	33206	Continuously	Auxiliary Function-A is prevented Auxiliary Function-B is prevented UGM J3-14 Aux Return is disabled Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Machine Setup's HYDRAULIC QUICK CONNECT is YES; short to battery is detected on UGM J1-23	Power cycled
HORN – OPEN CIRCUIT	33207	5000mS	Horn digital output is prevented	Platform attached; open-circuit is detected on UGM J2-2	Power cycled
HORN – SHORT TO BATTERY	33208	5000mS	Horn digital output is prevented	Platform attached; short to battery is detected on UGM J2-2	Power cycled
HORN – SHORT TO GROUND	33209	5000mS	Horn digital output is prevented	Platform attached; short to ground is detected on UGM J2-2	Power cycled
DUMP VALVE – OPEN CIRCUIT	33213	Continuously	Dump Valve digital output is prevented	Machine Setup's PLATFORM OPTION is ENABLED; Cabin Mode; open-circuit is detected on UGM J2-13 Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; 1,000mS after Platform startup sequence is complete; open-circuit is detected on UGM J2-13	Power cycled
DUMP VALVE – SHORT TO BATTERY	33214	Continuously	Hydraulic functions are prevented Dump Valve digital output is prevented	Machine Setup's PLATFORM OPTION is ENABLED; short to battery is detected on UGM J2-13	Power cycled
DUMP VALVE – SHORT TO GROUND	33215	Continuously	Dump Valve digital output is prevented	Machine Setup's PLATFORM OPTION is ENABLED; Cabin Mode; short to ground is detected on UGM J2-13 Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode; PLT J2-19 digital output is energized; short to ground is detected on UGM J2-13	Power cycled
AUXILIARY FUNCTION SELECT – OPEN CIRCUIT	33216	5000mS	Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Machine Setup's AUXILIARY FUNCTION SELECT is YES; Cabin Mode is selected; open-circuit is detected on UGM J2-1	Power cycled
AUXILIARY FUNCTION SELECT – SHORT TO BATTERY	33217	Continuously	Auxiliary Function-A is prevented Auxiliary Function-B is prevented UGM J3-14 Aux Return is disabled Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Machine Setup's AUXILIARY FUNCTION SELECT is YES; Cabin Mode is selected; short to battery is detected on UGM J2-1	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
AUXILIARY FUNCTION SELECT – SHORT TO GROUND	33218	Continuously	Auxiliary Function-A is prevented Auxiliary Function-B is prevented UGM J3-14 Aux Return is disabled Continuous Auxiliary Hydraulics is prevented Hydraulic Quick Connect is prevented Auxiliary Release is prevented	Machine Setup's AUXILIARY FUNCTION SELECT is YES; Cabin Mode is selected; short to ground is detected on UGM J2-1	Power cycled
LEFT STABILIZER DOWN VALVE – OPEN CIRCUIT	33222	5000mS	Left & Right Stabilizer Down is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; open circuit is detected on UGM J2-21	Power cycled
LEFT STABILIZER DOWN VALVE – SHORT TO BATTERY	33223	Continuously	Stabilizers are prevented Frame Level is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to battery is detected on UGM J2-21	Power cycled
LEFT STABILIZER DOWN VALVE – SHORT TO GROUND	33224	5000mS	Left & Right Stabilizer Down is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to ground is detected on UGM J2-21	Power cycled
LEFT STABILIZER UP VALVE – OPEN CIRCUIT	33225	5000mS	Stabilizers are prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; open circuit is detected on UGM J2-10	Power cycled
LEFT STABILIZER UP VALVE – SHORT TO BATTERY	33226	Continuously	Stabilizers are prevented Frame Level is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to battery is detected on UGM J2-10	Power cycled
LEFT STABILIZER UP VALVE – SHORT TO GROUND	33227	5000mS	Stabilizers are prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to ground is detected on UGM J2-10	Power cycled
RIGHT STABILIZER DOWN VALVE – OPEN CIRCUIT	33228	5000mS	Left & Right Stabilizer Down is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; open circuit is detected on UGM J2-15	Power cycled
RIGHT STABILIZER DOWN VALVE – SHORT TO BATTERY	33229	Continuously	Stabilizers are prevented Frame Level is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to battery is detected on UGM J2-15	Power cycled
RIGHT STABILIZER DOWN VALVE – SHORT TO GROUND	33230	5000mS	Left & Right Stabilizer Down is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to ground is detected on UGM J2-15	Power cycled
RIGHT STABILIZER UP VALVE – OPEN CIRCUIT	33231	5000mS	Stabilizers are prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; open circuit is detected on UGM J2-3	Power cycled
RIGHT STABILIZER UP VALVE – SHORT TO BATTERY	33232	Continuously	Stabilizers are prevented Frame Level is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to battery is detected on UGM J2-3	Power cycled
RIGHT STABILIZER UP VALVE – SHORT TO GROUND	33233	5000mS	Stabilizers are prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to ground is detected on UGM J2-3	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
FRAME LEVEL LEFT VALVE – OPEN CIRCUIT	33234	5000mS	Frame Level Left is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; open circuit is detected on UGM J2-7	Power cycled
FRAME LEVEL LEFT VALVE – SHORT TO BATTERY	33235	Continuously	Stabilizers are prevented Frame Level is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to battery is detected on UGM J2-7	Power cycled
FRAME LEVEL LEFT VALVE – SHORT TO GROUND	33236	5000mS	Frame Level Left is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to ground is detected on UGM J2-7	Power cycled
FRAME LEVEL RIGHT VALVE – OPEN CIRCUIT	33237	5000mS	Frame Level Right is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; open circuit is detected on UGM J2-5	Power cycled
FRAME LEVEL RIGHT VALVE – SHORT TO BATTERY	33238	Continuously	Stabilizers are prevented Frame Level is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to battery is detected on UGM J2-5	Power cycled
FRAME LEVEL RIGHT VALVE – SHORT TO GROUND	33239	5000mS	Frame Level Right is prevented	Machine Setup's MODEL is TH414C, TH417C, or TH514C; short to ground is detected on UGM J2-5	Power cycled
CRAB STEER VALVE – OPEN CIRCUIT	33270	5000mS	Refer to Steering Issues functionality	Open-circuit is detected on UGM J2-16	Power cycled
CRAB STEER VALVE – SHORT TO BATTERY	33271	5000mS	Refer to Steering Issues functionality	Short to battery is detected on UGM J2-16	Power cycled
CRAB STEER VALVE – SHORT TO GROUND	33272	5000mS	Refer to Steering Issues functionality	Short to ground is detected on UGM J2-16	Power cycled
ALL WHEEL STEER VALVE – OPEN CIRCUIT	33273	5000mS	Refer to Steering Issues functionality	Open-circuit is detected on UGM J2-4	Power cycled
ALL WHEEL STEER VALVE – SHORT TO BATTERY	33274	5000mS	Refer to Steering Issues functionality	Short to battery is detected on UGM J2-4	Power cycled
ALL WHEEL STEER VALVE – SHORT TO GROUND	33275	5000mS	Refer to Steering Issues functionality	Short to ground is detected on UGM J2-4	Power cycled
APU PUMP RELAY – OPEN CIRCUIT	33276	5000mS	APU functionality is prevented	Machine Setup's PLATFORM OPTION is ENABLED; open-circuit is detected on UGM J1-13	Power cycled
APU PUMP RELAY – SHORT TO BATTERY	33277	Continuously	APU functionality is prevented	Machine Setup's PLATFORM OPTION is ENABLED; short to battery is detected on UGM J1-13	Power cycled
APU PUMP RELAY – SHORT TO GROUND	33278	5000mS	APU functionality is prevented	Machine Setup's PLATFORM OPTION is ENABLED; short to ground is detected on UGM J1-13	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
GLOWPLUGS – OPEN CIRCUIT	33279	5000mS	–	Machine Setup's ENGINE CONTROL is T3 C4.4 74.5kW or T3 C4.4 93.1kW; open-circuit is detected on UGM J1-12	Power cycled
GLOWPLUGS – SHORT TO BATTERY	33280	Continuously	Glow Plug digital output is prevented	Machine Setup's ENGINE CONTROL is T3 C4.4 74.5kW or T3 C4.4 93.1kW; short to battery is detected on UGM J1-12	Power cycled
GLOWPLUGS - SHORT TO GROUND	33281	5000mS	Glow Plug digital output is prevented	Machine Setup's ENGINE CONTROL is T3 C4.4 74.5kW or T3 C4.4 93.1kW; short to ground is detected on UGM J1-12	Power cycled
ENGAGE STARTER OUTPUT – OPEN CIRCUIT	33282	5000mS	–	Open-circuit is detected on UGM J2-26	Power cycled
ENGAGE STARTER OUTPUT – SHORT TO BATTERY	33283	Continuously	Engage Starter digital output prevented Energize ECM / Fuel Relay digital output (to stop engine)	Short to battery is detected on UGM J2-26	Power cycled
ENGAGE STARTER OUTPUT – SHORT TO GROUND	33284	5000mS	Engage Starter digital output prevented	Short to ground is detected on UGM J2-26	Power cycled
ALTERNATOR EXCITATION LINE – SHORT TO BATTERY	33285	5000mS	Alternator Excitation digital output is prevented	UGM J4-7 Alternator D+ is energized 2,000mS after engine has stopped	Power cycled
LIFT – CURRENT FEEDBACK READING TOO LOW	33287	5000mS	–	Actual lift up / down (UGM J3-2) & commanded current disagree by >125mA when command is >250 mA for 1000mS Actual lift up / down current < 225mA and PWM is >40% for 100ms	Power cycled
TELESCOPE – CURRENT FEEDBACK READING TOO LOW	33288	5000mS	–	Actual telescope in / out (UGM J3-4) & commanded current disagree by >125mA when command is >250 mA for 1000mS Actual telescope in / out current < 225mA and PWM is >40% for 100ms	Power cycled
STABILIZERS/FRAME LEVEL – CURRENT FEEDBACK READING TOO LOW	33289	5000mS	–	Actual stabilizer / frame leveling (UGM J3-6) & commanded current disagree by >125mA when command is >250 mA for 1000mS Actual stabilizer / frame leveling current < 225mA and PWM is >40% for 100ms	

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
FORK TILT – CURRENT FEEDBACK READING TOO LOW	33290	5000mS	–	Actual fork tilt up / down (UGM J3-6) & commanded current disagree by >125mA when command is >250 mA for 1000mS Actual fork tilt up / down current < 225mA and PWM is >40% for 100ms	Power cycled
AUXILIARY HYDRAULICS – CURRENT FEEDBACK READING TOO LOW	33291	5000mS	–	Actual auxiliary function A / B (UGM J3-14) & commanded current disagree by >125mA when command is >250 mA for 1000mS Actual auxiliary A / B current < 225mA and PWM is >40% for 100ms	Power cycled
BOOM RIDE VALVE – SHORT TO BATTERY OR OPEN CIRCUIT	33369	Continuously	Boom Ride is prevented	Machine Setup's BOOM RIDE is YES; short to battery or open-circuit is detected on AM J1-7	Power cycled
BOOM RIDE VALVE – SHORT TO GROUND	33338	5000mS	Boom Ride is prevented	Machine Setup's BOOM RIDE is YES; short to ground is detected on AM J1-7	Power cycled
BOOM FLOAT VALVE – SHORT TO BATTERY OR OPEN CIRCUIT	33370	Continuously	Boom Ride is prevented Boom Float is prevented Main Lift Up is prevented	Machine Setup's BOOM FLOAT is YES; short to battery or open-circuit is detected on AM J1-9	Power cycled
BOOM FLOAT VALVE – SHORT TO GROUND	33341	5000mS	Boom Float is prevented Main Lift Up is prevented	Machine Setup's BOOM FLOAT is YES; short to ground is detected on AM J1-9	Power cycled
BOOM TANK VALVE – SHORT TO BATTERY OR OPEN CIRCUIT	33371	Continuously	Boom Ride is prevented Boom Float is prevented Main Lift Up is prevented	Machine Setup's BOOM FLOAT is YES; short to battery or open-circuit is detected on AM J1-8	Power cycled
BOOM TANK VALVE – SHORT TO GROUND	33344	5000mS	Boom Ride is prevented Boom Float is prevented	Machine Setup's BOOM FLOAT is YES; short to ground is detected on AM J1-8	Power cycled

h. Engine

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
ENGINE TROUBLE CODE: (SPN:FMI)	437	Continuously	–	The Electronic Engine's ECM detects a fault condition and transmits a DM1 message. The fault is not suppressed (refer to Diagnostic Code Suppression).	Power cycled
WRONG ENGINE SELECTED – ECM DETECTED	4314	Continuously	Engine Start is prevented	A Mechanical Engine is configured, but CAN bus messages from an ECM are detected	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
HIGH ENGINE COOLANT TEMPERATURE WARNING	4316	Continuously	–	Mechanical Engine is configured and the engine coolant temperature ≥ 113°C for a period longer than 10 seconds while the engine is running Electronic Engine is configured and SPN110:FMI15 or SPN110:FMI16 is active	Engine coolant temperature ≤ 110°C (Mechanical Engine) SPN110:FMI15 and SPN110:16 are not active (Electronic Engine)
HIGH ENGINE COOLANT TEMPERATURE CRITICAL	4317	Continuously	–	Mechanical Engine is configured and the engine coolant temperature ≥ 118C for a period longer than 10 seconds while the engine is running Electronic Engine is configured and SPN110:FMI0 is active	Engine coolant temperature ≤ 115°C (Mechanical Engine) SPN110:FMI10 is not active (Electronic Engine)
LOW ENGINE OIL PRESSURE WARNING	4318	Continuously	–	An Electronic Engine is configured and SPN100:FMI17 or SPN100:FMI18 is active	Power cycled
LOW ENGINE OIL PRESSURE CRITICAL	4319	Continuously	–	Mechanical Engine is configured, UGM J12-8 Engine Oil Pressure digital input is low for 3,000mS (Constant Data), and the engine has been running for at least 5,000mS Electronic Engine is configured and SPN100:FMI1 is active	Power cycled
ALTERNATOR CHARGING FAILURE	4320	5000mS	–	Machine Setup's ENGINE CONTROL is T4i C4.4 106kW, T4i C4.4 92.6W, T4i C3.4 74.5kW, T3 C4.4 93.1kW, or T3 C4.4 74.5kW; engine running > 3,000mS and UGM J4-7 Alternator D+ digital input is low	UGM J4-7 Alternator D+ is high for 3,000mS
AIR FILTER RESTRICTION	4321	5000mS	–	The engine has been running for at least 7,000mS, and UGM J1-34 Air Filter Restriction digital input is LOW	UGM J1-34 Air Filter Restriction input is high for 1,000mS
LOSS OF ENGINE SPEED SIGNAL	4322	5000mS	Engine Start is prevented Continuous Auxiliary Hydraulics is forced to 0% (cancelled)	Mechanical Engine is configured, engine running, and the UGM J1-16 Engine Speed reading is zero Electronic Engine is configured and the ECM reports a loss of engine speed signal via DM1 (190:8)	Power cycled

i. Battery Supply

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
BATTERY VOLTAGE TOO LOW – SYSTEM SHUTDOWN	441	-	Hydraulic functions are prevented All digital outputs are disabled Platform Indicators are disabled	UGM detects the battery voltage is < 9V for at least 500mS; engine is not cranking Machine Setup's PLATFORM OPTION is ENABLED; PLT detects the battery voltage is < 9V for at least 250mS; engine is not cranking	Power cycled
BATTERY VOLTAGE TOO HIGH – SYSTEM SHUTDOWN	442	-	Hydraulic functions are prevented All digital outputs are disabled	UGM detects the battery voltage ≥ 16V for at least 250mS Machine Setup's PLATFORM OPTION is ENABLED; PLT detects the battery voltage is >16V for at least 250mS	Power cycled
LSS BATTERY VOLTAGE TOO HIGH	443	Continuously	Platform assumed to be overloaded	Load Sensing System is configured; platform attached; engine is not cranking; LSS Module reports BATT TOO HIGH	Power cycled
LSS BATTERY VOLTAGE TOO LOW	444	Continuously	Platform assumed to be overloaded	Load Sensing System is configured; platform attached; engine is not cranking; LSS Module reports BATT TOO LOW	Power cycled
BATTERY VOLTAGE LOW	445	5000mS	–	UGM detects battery voltage < 11V for 3,000mS, and the engine is running	UGM detects battery voltage >11V for 10,000mS
REFERENCE VOLTAGE OUT OF RANGE – GROUND	447	5000mS	Hydraulic functions are prevented	UGM detects its reference voltage is out of range (>5.4V or <4.6V) for 1000mS.	Power cycled
REFERENCE VOLTAGE OUT OF RANGE – PLATFORM	448	5000mS	Hydraulic functions are prevented	Machine Setup's PLATFORM OPTION is ENABLED; PLT detects its reference voltage is out of range (>5.4V or <4.6V) for 1000mS.	Power cycled
REFERENCE VOLTAGE OUT OF RANGE – TCM	4423	5000mS	Hydraulic Variable Speed operates at maximum speed; Hydraulic Fan Reversing is prevented	Hydraulic Variable Speed Fan is configured; TCM detects its reference voltage is out of range (>5.4V or <4.6V) for 1000mS	Power cycled

j. Transmission and Drive System

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
HIGH TRANSMISSION OIL TEMPERATURE CRITICAL	461	Continuously	–	Transmission oil temperature is critical	Transmission oil temperature is normal
CONFLICTING DRIVE DIRECTION SIGNALS	462	5000mS	Column selector position is regarded as neutral Cabin joystick's FNR must be used for direction selection	Machine Setup's COLUMN SELECTOR is YES; more than one of the column selector digital inputs (UGM J4-4, J4-21, J4-23) is energized for at least 3,000mS	Power cycled
DRIVE DIRECTION SIGNAL LOST	463	5000mS	Column selector position is regarded as neutral Cabin joystick's FNR must be used for direction selection	Machine Setup's COLUMN SELECTOR is YES; all column selector digital inputs (UGM J4-4, J4-21, J4-23) are de-energized for at least 3,000mS	Power cycled
VEHICLE SPEED SENSOR – NOT RESPONDING	468	5000mS	Display "99" as Vehicle Speed on cabin display Restrict direction and gear selection to present state or associated neutral state when this occurs during operation Retain this fault through power cycles Restrict direction and gear selection to F3, N3, R2 (Platform Gear Restriction is not active) if this fault is active from the previous power cycle and Machine Setup's TRANSMISSION is TURNER 6F/3R. Restrict direction and gear selection to F2, N2, R2 (Platform Gear Restriction is not active) if this fault is active from the previous power cycle and Machine Setup's TRANSMISSION is TURNER 4F/3R.	Direction Selection is Forward or Reverse; Park Brake is not engaged; Service Brake is not applied; Engine RPM >1000 RPM; No vehicle speed counts > 40,000mS	Vehicle speed counts detected for 5,000mS
VEHICLE OVERSPEED	469	Continuously	Flash Vehicle Speed on cabin display	Vehicle speed is greater than 43KPH	Vehicle speed below threshold for 1000mS
PUMP DISPLACEMENT VALVE – SHORT TO BATTERY OR OPEN CIRCUIT	4618	5000mS	–	Anti-Stall functionality is enabled; short to battery or open-circuit is detected on TCM J5-1 for 1,000mS	Power cycled
PUMP DISPLACEMENT VALVE – SHORT TO GROUND	4619	5000mS	–	Anti-Stall functionality is enabled; short to ground is detected on TCM J5-1 at power-up *(momentarily energize digital output if engine speed is zero)*	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
FAN SPEED VALVE – SHORT TO BATTERY OR OPEN CIRCUIT	4620	5000mS	Hydraulic Fan Reversing is prevented	Hydraulic Variable Speed Fan is configured; short to battery or open-circuit is detected on TCM J2-11 for 1,000mS	Power cycled
FAN SPEED VALVE – SHORT TO GROUND	4621	5000mS	Hydraulic Fan Reversing is prevented	Hydraulic Variable Speed Fan is configured; short to ground is detected on TCM J2-11 at power-up *(momentarily energize digital output if engine speed is zero)*	Power cycled
FAN REVERSE VALVE – SHORT TO BATTERY OR OPEN CIRCUIT	4622	5000mS	Hydraulic Fan Reversing is prevented	Hydraulic Variable Speed Fan is configured; Machine Setup's HYD FAN REV is YES; short to battery or open-circuit is detected on TCM J2-12 for 1,000mS	Power cycled
FAN REVERSE VALVE – SHORT TO GROUND	4623	5000mS	Hydraulic Fan Reversing is prevented	Hydraulic Variable Speed Fan is configured; Machine Setup's HYD FAN REV is YES; short to ground is detected on TCM J2-12 at power-up *(momentarily energize digital output if engine speed is zero)*	Power cycled
TRANSMISSION REVERSE COIL – SHORT TO BATTERY OR OPEN CIRCUIT	4628	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to battery or open-circuit is detected on TCM J5-5 for 1,000mS	Power cycled
TRANSMISSION REVERSE COIL – SHORT TO GROUND	4629	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to ground is detected on TCM J5-5	Power cycled
TRANSMISSION FWD LOW COIL – SHORT TO BATTERY OR OPEN CIRCUIT	4630	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to battery or open-circuit is detected on TCM J5-3 for 1,000mS	Power cycled
TRANSMISSION FWD LOW COIL – SHORT TO GROUND	4631	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to ground is detected on TCM J5-3	Power cycled
TRANSMISSION FWD HIGH COIL – SHORT TO BATTERY OR OPEN CIRCUIT	4632	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to battery or open-circuit is detected on TCM J5-4 for 1,000mS	Power cycled
TRANSMISSION FWD HIGH COIL – SHORT TO GROUND	4633	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to ground is detected on TCM J5-4	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
TRANSMISSION 1ST GEAR COIL – SHORT TO BATTERY OR OPEN CIRCUIT	4634	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to battery or open-circuit is detected on TCM J5-6 for 1,000mS	Power cycled
TRANSMISSION 1ST GEAR COIL – SHORT TO GROUND	4635	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to ground is detected on TCM J5-6	Power cycled
TRANSMISSION 2ND GEAR COIL – SHORT TO BATTERY OR OPEN CIRCUIT	4636	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to battery or open-circuit is detected on TCM J5-7 for 1,000mS	Power cycled
TRANSMISSION 2ND GEAR COIL – SHORT TO GROUND	4637	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to ground is detected on TCM J5-7	Power cycled
TRANSMISSION 3RD GEAR COIL – SHORT TO BATTERY OR OPEN CIRCUIT	4638	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to battery or open-circuit is detected on TCM J5-8 for 1,000mS	Power cycled
TRANSMISSION 3RD GEAR COIL – SHORT TO GROUND	4639	Continuously	Direction Selection shall be Neutral when Calibration's TRANS SERVICE is NO	TCMSELECT is set to ICA; Short to ground is detected on TCM J5-8	Power cycled
HYD FLUID TEMP SENSOR – SHORT TO BATTERY OR OPEN CIRCUIT	4640	5000mS	Hydraulic Variable Speed operates at maximum speed	Hydraulic Variable Speed Fan is configured; TCM J3-5 is greater than 4.5V	Power cycled
TRANS FLUID TEMP SENSOR – SHORT TO BATTERY OR OPEN CIRCUIT	4641	5000mS	Hydraulic Variable Speed operates at maximum speed	Hydraulic Variable Speed Fan is configured; TCM J3-8 is greater than 4.5V	Power cycled
INTERCOOLER AIR TEMP SENSOR – SHORT TO BATTERY OR OPEN CIRCUIT	4642	5000mS	Hydraulic Variable Speed operates at maximum speed	Hydraulic Variable Speed Fan is configured; ENGINE CONTROL is T4i C3.4 75.0kW, T3 C4.4 74.5kW, T4i C4.4 106kW, T4i C4.4 92.6kW, TCD3.6L 90.0kW, or TCD3.6L 74.4kW; TCM J3-11 is greater than 4.5V	Power cycled

k. Communications

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
CANBUS FAILURE – PLATFORM MODULE	662	Continuously	All platform controls are prevented	Machine Setup's PLATFORM OPTION is ENABLED; Keys witch Platform; Platform Module messages not detected for more than 250mS	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
CANBUS FAILURE – LOAD SENSING SYSTEM MODULE	663	Continuously	Platform assumed to be overloaded	Machine Setup's PLATFORM OPTION is ENABLED; Load Sensing System is configured; platform attached; keys witch platform; LSS Module messages not detected for more than 1,000mS	Power cycled
CANBUS FAILURE – ENGINE CONTROLLER	666	Continuously	Engine Start is prevented Hydraulic Variable Speed Fan shall operate at maximum speed	Electronic Engine is configured; ECM messages not detected > 1000mS; UGM J4-12 is de-energized (Anti-Theft Disabled)	Power cycled
CANBUS FAILURE – EXCESSIVE CANBUS ERRORS	6613	Continuously	–	UGM detects > 500 Bus-Off conditions during a power cycle or > 22 Bus-Off conditions in 1,000mS	Power cycled
CANBUS FAILURE – TRANSMISSION CONTROLLER	6616	Continuously	Direction Selection shall be Neutral FWD LOW, FWD HIGH, REVERSE, 1ST GEAR, 2ND GEAR, and 3RD GEAR Transmission Solenoid are prevented	TCM messages not detected > 1,000mS; engine is not cranking	Power cycled
CANBUS FAILURE – CABIN JOYSTICK	6617	Continuously	Hydraulic functions are prevented	Cabin Mode is active; engine is not cranking; Cabin Joystick messages not detected for at least 1,000mS	Cabin Joystick messages detected
CANBUS FAILURE – CABIN DISPLAY	6618	Continuously	–	Cabin Display messages not detected > 500mS	Power cycled
CANBUS FAILURE – BOOM ANGLE SENSOR	6621	Continuously	Boom angle sensor assumed to be +99° Lift Up is prevented in Platform Mode, when the platform is attached, or when the platform is coupled Lift Up and Down is de-rated to 60% (Constant Data) for Cabin Mode	Machine Setup's PLATFORM OPTION is ENABLED; Boom Angle Sensor messages not detected > 250mS	Power cycled
CANBUS FAILURE - TCU MODULE	6622	–	–	Machine Setup's CLEARSKY is YES; TCU messages not detected > 30 seconds	TCU messages detected
CANBUS FAILURE - GATEWAY MODULE	6623	–	–	Machine Setup's CLEARSKY is YES; Gateway messages not detected > 30 seconds	Gateway messages detected
CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH	6629	–	CANBUS FAILURE - TCU MODULE (6622) fault is prevented	Machine Setup's CLEARSKY is YES; TCU exceeded message limit and was disabled by the Gateway	Power cycled
CANBUS FAILURE – BOOM RIDE/BOOM FLOAT MODULE	6631	5000mS	Boom Ride is prevented Boom Float is prevented	Machine Setup's MODEL is TH406C or TH407C; Machine Setup's BOOM RIDE is YES or BOOM FLOAT is YES; AM messages not detected > 250mS	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
CANBUS FAILURE – BOOM EXTENSION LIMIT MODULE	6637	5000mS	Assume Boom Extension Limit Switch 2 indicates critical length (boom extended)	Machine Setup's MODEL is TH417C; Machine Setup's PLATFORM OPTION is ENABLED; AM messages not detected > 250mS	Power cycled
CANBUS FAILURE - LSI	6638	Continuously	Assume Load Moment Reading is 100%	Machine Setup's LOAD MONITORING is LSI-CAN or LSI-CAN+LMI: UGM does not detect the LSI-CAN on the CAN bus > 1000msec and an ENGINE STOPPED or ENGINE RUNNING state exists for a period of one second.	Power cycled
CANBUS FAILURE - TILT/TEMP SENSOR	6649	5000mS	Assume Ambient Temperature Sensor is -99°C Platform Lift Up and Telescope Out prevented Platform Lift Down, Telescope In, Level, and Rotate function speeds derated to 60% (Constant Data)	Machine Setup's TEMP CUTOUT is YES; Platform Mode; UGM does not detect the Ambient Temperature Sensor on the CANBUS for at least 1000mS	Power cycled

l. Tilt Sensor

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
CHASSIS TILT SENSOR NOT CALIBRATED	813	5000mS	Chassis Tilt reading is 90°	Chassis Tilt Sensor has not been calibrated (refer to Chassis Tilt Sensor functionality)	Tilt calibration is completed
CHASSIS TILT SENSOR OUT OF RANGE	814	Continuously	Chassis Tilt reading is 90°	Chassis Tilt Sensor is Out of Range (refer to Chassis Tilt Sensor Issues functionality)	Power cycle
CHASSIS TILT SENSOR DISAGREEMENT	815	Continuously	Chassis Tilt reading is 90°	Chassis Tilt Sensor Disagreement exists (refer to Chassis Tilt Sensor Issues functionality)	Power cycle

m. Platform Load Sensing

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
LSS CELL #1 ERROR	821	Continuously	Platform assumed to be overloaded	Machine Setup's PLATFORM OPTION is ENABLED; Load Sensing System configured; platform attached; key switch platform; LSS Module reports CELL 1 ERROR	Power cycled
LSS CELL #2 ERROR	822	Continuously	Platform assumed to be overloaded	Machine Setup's PLATFORM OPTION is ENABLED; Load Sensing System configured; platform attached; key switch platform; LSS Module reports CELL 2 ERROR	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
LSS CELL #3 ERROR	823	Continuously	Platform assumed to be overloaded	Machine Setup's PLATFORM OPTION is ENABLED; Load Sensing System configured; platform attached; key switch platform; LSS Module reports CELL 3 ERROR	Power cycled
LSS CELL #4 ERROR	824	Continuously	Platform assumed to be overloaded	Machine Setup's PLATFORM OPTION is ENABLED; Load Sensing System configured; platform attached; key switch platform; LSS Module reports CELL 4 ERROR	Power cycled
LSS HAS NOT BEEN CALIBRATED	825	Continuously	Platform assumed to be overloaded	Machine Setup's PLATFORM OPTION is ENABLED; Load Sensing System configured; platform attached; key switch platform; load sensing system has not been calibrated	Successful LSS calibration has been performed
PLATFORM FUNCTIONS CUTOUT – PLATFORM OVERLOADED	829	Continuously	Platform assumed to be overloaded	Machine Setup's LOAD SENSING is PLATFORM CUTOUT; Keys witch Platform; Load Sensing System detects an overload (>110% or <50% rated load) (refer to Load Sensing System functionality)	Load Sensing System does not detected an overload

n. Load Moment

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
LSI NOT CALIBRATED	8514	5000mS	–	Load Monitoring configured; LSI System reports Fault #6 – System not calibrated	LSI System does not report Fault #6
LSI DETECTED BUT NOT CONFIGURED	8515	Continuously	Hydraulic functions are prevented	Load Monitoring is not configured; LSI System messages detected	Load Monitoring is configured
LSI LOAD CELL A – OUT OF RANGE	8516	Continuously	Load Moment Cutout assumed to be 100%	Load Monitoring configured; LSI System reports Fault #4 – Load Cell A – Out of Range	Power cycled
LSI LOAD CELL B – OUT OF RANGE	8517	Continuously	Load Moment Cutout assumed to be 100%	Load Monitoring configured; LSI System reports Fault #5 – Load Cell B – Out of Range	Power cycled
LSI CUTOUT OUTPUT – SHORT TO BATTERY OR OPEN CIRCUIT	8518	Continuously	Load Moment Cutout assumed to be 100%	Load Monitoring configured; LSI System reports Fault #7 – Open or Short Circuit condition on 100% Cutout digital output	Power cycled
LSI OUT OF CALIBRATION	8519	5000mS	Load Moment Cutout assumed to be 100%	Load Monitoring configured; Verification using OPERATOR TOOLS - LSI-CAN SYSTEM CHECK indicated FAIL (refer to Load Monitoring-Verification functionality)	Verification or Calibration performed successfully

o. Steering

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
LOW STEERING PRESSURE	8638	While fault is active	–	UGM J1-35 Steering Pressure is low (switch open) for 3,000mS and the engine is running for at least 5,000mS	UGM J1-35 Steering Pressure is OK (switch closed) for 3,000mS

p. Service Required

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	873	5000mS	–	MSSO Active; refer to Machine Safety System Override (MSSO) functionality	CALIBRATIONS - MSSO RESET Menu

q. Hardware

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
LSS WATCHDOG RESET	991	Continuously	Platform assumed to be overloaded	Load Sensing System is configured; platform attached; LSS Module reports WATCHDOG RST	Power cycled
LSS EEPROM ERROR	992	Continuously	Platform assumed to be overloaded	Load Sensing System is configured; platform attached; LSS Module reports EEPROM ERROR	Power cycled
LSS INTERNAL ERROR – PIN EXCITATION	993	Continuously	Platform assumed to be overloaded	Load Sensing System is configured; platform attached; LSS Module reports INTERNAL ERROR – Pin Excitation < 4.25V	Power cycled
LSS INTERNAL ERROR – DRDY MISSING FROM A/D	994	Continuously	Platform assumed to be overloaded	Load Sensing System is configured; platform attached; LSS Module reports INTERNAL ERROR – DRDY Interrupt from A/D Converter	Power cycled
EEPROM FAILURE – CHECK ALL SETTINGS	998	Continuously	Hydraulic functions are prevented Engine Start is prevented UGM J4-12 ECM / Fuel Relay is energized to shutdown engine	The control system has detected an EEPROM issue	Power cycled
FUNCTION LOCKED OUT – PLATFORM MODULE SOFTWARE VERSION IMPROPER	9910	Continuously	Hydraulic functions are prevented in Platform Mode Engine is shutdown in Platform Mode Engine Start is prevented in Platform Mode	Platform Module transmitted a Major Software Version that was not 4 when Software Type (UGM & PLT) is Production	Power cycled
FUNCTION LOCKED OUT – LSS MODULE SOFTWARE VERSION IMPROPER	9911	Continuously	Hydraulic functions are prevented in Platform Mode Engine is shutdown Engine Start is prevented in Platform Mode	LSS Module transmitted a Major Software Version that was not 7 or a Minor Software Version less than 17	Power cycled
CHASSIS TILT SENSOR NOT GAIN CALIBRATED	9915	Continuously	Platform controls are prevented Platform Mode is prevented	Machine Setup's PLATFORM OPTION is ENABLED; UGM is fitted with Fredericks tilt elements; Tilt Gains in the Manufacturing Data Area (0x4040 to 0x4046) are not within 178-308	Power cycled
GROUND MODULE FAILURE – HIGH SIDE DRIVER CUTOUT FAULTY	9921	5000mS	Hydraulic functions are prevented	Machine Setup's PLATFORM OPTION is ENABLED; Platform Mode is active; UGM detects an issue with the High-Side Driver Cutout circuitry associated with UGM J2-1, J2-13, and J1-23	Power cycled
FUNCTIONS LOCKED OUT – MACHINE NOT CONFIGURED	9924	5000mS	Hydraulic functions are prevented Engine Start is prevented UGM J4-12 ECM / Fuel Relay is energized to shutdown engine	Machine Setup's MODEL is UNKNOWN	Machine Setup's MODEL is set; Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
CURRENT FEEDBACK GAINS OUT OF RANGE	9944	Continuously	Hydraulic functions are prevented Engine Start is prevented UGM J4-12 ECM / Fuel Relay is energized to shutdown engine	Current feedback calibration data in the Manufacturing Data Area (0x4050; J3-1, J3-2, J3-4, J3-5, J3-6, J3-14) to are not within 204-307	Power cycled
CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	9945	Continuously	Hydraulic functions are prevented Engine Start is prevented UGM J4-12 ECM / Fuel Relay is energized to shutdown engine	Checksum for the current feedback calibration data in the Manufacturing Data Area (0x4050) was improper	Power cycled
CABIN DISPLAY EEPROM WRITE FAILURE	9946	5000mS	–	EEPROM access to the Cabin Display for Hardware Exchange functionality has failed	Power cycled
HARDWARE EXCHANGE REQUIRED	9947	5000mS	Hydraulic functions are prevented Display "PERFORM HARDWARE EXCHANGE" on Cabin Display	FUNCTIONS LOCKED OUT – MACHINE NOT CONFIGURED (9924) fault is not active; control system detects a data mismatch between the UGM and Cabin Display EEPROM	HARDWARE EXCHANGE must be completed successfully; Power cycled
PLATFORM MODULE HARDWARE FAILURE	9948	5000mS	Hydraulic functions are prevented in Platform Mode Engine Start is prevented is Platform Mode	Machine Setup's PLATFORM OPTION is ENABLED; Platform Module reports a Low sense FET failure	Power cycled
MACHINE CONFIGURATION OUT OF RANGE – CHECK ALL SETTINGS	9949	Continuously	Hydraulic functions are prevented Engine Start is prevented UGM J4-12 ECM / Fuel Relay is energized to shutdown engine	UGM detects a parameter range or checksum issue with Machine Setup	Machine Setup is properly configured; Power cycled
CABIN JOYSTICK - INTERNAL FAILURE	9976	Continuously	Hydraulic functions are prevented Direction selection shall be neutral	Cabin Mode; cabin joystick transmits a DM1 (SPN:FMI) with 520192:13 or 520193:13 Cabin Mode; cabin joystick transmitted an undocumented DM1 (SPN:FMI)	Power cycled
LSS CORRUPT EEPROM	9977	Continuously	Platform assumed to be overloaded Hydraulic functions are prevented	Platform attached; Load Sensing System is configured; control system detects parameter range or checksum issue; refer to Load Sensing System - Calibration functionality	Power cycled
EEPROM VALUE – OUT OF RANGE	9978	Continuously	Hydraulic functions are prevented Engine Start is prevented UGM J4-12 ECM / Fuel Relay is energized to shutdown engine	UGM detects a parameter range or checksum issue with Personalities	Personalities are properly configured; Power cycled
GROUND MODULE VLOW FET FAILURE	9986	Continuously	Hydraulic functions are prevented Engine Start is prevented UGM J4-12 ECM / Fuel Relay is energized to shutdown engine	UGM detects a Low sense FET failure (all high-sensing digital inputs are high)	Power cycled

Message	Fault Code	Indicators	Other Actions Taken	Trigger for Fault	Latch Until
FUNCTIONS LOCKED OUT – LSI SOFTWARE VERSION IMPROPER	99151	Continuously	Load Moment Cutout assumed to be 100%	Load Monitoring configured; LSI System transmitted Major / Minor Software version that is not compatible (P0.11 or greater; P1.x allowed)	Power cycled
LSI FAULTY – SYSTEM FLASH CRC ERROR	99152	Continuously	Load Moment Cutout assumed to be 100%	Load Monitoring configured; LSI System reports Fault #1 – CRC Error in System Flash	Power cycled
LSI FAULTY – DATA FLASH CRC ERROR	99153	Continuously	Load Moment Cutout assumed to be 100%	Load Monitoring configured; LSI System reports Fault #2 – CRC Error in Data Flash	Power cycled
LSI FAULTY – LOAD CELLS A AND B DISAGREEMENT	99154	Continuously	Load Moment Cutout assumed to be 100%	Load Monitoring configured; LSI System reports Fault #3 – Excessive Data Variance between Load Cell A and Load Cell B	Power cycled
FUNCTIONS LOCKED OUT – TCM SOFTWARE VERSION IMPROPER	99163	Continuously	Hydraulic functions are prevented Engine Start is prevented UGM J4-12 ECM / Fuel Relay is energized to shutdown engine	TCM transmitted a Major Software version that is not compatible (P3.x allowed)	Power cycled

9.24 ENGINE FAULT CODES

9.24.1 92.5 kW & 106 kW

SN MJR00150 to Present, DJB00150 to Present, GAT00150 to Present & SN MLH00150 to Present

Message	Fault Code	Indicators
No Diagnostic Code Detected	N/A	
Cylinder #1 Injector data incorrect	651	2
Cylinder #1 Injector current below normal	651-5	5
Cylinder #1 Injector current above normal	651-6	6
Cylinder #2 Injector data incorrect	652-2	2
Cylinder #2 Injector current below normal	652-5	5
Cylinder #2 Injector current above normal	652-6	6
Cylinder #3 Injector data incorrect	653-2	2
Cylinder #3 Injector current below normal	653-5	5
Cylinder #3 Injector current above normal	653-6	6
Cylinder #4 Injector data incorrect	654-2	2
Cylinder #4 Injector current below normal	654-5	5
Cylinder #4 Injector current above normal	654-6	6
Cylinder #5 Injector data incorrect	655-2	2
Cylinder #5 Injector current below normal	655-5	5
Cylinder #5 Injector current above normal	655-6	6
Cylinder #6 Injector data incorrect	656-2	2
Cylinder #6 Injector current below normal	656-5	5
Cylinder #6 Injector current above normal	656-6	6
Fuel Control Valve current below normal	1076-5	5
Fuel Control Valve current above normal	1076-6	6
8 Volt DC Supply voltage above normal	678-3	3
8 Volt DC Supply voltage below normal	678-4	4
Throttle Position Sensor erratic, intermittent, or incorrect	91-2	

Message	Fault Code	Indicators
Throttle Position Sensor voltage above normal	91-3	
Throttle Position Sensor voltage below normal	91-4	
Throttle Position Sensor abnormal frequency, pulse width, or period	91-08	
Engine Oil Pressure Sensor voltage above normal	100-3	
Engine Oil Pressure Sensor voltage below normal	100-4	
Engine Oil Pressure Sensor data drifted low	100-21	
Engine Coolant Temperature Sensor voltage above normal	110-3	
Engine Coolant Temperature Sensor voltage below normal	110-4	
Electrical System Voltage erratic, intermittent, or incorrect	168-2	
Electrical System Voltage voltage above normal	168-3	
Electrical System Voltage voltage Below normal	168-4	
Intake Manifold Air Temperature Sensor voltage above normal	105-3	
Intake Manifold Air Temperature Sensor voltage below normal	105-4	
Fuel Temperature Sensor voltage above normal	174-3	
Fuel Temperature Sensor voltage below normal	174-4	
Engine Speed Sensor abnormal frequency, pulse width, or period	190-8	
SAE J1939 Data Link abnormal update rate	-	
Personality Module erratic, intermittent, or incorrect	631-2	
Engine Timing Offset fault	637-11	
5 Volt Sensor DC Power Supply voltage above normal	3509-3	
5 Volt Sensor DC Power Supply voltage below normal	3509-4	
Programmed Parameter Fault erratic, intermittent, or incorrect	630-2	
Atmospheric Pressure Sensor voltage above normal	108-3	
Atmospheric Pressure Sensor voltage below normal	108-4	
Atmospheric Pressure Sensor calibration required	108-13	13
Atmospheric Pressure Sensor data drifted low	108-21	21
Secondary Engine Speed Sensor abnormal frequency, pulse width, or period	723-8	8

Message	Fault Code	Indicators
Turbo Wastegate Drive current below normal	1188-5	5
Turbo Wastegate Drive current above normal	1188-6	6
Exhaust Temperature Sensor voltage above normal	3241-3	3
Exhaust Temperature Sensor voltage below normal	3241-4	4
Secondary Throttle Position Sensor erratic, intermittent, or incorrect	29-2	2
Secondary Throttle Position Sensor voltage above normal	29-3	3
Secondary Throttle Position Sensor voltage below normal	29-4	4
Secondary Throttle Position Sensor abnormal frequency, pulse width, or period	29-8	8
DPF Active Regeneration Inhibited Due to Inhibit Switch	3703-31	31
Engine Throttle Actuator 1 Control Command not responding properly	3464-7	7
Idle Validation Switch #1 erratic, intermittent or incorrect	558-2	2
Idle Validation Switch #2 erratic, intermittent or incorrect	2970-2	2
Machine Security System Module abnormal update rate	1196-9	9
Engine Operation Mode Selector Switch erratic, intermittent, or incorrect	2882-2	2
Intake Manifold Pressure Sensor voltage above normal	3563-3	3
Intake Manifold Pressure Sensor voltage below normal	3563-4	4
Intake Manifold Pressure Sensor calibration required	3563-13	13
Intake Manifold Pressure Sensor data drifted low	3563-21	21
Fuel Rail Pressure Sensor voltage above normal	157-3	3
Fuel Rail Pressure Sensor voltage below normal	157-4	4
Ignition Key Switch loss of signal	158-2	2
5 Volt Sensor DC Power Supply #2 voltage above normal	3510-3	3
5 Volt Sensor DC Power Supply #2 voltage below normal	3510-4	4
Glow Plug Start Aid Relay current above normal	676-6	6
Ether Injection Control Solenoid current below normal	626-5	5
Ether Injection Control Solenoid current above normal	626-6	6
DPF #1 Intake Temperature Sensor voltage above normal	3242-3	3

Message	Fault Code	Indicators
DPF #1 Intake Temperature Sensor voltage below normal	3242-4	4
DPF #1 Differential Pressure Sensor voltage above normal	3251-3	3
DPF #1 Differential Pressure Sensor voltage below normal	3251-4	4
DPF #1 Differential Pressure Sensor calibration required	3251-13	13
ARD Fuel Pressure #1 Sensor voltage above normal	3480-3	3
ARD Fuel Pressure #1 Sensor voltage below normal	3480-4	4
ARD Fuel Pressure #1 Control current below normal	3479-5	5
ARD Fuel Pressure #1 Control current above normal	3479-6	6
Aftertreatment #1 Ignition Transformer Primary current below normal	3484-5	5
Aftertreatment #1 Ignition Transformer Primary current above normal	3484-6	6
ARD Air Pressure Control Actuator current below normal	3487-5	5
ARD Air Pressure Control Actuator current above normal	3487-6	6
ARD Air Pressure Control Actuator Position Sensor voltage above normal	3488-3	3
ARD Air Pressure Control Actuator Position Sensor voltage below normal	3488-4	4
ARD Supply Air Pressure Sensor voltage above normal	3837-3	3
ARD Supply Air Pressure Sensor voltage below normal	3837-4	4
ARD Supply Air Pressure Sensor calibration required	3837-13	13
ARD Supply Air Pressure Sensor data drifted low	3837	21
Air Inlet Temperature Sensor voltage above normal	172	3
Air Inlet Temperature Sensor voltage below normal	172	4
Aftertreatment #1 Ignition Transformer Secondary current below normal	4265	5
Aftertreatment #1 Ignition Transformer Secondary current above normal	4265	6
Aftertreatment #1 Fuel Injector #1 Heater current below normal	4301	5
Aftertreatment #1 Fuel Injector #1 Heater current above normal	4301	6
Engine Exhaust Gas Recirculation Intake Pressure Sensor voltage above normal	3358	3
Engine Exhaust Gas Recirculation Intake Pressure Sensor voltage below normal	3358	4
Engine Exhaust Gas Recirculation Intake Pressure Sensor calibration required	3358	13

Message	Fault Code	Indicators
Engine Exhaust Gas Recirculation Intake Pressure Sensor data drifted low	3358	21
Engine Exhaust Gas Recirculation Intake Pressure Sensor voltage above normal	412	3
Engine Exhaust Gas Recirculation Intake Pressure Sensor voltage below normal	412	4
EGR Differential Pressure Sensor voltage above normal	411	3
EGR Differential Pressure Sensor voltage below normal	411	4
EGR Differential Pressure Sensor calibration required	411	13
DPF #1 Soot Loading Sensor erratic, intermittent, or incorrect	4783	2
DPF #1 Soot Loading Sensor voltage above normal	4783	3
DPF #1 Soot Loading Sensor voltage below normal	4783	4
DPF #1 Soot Loading Sensor abnormal update rate	4783	9
DPF #1 Soot Loading Sensor failure	4783	12
DPF #1 Soot Loading Sensor calibration required	4783	13
DPF #1 Soot Loading Sensor data drifted low	4783	21
Engine Exhaust Gas Recirculation Valve Control current below normal	2791	5
Engine Exhaust Gas Recirculation Valve Control current above normal	2791	6
Engine Exhaust Gas Recirculation Valve Position Sensor voltage above normal	27	3
Engine Exhaust Gas Recirculation Valve Position Sensor voltage below normal	27	4
Aftertreatment Fuel Pump Relay current below normal	5423	5
Aftertreatment Fuel Pump Relay current above normal	5423	6
DPF #1 Intake Pressure Sensor voltage above normal	3609	3
DPF #1 Intake Pressure Sensor voltage below normal	3609	4
DPF #1 Intake Pressure Sensor calibration required	3609	13
DPF #1 Intake Pressure Sensor data drifted low	3609	21
Aftertreatment #1 Identification Number Module erratic, intermittent, or incorrect	5576	2
Aftertreatment #1 Identification Number Module abnormal frequency, pulse width, or period	5576	8
Aftertreatment #1 Identification Number Module special instruction	5576	14
Engine Throttle Actuator Control Command current below normal	3464	5

Message	Fault Code	Indicators
Engine Throttle Actuator Control Command current above normal	3464	6
Engine Throttle Valve Position Sensor voltage above normal	51	3
Engine Throttle Valve Position Sensor voltage below normal	51	4
Water in Fuel System Switch voltage above normal	97	3
High Air Filter Restriction - Warning	107	15
High Fuel/Water Separator Water Level - Warning	97	15
High Fuel/Water Separator Water Level - Derate	97	16
Low Engine Oil Pressure - Warning	100	17
Low Engine Oil Pressure - Shutdown	100	01
High Engine Coolant Temperature - Warning	110	15
High Engine Coolant Temperature - Derate	110	16
High Engine Coolant Temperature - Shutdown	110	0
Engine Overspeed - Warning	190	15
High Fuel Supply Temperature - Warning	174	15
High Fuel Supply Temperature - Derate	174	16
High Fuel Rail Pressure - Warning	157	16
Low Fuel Rail Pressure - Warning	157	18
Fuel Rail #1 Pressure Leak - Shutdown	1239	0
High Intake Manifold Air Temperature - Warning	105	15
High Intake Manifold Air Temperature - Derate	105	16
Aftertreatment Insufficient Temperature to Complete Regeneration - Derate	3711	31
DPF Active Regeneration Inhibited Due to Permanent System Lockout - Shutdown	3715	31
DPF Active Regeneration Inhibited Due to Temporary System Lockout - Shutdown	3714	31
High DPF #1 Soot Loading - Derate	3719	16
High DPF #1 Soot Loading - Shutdown	3719	0
High DPF #1 Ash Loading - Warning	3720	15
High DPF #1 Ash Loading - Derate	3720	16

Message	Fault Code	Indicators
High DPF #1 Intake Temperature - Warning	3242	15
High DPF #1 Intake Temperature - Derate	3242	16
Low DPF #1 Intake Temperature - Derate	3242	18
Low ARD Fuel Pressure #1 - Warning	3480	17
Low ARD Fuel Pressure #1 - Derate	3480	18
Aftertreatment #1 Loss of Ignition - Derate	3473	31
Aftertreatment #1 Loss of Combustion - Warning	3474	14
Aftertreatment #1 Loss of Combustion - Derate	3474	31
ARD Air Pressure Control Actuator Not Responding To Command - Derate	3487	7
High Intake Manifold Pressure - Derate	102	16
Low Intake Manifold Pressure - Derate	102	18
High Aftertreatment #1 Fuel Pressure #1 - Warning	3480	15
High Aftertreatment #1 Fuel Pressure #1 - Derate	3480	16
Aftertreatment Fuel Injector #1 not responding - Warning	3556	7
High Engine Exhaust Gas Recirculation Temperature - Warning	412	15
High Engine Exhaust Gas Recirculation Temperature - Derate	412	16
Engine Exhaust Gas Recirculation Valve Control Not Responding to Command - Derate	2791	7
Low DPF #1 Intake Pressure - Warning	3609	17
High DPF #1 Intake Pressure - Warning	3609	15
Low Aftertreatment #1 Secondary Air Pressure - Warning	3837	17
DPF #1 Conditions Not Met for Active Regeneration	3750	31
High Pressure Common Rail Fuel Pressure Relief Valve Active - Shutdown	5571	0
Initial Assembly Aftertreatment #1 Regeneration Required - Warning	3483	11
Engine Exhaust Gas Recirculation Mass Flow Rate Not Responding - Derate	2659	7

9.24.2 74.5 kW

SN MJR00150 to Present, DJB00150 to Present, GAT00150 to Present, SN MLH00150 to Present, KEK00150 to Present, MWC00150 to Present & RRJ00150 to Present

Fault Code Description	DTC/Code (SPN)	SYMPTOM (FMI)
Very Low After treatment 1 Diesel Particulate Filter NMHC Conversion Efficiency (Level 2)	5310	17
After treatment 1 Diesel Particulate Filter Regeneration too Frequent (emissions non compliance)	5397	31
Diesel Particulate Filter Active Regeneration Inhibited Due to Temporary System Lockout High	3714	15
Diesel Particulate Filter Active Regeneration Inhibit Status - Current Below Normal	3702	5
Diesel Particulate Filter Active Regeneration Inhibit Status - Current Above Normal	3702	6
Diesel Particulate Filter Active Regeneration Inhibit Status - Current Above Normal	3702	6
Diesel Particulate Filter Active Regeneration Inhibit Status - Current Below Normal	3702	5
Exhaust System High Temperature Lamp Command Current Below Normal	3698	5
Exhaust System High Temperature Lamp Command Current Above Normal	3698	6
Exhaust System High Temperature Lamp Command Current Above Normal	3698	6
Exhaust System High Temperature Lamp Command Current Below Normal	3698	5
Diesel Particulate Filter Lamp Command Current Below Normal	3697	5
Diesel Particulate Filter Lamp Command Current Above Normal	3697	6
Diesel Particulate Filter Lamp Command Current Above Normal	3697	6
Diesel Particulate Filter Lamp Command Current Below Normal	3697	5
Low After treatment 1 Diesel Particulate Filter NMHC Conversion Efficiency (Level 1).	5310	17
High Diesel Particulate Filter 1 Soot Load Percent (2)	3719	16
Very High Diesel Particulate Filter 1 Soot Load Percent (3)	3719	0
After treatment 1 Diesel Particulate Filter Incomplete Regeneration	5319	31
High After treatment 1 Diesel Particulate Filter Differential Pressure (1)	3251	15
High After treatment 1 Diesel Particulate Filter Differential Pressure (2)	3251	16
Diesel Particulate Filter Active Regeneration Inhibited Due to Inhibit Switch Intermittent	3703	2
Diesel Particulate Filter 1 Conditions Not Met for Active Regeneration	3750	31

Fault Code Description	DTC/Code (SPN)	SYMPTOM (FMI)
Customer or System Parameters Incorrect	630	2
Intake air pressure sensor Data Drifted High	102	20
Intake air pressure sensor Data Drifted Low	102	21
Engine Intake Manifold #1 Pressure Voltage Above Normal	102	3
Engine Intake Manifold #1 Pressure Voltage Below Normal	102	4
Aftertreatment 1 Diesel Particulate Filter Differential Pressure Not Responding Properly.	3251	7
Aftertreatment 1 DPF Differential Pressure Voltage Above Normal	3251	3
Aftertreatment 1 DPF Differential Pressure Voltage Below Normal	3251	4
High Pressure Common Rail Fuel Pressure Relief Valve Not Responding Properly	5571	7
High Pressure Common Rail Fuel Pressure Relief Valve Not Responding Properly	5571	7
High Pressure Common Rail Fuel Pressure Relief Valve Not Responding Properly	5571	7
High Pressure Common Rail Fuel Pressure Relief Valve Not Responding Properly	5571	16
High Pressure Common Rail Fuel Pressure Relief Valve Not Responding Properly	5571	7
High Pressure Common Rail Fuel Pressure Relief Valve Not Responding Properly	5571	7
High Pressure Common Rail Fuel Pressure Relief Valve Not Responding Properly	5571	7
Engine Exhaust Gas Pressure Voltage Above Normal	1209	3
Engine Exhaust Gas Pressure Voltage Below Normal	1209	4
ECU Instance Failure	2840	12
ECU Power Output Supply Voltage #1	3597	4
Engine Injector Metering Rail Pressure Low - Least Severe	157	18
Engine Fuel Leakage High - Most Severe	1239	0
Engine Injector Metering Rail Pressure High - Least Severe	157	16
Engine Injector Metering Rail Pressure Low - Least Severe	157	18
Engine Injector Metering Rail Pressure High - Least Severe	157	16
Injector Metering Rail Pressure High	157	16

Fault Code Description	DTC/Code (SPN)	SYMPTOM (FMI)
Injector Metering Rail Pressure Incorrect	157	2
Fuel Rail Pressure Data Intermittent	157	2
High Fuel Rail Pressure	157	0
Engine Injector Metering Rail 1 Pressure Voltage Above Normal	157	3
Engine Injector Metering Rail 1 Pressure Voltage Below Normal	157	4
Cruise Control States Data in Error	527	19
Accelerator Pedal Position 2 Voltage Above Normal	29	3
Accelerator Pedal Position 1 Voltage Above Normal	91	3
Accelerator Pedal Position 2 Voltage Below Normal	29	4
Accelerator Pedal Position 1 Voltage Below Normal	91	4
Sensor Supply Voltage 1 Erratic / Intermittent	3509	2
Sensor Supply Voltage 2 Erratic / Intermittent	3510	2
Sensor Supply Voltage 3 Erratic / Intermittent	3511	2
Red Stop Lamp Current Below Normal	623	5
Red Stop Lamp Current Below Normal	623	6
Red Stop Lamp Current Above Normal	623	6
Red Stop Lamp Current Below Normal	623	5
Engine Starter Motor Relay voltage above normal	677	3
Engine Starter Motor Relay Current Above Normal	677	6
Engine Starter Motor Relay current below normal	677	5
Engine Starter Motor Relay Current Above Normal	677	6
Engine Starter Motor Relay current high	677	6
Engine Starter Motor Relay current low	677	5
Number of ECU Resets Erratic / Intermittent	152	2
Number of ECU Resets Erratic / Intermittent	152	2

Fault Code Description	DTC/Code (SPN)	SYMPTOM (FMI)
Number of ECU Resets Erratic / Intermittent	152	2
Accelerator Pedal 1 Low Idle Switch Erratic / Intermittent	558	2
Accelerator Pedal 2 Low Idle Switch Erratic / Intermittent	2970	2
Start Signal Indicator Erratic / Intermittent	1041	2
Engine Air Intake Temperature Voltage Above Normal	172	3
Engine Air Intake Temperature Voltage Below Normal	172	4
High ECU Temperature (1)	1136	15
Low ECU Temperature (1)	1136	17
ECU Temperature Erratic / Intermittent	1136	2
Engine Throttle Actuator Control Command Not Responding Properly	3464	7
Engine Throttle Actuator Control Command Not Responding Properly	3464	7
Engine Throttle Actuator Current Below Normal	5419	5
Engine Throttle Actuator Current Above Normal	5419	6
Engine Throttle Actuator Current Above Normal	5419	6
Engine Throttle Actuator Current Below Normal	5419	5
Engine Throttle Actuator Current Below Normal	5419	5
Engine Throttle Actuator Current Above Normal	5419	6
Engine Throttle Actuator Current Above Normal	5419	6
Engine Throttle Actuator Current Above Normal	5419	6
Engine Throttle Actuator Current Above Normal	5419	6
Engine Throttle Actuator Current Below Normal	5419	5
Engine Throttle Actuator #1 Current High	5419	6
Engine Throttle Actuator #1 Not Responding Properly	5419	7
Engine Throttle Actuator #1 Not Responding Properly	5419	7
Engine Throttle Valve #1 Position Voltage above normal	51	3

Fault Code Description	DTC/Code (SPN)	SYMPTOM (FMI)
Engine Throttle Valve #1 Position Voltage below normal	51	4
Engine Intake Manifold 1 Temperature Voltage Above Normal	105	3
Engine Intake Manifold 1 Temperature Voltage Below Normal	105	4
Aftertreatment 1 Diesel Oxidation Catalyst Intake Gas Temperature Voltage Above Normal	4765	3
Aftertreatment 1 Diesel Oxidation Catalyst Intake Gas Temperature Voltage Below Normal	4765	4
Aftertreatment 1 Diesel Particulate Filter Intake Gas Temperature Voltage Above Normal	3242	3
Aftertreatment 1 Diesel Particulate Filter Intake Gas Temperature Voltage Below Normal	3242	4
Engine Turbocharger Wastegate Actuator Current Below Normal	1188	5
Engine Turbocharger Wastegate Actuator Current Above Normal	1188	6
Engine Turbocharger Wastegate Actuator Current Below Normal	1188	5
Engine Turbocharger Wastegate Actuator Current Above Normal	1188	6
J1939 Network #1, Primary Vehicle Network Special Instruction	639	14
Engine Exhaust Gas Temperature Voltage Above Normal	173	3
Engine Exhaust Gas Temperature Voltage Below Normal	173	4
Amber Warning Lamp Current Below Normal	624	5
Amber Warning Lamp Current Above Normal	624	6
Amber Warning Lamp Current Above Normal	624	6
Amber Warning Lamp Current Below Normal	624	5
Engine Injector Cylinder 1 Voltage Above Normal	651	20
Engine Injector Cylinder 3 Voltage Above Normal	653	20
Engine Injector Cylinder 4 Voltage Above Normal	654	20
Engine Injector Cylinder 2 Voltage Above Normal	652	20
Engine Injector Cylinder 1 Voltage Below Normal	651	21
Engine Injector Cylinder 3 Voltage Below Normal	653	21
Engine Injector Cylinder 4 Voltage Below Normal	654	21

Fault Code Description	DTC/Code (SPN)	SYMPTOM (FMI)
Engine Injector Cylinder 2 Voltage Below Normal	652	21

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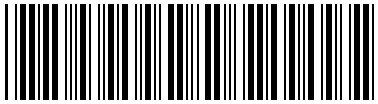

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