Service Manual

Models
G10-55A
G12-55A

S/N 0160045636 & After including
0160045082, 0160045094,
0160045209, 0160045295,
0160045296, 0160045449

31200795

Revised
December 21, 2015

An Oshkosh Corporation Company

EFFECTIVITY PAGE

December 10, 2012 - A - Original Issue Of Manual

January 31, 2014 - B - Revise pages ii, 1-4, 2-14, 3-20, 3-30, 3-31, 4-6, 6-2, 6-4, 6-7, 6-8, 7-2, 7-4, 7-6, 7-7, 7-13, 8-3, 8-8, 8-9, 8-21, 8-22, 9-12, 9-17.

October 13, 2014 - C - Revise pages 2-2 thru 2-12, 2-16, 3-20, 3-25, 8-4, 8-7, Add 431 Fault Code 9-26.

December 21, 2015 - D - Revise pages 1-4, 2-19 thru 2-24, 3-20, 7-2.

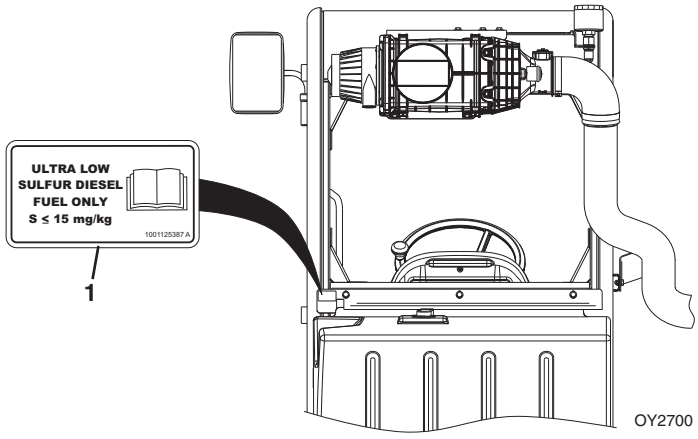
Modifications

Modifications to this machine may affect compliance with Industry Standards and/or Governmental Regulations. Any modification must be approved by JLG.

Machine Configuration

Two configurations of each machine are included in this manual. Determine if machine is equipped with Ultra Low Sulfur Fuel Decal (**1**) as indicated below.

- If equipped with the Ultra Low Sulfur decal, all specific references to this machine configuration will be referred to as Ultra Low Sulfur (**ULS**) from this point forward.
- If **not** equipped with the Ultra Low Sulfur decal, all specific references to this machine configuration will be referred to as Low Sulfur (**LS**) from this point forward.



REAR VIEW OF CAB

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 distributor.

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's seat looking in a forward direction.

Supplementary information is available from JLG in the form of Service Bulletins, Service Campaigns, Service Training Schools, the JLG 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. JLG 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 & SAFETY MANUAL

The mechanic must not operate the machine until the Operation & Safety 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 & Safety Manual is supplied with each machine and must be kept in manual holder located in cab. In event that Operation & Safety Manual is missing, consult local distributor 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's 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, JLG recommends a maximum pressure of 750 psi (52 bar) at a minimum distance of 12 in. (30,5 cm) 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.

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.

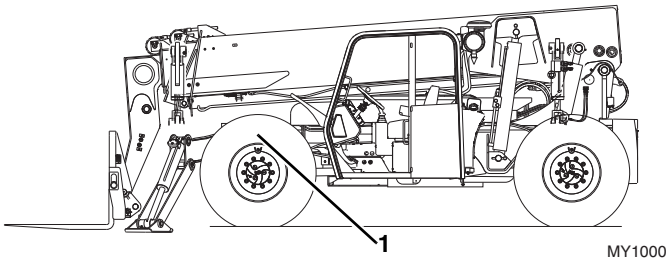
1.7 SAFETY DECALS

Check that all safety decals are present and readable on the machine. Refer to the Operation & Safety 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 left front frame rail behind the left front tire.

Note: *The replacement of any part on this machine with any other than **JLG** 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 **JLG** distributor, signed by the purchaser and returned to **JLG** when the machine is sold and/or put into use.

Registration activates the warranty period and helps to assure that warranty claims are promptly processed. To guarantee full warranty service, verify that the distributor has returned the business reply card of the warranty registration form to **JLG**.

2.2 THREAD LOCKING COMPOUND

JLG P/N	Loctite®	ND Industries	Description
0100011	242™	Vibra-TITE™121	Medium Strength (Blue)
1001095650	243™	Vibra-TITE™122	Medium Strength (Blue)
0100019	271™	Vibra-TITE™140	High Strength (Red)
0100071	262™	Vibra-TITE™131	Medium - High Strength (Red)

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

2.3 TORQUE CHARTS

2.3.1 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

2.3.1 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

2.3.1 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

2.3.1 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

2.3.1 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.

2.3.1 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.

2.3.2 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 (Lub)	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.

2.3.2 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 (Lub 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

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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.

2.3.2 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 (Lub 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.

2.3.2 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 (Lub 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.

2.3.3 Hydraulic Hose Torque Chart

O-Ring Face Seal & JIC Torque Chart

Size	ORFS	JIC	Flats Method
4	13 lb-ft (18 Nm)	13 lb-ft (18 Nm)	1.5 to 1.75
6	23 lb-ft (31 Nm)	23 lb-ft (31 Nm)	1 to 1.5
8	40 lb-ft (54 Nm)	40 lb-ft (54 Nm)	1.5 to 1.75
10	60 lb-ft (81 Nm)	60 lb-ft (81 Nm)	1.5 to 1.75
12	74 lb-ft (100 Nm)	85 lb-ft (115 Nm)	1.0 to 1.5
16	115 lb-ft (156 Nm)	115 lb-ft (156 Nm)	0.75 to 1.0
20	170 lb-ft (230 Nm)	170 lb-ft (230 Nm)	0.75 to 1.0
24	200 lb-ft (271 Nm)	200 lb-ft (271 Nm)	0.75 to 1.0
32	N/A	270 lb-ft (366 Nm)	0.75 to 1.0

Note: *By definition the "Flats Method" will contain some variance. Use the "Flats Method" only when accessibility with a torque wrench is not possible.*

Torque Wrench:

1. Identify the appropriate application and refer to the above chart for the correct torque value.
2. If equipped, lubricate o-ring with hydraulic oil. Hand tighten the swivel nut until no lateral movement of the swivel nut can be detected. Average hand torque is 3 lb-ft (4 Nm).
3. Use the double wrench method while tightening to avoid hose twist.
4. Torque wrench must be held at the center of the grip. Apply constant force until it clicks.
5. After connection has been properly tightened, mark a straight line across connecting parts indicating that connection has been properly tightened.

Flats Method:

1. If equipped, lubricate o-ring with hydraulic oil. Hand tighten the swivel nut until no lateral movement of the swivel nut can be detected. Average hand torque is 3 lb-ft (4 Nm).
2. Mark a dot on one of swivel nut flats and another dot in line on hex of adapter it's connecting to.
3. Use double wrench method while tightening to avoid hose twist.
4. After connection has been properly tightened, mark a straight line across connecting parts, not covering the dots indicating that the connection has been properly tightened.

2.4 SPECIFICATIONS

2.4.1 Travel Speeds

FUNCTION	G10-55A and G12-55A
First Gear	3.4 mph (5,47 km/h)
Second Gear	6.2 mph (9,97 km/h)
Third Gear	14.0 mph (22,5km/h)
Fourth Gear	20.0 mph (32,1 km/h)

2.4.2 Hydraulic Cylinder Performance

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

FUNCTION	APPROXIMATE TIMES (seconds)
Boom Extend (Boom Level)	16.3–18.0
Boom Retract (Boom Level)	12.2–14.5
Boom Lift	15.2–16.8
Boom Lower	14.1–15.5
Attachment Tilt Forward	5.8–6.5
Attachment Tilt Rearward	5.0–6.0
Frame Level—Full Right to Left	9.4–10.4
Frame Level—Full Left to Right	10.2–11.3
Outrigger—Down	16.3–18.0
Outrigger—Up	12.2–14.5

2.4.3 Cylinder Drift

CYLINDER	MAXIMUM ROD TRAVEL (loaded or unloaded)
Lift/Lower Cylinder	0.125 in (3.2 mm) per hour
Extend/Retract Cylinder	0.125 in (3.2 mm) per hour
Attachment Tilt Cylinder	0.125 in (3.2 mm) per hour

2.4.4 Electrical System Engine Performance

Battery	
Type, Rating	12 BCI, Negative (-) Ground, Maintenance Free
Quantity	2
Reserve Capacity Minutes @ 25 Amps	180
Cold Cranking Amps @ 0° F (-18° C)	700
Cranking Amps @ 32° F (-18° C)	840
Group/Series	Group 31
Alternator	12V, 100 Amps

2.4.5 Engine Specifications

Description	G10-55A & G12-55A
Engine Make/Model	Cummins QSB 4.5L
Displacement	276 in^3 (4,5 liters)
Low Idle	900 rpm
High Idle	2,500 to 2,700 rpm
Horsepower	130 HP (97 kW) @ 2500 rpm
Peak Torque	457 lb-ft (620 Nm) @ 1500 rpm
Fuel Delivery	Fuel Injection
Air Cleaner	Dry Type, Replaceable Primary and Safety Elements

2.4.6 Tires

Note: *Standard wheel lug nut torque is 350-400 lb-ft (475-542 Nm).*

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

Size	Tire Type	Minimum Ply/ Star Rating	Fill Type	Pressure
14.00 x 24	G-2/L-2 Bias Ply Traction	12 Ply	Pneumatic	65 psi (4,5 bar)
			Foam - Approx 720 lb (327 kg)	62 psi (4,3 bar)
17.50 x 25	G-2/L-2 Bias Ply Traction	12 Ply	Pneumatic	65 psi (4,5 bar)
			Foam - Approx 785 lb (356 kg)	51 psi (3,5 bar)
400/75-28	Duraforce	16 Ply	Pneumatic	76 psi (5,2 bar)
			Foam - Approx 570 lb (259 kg)	73 psi (5,0 bar)

2.5 FLUID AND LUBRICANT CAPACITIES

2.5.1 Fluids (if Equipped for ULS)

Compartment or System	Type and Classification	Viscosities	Ambient Temperature Range			
			°F		°C	
			Min	Max	Min	Max
Engine Crankcase	API CJ-4 Multigrade	SAE 15W-40	5	120	-15	49
		SAE 0W-40	-40	0	-40	-20
Transmission and Transfer Case	Mobilfluid 424	10W-30	0	104	-20	40
	Mobilfluid LT	75W-80	-40	0	-40	-20
Axle Differential and Wheel End	Mobilfluid 424*	10W-30	0	104	-20	40
	Mobilfluid LT*	75W-80	-40	0	-40	-20
	API GL4 with LS Additives or API GL5 with LS Additives	SAE140	50	122	10	50
		80W-140 85W-140	14	122	-10	50
		SAE90 SAE90LS	32	104	0	40
		80W-90 85W-90	-4	104	-20	40
		75W-90	-40	104	-40	40
		75W	-40	50	-40	10
Hydraulic System	Mobilfluid 424	10W-30	0	104	-20	40
	Exxon Univis HVI		-40	0	-40	-20
Boom Wear Pad Grease	Mystik Tetrimoly	NLGI Grade 2	-4	104	-20	40
Cylinder and Axle Grease	Multipurpose Grease	NLGI Grade 2	-22	104	-30	40
Boom Chain Lubricant	Schaffer 200S Silver Streak					
Engine Coolant	Ethylene Glycol and Water	50/50 Mix	Standard			
		60/40 Mix	Cold Weather			
Fuel	#2 Diesel	Ultra Low Sulfur (S ≤ 15mg/kg)	Standard			
	B5 Biodiesel					
	Blend of #1 diesel and #2 diesel fuels (“winterized” #2)		Cold Weather			
	B5 Biodiesel with Winter Conditioner					

Note: *Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”*

2.5.2 Fluids (if Equipped for LS)

Compartment or System	Type and Classification	Viscosities	Ambient Temperature Range			
			°F		°C	
			Min	Max	Min	Max
Engine Crankcase	API CI-4 Multigrade	SAE 15W-40	5	120	-15	49
		SAE 0W-40	-40	0	-40	-20
Transmission and Transfer Case	Mobilfluid 424	10W-30	0	104	-20	40
	Mobilfluid LT	75W-80	-40	0	-40	-20
Axle Differential and Wheel End	Mobilfluid 424*	10W-30	0	104	-20	40
	Mobilfluid LT*	75W-80	-40	0	-40	-20
	API GL4 with LS Additives or API GL5 with LS Additives	SAE140	50	122	10	50
		80W-140 85W-140	14	122	-10	50
		SAE90 SAE90LS	32	104	0	40
		80W-90 85W-90	-4	104	-20	40
		75W-90	-40	104	-40	40
		75W	-40	50	-40	10
Hydraulic System	Mobilfluid 424	10W-30	0	104	-20	40
	Exxon Univis HVI		-40	0	-40	-20
Boom Wear Pad Grease	Mystik Tetrimoly	NLGI Grade 2	-4	104	-20	40
Cylinder and Axle Grease	Multipurpose Grease	NLGI Grade 2	-22	104	-30	40
Boom Chain Lubricant	Schaffer 200S Silver Streak					
Engine Coolant	Ethylene Glycol and Water	50/50 Mix	Standard			
		60/40 Mix	Cold Weather			
Fuel	#2 Diesel	Low Sulfur (S ≤ 500 mg/kg)	Standard			
	B5 Biodiesel					
	Blend of #1 diesel and #2 diesel fuels (“winterized” #2)		Cold Weather			
	B5 Biodiesel with Winter Conditioner					

Note: *Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”*

2.5.3 Capacities

Engine Crankcase Oil

Capacity with Filter Change	14 quarts (13,3 liters)

Fuel Tank

Capacity	38 gallons (144 liters)

Cooling System

System Capacity	20 quarts (18,9 liters)

Hydraulic System

System Capacity	60.5 gallons (229 liters)
Reservoir Capacity to Middle of Sight Gauge	33 gallons (125 liters)
Auxiliary Hydraulic Circuit Max Flow	10 gpm (37,9 lpm)

Transmission

Capacity with Filter Change	22 quarts (20,8 liters)

Transfer Case

Capacity	1.8 quarts (1,7 liters)

Axles

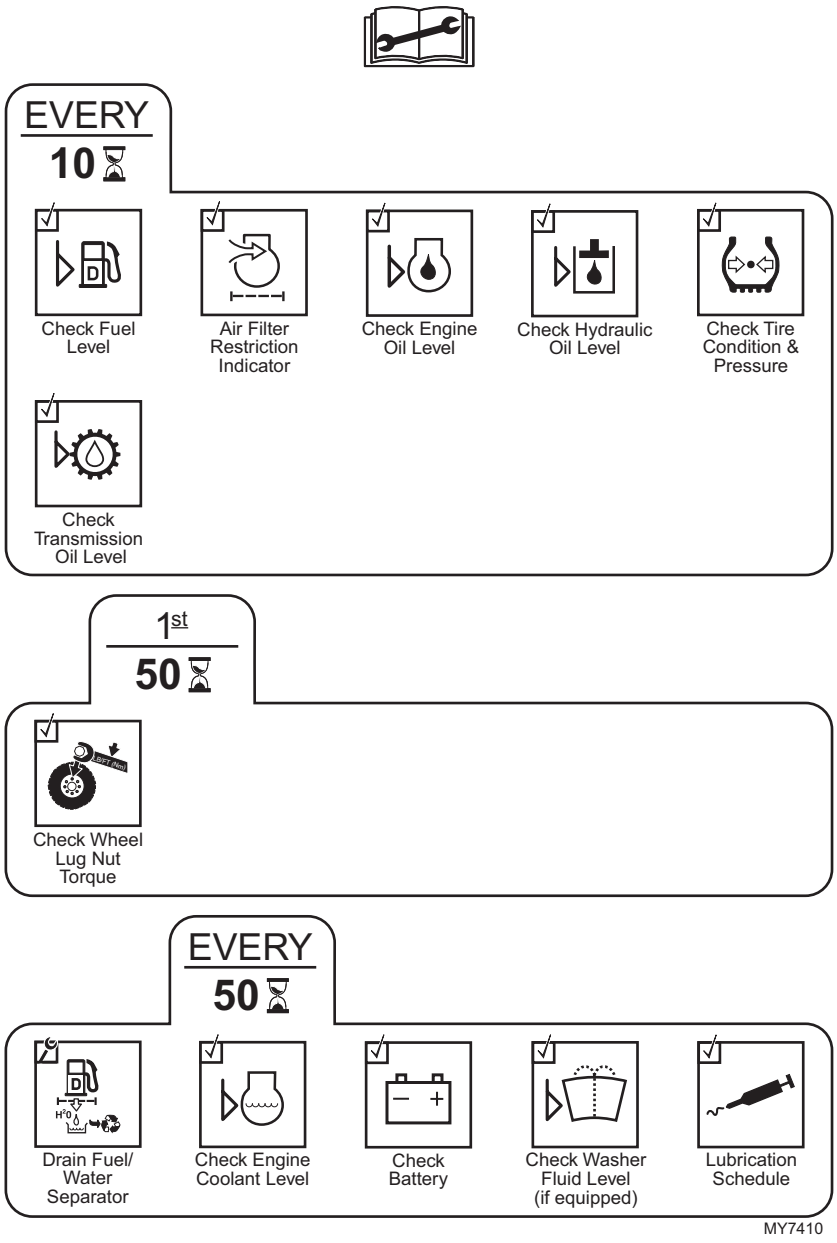
Differential Housing Capacity	
Front	15 quarts (14,2 liters)
Friction Modifier (Front Only-If needed)	Maximum 24 ounce (709,8 milliliter)
Rear	15.5 quarts (14,7 liters)
Wheel End Capacity	2 quarts (1,9 liters)

Air Conditioning System (If equipped)

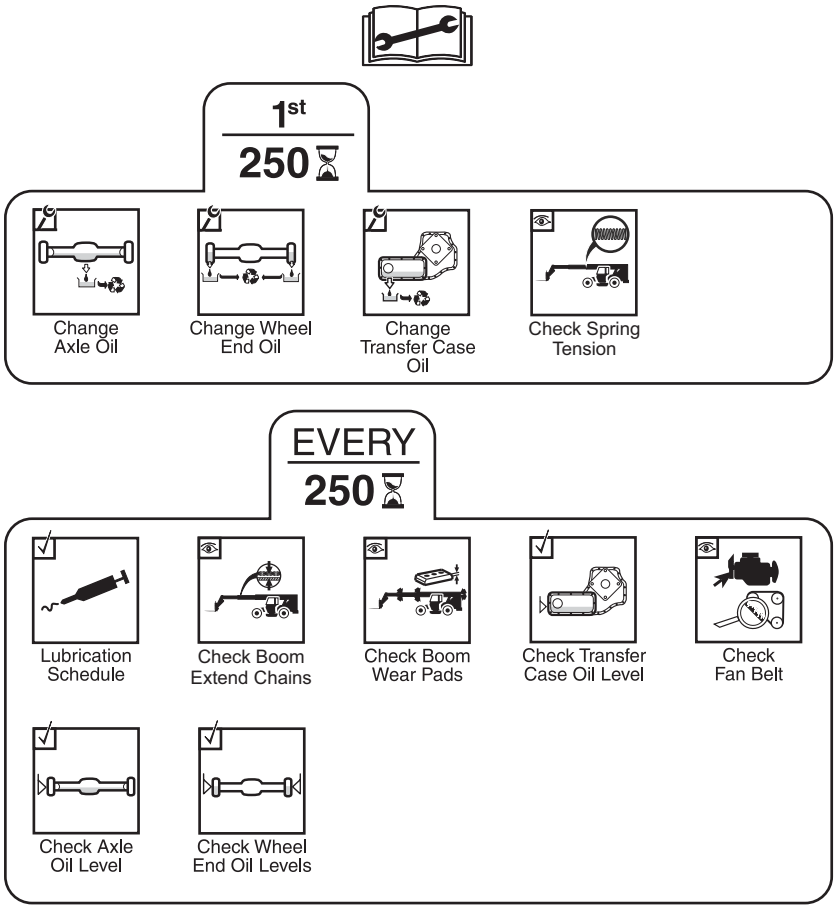
System Capacity	2.5 lb (1134 grams)

2.6 SERVICE AND MAINTENANCE SCHEDULES

2.6.1 10, 1st 50 & 50 Hour

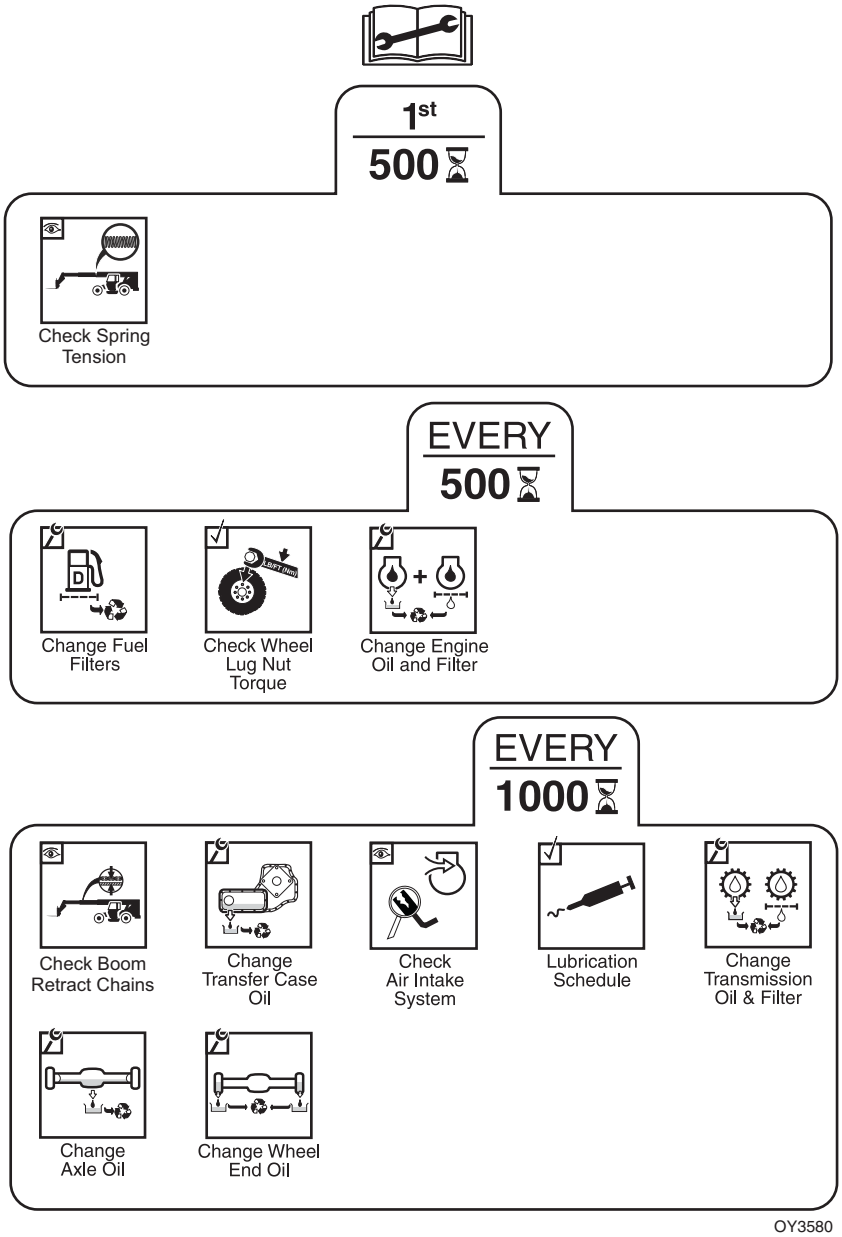


2.6.2 1st 250 & 250 Hour

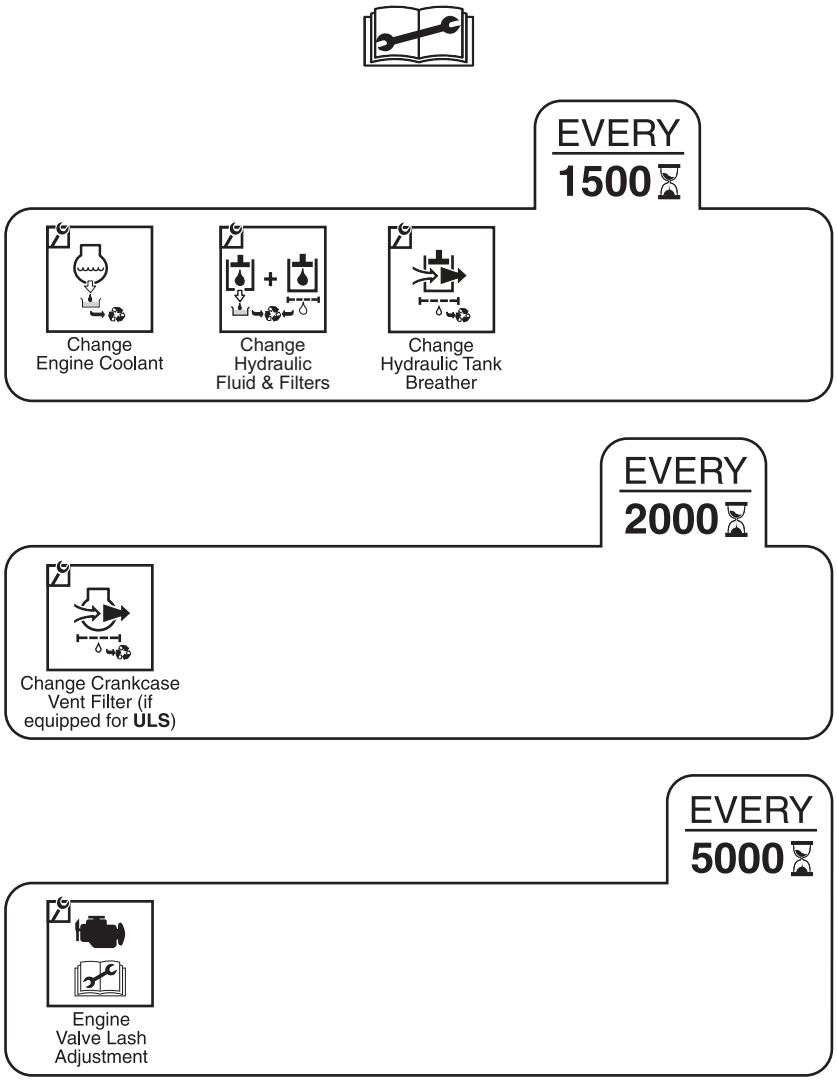


Note: *Engine oil & filter service interval can be extended. See Engine Manual for details.*

2.6.3 1st 500, 500 & 1000 Hour

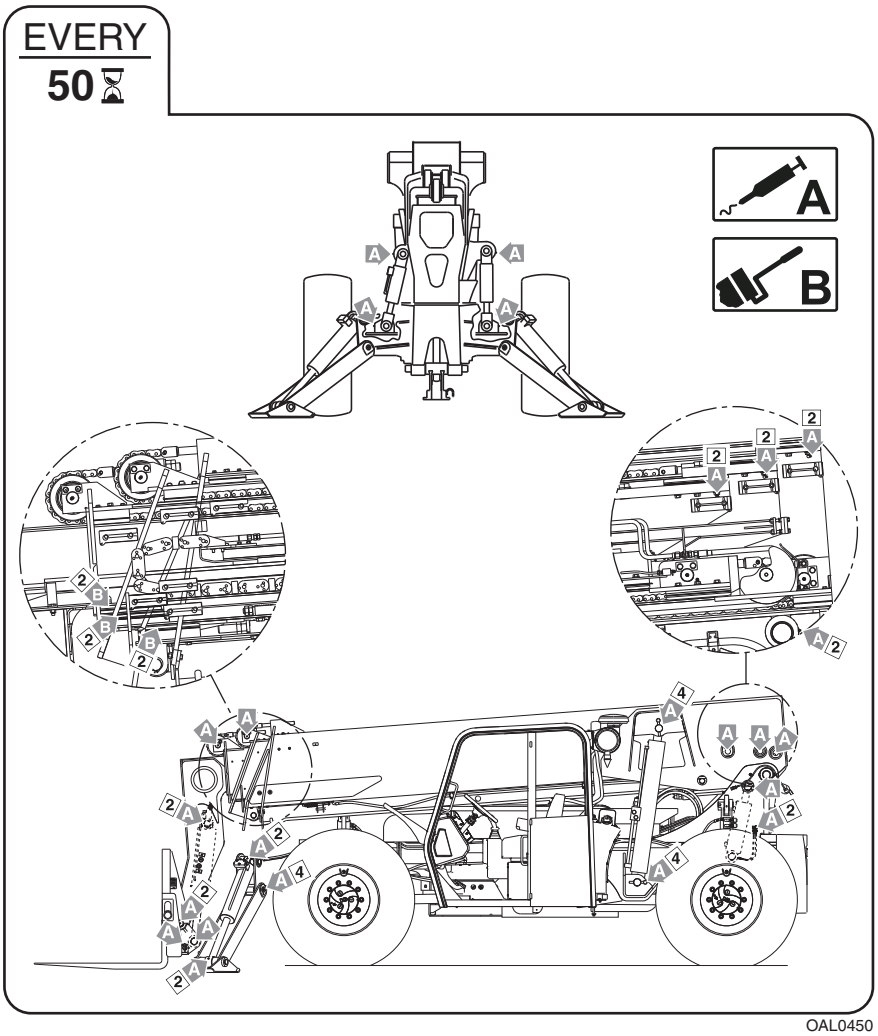


2.6.4 1500, 2000 & 5000 Hour

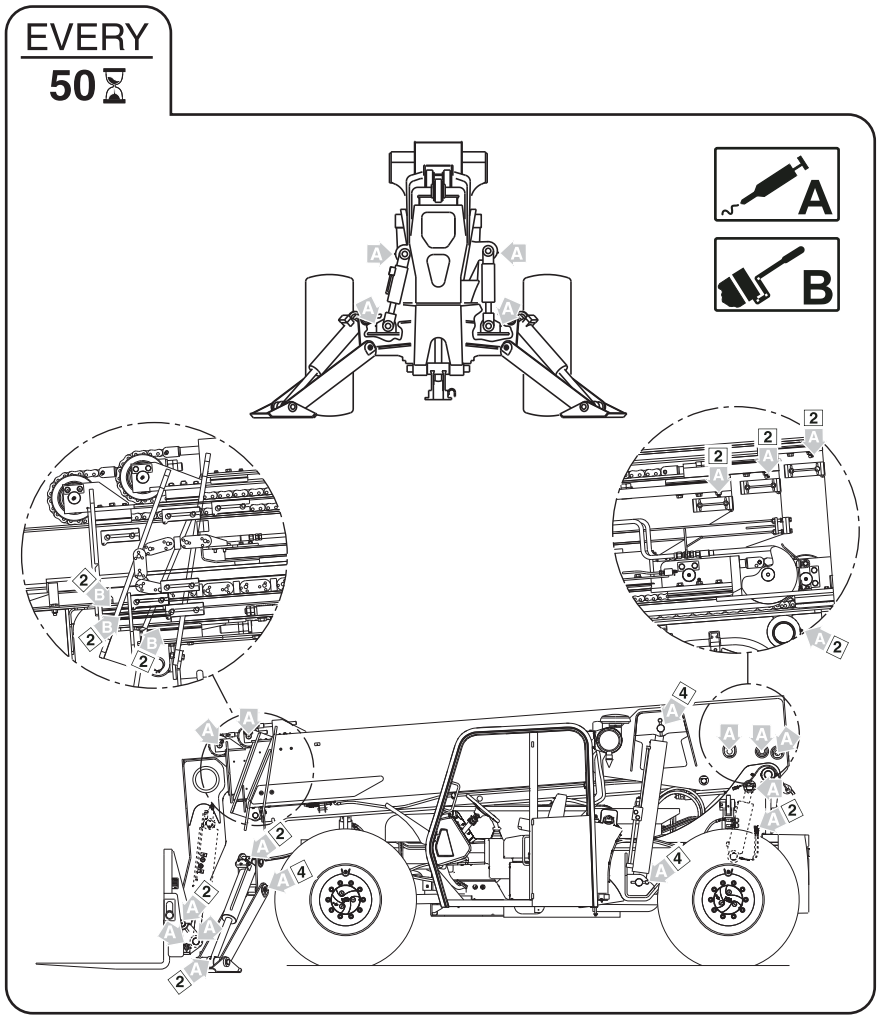


2.7 LUBRICATION SCHEDULES

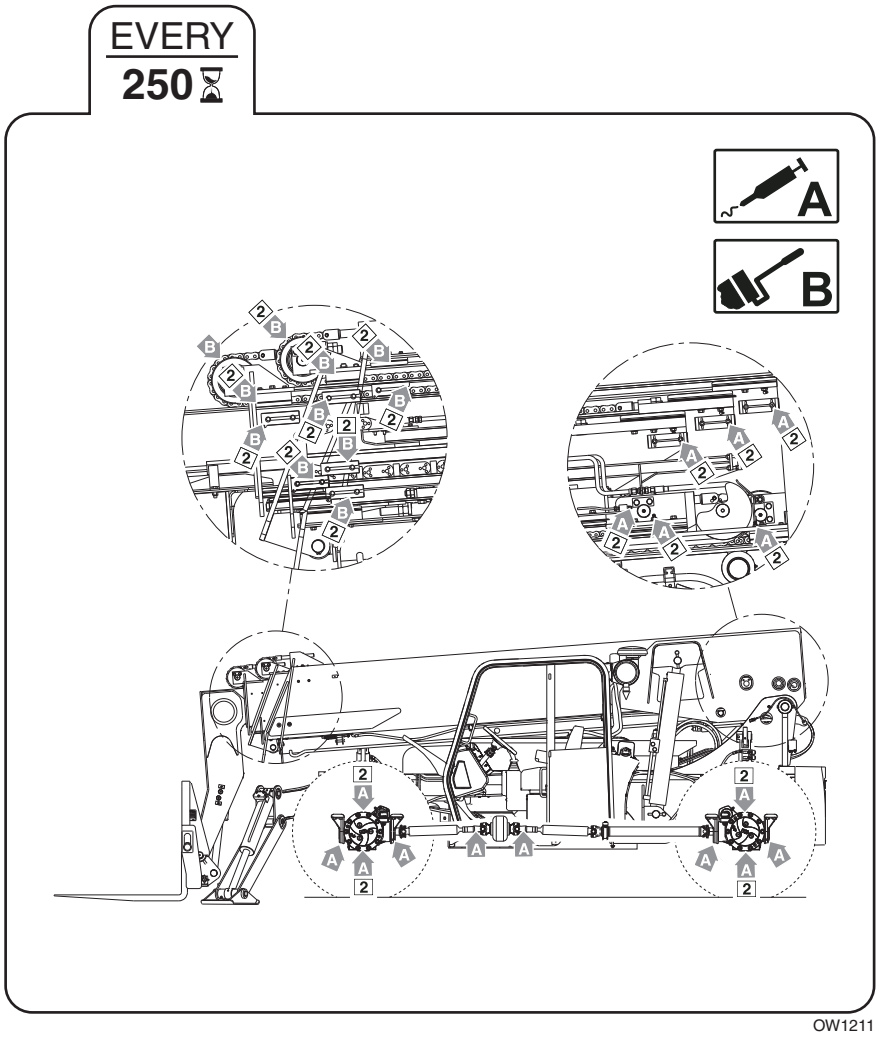
a. 50 Hour
Before S/N 0160050017



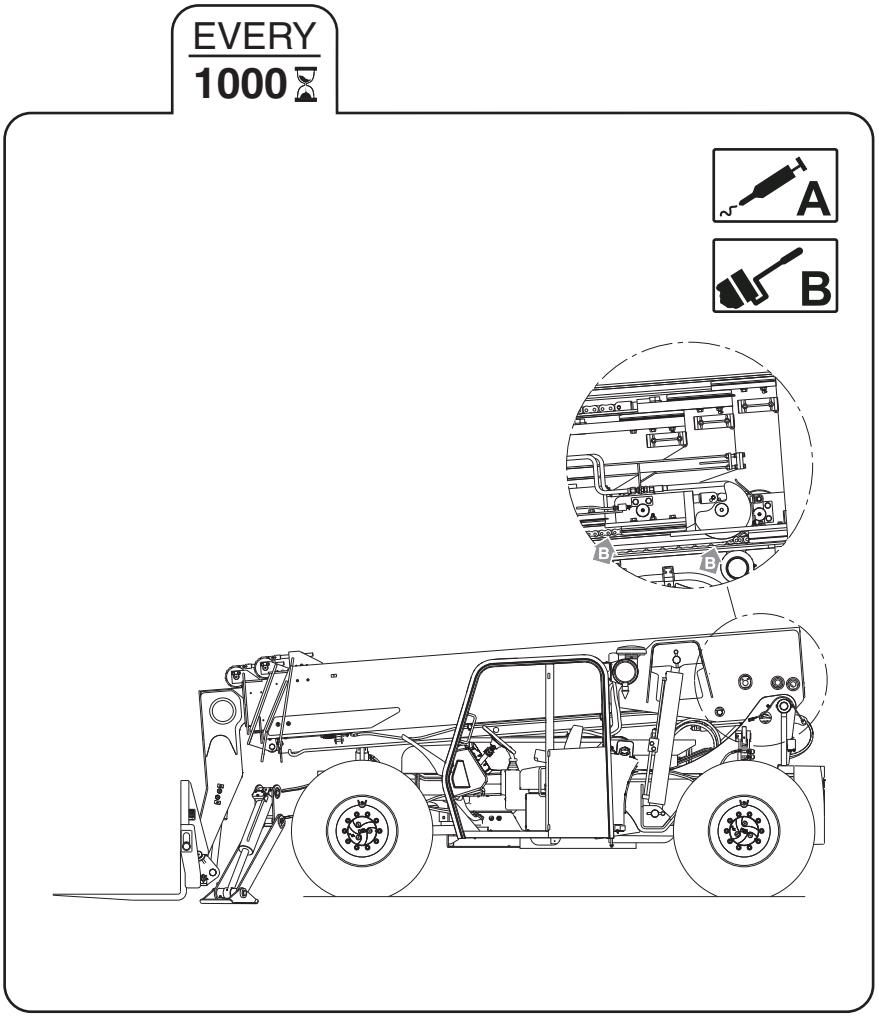
a. 50 Hour
S/N 0160050017 & After



b. 250 Hour



c. 1000 Hour



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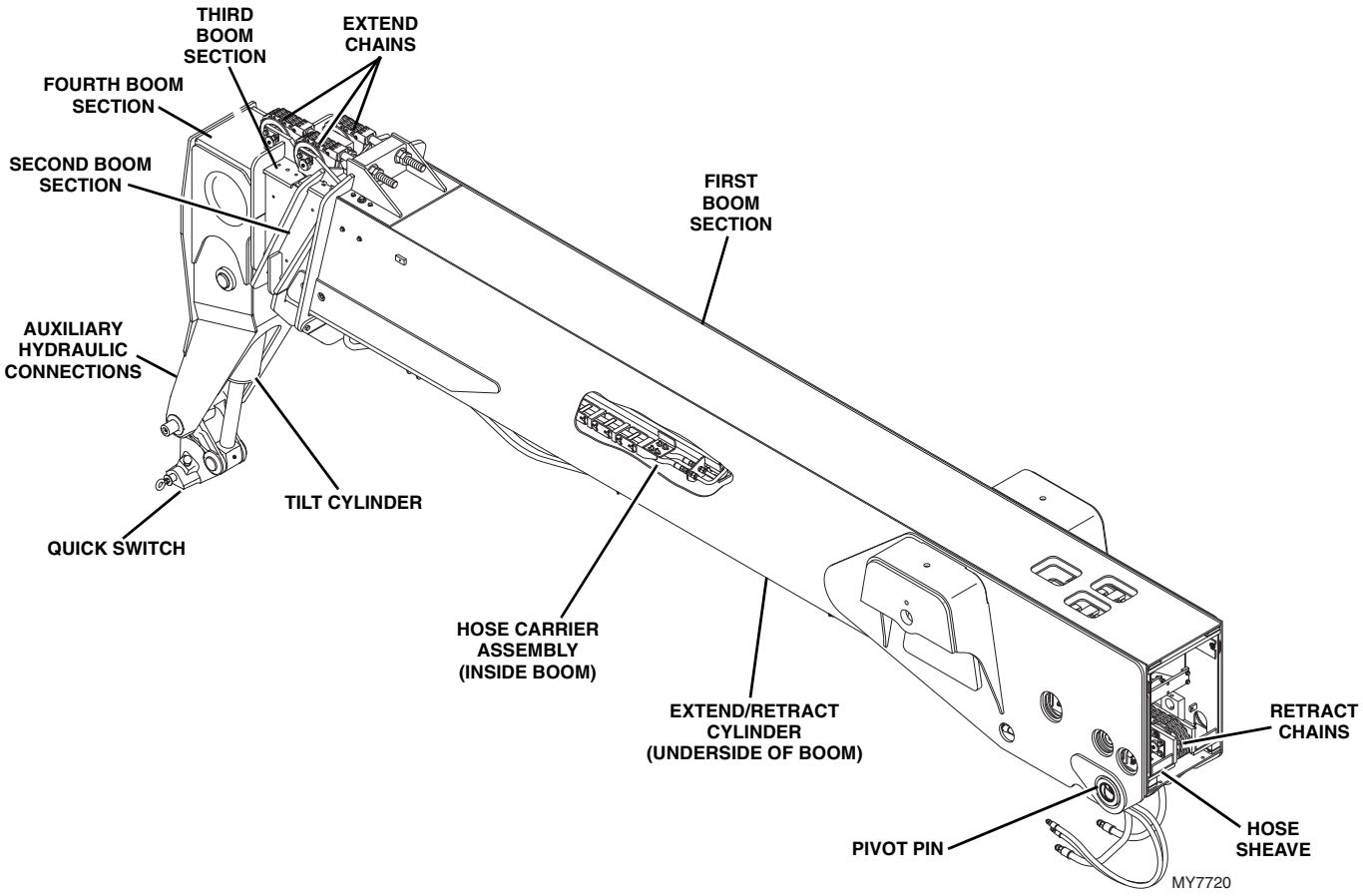
Section 3
Boom

Contents

3.1 BOOM SYSTEM COMPONENT TERMINOLOGY

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



3.2 BOOM SYSTEM - FOUR SECTION

3.2.1 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 chain 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 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 section is forced out hydraulically, the third and fourth boom sections are pulled out by the extend chains.

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

3.3 BOOM ASSEMBLY MAINTENANCE

These instructions provide the complete boom assembly removal and installation or the second, third and fourth boom sections removal and installation.

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 switch.*

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 3.11, “Boom Wear Pads.”)
2. Check hose sheaves and chain rollers.
3. Apply grease at all lubrication points (grease fittings). (Refer to Section 2.7, “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 the manufacturer. The structural integrity of the boom will be impaired if subjected to any repair involving welding or drilling.

3.4 COMPLETE BOOM REMOVAL/ INSTALLATION

3.4.1 Complete Boom Removal

1. Remove any attachment from the quick switch assembly. Refer to the appropriate operation and safety manual.
2. Remove the quick switch assembly. Refer to *Section 3.10, "Quick Switch Assembly."*
3. Park the machine on a hard, level surface, level the machine, fully retract the boom, raise the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
4. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
5. Open engine cover. Allow system fluids to cool.
6. Properly disconnect the batteries.
7. Support the front of the boom by placing a sling behind the boom head.
8. Label, disconnect and cap all hydraulic hoses for the extend/retract and tilt circuits. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
9. Support the lift/lower cylinder on the left side of the machine. Remove the lock bolt and rod end pin. Lower the lift/lower cylinder onto the frame rails. Repeat this step for the right side lift/lower cylinder.
10. Support the compensation cylinder. Remove the lock bolt and rod end pin. Lower the compensation cylinder onto the frame rails.
11. 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.
12. Remove the bolt securing the boom pivot pin. Pull out the boom pivot pin.
13. Lift the complete boom off machine and set on level ground or supports.

3.4.2 Complete Boom Installation

1. Park the machine on a hard, level surface, place the transmission control lever in (N) NEUTRAL, engage the park brake, chock the wheels and shut the engine OFF.
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.
3. Install the boom pivot pin.
4. With the sling still in place, install the compensation cylinder, pins and bolts.
5. With the sling still in place, install the rod end of the left lift/lower cylinder, pin and lock bolt. Repeat for the right side lift/lower cylinder.

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

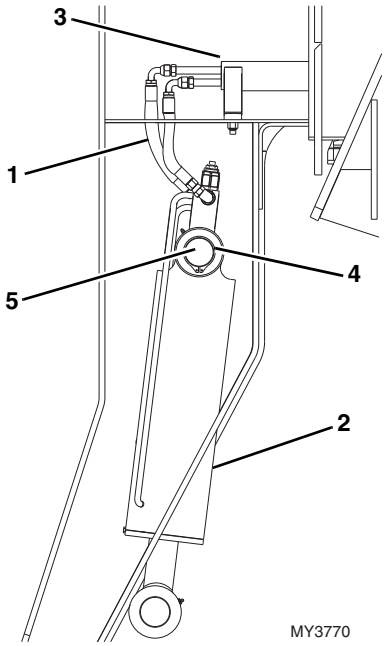
Note: *Grease the boom pivot bore, compensation cylinder rod ends, lift/lower cylinder rod end and pins before installing.*

6. Uncap and reconnect the previously labeled hydraulic hoses to the extend/retract cylinder.
7. Uncap and connect any remaining hydraulic fittings to their appropriate locations.
8. Recheck the wear pad gaps to ensure they meet the minimum gap requirement. Shim if necessary.
9. Ensure boom chains are properly adjusted. Refer to Section 3.6, "Boom Section Separation Adjustment."
10. Properly connect the batteries.
11. Start engine and operate all boom functions several times. Check for leaks, and check the hydraulic fluid level in reservoir; add fluid if required.
12. Install the quick switch assembly. Refer to *Section 3.10.4, "Manual Quick Switch Installation."*
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 Tags from both the ignition key switch and the steering wheel.
16. Install the previously remove attachment to the quick switch assembly. Refer to the appropriate operation and safety manual.

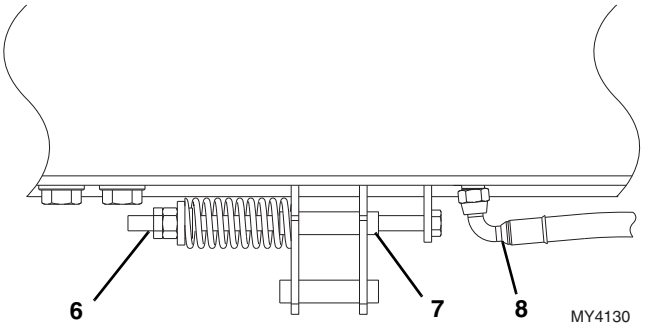
3.5 BOOM SECTION REMOVAL/INSTALLATION

3.5.1 Second, Third and Fourth Boom Section Removal

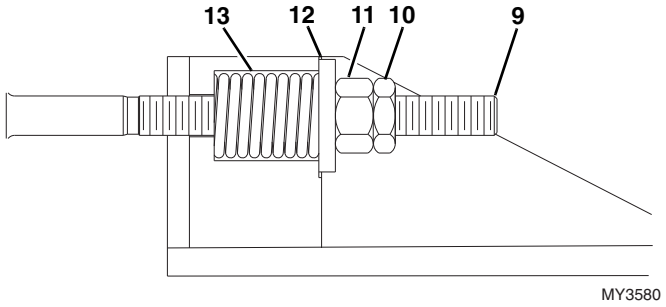
1. Remove any attachment from the quick switch assembly. Refer to the appropriate operation and safety manual.
2. Remove the quick switch assembly. Refer to *Section 3.10, "Quick Switch Assembly."*
3. Park the machine on a hard, level surface, level the machine, fully retract the boom, level the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
4. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
5. Open engine cover. Allow the system fluids to cool.



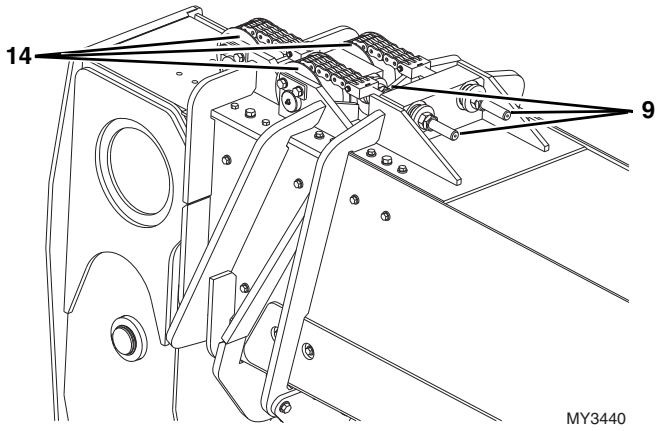
6. Label and remove both tilt cylinder hoses (**1**) between the tilt cylinder (**2**) and the hose carrier (**3**). Label, cap and plug the hose carrier tube ends and cylinder ports to prevent dirt and debris from entering the hydraulic system.
7. Using a suitable lifting device, secure the tilt cylinder barrel with a nylon strap.
8. Remove both retaining clips (**4**) from each side of the tilt cylinder mounting pin (**5**).
9. Remove the tilt cylinder mounting pin (**5**).
10. Lower tilt cylinder from the boom head.
11. Support the front of the boom by placing a sling behind the boom head.



12. Loosen jam nut and lock nut (**6**) to release tension from hoses on hose take-up weldment (**7**).
13. Loosen the hydraulic hoses (**8**) and electrical cables if equipped on the hose take-up weldment (**7**). Plug the hose ends and tube ends to prevent dirt and debris from entering the hydraulic system.



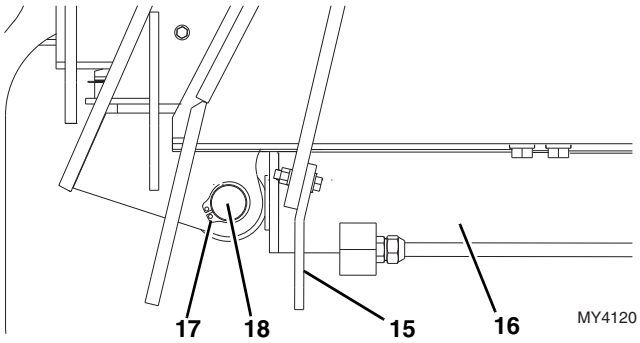
14. At the top front of the boom, measure and note the distance from the end of the three extend chain clevises (**9**) to the face of the lock nut (**10**).
15. Loosen and remove the lock nuts (**10**), adjusting nuts (**11**), washers (**12**) and springs (**13**) from the three extend chain clevises (**9**).



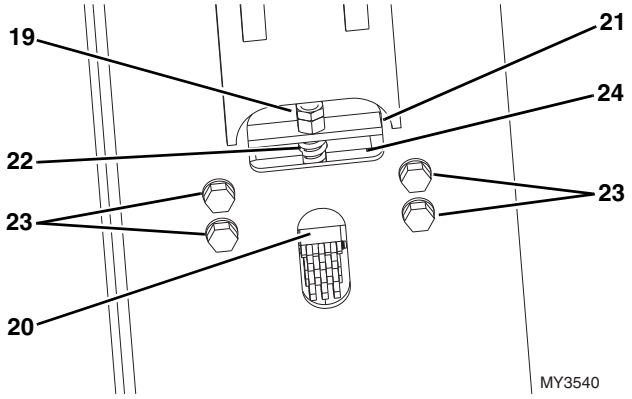
16. Pull the three extend chain clevises (**9**) off of each chain roller (**14**) and lay each assembly on the third and fourth boom sections respectively.

Note: *It may be necessary to remove the extend chain rollers to help in the removal of the top wear pads.*

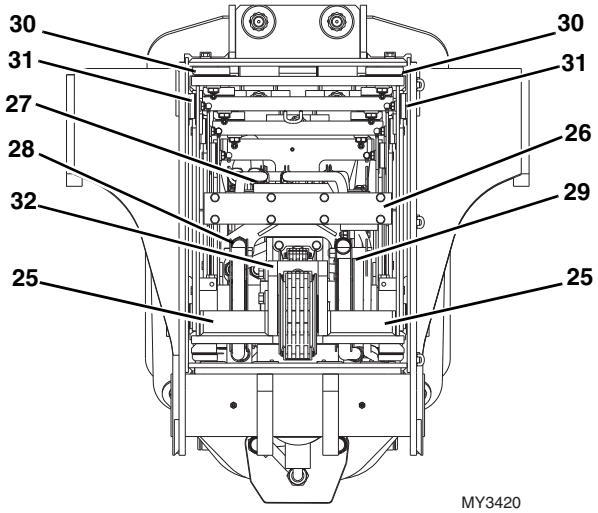
17. Verify all fittings, tubes and hoses are properly capped and /or plugged.
18. Extend the second boom section to access the retract chain adjusting block.



19. Remove the extend/retract cylinder support (**15**) from the front of the first boom section.
20. Support the extend/retract cylinder (**16**) with a suitable sling.
21. Remove the retaining clips (**17**) from each side of the extend/retract cylinder rod.
22. Remove extend/retract cylinder rod mounting pin (**18**).
23. Lower the front of the extend/retract cylinder to a secured block on top of the frame. Do Not use the engine hood for support.



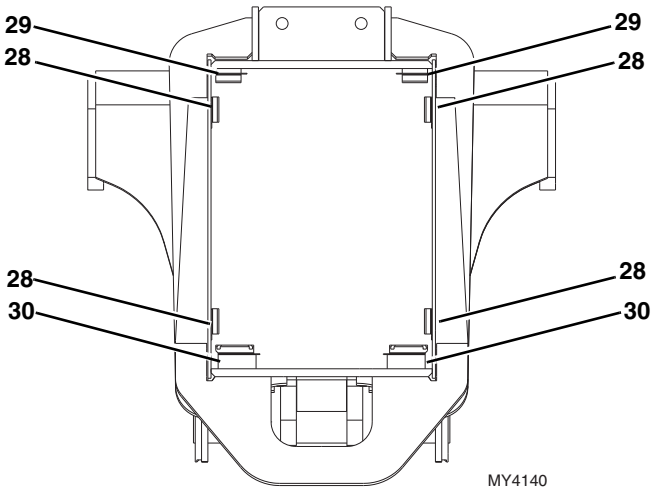
24. Remove the adjusting nut and lock nut (**19**), retract chain and clevis (**20**), spring stop (**21**) and spring (**22**). Loosen bolts (**23**) and adjusting block (**24**).
25. Properly disconnect the batteries.



26. At the rear of the boom, remove both of the hose sheave covers (**25**).
27. Unbolt the hose carrier bracket (**26**) from the rear of the second boom section and the hose carrier.
28. Pull hose carrier (**27**) back to gain access to tilt hose (**28**) and auxiliary hose (**29**) connections.
29. Disconnect the tilt hoses, auxiliary hoses and if equipped, the electrical connector at the rear of the hose carrier. Label, plug and cap all hydraulic connections to prevent dirt and debris from entering the hydraulic system.
30. Push hose carrier (**27**) as far forward as possible.

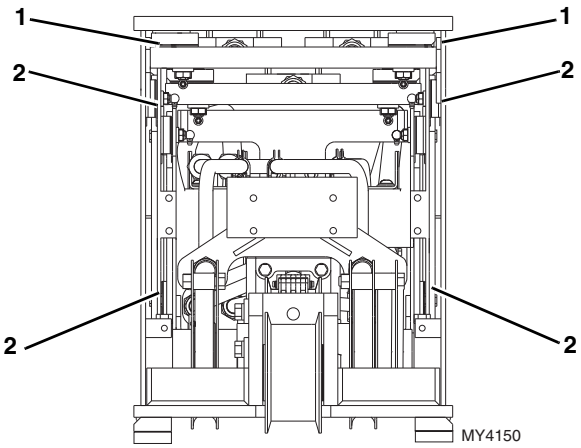
Note: *Tag each wear pad, spacer, shim and hardware from each location. Note the location of any grease fitting (if equipped) on each wear pad.*

31. Remove top rear wear pads, spacers, shims and hardware (**30**) from rear of second boom section.
32. Remove the left (or right) side rear wear pad, spacer, shims and hardware (**31**) from the rear of the second boom section.
33. Pull each boom section slightly forward to relieve the tension in retract chain (**32**).
34. Remove snap rings and pin connecting rear retract chain (**32**) from chain clevis at rear of boom. Allow chain to hang out over rear of boom.
35. Place a sling around the second boom section. With a suitable lifting device, slowly pull the second, third and fourth boom sections approximately 25% out of the first boom section.



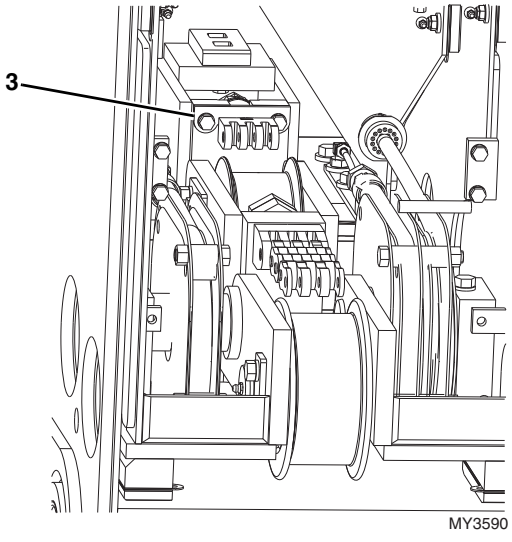
36. With the second, third and fourth boom section still connected to a suitable lifting device, remove all wear pads, spacers, shims, and hardware (**28**) from the front sides of the first boom section.
37. Remove both wear pads, spacers, shims, blocks and hardware (**29**) from front top of first boom section.
38. Remove both wear pads, spacers, shims and hardware (**30**) from the front bottom of the first boom section.
39. Adjust sling(s) around second boom section to help balance second, third and fourth boom sections.
40. Remove remainder of second, third and fourth boom sections from the first boom section and set on suitable supports.

3.5.2 Third and Fourth Boom Section Removal



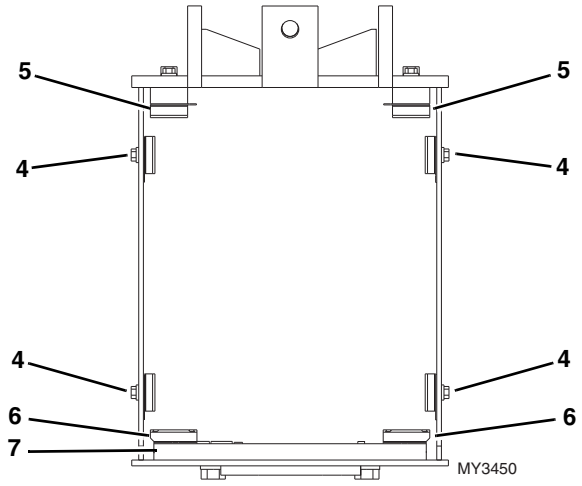
Note: *Tag each wear pad, spacer, shim and hardware from each location. Note the location of any grease fitting (if equipped) on each wear pad.*

1. Remove the top rear wear pads, spacers, shims and hardware (**1**) from the rear of the third boom section.
2. Remove the left (or right) side rear wear pad, spacer, shims and hardware (**2**) from the rear of the third boom section.
3. Verify all disconnected hoses, tubes and fittings are capped and/or plugged.



4. Pull each boom section slightly forward to relieve the tension on the retract chain (**3**).
5. Remove snap rings and pin connecting rear retract chain (**3**) from chain clevis at rear of boom. Allow chain to hang out over rear of boom.

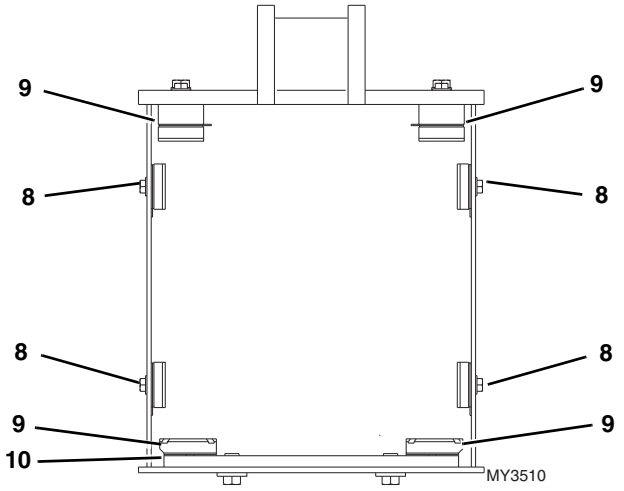
6. Place a sling around the third boom section. With a suitable lifting device, slowly pull the third and fourth boom sections approximately 25% out of the second boom section.



7. With the third and fourth boom section still connected to a suitable lifting device, remove all wear pads, spacers, shims, and hardware (**4**) from the front sides of the second boom section.
8. Remove both wear pads, spacers, shims, blocks and hardware (**5**) from front top of second boom section.
9. Remove both wear pads, spacers, shims and hardware (**6**) from the front bottom of the second boom section.
10. Loosen and remove the wear pad support plate (**7**) from the bottom front of the second boom section.
11. Adjust sling(s) around the third boom section to help balance the third and fourth boom sections.
12. Remove the remainder of the third and fourth boom sections from the second boom section and set on suitable supports.

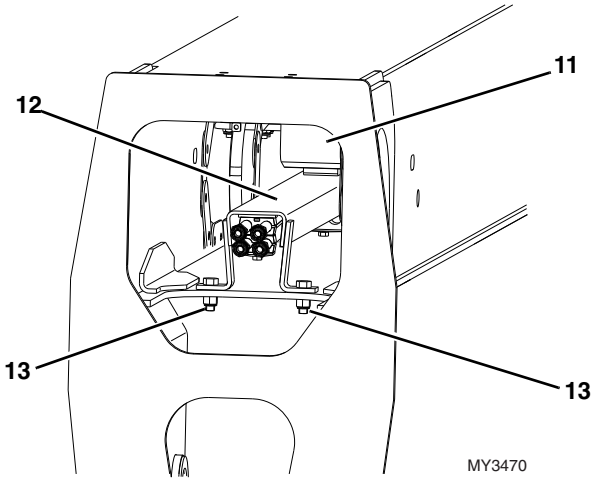
3.5.3 Fourth Boom Section Removal

1. Place a sling around the fourth boom section and slowly pull the fourth boom section approximately 25% out of the third boom section. Lower the fourth section boom head onto a suitable support.

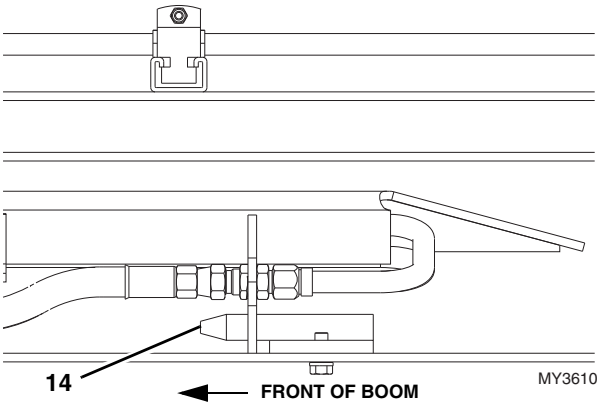


2. With the fourth boom section still connected to a suitable lifting device, remove all wear pads, spacers, shims, and hardware (**8**) from the front sides of the third boom section.
3. Remove top and bottom front wear pads, shims and blocks (**9**) from the third boom section.
4. Loosen and remove the wear pad support plate (**10**) from the bottom front of the third boom section.
5. Adjust the sling(s) around the fourth boom section for stability. Balance the fourth boom section and slowly pull the fourth boom section out of the third boom section being careful not to damage any surrounding components.
6. Lower fourth boom section onto a suitable support.

3.5.4 Hose Carrier Removal



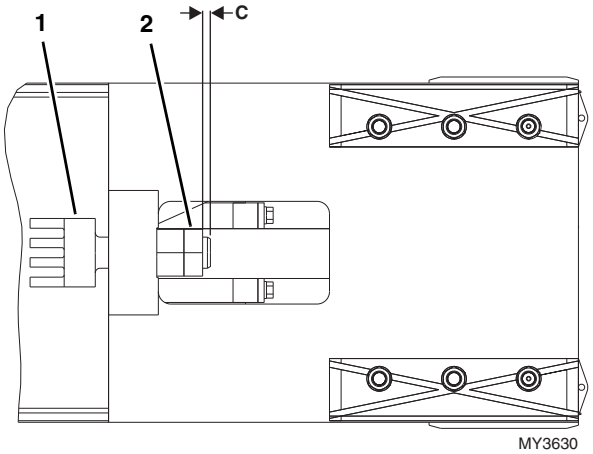
1. Remove the guide bracket (**11**) at the front of the hose carrier (**12**). Reuse the existing hardware.
2. Loosen and remove the front two mounting bolts (**13**) holding the hose carrier in place. Tag all hardware.
3. Remove the hose carrier through the front of the fourth boom section.
4. When the hose carrier is approximately 25% free of the fourth boom section, fasten the two hose carriers together (using nylon tie-wraps or nylon straps) to prevent separation.
5. Continue to remove the hose carrier, fastening the hose carriers together as they are being removed.
6. When the hose carrier is approximately 75% tied together, pull the assembly free of the boom section.
7. Lower the hose carrier onto a suitable support.



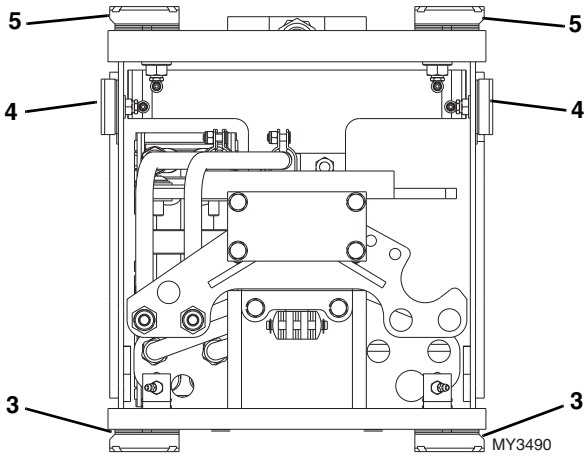
8. Remove the hose carrier guide bracket from the inside of the fourth boom section (**14**).

3.5.5 Fourth Boom Section Assembly

1. Place fourth boom section onto suitable supports.

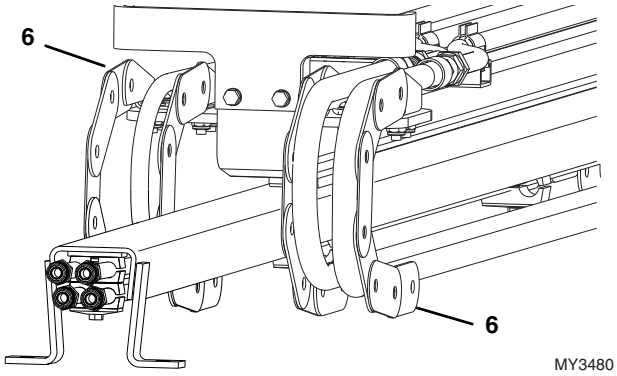


2. Install the previously removed extend chain assembly and clevis (**1**) at the top rear of the fourth boom section. Allow 0.250 in (6,35 mm) (**C**) between the end of the clevis (**1**) and the face of the lock nut (**2**). Torque lock nut to 100 lb-ft (135 Nm).

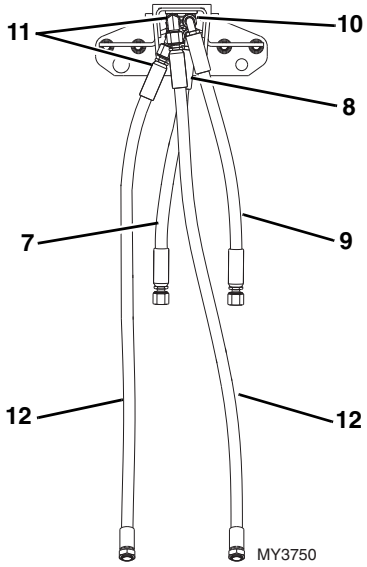


3. Install all wear pads, spacers and shims (**3**, **4** and **5**) at rear of the fourth boom section. Snug mounting bolts. Shim as needed AFTER boom section is installed. Refer to Section 3.11.2, “Wear Pad Installation and Lubrication,” for detailed information.

3.5.6 Hose Carrier Installation

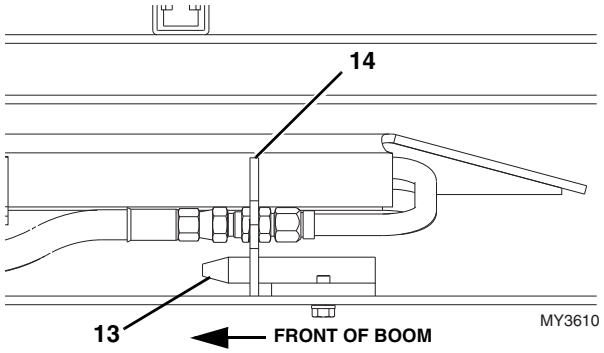


1. Inspect the hose carrier track (**6**) for any broken or missing clips. Repair or replace as needed.
2. Remove the caps from the tubes on the hose carrier.

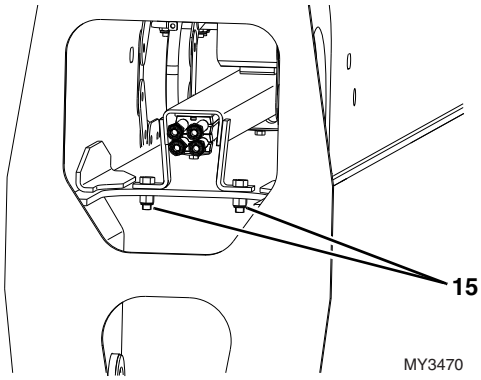


Note: *Connect the tilt cylinder hoses and the auxiliary hoses to the hose carrier bulkhead before installing the hose carrier in the fourth boom section.*

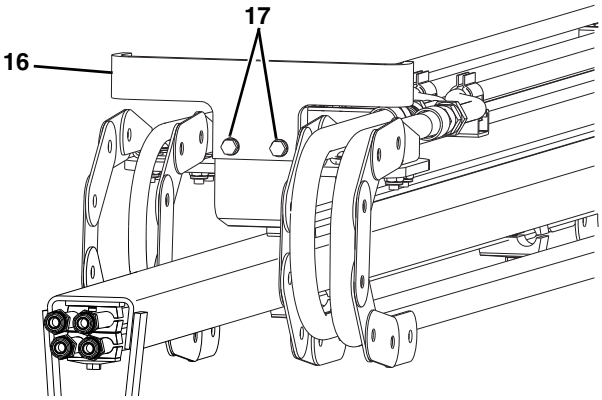
3. Install tilt cylinder hose (**7**) to the bottom left fitting on the hose carrier tube (**8**).
4. Install tilt cylinder hose (**9**) to the top left fitting on the hose carrier tube (**10**).
5. Install adaptors (**11**) to each auxiliary tube at the front right of the hose carrier.
6. Install auxiliary hoses (**12**) to each adaptor (**11**) on auxiliary tubes at front right of hose carrier.
7. Orient each auxiliary hose (**12**) as shown above.
8. Torque each fitting and hose as required.



9. Install the previously removed hose carrier guide bracket (**13**). Torque as required.
10. Install the hose carrier (**14**) into the front of the fourth boom section. Remove each nylon tie or nylon strap as the hose carrier is installed.
11. Align the hose carrier (**14**) to the hose carrier guide bracket (**13**).



12. Align hose carrier mounting bracket and install the previously removed hardware to mounting bracket at front of fourth boom section (**15**). Torque as required.



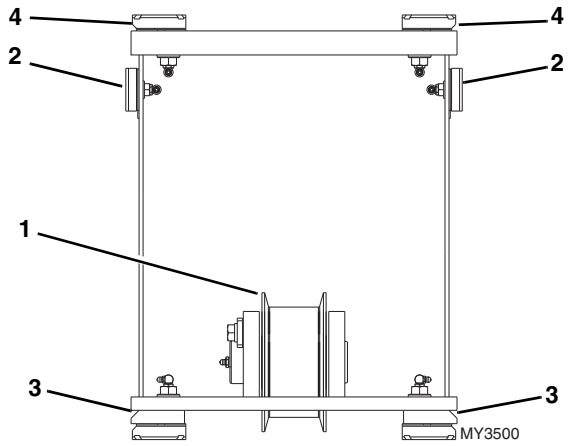
13. Install guide bracket (**16**) P/N using the previously removed hardware (**17**). Torque as required.

3.5.7 Third Boom Section Assembly

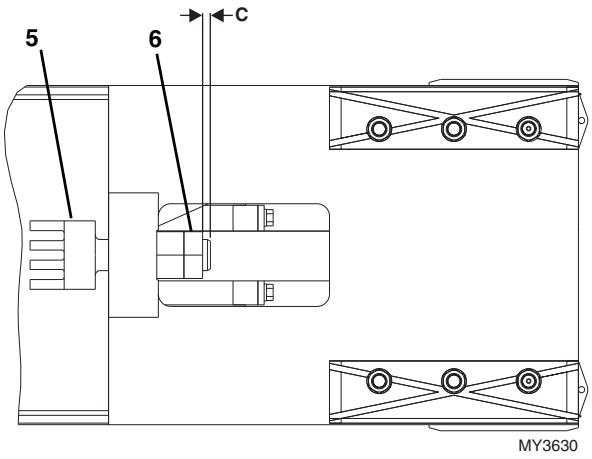
Note: *Inspect and lubricate all extend and retract chains before re-assembly. Refer to Section 3.13.1, "Boom Chain Inspection," for detailed information.*

Note: *Using a straight bar approximately 40 in (1041 mm) long will aid in the installation of the wear pads located on the inside front of each boom section.*

1. Place the third boom section onto suitable supports.



2. Install the previously removed chain roller (**1**) at the rear of the third boom section. Insert the mounting pin, retainer plate and hardware. Torque as required.
3. Install all wear pads, spacers and shims (**2**, **3** and **4**) at rear of third boom section. Snug mounting bolts. Shim as needed AFTER boom section is installed.Refer to Section 3.11.2, "Wear Pad Installation and Lubrication," for detailed information.

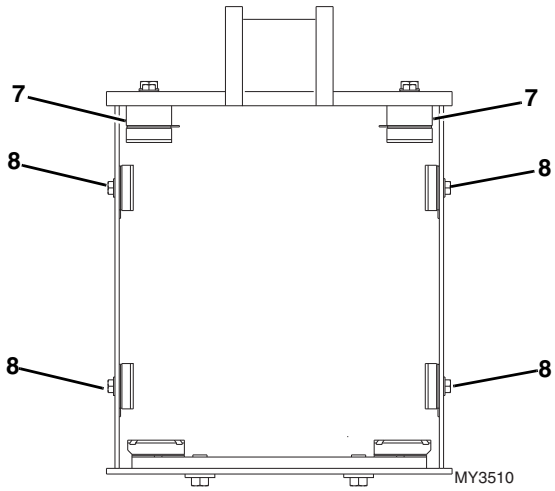


4. Install the previously removed extend chain assemblies and clevises (**5**) at the top rear of the third boom section. Allow 0.250 in (6,35 mm) between the end of the clevis (**5**) and the face of the lock nut (**6**). Torque lock nut to 100 lb-ft (135 Nm).

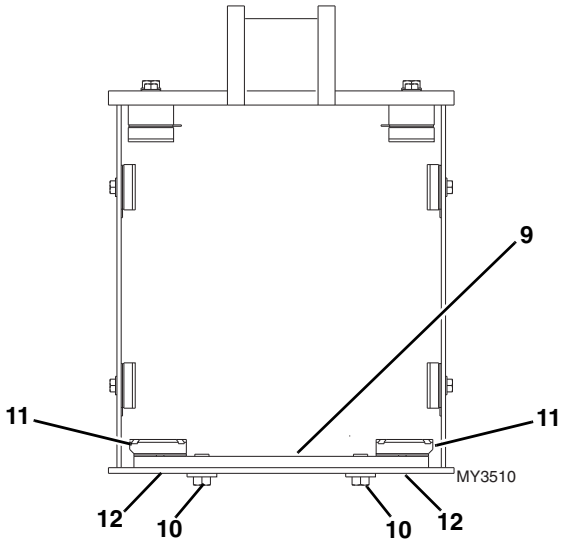
3.5.8 Fourth Boom Section Installation

Note: *Using a straight bar approximately 40 in (1041 mm) long will aid in the installation of the wear pads located on the inside front of each boom section.*

1. Clean and lubricate the bottom of the fourth boom section where the wear pads of the third boom section contact the fourth boom section.
2. Place sling, or two slings for better stability, around fourth boom section and slowly insert fourth boom section into third boom section being careful not to damage any surrounding components.
3. Install the wear pad, support plates and spacers (**7**)



with existing hardware at the inside top front of the third boom section. Snug mounting bolts. Shim as needed AFTER boom section is installed. Refer to Section 3.11.2, "Wear Pad Installation and Lubrication," for detailed information.

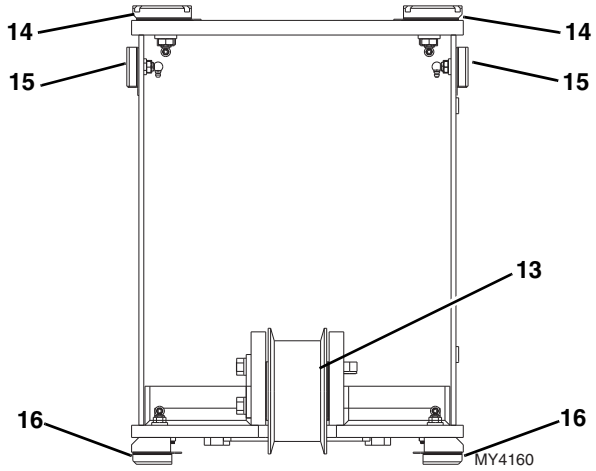


4. Install the previously removed wear pad support (**9**) at the front inside of the third boom section. Use the previously removed hardened washers and bolts (**10**). Torque as required.
5. Install the wear pads, spacers and shims on each side and bottom (**8** and **11**) at the front of the third boom section. Snug mounting bolts. Shim as needed AFTER boom section is installed. Refer to Section 3.11.2, “Wear Pad Installation and Lubrication,” for detailed information.

Note: *Longer bolts (**12**) may be required to fully engage the threaded inserts in the wear pads without allowing bolts to protrude past the chamfer on the wear pads. Refer to page 6, Wear Pad Installation and Lubrication for detailed information.*

3.5.9 Second Boom Section Assembly

1. Place second boom section onto suitable supports.



2. Install the previously removed chain roller (**13**) at the rear of the second boom section. Insert the mounting pin, retainer plate and hardware. Torque as required.
3. Install the wear pads and spacers (**14**, **15** and **16**) at the rear of the second boom section. Snug mounting bolts. Shim as needed AFTER boom section is installed. Refer to Section 3.11.2, “Wear Pad Installation and Lubrication,” for detailed information.

3.5.10 Third and Fourth Boom Section Installation

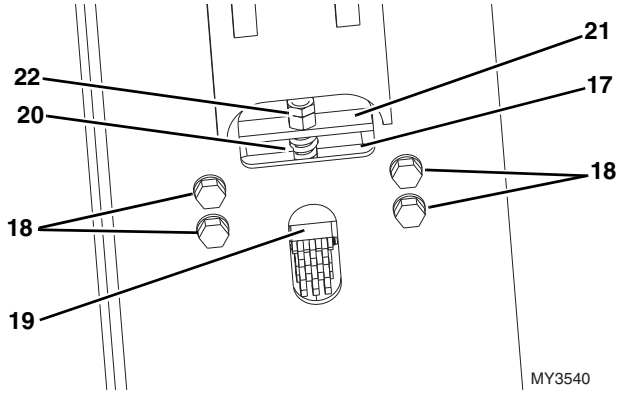
Note: *Refer to Section 2.3, “Torque Charts,” for standard bolt torque information.*

Note: *Refer to Section 2.3.3, “Hydraulic Hose Torque Chart,” for standard hose torque information.*

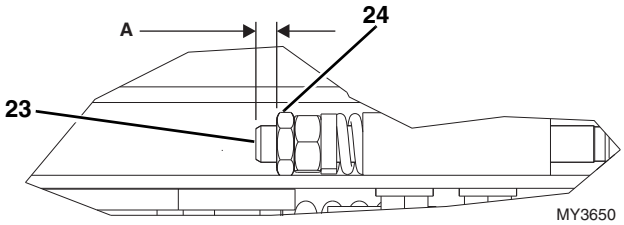
Note: *Apply Loctite® 242 ™ to all boom assembly bolts.*

Note: *Using a straight bar approximately 40 in (1041 mm) long will aid in the installation of the wear pads located on the inside front of each boom section.*

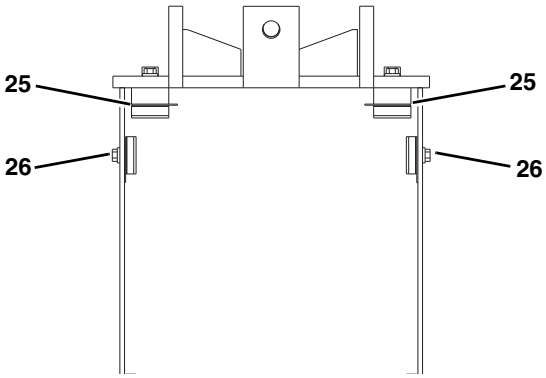
1. Place the sling or using two slings for better stability, around the third boom section and slowly insert the third and fourth boom sections into the second boom section being careful not to damage any surrounding components.



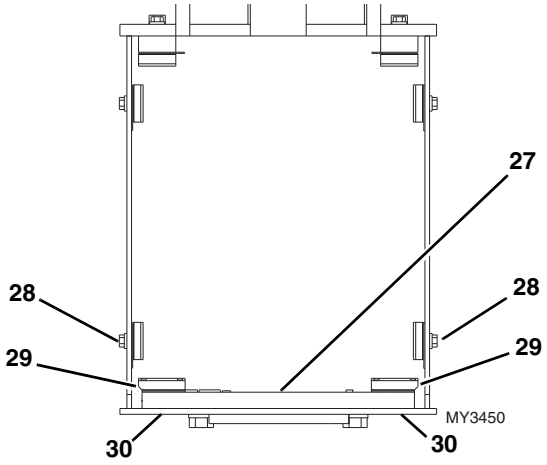
2. Install adjusting block (**17**) using existing hardware (**18**). Torque as required.
3. Install chain and clevis (**19**), spring (**20**), spring stop (**21**), adjusting nut and lock nut (**22**).



4. Allow 0.50 in (1,27 mm) (**A**) between the end of the clevis (**23**) and the face of the lock nut (**24**). Torque lock nut to 100 lb-ft (135 Nm).
5. Properly connect the batteries.
6. Retract the second boom section pulling both retract chains at the same time.



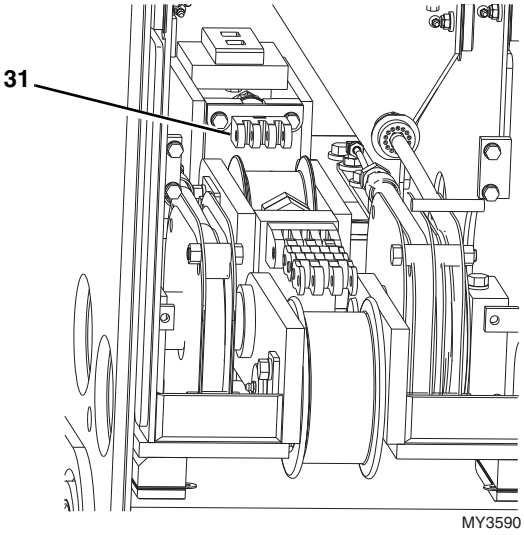
7. Install the wear pad, support plates and spacers (**25**) with existing hardware at the inside top front of the second boom section. Snug mounting bolts. Shim as needed AFTER boom section is installed. Refer to Section 3.11.2, “Wear Pad Installation and Lubrication,” for detailed information.



8. Install the wear pad support plate (**27**) with existing hardware at inside front of second boom section.

Note: *Longer bolts (**30**) may be required to fully engage threaded inserts in the wear pads without allowing bolts to protrude past the chamfer on the wear pads. Refer to Section 3.11.2, “Wear Pad Installation and Lubrication.”*

9. Install wear pads, spacers and shims on each side and bottom (**26**, **28** and **29**) at front of second boom section. Snug mounting bolts. Shim as needed AFTER boom section is installed. Refer to Section 3.11.2, “Wear Pad Installation and Lubrication,” for detailed information.
10. Manually retract the boom sections as required to connect the retract chains.

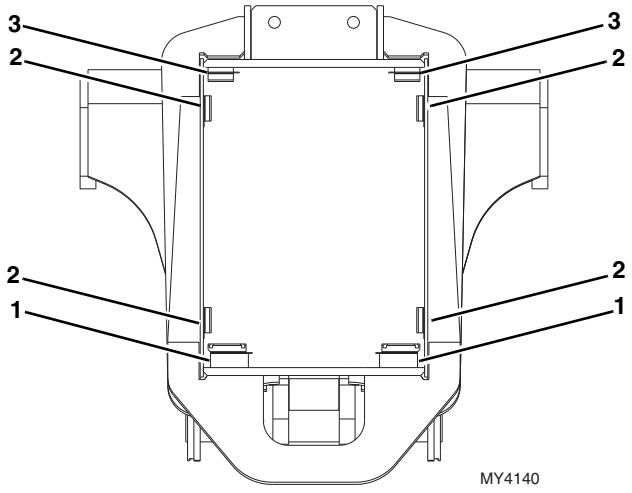


11. Install bracket and clevis assembly (**31**) at rear of fourth boom section. Torque mounting bolts.

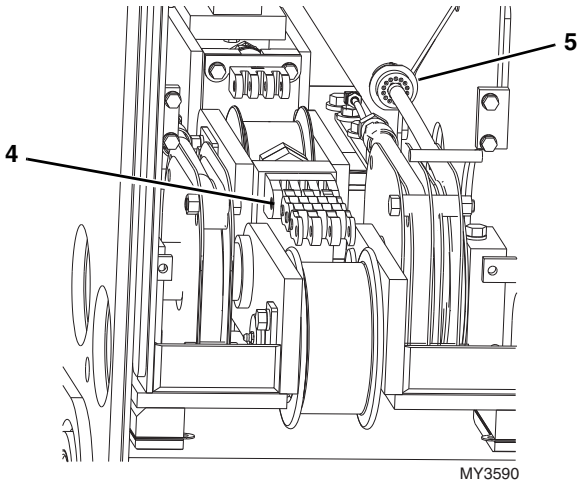
3.5.11 Second, Third and Fourth Boom Section Installation

Note: *Using a straight bar approximately 40 in (1041 mm) long will aid in the installation of the wear pads located on the inside front of each boom section.*

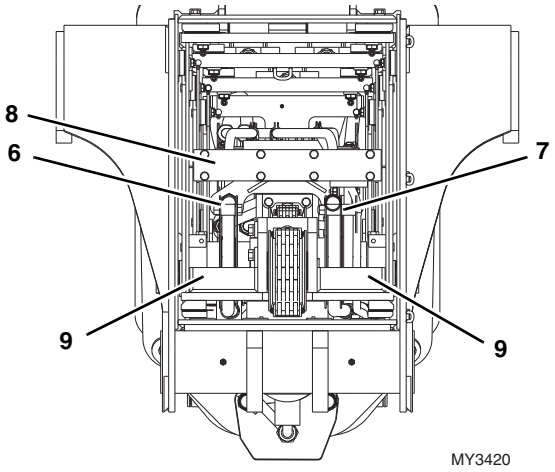
1. Place one or two slings for better stability, around second boom section and slowly insert second, third and fourth boom sections into first boom section being careful not to damage any surrounding components and allowing sufficient room to install wear pads at front of first boom section.



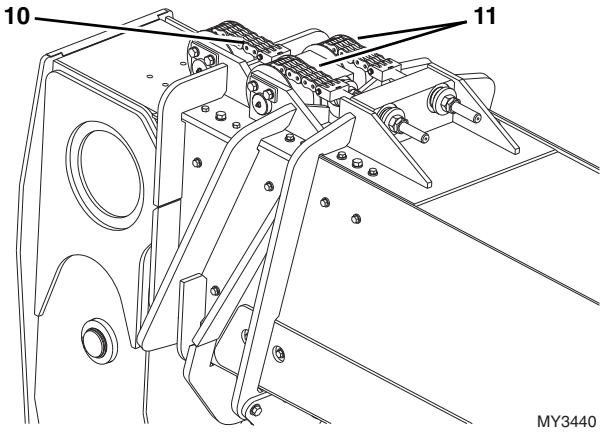
2. Install all wear pads, spacers and shims (**1**, **2** and **3**) at the front of the first boom section. Snug mounting bolts. Shim as needed AFTER boom section is installed. Refer to Section 3.11.2, “Wear Pad Installation and Lubrication,” for detailed information.
3. Re-adjust the sling(s) and push the second, third and fourth boom assembly the remainder of the way into the first boom section.



4. Connect the rear retract chain (**4**) to the chain clevis with the previously removed pin at the rear of the third boom section. Secure the pin with the previously removed snap rings.
5. Pull hose carrier from the rear as far as possible to access the hydraulic and if equipped, the electrical connections.
6. If equipped, connect the electrical cable (**5**) to the fitting on the hose carrier.



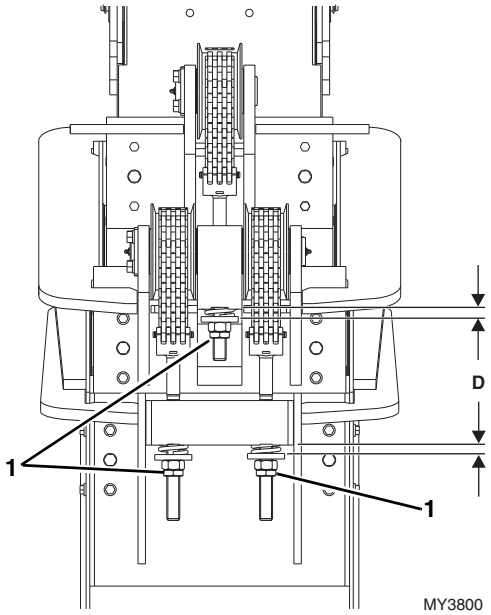
7. Remove any caps and plugs from the tilt and auxiliary hoses at the rear of the boom assembly. Connect and tighten the tilt (**6**) and auxiliary hoses (**7**) to their proper fitting locations on the hose carrier. Torque as required.
8. Install hose carrier bracket (**8**) at rear of third boom section and the hose carrier. Torque mounting bolts as required.
9. Install both hose sheave covers (**9**).Torque mounting bolts as required.



10. Connect fourth boom section extend chain (**10**) to clevis at top front of third boom section and adjust to previously measured setting. Do Not tighten lock nut at this time.
11. Connect third boom section extend chains (**11**) to clevises at top front of second boom section and adjust to previously measured setting. Do Not tighten lock nut at this time.
12. Grease all wear pad at rear of the boom using the grease fittings.
13. Refer to Section 3.7, “Hose Carrier Assembly Removal/Installation,” for proper boom section adjustments.

3.6 BOOM SECTION SEPARATION ADJUSTMENT

1. Start the machine and verify the boom is in a horizontal (level) position.
2. Extend the boom 4-5 ft (1,2-1,5 m), then fully retract the boom.
3. Shut machine OFF.



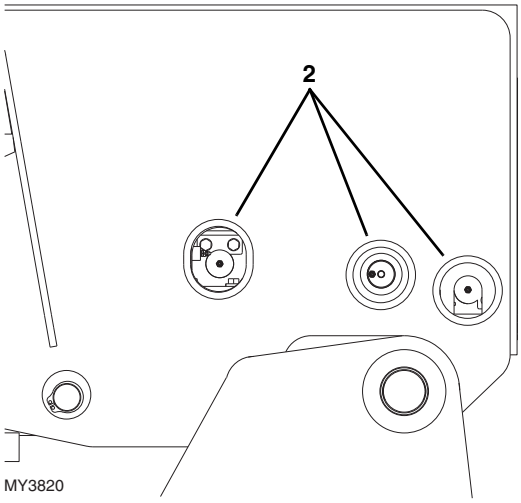
4. Measure the gap (**D**) between the flat washer at the extend chain anchor on the top front of the first boom section and the second boom section. If the gap is greater that 0.375 in (9.52 mm), the boom chains will need to be adjusted.

Adjust the extend chain as follows:

1. Loosen the lock nut (**1**) on each of the extend chains.
2. Tighten adjusting nuts on first boom section until gap (**D**) between flat washers and boom is 0.375 in (9,52 mm) maximum. gap must be equal on both chains. Torque lock nut to 100 lb-ft (135 Nm).

Note: *Verify the exposed threads on both extend chain clevises are kept equal.*

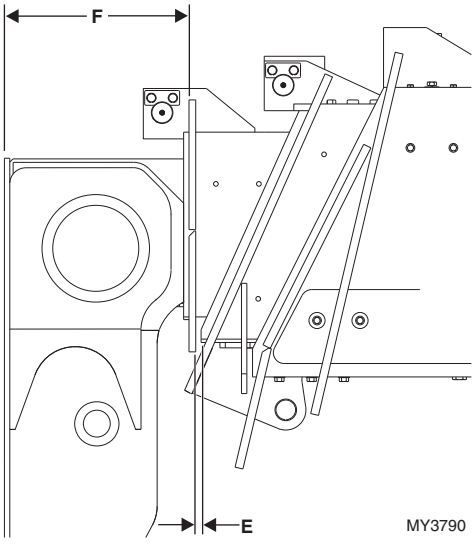
3. Tighten the adjusting nut on the second boom section until the gap (**D**) between the washer and boom is 0.375 in (9,52 mm) maximum. Torque the lock nut to 100 lb-ft (135 Nm).



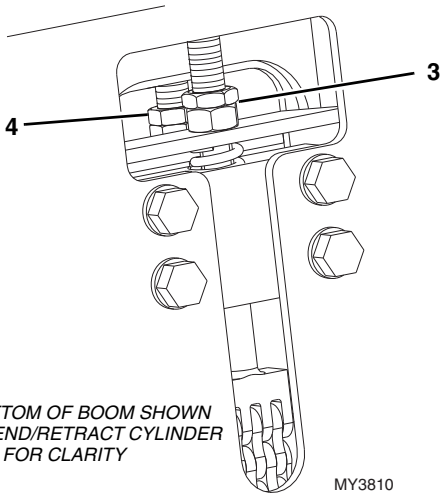
4. After adjusting, check to see that the boom sections and access holes (**2**) are aligned. If they are not, the retract chain will need to be adjusted as well.

Adjust the retract chain as follows:

1. Fully retract the boom.



2. Measure the distance between the second boom section and the third boom section (**E**). The dimension should be 0.50-0.75 in (12,7-19,5 mm).



Note: *BOTTOM OF BOOM SHOWN WITH EXTEND/RETRACT CYLINDER REMOVED FOR CLARITY*

3. Loosen second to third boom section retract chain lock nut and adjusting nut (**3**) as far as possible.
4. Loosen the third to fourth boom section retract chain lock nut and adjusting nut (**4**) as far as possible.
5. Tighten the retract chain adjusting nut (**3**) until the proper distance (**E**) is obtained and proper access hole alignment (**2**) is obtained.
6. Torque the lock nut to 100 lb-ft (135 Nm).
7. Recheck the extend chain adjustments and readjust if necessary.
8. Measure the distance between the third boom section and fourth boom section (**F**). The dimension should be:
   G10-55A - 17.5–17.75 in (444,5–451,3 mm)
   G12-55A - 18.5–18.75 in (469,9–476,7 mm)
9. Tighten the retract chain adjusting nut (**4**) until the proper distance (**F**) is obtained and proper access hole alignment (**2**) is obtained.
10. Torque the lock nuts to 100 lb-ft (135 Nm).
11. Re-adjust the extend chains as needed.

3.7 HOSE CARRIER ASSEMBLY REMOVAL/INSTALLATION

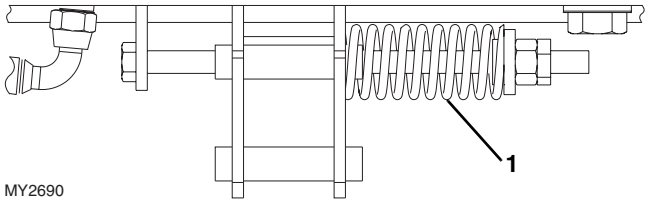
Hose carrier assembly locates primarily in fourth boom section. It is fastened at bottom front of fourth boom section and at rear of third boom section.

3.7.1 Hose Carrier Assembly Removal

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

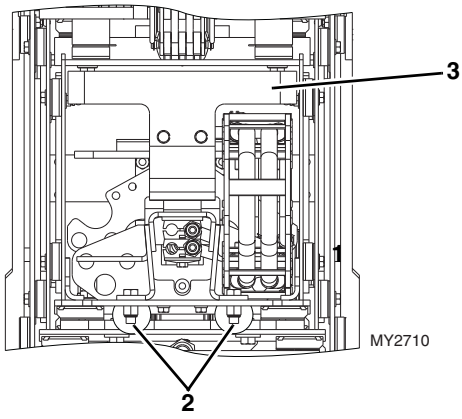
Note: *Allow adequate room in front of the machine when removing and installing the hose carrier assembly.*

2. Park the machine on a hard, level surface, level the machine, fully retract the boom, level the boom, place the transmission control lever 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 engine cover. Allow system fluids to cool.
5. Properly disconnect the batteries.

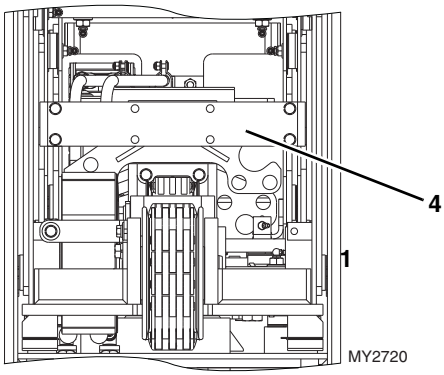


6. Loosen and remove both compression springs (**1**) from the hose take-up weldment at the bottom of the first boom section.
7. Label and disconnect the tilt and auxiliary hydraulic hoses attached to the hose carrier at the rear of the boom and at the front of the boom head. Plug and cap the hose ends to prevent dirt and debris from entering the hydraulic system.
8. If equipped, label and disconnect any electrical connections at front and rear of boom assembly.

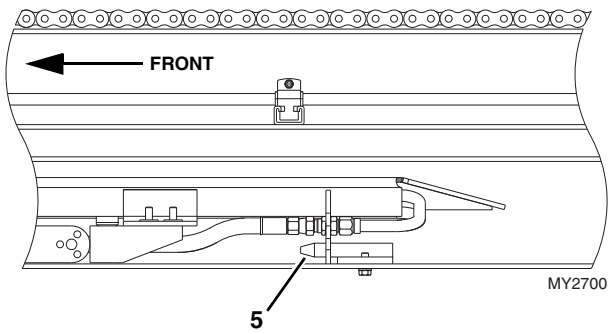
Note: *Tag or identify each hose to the corresponding fitting it was removed from.*



9. Loosen and remove both cap screws and locknuts (**2**) from the hose carrier bracket at the front of the fourth boom section.
10. Loosen and remove the guide bracket (**3**) from the front of the fourth boom section.



11. Loosen and remove the hose carrier bracket (**4**) at the rear of the third boom section.



12. Install a sling around hose carrier at front of boom. With a suitable lifting device, slowly pull hose carrier loose from bottom bracket (**5**) located approximately halfway in the fourth boom section.

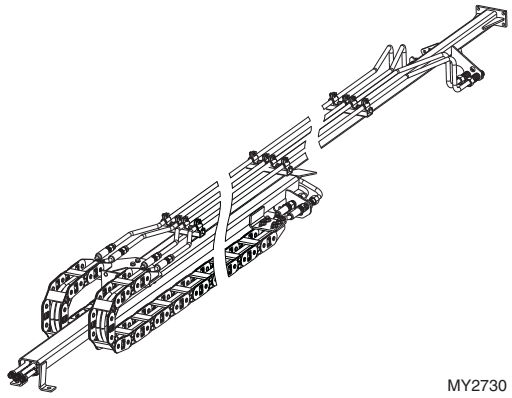
13. When the hose carrier is pulled approximately 25% out of the boom, fasten the two hydraulic carriers together using plastic tie wraps or nylon straps to keep them from separating.

Note: *Do Not wrap hose carrier since it will not prevent two hydraulic carriers from moving apart sideways.*

14. Continue withdrawing the hose carrier, fastening the two hydraulic carriers together.
15. With two hose assemblies tied together, remove hose carrier and set on ground or proper supports.

3.7.2 Assembling Hose Carrier Assembly

The following procedure is described with the assumption that all components have been removed and assembly proceeding from the beginning.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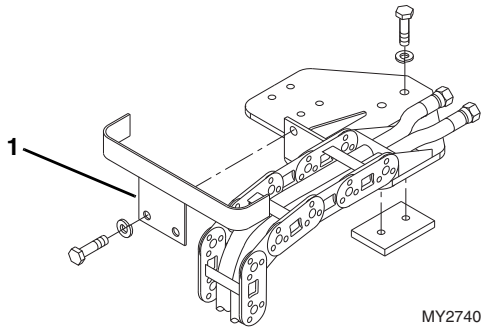
1. Place both sections on a suitable stand or support.
2. Install the wear pad to the bottom of the upper hydraulic carrier.
3. Install bulkhead fittings to each hydraulic carrier.
4. Install the tube assemblies to the bulkhead fittings on each hydraulic carrier.
5. Install the cushion clamps to the tube assemblies and secure to each hydraulic carrier.
6. Install the hose carrier to each hydraulic carrier and install each tilt hose and auxiliary hose to the proper fitting or tube connection.
7. Tie wrap the hydraulic hoses together where they extend from each end of the hose carrier.
8. Fasten the two hydraulic carriers together using plastic tie wraps or nylon straps for stability.

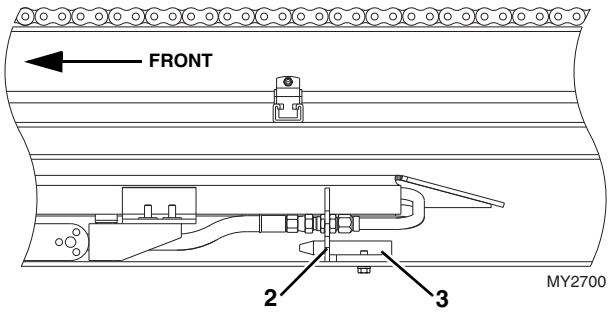
3.7.3 Hose Carrier-Assembly Installation

1. Clean and lubricate the side surfaces where the hose carrier rides.
2. Fully collapse the hose carriers and secure together using plastic tie wraps or nylon straps to keep them from separating.
3. Install a sling around the balance point of the hose carrier. With a suitable lifting device, slowly insert the hose carrier into the front of the fourth boom section.
4. Remove the first plastic tie wrap or nylon strap as the hose carrier is being inserted into the front of the fourth boom section.
5. Continue inserting the hose carrier and removing the plastic tie wraps or nylon straps until the hose carrier is fully inserted into the boom.



MY2740

6. Install guide bracket (**1**) on front of hose carrier.



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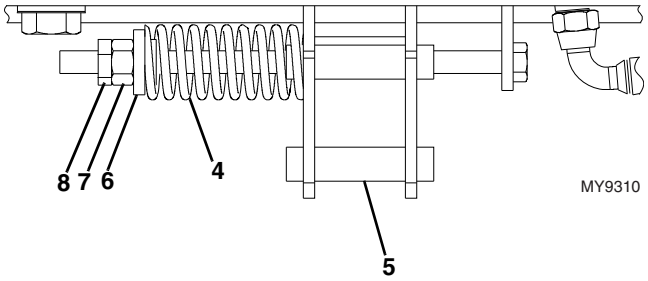
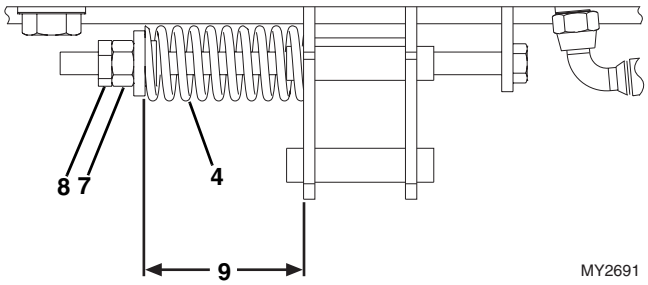
7. Verify that bottom bracket (**2**) on hose carrier is in place on bottom plate (**3**) of fourth boom section.
8. Install the cap screws, washers and nuts to the hose carrier bracket at the rear of the third boom section.
9. Install both cap screws and locknuts to hose carrier bracket at front of fourth boom section.
10. Uncap and reconnect the previously labeled tilt and auxiliary hydraulic hoses to the proper fittings at the rear of the hose carrier.

11. Uncap and reconnect the previously labeled tilt and auxiliary hydraulic hoses to the proper fittings at the front of the fourth boom section.
12. If equipped, reconnect any electrical connections at the front and rear of the boom assembly.



13. Install the boom hose take-up compression spring (**4**) on each hose take-up bracket (**5**) at the bottom of the first boom section. Install the washer (**6**), adjusting nut (**7**) and jam nut (**8**).
14. Properly connect the battery.
15. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel. Refer to Section 3.8, “Boom Hose Take-up Adjustment,” for detailed adjustment procedure.

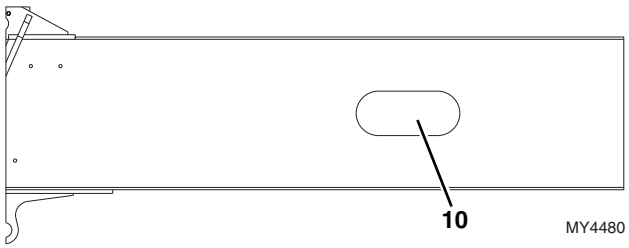
3.8 BOOM HOSE TAKE-UP ADJUSTMENT



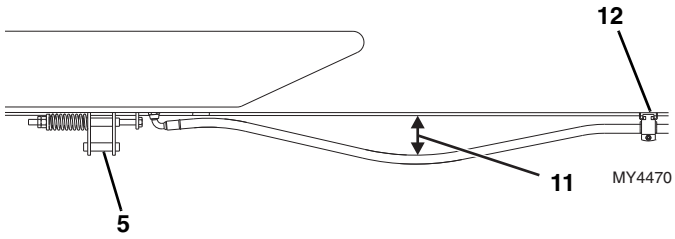
1. Tighten the adjusting nut (**7**) to compress the hose take-up compression spring (**4**) to measure 2.875-3.187 in (73-81 mm)(**9**). Refer to Section 3.9, “Boom Hose Adjustment,” if required.
2. Torque the jam nut (**8**) against the adjusting nut (**7**) to 100 ft-lb (135,5 Nm).

3.9 BOOM HOSE ADJUSTMENT

1. Park the machine on a hard, level surface, level the machine, fully extend the boom, lower the boom head to the ground, place the transmission control lever 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. Verify any trapped hydraulic pressure in the auxiliary circuit and the tilt circuit is relieved.
4. Open the engine cover. Allow the system fluids to cool.



5. Verify the auxiliary hoses and/or tilt hoses are NOT touching the bottom of the second boom section by viewing the auxiliary hoses and/or tilt hoses through the access hole (**10**) in each side of the second boom section.



6. Verify that 4 in (101,6 mm) of slack (**11**) is present between the hose take-up bracket (**5**) and the first hose clamp (**12**).
7. Verify the hose take-up bracket (**5**) is not bent and is at an 85° angle to the hose.

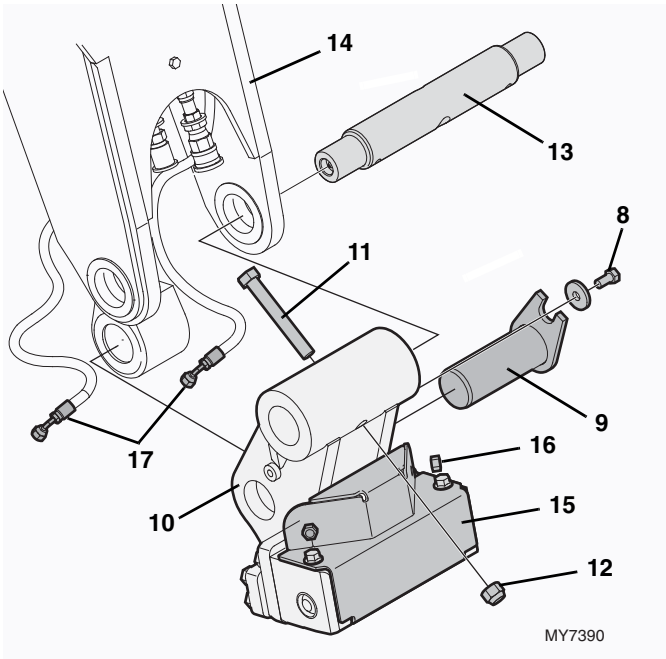
Note: *Replace both auxiliary hoses and/or tilt hoses if the hoses are touching the bottom of the second boom section AND 4 in (101,6 mm) of slack is present between the hose take-up bracket and the first hose clamp.*

8. Refer to Section 3.8, “Boom Hose Take-up Adjustment,” for boom hose take-up adjustment.
9. Measure the slack (**11**) at the lowest point between the hose take-up bracket (**5**) and the first hose clamp (**12**). The 4 in (101,6 mm) measurement is from the bottom of the first boom section to the top of the hose.
10. If necessary, loosen the hose clamp (**12**), pull the auxiliary hoses and/or the tilt hoses, tighten the hose clamp for additional clearance.
11. Replace the auxiliary hoses and/or the tilt hoses if the proper slack, 4 in (101,6 mm)(**11**) cannot be achieved.

12. Start the machine, raise the boom to level, cycle the extend/retract cylinder, fully extend the boom.
13. Cycle the auxiliary circuit and/or the tilt circuit, verifying the auxiliary hoses and the tilt hoses are NOT touching the bottom of the second boom section and the proper slack, 4 in (101,6 mm) is maintained.
14. Retract the boom and shut engine OFF.
15. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

3.10 QUICK SWITCH ASSEMBLY

3.10.1 Hydraulic Quick Switch Removal

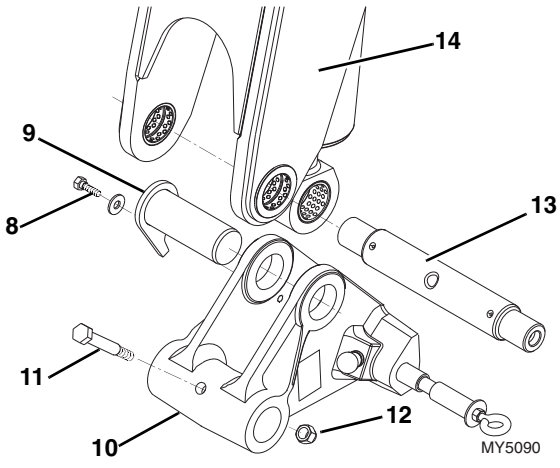


1. Remove hardware securing cylinder cover (**15**) and remove cylinder cover.
2. Remove clamp hardware (**16**) securing cylinder cover to hydraulic hoses (**17**).
3. Label and disconnect hydraulic hoses (**17**) attached to quick switch assembly (**10**). Drain fluid into suitable container.
4. Plug and cap the hose ends to prevent dirt and debris from entering the hydraulic system.
5. Remove lock bolt (**8**) holding tilt cylinder rod end pin (**9**) to quick switch assembly (**10**). Remove tilt cylinder rod end pin.
6. Support quick switch assembly (**10**). Remove capscrew (**11**) and locknut (**12**) securing head pin (**13**) to boom head (**14**).
7. Remove the head pin (**13**) and the quick switch assembly (**10**)
8. Inspect 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 pin must be replaced.

3.10.2 Hydraulic Quick Switch Installation

1. Assemble quick switch assembly (**10**) to boom head (**14**). Line up quick switch between mounts on boom head. The quick switch should be centered in the boom head.
2. Coat head pin (**13**) with an anti-seize compound. Insert head pin through quick switch and boom head. Secure with capscrew (**11**) and locknut (**12**).
3. Align quick switch with tilt cylinder rod end and insert tilt cylinder rod end pin (**9**). Align tilt cylinder rod end pin and screw in locking bolt (**8**). Torque as required.
4. Uncap and install hydraulic hoses (**17**) to proper fittings on quick switch assembly (**10**). torque as required.
5. Secure hoses (**17**) to cylinder cover (**15**) with clamp hardware (**16**).
6. Reinstall cylinder cover (**15**) with the hardware removed earlier.

3.10.3 Manual Quick Switch Removal



1. Remove lock bolt (**8**) holding tilt cylinder pin (**9**) to the quick switch assembly (**10**). Remove the tilt cylinder pin.

2. Support quick switch assembly (**10**). Remove capscrew (**11**) and locknut (**12**) securing head pin (**13**) to boom head (**14**).

3. Inspect 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 pin must be replaced.

3.10.4 Manual Quick Switch Installation

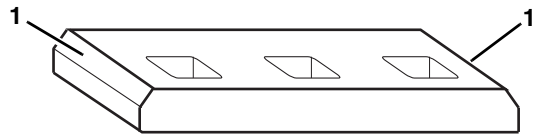
1. Assemble quick switch assembly (**10**) to boom head (**14**). Line up quick switch between mounts on boom head. The quick switch should be centered in the boom head.
2. Coat head pin (**13**) with an anti-seize compound. Insert head pin through the quick switch assembly and boom head. Secure with capscrew (**11**) and locknut (**12**).
3. Align quick switch assembly with tilt cylinder pin and insert tilt cylinder pin (**9**). Align tilt cylinder pin and screw in locking bolt (**8**). Torque as required.

3.11 BOOM WEAR PADS

The wear pads on this machine are flat rectangular wear pads with metal inserts.

A total of 42 wear pads are installed on the boom sections of the G10-55A and the G12-55A machines.

3.11.1 Wear Pad Inspection



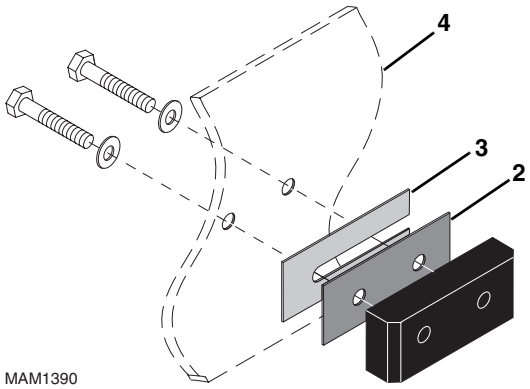
Inspect all wear pads for wear. If angle indicators (**1**) on ends of wear pads are visible, wear pads can be reused. If pads show uneven wear (front to back), they should be replaced. Replace pads as a set if worn or damaged.

3.11.2 Wear Pad Installation and Lubrication

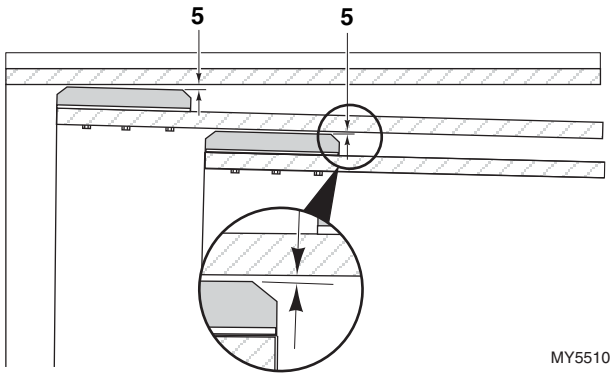
Note: *Inspect all wear pads. Replace as necessary.*

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

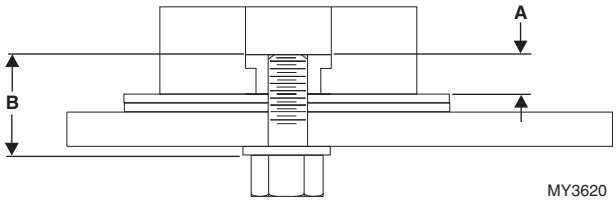
- Wear pad inserts and mounting bolts MUST be clean from any grease, oil or other contaminates before applying Loctite® 242™ and installing mounting bolts.
- Apply Loctite® 242™ to all wear pad mounting bolts.



- A spacer (**2**) with holes must be used before any shim (**3**) is used.
- A shim (**3**) must be inserted between 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 (**5**) of 0.070–0.130 in (1,78–3,30 mm) 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 0.312 in (7,92 mm) (**A**).
- Bolt length should be determined by measuring the distance from face of insert to face of boom (**B**) including any spacer, shim(s) and washer(s).
- Bolt thread engagement in the wear pad insert should be 0.275 ± 0.040 in (6,98 ± 1,0 mm).
- 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, 32–37 lb-ft (43–50 Nm)
  3/8 - 24 Hollow Bolt, 15–17 lb-ft (20–23 Nm)
  1/2 - 20 Bolt, 76–86 lb-ft (103 - 116 Nm)
  1/2 - 20 Hollow Bolt, 45–50 lb-ft (61–68 Nm)
- Torque wear pad bolts after shimming is completed.
- 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 Mystik Tetrimoly grease.
- Clean and lightly grease the hose carrier guide bar pathways with Mystik Tetrimoly grease.

3.12 BOOM EXTEND/RETRACT CHAIN REMOVAL/INSTALLATION

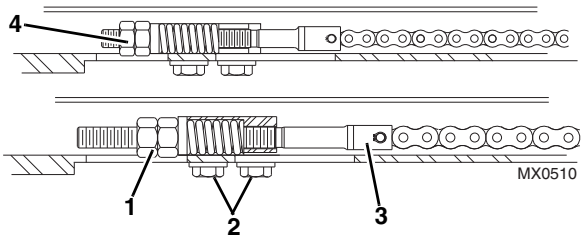
3.12.1 Boom Retract Chain Removal

The following section explains the removal of the retract chains without removing the boom assemblies.

Note: *The retract chain on the bottom of the boom must be removed to gain access to the inner retract chain.*

To remove retract chain from third to first boom sections:

1. Park the machine on level ground. Place the transmission control lever in (N) NEUTRAL, engage the parking brake switch, level the boom 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 batteries.
4. Attach a suitable sling to the extend/retract cylinder. Remove the extend/retract cylinder support.
5. Remove rod end pin and lower cylinder onto frame rails. Lowering extend/retract cylinder will allow access to chains.



6. Remove tension from the chain by backing off the jam nut and adjusting nut (**1**).
7. Remove four bolts (**2**) from chain adjustment block.
8. Remove chain from clevis (**3**) at block.
9. Install a nylon tie wrap through holes of removed chain, making a loop with a tie wrap and tie a rope to the loop.
10. At the rear of the boom, pull the chain to the rear to allow slack for removal.
11. Remove the chain from the clevis and drop it free from the boom.
12. Holding a rope at front adjustment block, carefully pull chain out through back of boom.
13. Untie the rope and leave it in place for reinstallation of the chain.

To remove the retract chain from the fourth to second boom sections:

1. Remove the jam nut (**4**) from the chain clevis installed in the chain adjustment block.
2. Back off the adjusting nut fully on the chain clevis. Do not remove the nut from the clevis.
3. Remove the chain from the clevis, install a nylon tie-wrap through the holes in the chain, making a loop with the tie-wrap and tie a rope to the loop.
4. Move to the back of the boom and pull the chain to the rear to allow slack for removal.
5. Remove the chain from the clevis and drop it free from the boom.
6. Holding the rope at the front, carefully pull the chain out through the back of the boom until it's free.
7. Untie the rope and leave it in place for reinstallation of the chain.

3.12.2 Boom Retract Chain Installation

Inspect and lubricate chains thoroughly before installation. Articulate the chains to make sure all working surfaces are thoroughly lubricated.

Note: *If the inner retract chain was removed, it must be installed first.*

1. Fasten a rope to the end of the 3/4 in. chain in order to pull it back into the boom.
2. Attach chain to chain clevis at rear of boom.
3. Carefully pull the chain into the boom until it can be fastened to the chain clevis.
4. Remove the rope.
5. Fasten the chain into the clevis by installing the pin and retaining ring.
6. Torque the jam nuts to 100 lb-ft (135 Nm).

To install the outer retract chain:

1. Fasten a rope to the end of the chain in order to pull it back into the boom.
2. Attach chain to chain clevis at rear of boom.
3. Carefully pull the chain into the boom until it can be fastened to the chain clevis.
4. Remove the rope.
5. Fastened the chain into the clevis by installing the pin and cotter pin.
6. Install the chain adjustment block and mounting bolts. Torque the chain adjustment block mounting bolts to 360-390 lb-ft (475-530 Nm).
7. Install extend/retract cylinder and cylinder support.

8. Adjust the retract chains as needed. Refer to Section 3.7, “Hose Carrier Assembly Removal/Installation.”
9. Properly connect the batteries.
10. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

3.12.3 Boom Extend Chain Removal

The following section explains the removal of the extend chains without removing the boom assemblies.

1. Park the machine on level ground. Place the transmission control lever in (N) NEUTRAL, engage the parking brake switch, level the boom, extend the boom far enough to access the chain anchor and the clevis through the top rear access hole, 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 batteries.
4. Secure the boom sections together to prevent uncontrolled boom run out when the extend chains are removed.
5. On the chain being removed, loosen and remove the jam nut from the rear chain clevis and back off the adjusting nut on the chain clevis to the end of the threads. Do not completely remove the nut.
6. Remove the chain clevis pin and retaining ring to free the chain.
7. Install the nylon tie wrap through the holes in the chain, making a loop with the tie wrap and tie a rope to the loop.
8. Pull slack to chain clevis at front of boom.
9. Remove the clevis pin and the retaining ring from the chain and chain clevis.
10. Install a nylon tie wrap through the chain holes, forming a loop and tie a rope to the loop.
11. Carefully pull the chain out of the boom.
12. Untie the rope and leave it in place for reinstallation of the chain.

3.12.4 Boom Extend Chain Installation

The following section explains the installation of the retract chains without removing the boom assemblies.

Inspect and lubricate the chains thoroughly before the installation.

1. Fasten the previously used rope to the end of the extend chain.
2. Carefully pull the chain into the boom to the chain clevis anchor.
3. Fasten the chain to clevis with a pin and cotter pin.
4. At the other end of the chain, connect the chain to the clevis fastening the chain to the clevis with a pin and retaining ring.
5. Install the chain clevis fastening and adjusting hardware on both ends.
6. Remove any clamping devises being used to keep the boom sections from moving.
7. Properly connect the batteries.
8. Adjust the extend chains as needed. Refer to Section 3.6, “Boom Section Separation Adjustment.”
9. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

3.13 BOOM CHAIN INSPECTION AND LUBRICATION

3.13.1 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 extend 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. 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 the 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 an d 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.

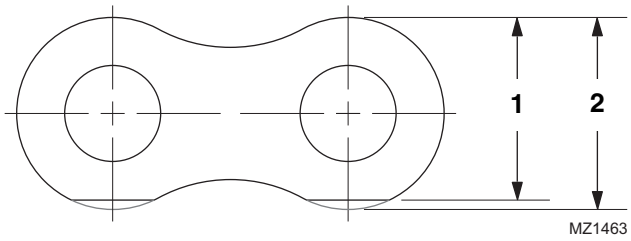
The above load cycles and environmental conditions make it impossible to predict chain life. It is therefore necessary to conduct frequent inspections until replacement life can be predicted.

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.

3.13.2 Inspection Guidelines

1. Park the machine on a firm, level surface, raise the boom to a horizontal (level) position, place the transmission control lever 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 retract chains every 1000 hours of operation.
6. Inspect chains for following conditions:

Edge Wear

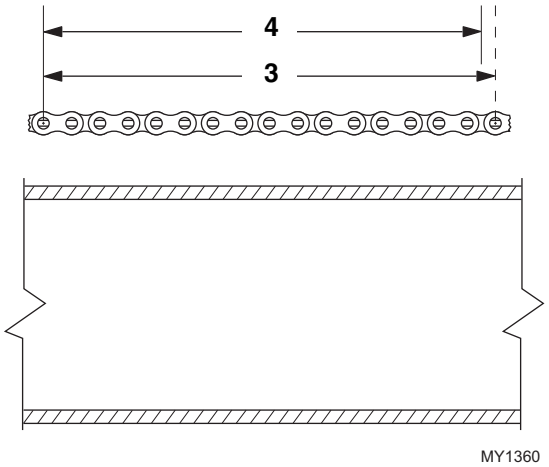


Check the chain for wear on the link plate edges caused by running back and forth over the sheave. The maximum reduction of material should not exceed 5%. Measure and compare to a normal link plate height by measuring a portion of chain that does not run over the sheave. If the measured plate height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

Elongation

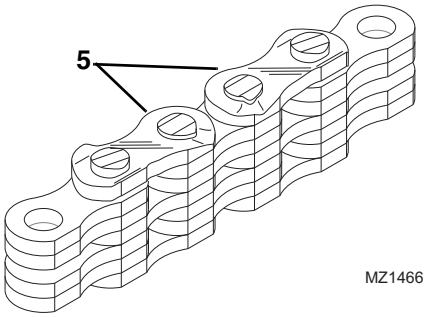
It is important to measure the chain in the section that moves over the sheaves because it receives the most frequent articulation. Measuring the chain near its clevis terminals could give an inaccurate reading. The ends of the chains, near the clevis terminal, will not have flexed as frequently, if 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 one inch from pin center to pin center, the distance should be 12 in (305 mm). If the links are 3/4 in apart, the distance after 12 pins should be 9 in.



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

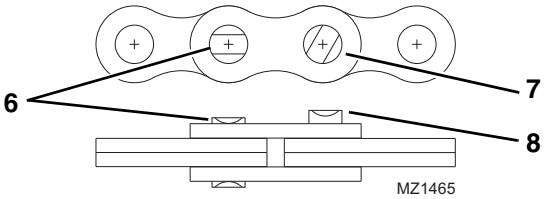
Distorted or Battered Link Plates



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.

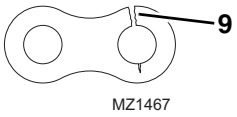
Cracked Plates

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.

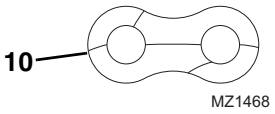
It is important, however to determine the cause of the crack before installing a new chain so the condition does not repeat itself.

The types of cracks are:

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



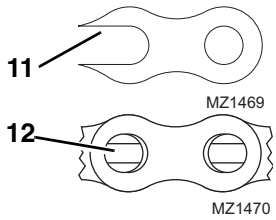
- **Stress Corrosion Cracking** - The outside link plates are particularly susceptible to stress corrosion cracking (**10**).



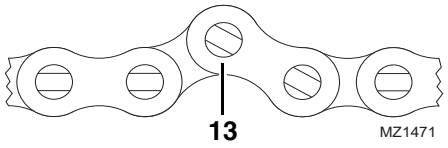
- **Corrosion Fatigue Cracking** - Corrosion fatigue cracks are very similar to fatigue cracks in appearance. Corrosion fatigue is the combined action of an aggressive environment and cyclic stress.

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.



3.13.3 Expose Chains for Inspection

d. Extend Chains

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

The extend chains 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, 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.

e. Retract Chains

The three retract 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 retract chain as the boom is slowly extended. If there is ANY question that one or all the retract chains are damaged, the chains should be removed and inspected. Refer to Section 3.12, "Boom Extend/Retract Chain Removal/Installation" for detailed information. Replace if necessary.

***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.*

3.13.4 Chain Lubrication

After inspection and before being returned to service, chains must be lubricated. Refer to Section 2.5, “Fluid and Lubricant Capacities,” for proper lubricant.

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.

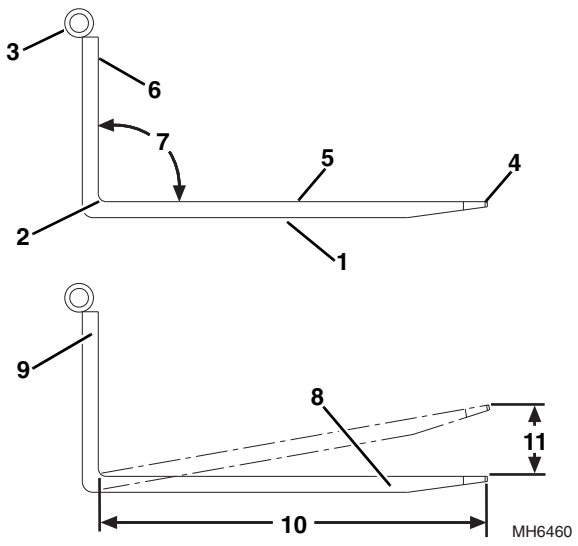
Regular application of lubricant is necessary to make sure that all working surfaces are adequately lubricated. In extremely dusty conditions, it may be necessary to lubricate the chains more often. Refer to Section 2.6, “Service and Maintenance Schedules,” and Section 2.7, “Lubrication Schedules,” for detailed information.

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

3.14 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 local distributor with fork part number to find manufactured dimensions of fork blade.*

4. Ensure that the fork length (**10**) is adequate for intended loads.
5. The Fork markings should be legible, re-stamp markings 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 (**10**).

3.15 EMERGENCY BOOM LOWERING PROCEDURE

⚠ WARNING

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

⚠ WARNING

Properly support the boom before attempting to proceed with the emergency boom lowering procedure.

⚠ WARNING

If possible, safely remove and/or secure the load on the machine before starting the boom lowering procedure. If load cannot be removed, the machine load chart MUST be followed.

3.15.1 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 22 gal (83 L) of hydraulic oil from the machine during lowering process.

Note: *If another machine is being used, the hydraulic reservoir must be drained to accept a minimum of 22 gal (83 L) of hydraulic oil before attempting this procedure.*

- Standard Mechanic Tools.

NOTICE

EQUIPMENT DAMAGE. Auxiliary Hydraulic Power Supply hydraulic oil must be compatible with hydraulic oil shown in Section 2.5, “Fluids and Lubricant Capacities.”

Hoses:

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

G10-55A or G12-55A - Fittings:

- Two -12 ORFS Caps
- Two -12 ORFS Plugs

Adaptors:

- Two -12 ORFS 90° Adaptors

Note: *The adaptor size may vary depending on the hose ends of the auxiliary hydraulic power supply.*

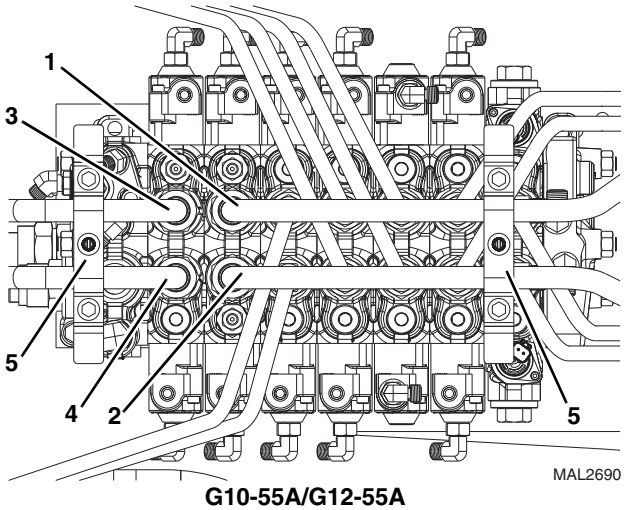
3.15.2 Lowering Procedure

a. Retract the boom as follows:

1. If equipped with Personal Work Platform, rescue occupants prior to performing procedure.
2. Properly support the boom before attempting to proceed with the emergency boom lowering procedure.
3. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
4. Properly support the boom as required.
5. Place a suitable receptacle under the main control valve.
6. Remove the plastic cover from the top of the main control valve.

⚠ WARNING

Loss of hydraulic oil is limited to the amount trapped within each tube/hose. Slowly loosen each hydraulic tube fitting to release any possible hydraulic oil pressure that may be trapped between the main control valve and the counterbalance valve of the extend/retract cylinder or the lift/lower cylinder.



G10-55A/G12-55A

7. Remove the brackets (**5**) that is attached to the steel tubes supporting the plastic cover.
8. Loosen and remove any clamps securing the extend/retract cylinder (**1** & **2**) and lift/lower cylinder tubes (**3** & **4**) together and to the frame.
9. Disconnect the extend/retract cylinder tubes (**1** & **2**) from the main control valve. Install plugs in tubes to prevent fluid loss. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
10. Using the hoses and fittings specified, connect the hoses between the auxiliary hydraulic power supply and the tubes removed from the main control valve extend/retract section of the affected machine. Retract tube (**1**) is the supply and extend tube (**2**) is the return. Connect the hoses in the proper order to ensure that the cylinder is retracted, not extended.
11. Remove the previously installed the boom support.
12. Use the auxiliary power supply to slowly retract the extend/retract cylinder.
13. Properly support the boom as required.
14. Loosen and remove the jumper hoses, caps, plugs and reconnect the extend/retract cylinder tubes. Torque as required.

b. Lower the boom as follows:

1. Place a suitable receptacle under the main control valve.
2. Disconnect the lift/lower cylinder tubes (**3** & **4**) from the main control valve. Install plugs in tubes to prevent fluid loss. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
3. Using the hoses and fittings specified, connect the hoses between the auxiliary hydraulic power supply and the tubes removed from the main control valve lift/lower section of the affected machine. Lift tube (**3**) is the return and lower tube (**4**) is the supply. Connect the hoses in the proper order to ensure that the boom is lowered, not raised.
4. Remove the previously installed boom support.
5. Use the auxiliary power supply to slowly lower the boom.
6. Loosen and remove the jumper hoses, caps, plugs and reconnect the lift/lower cylinder tubes. Torque as required.
7. Install the previously remove clamps securing the extend/retract and lift/lower cylinder tubes.
8. Install the plastic cover over the top of the main control valve.
9. 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.
10. Clean up all debris, hydraulic oil, etc., in, on, near and around the machine.
11. Remove the Do Not Operate Tag on both the ignition key switch and steering wheel.

3.16 TROUBLESHOOTING

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

Problem	Cause	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 8.4, “Hydraulic Circuits.”
	3. Faulty extend/retract cylinder.	3. Repair cylinder, Refer to Section 8.8, “Hydraulic Cylinders.”
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 3.11, “Boom Wear Pads.”
3. Excessive boom pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. Refer to Section 2.7, “Lubrication Schedules.” Replace worn pins as needed.
	2. Worn bearing(s).	2. Replace bearing(s) and lubricate at regular intervals. Refer to Section 2.7, “Lubrication Schedules.”
4. Excessive Compensation cylinder pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. Refer to Section 2.7, “Lubrication Schedules.” Replace worn pins as needed.
	2. Worn bushing(s).	2. Replace bushing(s) and lubricate at regular intervals.

Problem	Cause	Remedy
5. 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 3.6, “Boom Section Separation Adjustment.”
	3. Wear pads loose, contaminated, excessively worn or damaged.	3. Replace wear pad. Refer to Section 3.11, “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 8.4, “Hydraulic Circuits.”
	6. Damaged boom section.	6. Replace the damaged boom section. Refer to Section 3.3, “Boom Assembly Maintenance.”
6. 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 8.4, “Hydraulic Circuits.”
	3. Faulty lift/lower cylinder.	3. Repair cylinder. Refer toSection 8.8, “Hydraulic Cylinders.”
	4. Seized boom pivot pin bearing.	4. Replace bearing.
7. Excessive Lift/Lower cylinder pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. Refer to Section 2.6, “Service and Maintenance Schedules.” Replace worn pins as needed. Refer to Section 8.8, “Hydraulic Cylinders.”
	2. Worn self-aligning bushing(s).	2. Replace bushing(s) and lubricate at regular intervals. Refer to Section 2.7, “Lubrication Schedules.”

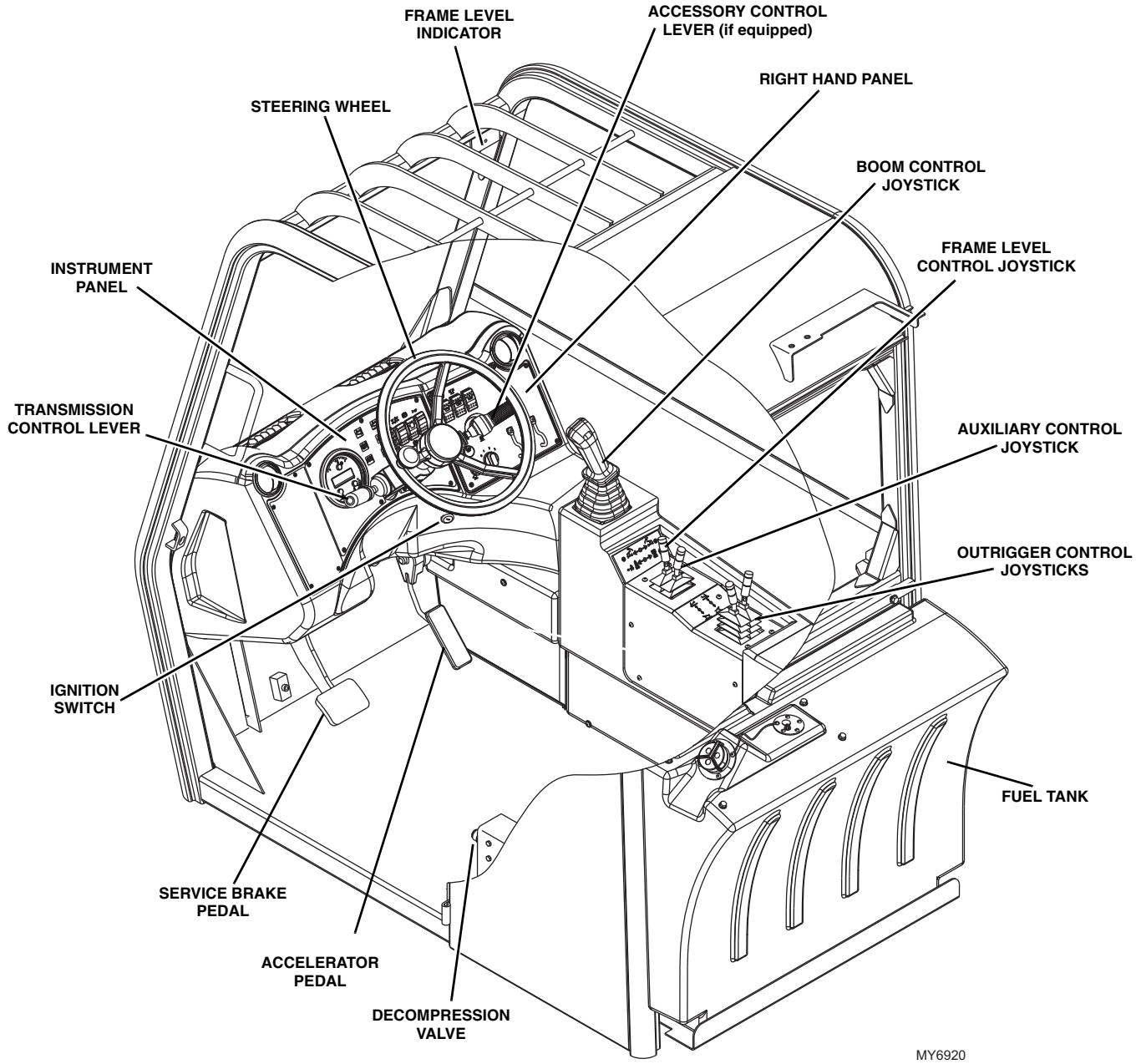
Problem	Cause	Remedy
8. Rapid boom pad wear.	1. Incorrect wear pad gap.	1. Check wear pad gaps and correct as needed. Refer to Section 3.11, “Boom Wear Pads.”
	2. Rapid cycle times with heavy loads.	2. Reduce cycle times.
	3. Contaminated, corroded or rusted wear pad sliding surfaces.	3. Remove contamination 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 8.4, “Hydraulic Circuits.”
10. Excessive chain wear.	1. Improper chain adjustment.	1. Adjust to correct tension. Refer to Section 3.6, “Boom Section Separation Adjustment.”- Replace chains as needed.
	2. Chain sheave(s) not properly lubricated.	2. Lubricate chain sheave. (Refer to Section 2.6, “Service and Maintenance Schedules.”
	3. Chain sheave(s) not rotating freely.	3. Lubricate chain sheave. Refer to Section 2.6, “Service and Maintenance Schedules.” Repair or replace chain sheave(s) as needed.
	4. Improper chain lubrication.	4. Lubricate at regular intervals. Refer to Section 2.6, “Service and Maintenance Schedules.” Replace chains as needed.

Section 4
Cab and Covers

Contents

4.1 OPERATORS 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 the "Safety Practices" section of this manual.

4.2.1 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 and grade, and torqued to their specified value.

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

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

4.2.2 Serial Number Decal

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

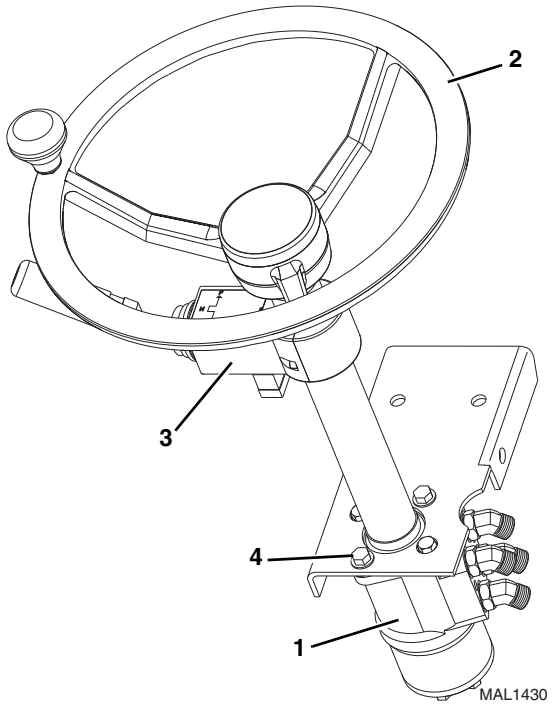
4.3 CAB COMPONENTS

4.3.1 Steering Column and Orbitrol Valve

a. Orbitrol Valve Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, engage 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 engine cover. Allow the system fluids to cool.
4. Properly disconnect the batteries.

Note: *It may be necessary to remove the main dash panel to gain access to the appropriate hydraulic hoses. Refer to Section 9.12.1, "Gauges."*



5. Label, disconnect and cap four hoses from side of steering valve (**1**). Cap fittings on steering valve. Label, disconnect and plug load sense hose at front of steering valve. Cap fitting on steering valve.
6. Remove the steering wheel (**2**).
7. Disconnect and remove the transmission control lever (**3**).
8. Remove the steering assembly through dash panel opening.
9. Support the steering valve, and remove the four hex-head capscrews and four lockwashers (**4**).

Note: ***DO NOT*** *disassemble the orbitrol valve. The orbitrol valve is not serviceable and must be replaced in its entirety, if defective.*

b. Orbitrol Valve Installation

1. Secure steering valve to steering column with four hex-flange capscrews and four lockwashers.
2. Install steering column through dash panel opening. Position steering valve to its original orientation in the cab.
3. Install the transmission control lever and connect the lever
4. Install steering wheel assembly. Torque steering wheel nut to 29–34 lb-ft (39–46 Nm).
5. Install new o-rings into the steering valve fittings. Lubricate the o-rings with clean hydraulic oil.
6. Uncap and connect the previously labeled load sense hose to the steering valve.
7. Uncap and connect the remaining previously labeled four hoses to the steering valve.

Note: *If necessary, install the main dash panel. Refer to Section 9.12.1, "Gauges."*

8. Properly connect the batteries.
9. Start engine and check operation of steering system. Check for hydraulic fluid leaks. Check hydraulic fluid level in tank and add fluid as required.
10. Close and secure the engine cover.
11. Remove the Do Not Operate Tags from both 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 8.3.1, "Pressure Checks and Adjustments."

4.3.2 Service Brake Pedal

a. Brake Valve Removal

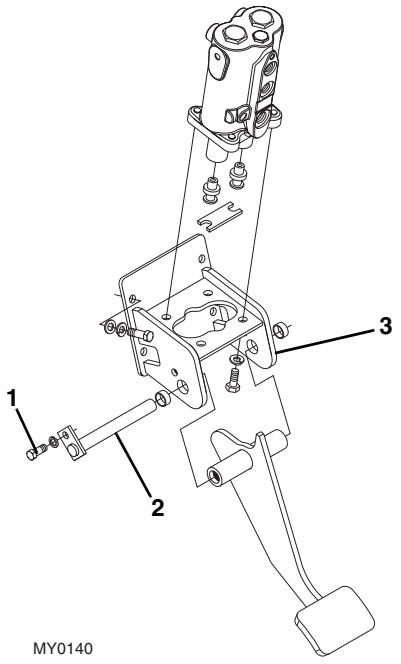
Refer to Section 8.7.3, "Service Brake Valve," for removal information.

b. Brake Valve Installation

Refer to Section 8.7.3, "Service Brake Valve," for installation information.

c. Service Brake Pedal Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, engage parking brake and turn 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 batteries.



5. Remove the bolt and lockwasher (**1**) securing the service brake pedal pivot pin (**2**).
6. Pull pivot pin from service brake pedal bracket (**3**).
7. Remove the service brake pedal from the cab.

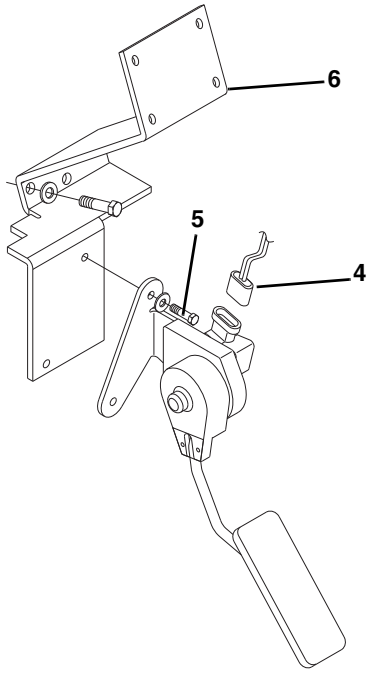
d. Service Brake Pedal Installation

1. Position the service brake pedal in its mounting location within the cab.
2. Secure the brake pedal into position with the pivot pin.
3. Be sure the brake pedal has the correct range of motion. Secure pivot pin with bolt and lockwasher.
4. Properly connect the batteries.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

4.3.3 Throttle Pedal

a. Throttle Pedal Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, engage parking brake and turn engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Properly disconnect the batteries.



4. Disconnect the electrical harness connector (**4**).
5. Remove the bolts (**5**) securing the throttle pedal to the throttle pedal bracket (**6**).
6. Remove the throttle pedal assembly from the cab.

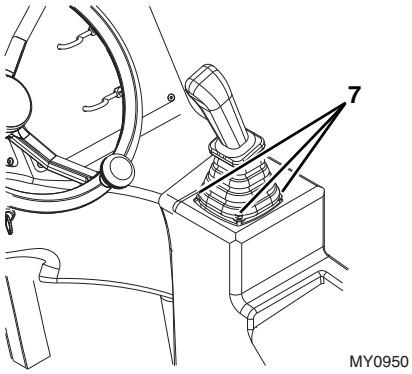
b. Throttle Pedal Installation

1. Position the throttle pedal in its mounting location within the cab.
2. Secure throttle pedal into position with pivot pin.
3. Install throttle pedal ball joint to throttle pedal.
4. Properly connect the batteries.
5. Verify proper throttle pedal operation.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

4.3.4 Boom and Tilt Joystick Assembly

a. Joystick Assembly Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, engage parking brake and turn 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 batteries



5. Lift the joystick's rubber sleeve, remove the bolts securing the boom joystick to the cab (**7**).
6. Lift the joystick from its mounting position.
7. Label, disconnect and cap the hydraulic hoses attached to boom joystick.
8. Disconnect the tilt function electronic connector.
9. Remove the joystick assembly.

b. Joystick Assembly Installation

1. Uncap and connect the previously labeled hydraulic hoses to their appropriate locations.
2. Connect the tilt function electronic connector.
3. Install the bolts securing the joystick to the cab.
4. Properly connect the batteries.
5. Test the complete range of the joystick functions per control decal in cab or Operation & Safety manual.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

4.3.5 Frame Level, Auxiliary and Outrigger Control Joysticks

a. Joystick Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, engage parking brake and turn 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 batteries.

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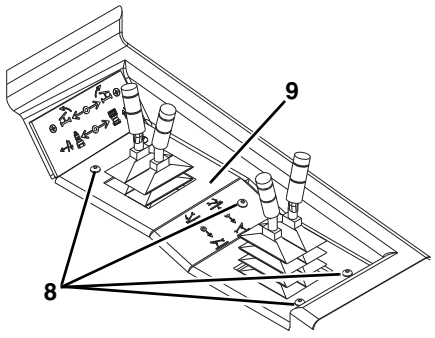


5. Remove the screws (**8**) securing the dash panel (**9**) to the cab. Remove the dash panel.
6. Remove any hardware securing joystick to cab.
7. Label, disconnect and cap the hydraulic hoses attached to the joystick.
8. Remove the joystick from the cab.

b. Joystick Installation

1. Uncap and connect the previously labeled hydraulic hoses to their appropriate locations.
2. Install the bolts securing the joystick to the cab.
3. Install the dash panel to its original position with the previously used hardware.
4. Properly connect the batteries.
5. Test the complete range of the joystick functions per control decal in cab or Operation & Safety manual.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

4.3.6 Windshield Wiper Assembly

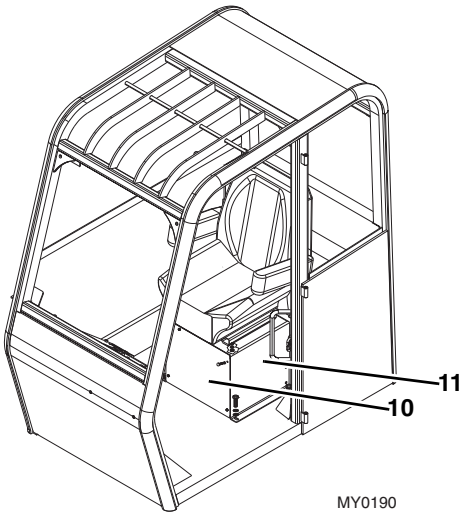
Refer to Section 9.9, “Window Wiper/Washer Windshield Wiper Motor,” for removal and installation information.

4.3.7 Heater/Air Conditioning System (if equipped)

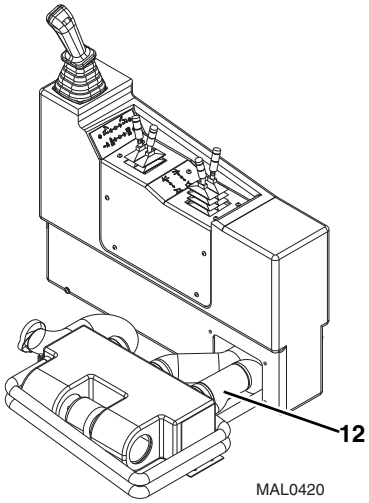
Note: *If machine is equipped with air conditioning, DO NOT loosen or disconnect any air conditioning hoses until the air conditioning system has been properly drained by the local distributor or certified air conditioning service center*.

a. Heater Assembly Removal

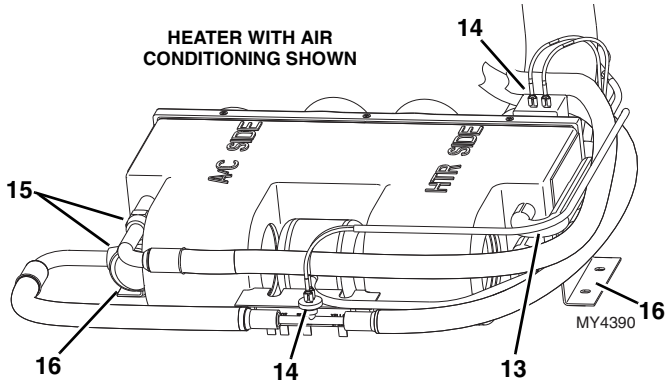
1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission control lever in the (N) NEUTRAL position, engage the park brake and shut the engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open engine cover. Allow the system fluids to cool.
4. Properly disconnect the batteries.
5. Place a suitable container beneath radiator. Slowly turn surge allowing 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 petcock 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 petcock.
9. Remove the bolts that secure the seat to the cab. Remove the seat.



10. Remove the bolts securing the front plate (**10**) to the seat riser weldment (**11**).
11. Remove the bolts securing the seat riser weldment to the cab. Remove the riser weldment.



12. Loosen the hose and disconnect the heater air duct hoses (**12**).



13. Loose hose clamps securing heater hoses (**13**).
14. Label and remove both heater hoses.
15. Label and disconnect any electrical connections (**14**).
16. Label and disconnect both air conditioning hoses (**15**).
17. Remove the bolts (**16**) securing the heater assembly to the cab. Remove the heater assembly.

b. Heater Assembly Installation

Note: *If machine is equipped with air conditioning, air conditioning system must be charged by local distributor or certified air conditioning service center.*

1. Position the heater assembly to its original orientation in the cab. Secure with the previous hardware.
2. Connect previously labeled electrical connections.
3. Connect previously labeled heater hoses to their appropriate locations.
4. Connect the previously labeled air conditioning hoses to their appropriate locations.
5. Install the seat riser weldment.
6. Install the front plate to the seat riser weldment.
7. Install the cab seat.
8. 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 2.5, “Fluids and Lubricant Capacities.”
9. Properly connect the batteries.

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.*

10. Wait for the engine to cool and check the coolant level. Add coolant as required to bring the coolant to the proper level.
11. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

4.4 CAB REMOVAL

⚠ WARNING

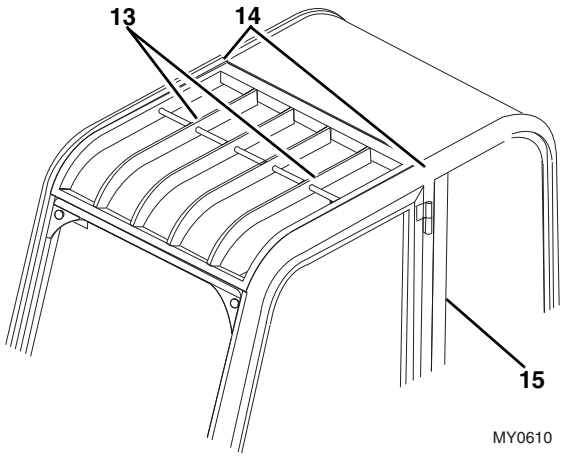
The protection offered by this ROPS/FOPS will be impaired if subjected to any modification or structural damage, at which time replacement is necessary. ROPS/FOPS must be properly installed using fasteners of correct size and grade, and torqued to their specified value.

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

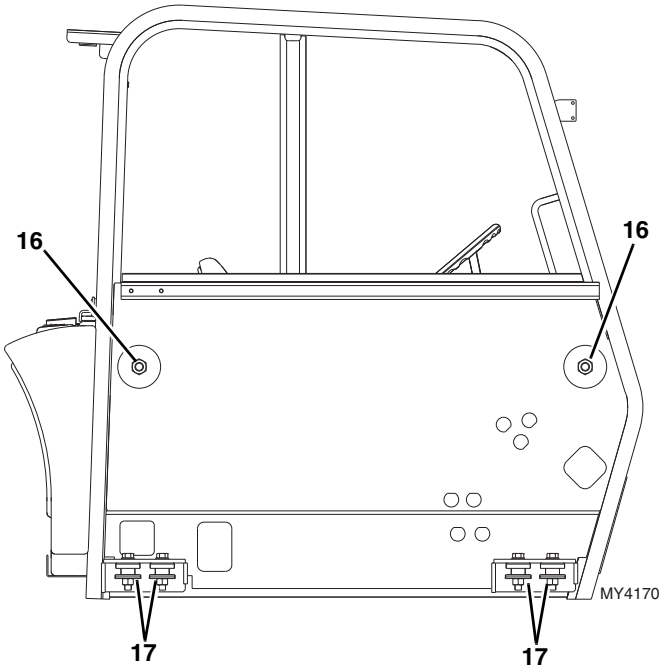
Inspect cab, its welds and mounts. If modification, damage, a cracked weld and/or fatigued metal is discovered, replace cab. Contact local distributor with any questions about suitability or condition of a cab.

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 machine on a firm, level surface. Allow sufficient overhead and side clearance for cab removal. Level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, engage park brake and shut 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 engine cover. Allow the system fluids to cool.
4. Properly disconnect the batteries.
5. If equipped with cab heater:
   - Place a funnel at base of radiator to channel drained coolant into container. Loosen drain petcock and allow coolant to drain.
   - Transfer the coolant to a container with a cover, and label as “Used Antifreeze.” Dispose of the used coolant at an approved recycling facility.
   - Tighten the radiator drain petcock.
   - Disconnect cab heater hoses. Refer to Section 4.3.7, “Heater/Air Conditioning System (if equipped).”
6. Remove necessary dash panels to gain access to electrical wiring connections. Label and disconnect harnesses. Push harness connectors through opening in the cab.
7. Remove boom joystick from is mounting position. Refer to Section 4.3.4, “Boom and Tilt Joystick Assembly.” Label, disconnect and cap all hydraulic hoses attached to the boom joystick. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
8. Remove frame level and attachment tilt and auxiliary control joystick. Refer to Section 4.3.5, “Frame Level, Auxiliary and Outrigger Control Joysticks.” Label, disconnect and cap all hydraulic hoses attached to joystick. Cap all fittings and openings to keep dirt and debris from entering hydraulic system.
9. Label, disconnect and cap all hydraulic hoses attached to the steering orbitrol valve. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
10. Label, disconnect and cap all hydraulic hoses attached to the steering orbitrol valve. 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. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
12. Push all hydraulic hoses through opening in cab.
13. Disconnect the throttle cable from the throttle assembly. Refer to Section 4.3.3, “Throttle Pedal.”
14. Disconnect engine air filter and hydraulic oil reservoir breather from their brackets at top of cab. Move air filter and breather clear from cab so they do not become damaged during cab removal.
15. Remove the fuel tank from the cab. Refer to Section 7.6.2, “Fuel Tank.”



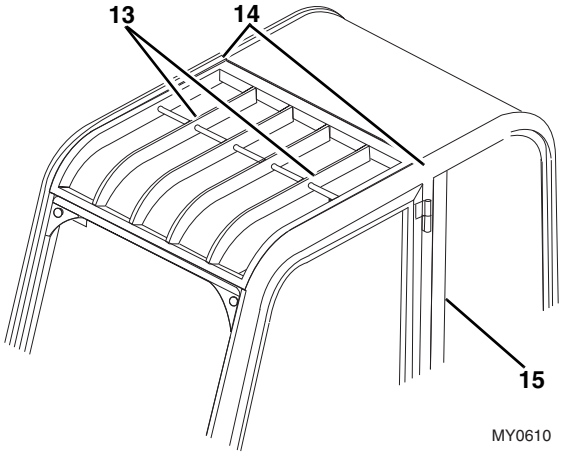
16. Open Cab: Route a sling with a minimum lifting capacity of 1000 lb (453 kg) under the inner four braces (**13**) and behind the center cross support above the wind shield or install two lifting eye bolts (**14**) in the threaded holes on the roof of the cab above the B pillars (**15**).
17. Enclosed Cab: Install two lifting eye bolts (**14**) in the threaded holes on roof of cab above B pillars (**15**).



18. Remove two cab side-mount bolts in cab (**16**).
19. Remove the four cab-to-frame bolts, flat washers and nuts (**17**).
20. Remove the mirrors and all other cab components as needed, if not previously removed.
21. Carefully begin to lift the cab. Stop and check that all wiring, hydraulic hoses and fasteners are disconnected or removed.
22. When all wiring, hydraulic hoses and fasteners are disconnected or removed, carefully and slowly lift cab and remove it from frame. Readjust position of sling as needed to help balance cab during removal.
23. 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.
24. Inspect condition of fittings, clamps, hydraulic hoses, etc. Replace parts as indicated by their condition.
25. Inspect and replace other machine parts that are exposed with the cab removed. Repair or replace as required.

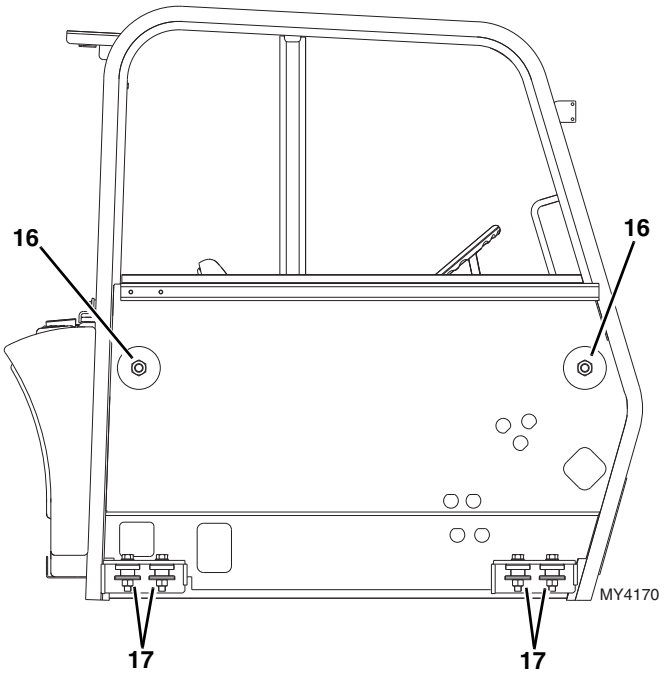
4.5 CAB INSTALLATION

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. Open Cab: Route a sling with a minimum lifting capacity of 1000 lb (453 kg) under the inner four braces (**13**) and behind the center cross support above the wind shield or install two lifting eye bolts (**14**) in the threaded holes on the roof of the cab above the B pillars (**15**).
3. Enclosed Cab: Install two lifting eye bolts (**14**) in threaded holes on roof of cab above B pillars (**15**).

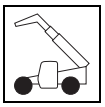
4. Use a hoist or overhead crane and sling attached to the cab. Carefully begin to align the cab with the mounting holes in the frame. Stop and check that wiring, hydraulic hoses, cables, etc., will not be pinched or damaged as the cab is positioned. Readjust the position of the sling as needed to help balance the cab during installation.



5. Install the four cab-to-frame mount bolts, washers and nuts (**17**). Torque to 280–305 lb-ft (379–414 Nm).
6. Install the two cab side mount bolts washers and nuts (**16**). Torque to 680–720 lb-ft (922–976 Nm).
7. Install the engine air filter and hydraulic oil reservoir breather to their brackets at the top of the cab.
8. Install the throttle cable to the throttle pedal assembly. Refer to Section 4.3.3, “Throttle Pedal.”
9. Pull all the hydraulic hoses and electrical wires through the cab.
10. Uncap and reconnect the previously labeled hydraulic hoses to their appropriate locations.
11. Reconnect the previously labeled electrical connections to their appropriate locations.
12. For machines equipped with heater option, reconnect the heater hoses to the cab heater. Refer to Section 4.3.7, “Heater/Air Conditioning System (if equipped).”
13. Install fuel tank to the cab. Refer to Section 7.6.2, “Fuel Tank.”
14. 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 2.5, “Fluids and Lubricant Capacities.”
15. Properly connect the batteries.
16. 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.*

17. 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.
18. Install the mirrors and all other cab components as needed, if removed.
19. Close and secure the engine cover.
20. Unblock the wheels.
21. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

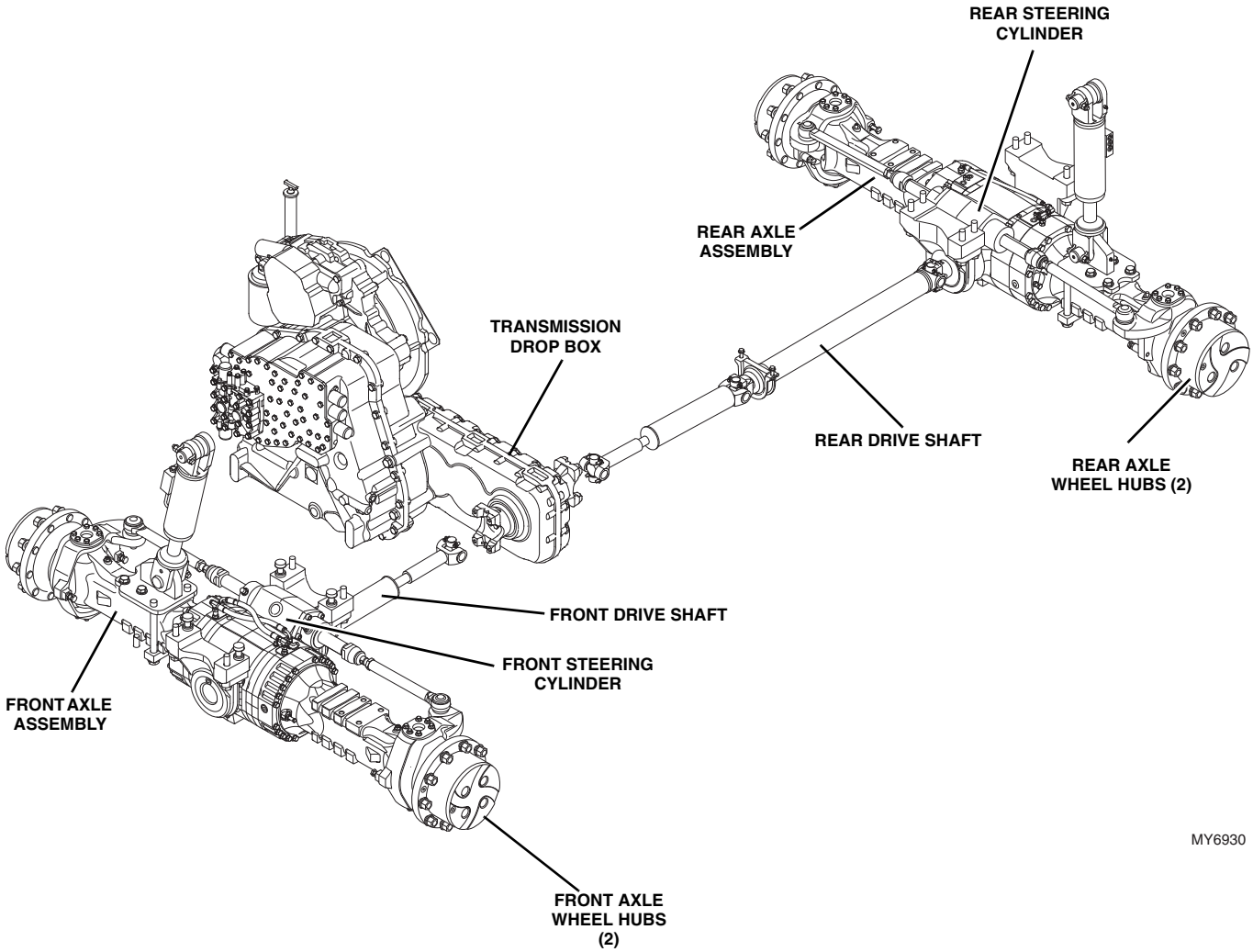


Section 5
Axles, Drive Shafts, Wheels and Tires

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

Front and rear axle serial number plate is located on a mounting pad on the front side of the center section of each axle. 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, “General Information and Specifications.”

Detailed axle service instructions are provided in the following publications:

- Service Manual (P/N 31200240)
- Parts Manual (P/N 31200728)

5.4 AXLE REPLACEMENT

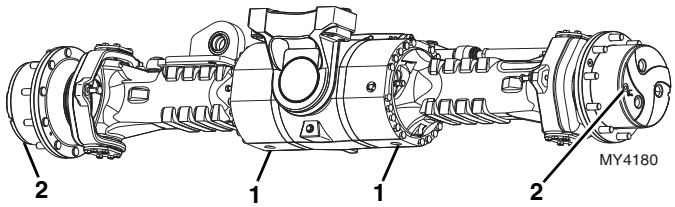
5.4.1 Axle Removal

Front and rear axle assemblies differ in that front axle assembly is equipped with a parking brake mechanism and a limited-slip feature; rear axle has neither. Following steps outline a typical axle removal procedure, suitable for either front or 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 machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in the (N) NEUTRAL position, engage 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 engine cover. Allow the system fluids to cool.
4. Properly disconnect the batteries.
5. Remove the optional fender assembly.



6. If axle will be disassembled after removal, place a suitable receptacle under axle (**1**) and wheel hubs drain plugs (**2**). Remove drain plugs and allow axle oil to drain into receptacle. Transfer used axle oil into a suitable covered container, and label container as “Used Oil.” Dispose of 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 front and rear of both tires on axle that is not being removed. Ensure that machine will remain in place during axle removal before proceeding.
9. Raise machine using a suitable jack or hoist. Place suitable supports under both sides of frame and lower machine onto supports. Ensure that 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 axle being removed. (Refer to Section 5.6.1, “Wheel and Tire Assembly Removal.”)

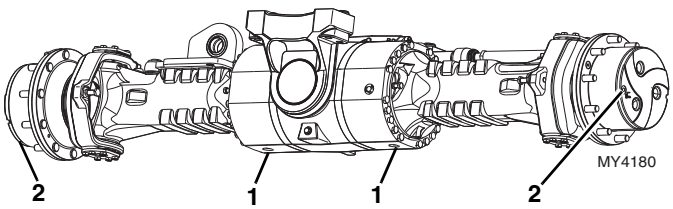
Note: *The wheel and tire assemblies must be re-installed later with the directional tread pattern “arrows” facing in the direction of forward travel.*

12. Remove the drive shaft assembly. Refer to Section 5.5.3, “Drive Shaft Removal.”
13. On the front axle, remove the capscrew and locknuts securing the lower position cylinder-mount pin to the front cylinder. Tap the cylinder mount pin out, and move the cylinder to prevent it from interfering with axle removal.
14. Remove bolts and locknuts securing axle to frame.

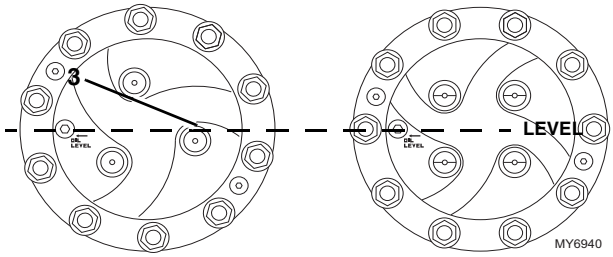
15. Remove axles from machine using jack, hoist or overhead crane and sling supporting the axle. **DO NOT** raise or otherwise disturb machine while removing axle. Balance axle and prevent it from tipping, turning or falling while removing it from beneath machine. Place axle on a suitable support or holding stand.

5.4.2 Axle Installation

1. Before proceeding, ensure that machine will remain in place during axle installation. Block front and rear of both tires on the axle that is already installed on the machine.
2. If applicable, raise machine using a suitable jack or hoist. Place suitable supports beneath frame and lower machine onto supports, allowing enough room for axle installation. Ensure that machine will remain in place during axle installation.
3. Using a suitable jack, hoist or overhead crane and sling, remove axle from its support or holding stand. Balance axle and prevent it from tipping, turning or falling while positioning it beneath machine. **DO NOT** raise or otherwise disturb machine while installing axle. Keep axle supported and balanced on jack, hoist or overhead crane and sling throughout the installation procedure.
4. Position axle under frame, and align axle housings with holes in frame.
5. Install four axle bolts and nuts. Tighten and torque to 530-565 lb-ft (718-766 Nm).
6. Move cylinder into position on axle cylinder anchor. Insert a cylinder-mount pin through cylinder and cylinder anchor. Secure the cylinder-mount pin with one capscrew and a new locknut.
7. Apply multi-purpose grease through the self-tapping lube fitting to lubricate the self-align bearing and the cylinder-mount pin.
8. Install the drive shaft assemblies. (Refer to Section 5.5.5, “Drive Shaft Installation.”)
9. If reinstalling an axle previously removed from the machine, position driveshaft yoke on axle according to alignment marks made earlier. If installing a new axle, note position of driveshaft yoke at transmission. Align driveshaft yoke on axle in same plane as yoke on transmission.



10. Tighten axle oil drain plug, loosen and remove axle oil fill plug (**1**). (Refer to Section 2.5, “Fluids and Lubricant Capacities,” for proper oil and capacities.

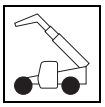


11. Rotate wheel hubs 90 degrees so drain plug (**2**) becomes fill plug (**3**). Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”,” for proper oil and capacities.
12. Install the wheel and tire assemblies. Refer to Section 5.6.2, “Wheel and Tire Assembly Installation.”
13. Carefully remove jack, hoist or overhead crane and sling supporting the axle.
14. Carefully raise machine using a suitable jack or hoist. Remove supports from beneath frame and lower the machine to ground.
15. Remove blocks from front and rear of both tires on other axle.

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

16. Install new o-rings into the fittings. Lubricate the o-rings with clean hydraulic oil.
17. Uncap and connect the steering and brake lines at their axle fittings.
18. Check the hydraulic reservoir oil level.
19. Start engine. Turn 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.
20. Install the optional fender assembly.
21. Close and secure the engine cover.
22. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

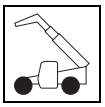
Note: *The service brake and parking brake circuits will need to bled after axle installation. Refer to Section 8.7.4, “Service Brake Bleeding.”*



5.4.3 Axle Assembly and Drive Shaft Troubleshooting

Problem	Cause	Remedy
1. Excessive axle noise while driving.	1. Oil level too low.	1. Fill oil to correct level. Refer to Section 2.5, “Fluid 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 with hydraulic oil. Refer to Section 2.5, “Fluid 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 with hydraulic oil. Refer to Section 2.5, “Fluid and Lubricant Capacities.”
	8. Axle housing damaged.	8. Replace damaged parts.
	9. Axle and/or brake noise.	9. Section 2.5, “Fluid and Lubricant Capacities.”
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	Cause	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 96 lb-ft (130 Nm).
	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 Engine Repair Manual.
	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 288 lb-ft (390 Nm).
	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 96 lb-ft (130 Nm).
	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 41 lb-ft (55 Nm).
	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	Cause	Remedy
7. Axle overheating.	1. Oil level too high.	1. Fill oil to correct level with hydraulic oil. Refer to Section 2.5, “Fluid 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 with hydraulic oil. Refer to Section 2.5, “Fluid and Lubricant Capacities.”
	3. Dragging brake/park brake.	3. Refer to Section 5.3, “Axle Specifications And Maintenance Information.”
8. High steering effort required.	1. Steering (hydraulic) system not operating properly.	1. Refer to Section 8.4, “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 8.4, “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, “Brakes.”
	2. Brake discs damaged.	2. Replace brake discs.
11. Brakes will not engage.	1. Brake (hydraulic) system not operating properly.	1. Refer to Section 8.4, “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 2.5, “Fluid and Lubricant Capacities.”
	2. Brake (hydraulic) system not operating properly.	2. Refer to Section 8.4, “Hydraulic Circuits.”
	3. Brake piston o-rings and seals damaged (leaking).	3. Replace o-rings and seals.

5.5 DRIVE SHAFTS

5.5.1 Drive Shaft Inspection and Service

Inspect areas where drive shaft flange yokes and slip yokes mount to 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 help ensure optimum performance, drive shaft assemblies are specially balanced as a unit at 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.*

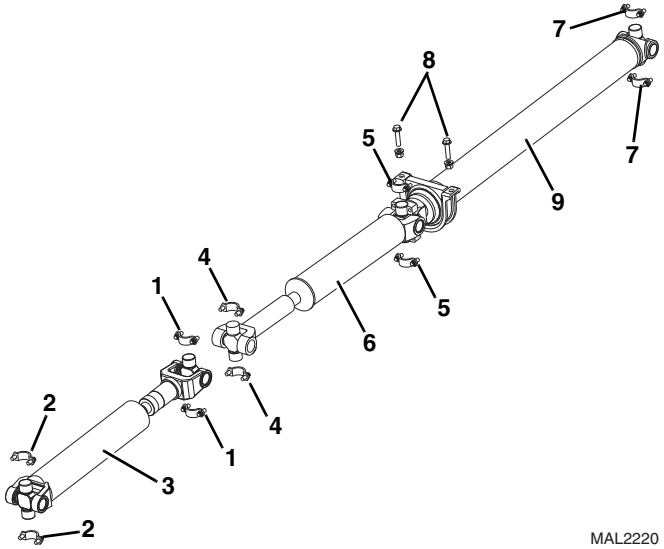
Note: *Any bolt removed from the drive shaft assembly MUST be replaced. Do Not re-torque.*

5.5.2 Drive Shaft Maintenance

Refer to Section 2.5, “Fluids and Lubricant Capacities,” for information regarding lubrication of drive shafts.

5.5.3 Drive Shaft Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL, engage park 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 batteries.
5. Block the wheels.
6. The drive shaft assembly is a balanced assembly. Mark yoke and axle, transmission and shaft and slip yoke so that these components can be returned to their original positions when reinstalled. Yokes at both ends of drive shaft must be in same plane to help prevent excessive vibration.



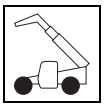
7. Remove four bolts and two straps (**1**) securing bearing cross to the transmission output shaft flange. Discard bolts.
8. Remove four bolts and two straps (**2**) securing bearing crosses to the axle. Discard bolts.
9. Remove front drive shaft assembly (**3**).
10. Remove four bolts and two straps (**4**) securing bearing cross to transmission output shaft flange. Discard bolts.
11. Remove four bolts and two straps (**5**) securing bearing crosses to rear axle (**6**) at carrier bearing. Discard bolts.
12. Remove rear drive shaft assembly (**6**).
13. Remove four bolts and two straps (**7**) securing bearing cross to rear axle. Discard bolts.
14. Remove two bolts, nuts and washers (**8**) securing carrier bearing to frame.
15. Remove rear drive shaft assembly (**9**).

5.5.4 Drive Shaft Cleaning and Drying

1. Disassemble and clean all parts using an approved cleaning fluid. Allow to dry.
2. Remove and burrs or rough spots from all machined surfaces. Re-clean and dry as required.

5.5.5 Drive Shaft Installation

1. Raise drive shaft assembly into position. Slip-yoke end of drive shaft mounts toward axle. If reinstalling a drive shaft previously removed, align flange yokes according to alignment marks made during removal.



Note: *The 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 two straps and four new bolts (**1**) securing front axle (**3**) bearing crosses to transmission. Torque bolts to 55-60 lb-ft (75-81 Nm).
4. Install two straps and four new bolts (**2**) securing front axle (**3**) bearing crosses to axle. Torque bolts to 55-60 lb-ft (75-81 Nm).
5. Install two straps and four new bolts (**7**) securing rear axle (**9**) bearing crosses to axle. Torque bolts to 55-60 lb-ft (75-81 Nm).
6. Install previously removed bolts, nuts and washers (**8**) and secure the carrier bearing to frame. Torque to 55 lb-ft (75 Nm).
7. Install two straps and four new bolts (**4**) securing the rear axle (**6**) bearing crosses to the transmission. Torque bolts to 55-60 lb-ft (75-81 Nm).
8. Install two straps and four new bolts (**4**) securing the rear axle (**6**) bearing crosses to the rear axle (**9**) at the carrier bearing. Torque bolts to 55-60 lb-ft (75-81 Nm).
9. Properly connect the batteries.
10. Close and secure the engine cover.
11. Unblock the wheels.
12. Remove Do Not Operate Tags from both ignition key switch and steering wheel.

5.6 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 same size, ply and brand as originally installed. Refer to 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.

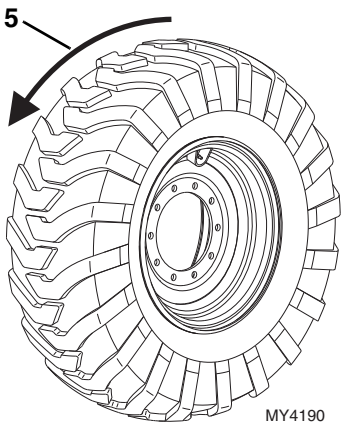
Large-bore valve stems are used to help expedite tire inflation and deflation. An inner tube may be used if a tire does not provide an airtight seal. Check tire inflation pressures when the tires are cold. When mounting a tire on the wheel, the tire must be mounted on the wheel respective of the directional tread pattern of the tire; this produces a left or right tire and wheel assembly.

5.6.1 Wheel and Tire Assembly Removal

1. Park the machine on a firm, level surface, fully retract the boom, lower the boom, place the transmission control lever in (N) NEUTRAL, engage the park brake and shut the engine OFF.
2. Place an Do Not Operate Tag on both the ignition key switch and steering wheel.
3. Loosen but **DO NOT** remove the lug nuts on the wheel and tire assembly to be removed.

4. Place a suitable jack under axle pad closest to wheel being removed. Raise machine and position a suitable support beneath 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 lug washers in an alternating pattern.
7. Remove wheel and tire assembly from machine.

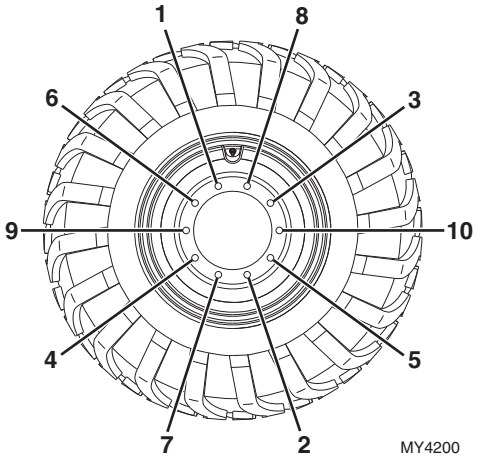
5.6.2 Wheel and Tire Assembly Installation



Note: *If the machine is equipped with directional tire assemblies, the wheel and tire assemblies must be installed with the directional tread pattern "arrows" facing in the direction of forward travel (**5**).*

Note: *Verify valve stems face outward on all wheel and tire assemblies.*

1. Position wheel onto studs on wheel end of axle.
2. Install wheel lug washers.
3. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.



4. Tighten lug nuts in an alternating pattern as indicated in figure. Torque to 350-400 lb-ft (475-542 Nm).
5. Remove machine from supports.
6. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

5.7 BRAKES

Check the brake disks for wear every 1,000 hours of operation or yearly.

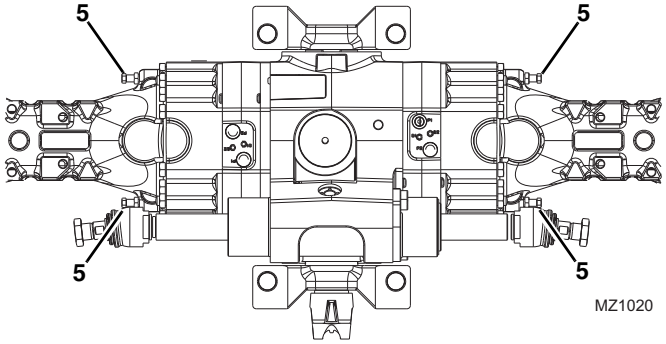
For more information on brake disk inspection, refer to the Axle Repair Manual (P/N 31200240).

5.8 TOWING A DISABLED MACHINE

Towing a disabled machine should only be attempted as a last resort, after exhausting all other options. Make every effort to repair the machine, and move it under its own power, before using the emergency towing procedures outlined below.

Note: *Block the wheels of the machine BEFORE attempting to release the park brake. Once the park brake is released the machine's park brake AND service brakes are inoperable.*

5.8.1 Manually Releasing the Park Brake

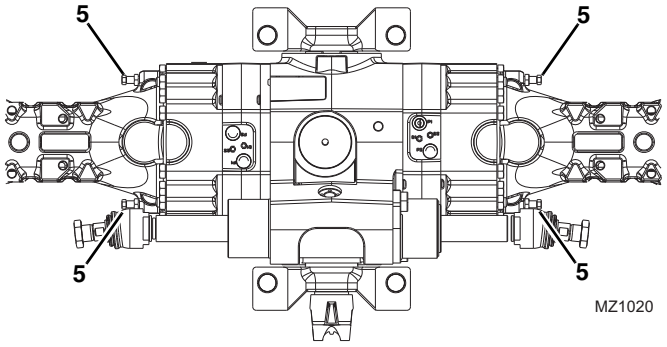


1. Loosen the nuts of the screws (**5**) for the manual release of the braking units. Draw the nuts back approximately 6 mm.
2. Tighten the screws until they are gently seated on the driving plate.
3. Carefully tighten each release screw a 1/4 turn at a time in sequence until all have been turned on full turn 360°.
4. Repeat steps 1 thru 3 for other side of differential.

Note: *After machine has been towed to a secure location, reactivate parking brake. Carefully follow procedures from start to finish. Contact local JLG dealer if you are unsure about any part of the procedure, or for specific instructions concerning your particular situation.*

5.8.2 Manually Resetting the Park Brake

Note: *Block the wheels of the machine BEFORE attempting to reset the machine's park brake. Once the park brake is released the machine's park brake AND service brakes are inoperable.*



1. Loosen each release screw (**5**), only 1/4 turn at a time, in sequence, until each screw has lost contact with the guide pin.
2. Remove screws along with nuts and seals. Replace seals, lubricate screws with a silicone-based grease and re-install screws along with nuts.
3. Adjust the nut of the screw heads in relation to the arm by 1.18 in (30 mm).
4. Repeat steps 1 thru 3 for other side of differential.
5. After repairs to machine have been made, start machine and check park brake and service brakes for proper function. Refer to Section 8.7.4, "Service Brake Bleeding," Section 8.7.5, "Service Brake Test," and Section 8.7.6, "Steering Orbitrol Valve."

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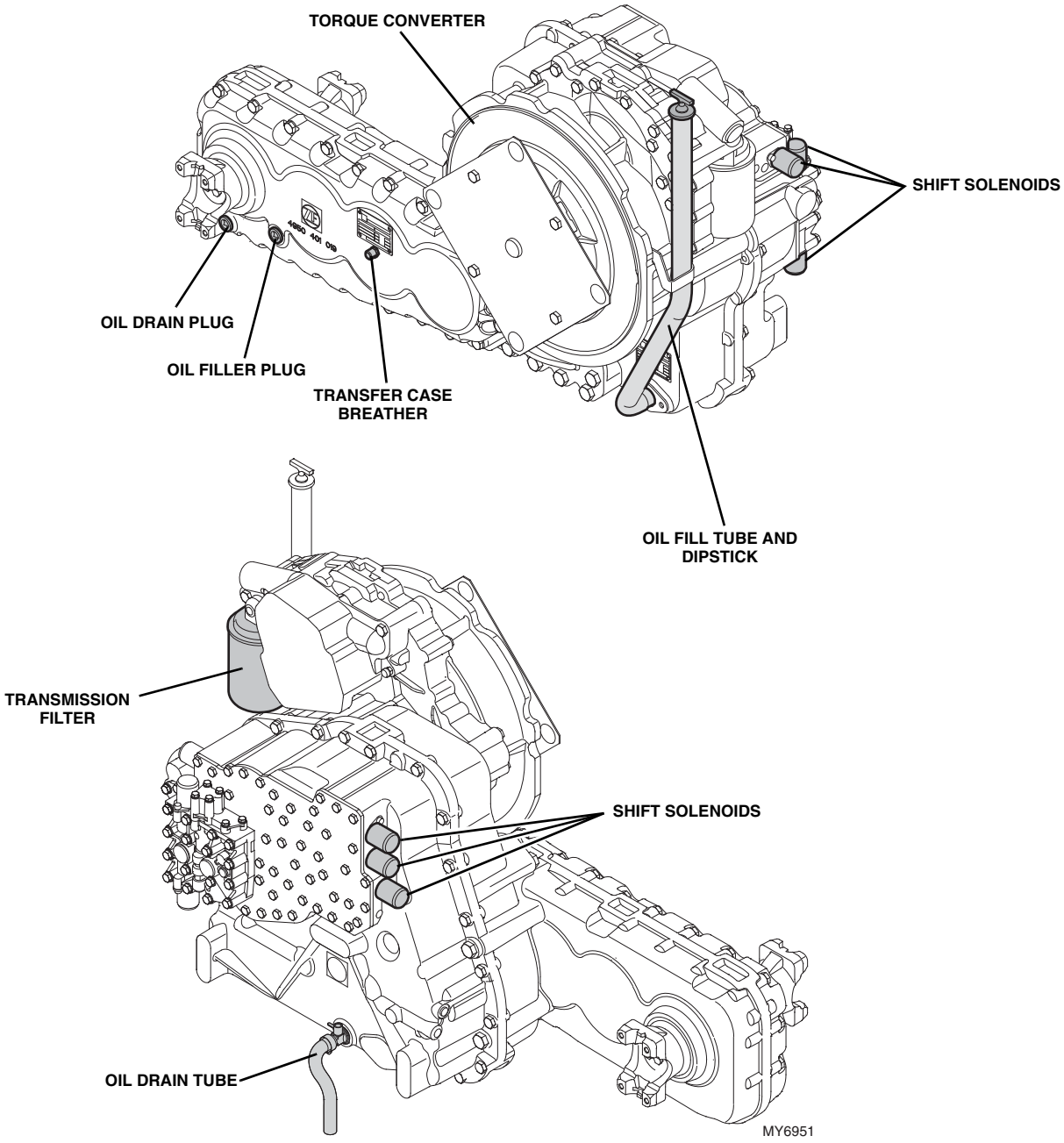
Section 6
Transmission

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.

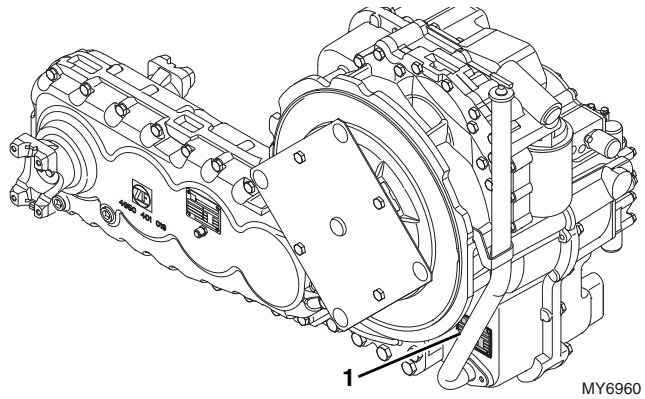


⚠ WARNING

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 transmission. Refer to local distributor and applicable Transmission Service Manual for assistance with comprehensive transmission diagnosis, repair and component replacement.*

6.2 TRANSMISSION SERIAL NUMBER



Transmission serial number plate (**1**) is located on front of transmission case behind oil dipstick. Information on the serial number plate is required in correspondence regarding the transmission.

6.3 TRANSMISSION SPECIFICATIONS AND MAINTENANCE INFORMATION

For transmission, oil specifications and maintenance information, refer to Section 2, “General Information and Specifications.”

Detailed transmission service instructions are provided in the following publications:

- Service Manual (P/N 31200241)
- Parts Manual (P/N 31200728)

6.4 TRANSMISSION REPLACEMENT

Note: *Contact local distributor if internal transmission repair is required during the warranty period.*

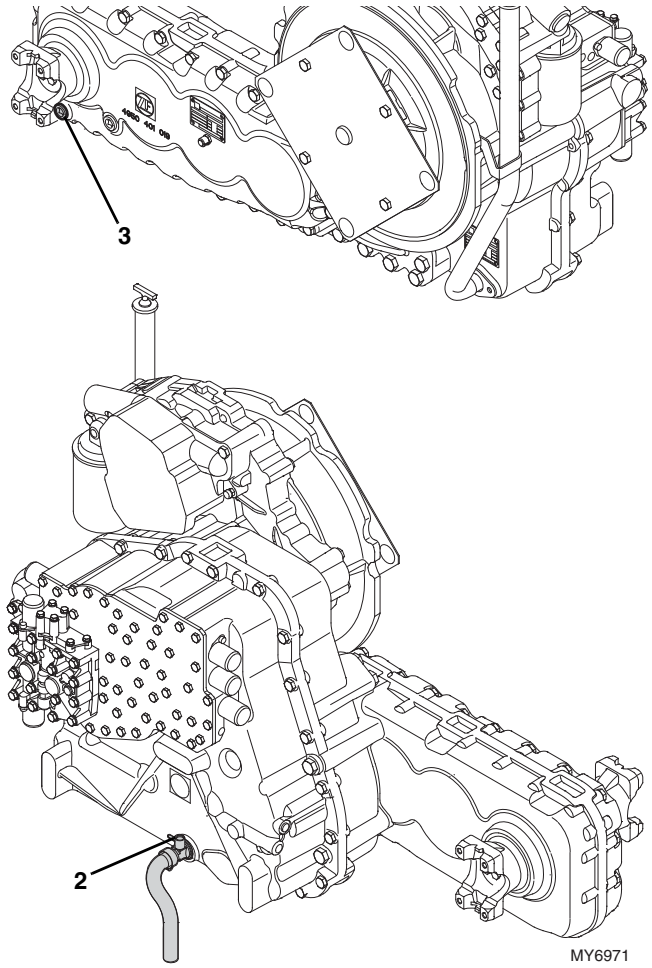
Cleanliness is of extreme importance. Before attempting to remove transmission, thoroughly clean exterior of transmission to help prevent dirt from entering during replacement process. Avoid spraying water or cleaning solution onto or near transmission shift solenoids and other electrical components

6.4.1 Transmission Removal

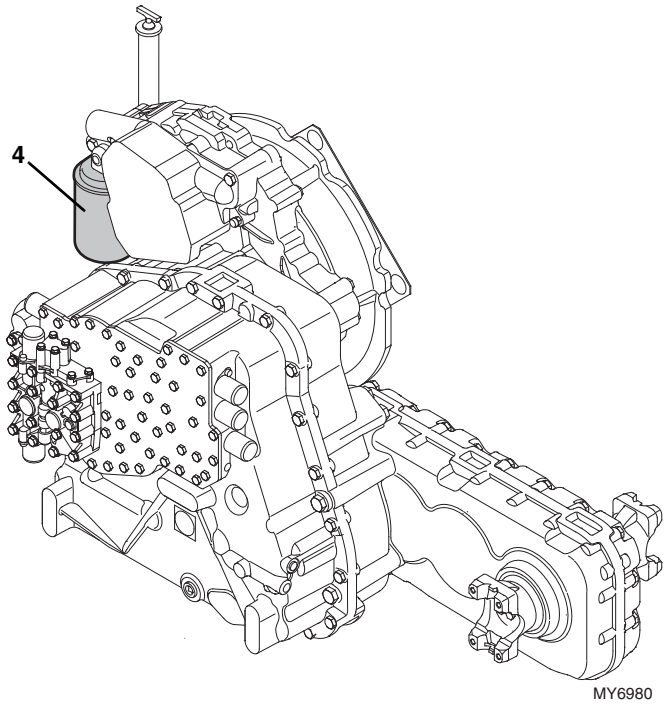
⚠ WARNING

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 1000 lb (454 kg).

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL, engage park brake and shut 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. Remove engine cover. Mark position of cover to help with cover adjustment when being reinstalled.
5. Drain the hydraulic oil reservoir. Refer to Section 8.5.1, “Hydraulic Oil Reservoir Draining.”
6. Properly disconnect the batteries.
7. Thoroughly clean the transmission and surrounding area, including all the hoses and fittings, before proceeding.



8. Place a suitable receptacle under transmission drain cock (**2**). Open transmission drain cock, and allow transmission oil to drain into receptacle. Remove drain plug and repeat drain procedure with the drop box (**3**).
9. Transfer used transmission oil into a suitable, covered container, and label container as “Used Oil.” Dispose of used oil at an approved recycling facility. Close the transmission drain cock. Clean and reinstall the drop box drain plug.
10. Remove the transmission-to-axle drive shafts. Refer to Section 5.5.3, “Drive Shaft Removal.”
11. Remove exhaust components from turbo to exhaust pipe. Refer to Section 7.5, “Engine Exhaust System.”
12. Remove the implement pump. Refer to Section 8.6.1, “Implement Pump Replacement.”
13. Label and disconnect transmission temperature switch connector and shift solenoid wiring harness connectors.
14. Label, disconnect and cap the transmission oil cooler inlet and outlet hoses at the transmission.
15. Remove access cover from bottom of engine bell housing. This will allow access to remove four bolts holding the torque convertor diaphragm to the engine flywheel.
16. Turn the engine over slowly by hand and align each of the four torque convertor diaphragm bolts to be accessed. Remove them one at a time.
17. Wipe up any spilled hydraulic and transmission oil.
18. Connect a lifting strap or chain to lifting eye at top of transmission, and to a suitable hoist or overhead crane. Operate hoist or crane to remove slack from chain, but **DO NOT** raise transmission at this time.
19. Place blocks under rear of engine for support BEFORE transmission mounts are removed.
20. Place blocks under the transmission to help support it during removal.
21. Remove both rear transmission mount bolts and lockwashers securing transmission mount to frame.
22. Remove the bolts and washers holding the transmission to the engine.
23. Remove the capscrews and lockwashers securing each rear transmission mount to the transmission.
24. Carefully remove the transmission from the machine. Avoid causing damage to the transmission or surrounding parts.
25. 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.
26. Remove any external transmission components as required, including the transmission temperature switch, and inlet and outlet cooler hose fittings. Cover all transmission openings.



27. Remove the transmission oil filter (**4**) and dispose of properly. Clean the filter mounting surface. Cover or cap the oil filter mount.
28. If transmission oil is suspect to contamination or torque converter is damaged, remove the converter and flex plate from the transmission.
29. Remove the bolt and washers holding the converter to the flex plate.

6.4.2 Transmission Inspection and Internal Repair

If replacing entire transmission, transfer transmission temperature switch to replacement transmission. Gear shift solenoids are included with a new transmission.

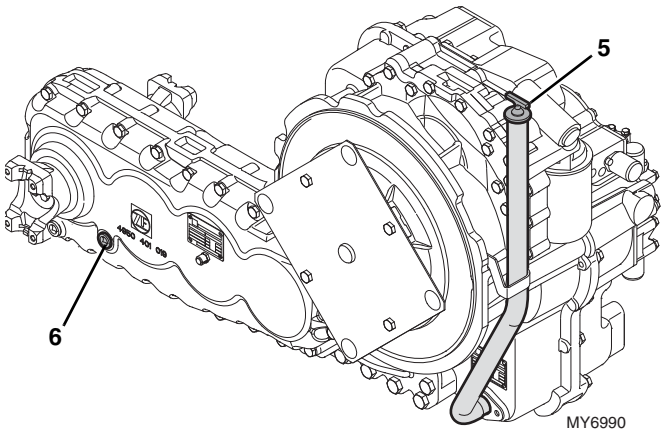
6.4.3 Transmission Installation

⚠ WARNING

NEVER lift a transmission alone; enlist the help of at least one assistant or use a suitable hoist or overhead crane and sling.

1. Install two guide studs near the top of the bell housing holes.
2. Use a hoist or overhead crane and sling attached to the lifting eye at the top of the transmission. Raise and position the transmission within the chassis.
3. Align the torque converter, align the transmission bolt holes with the two studs in the bell housing. Install the eight bolts and washers and torque to 53 lb-ft (72 Nm). Remove the two alignment studs and install and torque the last two transmission mounting bolts.
4. Install capscrews and lockwashers securing rear transmission mount to transmission. Torque capscrews to 125-140 lb-ft (170-190 Nm).
5. Install the two rear transmission mounting bolts on the frame with two capscrews and two lockwashers. Apply Loctite® 24™ to the transmission mount bolts and torque to 125-140 lb-ft (169-190 Nm)
6. Turn the engine over slowly by hand and align each of the four torque convertor diaphragm bolts through the access plug in the bell housing. Install them one at a time. DO NOT fully tighten until all of the capscrews and locknuts are in place. Torque to 26-39 lb-ft (35-59 Nm). Replace access plug.
7. Remove the hoist or overhead crane and sling.
8. Connect the transmission temperature switch connector and the shift solenoid wiring harness connectors.
9. Secure wiring harness to transmission housing.
10. Connect the transmission oil cooler inlet and outlet hoses at the transmission.
11. Install the hydraulic pump. Refer to Section 8.6.1, “Implement Pump Replacement.”
12. Install the transmission-to-axle drive shafts. Refer to Section 5.5.5, “Drive Shaft Installation.”
13. Install exhaust components from turbo to exhaust pipe. Refer to Section 7.5, “Engine Exhaust System.”
14. Clean the transmission oil filter mounting surface.

15. Apply a thin film of clean hydraulic oil to the new transmission filter gasket. Install the new filter and torque to 20-25 lb-ft (27-34 Nm).



16. Fill the transmission. Refer to Section 2.5, “Fluids and Lubricant Capacities,” for proper capacity.
17. Transmission oil may be added through the dipstick tube (**5**). Remove the dipstick and add hydraulic oil. Check the oil level by taking intermittent dipstick readings as outlined in the appropriate Operation & Safety Manual. **DO NOT** overfill. Reinstall the dipstick when finished.
18. Transmission transfer case fluid may be added through the fill plug (**6**). Install fill plug and tighten when filled to appropriate level.
19. Properly connect the batteries.

Note: *Check transmission oil level with engine at idle and transmission oil cold.*

20. Apply park brake, shift transmission control lever to the (N) NEUTRAL position and lower the forks or attachment to the ground.
21. Remove the transmission dipstick (**5**) and check the oil level. The oil level should be at the MAX line.
22. If oil is low, add oil as required and recheck level.
23. Replace the transmission dipstick. when finished.
24. Install the engine cover.
25. Close and secure engine cover.
26. Recheck all drain plugs, lines, connections, etc., for leaks, and tighten where necessary.Close and secure the engine cover.
27. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

6.4.4 After Transmission Service or Replacement

In general:

1. Check transmission oil level and add oil as required.
2. Disconnect and clean all transmission cooler hoses. When possible, remove transmission lines from the machine for cleaning.
3. Drain and flush entire transmission cooling system.
4. Thoroughly clean transmission filter screens and cases, and replace transmission filter elements.

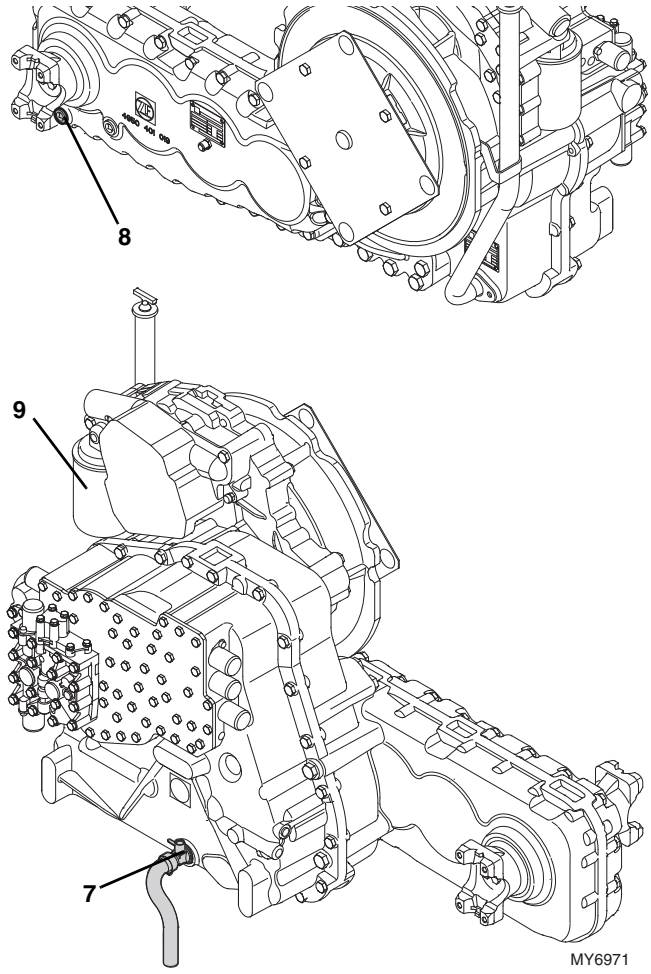
Note: *Check transmission oil level with engine at idle and oil at normal operating temperature.*

5. Reassemble all components and fill the transmission with clean, fresh hydraulic oil through the dipstick tube opening (**5**). Check the level by taking intermittent dipstick readings as outlined in the appropriate Operation & Safety Manual. **DO NOT** overfill. Reinstall the dipstick when finished.
6. Transmission transfer case fluid may be added through the fill plug (**6**). Install fill plug and tighten.
7. Apply park brake, shift transmission control lever to the (N) NEUTRAL position and lower the forks or attachment to the ground.
8. Remove the transmission dipstick (**5**) and check the oil level. The oil level should be at the MAX line.
9. If oil is low, add oil as required and recheck level.
10. Replace the transmission dipstick. when finished.
11. Close and secure engine cover.
12. Recheck all drain plugs, lines, connections, etc., for leaks, and tighten where necessary.

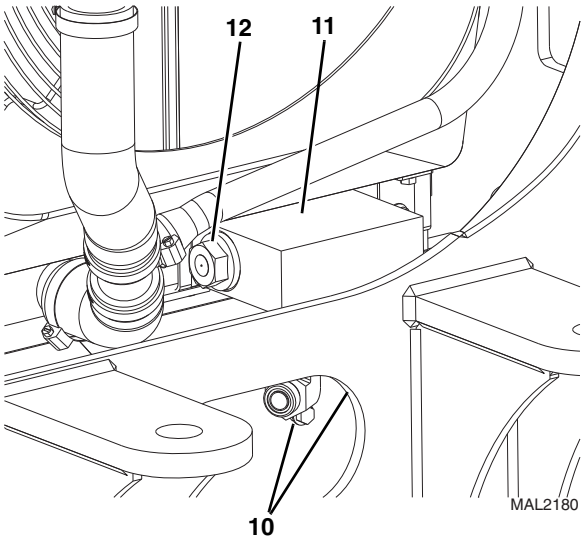
6.5 TRANSMISSION COOLER THERMAL BY-PASS VALVE

6.5.1 Thermal By-Pass Valve Cartridge Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, 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 system fluids to cool.
4. Properly disconnect the batteries.
5. Thoroughly clean the transmission and surrounding area, including all the hoses and fittings, before proceeding.



6. Place a suitable receptacle under transmission drain cock (**7**). Open transmission drain cock, and allow transmission oil to drain into receptacle. Remove drain plug and repeat drain procedure with the drop box (**8**).
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. Close the transmission drain cock. Clean and reinstall the drop box drain plug.
8. Remove transmission oil filter (**9**) and dispose of properly. Clean filter mounting surface. Cover or cap oil filter mount.
9. 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 and drop box drain plugs.
10. Place a suitable container beneath transmission cooler fittings on hydraulic cooler. Transfer any transmission oil into a properly labeled container. Dispose of properly.



11. Label, disconnect and cap the transmission oil cooler hoses (**10**) at the thermal by-pass valve (**11**). Cap all fittings and openings to prevent dirt and debris from entering.
12. Loosen and remove the cartridge (**12**) from side of thermal by-pass valve. Plug opening to prevent dirt and debris from entering system.

6.5.2 Thermal By-Pass Valve Cartridge Installation

1. Remove the plug and install the new cartridge (**12**) in the thermal by-pass valve (**11**).
2. Uncap and connect previously labeled transmission oil cooler hoses (**10**) to thermal by-pass valve.
3. Clean transmission oil filter mounting surface.
4. Apply a thin film of clean hydraulic oil to new transmission filter gasket. Install new filter and torque to 20-25 lb-ft (27-34 Nm).
5. Fill the transmission. Refer to Section 2.5, “Fluids and Lubricant Capacities,” for proper capacity.
6. Properly connect batteries.

Note: *Check transmission oil level with engine at idle and transmission oil cold.*

7. Apply park brake, shift transmission control lever to (N) NEUTRAL position and lower the forks or attachment to ground.
8. Open engine cover.
9. Remove transmission dipstick (**5**) and check oil level. Oil level should be at MAX line. Add oil as required.
10. Replace transmission dipstick.
11. Close and secure engine cover.
12. Recheck all drain plugs, lines, connections, etc., for leaks, and tighten where necessary.

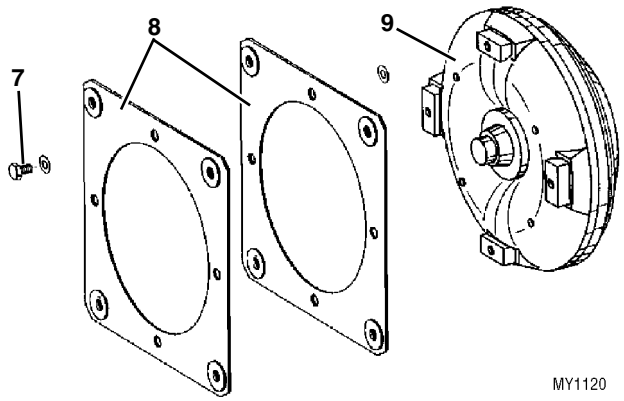
6.6 TORQUE CONVERTOR DIAPHRAGM

6.6.1 Torque Convertor Diaphragm Removal

1. Park the machine on a firm, level surface, level the machine, fully retract the boom, lower the boom, place the transmission control lever in the (N) NEUTRAL position, engage the parking brake, and shut the engine OFF.

Note: *In order to remove engine drive plates, engine and transmission must be separated.*

2. Refer to Section 6.4.1, “Transmission Removal,” or Section 7.7.1, “Engine Removal.”



3. Remove four bolts holding diaphragms to flywheel.
4. With drive plates and torque converter removed, loosen and remove four bolts (**7**) and eight lock washers holding the two diaphragms (**8**) to the torque converter (**9**).
5. Replace both diaphragms if damaged.

6.6.2 Torque Convertor Diaphragm Installation

1. Install two new diaphragms on torque converter and install the four bolts with lock washers.
2. Mount the diaphragm/converter assembly to the transmission.
3. Refer to Section 6.4.3, “Transmission Installation,” or Section 7.7.2, “Engine Installation,” for the remainder of the installation.

6.7 TROUBLESHOOTING

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

Note: *Contact local distributor if internal transmission repair is required during the warranty period.*

The transmission should be checked, serviced and repaired only by experienced service technicians who are aware of all safety instructions and particular component features

Problem	Cause	Remedy
1. Transmission will not engage or will not shift properly.	1. Oil level too high or low.	1. Fill transmission to correct level with hydraulic oil. Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”.”
	2. Transmission control lever not functioning properly and/or a fault in the wiring harness.Transmission control lever not functioning properly and/or a fault in the wiring harness.	2. Refer to Section 9.5, “Electrical System Schematics.”
	3. Transmission valve body solenoids not functioning properly.	3. Refer to Section 9.5, “Electrical System Schematics.”
	4. Pilot-operated shift valves not operating properly.	4. Clean the valve spool and housing. Replace return spring as needed.
	5. Pump output pressure low.	5. Refer to **Problem 2.** “Low or no pump flow or pressure.”
	6. Clutch piston o-rings damaged.	6. Replace o-rings.
	7. Clutch discs worn or damaged.	7. Replace clutch discs.
	8. Coupling shafts or gear teeth damaged.	8. Replace couplings.
2. Low or no pump flow or pressure.	1. Low oil level.	1. Fill transmission to correct level with hydraulic oil. Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”.”
	2. Transmission filled with incorrect oil, or oil contaminated.	2. Drain transmission and fill to correct level with hydraulic oil. Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”.”
	3. Pump suction pipe screen clogged.	3. Clean, repair and/or replace suction pipe.
	4. Central shaft damaged.	4. Replace central shaft.
	5. Pump worn or damaged.	5. Repair or replace pump assembly.

Problem	Cause	Remedy
3. Low clutch pressure.	1. Incorrect oil level.	1. Fill transmission to correct level with hydraulic oil. Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”.”
	2. Main pressure valve stuck open.	2. Clean the valve spool and housing.
	3. Broken or worn coupling shaft or piston o-rings.	3. Replace coupling and/or o-rings.
	4. Pressure reducing valve stuck open.	4. Clean the valve spool and housing.
4. Lack of power.	1. Park or service brake dragging.	1. Refer to Section 8.4, “Hydraulic Circuits.”
	2. Low engine rpm causes converter stall.	2. Adjust the engine rpm to specifications. Refer to Engine Service Manual.
	3. Pump output pressure is low.	3. Refer to **Problem 2.** “Low or no pump flow or pressure.”
	4. Clutch discs worn or damaged.	4. Replace clutch discs.
	5. Transmission overheating.	5. Refer to **Problem 5.** “Transmission overheating (oil above 248° F (120° C)).”
5. Transmission overheating (oil above 248° F (120° C)).	1. Low oil level.	1. Fill transmission to correct level with hydraulic oil. Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”.”
	2. Clogged radiator.	2. Remove debris from the radiator.
	3. Transmission filled with incorrect oil, or oil contaminated.	3. Drain transmission and fill to correct level with hydraulic oil. Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”.”
	4. Excessive “roading.”	4. Stop and idle the engine.
	5. Restriction in oil cooler hoses.	5. Replace cooler hoses.
	6. Pump worn or damaged.	6. Repair or replace pump assembly.
	7. Thermal by-pass valve damaged or flow restricted.	7. Replace thermal by-pass valve cartridge. Refer to Section 6.5, “Transmission Cooler Thermal By-Pass Valve.”

Problem	Cause	Remedy
6. Grinding or "clunking" noise from transmission.	1. Oil level too low.	1. Fill oil to correct level. Refer to Section Note:, "Friction Modifier may be added to front axle differentials, see Section 2.5.3, "Capacities."."
		2. Repair or replace parts as needed.
	2. Transmission filled with incorrect oil.	3. Drain transmission and fill to correct level with hydraulic oil. Refer to Section Note:, "Friction Modifier may be added to front axle differentials, see Section 2.5.3, "Capacities."."
	3. Incorrect clutch engagement.	4. Refer to Section 9.9.2, "Transmission Solenoid Valves."
	4. Internal damage.	5. Repair or replace parts as needed.
	5. Broken diaphragm (torque convertor).	6. Replace diaphragm (torque convertor). Refer to Section 6.4.1, "Transmission Removal."
	6. Loose diaphragm (torque convertor) mounting capscrews.	7. Tighten capscrews.

Problem	Cause	Remedy
7. Oil leaking from transmission.	1. Oil leaking from vent (high oil level).	1. Remove drain plug and drain oil as needed, until oil is at correct level. Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”.” Replace o-rings as needed and tighten plugs to 96 lb-ft (130 Nm).
	2. Drain plug loose and/or o-rings damaged or missing.	2. Replace o-rings as needed and tighten plug to 26 lb-ft (35 Nm).
	3. Hose fittings loose.	3. Tighten fittings.
	4. Oil leaking at valve bodies (possible valve body gaskets damaged or missing and/or mounting capscrews not tight).	4. Replace gaskets and/or tighten capscrews to 7 lb-ft (9,5 Nm).
	5. Housing capscrews loose.	5. Tighten capscrews to 34 lb-ft (46 Nm).
	6. Oil leaking at pump (possible pump-to-housing o-rings missing or damaged, and/or pump mounting capscrews not tight).	6. Replace o-rings and/or tighten capscrews to 85 lb-ft (115 Nm).
	7. Oil leaking at converter bell (possible converter leak and/or input shaft seal damage).	7. Replace converter and/or input shaft seal.
	8. Oil leaking at output shaft (output shaft seal damaged).	8. Replace output shaft seal.
	9. Oil escaping from breather at shut down.	9. Transmission may be under full. Ensure transmission is at operating temperature, 185° F (85° C) and fill to upper mark on transmission dip stick.
	10. Housing damaged.	10. Replace housing as needed.

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 140° F (60° C). 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 Engine Serial Number

The serial number is stamped on top of engine. Information contained in serial number is required in correspondence with engine manufacturer.

7.1.3 Specifications and Maintenance Information

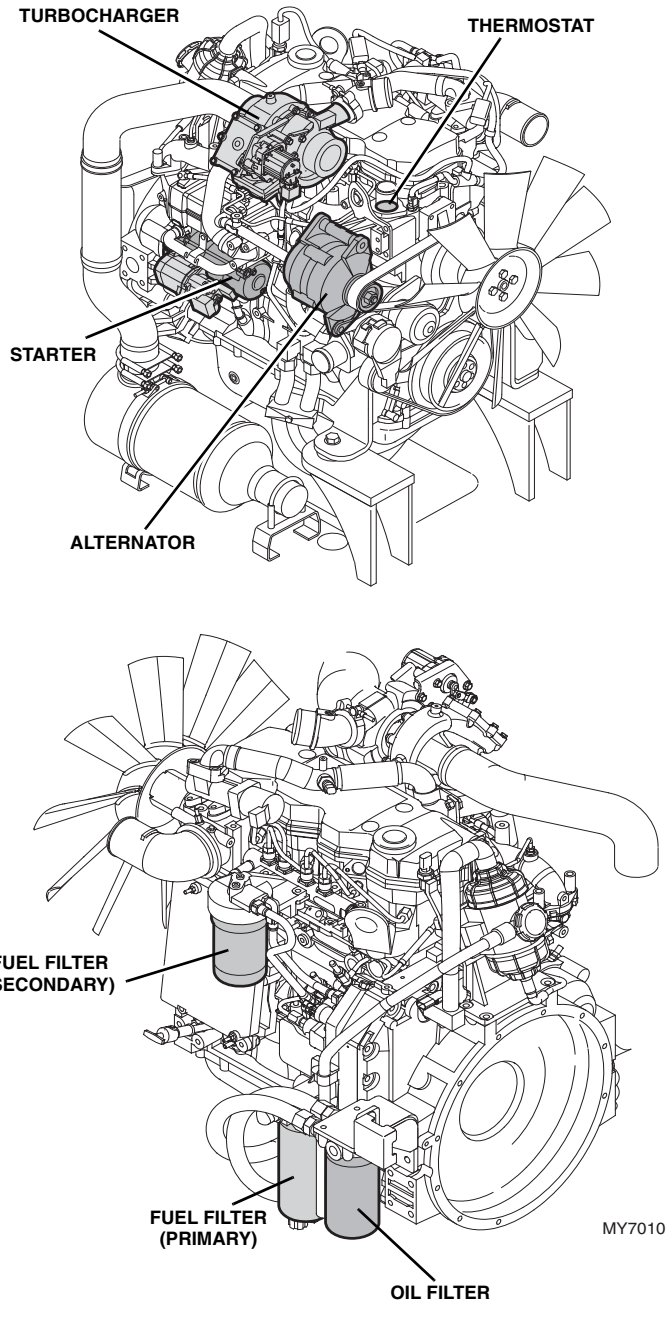
Note: *Refer to Section 9.12, “SAE Diagnostic Trouble and Fault Codes,” for error codes and troubleshooting.*

For engine, coolant and oil specifications, and maintenance information, refer to Section 2, “General Information and Specifications.”

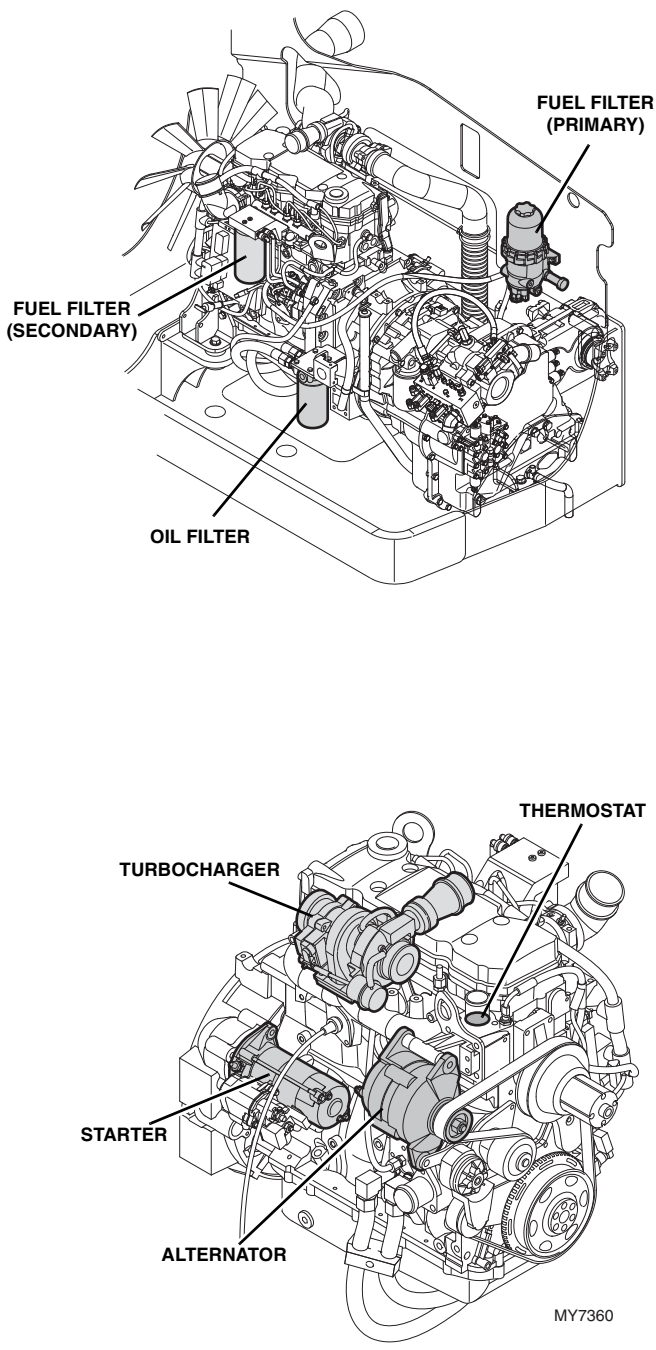
7.1.4 Component Terminology

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.

IF EQUIPPED FOR ULS



IF EQUIPPED FOR LS



7.2 ENGINE COOLING SYSTEM

7.2.1 Surge Tank Cap

A 17.4 psi (1,2 Bar) cap is used on the surge tank. An incorrect or malfunctioning cap can result in the loss of coolant and a hot-running engine.

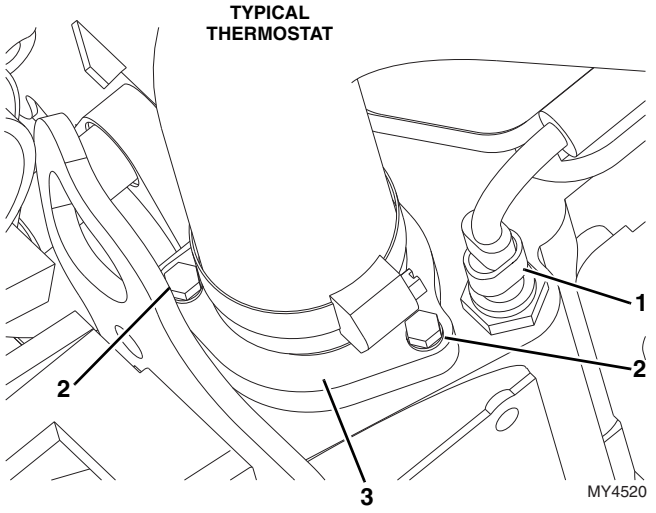
7.2.2 Thermostat Replacement

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 machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, 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 system fluids to cool.
4. Properly disconnect the batteries.
5. Slowly turn surge tank cap and allow any pressure to escape. Remove surge tank cap.
6. Place a funnel at the base of the radiator to channel drained coolant into container. Loosen draincock and slowly remove to allow the coolant to drain. Transfer coolant into a properly labeled container. Dispose of properly if coolant needs to be replaced. Replace radiator draincock.
7. Loosen and remove the top radiator hose from the thermostat housing.



8. Disconnect the engine water temperature sender (**1**) if connected to the thermostat housing.
9. Remove the two capscrews (**2**) securing the thermostat housing (**3**) to the engine.
10. 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 engine thermostat, thermostat gasket and thermostat housing. Secure with two capscrews and torque as required.
2. Connect the engine water temperature sender if connected to the thermostat housing.
3. Properly connect the batteries.
4. Open surge tank cap, and fill system complete to the “Full Cold” level with coolant. 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 engine cover.
7. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

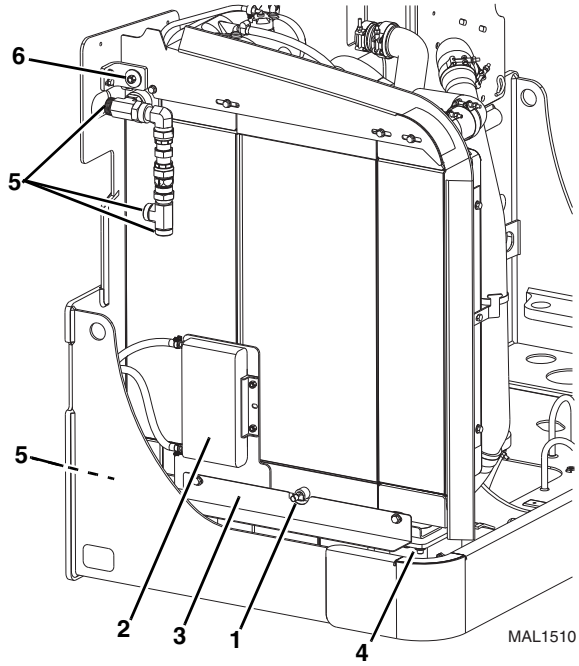
7.2.3 Radiator/Oil Cooler and Replacement

Before considering radiator or oil cooler replacement for other than obvious damage, conduct a cooling system pressure test check the coolant specific gravity, coolant level, fan belt tension and dash panel temperature indicator.

- If the engine runs hot, check the temperature of the upper radiator hose.
- If the hose is not hot, the thermostat may be stuck in the closed position.
- If the 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.

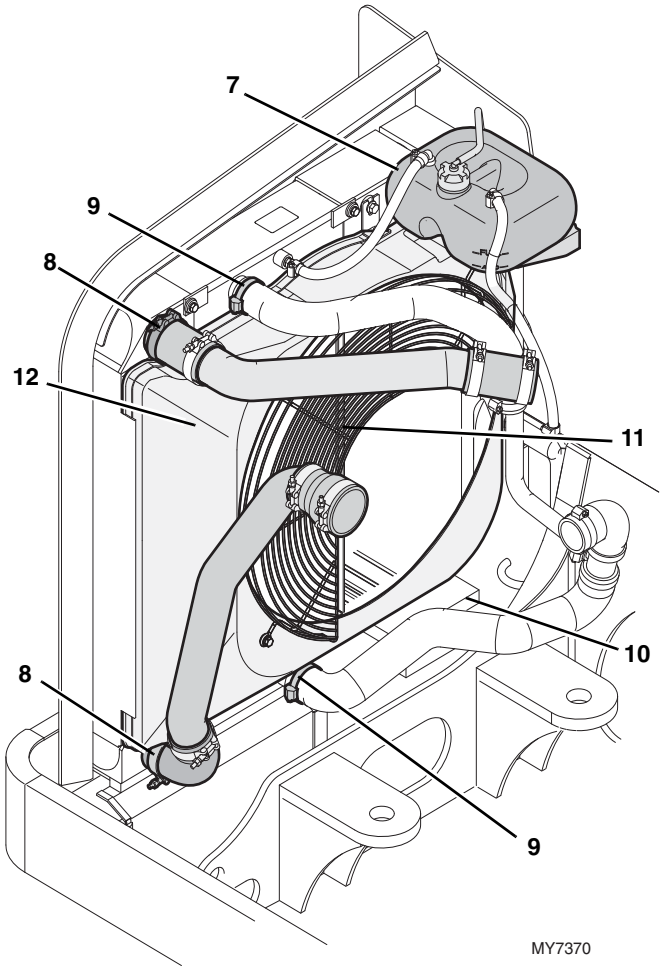
a. Radiator/Oil Cooler Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, 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 system fluids to cool.
4. Properly disconnect the batteries.
5. Slowly turn surge tank cap and allow any pressure to escape. Remove surge tank cap.
6. Place a suitable container beneath radiator drain.



7. Place a funnel at base of radiator to channel drained coolant into a container. Loosen drain cock (**1**) to allow coolant to drain. Transfer the coolant into a properly labeled container. Dispose of properly if coolant needs to be replaced. Tighten the radiator drain cock.
8. Label, remove and cap the fuel cooler (**2**) fuel lines.
9. Remove drip shield plate (**3**).
10. Loosen and remove the nuts and washers from two isolator mounts at the bottom of the radiator (**4**).
11. Place a suitable container beneath the hydraulic oil cooler fittings.Transfer any hydraulic oil into a properly labeled container. Dispose of properly.
12. Label, disconnect and cap four hydraulic cooler hoses (**5**). Cap all fittings and openings to prevent dirt and debris from entering hydraulic system.
13. Loosen and remove the nut and washer (**6**) from top of radiator.

IF EQUIPPED FOR ULS



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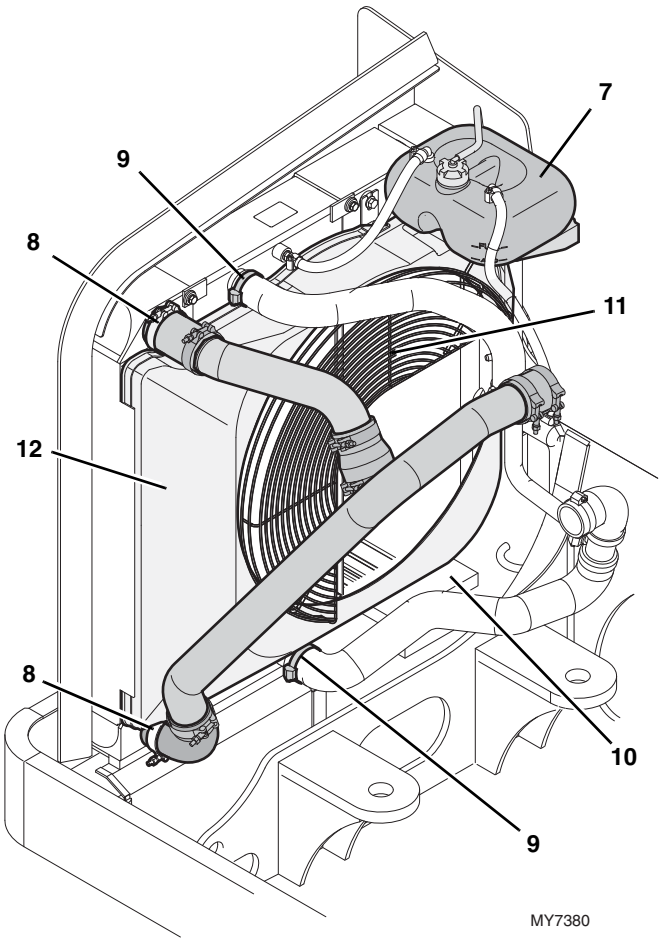
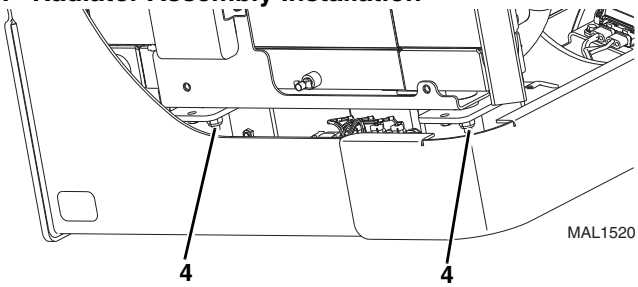


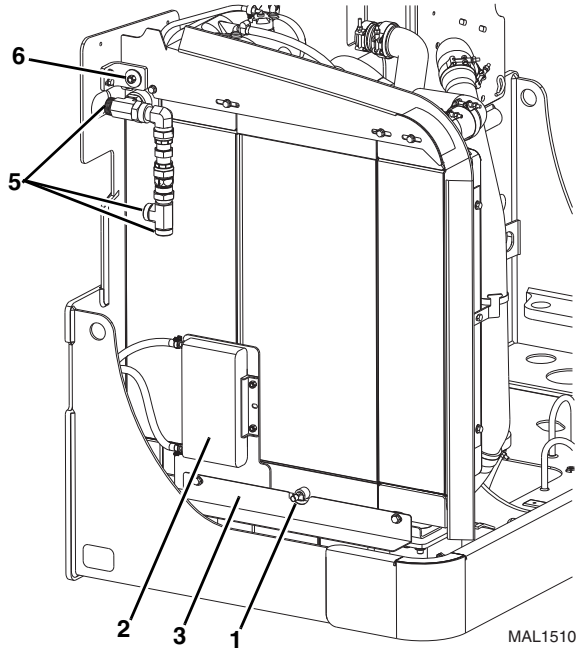
14. Label, disconnect and cap hose attached to surge tank (**7**). Remove coolant recovery tank and mounting plate.
15. Loosen clamps on both hoses attached to charge air cooler (**8**). Work hoses and tubes off charge air cooler. Position hoses and tubes out of way to allow radiator removal, or remove hoses and tubes from engine. Plug and/or cap openings on charge air cooler and tubes to prevent dirt and debris from entering system.
16. Loosen clamps on both hoses attached to radiator (**9**). Work hoses off radiator. Position hoses out of way to allow radiator removal, or remove hoses from engine. Inspect hoses, and replace if necessary. Plug and/or cap openings on radiator and hoses to prevent dirt and debris from entering system.
17. Place a suitable container beneath transmission cooler fittings.Transfer any transmission oil into a properly labeled container. Dispose of properly.
18. Label, disconnect and cap both transmission cooler hoses at radiator (**10**). Cap fittings and openings to prevent dirt and debris from entering transmission.
19. Remove fan guard (**11**).
20. Loosen and remove bolts from radiator fan shroud (**12**). Pull fan shroud back and over fan assembly.
21. Carefully lift and remove radiator assembly.

Note: *If more clearance is needed to remove radiator, engine fan may be removed for easier access.*

b. Radiator Assembly Installation



1. Place radiator assembly in engine compartment and secure using previously used hardware (**4**).
2. Install engine fan if previously removed.
3. Install radiator fan shroud (**12**) with previously removed hardware.
4. Install previously removed fan guard (**11**).
5. Uncap and connect both transmission cooler hoses at radiator (**10**).
6. Uncap and install both radiator hoses (**9**) to the radiator and tighten clamps.
7. Uncap and install both charge air cooler tubes (**8**) to radiator and tighten clamps.
8. Install surge tank (**7**) and mounting plate. Uncap and connect previously removed coolant recovery tank hoses.



9. Install previously removed nut and washer (**6**) to isolator mount at top of radiator.

Note: *Verify proper clearance between the fan and the fan shroud (**12**).*

10. Uncap and connect the previously labeled hydraulic oil cooler hoses to the hydraulic oil cooler fittings (**5**).
11. Uncap and connect the previously labeled fuel cooler hoses to the fuel cooler fittings (**2**).
12. Install previously removed drip shield plate (**3**).
13. Open surge tank cap and fill system complete to the “Full Cold” level with coolant. Replace and tighten surge tank cap. Refer to Section 2.5, “Fluid and Lubricant Capacities,” for proper capacities.
14. Properly connect batteries.
15. Run engine to operating temperature. Visually check for leaks with engine running. Check coolant level in surge tank and fill, or drain, as necessary.
16. Close and secure engine cover.
17. Remove Do Not Operate Tags from both ignition key switch and steering wheel.

7.3 ENGINE ELECTRICAL SYSTEM

The engine electrical system, including the starter, alternator and primary wiring, is described in Section 9.5, “Electrical System Schematics.”

7.4 FUEL SYSTEM

7.4.1 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.

Note: *Use only diesel fuel designed for diesel engines. Some heating fuels contain harmful chemicals that can seriously affect engine efficiency and performance.*

Note: *Due to the precise tolerances of diesel injection systems, keep the fuel clean, and free of dirt and water. Dirt and water in the fuel system can cause severe damage to both the injection pump and the injection nozzles. Use ASTM #2 diesel fuel with a minimum Cetane rating of 40. #2 diesel fuel gives the best economy and performance under most operating conditions. Fuels with Cetane numbers higher than 40 may be needed in high altitudes or extremely low ambient temperatures to help prevent misfiring and excessive smoking.*

Inform the owner/operator of the machine to use #2 diesel fuel, unless ambient temperatures are below 32° F (0° C). When temperatures are below 32° F (0° C), a blend of #1 diesel and #2 diesel fuels (known as “winterized” #2 diesel) may be used.

Note: *#1 diesel fuel may be used, however, fuel economy will be reduced.*

If equipped for ULS, use ultra low-sulfur content fuel with a cloud point (temperature at which wax crystals form in diesel fuel) at least 10° below lowest expected fuel temperature. Viscosity of fuel must be kept above 1.3 centistrokes to provide adequate fuel system lubrication.

If equipped for LS, use low-sulfur content fuel with a cloud point (temperature at which wax crystals form in diesel fuel) at least 10° below lowest expected fuel temperature. Viscosity of fuel must be kept above 1.3 centistrokes to provide adequate fuel system lubrication.

7.4.2 Fuel Tank

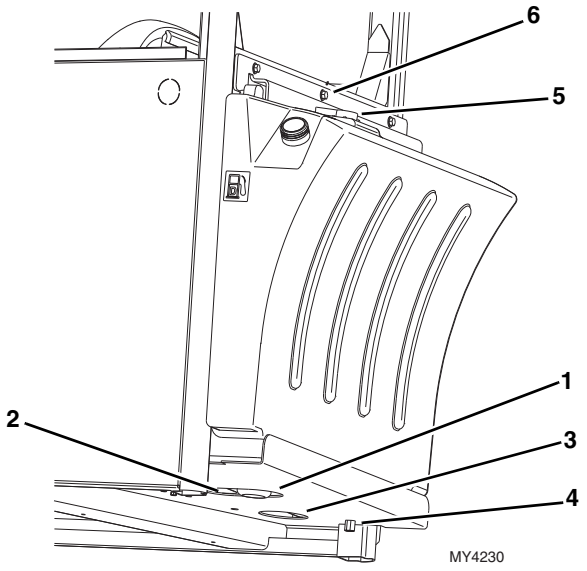
Note: *The fuel tank is a one piece unit. It is located on the rear of the cab. If it is determined that the fuel tank must be removed, the fuel must be drained before tank removal. Always dispose of fuel properly.*

a. Fuel Tank Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, 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 system fluids to cool.
4. Properly disconnect the batteries.

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 work area.*



5. Remove the fuel tank drain plug (**1**), and drain fuel into an approved and suitable container. Dispose of fuel properly.
6. Label, disconnect and cap the supply fuel line (**2**) from the bottom of the fuel tank.
7. Label, disconnect and cap the return fuel line (**3**) from the bottom of the fuel tank.
8. Disconnect the fuel gauge harness (**4**).
9. Remove screws securing fuel sender (**5**) to the tank. Remove fuel sender from tank.
10. Remove bolts on the fuel tank hold down bar (**6**).
11. Lift the empty fuel tank from the rear of the cab.

b. Disassembly

The fuel tank is a one-piece unit and cannot be disassembled. The fuel level indicator can be removed and reused on the new replacement tank. Dispose of the 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.

Note: *If a leak is suspected in the fuel tank, contact **JLG** Service Department.*

To clean the fuel tank:

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Remove the fuel or oil tank drain plug, and safely drain any fuel into a suitable 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 the 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 the fuel tank with water until it overflows. Completely flush the tank with water. Empty the fuel tank, and allow it to dry completely.

d. Assembly

The fuel level indicator can be removed and reused on the new replacement tank. Dispose of the old tank according to local regulations concerning hazardous materials disposal regulations.

e. Inspection

Note: *If a leak is suspected in the fuel tank, contact a* ***JLG*** *Service Department.*

1. Inspect the fuel tank thoroughly for any cracks, slices, leaks or other damage.
2. With the fuel tank removed from the machine, plug all openings except one elbow fitting. Install the elbow fitting, and apply approximately 1-1.5 psi (7-10 kPa) 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. Fuel Tank Installation

1. Set fuel tank in its original orientation at rear of cab.
2. Install the fuel tank hold down bar.
3. Install the fuel sender with new gasket into the fuel tank and secure with screws. **DO NOT** overtighten.
4. Connect the previously labeled fuel hoses to their appropriate locations. Secure with clamps.
5. Connect the fuel gauge harness.
6. Fill the fuel tank according to specifications.Refer to Section Note:, “Friction Modifier may be added to front axle differentials, see Section 2.5.3, “Capacities.”.”
7. Check fuel tank for leaks.
8. Properly connect the batteries.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

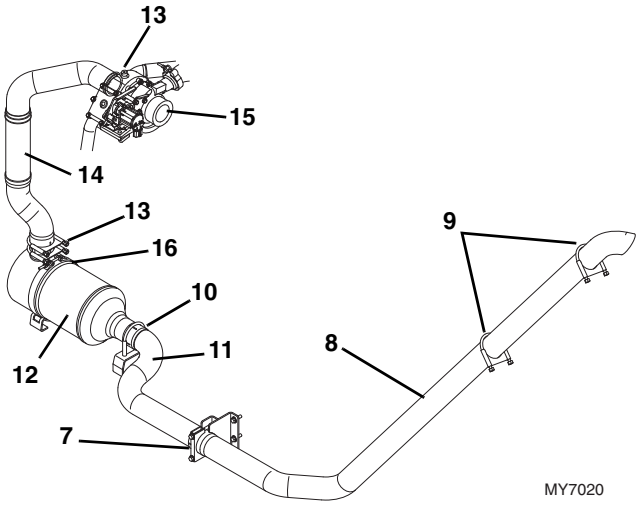
7.4.3 After Fuel System Service

1. Drain and flush the fuel tank if it was contaminated.
2. Vent air from the fuel system in accordance with the instructions found in the appropriate Operation & Safety Manual.
3. Fill the fuel tank with fresh, clean diesel fuel as required.

7.5 ENGINE EXHAUST SYSTEM

7.5.1 Exhaust System Removal—ULS

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, 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 system fluids and exhaust system to cool.
4. Properly disconnect the batteries.



5. Loosen and remove the clamp (**7**) securing exhaust tail pipe (**8**) to frame at bottom rear corner of the engine pod.
6. Loosen and remove clamps (**9**) securing exhaust tail pipe (**8**). Remove exhaust tail pipe
7. Loosen and remove clamp (**10**) securing engine pod exhaust pipe (**11**) to muffler (**12**). Remove engine pod exhaust pipe.
8. Loosen and remove clamps (**13**) securing exhaust flex pipe (**14**) to muffler and turbo charger (**15**). Remove exhaust flex pipe.
9. Loosen and open clamp strap(**16**) securing muffler to bottom of engine pod. Remove the muffler.

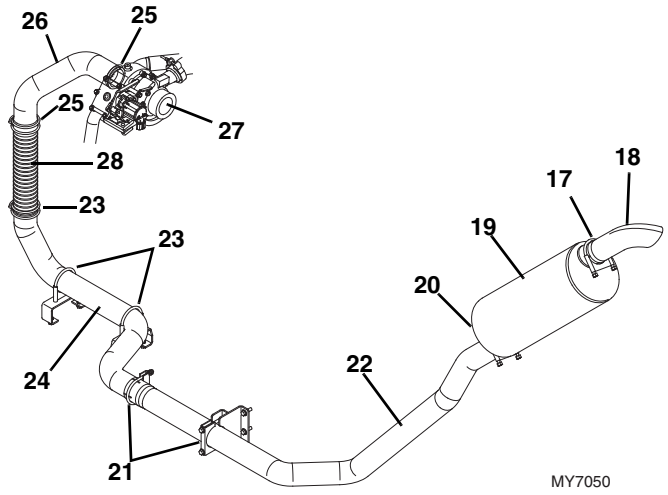
7.5.2 Exhaust System Installation—ULS

Note: *Keep all clamps loosened until entire exhaust system is in place.*

1. Install the flex pipe (**14**) to the turbo charger (**15**).
2. Install clamps (**13**) securing flex pipe.
3. Install the engine pod exhaust pipe (**11**) and secure with clamp (**10**).
4. Install exhaust tail pipe (**8**) with clamps (**9**) and clamp (**7**) to engine pod.
5. Adjust the muffler, exhaust and tail pipes for proper clearance then tighten all clamps.
6. Properly connect the batteries.
7. Start engine and check for exhaust leaks at all exhaust connections. Adjust as needed.
8. Close and secure the engine cover.
9. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.
10.

7.5.3 Exhaust System Removal—LS

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, 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 system fluids and exhaust system to cool.
4. Properly disconnect the batteries.



1. Loosen and remove clamp (**17**) securing tail pipe (**18**) to muffler (**19**). Remove tail pipe.
2. Loosen and remove clamp (**20**) securing muffler (**19**). Remove muffler.
3. Loosen and remove clamps (**21**) securing exhaust pipe (**22**). Remove exhaust tail pipe.
4. Loosen and remove clamps (**23**) securing exhaust pipe (**24**). Remove exhaust pipe.
5. Loosen and remove clamps (**25**) securing exhaust outlet pipe (**26**) to turbo charger (**27**). Remove exhaust outlet pipe and flex pipe (**28**).

7.5.4 Exhaust System Installation—LS

Note: *Keep all clamps loosened until entire exhaust system is in place.*

1. Install exhaust outlet pipe (**26**) to turbo charger (**27**) and secure with clamp (**25**).
2. Install flex (**28**) with and secure with clamp (**25**).
3. Install exhaust pipe (**24**) and secure with clamps (**23**).
4. Install exhaust pipe (**22**) and secure with clamps (**21**).
5. Install muffler (**19**) and secure with clamp (**20**).
6. Install tail pipe (**18**) and secure with clamp (**17**).
7. Adjust the muffler, exhaust and tail pipes for proper clearance then tighten all clamps.
8. Properly connect the batteries.
9. Start engine and check for exhaust leaks at all exhaust connections. Adjust as needed.
10. Close and secure the engine cover.
11. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

7.6 AIR CLEANER ASSEMBLY

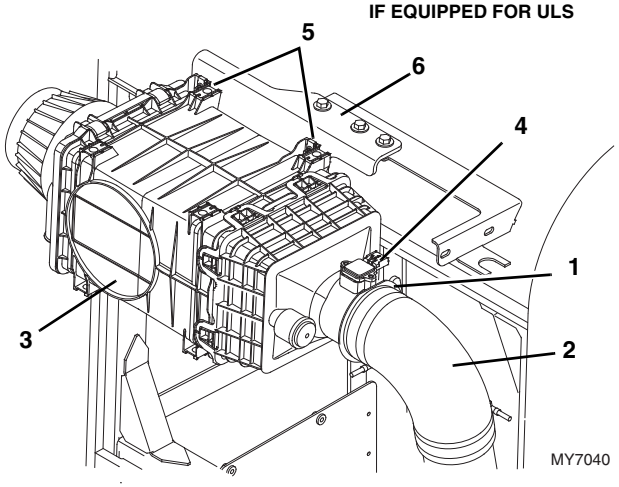
WARNING

NEVER run the engine with only the inner safety element installed.

Note: *Refer to the appropriate Operation & Safety Manual for your machine for the correct element change procedure.*

7.6.1 Air Cleaner Assembly Removal—ULS

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, 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 system fluids to cool.
4. Properly disconnect batteries.



5. Loosen clamp (**1**) securing air intake elbow (**2**) to the air cleaner assembly (**3**). Pull air intake elbow off air the cleaner.
6. Disconnect sensor (**4**).
7. Remove the screws securing mounting bracket (**6**) to the cab.
8. Remove capscrews and nuts (**5**) securing air cleaner assembly (**3**) to mounting bracket (**6**). Remove air cleaner assembly.

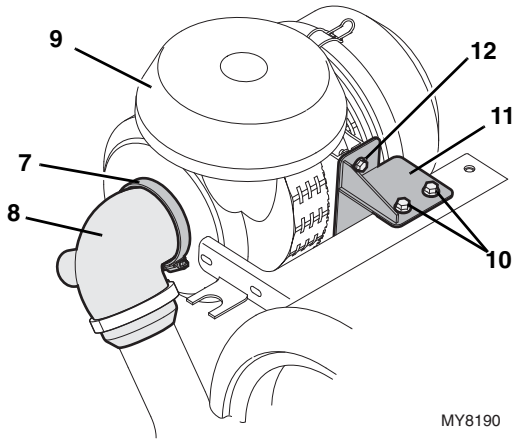
7.6.2 Air Cleaner Assembly Installation —ULS

Note: *Apply Loctite® 242™ to the capscrew threads before installation.*

1. Install the air cleaner assembly (**3**) to mounting bracket (**6**) with previously removed hardware (**5**).
2. Install mounting bracket onto cab with previously removed hardware.
3. Place loosened clamp (**1**) over air intake elbow (**2**) and install elbow on air cleaner assembly.
4. Adjust and tighten the clamp.
5. Connect sensor (**4**).
6. Properly connect the batteries.
7. Close and secure the engine cover.
8. Remove Do Not Operate Tags from both ignition key switch and steering wheel.

7.6.3 Air Cleaner Assembly Removal—LS

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL position, 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 system fluids to cool.
4. Properly disconnect battery.



1. Remove clamp (**7**) securing air intake elbow (**8**) to air cleaner assembly (**9**).
2. Remove two capscrews (**10**) securing mounting bracket (**11**) to cab.
3. Remove air cleaner assembly.
4. Remove capscrews (**12**) securing mounting bracket to air cleaner assembly. Remove mounting bracket.

7.6.4 Air Cleaner Assembly Installation—LS

Note: *Apply Loctite® 242™ to the capscrew threads before installation.*

1. Install the air cleaner assembly (**10**) to mounting bracket (**11**) and secure with previously removed hardware (**12**).
2. Install mounting bracket onto cab with previously removed hardware (**10**).Secure the air intake elbow (**8**) to air cleaner assembly (**9**) with clamp (**7**).
3. Adjust and tighten the clamp.
4. Properly connect the battery.
5. Close and secure the engine cover.
6. Remove Do Not Operate Tags from both ignition key switch and steering wheel.

7.7 ENGINE REPLACEMENT

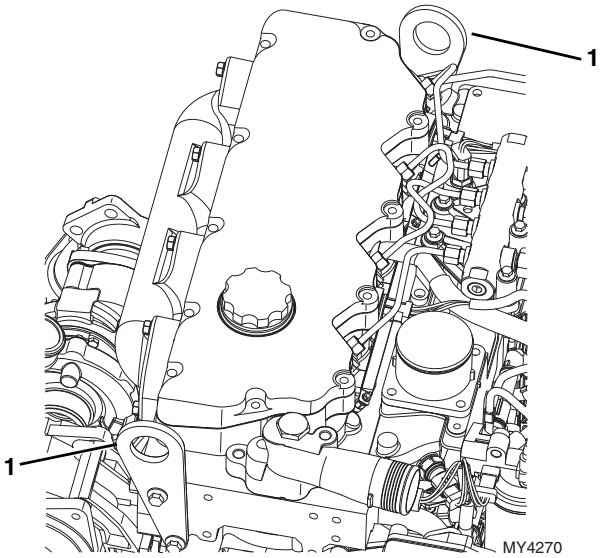
7.7.1 Engine Removal

Note: *The radiator and oil cooler must be removed from the machine before engine removal. Refer to Section 7.2, "Engine Cooling System." Several additional components must be removed before engine 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 control lever in (N) NEUTRAL position, 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 system fluids to cool.
4. Properly disconnect and remove batteries. Remove engine cover. Mark position of cover to help with cover adjustment when being reinstalled.
5. Remove the oil pan cover underneath the engine compartment.
6. Drain and remove the radiator assembly. Refer to Section 7.2.3, "Radiator/Oil Cooler and Replacement."
7. Remove the heater hoses attached to the engine (if equipped).

Note: *Engine harness is routed and attached to engine using hold-down clamps and plastic wire ties at various places on engine. Before removing engine, ensure that harness has been completely separated (disconnected) from engine. Move harness clear of engine, and with help of an observer, ensure that engine clears harness during removal.*

8. Label and disconnect all electrical wire connections on the engine.
9. Label and disconnect all electrical wire connections on the Power Distribution bracket.
10. Remove the Power Distribution bracket.
11. Disconnect and cap fuel inlet line at fuel filter head.
12. Disconnect and cap the fuel return line from the fuel filter head.
13. Remove exhaust pipe from the exhaust manifold. Refer to Section 7.5.1, "Exhaust System Removal—ULS."
14. Loosen clamps on sleeve reducer at engine and on air suction pipe.
15. Remove air cleaner tube from turbo charger.
16. Remove access plug from bottom of engine bell housing. This will allow access to remove bolts holding the torque convertor diaphragm to the engine flywheel.
17. Turn engine over slowly by hand and align each of four torque convertor diaphragm bolts to be accessed. Remove them one at a time.



18. Secure the engine with a lifting strap or chain from the appropriate lifting points (**1**). Use a suitable hoist or overhead crane.
19. Place a support or jack under transmission to hold transmission in place while engine is being removed.
20. Remove bolts and washer securing engine mounts.
21. Remove bolts holding transmission to engine. Slightly lift and pull engine out of machine. Have an assistant ensure that engine clears all frame components during removal.
22. Place engine on a flat, level surface.

7.7.2 Engine Installation

1. Secure engine with a lifting strap or chain from the appropriate lifting points (**1**). Use a suitable hoist or overhead crane.

Note: *Apply Loctite® 242™ to engine mount bracket capscrew threads before installation.*

2. Install two guide studs in bell housing holes.
3. Lift engine and slowly push and lower into engine bay. Have an assistant ensure that engine clears frame, hose and harness components during engine installation. Position engine brackets over the front frame mounts.
4. Push engine towards the transmission aligning the guide studs and the torque convertor shaft with the corresponding holes.
5. Push the engine against the transmission and install eight of the ten bolts and washers. Remove both guide studs and replace with the remaining two bolts and washers. Torque bolts to 53-58 lb-ft (72-79 Nm).
6. Remove support from under transmission and lower engine remainder of way onto frame. Align motor mount holes and install bolts. Apply Loctite® 242™ to motor mount bolts and torque to 125-140 lb-ft (169-190 Nm).
7. Turn engine over slowly by hand and align each of four torque convertor diaphragm bolts through access plug in bell housing. Install them one at a time. DO NOT fully tighten until all of capscrews and locknuts are in place. Torque to 26-39 lb-ft (35-59 Nm). Replace access plug.
8. Install the exhaust pipe. Refer to Section 7.5.4, “Exhaust System Installation—LS.”
9. Secure air cleaner tube to turbo charger.
10. Connect fuel inlet line to fuel filter head.
11. Connect fuel return line to fuel filter head.
12. Install Power Distribution bracket.
13. Connect all previously labeled electrical wire connections on Power Distribution bracket.
14. Connect all previously labeled electrical wire connections on engine.
15. Install both heater hoses to engine and tighten clamps (if equipped).
16. Install complete radiator assembly. Refer to Section 7.2.3, “Radiator/Oil Cooler and Replacement.”
17. Install the engine cover and adjust.
18. Install and properly connect batteries.
19. Check that all hydraulic system, electrical system, cooling system, fuel system and exhaust system connections are correct and connected tightly.
20. From within cab, lightly depress throttle pedal to full-throttle position. As needed, adjust limit-stop screw until it touches pedal bracket.

Note: *Have an assistant stand by with a Class B fire extinguisher.*

21. Start the engine and run to normal operating temperature then shut off engine. While engine is cooling, check for leaks.
22. Allow engine to cool. Check radiator coolant level and add coolant if required. Replace pressure cap.
23. Check for leaks from engine, main hydraulic pump and lines, transmission, hydraulic reservoir and fuel tank. Check the levels of all fluids and lubricants. Fill as required.

Note: *During the full throttle check:*

- **DO NOT** operate any hydraulic function.
- **DO NOT** steer or apply any pressure to the steering wheel.
- Keep the transmission in (N) NEUTRAL.

24. Obtain and connect an appropriate engine analyzer or tachometer. Check engine rpm at full throttle.
25. Purge hydraulic system of air by operating all boom functions through their entire range of motion several times. Check hydraulic oil level.
26. Check for proper operation of all components.
27. Turn the engine OFF.
28. Install oil pan cover underneath engine compartment.
29. Close and secure the engine cover.
30. Remove Do Not Operate Tags from both ignition key switch and steering wheel.

7.8 TROUBLESHOOTING

Trouble	Possible Causes (see key, below)
Low Cranking Power	1, 2, 3, 4
Will Not Start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 31, 32, 33
Difficult Starting	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33, 61, 63
Lack of Power	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33, 61, 63
Misfiring	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26, 28, 29, 30, 32
Excessive Fuel Consumption	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33, 63
Black Exhaust	11, 13, 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 31, 32, 33, 61, 63
Blue/White Exhaust	4, 16, 18, 19, 20, 25, 27, 31, 33, 34, 35, 45, 56, 62
Low Oil Pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 58
Knocking	9, 14, 16, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59
Erratic Running	7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 23, 26, 28, 29, 30, 33, 35, 45, 59
Vibration	13, 14, 20, 23, 25, 26, 29, 30, 33, 45, 47, 48, 49
High Oil Pressure	4, 38, 41
Overheating	11, 13, 14, 16, 18, 19, 24, 25, 45, 50, 51, 52, 53, 54, 57
Excessive Crankcase Pressure	25, 31, 33, 34, 45, 55, 60
Poor Compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59
Starts and Stops	10, 11, 12

Key to Possible Causes

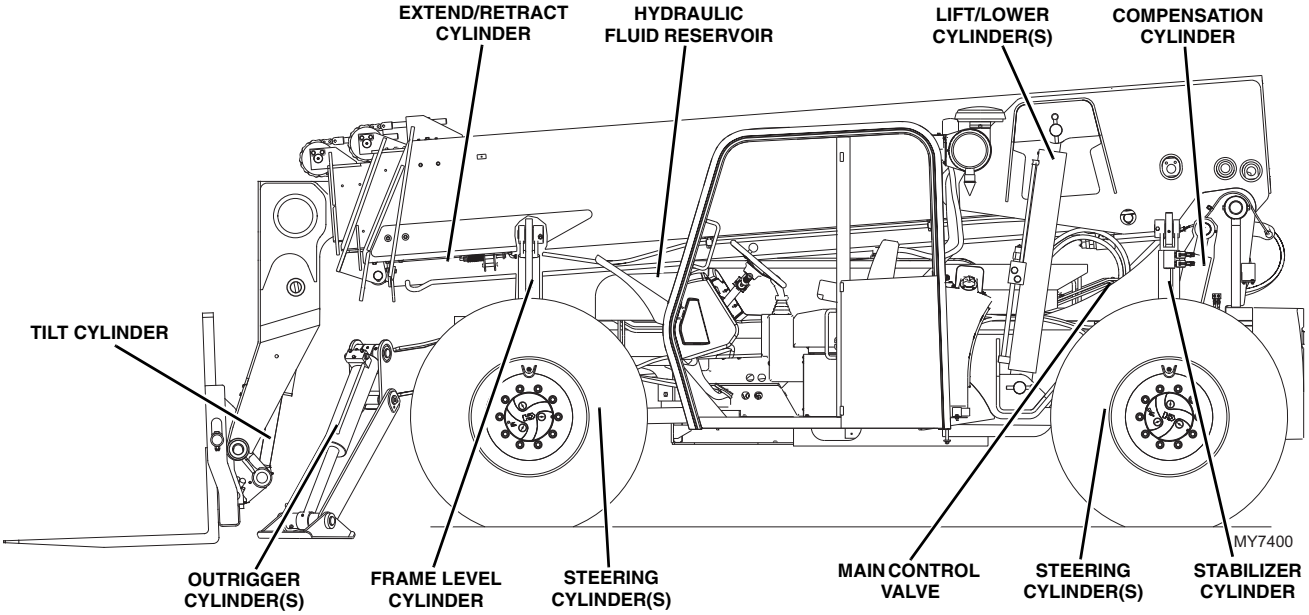
1. Battery charge low
2. Bad electrical connection
3. Faulty starter motor
4. Incorrect grade of lubricating oil
5. Low cranking speed
6. Fuel tank empty
7. Faulty stop control operation
8. Fuel inlet restricted
9. Faulty fuel lift pump
10. Clogged fuel filter
11. Restricted air cleaner
12. Air in fuel system
13. Faulty fuel injection pump
14. Faulty fuel injectors or incorrect type
15. Incorrect use of cold start equipment
16. Faulty cold start equipment
17. Broken fuel injection pump drive
18. Incorrect fuel pump timing
19. Incorrect valve timing
20. Poor compression
21. Blocked fuel tank vent
22. Incorrect grade of fuel
23. Sticking throttle or restricted movement
24. Exhaust pipe restriction
25. Leaking cylinder head gasket
26. Overheating
27. Cold running
28. Incorrect tappet adjustment
29. Sticking valves
30. Incorrect high pressure pipes
31. Worn cylinder bores
32. Pitted valves and seats
33. Broken, worn or sticking piston ring(s)
34. Worn valve stems and guides
35. Restricted air cleaner
36. Worn or damaged bearings
37. Insufficient oil in sump
38. Inaccurate gauge
39. Oil pump worn
40. Pressure relief valve sticking open
41. Pressure relief valve sticking closed
42. Broken relief valve spring
43. Faulty suction pipe
44. Restricted oil filter
45. Piston seizure/pick up
46. Incorrect piston height
47. Damaged fan
48. Faulty engine mounting
49. Incorrectly aligned flywheel housing or incorrectly aligned flywheel
50. Faulty thermostat
51. Restriction in water jacket
52. Loose fan belt
53. Restricted radiator
54. Faulty water pump
55. Restricted breather pipe
56. Damaged valve stem oil deflectors (if fitted)
57. Coolant level too low
58. Blocked sump strainer
59. Broken valve spring
60. Exhauster or vacuum pipe leak
61. Turbo impeller damaged or dirty
62. Turbo lubricating oil seal leak
63. Induction system leaks

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 operator/mechanic be familiar with name and location of hydraulic components of the machine. The following illustration identifies components that are referred to throughout this section.



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 operation of various hydraulic functions. A heated petroleum-based hydraulic fluid presents a fire hazard, especially when an ignition source is present. Hydraulic fluid has a flash point that ranges from 300–600° F (150–318° C) and an auto-ignition temperature of 500–750° F (262–402° C).

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.

Operate the hydraulic controls after the engine has stopped to relieve trapped pressure.

Note: *Residual pressure may remain in hydraulic cylinders, hoses, valve bodies, components, etc. If hydraulic lines going to or coming from a component are taut,* **slowly** *and* **cautiously** *relieve (“bleed off”) the pressure.*

Whenever you disconnect a hydraulic line, coupler, fitting or other component, ***slowly*** and ***cautiously*** loosen part involved. A hissing sound or slow seepage of hydraulic fluid may occur in most cases. After hissing sound has ceased, continue removing the part. Any escaping oil should be directed into an appropriate container. Cap or otherwise block off part to prevent further fluid seepage.

Hydraulic system maintenance will, at times, require that engine be operated. Always follow safety precautions.

A major cause of hydraulic component failure is contamination. Keeping hydraulic fluid as clean as possible will help avoid downtime and repairs. Sand, grit and other contaminants can damage finely machined surfaces within hydraulic components. If operating in an exceptionally dirty environment, change filters and inspect fluid more often. When servicing 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.

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 9.5, “Electrical System Schematics,” in this manual.

8.3 HYDRAULIC PRESSURE DIAGNOSIS

JLG Parts Department has a kit available to use for hydraulic system maintenance and troubleshooting: the JLG Pressure Test Kit. The kit is contained in a durable polyethylene carrying case for demanding field service conditions.

Hydraulic Pressure Test Kit

The hydraulic pressure test kit is used to pressure test the various hydraulic components in the hydraulic system. The kit includes:

- Gauges for testing high and low pressure circuits
- Fittings, couplers and hoses

Contact JLG Parts Department Toll Free at 1-877-554-5438 or 717-485-6472 for ordering information.

Part Number	Description	Approximate Weight	Price and Availability
70000652	Dial Hydraulic Pressure Test Kit	10 lbs.	Consult Factory
70000101	Digital Hydraulic Pressure Test Kit	7 lbs.	Consult Factory
70027911	Digital Hydraulic Pressure Test Kit	7 lbs.	Consult Factory

8.3.1 Pressure Checks and Adjustments

When diagnosing trouble in the hydraulic system, use the hydraulic testing information in Section 8.4.1, “Hydraulic Pressures.”

In general, follow the steps below whenever conducting pressure checks and performing adjustments:

1. Park machine on a firm, level surface. Engage park brake, place transmission control lever in (N) NEUTRAL, level boom and turn engine OFF.
2. Locate proper test port. Install a pressure gauge capable of measuring at least 10% more pressure than the circuit being checked operates under.
3. Start engine. Operate machine functions several times to allow hydraulic oil to reach operating temperature. The hydraulic oil temperature should be a minimum of 130°F (54° C). If a temperature gauge or thermometer is unavailable, hydraulic oil reservoir should be warm to touch.
4. Refer to Section 8.4.1, “Hydraulic Pressures.” for testing procedures.
5. Fully depress accelerator pedal if required. Place and hold joystick in position needed to operate particular machine function being checked. Continue holding joystick in position until pressure readings are taken.
6. Check pressure gauge reading. It should read as specified in the Pressure Readings column of the charts found in Section 8.4.3, “Pressure Specifications,” 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 relief valve by turning adjustment screw Turning clockwise will increase pressure; turning screw counterclockwise will decrease pressure.
8. Start engine and check pressure again. Turn engine OFF. If there is pressure reading in gauge, bleed it off then disconnect or remove the pressure gauge from the machine.

8.4 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 electrical components of the circuit are functioning properly whenever troubleshooting hydraulic circuit.

Always check following before beginning to troubleshoot a circuit that is not functioning correctly.

1. Check hydraulic oil reservoir level. Oil level should be to middle of sight glass with all cylinders retracted.
2. Check hoses, tubes, fittings and other hydraulic components for leaks, bends, kinks, interference, etc.
3. Check for air in hydraulic system. Erratic machine performance and/or spongy cylinder operation are signs of air in hydraulic system.

   If air in hydraulic system is suspected, you will hear air leakage when hydraulic fittings are loosened and see air bubbles in hydraulic fluid.

   Loose fittings, faulty o-rings or seals, trapped oil, leaks, system opened for service, etc., can cause air in system. Determine what is causing air to enter system and correct it. Bleed air from system.

8.4.1 Hydraulic Pressures

a. Checking Pressure

1. Start the machine and warm the hydraulic system to operating temperature.
2. Shut off machine and install a digital or a 5000 psi (345 bar) gauge to appropriate test port on the hydraulic manifold.
3. Start machine, run engine at high idle and bottom appropriate hydraulic function. Refer to Section 8.4.3, “Pressure Specifications,” for the correct pressure rating.

b. Adjusting Hydraulic Pressure

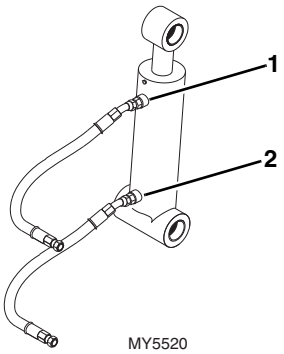
1. Shut the machine off. Remove the cap on the relief (if necessary).
2. Start machine and loosen the jam nut on the relief. Turn the relief clockwise to increase pressure or counter-clockwise to decrease pressure. Set to the correct pressure.

3. Tighten jam nut and recheck pressure at full throttle. If reading is within specification, shut machine off, install safety cap and remove gauge from test port.
4. If proper pressure cannot be set, use accompanying hydraulic schematic and/or electrical schematic to help troubleshoot and correct problem.

8.4.2 Tilt Circuit Port Relief Adjustment

The following procedure is specific to tilt circuit only and should be performed and verified if main and/or load sense circuits pressures are in question.

1. Remove any attachment from the quick coupler assembly. Refer to the Operation & Maintenance Manual for attachment removal information.
2. Raise boom for access to compensation cylinder.



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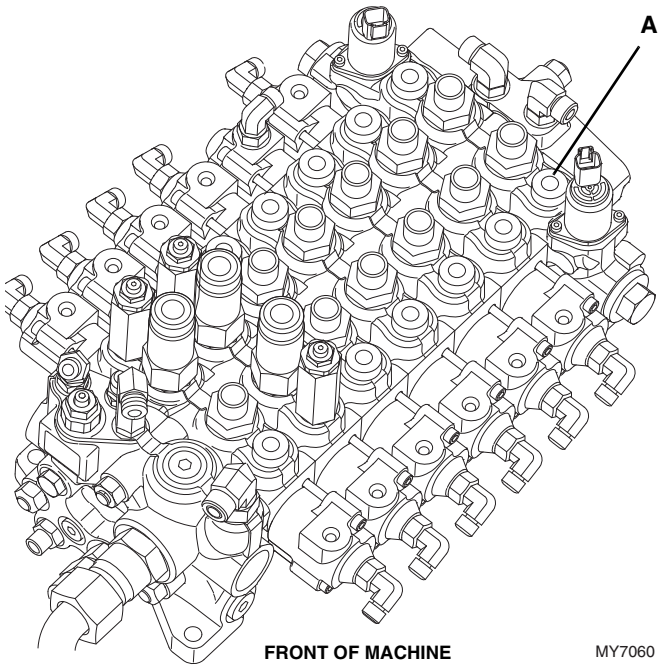
3. Slowly loosen and remove the retract (**1**) hose from the compensation cylinder.
4. Install a tee fitting to retract (**1**) port of compensation cylinder. Reconnect previously removed retract (**1**) hose to tee fitting.
5. Slowly loosen and remove extend (**2**) hose from compensation cylinder.
6. Install a tee fitting to extend (**2**) port of compensation cylinder. Reconnect previously removed extend (**2**) hose to tee fitting and cap open port.
7. Install a digital or a 5000 psi (345 bar) gauge to retract (**1**) port tee fitting on compensation cylinder.
8. Start machine and warm the hydraulic system to operating temperature.
9. Tilt forks down to allow tilt cylinder to fully retract.
10. Monitor gauge and slowly raise boom. The gauge should read 4100 psi (282 bar).
11. If pressure is correct, proceed to step 14.



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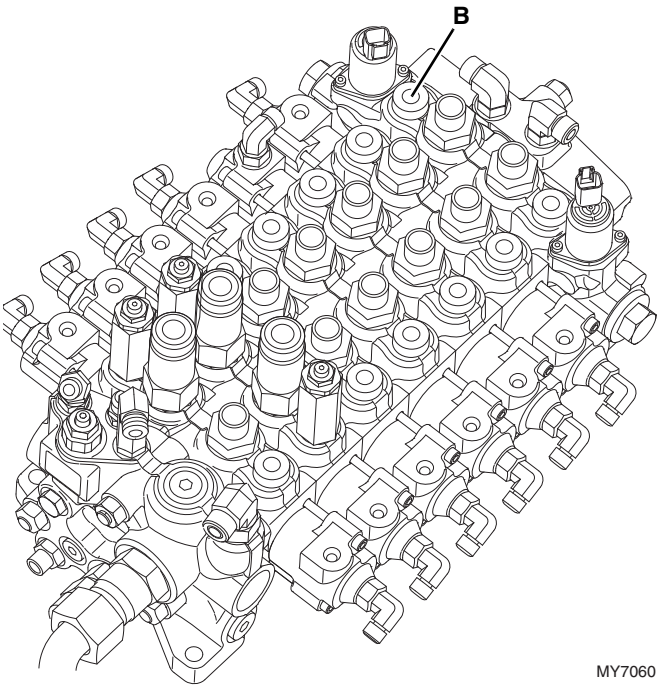
12. Relief on (**A**) port of main control valve is non-adjustable and must be replaced. Replace and repeat steps 9 and 10.
13. Verify pressure is correct.
14. Shut engine OFF.
15. Remove digital or 5000 psi (345 bar) gauge from retract (**1**) port fitting on compensation cylinder and cap open port.
16. Remove cap and install a digital or a 5000 psi (345 bar) gauge to extend (**2**) port tee fitting on the compensation cylinder.
17. Start machine and if needed, warm hydraulic system to operating temperature.
18. Tilt forks up to allow tilt cylinder to fully extend.
19. Monitor gauge and slowly lower boom. The gauge should read 4100 psi (282 bar).
20. If pressure is correct, proceed to step 23.



21. The relief on the (**B**) port of the main control valve is non-adjustable and must be replaced. Replace and repeat steps 17 and 18.
22. Verify pressure is correct.
23. Shut engine OFF.
24. Slowly remove the gauge, line and tee fitting from the compensation cylinder (**1** and **2**). Reinstall each hose and torque as required.
25. Install any previously removed attachment.

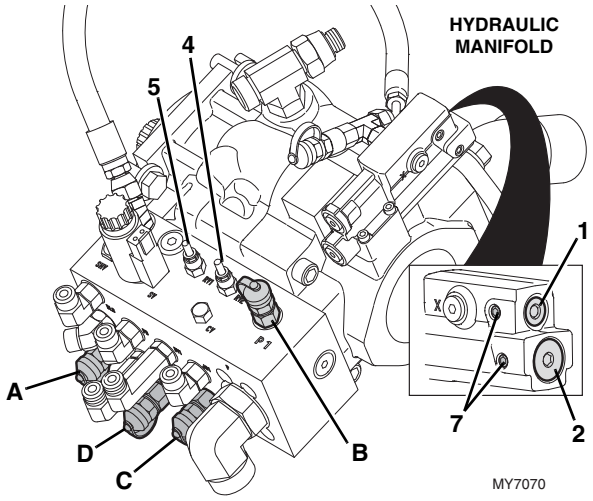
8.4.3 Pressure Specifications

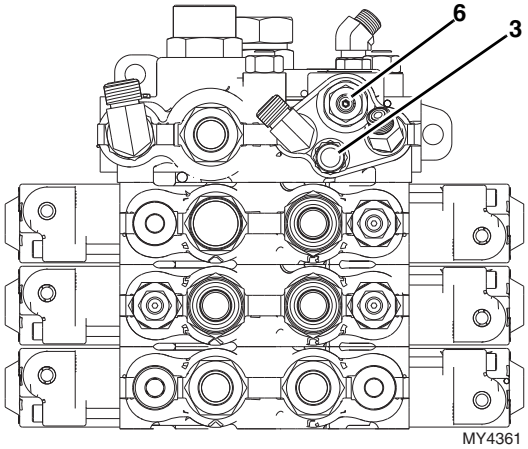
Note: *1. All pressures must be checked in numerical order.*

Note: *2. Connect gauge to P1 port, adjust Standby Pressure down to 300 psi (step 2). Adjust Main Compensator Pressure to 3800 psi (step 3). Connect additional gauge to GLS (**A**) port, stall lift down, adjust Load Sense relief to the setting noted below.*

	Hydraulic Circuit	Test Port	Function Used to Test	Adjustment Location	Pressure Range
1	Load Sense Relief	GLS (**A**)	Bottom Lift Down (See Note 2)	6	3250-3350 psi (224-231 Bar)
2	Standby	P1 (**B**)	High Idle - No Function	1	500-515 psi (34-35 Bar)
3	Main	P1 (**B**)	High Idle - Bottom Lift Down	2	3575-3675 psi (246-253 Bar)
4	Pilot	JS (**C**)	High Idle - Bottom Steering, Any Mode	4 (**RV2**)	500-550 psi (34-38 Bar)
5	Service Brake	BV (**D**)	High Idle - Bottom Steering, Any Mode	5 (**RV1**)	1050-1150 psi (72-79 Bar)
6	Priority Load Sense	GLS (**A**)	High Idle - Bottom Steering, Any Mode	3	2375-2475 psi (164-171 Bar)
7	Boom Extend	GLS (**A**)	High Idle - Bottom Boom Extend	No Adjustment	3250-3350 psi (224-231 Bar)
8	Boom Retract	GLS (**A**)	High Idle - Bottom Boom Retract	No Adjustment	3250-3350 psi (224-231 Bar)
9	Boom Lift	GLS (**A**)	High Idle - Bottom Lift Up	No Adjustment	3250-3350 psi (224-231 Bar)
10	Auxiliary Hydraulic	GLS (**A**)	High Idle - Bottom Auxiliary Function	No Adjustment	3100-3300 psi (214-227 Bar)

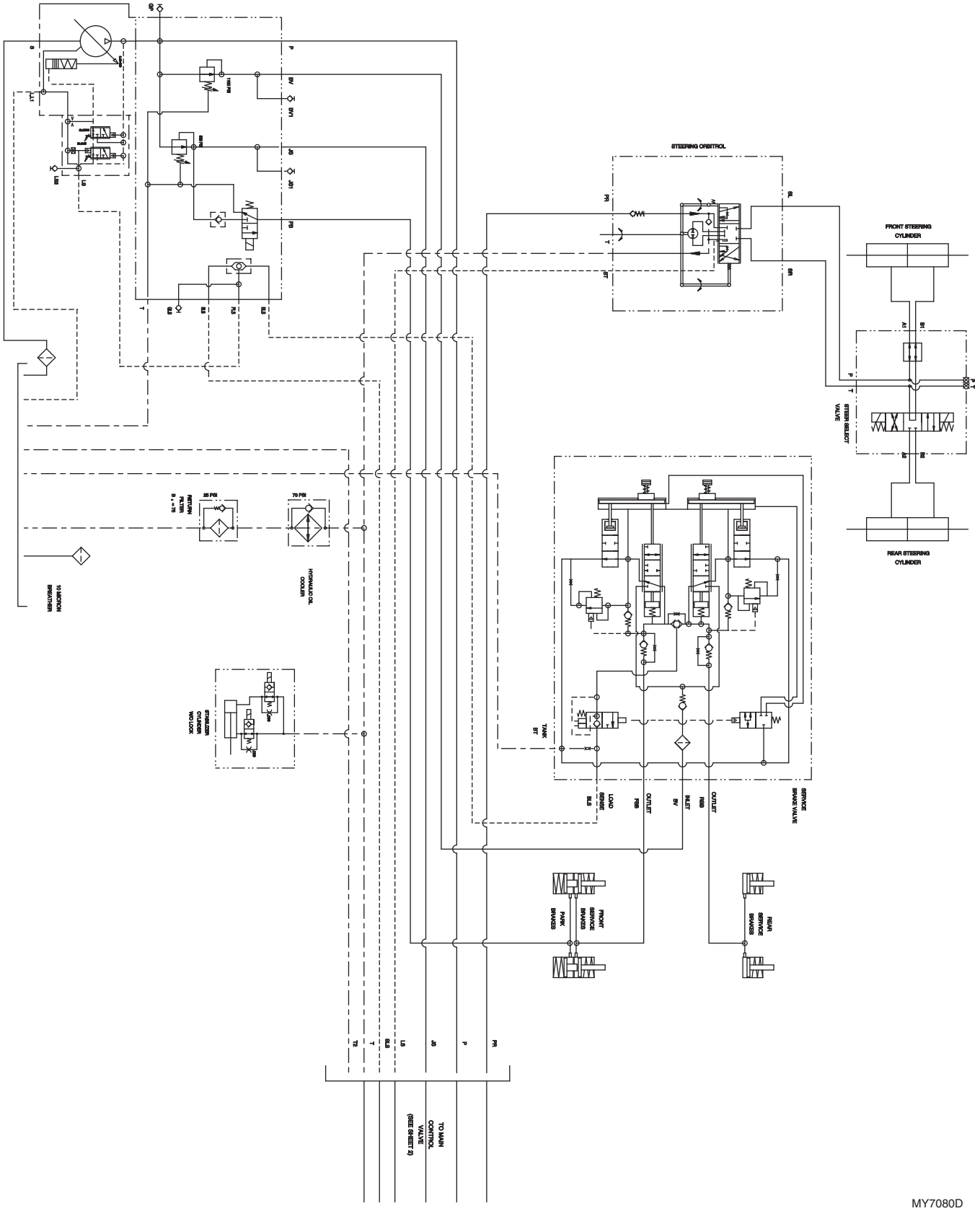
Note: *Set Screws (**7**) must be loosened before adjusting Standby (**1**) or Main (**2**) ports. Tighten Set Screws when adjustments are done.*





MAIN CONTROL VALVE

8.4.4 Hydraulic Schematic



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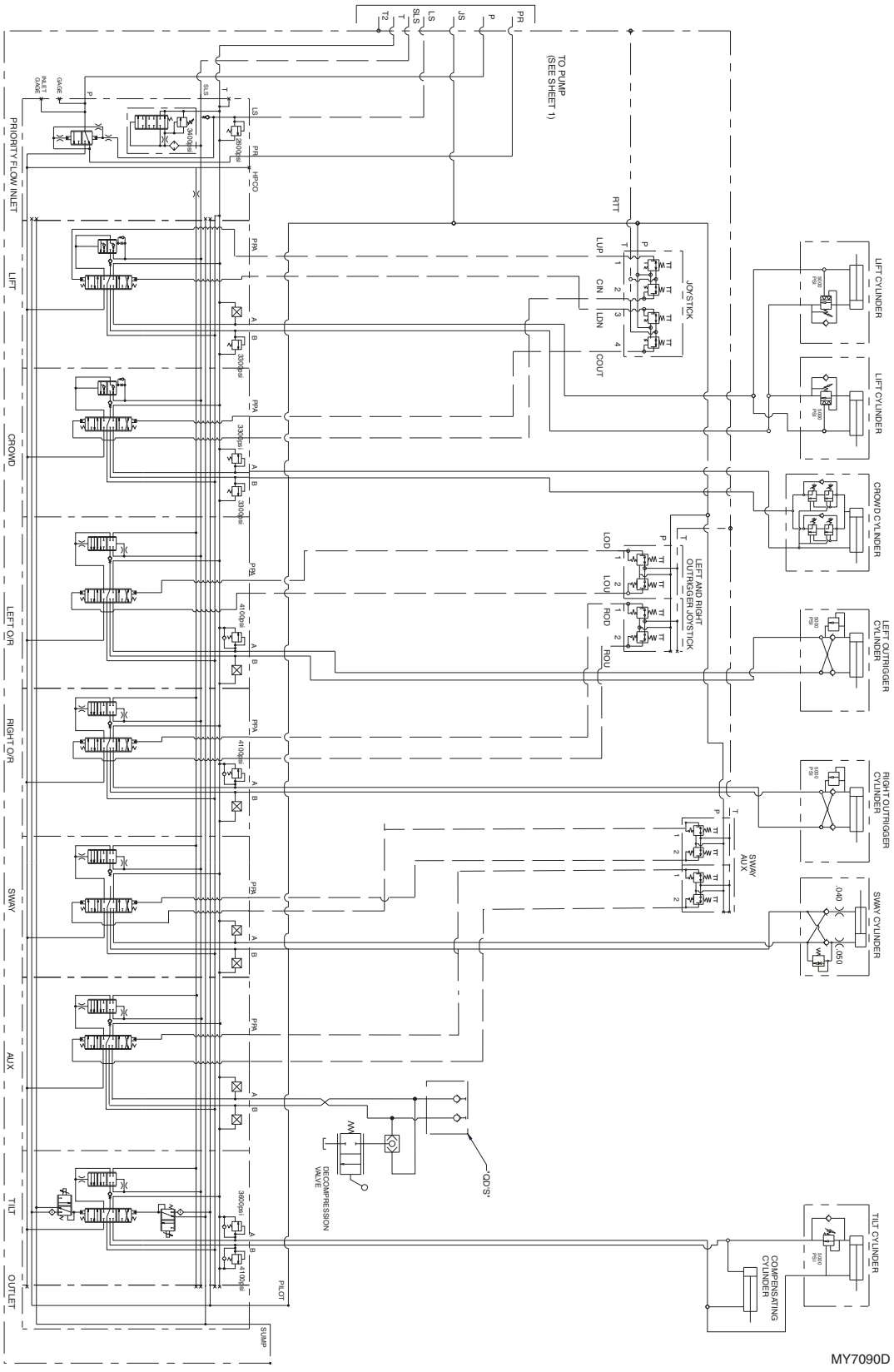
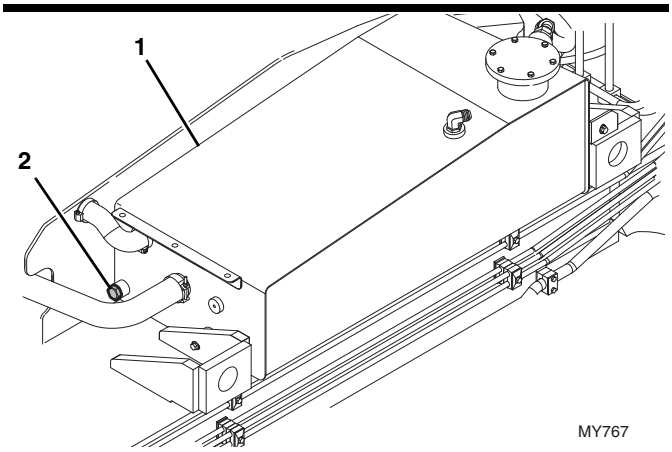
8.4.4 Hydraulic Schematic (Continued)



8.5 HYDRAULIC RESERVOIR



The hydraulic reservoir (**1**) is located on frame between engine compartment and cab.

8.5.1 Hydraulic Oil Reservoir Draining

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

Note: *If equipped with extreme cold weather components, the hydraulic oil heating element must be removed to drain the hydraulic tank.*

5. Remove drain plug (**2**) on hydraulic oil reservoir and drain hydraulic oil into a suitable container.

Note: *Proper precautions must be used to ensure any hydraulic oil being drained is contained and disposed.*

6. Transfer used hydraulic oil into a suitable covered container, and label as “Used Oil”. Dispose of used oil at an approved recycling facility. Close drain valve and remove drain hose.
7. Wipe up any hydraulic fluid spillage in, on, near and around machine and work area.

8.5.2 Hydraulic Oil Reservoir Filling

1. Be sure reservoir is clean and free of all debris.
2. Install a new hydraulic oil filter.
3. Fill the reservoir with hydraulic oil. Refer to Section 2.5, “Fluid and Lubricant Capacities.”
4. Properly connect the batteries.
5. Close and secure the engine cover.
6. Remove Do Not Operate Tags from both ignition key switch and steering wheel.

8.5.3 Hydraulic Oil Reservoir Removal/ Installation

Note: *If determined that hydraulic oil reservoir must be removed, hydraulic oil must be drained before reservoir is removed. Always dispose of hydraulic oil properly.*

a. Reservoir Removal

1. Park machine on a firm, level surface, level machine, fully retract the boom.
2. Raise and properly support boom to adequate height to allow for removal of reservoir tank.
3. Place transmission control lever in (N) NEUTRAL, engage park brake and shut engine OFF.
4. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
5. Open engine cover. Allow system fluids to cool.
6. Properly disconnect the batteries.
7. Drain the hydraulic oil reservoir. Refer to Section 8.5.1, “Hydraulic Oil Reservoir Draining.”
8. Label, disconnect and cap all hydraulic hoses attached to hydraulic oil reservoir.
9. Cap all fittings and openings to keep dirt and debris from entering the hydraulic system.
10. Remove the bolts securing the hydraulic oil reservoir to the frame.
11. Remove the hydraulic oil reservoir.

b. Disassembly

The hydraulic oil reservoir is a one-piece unit and cannot be disassembled. The hydraulic oil level sight-glass and hydraulic oil filler cap can be removed and reused on the new replacement reservoir. Dispose of the old reservoir according to local regulations concerning hazardous materials disposal.

c. Cleaning and Drying

If contaminated hydraulic oil or foreign material is in the tank, the tank can usually be cleaned.

Note: *If a leak is suspected in the hydraulic oil reservoir, contact your local JLG distributor.*

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.

d. Inspection

1. Inspect the hydraulic oil reservoir thoroughly for any cracks, slices, leaks or other damage.
2. With hydraulic oil reservoir removed from machine, plug all openings except one elbow fitting. Install elbow fitting, and apply approximately 1-1.5 psi (7-10 kPa) of air pressure through elbow. Check reservoir for leaks by applying a soap solution to exterior and look for bubbles to appear at the cracked or damaged area.

e. Reservoir Installation

1. Place hydraulic oil reservoir into original orientation.
2. Secure hydraulic oil reservoir to frame with previous mounting hardware.
3. Uncap and connect the previously labeled hydraulic hoses to their appropriate locations.
4. Install the hydraulic fluid level sight-glass using special designed and drilled capscrews and gaskets.
5. Install hydraulic filter bracket and hydraulic filter.
6. Fill the hydraulic oil reservoir according to specifications. Refer to Section 2.5, “Fluid and Lubricant Capacities.”
7. Check the hydraulic oil reservoir for leaks.
8. Properly connect the batteries.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

8.6 IMPLEMENT PUMP

For internal service instructions, contact your local JLG distributor.

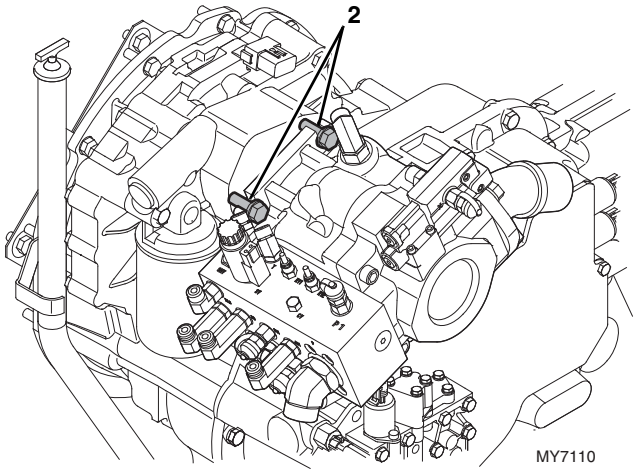
8.6.1 Implement Pump Replacement

a. Pump Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL, engage park brake and shut engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Drain the hydraulic reservoir. Refer to Section 8.5.1, “Hydraulic Oil Reservoir Draining.”
6. 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.*

7. Label, disconnect and cap the hydraulic hoses attached to the pump.



8. Remove the four bolts and lockwashers (**2**) securing the pump to the transmission (top bolts shown only). Remove the o-ring located between the transmission and the pump. Wipe up any hydraulic oil spillage.

Note: *DO NOT disassemble the operating pump. The pump is pre-set from the manufacturer. Any adjustments or repairs performed by anyone other than an authorized dealer could void the warranty.*

b. Pump Installation

1. Place pump and a new, oiled o-ring into position on the transmission. Align the pump shaft with the internal transmission gear, so that the machined teeth mesh together.
2. Align the bolt holes with the pump mount holes.
3. Apply Loctite® 242™ to the previously removed bolts.
4. Secure the pump to the transmission with the four 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 8.5.2, “Hydraulic Oil Reservoir Filling.”
7. Prime the pump by filling the case drain port with fresh, filtered hydraulic oil from a clean container before installing the case drain connector and hose.
8. Check all routing of hoses and tubing for sharp bends or interference with any rotating members. All tube and hose clamps must be tight.
9. Properly connect the batteries.
10. Inspect for leaks and check all fluid levels. The hydraulic reservoir oil level must be to the middle of the sight gauge.

c. Pump Test

d. Refer to Section 8.3.1, “Pressure Checks and Adjustments.”

8.7 CONTROL VALVES

8.7.1 Main Control Valve

The main control valve is mounted at the top of the chassis in front of the mast supports.

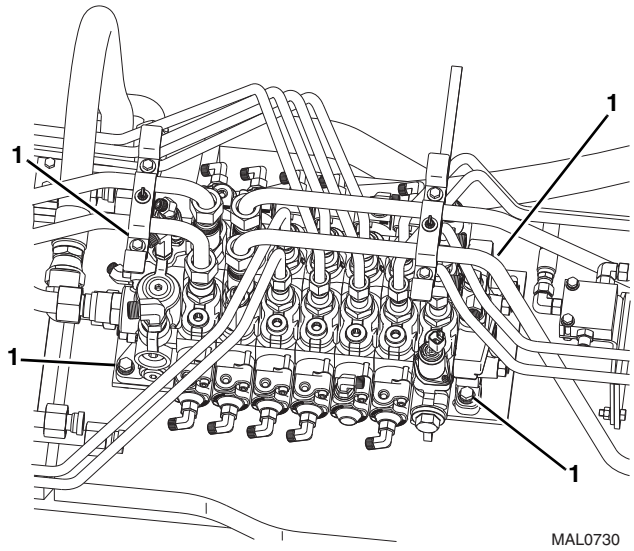
The main control valve assembly consists of individual working sections with their own valve assemblies, each providing a specific hydraulic function.

a. Main Control Valve Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, raise boom, place transmission control lever in (N) NEUTRAL, engage park brake and shut engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Close the engine cover.
6. Remove the main valve cover.
7. Thoroughly clean the main control valve and surrounding area, including all hoses and fittings, before proceeding.
8. Drain the hydraulic fluid reservoir. Refer to Section 8.5.1, “Hydraulic Oil Reservoir Draining.”
9. Place a suitable container to catch hydraulic fluid drainage beneath the frame.

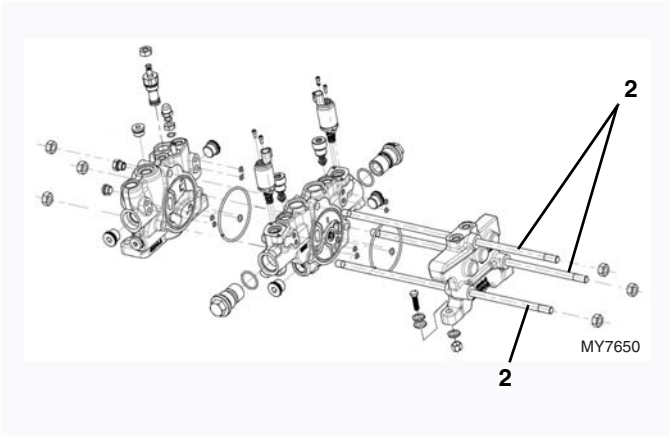
Note: *Slowly remove the hydraulic hoses attached to the main control valve to relieve any possible trapped pressure in the hydraulic line.*

10. Label, disconnect and cap all the hydraulic hoses, tubes and wires at the main control valve.
11. Wipe up any hydraulic fluid spillage in, on, near and around the machine and the work area.



12. Remove the four bolts, washers and nuts (**1**) securing the main control valve to the frame.

b. Main Control Valve Disassembly



1. To disassemble the individual sections of the main control valve, remove the nuts from one end of the tie rods (**2**). Pull the tie rods out through the sections.
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 lift/lower section.
2. Remove the o-rings from between the two sections.
3. Carefully separate each remaining sections, being careful not to lose the load sense shuttle ball.
4. Remove both end caps from each end of the valve sections then remove each control spool.
5. Remove any check valves, compensator valves, anti-cavitation valves or shock valves from individual valve section if equipped.
6. 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.

8.7.2 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 control spool being careful not to nick or scratch the valve section bore or the control spool.
3. Install end caps on each end of valve section.

Assemble the Main Control Valve.

1. Place all three tie rods (**2**) with the washers and nuts through the end main control valve section.
2. Stand the end main control valve section on end.
3. Install proper o-rings and load sense shuttle on inner face of end main control valve section. Align tilt control valve section over three tie rods and slide onto 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 three washers and nuts on the tie rods. Torque to 30 lb-ft (41 Nm).

e. 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 previously labeled hoses, clamps, etc. to the main control valve.
4. Check 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 the tube and hose clamps.
5. Fill the hydraulic fluid reservoir. Refer to Section 8.5.2, “Hydraulic Oil Reservoir Filling.”
6. Properly connect the batteries.
7. Start engine and run at approximately one-third to one-half throttle for about one minute without moving 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.

Note: *Check for leaks and repair as required before continuing. Add hydraulic fluid to the reservoir as needed.*

9. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
10. Install the main control valve cover.
11. Close and secure the engine cover.
12. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

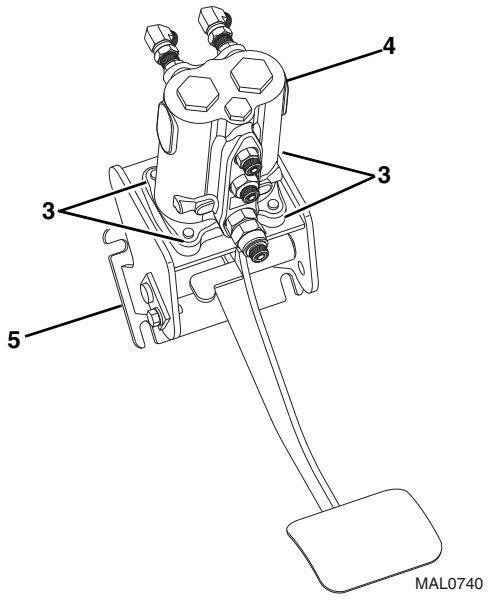
f. Main Control Valve Test

Conduct a pressure check of the hydraulic system in its entirety. Adjust pressure(s) as required. Refer to Section 8.3.1, “Pressure Checks and Adjustments.”

8.7.3 Service Brake Valve

a. Service Brake Valve Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL, engage park 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 system fluids to cool.
4. Properly disconnect the batteries.
5. Label, disconnect and cap all hose attached to the service brake valve.
6. Remove the service brake pedal. Refer to Section 4.3.2, “Service Brake Pedal.”



7. Remove the four capscrews, four nuts and four lockwashers (**3**) mounting the service brake valve (**4**) to the service brake bracket (**5**).

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 (**4**) with the four capscrews, four lockwashers and four nuts (**3**) onto the service brake bracket (**5**).
2. Install the service brake pedal. Refer to Section 4.3.2, “Service Brake Pedal.”

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.*

3. Use new oiled o-rings as required. Uncap and connect the previously labeled 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 batteries.
6. Start engine and run at approximately one-third to one-half throttle for about one minute, without moving 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.

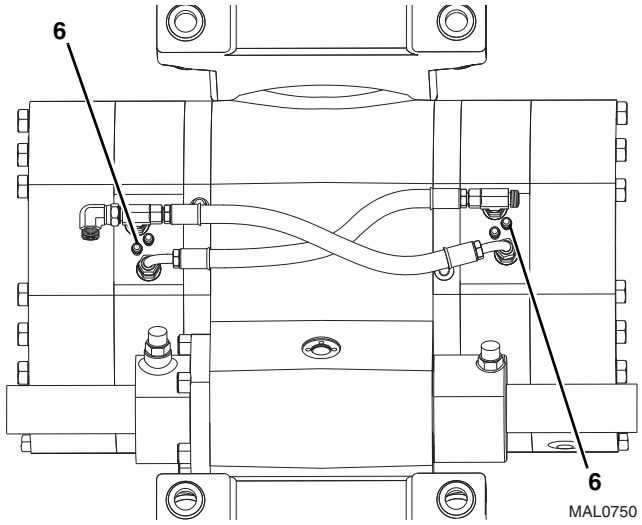
Note: *Check for leaks, and repair as required before continuing. Add hydraulic fluid to reservoir as needed.*

8. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

8.7.4 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 four brake bleeder located on the front axle (two inner service brake bleeders and two outer park brake bleeders) and two service brake bleeders on the rear axle). Work with an assistant to perform this procedure.

1. Place transmission control lever in (N) NEUTRAL, engage the park brake, and start engine.



2. Remove plastic cap from one service brake bleeder (**6**). Attach one end of a length of transparent tubing over brake bleeder. Place other end of this tubing in a suitable transparent container that is partially filled with hydraulic oil. The end of tubing must be below oil level in container.
3. Have assistant depress brake pedal. **DO NOT** open service brake bleeder without holding tubing firmly on bleeder. There is pressure at brakes. Carefully open bleeder with a 12 mm. wrench. Close service brake bleeder when air bubbles no longer appear in oil. Release brake pedal. Remove tubing from service brake bleeder.
4. Repeat Steps 2 and 3 for the remaining service brake bleeders.
5. Check hydraulic oil level and add if necessary.
6. Conduct a pressure and function check of service brake. Refer to Section 8.4.1, “Hydraulic Pressures.”

8.7.5 Service Brake Test

This procedure is used in order to determine if service brake is functional. This procedure is not intended to measure maximum brake performance. Brake holding torque that is required to sustain an engine torque at a specific engine rpm varies depending on machine configuration. Variations are differences in engine settings, power train efficiency and in brake holding ability, etc.

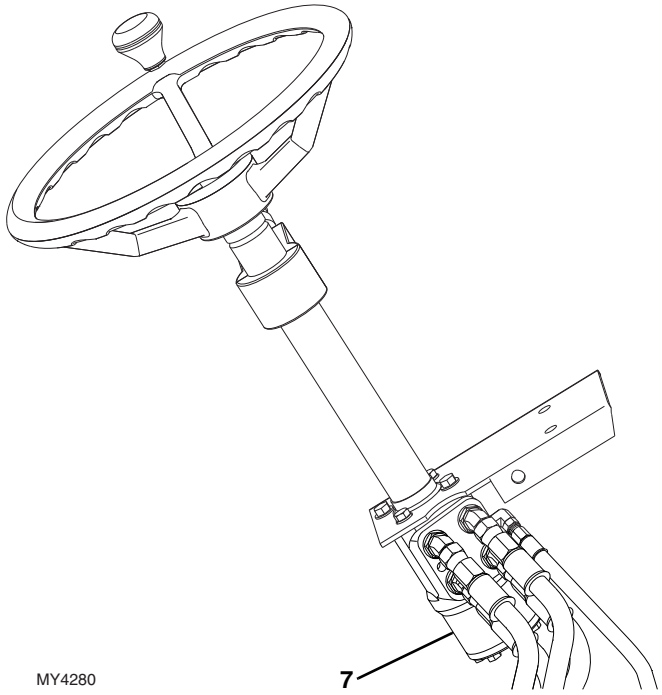
Conduct the following service brake test on a dry level surface, clear of any personnel and/or obstacles.

1. Place transmission control lever in (N) NEUTRAL, engage the park brake, and start the engine.
2. Raise the boom to a travel position.
3. Depress the service brake, disengage the parking brake and place the transmission control lever in third gear forward.
4. Smoothly and controllably depress the throttle pedal.

Note: *Do Not hold the accelerator pedal in the fully depressed position for more than ten seconds. Damage to the power train could occur.*

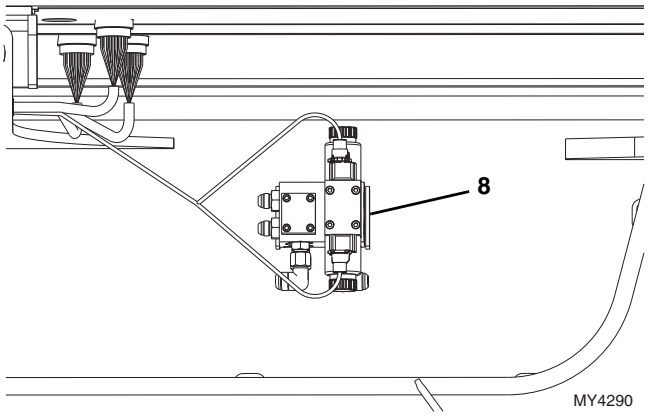
5. Smoothly and controllably fully release the throttle pedal.
6. Machine should remain stationary during test.
7. If machine does not remain stationary during this test, contact the local distributor for proper service.
8. Engage park brake, place transmission control lever in (N) NEUTRAL, lower boom and shut engine OFF.

8.7.6 Steering Orbitrol Valve



The steering orbitrol valve (**7**) is located at base of steering wheel shaft, concealed by lower dash cover. The valve is not serviceable and must be replaced in its entirety if defective. For detailed information refer to Section 4.3.1, “Steering Column and Orbitrol Valve.”

8.7.7 Steer Select Valve



Machine can be used in front-wheel, four-wheel or crab steering mode. Steer select valve (**8**) controls direction of hydraulic fluid flow to steering cylinder mounted on each axle. Steer select valve is attached to a mounting plate under frame near left front corner of cab.

Verify correct operation of steer select valve solenoids before considering replacement of valve. Refer to Section 9.5, “Electrical System Schematics,” and Section 9.10, “Display Monitor and Gauges.” Housing of steer select valve is not serviceable and must be replaced if defective.

a. Steer Select Manifold and Valve Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL, engage park brake and shut engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Label, disconnect and cap hydraulic hoses and electrical plugs connected to steering select valve.
6. Remove bolts holding steer select valve to mounting plate on frame.
7. Remove steer select manifold with attached steer select valve from machine. Wipe up any hydraulic fluid spillage in, on, near and around 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 steer select valve from manifold by removing four socket head capscrews. Discard four o-rings.
3. Remove solenoid valves and cartridges from steer select housing.
4. Clean all components with a suitable cleaner before inspection.
5. Inspect solenoid cartridges for proper operation. Check by shifting the spool to ensure that it is functioning properly. Check that spring is intact. Inspect the cartridge interior for contamination.
6. Inspect internal passageways of the steer select manifold and valve for wear, damage, etc. If inner surfaces of manifold DO NOT display an ultra-smooth, polished finish, or components are damaged in any way, replace manifold or appropriate part. Often, dirty hydraulic fluid causes failure of internal seals and damage to polished surfaces within 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.*

7. Install the solenoid valves and cartridges in the steer select housing.
8. Attach the steer select valve to the manifold using four new, oiled o-rings and the four socket head capscrews.

c. Steer Select Valve and Manifold Installation

1. Install steer select valve to mounting plate under left front side of frame using two bolts.
2. Connect all hydraulic hoses, fittings, solenoid wire terminal leads, etc., to steer select valve
3. Check 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 batteries.
5. Start engine and run at approximately 1/3-1/2 throttle for about one minute without moving machine or operating any hydraulic functions.
6. Inspect for leaks and check level of hydraulic fluid in reservoir. Shut 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 Tags from both the ignition key switch and the steering wheel.

d. Steering Test

Refer to Section 8.4.1, “Hydraulic Pressures.”

1. Conduct a pressure check of steering hydraulic circuit.
2. Check each steering mode for proper function.

8.8 HYDRAULIC CYLINDERS

8.8.1 General Cylinder Removal Instructions

1. Remove any attachment from machine. Park machine on a firm level surface and fully retract boom. Allow sufficient work space around hydraulic cylinder being removed. Support boom if lift/lower cylinder is being removed. Place transmission control lever in (N) NEUTRAL, engage park brake, shut engine OFF and chock wheels.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Label, disconnect and cap or plug hydraulic hoses in relation to the cylinder.
6. Attach a suitable sling to an appropriate lifting device and to the cylinder. Make sure the device used can actually support the cylinder.
7. Remove the lock bolt and/or any retaining clips securing the cylinder pins. Remove the cylinder pins.
8. Remove the cylinder.
9. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.

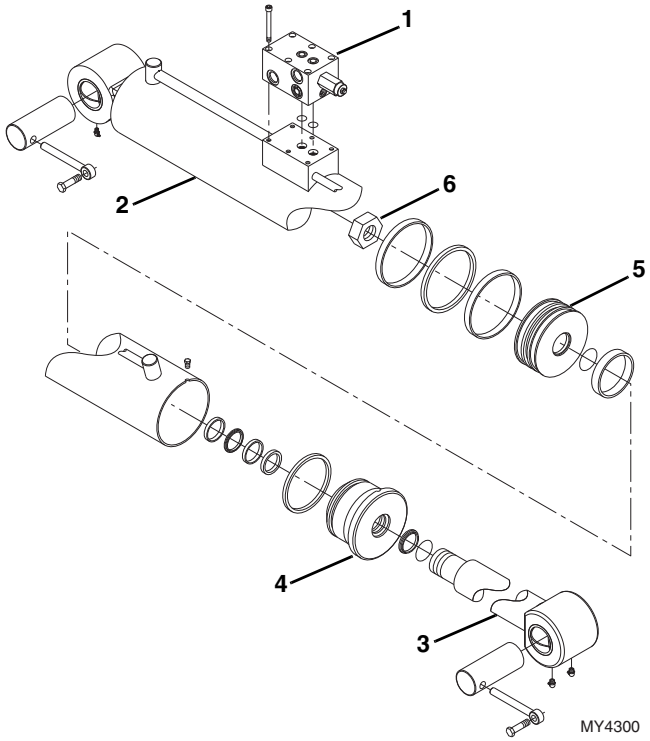
a. General Cylinder Disassembly

1. Clean the cylinder with a suitable cleaner before disassembly. Remove all dirt, debris and grease from the cylinder.
2. Clamp barrel end of 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 (**1**) from the side of the cylinder barrel (**2**).

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 (**3**) 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 (**4**) from the tube (**2**). A considerable amount of force will be needed to remove the head gland.
6. 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.*

7. Carefully pull the rod assembly (**3**) along with the head gland (**4**) out of the cylinder barrel.
8. 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.
9. Remove the set screw from the piston head (**5**).
10. If equipped, remove piston head (**5**) mounting nut (**6**).

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 300-400° F (149-204° C) 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.

11. Remove piston head (**5**) from the rod (**3**) and carefully slide head gland (**4**) off end of rod.
12. Remove all seals, back-up rings and o-rings from piston head and all seals, back-up rings and o-rings from 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.*

8.8.2 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.

c. 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® 242™ and install the set screw in the piston head. Refer to Section 8.8.5, “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 8.8.5, “Cylinder Torque Specifications” for torque specifications for the head gland.
8. If applicable, install new counter balance valve into block on the cylinder barrel.

d. General Cylinder Installation

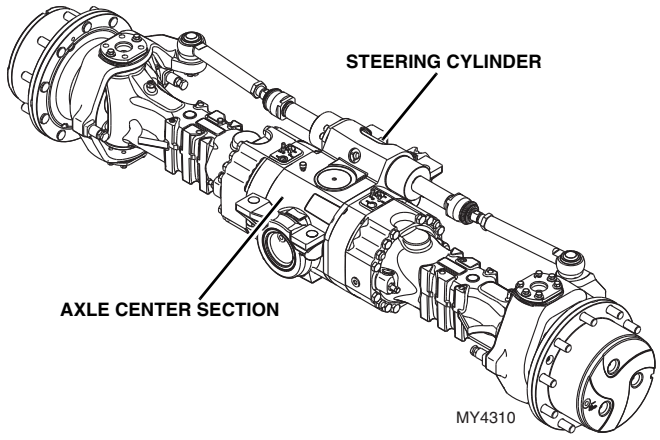
1. Grease the bushings at the ends of the hydraulic cylinder. Using an appropriate sling, lift the cylinder into it’s mounting position.
2. Align cylinder bushing and install pin, lock bolt or retaining clip.
3. Connect the hydraulic hoses in relation to the labels or markings made during removal.
4. Before starting the machine, check fluid level of the hydraulic fluid reservoir and if necessary fill to full mark with hydraulic oil.
5. Properly connect the batteries.
6. 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.
7. Inspect for leaks and check level of hydraulic fluid in reservoir. Add hydraulic fluid if needed. Shut the engine OFF.
8. Wipe up any hydraulic fluid spillage in, on, near and around the machine, work area and tools.
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

8.8.3 Cylinder Pressure Checking

Attach a 5000 psi (345 bar) 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, “Hydraulic Pressures.”

Note: *If a hydraulic cylinder pressure is greater than main control valve pressure, increase main control valve pressure by adjusting main relief. Generally, one half turn clockwise will be adequate to check an individual circuit. Activate circuit and if pressure is obtained turn main relief counter clockwise one half turn. Re-check main relief setting and adjust if necessary.*

8.8.4 Steering Cylinders



The steer cylinder is attached to each axle center housing. Steer cylinder service instructions are provided in the following publications:

- Service Manual (P/N 31200240)
- Parts Manual (P/N 31200728)

8.8.5 Cylinder Torque Specifications

a. Lift/Lower Cylinder

	Head	Nut	CB Valve	CB Cap Screw
G10-55A, G12-55A	120 lb-ft (163 Nm)	2682 lb-ft (3636 Nm)	45-50 lb-ft (61-67 Nm)	35 lb-ft (47 Nm)

b. Extend/Retract CylinderTilt Cylinder

	Head	Nut	CB Valve (Large)	CB Valve (Small)
G10-55A, G12-55A	100 lb-ft (135 Nm)	1376 lb-ft (1866 Nm)	110 lb-ft (149 Nm)	33 lb-ft (45 Nm)

c. Tilt Cylinder

	Head	Nut	CB Valve
G10-55A, G12-55A	550-600 lb-ft (746-814 Nm)	2200-2500 lb-ft (2982-3389 Nm)	40-45 lb-ft (54-61 Nm)

d. Compensation Cylinder

	Head	Nut
G10-55A	400-500 lb-ft (542-678 Nm)	2900-3100 lb-ft (3932-4203 Nm)
G12-55A	500-600 lb-ft (678-814 Nm)	

e. Frame Level Cylinder

	Head	Nut	Check Valve
G10-55A, G12-55A	300-400 lb-ft (407-542 Nm)	750-800 lb-ft (1017-1085 Nm)	20-22 lb-ft (27-30 Nm)

f. Stabilizer Cylinder

	Head	Nut	Solenoid	Solenoid Nut
G10-55A, G12-55A	300-400 lb-ft (407-542 Nm)	750-800 lb-ft (1017-1085 Nm)	20-22 lb-ft (27-30 Nm)	2.5 lb-ft (3,3 Nm)

g. Outrigger Cylinder

	Head	Nut	Check Valve
G10-55A, G12-55A	300-400 lb-ft (407-542 Nm)	2350-2600 lb-ft (3186-3525 Nm)	30-35 lb-ft (41-47 Nm)

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Section 9
Electrical System

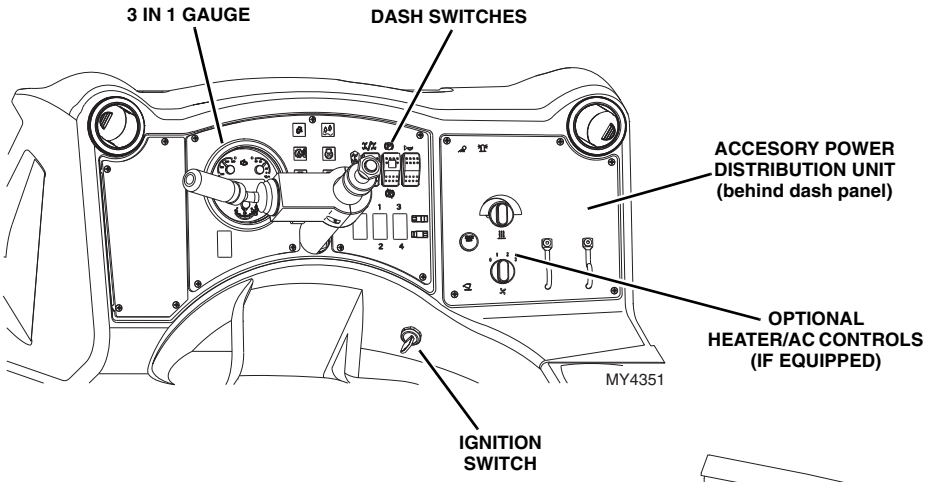
Contents

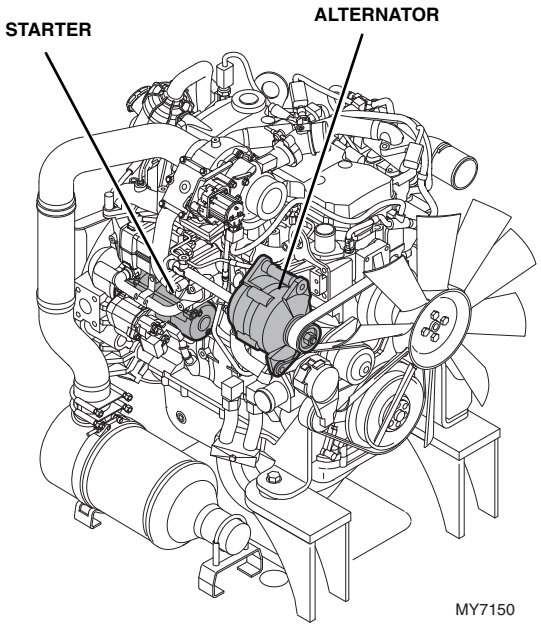
9.1 ELECTRICAL COMPONENT TERMINOLOGY

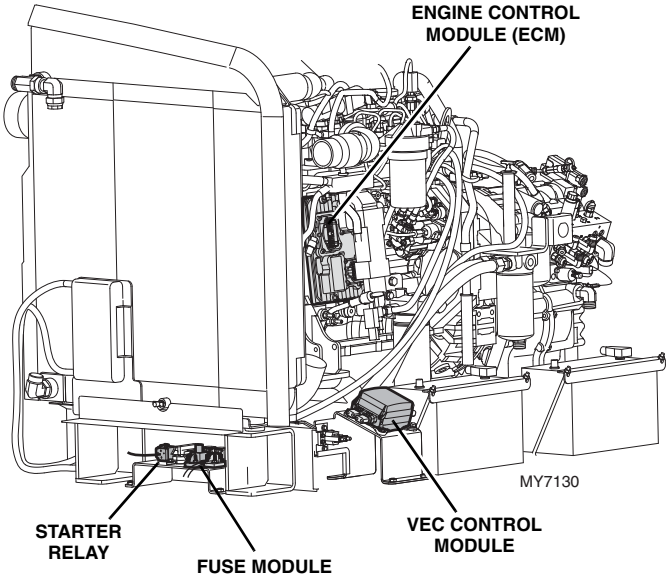
To understand the safety, operation, and service information presented in this section, it is necessary that the operator/mechanic be familiar with the name and location of the electrical components of the machine. The following illustration identifies the components that are referred to throughout this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

9.1.1 General Overview

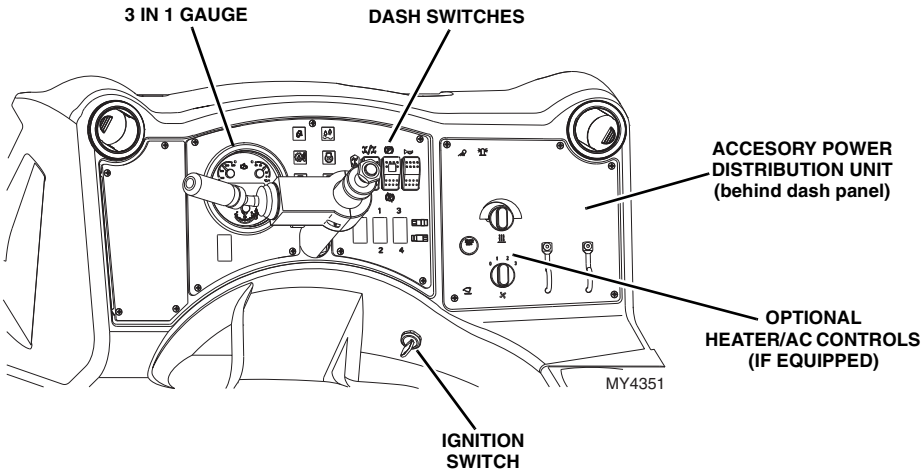
a. ULS

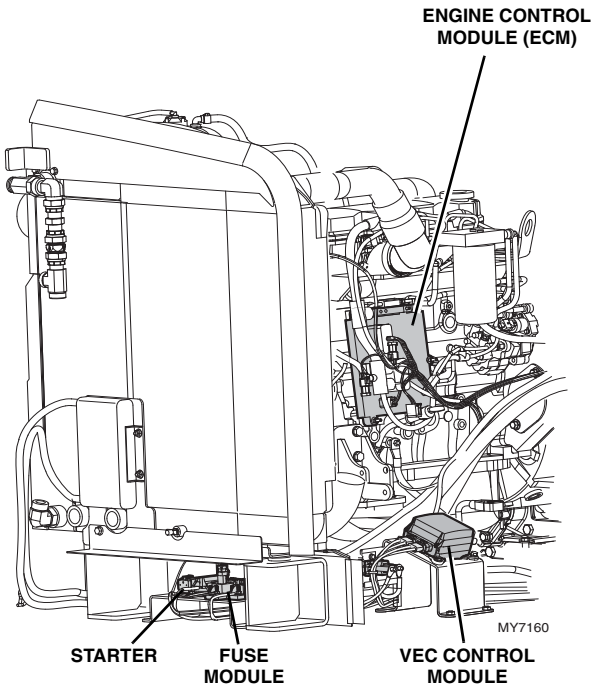


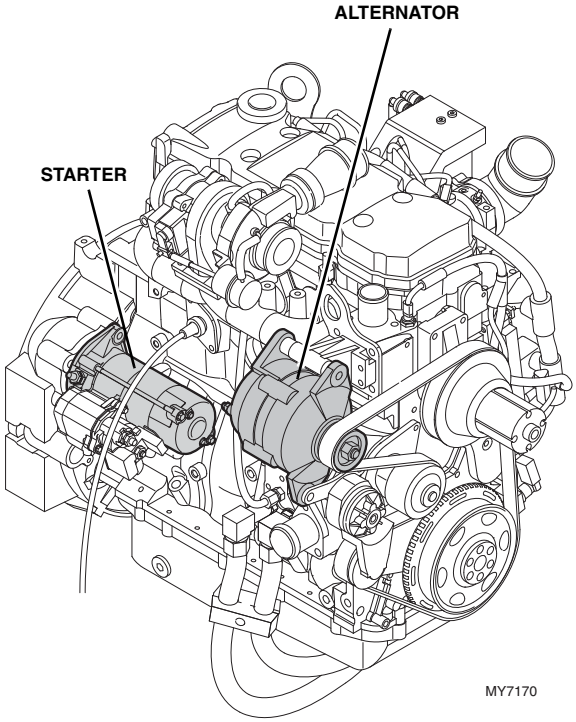




b. LS


3 IN 1 GAUGE
DASH SWITCHES
ACCESORY POWER DISTRIBUTION UNIT (behind dash panel)
OPTIONAL HEATER/AC CONTROLS (IF EQUIPPED)
IGNITION SWITCH
MY4351


ENGINE CONTROL MODULE (ECM)
STARTER
FUSE MODULE
VEC CONTROL MODULE
MY7160


ALTERNATOR
STARTER
MY7170

9.2 SPECIFICATIONS

Electrical system specifications are listed in Section 2, “General Information and Specifications.”

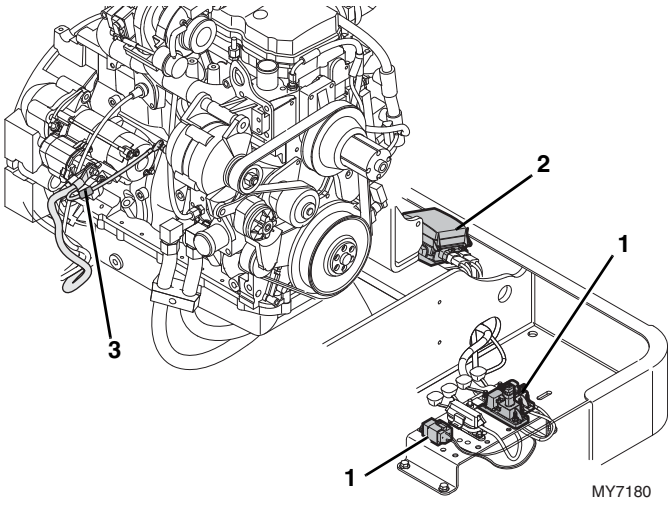
9.3 SAFETY INFORMATION

⚠ WARNING

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

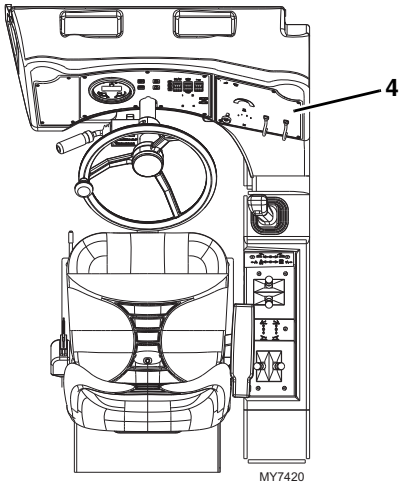
9.4 FUSES AND RELAYS

9.4.1 Engine Compartment



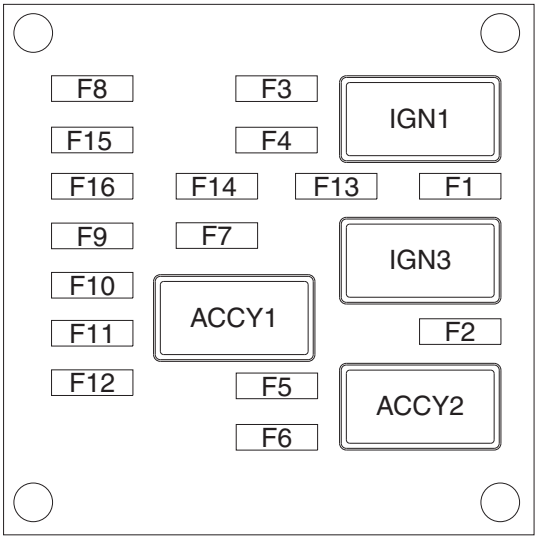
Starter relays (**1**), Fuse module (**2**) and 150 amp fusible link (**3**) are located in engine compartment.

9.4.2 Cab



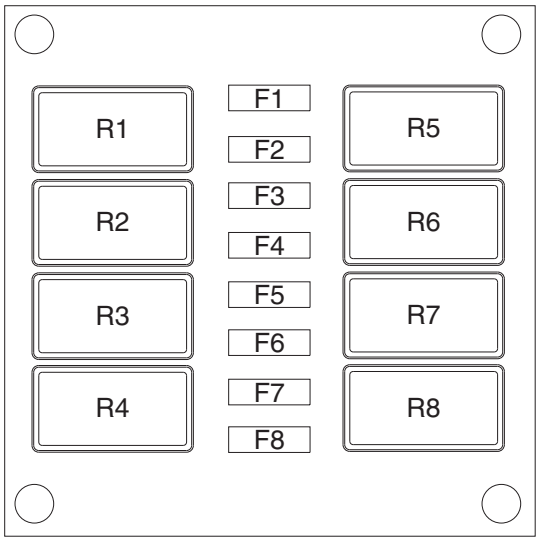
The optional power distribution unit is located in the cab. For access, remove the screws securing the load chart panel (**4**) to the dash.

9.4.3 Power Distribution Unit (VEC)



Connector Legend			
No.	**Type**	**Function**	**Amp Rating**
F1	Fuse	Trans/Park Brake Power	15
F2	Fuse	Alternator Excite	5
F3	Fuse	Engine ECU Ignition Power	10
F4	Fuse	Gauge Power	10
F5	Fuse	Spare Accessory Power	15
F6	Fuse	Auxiliary Electric Power	10
F7	Fuse	Horn Power	15
F8	Fuse	Spare Battery Power	25
F9	Fuse	Engine ECU Battery Power	25
F10	Fuse	Steer/Frame Level Power	10
F11	Fuse	Rear Axle Stabilizer/Tilt Power	10
F12	Fuse	Key Battery Power	15
F13	Fuse	Options Power 3	20
F14	Fuse	Options Power 4	20
F15	Fuse	Options Power 1	20
F16	Fuse	Options Power 2	20
IGN1	Relay	Ignition 1	
IGN 2	Relay	Ignition 2	
ACCY1	Relay	Accessory 1	
ACCY2	Relay	Accessory 2	

9.4.4 Optional Power Distribution Unit (VEC)

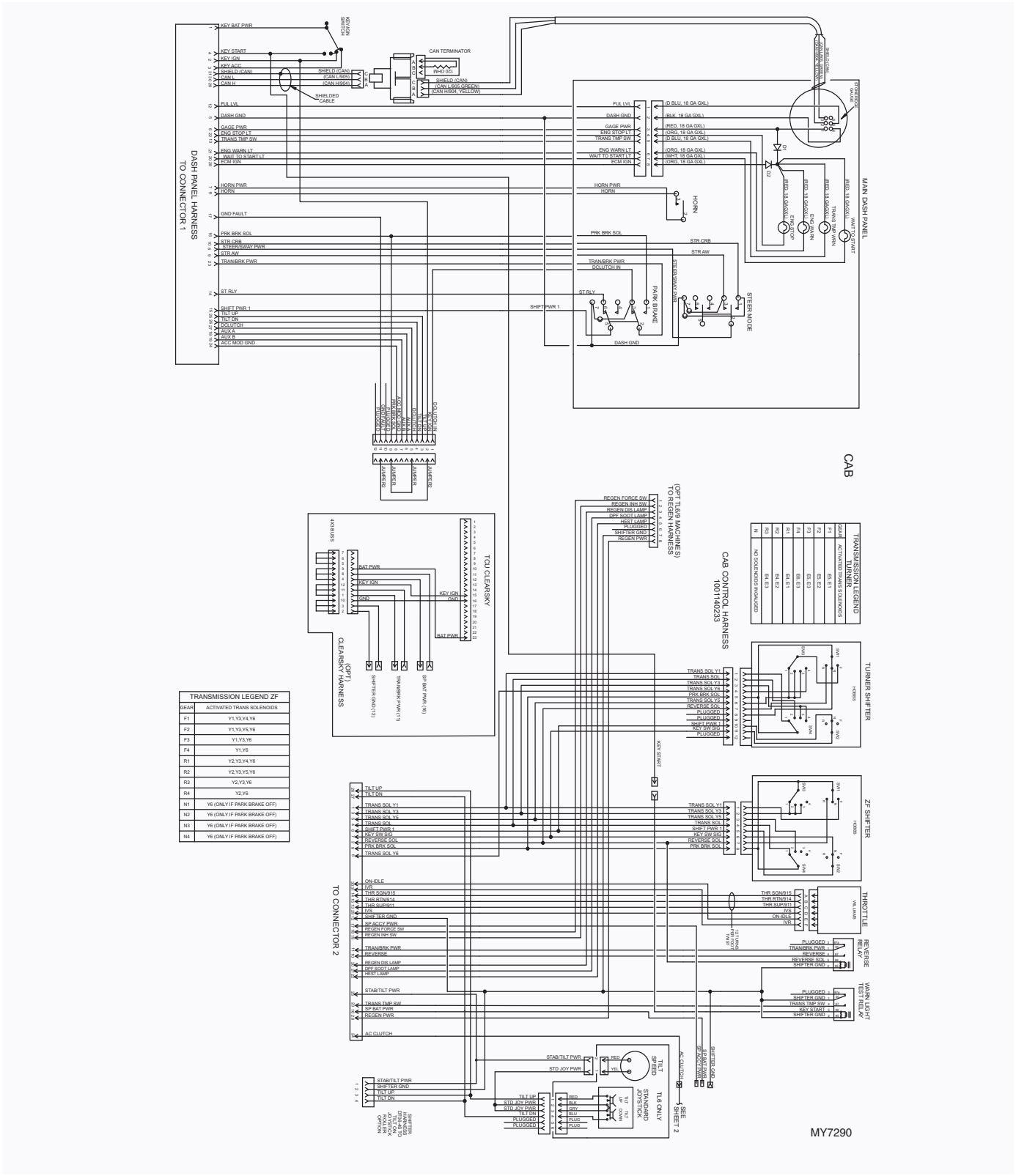


MY1260

Connector Legend			
No.	**Type**	**Function**	**Amp Rating**
F1	Fuse	Wiper	20
F2	Fuse	Roof Wiper	5
F3	Fuse	Option	15
F4	Fuse	Option	25
F5	Fuse	Heater	20
F6	Fuse	Lights	30
F7	Fuse	Beacon	10
F8	Fuse	Dash Fan	10
R1	Relay	Wiper	
R2	Relay	Heater Blower	
R3	Relay	Aux Elec 1	
R4	Relay	Aux Elec 2	
R5	Relay	Option	15
R6	Relay	Option	25
R7	Relay	Lights	
R8	Relay	Beacon/Fan	

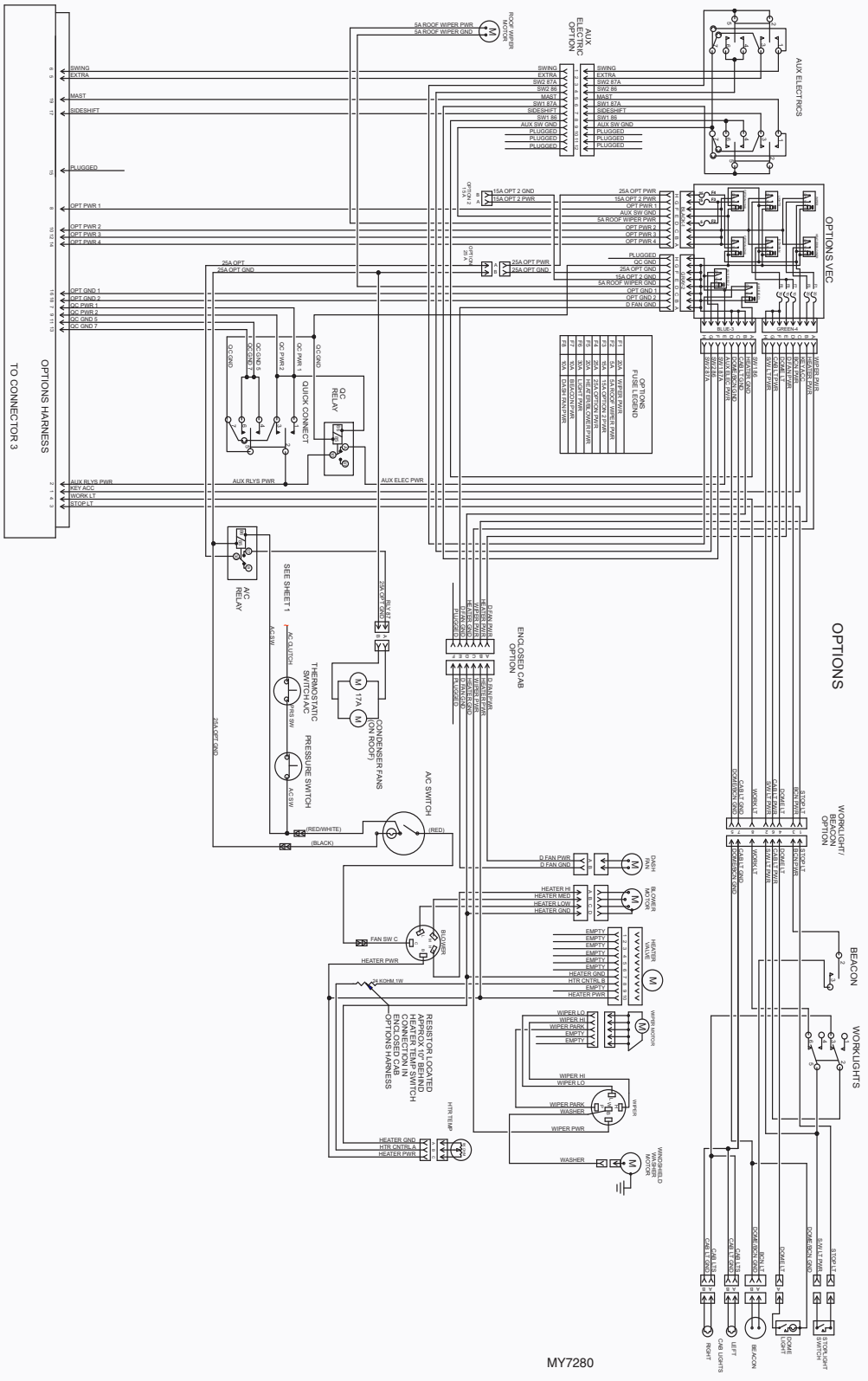
9.5 ELECTRICAL SYSTEM SCHEMATICS

9.5.1 Cab Schematic

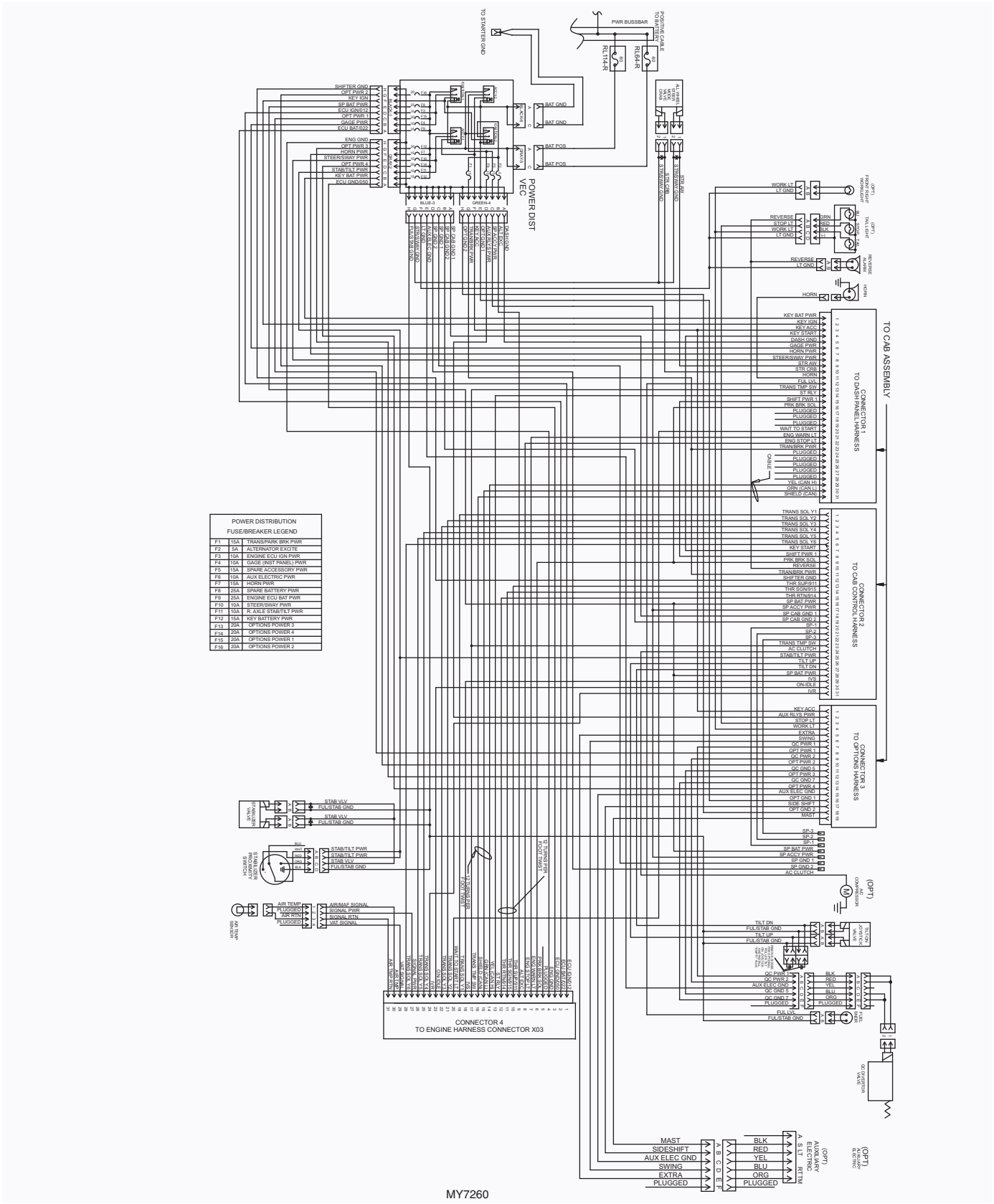


TRANSMISSION LEGEND ZF	
GEAR	ACTIVATED TRANS SOLENOIDS
F1	Y1,Y3,Y4,Y6
F2	Y1,Y3,Y5,Y6
F3	Y1,Y3,Y6
F4	Y1,Y6
R1	Y2,Y3,Y4,Y6
R2	Y2,Y3,Y5,Y6
R3	Y2,Y3,Y6
R4	Y2,Y6
N1	Y6 (ONLY IF PARK BRAKE OFF)
N2	Y6 (ONLY IF PARK BRAKE OFF)
N3	Y6 (ONLY IF PARK BRAKE OFF)
N4	Y6 (ONLY IF PARK BRAKE OFF)

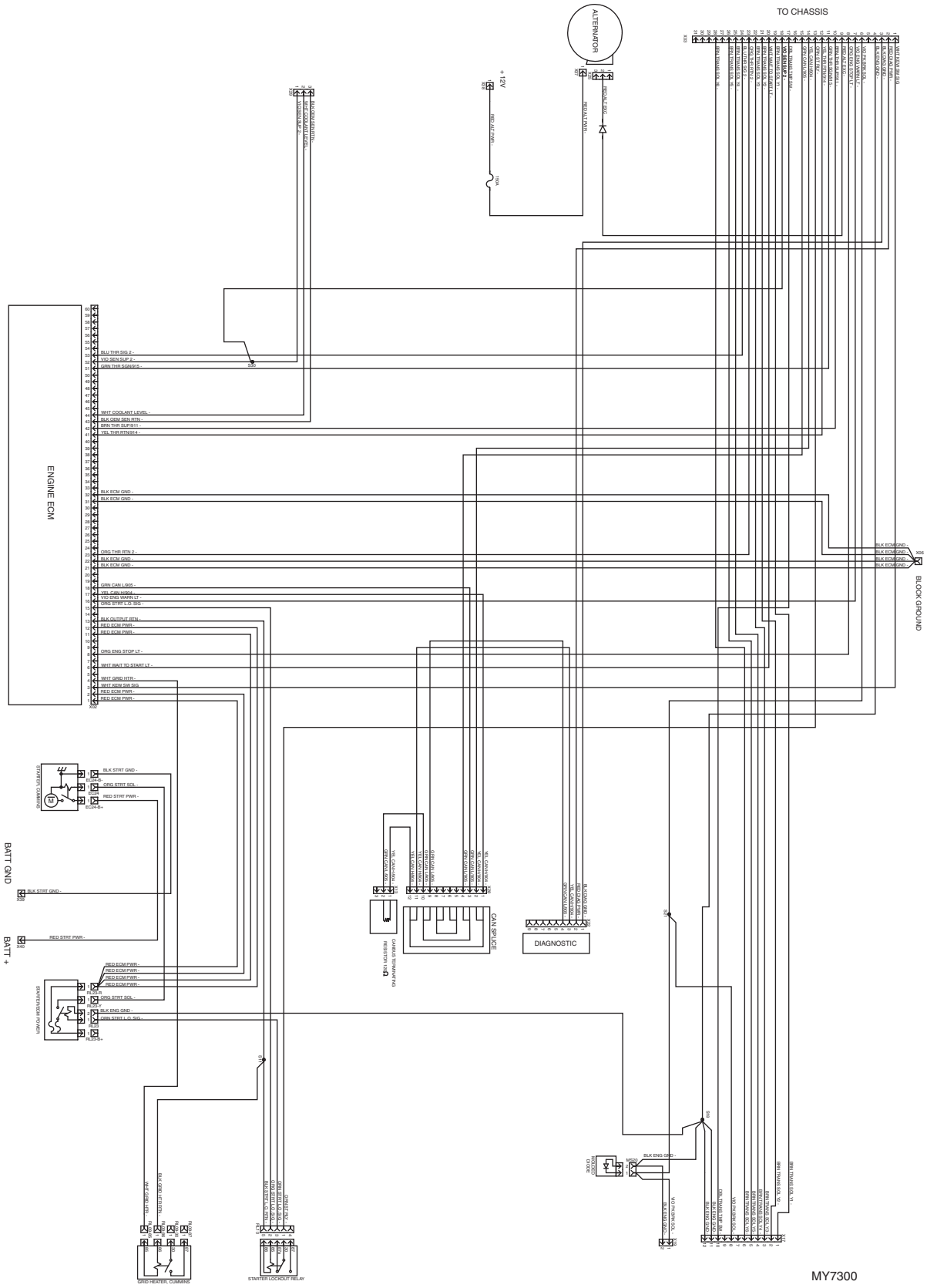
9.5.2 Options Schematic



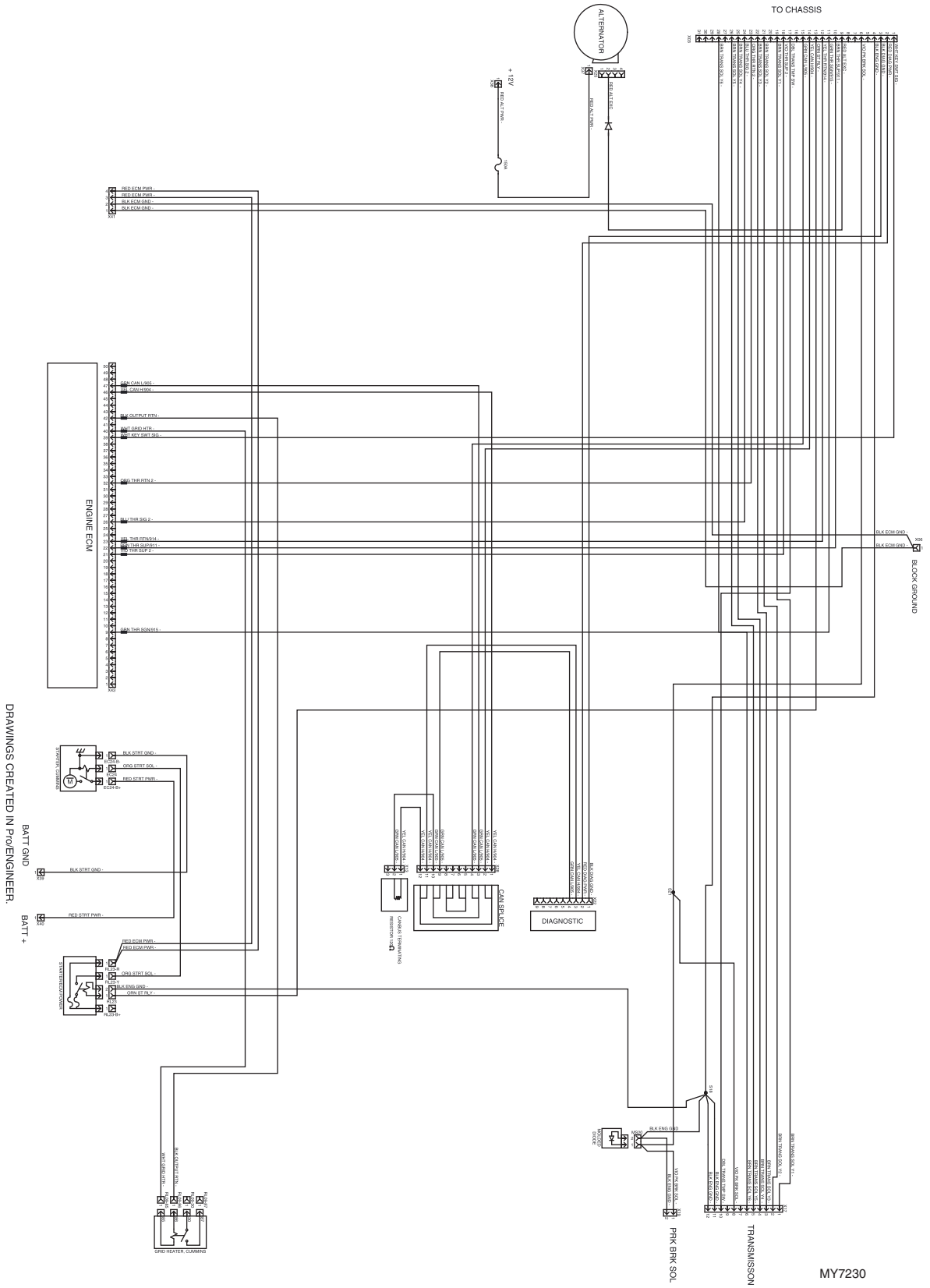
9.5.3 Chassis Schematic



9.5.4 Engine Schematic (if equipped for ULS)

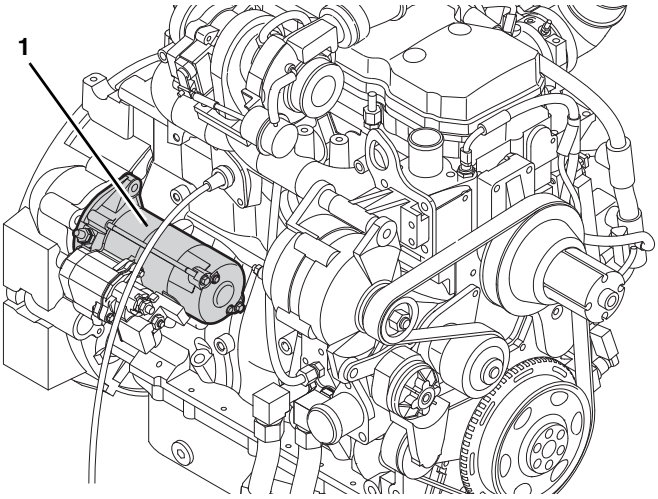


9.5.5 Engine Schematic (if equipped for LS)



9.6 ENGINE START CIRCUIT

9.6.1 Starter



a. Testing the Starter on the Engine

If starter (**1**) does not engage when ignition key switch is turned, check following:

1. The main fuse may be blown, requiring replacement. Check for cause of blown fuse.
2. There may be a defect in ignition key switch, ignition wiring or starter solenoid.
3. Check batteries condition. Clean batteries posts and connectors at each end of battery cables.
4. Check for broken wiring and damaged insulation on wiring. Replace all broken or damaged wiring.
5. Check all connections at starter solenoid, key switch and wiring harness plugs. Clean and tighten all connections.
6. If starter still does not operate after these checks have been performed, check starting circuit.

b. Starter Circuit Checks

1. Check wires and connections for looseness, corrosion, damage, etc.
2. If a “whirring” noise is heard but engine does not turn over, starter is spinning but not engaging flywheel. The starter drive or solenoid that pushes drive forward to engage flywheel may be defective. Missing or damaged teeth on flywheel can also prevent starter from cranking engine.
3. If starter only “clicks” it may indicate that battery is discharged, or that there is a loose or corroded battery cable connection. Check battery state of charge and battery condition first, then check cables and cable connections.
4. For additional information on the starting circuit, refer to Section 9.5, “Electrical System Schematics.”

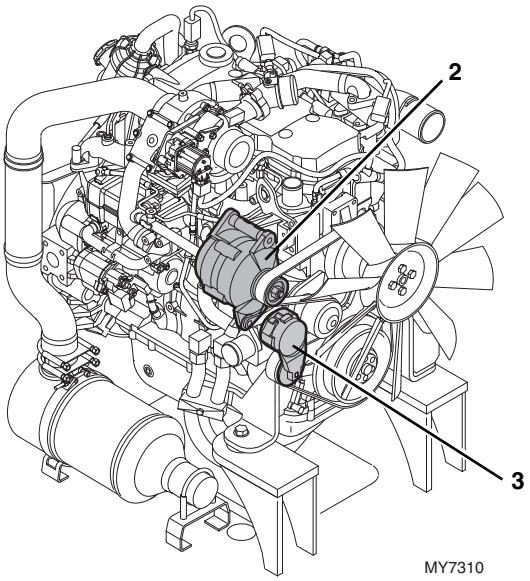
c. Starter Removal

1. Park machine on a firm, level surface, level machine, fully retract the boom, lower the boom, place transmission control lever in (N) NEUTRAL, engage park brake and shut engine OFF.
2. Place a Do Not Operate Tag on both the ignition key switch and the steering wheel.
3. Open engine cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Remove positive (+) cable/wire from the solenoid stud.
6. Remove negative (-) battery cable from starter.
7. Label and disconnect wire from starter solenoid housing stud. Record how wires are installed to ensure correct installation later.
8. Loosen, but **DO NOT** remove, fasteners securing starter to flywheel housing. Support starter securely, as it is relatively heavy and will fall if not supported.
9. Support starter and remove fasteners securing starter to engine. Remove negative (-) ground cable.
10. Remove starter from machine.

d. Starter Installation

1. Position the starter in its mounting opening on flywheel housing.
2. Install negative (-) ground cable to starter.
3. Secure starter with the three fasteners.
4. Connect the positive (+) battery cable to upper solenoid stud. Install wires to solenoid stud and secure with lock washer and nut.
5. Connect wires removed earlier to the solenoid mounting stud.
6. Properly connect batteries.
7. Close and secure engine cover.
8. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

9.6.2 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 & Safety 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 batteries cable connections at the battery, and verify that they are clean and tight.
2. Check the in-line fuse below radiator.
3. Check external alternator wiring and connections, and verify that they are in good condition.
4. Check the fan belt condition and tension.
5. Run engine and check 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.

9.6.3 Alternator

a. Alternator Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever in (N) NEUTRAL, engage park brake and shut engine OFF.
1. Place a Do Not Operate Tag on both ignition key switch and steering wheel.
2. Open engine cover. Allow system fluids to cool.
3. Properly disconnect the batteries.
4. Install a drive ratchet into the square hole in the serpentine belt tensioner bracket (**3**).
5. 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.*

6. Label and disconnect the wire leads attached to the alternator assembly.
7. Remove the lower mounting capscrew securing the alternator to the lower mounting hole on the engine.
8. While supporting alternator with one hand, remove upper (longer) mounting hardware from upper alternator mount. Remove alternator from machine.

b. Alternator Installation

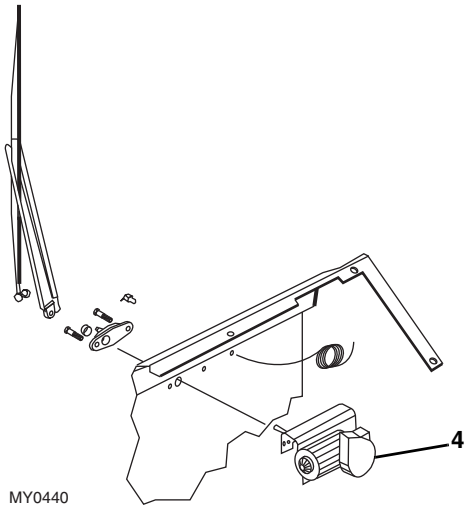
1. Position alternator and align with upper alternator mount on engine bracket. Insert upper (longer) mounting hardware through alternator mount. Thread longer capscrew into alternator front mount. **DO NOT** tighten completely at this time.
2. Align lower alternator mount hole with lower mounting bracket on engine, and insert lower mounting capscrew. Tighten lower capscrew and upper capscrew securely.
3. Place a drive ratchet into square hole on serpentine belt tensioner bracket (**3**). Apply pressure against tensioner bracket and route serpentine belt onto alternator and engine pulleys. Release and check tensioner pulley to verify that it is pivoting freely in order to provide proper tension on belt. Check for proper belt alignment. (Refer to the appropriate Operation & Safety Manual.)
4. Connect previously labeled wire leads to alternator.
5. Properly connect batteries.
6. Close and secure engine cover.
7. Remove the Do Not Operate Tags from both ignition key switch and steering wheel.

9.7 WINDOW WIPER/WASHER WINDSHIELD WIPER MOTOR

a. Removal

Note: *It may be necessary to remove several hydraulic hoses from behind the dash in order to remove and install the wiper motor housing. (Refer to Section 4.3.1, "Steering Column and Orbitrol Valve.")*

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.



5. Remove the screws that secure the main dash panel. Pull out the dash panel to gain access to the wiper motor (**4**).
6. Disconnect the cab harness connectors from the wiper motor.
7. Remove the linkage attached to the wiper motor.
8. Loosen and remove the four bolts holding the wiper motor to the mounting bracket.

Note: *Retain all hardware removed from wiper assembly for possible reuse on replacement motor housing.*

9. Remove the motor from the inside 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.

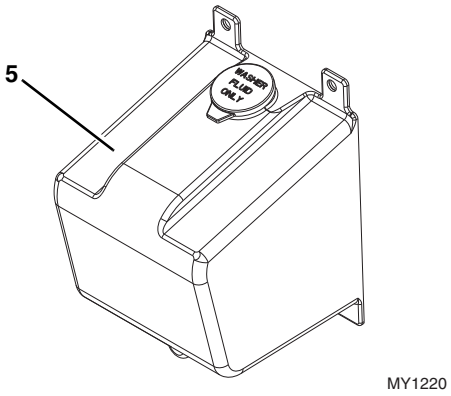
d. Installation and Testing

1. Install all required hardware to the motor assembly.
2. Align motor with the mounting holes and bolt the motor to the mounting bracket.
3. 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.*

4. Connect the cab harness connectors to windshield wiper motor connectors.
5. Replace the main dash panel to its original orientation. Secure with the previously used screws.
6. Properly connect the batteries.
7. 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.
8. If previously removed, install hydraulic hoses under the dash. (Refer to Section 4.3.1, "Steering Column and Orbitrol Valve.")
9. Close and secure the engine cover.
10. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

9.7.1 Windshield/Rear Window Washer Reservoir



Windshield washer motor and reservoir (**5**) is located in cab behind the seat. It is labeled as a unit and cannot be serviced separately.

a. Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Remove nuts and lock washers from washer mounting bolts.
6. Pull the washer reservoir out and away from the mounting bracket.
7. Rotate the washer reservoir, label and remove the cab harness connectors from the washer reservoir connectors.
8. Remove windshield washer hoses from reservoir.

b. Disassembly

DO NOT disassemble the pump. The pump is not serviceable. Replace pump if found to be defective.

c. Installation and Testing

1. Connect windshield washer hoses to reservoir.
2. Connect the cab wiring harness connectors to the reservoir connectors.
3. Install reservoir tank onto mounting bracket.
4. Install lock washers and nuts and secure.
5. Fill the washer fluid reservoir with washer fluid.
6. Properly connect the batteries.
7. Turn ignition key switch to RUN position and press washer switch. Verify that fluid is sprayed on both windshield and rear glass.
8. Close and secure the engine cover.
9. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

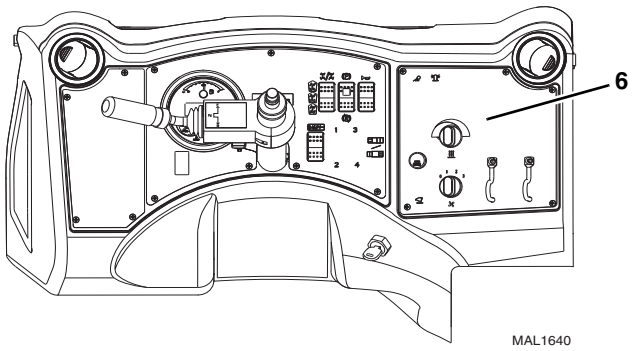
9.8 CAB HEATER AND FAN

9.8.1 Cab Heater Controls

Note: *If the suspect component is found to be within the heater box, the heater box must be removed as a complete unit and replaced.*

a. Cab Heater Controls Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.



5. Remove screws securing right cab dash panel (**6**).
6. Pull out panel to gain access to heater control electrical connections. Disconnect harnesses.
7. Remove heater control knobs.
8. Remove necessary hardware securing heater control from dash panel. Remove control from panel.

b. Disassembly

DO NOT disassemble cab heater and fan controls. The controls are not serviceable. Replace controls if found to be defective.

c. Installation and Testing

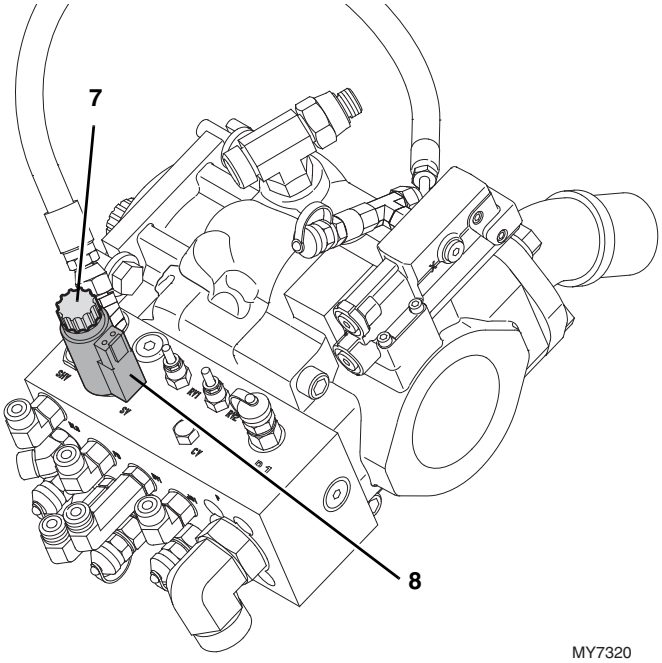
1. Check that the variable speed fan control is in the OFF position.
2. Install the heater controls to the dash panel with the previously used hardware.
3. Connect the cab electrical harness connector to the controls.
4. Install the control knobs.
5. Install screws securing dash panel to cab.
6. Properly connect the batteries.
7. Turn ignition key to ON position and check fan speeds. If further repair is needed, refer to Section 9.5, “Electrical System Schematics.”
8. Start the machine and allow engine to warm to operating temperature. Check heat control at different levels.
9. Close and secure the engine cover.
10. Remove Do Not Operate Tags from both ignition key switch and steering wheel.

9.9 SOLENOIDS, SENSORS AND SENDERS

9.9.1 Park Brake Solenoid Valve

a. Park Brake Solenoid Valve Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Disconnect the wiring connector at the park brake solenoid lead.



6. Remove nut on end of park brake coil (**7**).
7. Remove park brake coil.
8. Remove park brake solenoid (**8**). (Remove only if electrical coil is found to not be faulty.)

b. Disassembly

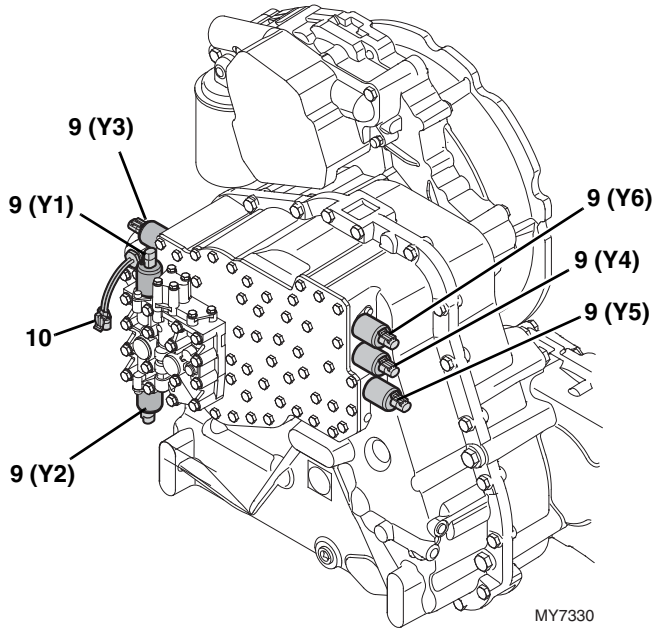
DO NOT disassemble the solenoid. The solenoid is not serviceable. Replace solenoid if found to be defective.

c. Park Brake Solenoid Valve Installation

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.*

1. If necessary, install the park brake solenoid in its original orientation.
2. Slide park brake coil over solenoid. Tighten nut to secure solenoid. DO NOT overtighten.
3. Connect wiring connector to park brake coil lead.
4. Properly connect batteries.
5. Close and secure engine cover.
6. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

9.9.2 Transmission Solenoid Valves



Note: If the transmission is not shifting properly, the transmission shift control switch (transmission control lever), wiring harness or transmission shift solenoids (**9**) 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 ZF Powershift Transmission 4WG-92/98 TSC Repair Manual, (JLG P/N 31200241) and can be obtained by calling your local JLG dealer or ZF Service Center.

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 **JLG** Service Department if internal transmission repair is required during warranty period.*

9.9.3 Transmission Temperature Sender

a. Transmission Temperature Sender Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Unplug transmission temperature sender connector (**10**) from the wiring harness connector.
6. The sender is threaded into the transmission housing. Remove the sender.

b. Transmission Temperature Sender Inspection and Replacement

Inspect the sender and the wiring harness connector terminals for continuity. Replace a defective or faulty sender with a new part.

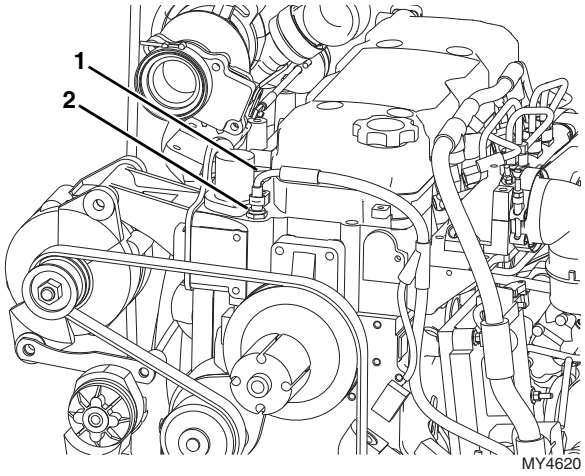
c. Transmission Temperature Sender Installation and Testing

1. Thread transmission temperature sender into transmission housing snugly, then connect sender connector to wiring harness connector.
2. Properly connect the batteries.
3. Check for proper fluid level.
4. Start engine, allow it to reach operating temperature and observe the operator's display cluster for warning indication. If sender is not defective, 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 Tags from both ignition key switch and steering wheel.

9.9.4 Engine Coolant Temperature Sender

a. Engine Coolant Temperature Sender Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.



5. Unplug the engine coolant temperature sender connector (**1**) from the wiring harness connector.
6. Engine coolant temperature sender (**2**) is located near upper radiator hose thermostat housing and threaded into engine block. Remove the sender.

b. Engine Coolant Temperature Sender Inspection and Replacement

Inspect sender and wiring harness connector terminals for continuity. Replace a defective or faulty sender with a new part.

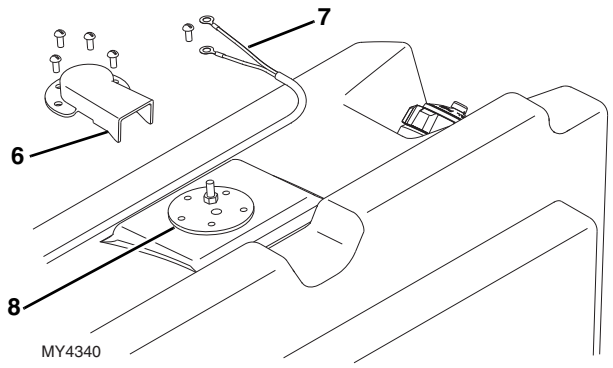
c. Engine Coolant Temperature Sender Installation and Testing

1. Thread engine coolant temperature sender into engine block snugly, then connect sender connector to wiring harness connector.
2. Properly connect the batteries.
3. Check for proper coolant level.
4. Start engine, allow it to reach operating temperature and observe the operator's instrument cluster for warning indication. If sender 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.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

9.9.5 Fuel Level Sender

a. Fuel Level Indicator Testing

The fuel level sender wiring harness leads can be accessed from the top of the fuel tank.



1. Loosen and remove he four screws securing the fuel sender cover (**6**).
2. Disconnect the fuel level sender wiring harness leads (**7**) from the fuel sender (**8**). With the help of an assistant, touch both harness leads together.
3. From the operator's 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's instrument cluster. The reading must be at the FULL mark.
4. Turn the ignition key switch to the OFF position. The fuel level indicator needle should return to the EMPTY position.

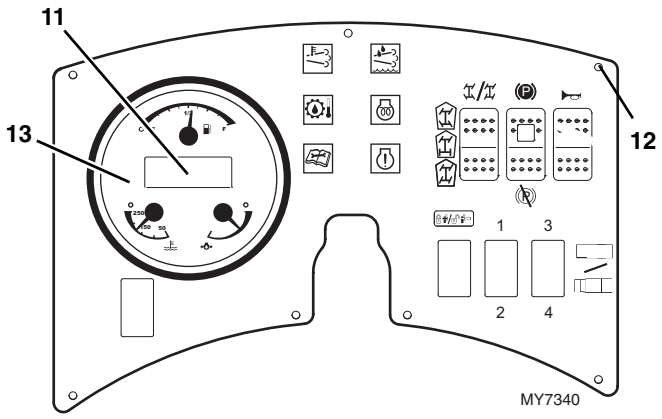
b. Fuel Level Circuit Tests

If the fuel level sender (**8**) 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 fuel level indicator needle does not move after ignition key switch is turned to the RUN position, use a test lamp to determine whether current is flowing from ignition switch to fuel level sender.
4. If 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 ignition terminal has current and that fuse in 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 fuel tank through wiring in cab.
7. Check fuel level sender. A defective fuel level sender in fuel tank may also prevent fuel level indicator from moving. Refer to Section 9.5, "Electrical System Schematics," for further information.

9.10 DISPLAY MONITOR AND GAUGES

9.10.1 Gauges



Note: *Error codes will appear in the display area (**11**) of the gauge (**13**). Refer to Section 9.12, "SAE Diagnostic Trouble and Fault Codes"*

a. Gauge Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.
5. Remove the screws (**12**) securing the dash panel.
6. Label and disconnect the wires from the gauge, remove the gauge bracket.
7. Pull the gauge (**13**) out from the dash.

b. Disassembly

DO NOT disassemble the gauge. The gauge is not serviceable. Replace the gauge if found to be defective.

c. Gauge Installation and Testing

1. Install gauge (**13**) in dash. Install gauge bracket.
2. Connect previously labeled wires to the gauge.
3. Install panel with previously used hardware (**12**).
4. Properly connect the batteries.
5. Turn ignition to ON position to check gauge values.
6. Close and secure the engine cover.
7. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

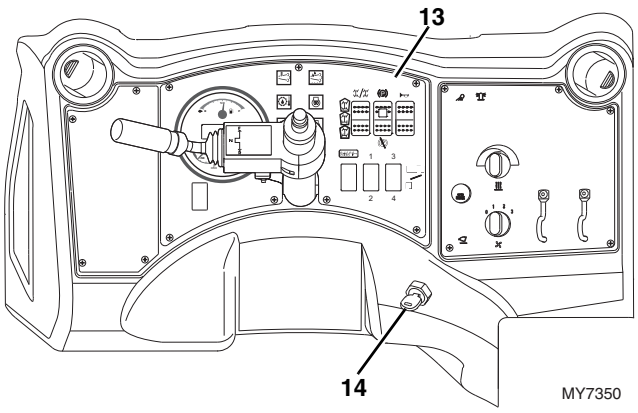
9.11 DASH SWITCHES

9.11.1 Ignition Key Switch

Note: *For information on the front windshield wiper, rear window wiper and washer systems, refer to Section 9.7, "Window Wiper/Washer Windshield Wiper Motor."*

a. Ignition Switch Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.



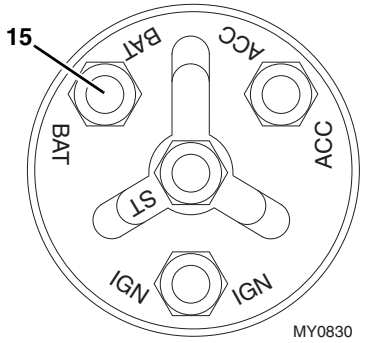
5. Remove the screws securing the dash panel (**13**).
6. Remove hex nut securing ignition key switch (**14**) to the dash.
7. Label and disconnect the ignition switch wires and remove the switch from the machine.

b. Disassembly

DO NOT disassemble the ignition switch. Replace a defective switch with a new part.

c. Inspection and Replacement

To determine proper operation of ignition key switch, test terminals on back of switch for continuity with ohmmeter.



Test ignition key switch for continuity, by checking from BAT terminal (**15**) to each of remaining terminals in their corresponding switch position.

If all terminals do not show proper continuity, replace the ignition switch.

d. Ignition Switch Installation

1. Connect the ignition key switch to the previously labeled wires.
2. Align the ignition switch in the dash so that when it is in the OFF position, the key slot is positioned vertically (straight up and down). Install the hex nut securing the ignition switch to the dash. **DO NOT** overtighten.
3. Install dash panel with previously used hardware.
4. Properly connect the batteries.
5. Close and secure the engine cover.
6. Remove the Do Not Operate Tags from both the ignition key switch and the steering wheel.

Note: *If further information is needed, refer to Section 9.5, "Electrical System Schematics."*

9.11.2 Dash Switches

a. Switch Removal

1. Park machine on a firm, level surface, level machine, fully retract boom, lower boom, place transmission control lever 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 cover. Allow system fluids to cool.
4. Properly disconnect the batteries.

5. Each switch (**16**) is mounted in dash panel (**17**).
6. Pull switch out of dash panel and disconnect harness connector to switch in question.

b. Disassembly

DO NOT disassemble dash panel 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 opening in the dash and snap into position.
3. Properly connect the batteries.
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 Tags from both the ignition key switch and the steering wheel.

9.12 SAE DIAGNOSTIC TROUBLE AND FAULT CODES

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
115	612	2	Red	System Diagnostic Code # 2	Engine Speed/Position Sensor Circuit lost both of two signals from the magnetic pickup sensor—Data Erratic, Intermittent, or incorrect
122	102	3	Amber	Boost Pressure	Intake Manifold Pressure Sensor Circuit—Voltage Above Normal, or Shorted to High Source
123	102	4	Amber	Boost Pressure	Intake Manifold Pressure Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
131	91	3	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor Circuit—Voltage Above Normal, or Shorted to High Source
132	91	4	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor Circuit—Voltage Above Normal, or Shorted to High Source
133	974	3	Red	Remote Accelerator	Remote Accelerator Pedal or Lever Position Sensor Circuit—Voltage Above Normal, or Shorted to High Source
134	974	4	Red	Remote Accelerator	Remote Accelerator Pedal or Lever Position Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
135	100	3	Amber	Engine Oil Pressure	Oil Pressure Sensor Circuit—Voltage Above Normal, or Shorted to High Source
141	100	4	Amber	Engine Oil Pressure	Oil Pressure Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
143	100	18	Amber	Engine Oil Pressure	Oil Pressure Low—Data Valid but Below Normal Operational Range—Moderately Severe Level
144	110	3	Amber	Engine Coolant Temperature	Coolant Temperature Sensor Circuit—Voltage Above Normal, or Shorted to High Source
145	110	4	Amber	Engine Coolant Temperature	Coolant Temperature Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
146	110	16	Amber	Engine Coolant Temperature	Coolant Temperature High—Data Valid but Above Normal Operational Range—Moderately Severe Level
147	91	1	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor Circuit—Abnormal Frequency, Pulse Width, or Period

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
148	91	0	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor Circuit—Abnormal Frequency, Pulse Width, or Period
151	110	0	Red	Engine Coolant Temperature	Coolant Temperature High—Data Valid but Above Normal Operational Range—Most Severe Level
153	105	3	Amber	Temp—Intake Manifold #1	Intake Manifold Air Temperature Sensor Circuit—Voltage Above Normal, or Shorted to High Source
154	105	4	Amber	Temp—Intake Manifold #1	Intake Manifold Air Temperature Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
155	105	0	Red	Temp—Intake Manifold #1	Intake Manifold Air Temperature High—Data Valid but Above Normal Operational Range—Most Severe Level
187	3510	4	Amber	5 Volts DC Supply	Sensor Supply Voltage #2 Circuit—Voltage Below Normal, or Shorted to Low Source
195	111	3	Amber	Coolant Level	Coolant Level Sensor Circuit—Voltage Above Normal, or Shorted to High Source
196	111	4	Amber	Coolant Level	Coolant Level Sensor Circuit—Voltage Above Normal, or Shorted to High Source
197	111	18	Amber	Coolant Level	Coolant Level—Data Valid but Below Normal Operational Range—Moderately Severe Level
221	108	3	Amber	Barometric Pressure	Barometric Pressure Sensor Circuit—Voltage Above Normal, or Shorted to High Source
222	108	4	Amber	Barometric Pressure	Barometric Pressure Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
227	3510	3	Amber	5 Volts DC Supply	Sensor Supply Voltage #2 Circuit—Voltage Above Normal, or Shorted to High Source
234	190	0	Red	Engine Speed	Engine Speed High—Data Valid but Above Normal Operational Range—Most Severe Level
235	111	1	Red	Coolant Level	Coolant Level Low—Data Valid but Below Normal Operational Range—Most Severe Level
237	644	2	Amber	External Speed Input	External Speed Input (Multiple Unit Synchronization)—Data Erratic, Intermittent, or Incorrect
238	3511	4	Amber	System code # 1 Diagnostic	Sensor Supply Voltage #3 Circuit—Voltage Below Normal, or Shorted to Low Source

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
239	3511	3	Amber	System code #2 Diagnostic	Sensor Supply Voltage #3 Circuit—Voltage Above Normal, or Shorted to High Source
241	84	2	Amber	Wheel-based Vehicle Speed	Vehicle Speed Sensor Circuit—Data Erratic, Intermittent, or Incorrect
242	84	10	Amber	Wheel-based Vehicle Speed	Vehicle Speed Sensor Circuit tampering has been detected—Abnormal Rate of Change
244	623	4	Amber	Red Stop Lamp	Red Stop Lamp Driver Circuit—Voltage Below Normal, or Shorted to Low Source
245	647	4	Amber	Fan Clutch Output Device Driver	Fan Control Circuit—Voltage Below Normal, or Shorted to Low Source
271	1347	4	Amber	Fuel Pump Pressurizing Assembly #1	High Fuel Pressure Solenoid Valve Circuit—Voltage Below Normal, or Shorted to Low Source
272	1347	3	Amber	Fuel Pump Pressurizing Assembly #1	High Fuel Pressure Solenoid Valve Circuit—Voltage Above Normal, or Shorted to High Source
285	639	9	Amber	Datalink	Multiplexing PGN Timeout Error—Abnormal Update Rate
286	639	13	Amber	Datalink	Multiplexing Configuration Error—Out of Calibration
288	974	19	Red	Remote Accelerator	Multiplexing Remote Accelerator Pedal or Lever Data Error—Received Network Data In Error
292	441	14	Red	Auxiliary Temperature 1	Auxiliary Temperature Sensor Input 1 —Special Instructions
293	441	3	Amber	OEM Temperature	Auxiliary Temperature Sensor Input # 1 Circuit —Voltage Above Normal, or Shorted to High Source
294	441	4	Amber	OEM Temperature	Auxiliary Temperature Sensor Input # 1 Circuit —Voltage Below Normal, or Shorted to Low Source
295	108	2	Amber	Barometric Pressure	Barometric Pressure Sensor Circuit—Data Erratic, Intermittent, or Incorrect
296	1388	14	Red	Auxiliary Pressure	Auxiliary Pressure Sensor Input 1 —Special Instructions
322	651	5	Amber	Injector Cylinder #01	Injector Solenoid Cylinder #1 Circuit —Current Below Normal, or Open Circuit

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
324	653	5	Amber	Injector Cylinder #03	Injector Solenoid Cylinder #3 Circuit—Current Below Normal, or Open Circuit
331	652	5	Amber	Injector Cylinder #02	Injector Solenoid Cylinder #2 Circuit—Current Below Normal, or Open Circuit
332	654	5	Amber	Injector Cylinder #04	Injector Solenoid Cylinder #4 Circuit—Current Below Normal, or Open Circuit
343	629	12	Amber	Controller #1	Engine Control Module Warning internal hardware failure—Bad Intelligent Device or Component
349	191	16	Amber	Transmission Output Shaft Speed	Transmission Output Shaft Speed—Data Valid but Above Normal Operational Range—Moderately Severe Level
351	627	12	Amber	Controller #1	Injector Power Supply—Bad Intelligent Device or Component
352	3509	4	Amber	5 Volts DC Supply	Sensor Supply Voltage #1 Circuit—Voltage Below Normal, or Shorted to Low Source
386	3509	3	Amber	5 Volts DC Supply	Sensor Supply Voltage #1 Circuit—Voltage Above Normal, or Shorted to High Source
415	100	1	Red	Engine Oil Pressure	Oil Pressure Low—Data Valid but Below Normal Operational Range—Most Severe Level
418	97	15	Amber/ Blinking	Water in Fuel Indicator	Water in Fuel Indicator High—Data Valid but Above Normal Operational Range—Least Severe Level
422	111	2	Amber	Coolant Level	Coolant Level—Data Erratic, Intermittent, or Incorrect
428	97	3	Amber	Water in Fuel Indicator	Water in Fuel Sensor Circuit—Voltage Above Normal, or Shorted to High Source
429	97	4	Amber	Water in Fuel Indicator	Water in Fuel Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
431	-	-	Red	Fuel Sender	Fuel Sender Short to Battery Fault—Fuel Sender Shorted to Battery.
432	558	13	Red	Pedal Low Idle Switch	Accelerator Pedal or Lever Idle Validation Circuit—Out of Calibration
435	100	2	Amber	Engine Oil Pressure	Oil Pressure Sensor Circuit—Data Erratic, Intermittent, or Incorrect

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
441	168	18	Amber	Electrical Potential (Voltage)	Battery #1 Voltage Low—Data Valid but Below Normal Operational Range—Moderately Severe Level
442	168	16	Amber	Electrical Potential (Voltage)	Battery #1 Voltage High—Data Valid but Above Normal Operational Range—Moderately Severe Level
449	157	0	Red	Injector Metering Rail 1	Fuel Pressure High—Data Valid but Above Normal Operational Range—Moderately Severe Level
451	157	3	Amber	Injector Metering Rail 1	Injector Metering Rail #1 Pressure Sensor Circuit—Voltage Above Normal, or Shorted to High Source
452	157	4	Amber	Injector Metering Rail 1	Injector Metering Rail #1 Pressure Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
488	105	16	Amber	Intake Manifold	Manifold 1 Temperature—Data Valid but Above Normal Operational Range—Moderately Severe Level
489	191	18	Amber	Transmission Output Shaft Speed	Transmission Output Shaft Speed—Data Valid but Below Normal Operational Range—Moderately Severe Level
497	1377	2	Amber	Switch Circuit	Multiple Unit Synchronization Switch Circuit—Data Erratic, Intermittent, or Incorrect
515	3514	3	Amber	Not Available	Sensor Supply 6 Circuit—Voltage above normal, or shorted to high source
516	3514	4	Amber	Not Available	Sensor Supply 6 Circuit—Voltage below normal, or shorted to low source
523	611	2	Amber	System code # 1 Diagnostic	OEM Intermediate (PTO) Speed switch Validation—Data Erratic, Intermittent, or Incorrect
527	702	3	Amber	Circuit—Voltage	Auxiliary Input/Output 2 Circuit—Voltage Above Normal, or Shorted to High Source
528	93	2	Amber	Switch—Data	Auxiliary Constrained Operation Curve Validation Switch—Data Erratic, Intermittent, or Incorrect
529	703	3	Amber	Circuit—Voltage	Auxiliary Input/Output 3 Circuit—Voltage Above Normal, or Shorted to High Source
553	157	16	Amber	Injector Metering Rail 1 Pressure	Injector Metering Rail #1 Pressure High—Data Valid but Above Normal Operational Range—Moderately Severe Level

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
555	101	16	Amber	Not Available	Crankcase Pressure—Data Valid But Above Normal Operating Range—Moderately Severe Level
556	101	0	Red	Not Available	Crankcase Pressure—Data Valid But Above Normal Operating Range—Moderately Severe Level
559	157	18	Amber	Injector Metering Rail 1 Pressure	Injector Metering Rail #1 Pressure Low—Data Valid but Below Normal Operational Range—Moderately Severe Level
584	677	3	Amber	Starter Solenoid Lockout Relay Driver Circuit	Starter Relay Driver Circuit—Voltage Above Normal, or Shorted to High Source
595	103	16	Amber	Turbocharger 1 Speed	Turbocharger #1 Speed High—Data Valid but Above Normal Operational Range—Moderately Severe Level
599	640	14	Red	Engine External Protection Input	Auxiliary Commanded Dual Output Shutdown—Special Instructions
649	1378	31	Amber/ Blinking	Engine Oil Change Interval	Change Lubricating Oil and Filter—Condition Exists
687	103	18	Amber	Turbocharger 1 Speed	Turbocharger #1 Speed Low—Data Valid but Below Normal Operational Range—Moderately Severe Level
689	190	2	Amber	Engine Speed	Primary Engine Speed Sensor Error—Data Erratic, Intermittent, or Incorrect
691	1172	3	Amber	Turbocharger #1Compressor Inlet Temperature	Turbocharger 1 Compressor Inlet Temperature Circuit—Voltage Above Normal, or Shorted to High Source
697	1136	3	Amber	Sensor Circuit —Voltage	ECM Internal Temperature Sensor Circuit—Voltage Above Normal, or Shorted to High Source
698	1136	4	Amber	Sensor Circuit —Voltage	ECM Internal Temperature Sensor Circuit - Voltage Below Normal, or Shorted to Low Source
731	723	7	Amber	Engine Speed Sensor #2	Mechanical Misalignment Between Camshaft and Crankshaft Sensors—Mechanical System Not Responding Properly or Out of Adjustment
952	524286	31	Amber	Not Available	Reserved for temporary use—Condition Exists

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
953	524286	31	Amber	Not Available	Reserved for temporary use—Condition Exists
1117	627	2	None	Power Supply	Power Lost With Ignition On—Data Erratic, Intermittent, or Incorrect
1239	2623	3	Amber	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor 2 Circuit —Voltage Above Normal, or Shorted to High Source
1241	2623	4	Amber	Not Available	Accelerator Pedal or Lever Position Sensor 2 Circuit —Voltage Below Normal, or Shorted to Low Source
1242	91	2	Red	Accelerator Pedal Position	Accelerator Pedal or Lever Position Sensor 1 and 2—Data Erratic, Intermittent, or Incorrect
1695	3513	3	Amber	Not Available	Sensor Supply 5—Voltage Above Normal, or Shorted to High Source
1696	3513	4	Amber	Not Available	Sensor Supply 5—Voltage Below Normal, or Shorted to Low Source
1843	101	3	Amber	Not Available	Crankcase Pressure Circuit—Voltage Above Normal, or Shorted to High Source
1844	101	4	Amber	Not Available	Crankcase Pressure Circuit—Below Normal, or Shorted to Low Source
1852	97	16	Amber	Water in Fuel Indicator	Water in Fuel Indicator—Data Valid but Above Normal Operational Range—Moderately Severe Level
1896	2791	13	Amber	Not Available	EGR Valve Controller—Out of Calibration
1911	157	0	Amber	Injector Metering Rail	Injector Metering Rail 1 Pressure—Data Valid but Above Normal Operational Range—Most Severe Level
1938	3597	18	Amber	Not Available	ECU Power Output Supply Voltage 1—Data Valid But Below Normal Operating Range—Moderately Severe Level
1939	3597	3	Amber	Not Available	ECU Power Output Supply Voltage 1—Voltage Above Normal, or Shorted to High Source
1941	3597	4	Amber	Not Available	ECU Power Output Supply Voltage 1—Voltage Below Normal, or Shorted to Low Source
1942	101	2	Amber	Not Available	Crankcase Pressure—Data Erratic, Intermittent or Incorrect

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
1974	101	15	Amber/ Blink- ing	Not Available	Crankcase Pressure—Data Valid But Above Normal Operating Range—Least Severe Level
2185	3512	3			Sensor Supply 4 Circuit—Voltage above normal, or shorted to high source
2186	611	4	Amber	System code # 1 Diagnostic	Sensor Supply 4 Circuit—Voltage Below Normal, or Shorted to Low Source
2195	703	14			Auxiliary Equipment Sensor Input 3 Engine Protection Critical—Special Instructions
2249	157	1	Amber	Injector Metering Rail 1 Pressure	Injector Metering Rail 1 Pressure—Data Valid but Below Normal Operational Range—Most Severe Level
2272	27	4	Amber	Not Available	EGR Valve Position Circuit—Voltage Below Normal, or Shorted to Low Source
2288	103	15	None	Not Available	Turbocharger 1 Speed—Data Valid But Above Normal Operating Range—Least Severe Level
2311	633	31	Amber	Fuel Control Valve #1	Fueling Actuator #1 Circuit Error—Condition Exists
2321	190	2	None	Engine Speed	Engine Speed / Position Sensor #1—Data Erratic, Intermittent, or Incorrect
2322	723	2	None	Engine Speed Sensor #2	Engine Speed / Position Sensor #2—Data Erratic, Intermittent, or Incorrect
2349	2791	5	Amber	Not Available	EGR Valve Control Circuit—Current below normal or open circuit
2353	2791	6			EGR Valve Control Circuit—Current above normal or grounded circuit
2357	2791	7	Amber	Not Available	EGR Valve Control Circuit—Mechanical system not responding or out of adjustment
2372	95	16			Fuel Filter Differential Pressure—Data Valid But Above Normal Operating Range—Moderately Severe Level
2373	1209	3	Amber	Exhaust Gas Pressure	Exhaust Gas Pressure Sensor Circuit—Voltage Above Normal, or Shorted to High Source

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
2374	1209	4	Amber	Exhaust Gas Pressure	Exhaust Gas Pressure Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
2375	412	3	Amber	Exhaust Gas Recirculation (EGR) Temperature	Exhaust Gas Recirculation (EGR) Temperature Sensor Circuit—Voltage Above Normal, or Shorted to High Source
2376	412	4	Amber	Exhaust Gas Recirculation (EGR) Temperature	Exhaust Gas Recirculation (EGR) Temperature Sensor Circuit—Voltage Below Normal, or Shorted to Low Source
2377	647	3	Amber	Fan Clutch Output Device Driver	Fan Control Circuit—Voltage Above Normal, or Shorted to High Source
2448	111	17	Amber/ Blink-ing	Coolant Level	Coolant Level—Data Valid But Below Normal Operating Range—Least Severe Level
2468	190	0			Engine Crankshaft Speed/Position—Data Valid But Above Normal Operating Range—Moderately Severe Level
2554	1209	2	Amber	Not Available	Exhaust Gas Pressure—Data Erratic, Intermittent or Incorrect
2555	729	3	Amber	Inlet Air Heater Driver #1	Intake Air Heater #1 Circuit—Voltage Above Normal, or Shorted to High Source
2556	729	4	Amber	Inlet Air Heater Driver #1	Intake Air Heater #1 Circuit—Voltage Below Normal, or Shorted to Low Source
2646	110	31	Amber	Not Available	Engine Coolant Temperature—Condition Exists
2765	2797	13	None	Not Available	Engine Injector Bank 1 Barcodes —Out of Calibration
2961	412	15	None	Engine Intake Valve Actuator #12	Exhaust Gas Recirculation (EGR) Temperature—Data Valid But Above Normal Operating Range—Least Severe Level
2973	102	2	Amber	Boost Pressure	Intake Manifold Pressure Sensor Circuit—Data Erratic, Intermittent, or Incorrect Circuit—Voltage Below Normal, or Shorted to Low Source
3139	3667	3	Amber		Engine Air Shutoff Circuit—Voltage above normal, or shorted to high source

Fault Codes	SPN Codes	FMI Codes	Lamp Color	SPN Description	Cummins Description
3141	3667	4	Amber		Engine Air Shutoff Circuit—Voltage below normal, or shorted to low source
3186	1623	9	Amber		Tachograph Output Shaft Speed—Abnormal update rate
3213	1623	2	Amber		Tachograph Output Shaft Speed—Received Network Data In Error
3222	520435	12	Amber		Glow Plug Module—Bad intelligent device or component
3326	91	9	Red		Multiplexed Accelerator Pedal or Lever Sensor System—Abnormal update rate
3328	191	9	Amber		Transmission Output Shaft Speed—Abnormal update rate
3727	5571	7	NA		High Pressure Common Rail Fuel Pressure Relief Valve—Mechanical system not responding or out of adjustment
3737	1675	11	NA		Engine Starter Mode Overcrank Protection—Condition Exists
3918	5421	13	Amber		Engine Turbocharger Wastegate Actuator—Out of Calibration
3921	5421	7	Amber		Engine Turbocharger Wastegate Actuator—Mechanical system not responding or out of adjustment
3922	5421	5	Amber		Engine Turbocharger Wastegate Actuator—Current below normal or open circuit
3923	5421	6	Amber		Engine Turbocharger Wastegate Actuator—Current above normal or grounded circuit
3924	520553	11	Amber		Utility Reverse kW Fault—Condition Exists
3925	1188	2	Amber		Engine Turbocharger Wastegate Actuator 1 Position—Data erratic, intermittent or incorrect
3927	5421	11	Amber		Engine Turbocharger Wastegate Actuator—Root Cause Not Known
3928	5421	11	Amber		Engine Turbocharger Wastegate Actuator—Condition Exists

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