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SKY TRAK®

Model MMV



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SERVICE MANUAL

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EFFECTIVITY PAGE

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Safety Practices

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1.1 INTRODUCTION

JLG (hereafter, **JLG**) products meet all applicable industry safety standards. **JLG** actively promotes safe practices in the use and maintenance of its products through training programs, instructional manuals and the pro-active efforts of all employees involved in engineering, design, manufacture, marketing and service.

This manual is designed to provide service technicians with complete information on the maintenance and repair of the Sky Trak MMV Telescopic Material Handler.

Particular effort has been made to produce a manual to serve as a reference handbook for the experienced service technician, but also provide essential step-by-step procedures for the professional development of the less experienced person. Remember, even the best manual in the world is no substitute for an appropriate education, skill development that comes through experience alone, safety, wise and judicious discernment, and ultimately, proper performance of service procedures.

This service manual provides general directions for accomplishing service and repair procedures with tested, effective techniques. 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. Prior to performing any maintenance on the vehicle, consider all factors, circumstances and conditions which can have an effect upon the safety of personnel and equipment, and take appropriate action to ensure the safety of all involved.

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 to satisfy a situation not covered sufficiently, consult the local **JLG** Authorized Service Center (ASC) or the **JLG** Service Department at 1-877-554-5438 or 1-717-485-5161.

Many factors contribute to unsafe conditions; carelessness, fatigue, overload, inattentiveness, unfamiliarity, even drugs and alcohol, among others. Although equipment damage can usually be repaired in a brief period of time, death and irreparable injury are permanent. 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 vehicle.

Provisions for supplementary information are made by **JLG** in the form of Service Bulletins, Service Campaigns, Service Training Schools, the **JLG** web site, other literature, and through updates to the manual itself. Comments and suggestions for improvement are welcome and encouraged.

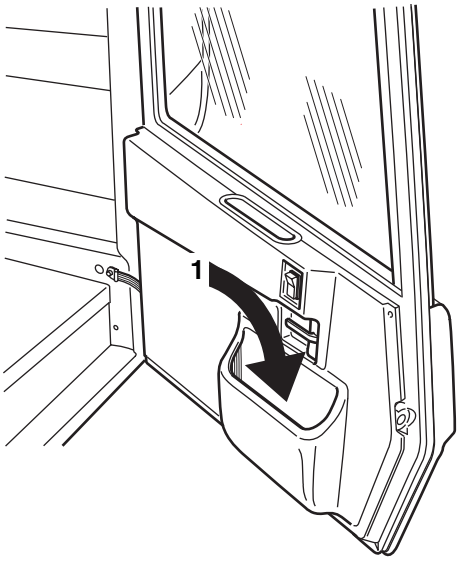
All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. **JLG** reserves the right to make changes and improvements to its products, and to discontinue the manufacture of any product, at its discretion at any time without public notice or obligation.

1.2 OWNERS/OPERATORS MANUAL

The vehicle must be driven and operated as a consequence of, or when performing, service, maintenance and test procedures. The service technician must, therefore, thoroughly read, understand and follow the Sky Trak MMV Telescopic Material Handler Owners/Operators Manual.

An Owners/Operators and EMI Safety Manuals are supplied with each vehicle and must be kept in the pocket (**1**) located in the lower door in the cab.

In the event that the Owners/Operators or Safety Manuals are missing, consult the local **JLG** Authorized Service Center (ASC) or the **JLG** Service Department before proceeding.



MM2240

1.3 TRAINING MECHANICS AS OPERATORS

Because it is necessary to move the vehicle to service or maintain the vehicle, it is necessary that all mechanics are OSHA trained and certified as operators. A mechanic trained in the proper operation of the vehicle can better determine whether all the functions are operating correctly.

At the time of original purchase, the purchaser of this vehicle was instructed by the seller on its proper use. When this vehicle is to be serviced or maintained by someone other than the purchaser, make certain that the mechanic is trained, in accordance with the OSHA regulations listed in the NOTICE below, and reads and understands the Sky Trak MMV Telescopic Material Handler Owners/Operators Manual before operating or maintaining the vehicle.

NOTICE: Under OSHA rules, it is the responsibility of the employer to provide operator training. Successful completion and certification of Safety Training for Rough Terrain Forklifts is required. Operator Training Kits are available by calling Ken Cook Company at (414) 466-6060. An order form for these kits is available through our website, http://www.jlg.com.

In addition, make sure that the mechanic has completed a walk-around inspection of the vehicle, is familiar with all decals and/or decal plates on the vehicle, and has demonstrated the correct use of all controls.

1.4 SAFETY INFORMATION

The following information provides general safety instructions, including examples of hazard statements with signal words, notification of hazards, methods to help avoid hazards and the consequences of failing to follow the safety information. To avoid possible death or injury, carefully read and follow all safety messages. Fully understand the potential causes of death or injury.

In the event of an accident, know where to obtain medical assistance, 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 ensure personal safety.

The information in this manual does not replace any other safety rules or proper judgment. Governmental authorities and employers also have their own sets of rules, codes, regulations and laws. Before starting work at a worksite, check with the supervisor or safety coordinator and ask about the safety policy. Learn the safety requirements in effect before operating, maintaining, servicing or testing the vehicle. Safety depends on following safety requirements.

1.4.1 Safety Alert Symbol

The exclamation mark within a triangle is the Safety Alert Symbol.



OP0330

This symbol means **"Attention! Become Alert! Your Safety Is Involved!"** The symbol is used to attract attention to safety hazards found on the vehicle safety decals and/or decal plates throughout this manual.

1.4.2 Hazard Statements

Signal words and messages are used in conjunction with the safety alert symbol to create hazard statements. These hazard statements convey important information about safety.

Four types of hazard statements are used in this manual. Each statement indicates the existence and degree of relative risk of the hazard described within the statement that follows the signal word.

Explanations of the types of hazard statements are as follows:

DANGER:

The signal word **"DANGER"** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING:

The signal word **"WARNING"** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION:

The signal word **"CAUTION"** indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION:

The signal word **"CAUTION,"** used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, could result in property damage.

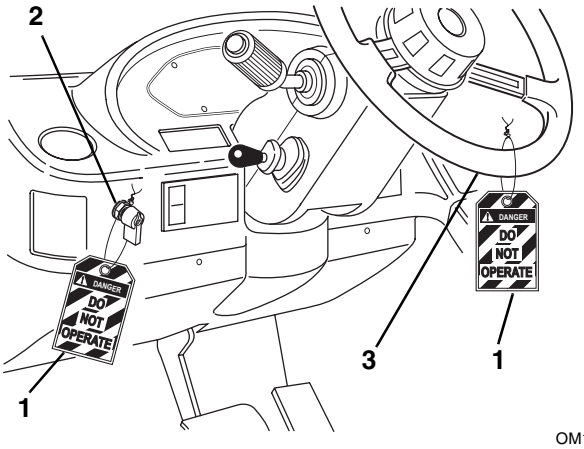
For safe maintenance of the vehicle, read, understand and follow all DANGER, WARNING and CAUTION information.

1.5 ACCIDENT PREVENTION TAG USAGE



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Before beginning any maintenance or service, place an Accident Prevention Tag (**1**) on both the ignition switch (**2**) and steering wheel (**3**), stating that the vehicle should not be operated. Actual Accident Prevention Tags, that can be punched out and used, are included as the last page in this manual. Retain these Accident Prevention Tags for reuse at a later date.



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1.6 SAFETY INSTRUCTIONS

Following are general safety statements to consider ***before*** performing maintenance procedures on a vehicle. 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 hazard occurs.

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

1.6.1 Personal Hazards

HAIR and CLOTHING: **DO NOT** wear loose clothing or jewelry. Tie up or restrain hair. Wear the correct safety equipment for the job (including but not limited to: hard hat; safety shoes; safety glasses, goggles, or face shield; heavy gloves; hearing protection; reflective clothing; wet-weather gear; respirator or filter mask).

EYE PROTECTION: Always wear appropriate eye protection when chiseling, grinding, sanding, welding, painting, repairing hydraulic systems, or checking, testing or charging the battery.

BREATHING PROTECTION: Wear respiratory protection when grinding or painting.

HEARING PROTECTION: Always wear hearing protection in a high-noise area.

FOOT PROTECTION: Wear protective footwear with reinforced toe caps and slip-resistant soles.

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

OWNERS/OPERATORS MANUAL: Before operating the vehicle, carefully read, understand and follow the Owners/Operators Manual.

OPERATIONAL PROTECTION: Before operating the vehicle or returning it for operational use, check that the operator's protective structure is intact, undamaged, unmodified and secure.

LIFTING OF EQUIPMENT: Before using any lifting equipment (chains, slings, brackets, hooks, etc.), verify that it is of the proper capacity, in good working condition and 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 or jack to support raised equipment. A hoist or jack failure can allow the equipment to fall or tip.

Always support equipment with proper capacity blocks or stands that are properly rated for the load.

COMPRESSED AIR: Before and during the use of compressed air, wear eye protection and advise other personnel in the work area that compressed air is about to be used.

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, and 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. 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 vehicle to capture fluid run-off.

1.6.4 Operational Hazards

OPERATIONAL CONSIDERATIONS: Before operating the vehicle, carefully read, understand and follow the Owners/Operators Manual.

ENGINE: Stop the engine before performing any service.

DANGEROUS START: Place Accident Prevention Tags on both the ignition switch and steering wheel before attempting to perform any service or maintenance. Disconnect battery leads. Place a warning sign on vehicles that are dangerous to start, if leaving the vehicle unattended.

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

RADIATOR CAP: Always wear steam-resistant, heat-protective gloves when opening the radiator cap. Cover cap with a clean, thick cloth and turn slowly to the first stop to relieve pressure.

SOFT SURFACES AND SLOPES: **NEVER** work on a vehicle that is parked on a soft surface or slope (inclined ground or hill). The vehicle must be on a hard, level surface with the wheels blocked when performing any service. Obtain assistance, block all wheels, and add supports if necessary before beginning any work.

SUPPORTS AND STRAPS: Install safe, stable supports, slings or straps, beneath or around a component or structural member before beginning any work.

FLUID PRESSURE: Before loosening any hydraulic or diesel fuel component, hose or tube, turn 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 fuel leaking under pressure can explode. Hydraulic fluid and diesel fuel leaking under pressure can penetrate the skin, causing infection, gangrene, and other serious personal injury.

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 engine or applying pressure, use components, parts, hoses and pipes that are in good condition, connected properly, and tightened to the proper torque. Capture fluid in an appropriate container and dispose of it in accordance with prevailing environmental regulations.

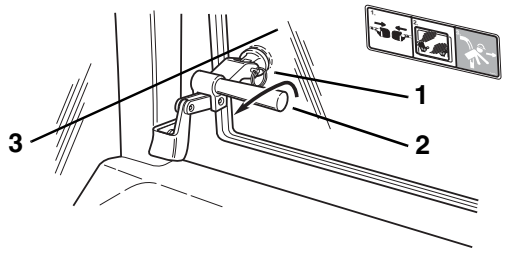
PRESSURE TESTING: When conducting any test, only use test equipment that is correctly calibrated and in good condition. Use the correct equipment in the proper manner, and make changes or repairs as indicated by the test procedures to achieve the desired results.

LEAVING VEHICLE: Lower the attachment to the ground before leaving the vehicle.

TIRE PRESSURE: Always keep tires inflated to the proper pressure to help prevent dangerous travel and load-handling situations. **DO NOT** over-inflate tires.

1.7 EMERGENCY EXIT REAR WINDOW

The rear window in the enclosed cab can be used as an emergency exit by removing the latch pins (**1**) located on the two window latches (**2**). Once the latch pins have been removed, the window (**3**) can be swung open.



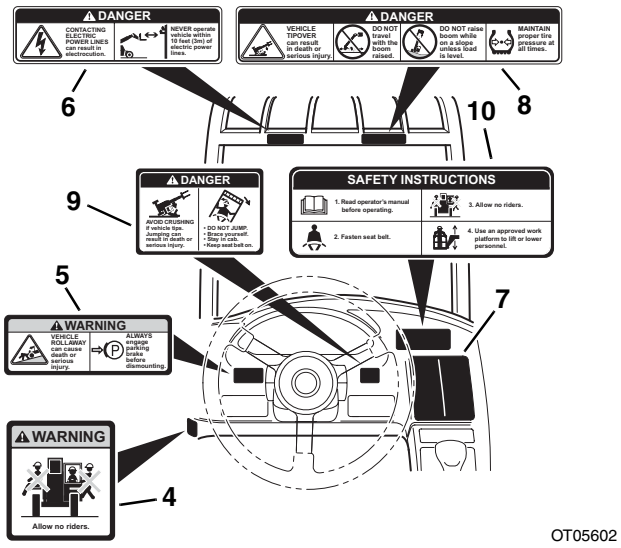
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1.8 HAZARD/EMERGENCY INFORMATION SIGNS

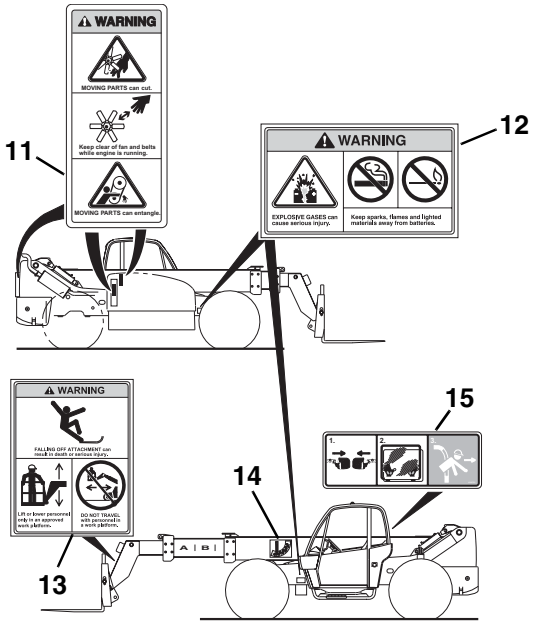
Locations of vehicle hazard and other emergency information signs are shown below. As part of routine maintenance, check that ALL hazard and emergency information signs on the vehicle are present and readable. Keep all signs clean.

If a replacement sign is needed, refer to the Owners/Operators Manual and parts catalog for the latest parts numbers and ordering information. Or, contact JLG Inc. directly at:

Domestic: 1-877-554-5438
or
International: 1-717-485-5161



OT05602



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4. No Riders WARNING	10. Safety Instructions
5. Vehicle Rollaway WARNING	11. Moving Parts WARNING
6. Electrocution DANGER	12. Explosive Gases WARNING
7. Load Chart Booklet	13. Carrying Personnel WARNING
8. Tipover DANGER - Operating	14. Boom Angle Indicator
9. Do Not Jump DANGER	15. Emergency Exit (Enclosed Cab Only)

Note: *Many of these hazard related signs are available free of charge by calling JLG Inc. at 1-717-485-5161(Domestic) or 1-877-554-5438(International).*

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General Information, Specifications and Maintenance

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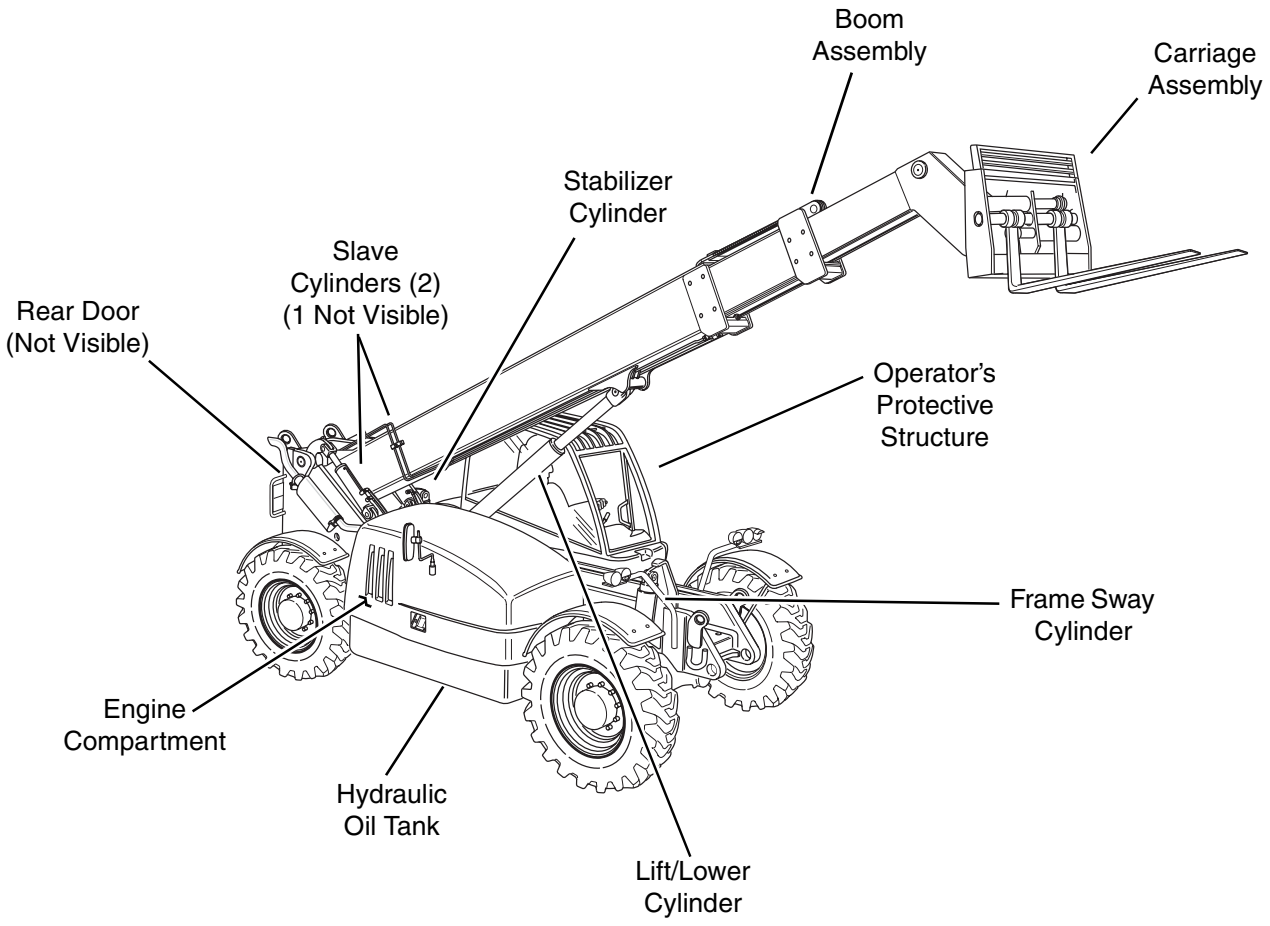


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2.1 MMV COMPONENT TERMINOLOGY

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



MM1731

2.2 INTRODUCTION

2.2.1 Service Methods

Appropriate service methods and proper repair procedures are essential for safe, reliable operation of this vehicle and the safety of the individual doing the work. This Service Manual provides general direction for accomplishing service and repair work with tested, effective techniques. Following them will assure reliability.

There are many variations in procedures, techniques, tools, and parts for servicing vehicles, as well as work skills. This Manual cannot possibly anticipate all such variations and provide advice or cautions for each one. Accordingly, anyone who intends to depart from the instructions in this Manual must first consider personal safety and then vehicle integrity.

IMPORTANT: ***JLG*** *recommends the use of environmentally sound waste storage and disposal practices.* ***NEVER*** *drain fluids on the ground or into a sewer or catch basin. Use suitable collection containers, then store and/or dispose of waste products in an approved and safe manner. Check and obey all Federal, State and/or Local regulations regarding waste storage, disposal and recycling.*

2.2.2 The Owners/Operators Manual

The Owners/Operators Manual provides information you need to properly operate and maintain this vehicle.

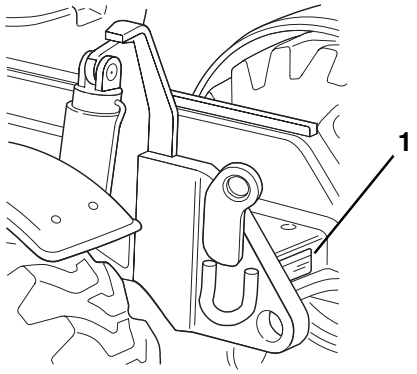
IMPORTANT: *Before you operate this vehicle, read the manual completely and carefully, so that you will understand the safety instructions and the operation of the controls and safety equipment. You must comply with all Danger, Warning, and Caution notices. They are for your benefit.*

All references to the right side, left side, front, and rear are given from the operator's seat looking in a forward direction.

2.2.3 Replacement Parts and Warranty Information

For reference when ordering replacement parts or making service inquiries about the vehicle, the vehicle serial number is required to help assure the provision of correct parts and information. Before ordering parts or initiating service inquiries, make note of the serial number.

The vehicle serial number plate (**1**) is located on the front of the main frame.



OM1370

IMPORTANT: *The replacement of any part on this vehicle with any other than a* ***JLG*** *authorized replacement part can adversely affect the performance, durability, or safety of the vehicle, 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** Authorized Service Center (ASC), signed by the purchaser, and returned to **JLG** when the vehicle 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**.

2.2.4 Disclaimer

JLG reserves the right to make changes to and to add improvements upon its product at any time, without public notice or obligation. **JLG** also reserves the right to discontinue manufacturing any product at its discretion at any time.



2.3 TORQUES

2.3.1 Fasteners

All fasteners (nuts, bolts, washers, etc.) are equal to SAE Grade 5 (PC8.8) and are plated, unless otherwise specified.

2.3.2 Bolts and Nuts

Unless otherwise specified, the following values apply for Grade 5 (PC8.8) nuts and bolts:

Size	Torque		Size	Torque	
Inch	lb/ft	Nm	mm	Nm	lb/ft
1/4	9	12	6.0	10	7
5/16	17	24	8.0	25	18
3/8	31	42	10.0	50	37
7/16	50	68	--	--	--
1/2	75	102	12.0	80	59
9/16	110	150	14.0	130	95
5/8	150	203	16.0	200	146
3/4	250	340	20.0	360	263
7/8	380	515	22.0	510	372
1.0	585	793	24.0	650	475

2.3.3 Straight Thread O-ring Fitting (Non-Adjustable)

When the vehicle leaves the factory, it is equipped only with straight thread o-ring fittings. Customer-added accessories may differ; therefore, consult the manufacturer's product literature for information.

1. Verify that both threads and sealing surfaces are free of burrs, nicks, scratches, and any foreign material.
2. Lubricate the new o-ring with a light coating of hydraulic oil.
3. Tighten fitting to the proper torque according to the following chart:

SAE Size	Torque	
	lb/ft	Nm
4	15-17	20-23
6	34-36	46-49
8	58-62	79-84
10	100-110	136-149
12	134-146	181-198
16	202-218	274-296
20	248-272	336-369
24	303-327	411-443

2.3.4 Straight Thread O-ring Fitting (Adjustable)

When the vehicle leaves the factory, it is equipped only with straight thread o-ring fittings. Customer-added accessories may differ; therefore, consult the manufacturer's product literature for information.

1. Verify that both mating parts are free of burrs, nicks, scratches, and any foreign material.
2. Lubricate the new o-ring with a light coat of hydraulic oil.
3. Back off the locknut as far as possible.
4. Screw the fitting into the port by hand until the back-up washer contacts the face of the port and is pushed all the way towards the locknut.
5. To position the fitting, unscrew by the required amount, but not more than one full turn.
6. Hold the fitting in the desired position and tighten to the proper torque according to the following chart:

Adjustable Straight-Thread O-ring Fitting Torque Chart		
SAE Size	Torque	
	lb/ft	Nm
4	15-17	20-23
6	34-36	46-49
8	58-62	79-84
10	100-110	136-149
12	134-146	181-198
16	202-218	274-296
20	248-272	336-369
24	303-327	411-443

2.3.5 Flat-Face O-ring Fittings

When the vehicle leaves the factory, it is equipped only with straight thread o-ring fittings. Customer-added accessories may differ; therefore, consult the manufacturer's product literature for information.

Improper assembly of this type of joint will result in a leaking joint. Under tightening will result in the joint loosening during normal use. Foreign material on either sealing surfaces will cause damage to one or both mating parts when the joint is tightened, resulting in a leaking joint. The absence of the fitting o-ring will cause the joint to leak.

1. Verify that both threads and sealing surfaces are free of burrs, nicks, scratches, and any foreign material.
2. Inspect the male fitting for the presence of the o-ring seal. Replace the o-ring if missing or damaged.
3. Place the flat surface of the female connector in full contact with the o-ring in the male connector.
4. Finger tighten the nut onto the fitting.
5. Hold the fitting in the desired position, for hoses and swivel fittings, use a second wrench to keep the female connector from moving during tightening. Tighten to the proper torque according to the following chart:

SAE Size	Torque	
	lb/ft	Nm
4	19-36	26-49
6	28-54	38-73
8	42-80	57-108
10	65-126	88-171
12	100-180	136-244
16	130-240	176-325
20	150-280	203-380
24	175-330	237-447

2.4 METRIC CONVERSION FACTORS

2.4.1 Approximate American to Metric Conversions

When this is known	*Multiply by*	*To Find*
TORQUE (moment of force)		
Pound/feet (lb/ft)	1.356	Newton meters (Nm)
Pound/inches (lb/in)	0.113	Newton meters (Nm)
POWER		
Horsepower (hp)	745.7	Watts
SPEED (velocity)		
Miles per hour (mph)	1.609	Kilometers per hour (km/hr; kph)
LENGTH (distance)		
Inches (in)	25.4	Millimeters (mm)
Inches (in)	2.5	Centimeters (cm)
Feet (ft)	30.5	Centimeters (cm)
Feet (ft)	0.305	Meters (m)
Yards (yd)	0.9	Meters (m)
Miles (mi)	1.6	Kilometers (km)
AREA		
Square inches (in^2)	6.5	Square centimeters (cm^2)
Square feet (ft^2)	0.09	Square meters (m^2)
Square yards (yd^2)	0.8	Square meters (m^2)
Square miles (mi^2)	2.6	Square kilometers (km^2)
Acres	0.4	Hectares (ha)
MASS (weight)		
Ounces (oz)	28.3	Grams (g)
Pounds (lb)	0.4536	Kilograms (kg)
Short tons (2000 lb)	0.9	Metric ton (t)



VOLUME		
Teaspoons (tsp)	5	Milliliters (ml)
Tablespoons (Tbsp)	15	Milliliters (ml)
Cubic inches (in^3)	16	Milliliters (ml)
Fluid ounces (fl oz)	30	Milliliters (ml)
Cups (c)	0.24	Liters
Pints (pt)	0.47	Liters
Quarts (qt)	0.95	Liters
Gallons (gal)	3.8	Liters
Cubic feet (ft^3)	0.03	Cubic meters (m^3)
Cubic yards (yd^3)	0.76	Cubic meters (m^3)
AIR PRESSURE		
Pounds per square inch (psi)	6.895	Kilopascals (kPa)
HYDRAULIC PRESSURE		
Pounds per square inch (psi)	0.069	Bar

TEMPERATURE (exact)

To determine degrees Celsius (° C), subtract 32, then multiply by 0.56; (° F -32) x 0.56 = ° C.

2.4.2 Approximate Metric to American Conversions

When this is known	*Multiply by*	*To Find*
TORQUE (moment of force)		
Newton meters (Nm)	0,738	Pounds/feet (lb/ft)
Newton meters (Nm)	8,85	Pounds/inches (lb/in)
POWER		
Watts	0,0013	Horsepower (hp)
SPEED (velocity)		
Kilometers per hour (km/hr; kph)	0,621	Miles per hour (mph)
LENGTH (distance)		
Millimeters (mm)	0,0394	Inches (in)
Centimeters (cm)	0,394	Inches (in)
Meters (m)	3,281	Feet (ft)
Meters (m)	1,1	Yards (yd)
Kilometers (km)	0,621	Miles (mi)
AREA		
Square centimeters (cm^2)	0,4	Square inches (in^2)
Square meters (m^2)	1,1	Square yards (yd^2)
Square kilometers (km^2)	0,6	Square miles (mi^2)
Hectares (10000 m^2)	2,5	Acres
MASS (weight)		
Grams (g)	0,035	Ounces (oz)
Kilograms (kg)	2,2	Pounds (lb)
Metric ton (1000 kg) (t)	1,1	Short tons
VOLUME		
Milliliters (ml)	0,03	Fluid ounces (fl oz)
Milliliters (ml)	0,06	Cubic inches (in^3)
Liters	2,1	Pints (pt)
Liters	1,06	Quarts (qt)
Liters	0,26	Gallons (gal)
Cubic meters (m^3)	35	Cubic feet (ft^3)
Cubic meters (m^3)	1,3	Cubic yards (yd^3)
AIR PRESSURE		
Kilopascals (kPa)	0,145	Pounds per square inch (psi)
HYDRAULIC PRESSURE		
Bar	14,5	Pounds per square inch (psi)

TEMPERATURE (exact)

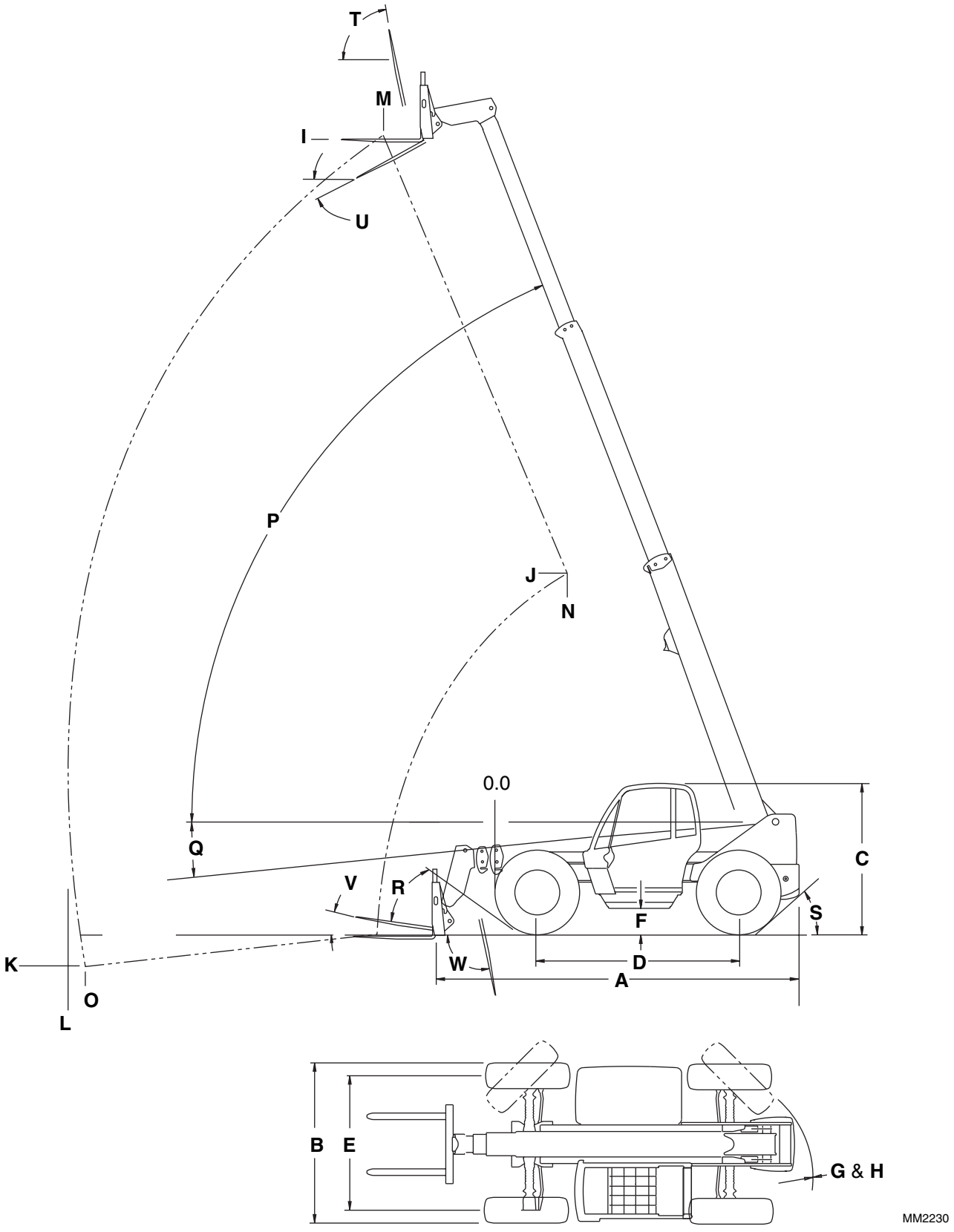
To determine degrees Fahrenheit (° F), multiply degrees Celsius (° C) by 1.8, then add 32; (° C x 1.8) + 32 = ° F.

2.5 SPECIFICATIONS

2.5.1 Vehicle Dimensions

With 15.50-25 Radial Tires

Description	Specifications
(A) Length (without Forks)	248" (6.299 mm)
(B) Width	101" (2.565 mm)
(C) Height (Boom Lowered)	93" (2.362 mm)
(D) Wheelbase	131" (3.327 mm)
(E) Tread Center	84" (2.134 mm)
(F) Ground Clearance (at the bottom of the hydraulic reservoir drain plug)	15.1" (383 mm)
(G) Turning Radius, Curb to Curb	32.5' (9,91 m)
(H) Turning Radius, Clearance	45.5' (13,9 m)
(I) Maximum Lift Height, Boom Extended	42' 4" (12,9 m)
(J) Maximum Lift Height, Boom Retracted	20' 3" (6,2 m)
(K) Maximum Below Grade Depth, Boom Extended	1' 8" (0,5 m)
(L) Maximum Reach, from Front of Front Tires	30' (9,1 m)
(M) Maximum Reach at Maximum Lift Angle, Boom Extended	6' 2" (1,9 m)
(N) Maximum Reach at Maximum Lift Angle, Boom Retracted	-2' 8" (-0,8 m)
(O) Maximum Reach at Minimum Lift Angle, Boom Extended	29' (8,8 m)
(P) Maximum Boom Lift Angle	70.0°
(Q) Minimum Boom Lift Angle	-2.9°
(R) Percentage of Slope of Approach	>45°
(S) Percentage of Slope of Departure	>45°
Fork Tilt Angle:	
(T) At Maximum Boom Angle - UP	84.0°
(U) At Maximum Boom Angle - DOWN	-23.4°
(V) At Minimum Boom Angle - UP	12.2°
(W) At Minimum Boom Angle - DOWN	-30.3°
Frame Sway Angle (Not Shown):	
Right	10.0°
Left	10.0°


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2.5.2 Vehicle Weights

Vehicle Configuration	Front Axle	Rear Axle	Total
Without Carriage	9,250 lbs (4.196 Kg)	17,650 lbs (8.006 Kg)	26,900 lbs (12.202 Kg)
With 11K Carriage	11,200 lbs (5.080 Kg)	16,900 lbs (7.666 Kg)	28,100 lbs (12.746 Kg)
With 7K Carriage	12,900 lbs (5.851 Kg)	16,400 lbs (7.439 Kg)	29,300 lbs (13.290 Kg)
With Both Carriages	14,800 lbs (6.713 Kg)	15,700 lbs (7.122 Kg)	30,500 lbs (13.835 Kg)
Working Weight (Vehicle working weight is figured with one of the configurations listed above, 25%-full fuel tank, and radial tires [no hydrofill]):			
Operating Load 7K Carriage			7,000 lbs (3.175 Kg)
Operating Load 11K Carriage			11,000 lbs (4.989 Kg)

2.5.3 Attachment Weights

Description	Weight
7K Carriage	2,300 lb (1.043 kg)
11K Carriage	1,300 lb (590 kg)

2.5.4 Performance Specifications

Description	Speed
Travel Speed (Radial Tires, No Load):	
First Gear	3.5 mph (5,6 km/hr)
Second Gear	5.7 mph (9,2 km/hr)
Third Gear	13.5 mph (21,7 km/hr)
Fourth Gear	19.4 mph (31,2 km/hr)



2.5.5 Hydraulic Cylinder Performance Specifications

Note: *Vehicle with no load, engine at full throttle, hydraulic oil warm (80° F [27° C] minimum), engine at operating temperature*.

Function	Approximate Times, in Seconds 7K Carriage	Approximate Times, in Seconds 11K Carriage
Boom Extend	17.00	17.00
Boom Retract	23.60	23.60
Boom Lift Retracted	17.50	17.50
Boom Lower Retracted	19.80	19.80
Attachment Tilt - UP	7.60	7.60
Attachment Tilt - DOWN	7.30	7.30
Frame Sway Left to Right with Boom Down	*12.00 to 15.50	*12.00 to 15.50
Frame Sway Left to Right with Boom Above 40° and Emergency Brake Engaged	*17.50 to 33.40	*17.50 to 33.40
Frame Sway Right to Left with Boom Down	*12.00 to 15.50	*12.00 to 15.50
Frame Sway Right to Left with Boom Above 40° and Emergency Brake Engaged	*21.50 to 43.00	*21.50 to 43.00
Fork Side Shift		
Left Cylinder, Right to Left	13.00	13.30
Left Cylinder, Left to Right	22.00	11.40
Right Cylinder, Right to Left	13.00	13.30
Right Cylinder, Left to Right	22.00	11.40

* *All times listed are approximate MAXIMUM times except where noted. Noted times are given as a minimum to maximum range.*

2.5.6 Electrical System

Description	Specifications
Battery:	
Type, Rating	12 VDC, Negative (-) Ground, Maintenance Free
Quantity	2
Reserve Capacity	1225 Cold Cranking amps @ 0° F (-18° C)
Group/Series	HASP-FT
Alternator	24V/70 amps
Fuses - Standard Blade Style:	
Switch Lamps, Service Brake, Hourmeter	2 amps
LMI System	3 amps
Fuel Shut-off Solenoid (FSOS), Transmission Gear, Transmission Direction, Steer Mode, Parking Brake	5 amps
Joystick Logic Panel, Horn, Front Wiper/Washer, Top Wiper/ Washer, Rear Wiper, Left Fork Shift, Right Fork Shift	7.5 amps
Front Dash Display Panel, Ignition Pre-heat, Air Conditioner Condenser Fan Motor	15 amps
Heater, Normal Lights, Blackout Lights	25 amps
Main, Power Window	30 amps
Fuses -	
Battery Equalizer	125 amps
Circuit Breaker	
Ignition Switch	12 volt/ 50 amp
Relays:	
Neutral Engage Relay	12 volt
Work Light Power Relay	24 volt
High Beam Power Relay	24 volt
Brake Light Relay	12 volt
Light Power Relay	12 volt
Blackout Ignition Relay	12 volt
Normal Lights Ignition Relay	12 volt
Reverse Signal Relay	12 volt
Door Window Relay	12 volt
Closed Cab Accessory Power Relay	12 volt
Fuel Shut Off Solenoid Relay	12 volt
Air Conditioner Condenser Fan	12 volt



2.5.7 Engine Performance Specifications

Note: *Engine manufacturer's maximum "high idle" setting is lockwired and sealed.* ***DO NOT*** *disturb this setting.*

Description	Specifications
Engine Make/Model	Cummins Turbo/4BTA3.9
Displacement	239 in^3 (3.9 liters)
Horsepower	116 HP @ 2500 rpm
Number of Cylinders	4
Engine High Idle with No Load	2750 ±100
Engine Low Idle	1050 ±50 rpm
Fuel Delivery	Fuel Injection
Air Cleaner	Dry Type, Replaceable Primary and Safety Elements
Peak Torque	407 lb/ft @ 1500 rpm
Average Fuel Consumption, Depending on Load/Duty	2.67 gal/hr (2,22 Imp gal/hr, or 10,1 l/hr)

2.5.8 Fluid and Lubricant Capacities

Fluid & Lubricant Description	Specifications
Engine Crankcase Oil:	
Capacity with Filter Change	13.3 qt (12,6 liters)
Filter Capacity	1.3 qt (1,2 liters)
Oil Type (Refer to *Section 2.6.5, Engine*.)	Above 23° F (-5° C) use SAE 15W40 Diesel Engine Oil. 23° F (-5° C) to -25° F (-32° C) use 5W30 Below -25° F (-32° C) use 0W30 Oil Meeting MIL-PRF-2104G Specifications is Also acceptable
Fuel Tank:	
Total Capacity	35.5 gal (134 liters)
Usable Capacity	33.5 gal (127 liters)
Type of Fuel Above 32° F (0° C)	Standard No. 2 Diesel. (Refer to *Section 2.6.5, Engine*.)
Type of Fuel Below 32° F (0° C)	50/50 Mix of #1 and #2 Diesel Fuels. (Refer to *Section 2.6.5, Engine*.)
Alternate Fuel	JP-5, JP-8 and Jet A-1
Cooling System:	
Capacity w/o Heater (including 1.5 qt [1,4 liters] for overflow bottle)	12.5 qt (11,8 liters)
Overflow Bottle Capacity	3.0 qt (2,8 liters)
Type of Fluid	50/50-mix of ethylene glycol and water. (Refer to *Section 2.6.5, Engine*.)
Transmission:	
Capacity w/Filter Change	12 qt (11,4 liters)
Filter Capacity	1 qt (1 liter)
Type of Oil (Refer to *Section 2.6.6, Transmission*.)	Above 125° F (50° C) Use MIL-PRF-2104G Grade 15W40 14° F (-10° C) to 125° F (50° C) use MIL-PRF-2104G Grade 10W30 (Universal Tractor Fluid) Below 14° F (-10° C) use DEXRON lll (Automatic Transmission Fluid)
Transfer Case:	
Capacity	1.5 qt (1,4 liters)
Type of Oil (Refer to *Section 2.6.1, Axles (Differential Housings) and Transfer Case*.)	Above 100° F (38° C) use MIL-PRF-2104G Grade 15W40 Below 100° F (38° C) use MIL-PRF-2104G Grade 10W30 (Universal Tractor Fluid)
Axle (Differential Housing):	
Capacity	10.5 qt (10,0 liters)
Type of Oil (Refer to *Section 2.6.1, Axles (Differential Housings) and Transfer Case*.)	Above 100° F (38° C) use MIL-PRF-2104G Grade 15W40 Below 100° F (38° C) use MIL-PRF-2104G Grade 10W30 (Universal Tractor Fluid)



Fluid & Lubricant Description	Specifications
Axle (Wheel Ends):	
Capacity	1.3 qt (41.6 fl oz, or 1,2 liters)
Type of Oil (Refer to *Section 2.6.1, Axles (Differential Housings) and Transfer Case*.)	Above 100° F (38° C) use MIL-PRF-2104G Grade 15W40 Below 100° F (38° C) use MIL-PRF-2104G Grade 10W30 (Universal Tractor Fluid)
Hydraulic System:	
System Capacity	41.3 gal (156 liters)
Reservoir Capacity	28.5 gal (108 liters)
Type of Oil (Refer to *Section 2.6.4, Hydraulic System*.)	14° F (-10° C) & Above use MIL-PRF-2104G Grade 10 Hydraulic Oil 125° F (50° C) & Below use DEXRON lll (Automatic Transmission Fluid)

2.5.9 Hydraulic System

Description	Specifications
Valve Relief Settings:	
Main System Relief	3500 ±100 psi (241 ±6,9 bar)
Port Relief Boom - Hoist/Lower/Extend/Retract	3200 ±100 psi (220,6 ±6,9 bar)
Port Relief Fork Tilt (Both Sides)	3500 ±100 psi (241 ±6,9 bar)
Stabilizer Cylinder	75-150 psi (5,2-10,3 bar)
Power Steering Relief	2500 ±100 psi (172,3 ±7 bar)
Standby Pressure	200 ±50 psi (13,8 ±3,4 bar)
Pilot Pressure	550 ±100 psi (37,9 ±7 bar)
Parking Brake Relief	650 ±50 psi (44.8 ±3,4 bar)

2.5.10 Tires

Description	Specifications
Tire Size	15.5R25, L-2, (2 Star Minimum) Radial
Wheel Lug Nut Torque	430-470 lb/ft (583-637 Nm)
Air Pressure	87 psi (600 kPa)
Tire Footprint Area (area is established under max. tip load):	
Vehicle with 7K Carriage with No Load (15.5R25, L-2, 2 Star tires at specified air pressure):	126 in^2 (810 cm^2)
Vehicle with 7K Carriage with Rated Load (15.5R25, L-2, 2 Star tires at specified air pressure):	183 in^2 (1.180 cm^2)
Vehicle with 11K Carriage with No Load (15.5R25, L-2, 2 Star tires at specified air pressure):	129 in^2 (835 cm^2)
Vehicle with 11K Carriage with Rated Load (15.5R25, L-2, 2 Star tires at specified air pressure):	209 in^2 (1.350 cm^2)
Maximum Ground Pressure (maximum ground pressure at tip = (machine weight + load) / (2 x footprint area):	
Vehicle with 7K Carriage with No Load (15.5R25, L-2, 2 Star tires at specified air pressure):	156 psi (1.070 kPa)
Vehicle with 7K Carriage with Rated Load (15.5R25, L-2, 2 Star tires at specified air pressure):	174 psi (1.200 kPa)
Vehicle with 11K Carriage with No Load (15.5R25, L-2, 2 Star tires at specified air pressure):	152 psi (1.050 kPa)
Vehicle with 11K Carriage with Rated Load (15.5R25, L-2, 2 Star tires at specified air pressure):	185 psi (1.275 kPa)

2.5.11 Miscellaneous Specifications

Description	Specifications
Steering Wheel:	
Maximum Number of Turns, Lock to Lock	4.25 turns
Minimum Number of Turns, Lock to Lock	3.75 turns

2.5.12 Tamper Proofing

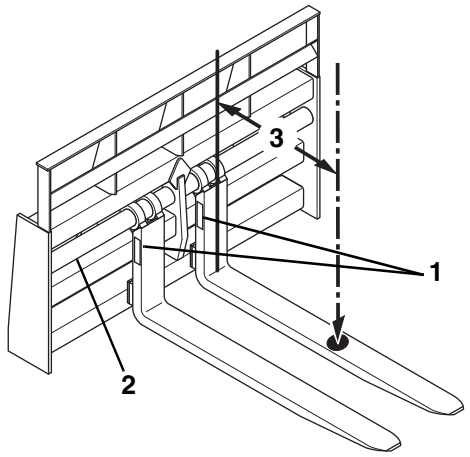
A tamper-proof means is in place on the following adjustable components prior to machine shipment. This can either be tamper-proof paint, or a steel tamper-proof cap. **DO NOT** attempt to defeat, by-pass or alter any tamper-proof device.

- Main Valve Port Relief Valves [5]
- Fork Cylinder Counterbalance Valves [2]
- Secondary Function Manifold Valves [2]
- Unloader Valve [2]
- Main System Relief Valve [1]

2.5.13 Fork Ratings

All approved forks for this vehicle are marked with a maximum load capacity rating. This rating (**1**) is stamped on the right edge of the fork just below the fork pivot shaft (**2**). The rating is listed in U.S. pounds and based upon a 24" (610 mm) load center (**3**) (11K carriage) or 48" (1219 mm) load center (**3**) (7K carriage). This rating specifies the maximum load capacity that the individual fork can safely carry at the maximum specified load center.

Since forks are always used in multiples, the total rating of any combination of forks will be the sum of their rated capacity. All forks should be used in matched pairs.



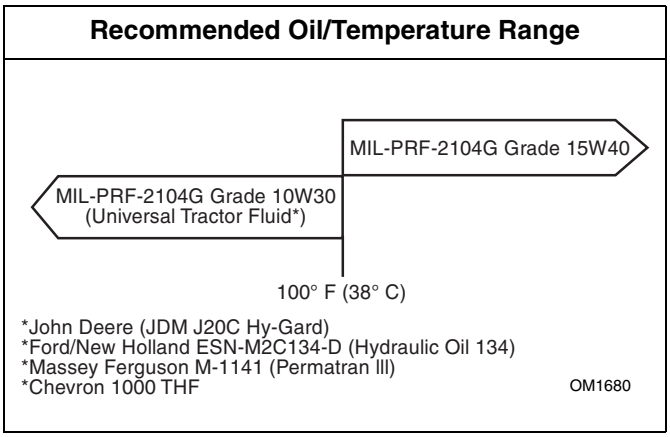
WARNING: **DO NOT** exceed the total rated capacity of the specific pair of forks being used. Forks can break causing loss of load and possible death or serious personal injury to the operator or personnel in the area. If the total rated capacity of the forks exceeds the capacity of the vehicle, the vehicle capacity should not be exceeded.

The maximum load capacity for this vehicle is 7,000 pounds (3.175 Kg) for the 7K carriage or 11,000 pounds (4.989 Kg) for the 11K carriage. The matched pair or set of forks used on this vehicle should have total load ratings which equal or exceed these weights. When the load rating of the vehicle differs from the load capacity of the forks, the lower value becomes the overall load capacity.

2.6 FLUIDS, LUBRICANTS AND CAPACITIES

2.6.1 Axles (Differential Housings) and Transfer Case

a. Axle and Transfer Case Lubricants



In general, use a oil that meets the following specifications:

Nominal viscosity at 104° F (40° C) ..... 55 cSt

Minimum viscosity at 212° F (100° C) ..... 9.1 cSt

Pour point (Maximum) .....-32° F (-36° C)

Flash point (Minimum) ..... 392° F (200° C)

Minimum viscosity index..... 135

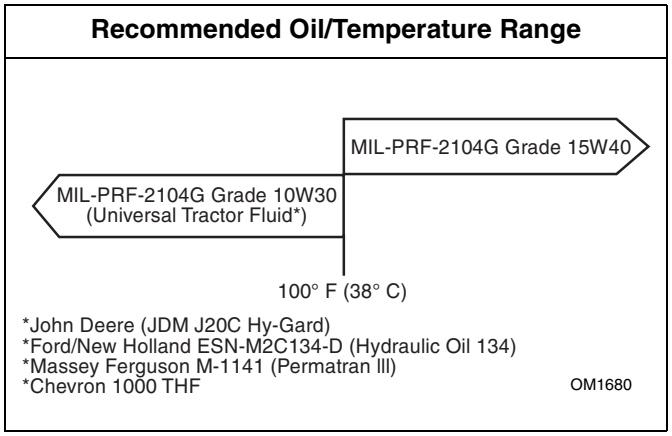
b. Axle and Transfer Case Capacities

Axles (differential housings) ..... 10.5 qt (10,0 liters)

Transfer case..... 1.5 qt (1,4 liters)

2.6.2 Wheel Ends

a. Wheel-End Lubricants



In general, use a oil that meets the following specifications:

Nominal viscosity at 104° F (40° C) ..... 55 cSt

Minimum viscosity at 212° F (10° C)..... 9.1 cSt

Pour point (Maximum)..... -32° F (-36° C)

Flash point (Minimum).....392° F (200° C)

Minimum viscosity index 135

DO NOT add additional friction modifier to factory-filled wheel ends. All wheel ends are factory-filled by the manufacturer with oil. If a wheel end is drained for service, it should be refilled with the gear oils listed.

***Note: DO NOT** use synthetic oil without the express written consent of the manufacturer.*

b. Wheel-End Capacity

Wheel ends ..... 1.3 qt (41.6 fl oz, or 1,2 liters)

2.6.3 Lubrication Points (Grease Fittings)

Lubricants

When lubricating any component via the grease fittings, use multi-purpose lithium-based grease with EP additives that meets NLGI Grade 2 specifications. Products known to meet these requirements include:

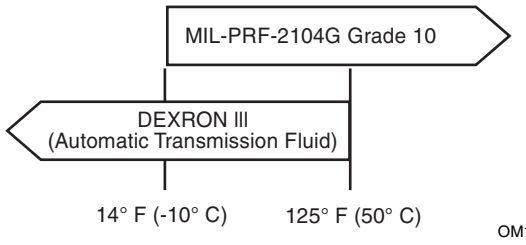
- AMOCO AMOLITH EP2
- ARCO LITHOLINE EP2
- BENZ MOLY-SERVICE EP2
- CHEVRON DUROLITH EP2
- CITGO H EP2
- GULF GULFCROWN EP2
- MOBILE MOBILUX EP2
- SHELL ALVANIA EP2
- SUN PRESTIGE 742EP
- TEXACO MULTIFAX EP2

Note: *Refer to Section 2.13.1, Maintenance Schedule and Checklist for lubrication intervals and grease fitting locations.*

2.6.4 Hydraulic System

a. Hydraulic Fluids

Recommended Oil/Temperature Range



The hydraulic system is factory filled hydraulic oil that meets the requirements of U.S. ordinance specification MIL-PRF-2104G. When filling the hydraulic system, use only an oil that meets these requirements or a grade10 oil that meets the requirements of U.S. ordinance specification MIL-PRF-2104G.

b. Hydraulic System Capacity

System capacity .....41.3 gal (156 liters)

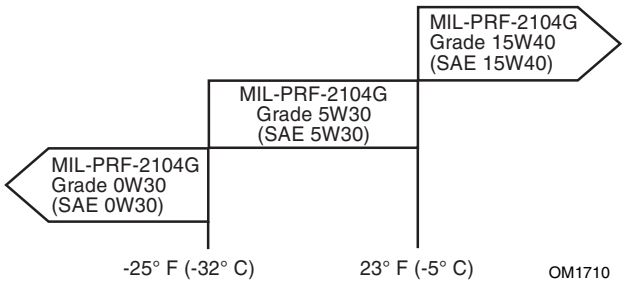
Reservoir capacity.....28.5 gal (108 liters)

2.6.5 Engine

a. Engine Fluids and Lubricants

1. Engine oil:

Recommended Oil/Temperature Range



2. Cooling system (engine coolant):

In general, use a 50/50-mix of premium-quality ethylene glycol (commonly referred to as “anti-freeze/anti-boil over”) and water. Additives are not necessary.

3. Fuel:

In general, use No. 2 diesel fuel. From November 15 to March 15 when operating in cooler climates where ambient (outside air) temperatures are consistently at or below 32° F (0° C), use a 50/50 mix of #1 and #2 diesel fuels. Use good quality diesel fuel and change the fuel filter regularly. Additives are not necessary.

The vehicle is also capable of operation on alternate military fuels including JP-5, JP-8 and Jet A-1. However, an up to 5% reduction in engine horsepower output can be expected when using alternate military fuels due to the lower BTU rating of these fuels.

b. Engine Capacities

1. Engine Oil Capacity

Capacity w/filter change ..... 13.3 qt (12,6 liters)

Filter..... 1.3 qt (1,2 liters)

2. Cooling System Capacity

Capacity..... 12.5 qt (11,8 liters)

Overflow bottle capacity ..... 3.0 qt (2,8 liters)

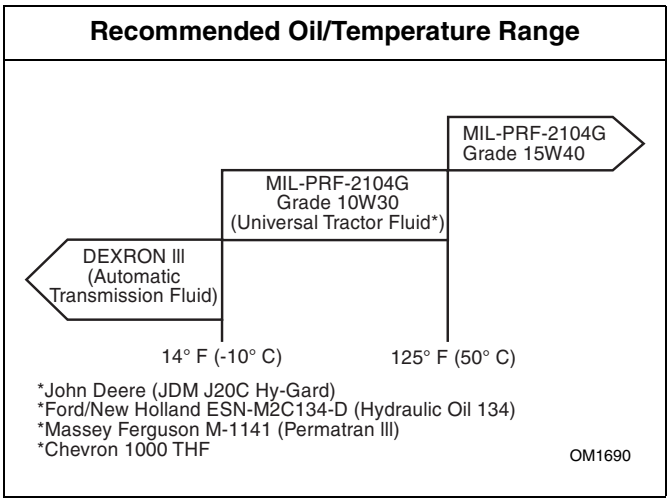
3. Fuel Tank Capacity

Total capacity .....35.5 gal (134 liters)

Usable capacity .....33.5 gal (127 liters)

2.6.6 Transmission

a. Transmission Fluid



In general, use a oil that meets the following specifications:

Nominal viscosity at 10° F (40° C)..... 55 cSt

Minimum viscosity at 212° F (100° C) ..... 9.1 cSt

Pour point (Maximum) .....-32° F (-36° C)

Flash point (Minimum)..... 392° F (200° C)

Minimum viscosity index..... 135

b. Transmission Capacity

Capacity w/filter change ..... 12 quarts (11,4 liters)

Filter..... 1 qt (1 liter)

2.6.7 Air Conditioning

a. Air Conditioning Fluid

Type R134a

b. Air Conditioning System Capacity

System Capacity .....3.0 lbs (1,4 kg)

2.6.8 Drive Shaft Splines

***IMPORTANT: DO NOT** disassemble any of the drive shafts (refer to Section 6, Transfer Case and Drive Shafts of this manual for information covering drive shafts and U-joints). To help ensure optimum performance, the drive shaft assemblies are specially balanced as a unit at the factory. When servicing any flange yoke, slip yoke or drive shaft tube, order a complete assembly. Refer to the appropriate parts manual for ordering information.*

Respective of the above statement, should it become necessary to coat the transmission input drive shaft splines, use molybdenum disulfide grease. Molybdenum disulfide grease specifically formulated for this purpose is marketed by several manufacturers under various names, including:

Aldrich Chemical Co., Inc.
Product name: *Aldrich MOLYBDENUM (IV) SULFIDE*,
Catalog Number 23,484-2
Package Size: 5 g (0.175 oz)
100 g (3.5 oz)
500 g (17.5 oz)
Contact:
Aldrich Chemical Co., Inc.
P.O. Box 335
Milwaukee, WI 53201 USA
Phone: (414) 273-3850

DOW CORNING INC.
Product name: *MOLYKOTE® 77 Paste*
Contact:
Dow Corning Corporate Center
P.O. Box 994
Midland, MI 48686-0994 USA
Phone: (517) 496-4400

2.6.9 General Anti-Corrosion

a. Anti-Corrosion Compound

For general anti-corrosion protection, use a wax film rust inhibitor that provides a protective film two ten-thousandths of an inch (0.0002" or 0,00005 mm) thick. One such rust inhibitor that is specifically formulated for this purpose is *LPS 3*. It is marketed by:

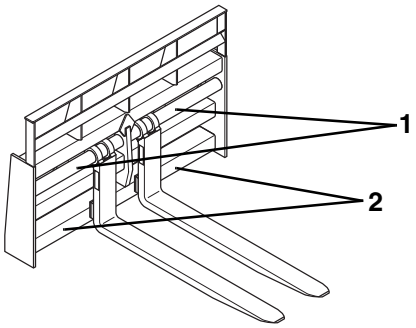
LPS Laboratories, Inc.
4647 Hugh Howell Rd.
Tucker, GA 30085-5052 USA
Phone: 1-800-241-8334
Fax: (770) 493-9206

Note: *Anti-corrosion protection is especially important in frame and stabilizer cylinder pin support bores for protection from fretting corrosion wear.*

b. Anti-Corrosion Need Areas

Coat all unplated pins and all bores for cylinder pins, attachment pivot pins, chain sheave pins, the quick attach lock pin, and all quick attach lock pin bores. On the boom, coat the fork shaft and unpainted boom slide pathways.

2.6.10 Carriage Fork Shafts and Wear Pads



Use ONLY Teflon Lube to coat the entire fork shaft (**1**) and the wear bar (**2**). **DO NOT** apply grease or any other type of petroleum based lubricant to these areas. Grease and petroleum based lubricants attract debris which will prematurely wear the fork bushings and/or wear pads.

Apply Teflon Lube as needed to keep forks sliding side-to-side smoothly, when putting vehicle into storage or when Teflon Lube appears to be worn off or rust starts to appear on the fork shaft or wear bar.

2.6.11 Paint

Unless otherwise specified, paint components as indicated in the following sections.

a. Military Paint (CARC)

Durable, premium military paint is available in a production-sized one gallon (3,8 liters) container for extensive repainting. Consult the appropriate parts manual for the applicable part number and ordering information. Use military paint on all vehicle components except as specified in paragraph *2.6.11, b*.

b. Black Paint

Durable, premium black paint is available in both a convenient 16-ounce (480 ml) spray can for touch-ups, and in a production-sized one gallon (3,8 liters) container for extensive repainting. Consult the appropriate parts manual for the applicable part number and ordering information.

- Boom Angle Indicator Pointer
- Brake Pedal
- Radiator
- Seat Adapter Plate
- Radiator Shroud
- Transmission Oil Cooler
- Drive Shafts
- Transfer Case
- Forks
- Mirrors and Mirror Brackets
- Steering Column
- Wheels
- Air Conditioner Condenser
- Air Conditioner Condenser Guard

2.6.12 Thread Locking Compound

For general thread-locking purposes, Loctite® products, manufactured by Loctite Corporation, are recommended.

Contact:
Loctite Corporation
1001 Trout Brook Crossing
Rocky Hill, CT 06067 USA
Phone: 1-800-LOCTITE (1-800-562-8483)
FAX: (860) 571-2460
Internet: http://www.loctite.com

Loctite® is a registered trademark of Loctite Corporation.

2.7 CLEANING

Dirt and abrasive dust reduce the efficient working life of parts and systems, and lead to the costly replacement of components. To help increase the service life of parts, clean the exterior of all parts before beginning any repairs.

Use cleaning fluids and solvents suitable for cleaning parts that do not create safety hazards. Certain types of cleaning fluids can cause skin irritation and damage to components (such as rubber, electrical parts, etc.).

Servicing the hydraulic system in particular requires cleanliness.

Follow these precautions before attempting to service any hydraulic component:

1. Flush hose and tube assemblies with a solvent compatible with hose materials. Blow excess solvent away with shop air.
2. Cap hydraulic fittings, hoses and tube assemblies, and protect threads until time of installation. Clean up any hydraulic fluid spillage immediately.
3. Flush hydraulic reservoir, fuel tank, and gear housing with a suitable solvent to remove paint, metal chips, etc.
4. Protect hydraulic system components from airborne contaminants. Plug all cylinder, valve, reservoir, tank and pump openings until time of installation.
5. Use clean, filtered oil when filling the system. Maintain the hydraulic system at a minimum cleanliness level of ISO code 18/15-particle ration count.

2.8 REPLACEMENT

ALWAYS use the correct tool when removing or replacing any part or performing any service.

Some procedures may require the use of specialized tools. If needed, many of these tools can be obtained through Snap-on® tool distributors.

Contact:
Snap-on Incorporated
P.O. Box 1410
Kenosha, WI 53141-1410 USA
Phone: 1-262-656-5200
Internet: http://www.snapon.com

Snap-on® is a registered trademark of Snap-on Technologies, Inc.

Replace o-rings, seals, and gaskets whenever they are disturbed. **NEVER** mix new and old seals or o-rings, regardless of apparent visual condition. ALWAYS lubricate new seals and o-rings with hydraulic oil before installation.

2.9 HOSES AND TUBES

2.9.1 Hose and Tube Inspection

1. Damaged, dented, crushed, or leaking hose and tube fittings restrict oil flow and the operation of the system being served. Fittings showing signs of movement from their original position have failed and must be replaced. ALWAYS replace the entire hose or tube assembly if the fittings are damaged.
2. Hoses must remain in good condition. Obvious signs of external hose wear or hydraulic fluid leaking or weeping indicates the need to replace the hose assembly. If in doubt, replace the hose.
3. Replace if any of the following conditions exist:
   - Ballooning **(replace hose immediately!)**
   - Kinking, crushing, stretching or deforming
   - Concealed corrosion of wire reinforcement
   - Chafed outer cover

2.9.2 Hose and Tube Installation

1. When installing a new hose, loosely connect each end and verify that the hose takes up the designed position before tightening the connection completely. Tighten clamps sufficiently to hold the hose without crushing it, and to prevent movement and chafing.
2. If a hose is replaced on a moving part, move the part through its entire range of motion to verify that the hose will not incur damage. Adjust as necessary.
3. When installing any hose, verify that it does not become kinked or twisted.
4. **NEVER** allow freely moving or unsupported hoses to contact each other or a related work surface. Such contact causes chafing and reduces hose life.

2.10 BEARINGS

2.10.1 Bearing Removal

1. **NEVER** remove bearings unless absolutely necessary! Always use the recommended puller to reduce the risk of bearing or related component damage.
2. When bearings or bushings are removed, verify that the bearing or bushing is free from discoloration, nicks, scuffing, and signs of overheating. If in doubt, replace the bearing or bushing.

2.10.2 Bearing Cleaning

Wear safety glasses. Clean bearings acceptable for service in a suitable solvent. **NEVER** spin-dry a bearing with compressed air; this can cause metal-to-metal contact and bearing damage. Compressed air can also cause a bearing to come apart. After cleaning a bearing, immerse it in clean lubricating oil until needed.

2.10.3 Bearing Installation

1. Always install bearings carefully to help avoid damaging their delicate surfaces.
2. Install bearings using one of the following methods:
   - PRESS FIT for installation on rotating parts such as shafts and gears;
   - PUSH FIT into static locations such as reduction gear housings.
3. Always install the bearing into the rotating part first whenever possible.
4. Use a press or the proper installation tools when installing a bearing or bushing.
5. In the absence of a press or proper installation tools, carefully heat the casing and/or bearing in hot oil to assist in the installation.

2.11 PRESSURE TESTING AND ADJUSTMENT

Prior to pressure testing or adjustment, verify that all hoses and tubes are in good condition and that all fittings are tight.

Use pressure gauges with the proper ranges and ratings to measure the specified pressures.

Use correct test procedures to help prevent personal injury, damage to the system or test equipment.

Verify that the hydraulic oil is at proper operating temperature, 80-120° F (27-49° C), before adjusting the pressure reducing valve, or relief valves. If necessary, operate the vehicle to raise the oil temperature. In the absence of a temperature gauge, the oil temperature can be checked by placing a hand against the side or the bottom of the reservoir; if the tank is too hot to keep the hand in contact with it, the oil temperature should be within the proper range.

2.12 AFTER SERVICE STARTUP AND CHECKS

2.12.1 After Service Startup

Note: *Refer to the Owners/Operators Manual for engine cold-start procedures.*

1. Check fluid levels.
2. Connect the negative (-) battery cable to the battery (if it is disconnected).
3. Start and idle engine. Check for leaks from hydraulic components, engine, axles, transmission, brakes and reservoirs or tanks. Check the levels of all fluids and lubricants.
4. Purge the hydraulic system of air by operating all vehicle functions through their entire range of motion several times.
5. Check for proper operation of all components.
6. Retract all cylinders fully. Turn the engine OFF and check the hydraulic reservoir level. Recheck the level when the hydraulic oil is cold.
7. Replace the hydraulic filter if required.

2.12.2 After Electrical/Electronic Component Service

1. Check the torque of all fasteners securing replaced electrical/electronic components.
2. Check wiring connections to components.
3. Verify that wiring components are dry and free of moisture.
4. Check connectors for broken, frayed, or loose wires.
5. Check for brittle or frayed wire shielding.
6. Connect the negative (-) battery cable terminal to the battery (if it is disconnected).
7. Check the operation of the replaced component(s).

2.12.3 After Hydraulic Component Service

1. Check torque of fasteners on replaced components.
2. Check that hoses and tubes are properly attached, positioned, and tightly connected.
3. If a hydraulic component failed and contaminated the system, flush the system, clean the hydraulic oil reservoir (tank), and replace the hydraulic oil filter.
4. After normal hydraulic component maintenance, check the hydraulic fluid level and add fluid as required.
5. Start engine and bleed hydraulic system of air. Operate all boom functions through their full range of motion several times. Cycle the hoist and extend cylinders to bleed air from the system. Visually check for leaks.
6. Check operation of all systems in the hydraulic circuit by operating the controls through all functions several times.

2.12.4 After Brake System Service

1. Check the oil level in the axle and replenish with oil as required.
2. Bleed the brakes.
3. Check brake pressure.
4. Check brake operation.

2.12.5 After Fuel System Service

1. Drain and flush fuel tank; if it was contaminated.
2. Bleed fuel system.
3. Fill fuel tank with fresh, clean fuel, as required.

2.12.6 After Transmission Service or Replacement

1. Check transmission oil level and fill to level with oil as required. (Refer to *Section 2.6.6, Transmission* for information on transmission lubricants.)
2. Replace transmission filter.
3. Check torque on drive shaft yoke retaining bolts. Tighten these M12 bolts to 156 lb/ft (212 Nm).
4. Refer to the ZF 4 WG-98 TS Transmission Repair Manual (ZF part number 5871 139 002, **JLG** part number 8990418) for servicing the transmission after overhaul or repair.
5. Wear suitable eye protection. When an overhauled or repaired transmission is installed, thoroughly clean the oil cooler lines to and from the transmission.
6. Drain and flush the entire system.
7. Disconnect and clean all transmission lines. When possible, remove transmissions lines from the vehicle for cleaning.
8. Thoroughly clean transmission filter screens and cases, and replace transmission filter elements.

	CAUTION: **DO NOT** exceed 165 psi (11,4 bar) when back flushing the oil cooler. Applying too much pressure may damage the oil cooler/radiator.

9. “Back flush” the transmission oil cooler with oil and compressed air until all foreign material is removed. Flushing in direction of normal oil flow does not adequately clean the cooler. If needed, remove the transmission oil cooler assembly from the vehicle. **DO NOT** use flushing compounds for cleaning purposes.
10. Reassemble all components and fill the transmission with clean, fresh oil through the dipstick tube opening until oil comes up to the FULL mark on the transmission dipstick.
11. Run engine for two minutes at idle to help prime the torque converter and transmission lines.

12. Recheck the level of fluid in the transmission with the engine running at idle.
13. Add oil as necessary to bring the fluid level up to the FULL mark on the transmission dipstick. Install the oil dipstick. Recheck the oil level when it reaches operating temperature (180-200° F or 83-94° C).
14. Recheck all drain plugs, lines, connections, etc., for leaks and tighten where necessary.

2.12.7 After Tire and Wheel Service

1. Check air pressure.
2. Be sure the lockwashers are properly positioned under each wheel nut.
3. Check wheel nut torque. Tighten to 430-470 lb/ft (583-637 Nm).

2.12.8 After Engine Service

Consult the qualified service agent (manufacturer's representative and/or service manual) for proper procedures before engine startup.

2.12.9 After Boom Service

1. Check wear pads.
2. Check chain tension adjustment.
3. Apply grease at all lubrication points (grease fittings).
4. Check for proper operation by operating all boom functions through their full range of motion several times.

2.12.10 After Axle Service

1. Check fluid levels.
2. Check torque on drive shaft flange yoke retaining bolts. Tighten these M12 bolts to 156 lb/ft (212 Nm).
3. Be sure the lockwashers are properly positioned under each wheel nut.
4. Check wheel nut torque. Tighten to 430-470 lb/ft (583-637 Nm).
5. Check toe-in if required.
6. Apply grease at all lubrication points (grease fittings).
7. Refer to the axle manufacturer's maintenance manual for further information.

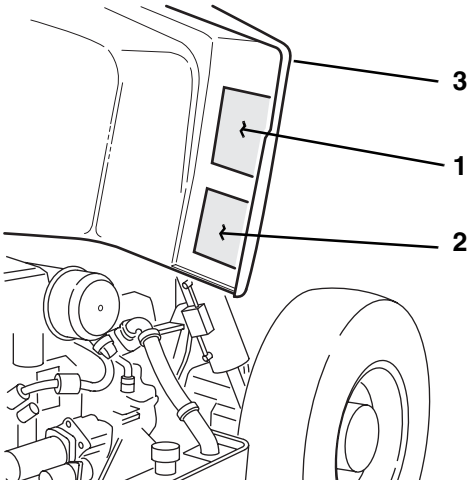
2.13 MAINTENANCE INSTRUCTIONS

WARNING: DO NOT service the vehicle without following all safety precautions as outlined in the “Safety Practices” section of this manual. Failure to follow the safety practices may result in death or serious injury.

WARNING: DO NOT perform service or maintenance on the vehicle with the engine running. Contact with moving parts can cause death or serious injury.

***IMPORTANT: JLG** recommends the use of environmentally sound waste storage and disposal practices. **NEVER** drain fluids on the ground or into a sewer or catch basin. Use suitable collection containers, then store and/or dispose of waste products in an approved and safe manner. Check and obey all Federal, State and/or Local regulations regarding waste storage, disposal and recycling.*

This section contains a routine equipment checklist and a maintenance schedule and checklist with references to pertinent procedures and instructions. To help prevent problems before they occur, follow the maintenance schedule.

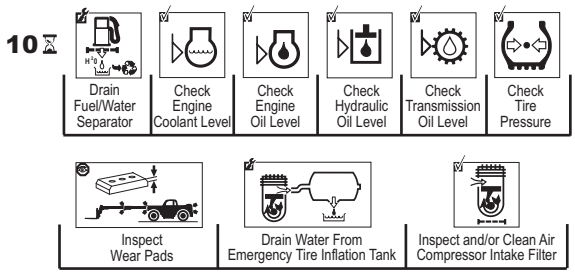


OS1171

***Note:** Lubrication (**1**) and maintenance (**2**) chart decals are located inside the engine compartment cover (**3**). These decals contain a general maintenance schedule that should be followed to maintain the vehicle in good operating condition. The same schedule information is presented in this manual, except that it contains a more detailed account of how to perform these specific maintenance operations.*

2.13.1 Maintenance Schedule and Checklist

a. 10 Hour Intervals

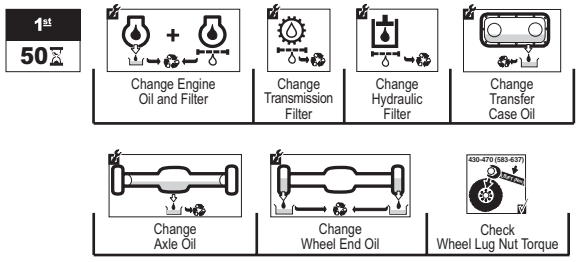


MM3211

At ten-hour intervals, perform the following:

- Drain the fuel/water separator (refer to *Section 2.13.7, Engine Fuel System*).
- Check the engine coolant level (refer to *Section 2.13.4, Engine Cooling System*).
- Check the engine oil level (refer to *Section 2.13.5, Engine Oil and Filter*).
- Check the hydraulic reservoir oil level (refer to *Section 2.13.9, Hydraulic System Oil and Filter*).
- Check the transmission oil level (refer to *Section 2.13.10, Transmission Oil and Filter*).
- Check the air pressure in the tires (refer to *Section 2.13.15, Wheels and Tires*).
- Check boom wear pad thickness (refer to *Section 2.13.19, Boom Wear Pad Maintenance*).
- Drain water from emergency tire inflation tank (refer to *Section 2.13.16, Emergency Tire Inflation System*).
- Inspect and/or clean air compressor intake filter (refer to *Section 2.13.16, Emergency Tire Inflation System*).

b. At First 50 Hours of Use

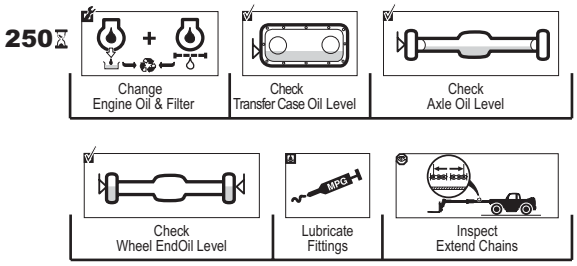


MM3200

When the vehicle completes its first 50 hours of use, perform the following:

- Change the engine oil and filter (refer to *Section 2.13.5, Engine Oil and Filter*).
- Change the transmission filter (refer to *Section 2.13.10, Transmission Oil and Filter*).
- Change the hydraulic filter (refer to *Section 2.13.9, Hydraulic System Oil and Filter*).
- Change the transfer case oil (refer to *Section 2.13.14, Transfer Case Oil*).
- Change the axle oil (refer to *Section 2.13.11, Axle Oil*).
- Change the wheel end oil (refer to *Section 2.13.13, Wheel End Oil*).
- Check the wheel lug nut torque (refer to *Section 2.13.15, Wheels and Tires*).

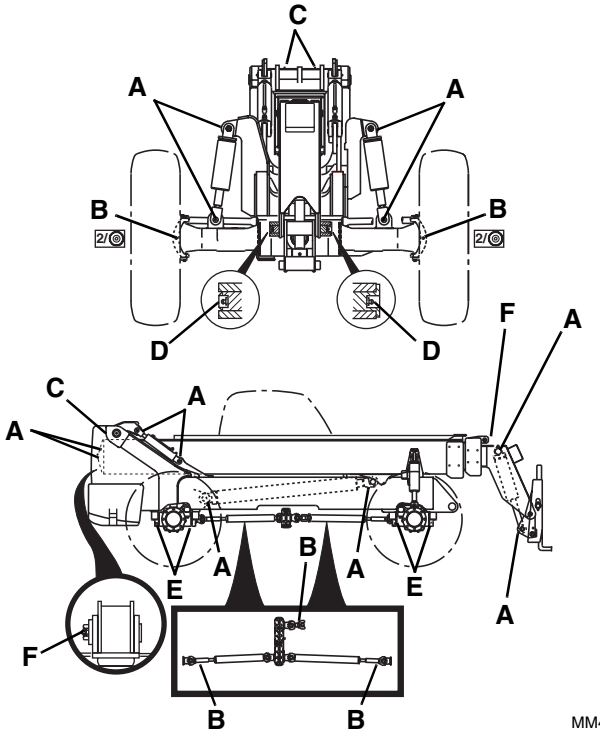
c. 250 Hour Intervals



MM3220

At 250 hour intervals, perform the following:

- Change the engine oil and filter (refer to *Section 2.13.5, Engine Oil and Filter*).
- Check the transfer case oil level (refer to *Section 2.13.14, Transfer Case Oil*).
- Check the axle oil level (refer to *Section 2.13.11, Axle Oil*).
- Check the wheel end oil level (refer to *Section 2.13.13, Wheel End Oil*).
- Inspect Extend Chains (refer to *Section 2.13.21, Boom Chain Tension & Adjustment*).
- Apply multi-purpose grease at all lubrication points. Lubricate the following components via the grease fittings with good grade of a multi-purpose, lithium-based grease every 250 hours (remove all excess grease):

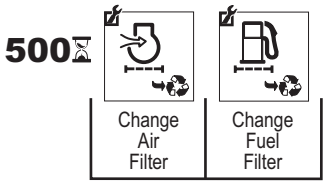


MM4150

A. Hydraulic cylinder pins..... 14 points
B. Powertrain slip joints & axle U-joints..... 11 points
C. Boom pivot pin ..... 4 points
D. Quick attach pivot pin..... 2 points
E. Axle pivot pins..... 4 points
F. Chain sheave..... 2 points

Note: *Shorten the lubrication interval on all lubrication points when operating under severe conditions.*

d. 500 Hour Intervals

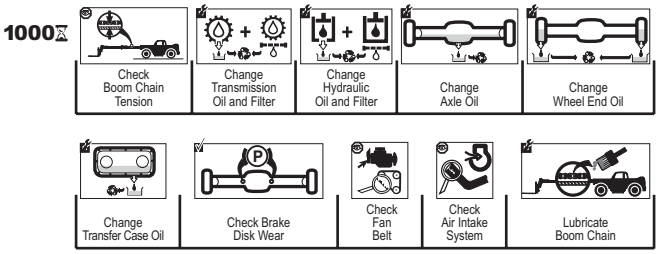


MT00701

At 500 hour intervals, perform the following:

- Change the air filter (refer to *Section 2.13.2, Air Cleaner*).
- Change the fuel filter (refer to *Section 2.13.7, Engine Fuel System*).

e. 1,000 Hour Intervals

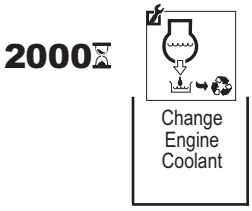


MM4160

At 1,000 hour intervals, perform the following:

- Check boom chain tension (refer to *Section 2.13.21, Boom Chain Tension & Adjustment*).
- Change the transmission oil and filter (refer to *Section 2.13.10, Transmission Oil and Filter*).
- Change the hydraulic oil and filter (refer to *Section 2.13.9, Hydraulic System Oil and Filter*).
- Change the axle oil (refer to *Section 2.13.11, Axle Oil*).
- Change the wheel end oil (refer to *Section 2.13.13, Wheel End Oil*).
- Change the transfer case oil (refer to *Section 2.13.14, Transfer Case Oil*).
- Check brake disc wear (refer to *Section 2.13.12, Brake Disc Wear Check*).
- Check the fan belt (refer to *Section 2.13.8, Engine Fan Belt & Air Conditioner Compressor Belt*).
- Check air intake system (refer to *Section 2.13.2, Air Cleaner*).
- Lubricate Boom Chains (refer to *Section 2.13.22, Chain Lubrication*).

f. 2,000 Hour Intervals



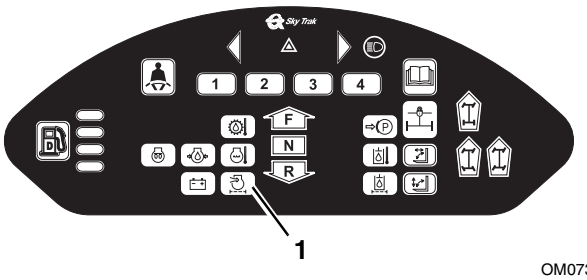
MS1380

At 2,000 hour intervals, perform the following:

- Change the engine coolant (refer to *Section 2.13.4, Engine Cooling System*).

2.13.2 Air Cleaner

a. Engine Air Restriction Warning Indicator



OM07312

The operator's display panel includes an indicator light (**1**) that illuminates to alert the operator when restricted air flow to the engine is sensed. This indicates that the air filter needs servicing. **NEVER** operate the vehicle without the air cleaner assembly and both filters in place.

b. Air Cleaner Element: Change



MS21802

OS0790

As indicated by the air cleaner restriction indicator, and/or every 500 hours, change the air filter element.

Outer Primary Element

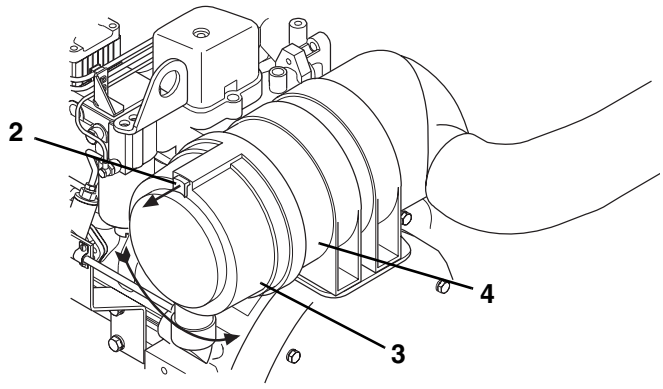
All air cleaner manufacturers agree that attempting to clean or wash an element increases the chance for element damage. It is highly recommended that you consider the value of cleaning an element against the risks that could lead to engine damage. Adopt the policy that all elements should be replaced with new and not cleaned.

Inner Safety Element

An inner safety element should **NEVER** be washed or reused. ALWAYS install a new element.

Replace safety elements after every third primary element change. **DO NOT** remove a safety element until the inside of the air cleaner canister is thoroughly cleaned. This will help prevent dirt that could damage the engine from entering the induction manifold.

	CAUTION: **NEVER** run the engine with only the safety element installed. Severe engine damage will result from dust entering the engine.



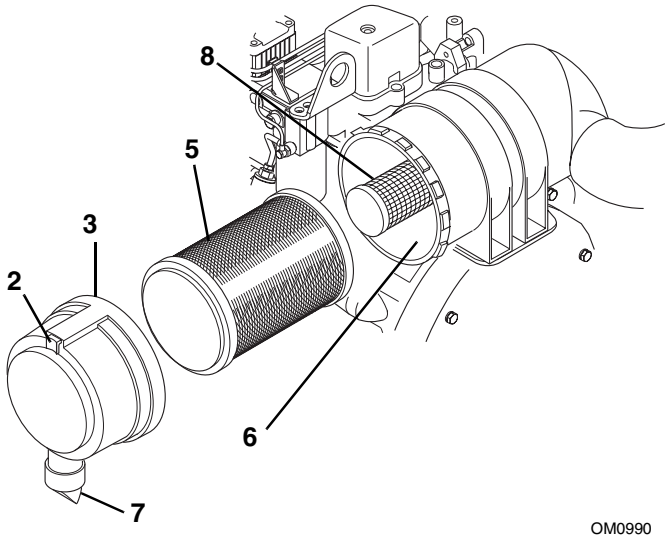
OM0980

To change elements:

1. Pull the air cleaner cover lock (**2**) out, turn the air cleaner cover (**3**) counter-clockwise and remove the cover from the air cleaner canister (**4**).
2. Remove the primary element (**5**). Inspect the element for damage. Damaged elements should never be reused.
3. Thoroughly clean the interior of the air filter canister (**6**) and vacuator valve (**7**).
4. If replacing the inner element (**8**) at this time, carefully slide the element out. Always discard this element and replace with a new element.
5. Slide the new primary element over the inner element making sure the sealing edge is flush with the base of the air cleaner.

***IMPORTANT: DO NOT** apply any type of petroleum product to the sealing surface of the filter in an attempt to get a more positive seal. This will cause sealing surface damage and allow dirt to by-pass the filter. Use liquid dishwashing soap (Ivory, Dawn, etc.) on the seal of the filter only.*

6. Position the canister cover (**3**) in place, turn clockwise to lock into position and secure in place by pushing the air cleaner cover lock (**2**) all the way in.



OM0990

c. Air Intake System-Inspection



MS21902



OT0880

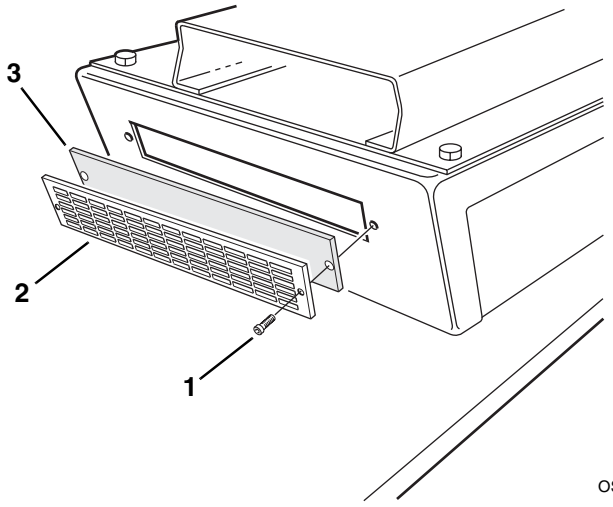
Inspect the intake piping for cracked hoses, loose clamps, or punctures that can allow dirt or debris to enter the combustion chamber. If dirt or debris is allowed to enter the combustion chamber, it can severely damage the engine. If necessary, tighten or replace parts to help prevent air intake system leakage.

2.13.3 Closed Cab Air Filters

The closed cab has two air filters, the recirculation air filter and the fresh air intake filter. Both of these filters require periodic inspection and maintenance.

Recirculation Air Filter

Periodically remove two truss-head bolts (**1**), vent cover (**2**) the recirculation air filter (**3**) located directly below the seat. Inspect the filter. Gently hand wash with water, a mild detergent may also be used if the filter is saturated with dirt.

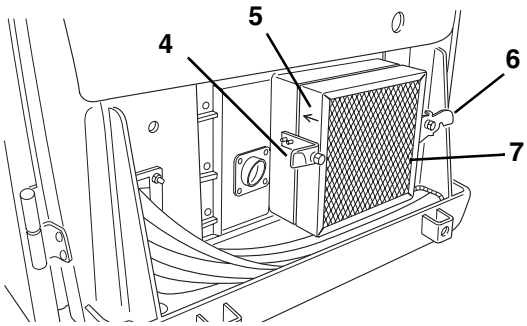


OS1810

Fresh Air Intake Filter

Periodically remove the cab rear panel and inspect the fresh air intake filter (**7**). The filter must be cleaned sometimes as often as twice a day, depending on the operating environment. This is done by removing the filter and shaking it. The filter can be gently hand washed with water. A mild detergent may also be used if the filter is saturated with dirt. When re-installing the filter make sure the filter is held in place with both filter latches (**4** and **6**). The filter will clean outside air when pressurizing the cab. The filter should be replaced at 250 hour intervals under normal operating conditions and at 50 hour intervals under extreme operating conditions.

Note: *Correctly position the filter so the air flow (**5**) is directed into the cab.*



OS1791

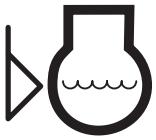
4. Filter latch
5. Direction of air flow
6. Filter latch
7. Fresh air intake filter

2.13.4 Engine Cooling System

a. Engine Coolant Level Check (10 Hour Intervals)

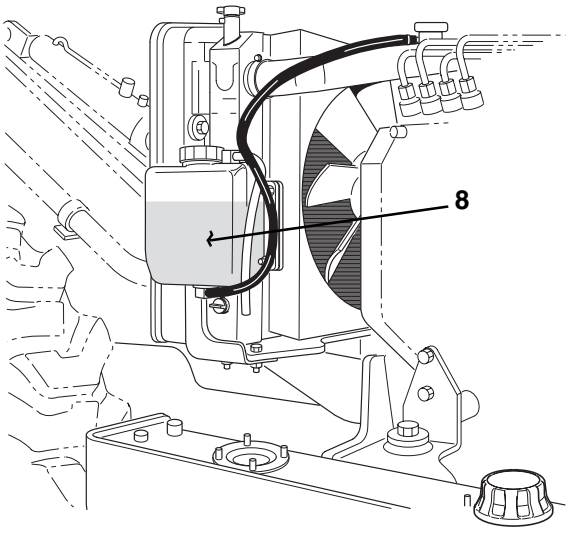


MS21402



OS0800

1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Unlatch and open the engine cover.
3. Check the coolant level in the overflow bottle (**8**). When the coolant is hot, the bottle should be half to three-quarters full. When the coolant is cool, the bottle should be one-quarter to half full. Add coolant (use a 50/50 mixture of ethylene glycol and water) as required through the overflow bottle.

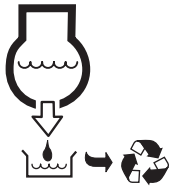


OM1630

b. Drain and Flush the Radiator



MS3000



OS0810

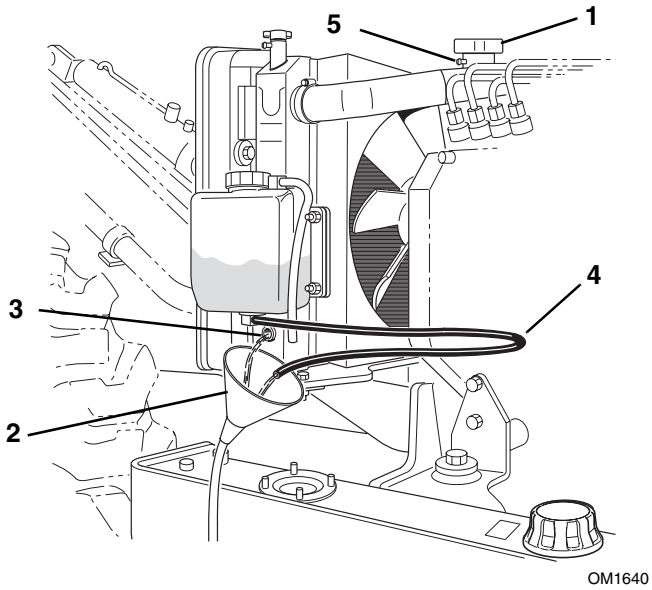
1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)

> **WARNING:** **DO NOT** attempt this procedure when the engine is hot. Wait for the engine, muffler, and tailpipes to cool down before proceeding. Failure to do so could result in severe burns.

3. Unlatch and open the engine cover. Allow the engine to cool before proceeding. Draining and flushing the cooling system while the engine is hot can cause cracks in the engine block.

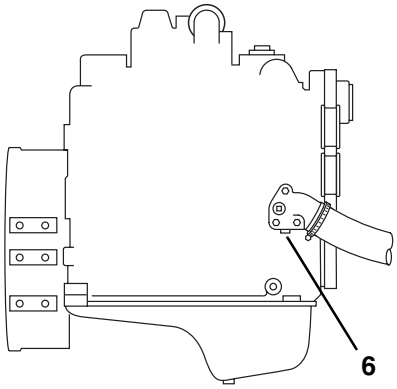
> **WARNING:** **NEVER** remove the radiator cap while the engine is hot. The cooling system is under pressure. Hot coolant can cause severe burns or eye injury. Wear protective clothing and safety glasses.

4. Slowly turn the radiator cap (**1**), located in the upper radiator hose, to the first stop and allow any pressure to escape. Remove the radiator cap.
5. Place a funnel (**2**) at the base of the radiator to channel the drained coolant into a container. Unscrew the radiator drain plug (**3**) and allow the coolant to drain into the funnel.
6. Detach the hose (**4**) from the fitting (**5**) on the neck of the radiator fill tube and drain any coolant from the overflow bottle into the funnel.
7. Flush the radiator with clean water, and flush drain again.



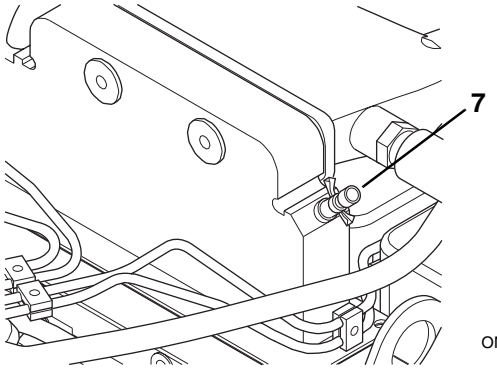
OM1640

8. Remove the engine block drain plug (**6**) and drain any coolant from the engine block. Replace the engine block plug.



OT0260

9. Transfer the coolant to a container with a cover and label the container “Used Anti-freeze.” Dispose of the used coolant at an approved recycling facility.
10. Reconnect the hose (**4**) to the fitting on (**5**) the neck of the radiator fill tube. Close the radiator drain plug or petcock.



OM1300

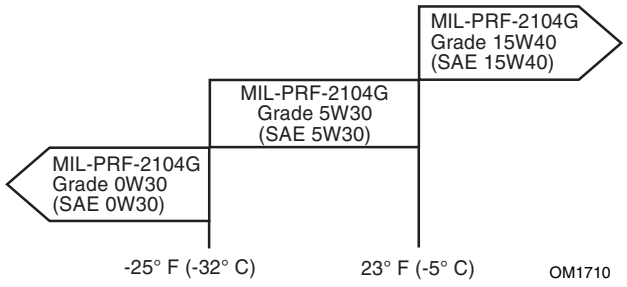
11. Open the petcock (**7**) on the turbo aftercooler.
12. Fill the radiator completely with a 50/50 mixture of ethylene glycol and water. Replace the radiator cap. Add coolant to the overflow bottle until the bottle is half to three-quarters full. This “overfilling” will compensate for any air in the cooling system.
13. Close the petcock (**7**) on the turbo aftercooler.
14. Clean dirt and debris from the radiator core.
15. Start and run the engine until normal engine operating temperature is reached, then turn the engine OFF. Check for leaks while the engine is cooling.
16. After engine has cooled for several minutes, open the petcock (**7**) on the turbo aftercooler. Allow air in the system to escape. Close the petcock when coolant starts flowing from the petcock. All air is now purged from the aftercooler.
17. Allow the engine to cool. Check the radiator coolant level again and top off as needed with a 50/50 mixture of ethylene glycol and water. Replace the radiator cap.
18. The overflow bottle should be one-quarter to one-half full. If not, fill as necessary with a 50/50 mixture of ethylene glycol and water.

2.13.5 Engine Oil and Filter

a. Engine Oil Recommendations

The use of quality engine oil combined with the appropriate oil and filter change intervals are critical factors in maintaining engine performance and durability. (Refer to the chart below for recommended oil types for various operating conditions).

Recommended Engine Oil/Temperature Range

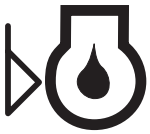


Engine oil capacity, with filter change, is 13.3 quarts (12,6 liters).

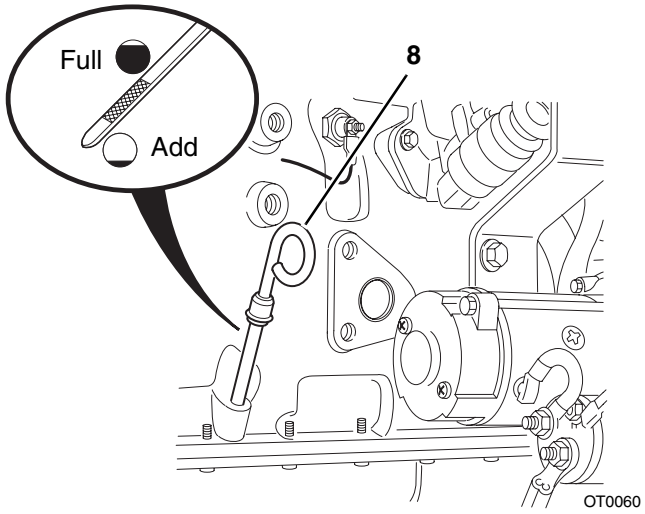
b. Oil Level Check



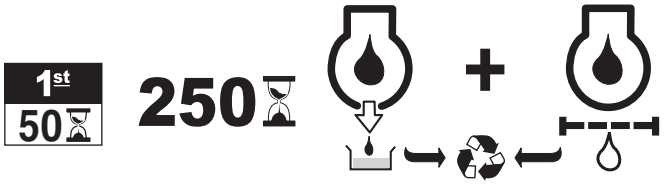
MS21402


OS0820

1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Open the engine cover.
3. Remove the engine dipstick (**8**). Check the oil mark on the dipstick. The oil should be within the crosshatched area of the dipstick.
4. Add oil as required. Replace the dipstick.



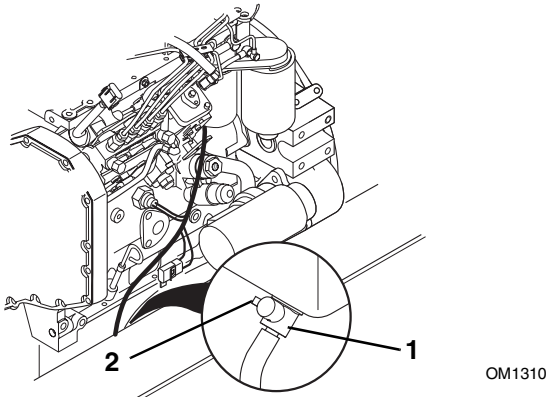
c. Oil and Filter Change



OH26701 MS21702 OS0830

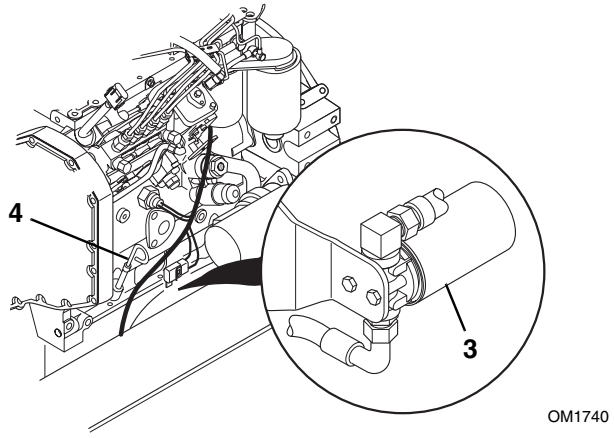
Change the oil and filter after the first 50 hours of vehicle operation, at 250-hour intervals. To change the oil and filter:

1. Operate the engine until it reaches operating temperature (approximately five minutes).
2. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
3. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
4. Open the engine cover.

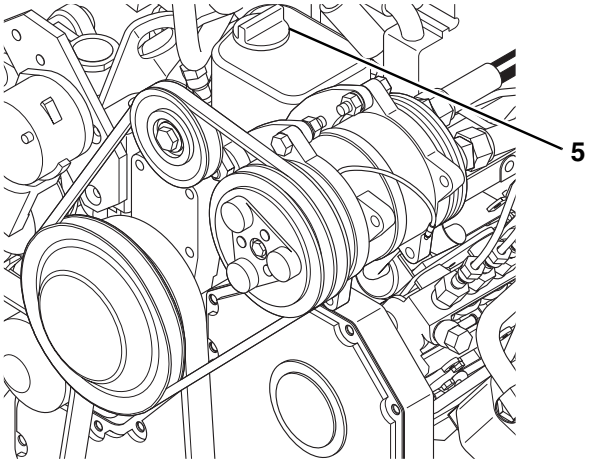


OM1310

5. Place an oil drain pan under the engine oil pan drain hose (**1**). The hose is located under the engine up behind the hydraulic oil reservoir.
6. Lift the petcock lever (**2**) up and turn counterclockwise to OPEN and drain the oil from the engine oil pan.
7. Allow the oil to drain completely into the receptacle. Transfer the oil to a container with a cover and label the container as used motor oil. Dispose of used oil at an approved recycling facility.
8. Remove the oil filter (**3**) and clean the filter-sealing surface. The oil filter is remotely mounted on a bracket under the frame, in front of the transfer box. Access the filter from under the vehicle.
9. Apply a thin coat of clean engine oil to the new filter mating surface.
10. Install the new oil filter and hand tighten. Use an oil filter wrench or strap to tighten the filter down an additional one-quarter to half turn. **DO NOT** overtighten.
11. Turn the oil drain petcock lever (**2**) clockwise and lock into the CLOSED position. The petcock lever is spring loaded and will lock in the CLOSED position.
12. Remove the engine oil fill cap (**5**) and add oil (refer to the recommended engine oil/temperature range chart on page 2.35 for recommended oil types for various operating conditions). Engine oil capacity with filter change is 13.3 qt (12,6 liters).
13. Reinstall the oil fill cap. Start the engine and allow it to run for several minutes.
14. Shut off the engine. Wait several minutes, and then check the oil level again on the dipstick (**4**). Add oil as required. **DO NOT** overfill.
15. Look for oil leaks at the filter and drain plug. Tighten as required.



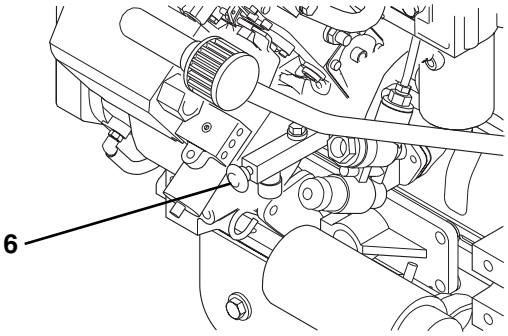
OM1740



MM4570

2.13.6 Engine Oil Sample Point

1. Open the engine cover.
2. Locate the oil sample valve (**6**) on the side of the engine.
3. After oil sample has been taken, close the engine cover.



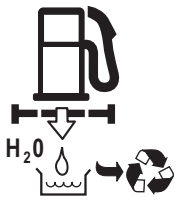
OM1321

2.13.7 Engine Fuel System

a. Drain Water from Fuel-Water Separator/Filter

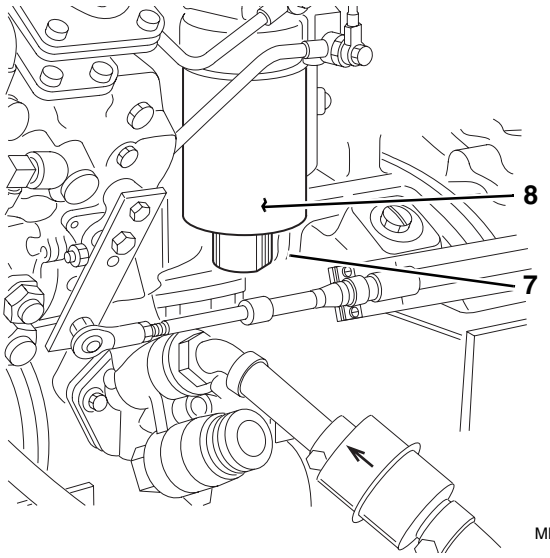


MS21402



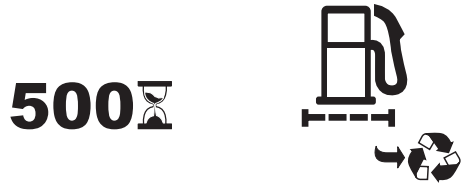
OS0851

1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Allow the engine to cool.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover.
4. Position a suitable glass container beneath the fuel filter drain cock (**7**), located on the underside of the fuel filter (**8**).
5. Loosen the fuel filter drain cock. Allow the water to drain into the glass container until clear fuel is visible. After draining is complete, tighten the drain cock. Dispose of drainage properly.
6. Close the engine compartment cover.



MM3240

b. Change Fuel Filter



Change the fuel filter every 500 hours of engine operation, or at shorter intervals with water evidence of contaminated fuel.

1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Allow engine to cool.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine cover. Clean around the fuel-filter head (**1**).
4. Unscrew the fuel filter and dispose of properly.
5. Clean the filter head gasket surface and replace the o-ring.
6. Fill the new fuel filter (**2**) with clean No. 2 diesel fuel. Alternate fuels can also be used. They are: JP-5, JP-8 or Jet A-1.
7. Lubricate the o-ring seal (**3**) with clean No. 2 diesel fuel. Alternate fuels can also be used. They are: JP-5, JP-8 or Jet A-1.
8. Install the fuel-filled filter and tighten by hand. **DO NOT** over-tighten.

Note: ***DO NOT*** *over-tighten.* ***DO NOT*** *tighten with mechanical means (tools, etc.). Mechanical over-tightening may distort the threads or damage the o-ring seal.*

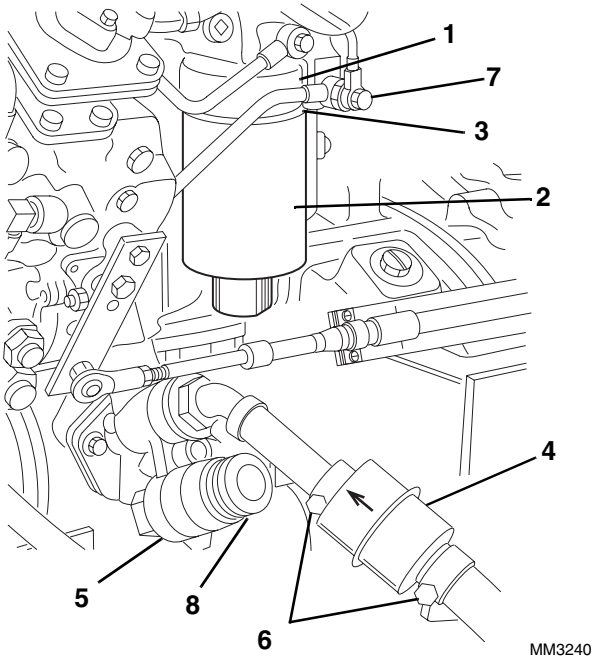
9. Close the engine cover.

Controlled venting is provided at the injection pump through the fuel drain manifold. Small amounts of air introduced by changing the fuel filter element will be vented automatically as long as the element was filled with fuel prior to installation.

c. In-line Fuel Strainer



1. Level the vehicle, ground the attachment, place the travel select lever in the NEUTRAL [N] position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Allow engine to cool.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)



3. Open the engine cover.
4. The in-line fuel strainer (**4**) is located down line from the engine lift pump (**5**). Loosen the two hose clamps (**6**) securing the strainer in place.

5. Remove and properly dispose of the old strainer.
6. Install the new strainer with the arrow pointing toward the lift pump.
7. Assemble the hoses to the strainer and tighten the hose clamps.
8. Remove air from the fuel system. (Refer to *Section 2.13.7, d. Venting Air from the Fuel System*.)
9. Close the engine cover.

d. Venting Air from the Fuel System

> **WARNING:** **DO NOT** vent air from the fuel system of a hot engine. Allow the engine to cool before attempting to purge air from the fuel system. Failure to do so could create a fire hazard.

Air must be vented from the fuel system whenever any component between the fuel tank and the injection pump has been disconnected, or when the system has been emptied, or has run out of fuel.

***IMPORTANT: DO NOT** attempt to start the engine until the injection pump has been filled and primed with fuel. Serious damage to the lift pump will result due to lack of proper lubrication.*

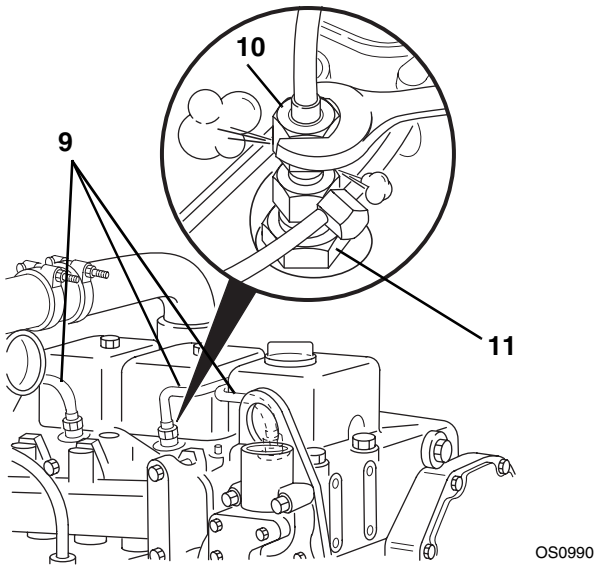
1. To vent the low pressure lines and fuel filter, open the vent screw (**7**), located on the filter head.
2. Operate the hand plunger (**8**) on the lift pump (**5**) until fuel flowing from the fitting is free of air.
3. Tighten the vent screw and torque to 7 lb/ft (9 Nm).

The process of venting the high-pressure fuel lines (**9**) involves energizing the starter motor, which rotates the crankshaft, which, in turn, operates the fuel pump to purge air from the high-pressure fuel lines.

> **CAUTION:** When cranking the engine with the starter motor to vent air from the fuel system, DO NOT energize the starter solenoid or crank the engine for more than 15 seconds at a time. Wait two minutes between each 15-second cranking interval.

> **WARNING:** Diesel fuel under pressure can penetrate the skin and cause serious personal injury. Slowly loosen fittings and allow release of residual pressure before removing any fuel line.

4. Loosen one high-pressure line fitting (**10**) at the injector (**11**). Operate the starter motor for 15 seconds. Wait two minutes. Operate the starter motor again for 15 seconds. Repeat this process until fuel, free of air, comes out of the injector fitting.

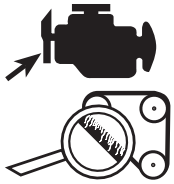


5. Tighten the fitting to 22 lb/ft (30 Nm). Repeat this procedure for each fitting until the engine runs smoothly. With the engine running, visually check for leaks. Turn the ignition switch OFF.

2.13.8 Engine Fan Belt & Air Conditioner Compressor Belt

1000

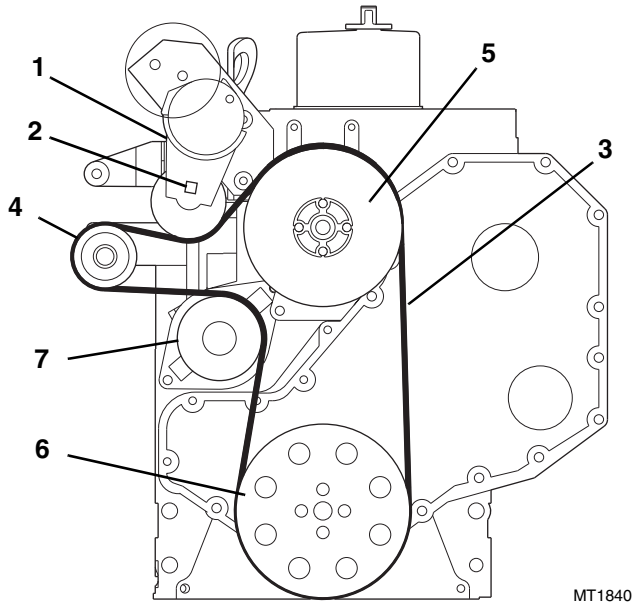
MS21902



OS0880

a. Engine Fan Belt

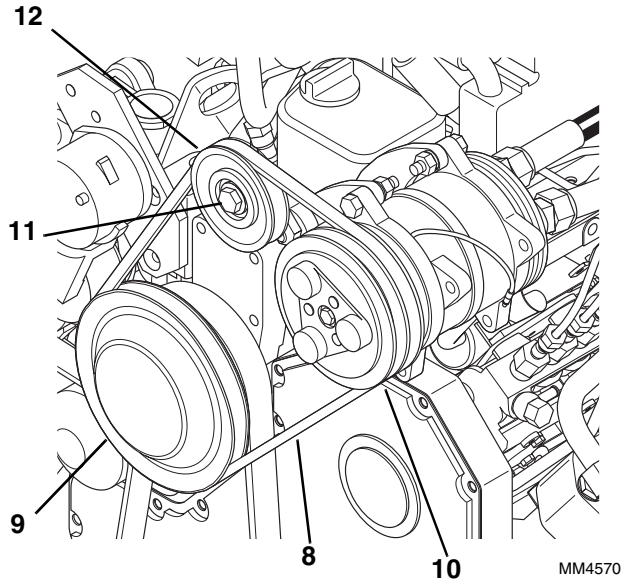
1. Ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Allow engine to cool.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine cover.
4. Inspect the engine fan belt. Replace if cracked or frayed.
5. This engine is equipped with an automatic belt tensioner (**1**). Insert a 1/2" drive ratchet into the square hole (**2**) in the tensioner, and rotate the ratchet up to remove tension from the belt. Remove the fan belt (**3**).
6. Inspect the fan belt and tensioner bearing. Inspect the fan belt. Replace if cracked or frayed. Spin the bearing, and check for resistance or rough spots in bearing travel.
7. Spin the fan and check for wobble or excessive play. Maximum play should be 0.006 inch (0,15 mm).
8. To install the fan belt, position the belt over the alternator (**4**), fan (**5**) and crankshaft (**6**) pulleys. While holding the tensioner up, slide the belt over the water pump pulley (**7**).
9. Close the engine compartment cover.



MT1840

b. Air Conditioner Compressor Belt

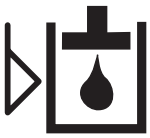
1. Ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Allow engine to cool.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine cover.
4. Inspect the air conditioner compressor belt (**8**). Replace if cracked or frayed.
5. Check the tension of the compressor belt (**8**) midway between the fan pulley (**9**) and the compressor pulley (**10**). The belt deflection should be 3/16" (4,8 mm) with an applied force of 5-1/2 lb (2,5 kg).
6. Adjust the tension on the belt by loosening the bolt (**11**) on the belt tensioning pulley (**12**). Reposition the pulley and securely tighten the bolt.
7. Recheck the tension and readjust if needed.
8. Close the engine compartment cover.



2.13.9 Hydraulic System Oil and Filter

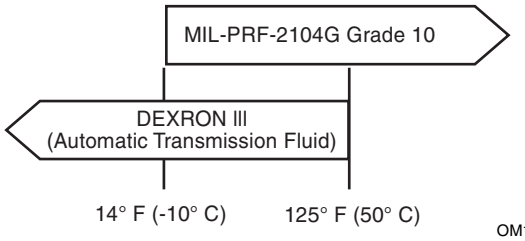
a. Hydraulic Oil Level Check



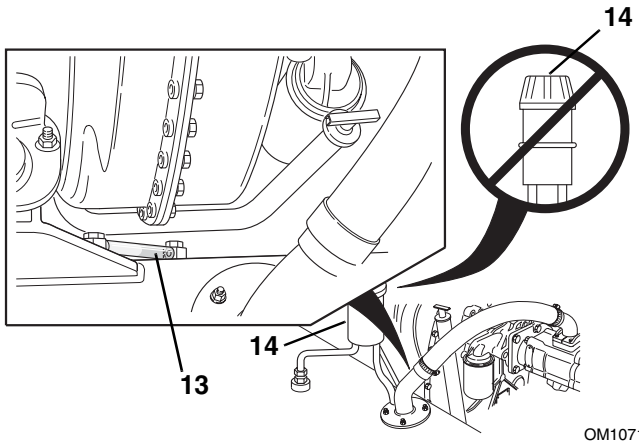


1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, and engage the parking brake switch.
2. Fully retract all hydraulic cylinders and shut the engine OFF.
3. Allow the hydraulic oil to cool.
4. Open the engine cover. Locate the hydraulic oil sight glass (**13**) along the vertical wall of the hydraulic oil tank. Check the level of the hydraulic oil in the tank. The oil level should be in the upper 2/3 to 3/4 of the sight glass when oil is cold and all cylinders retracted. If hydraulic oil is not visible, remove the hydraulic oil fill cap (**15**) and add hydraulic oil (see the following chart for oil recommendations) until the level of the oil is visible in the upper 2/3 to 3/4 of the sight glass. **DO NOT** overfill.

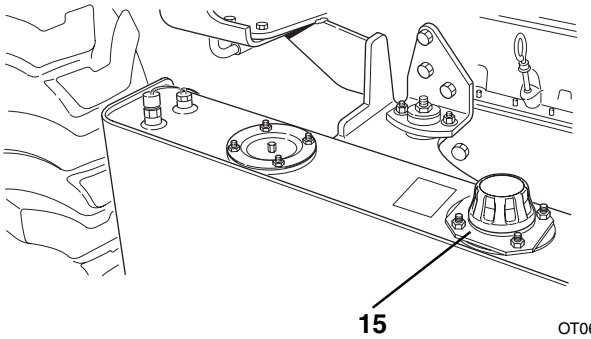
Recommended Hydraulic Oil/Temperature Range



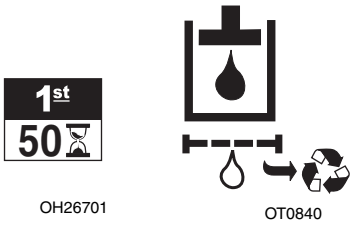
5. **DO NOT** add oil through the hydraulic oil tank breather (**14**) located beside the suction hose fitting.



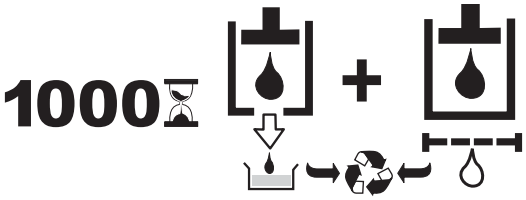
6. Reinstall the hydraulic oil fill cap (**15**). Close the engine cover.



b. Hydraulic Oil and Hydraulic Oil Filter Change



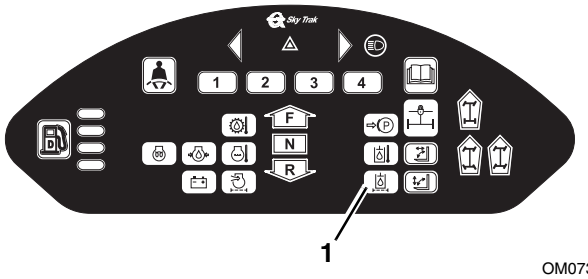
OH26701 OT0840



MS21902 OS0840

Change the hydraulic oil filter after the first 50 hours of engine operation, and every 1,000 hours of operation thereafter.

Also, the hydraulic filter must be changed anytime the hydraulic oil filter restriction warning indicator light (**1**) on the operator's instrument panel begins to flicker ON and OFF at high idle.

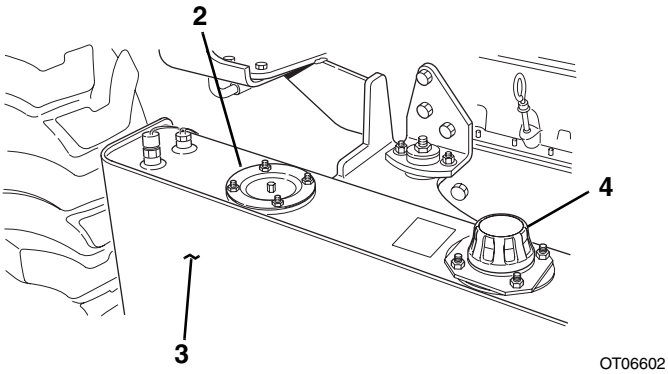


OM07312

1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, and engage the parking brake switch.

WARNING: **DO NOT** change the hydraulic oil, or the hydraulic oil filter with the engine running. Contact with moving parts can cause death or serious injury.

2. Fully retract all hydraulic cylinders and shut the engine OFF.
3. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
4. Open the engine cover. Allow the hydraulic oil to cool.
5. Clean around the hydraulic oil filter head (**2**). Loosen, but **DO NOT** remove, the nuts that secure the hydraulic oil filter head to the hydraulic oil reservoir (**3**).
6. Place a suitable container under the hydraulic reservoir drain plug. The container must be large enough to hold 30 gallons (113 liters) of hydraulic oil.
7. To facilitate removal of the hydraulic oil filter head and filter, the hydraulic oil return line may need to be swiveled out of the way, and the indicator wiring unplugged. **DO NOT** crimp the hydraulic oil return line or indicator wiring. Rotate and remove the hydraulic oil filter head; be prepared for a large amount of oil to be displaced.

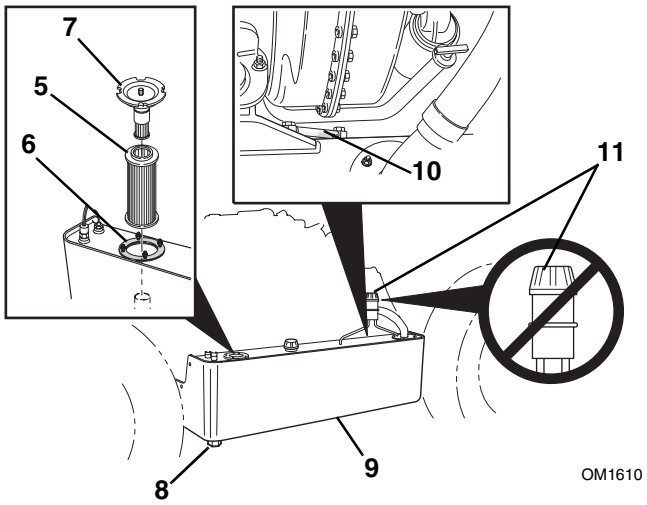


OT06602

8. Remove the hydraulic oil filter element (**5**) and seal (**6**) from the hydraulic oil filter head (**7**). Dispose of used filter properly.
9. Clean the filter head sealing surface.
10. Remove the magnetic drain plug (**8**) and allow the hydraulic oil to drain into the container. Clean loose particles from the magnetic drain plug. Transfer the used hydraulic oil to a container with a cover and label the container as used hydraulic oil. Dispose of used oil at an approved recycling facility.
11. Reinstall the magnetic drain plug into the hydraulic oil reservoir.
12. Reinstall the top seal (**6**) and fully install a new hydraulic oil filter element onto the hydraulic oil filter head until the filter seats. Slide the filter assembly into the reservoir (**9**). Secure the filter head by tightening the nuts loosened earlier.

13. If the hydraulic oil return line was swiveled out of the way, reposition the line. If the indicator wiring was unplugged, reconnect it.
14. Remove the fill cap (**4**) and fill with hydraulic oil until the oil level is visible within the lower end of the sight glass (**10**). Refer to the recommended hydraulic oil/ temperature range chart on page 2.41 for proper oil to use. Reservoir capacity is 28.5 gallons (108 liters). Reinstall the fill cap. **DO NOT** add oil through the hydraulic oil tank breather (**11**) located beside the suction hose fitting. Thoroughly clean or wipe up any spilled hydraulic oil.
15. Close the engine compartment cover.
16. Operate all hydraulic functions through their full range of motion several times. Cycle all control modes to help purge air from the hydraulic system.

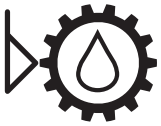
> **WARNING:** Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.



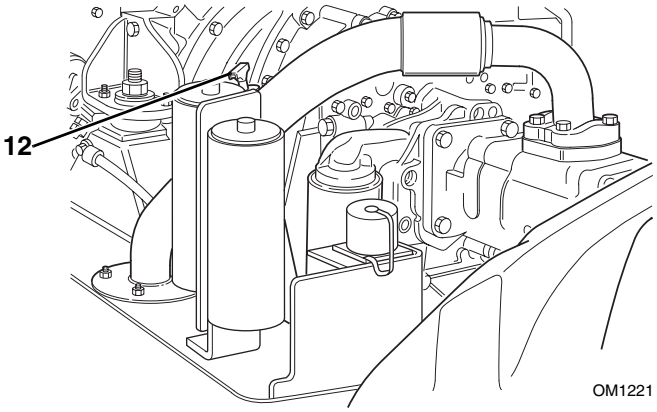
2.13.10 Transmission Oil and Filter

a. Transmission Oil Level Check



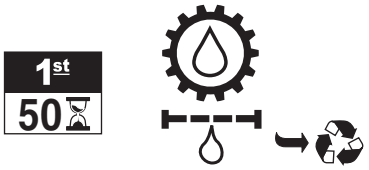


1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Open the engine compartment cover.
3. Check the transmission oil level with the engine at idle and the oil at normal operating temperature.
4. Remove the transmission dipstick (**12**). Check the transmission oil level.

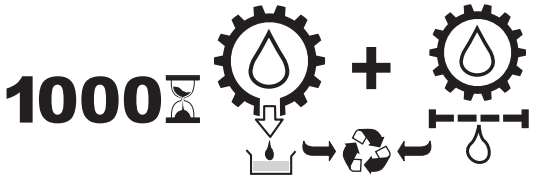


5. As required, add oil (refer to the recommended transmission oil/temperature range chart on page 2.44 for proper oil) to the transmission to bring the level up to the full mark.
6. Close the engine compartment cover.

b. Transmission Oil and Filter Change



OH26701 OT0830



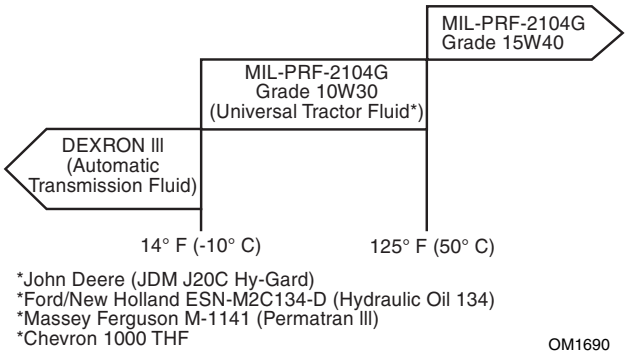
MS21902 OS0950

1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch, and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover. Allow the engine and transmission to cool.
4. Place a suitable receptacle under the transmission drain plug (**1**). Remove the drain plug and allow the oil to drain into the receptacle. Transfer the used oil into a suitable covered container and label the container as used transmission oil. Dispose of used oil at an approved recycling facility.

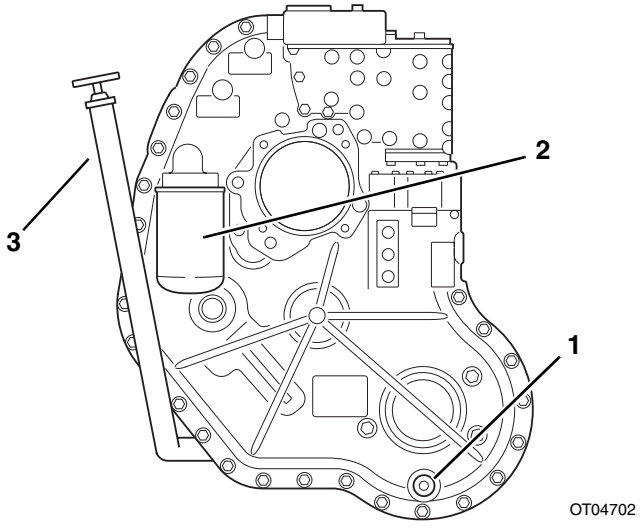
Note: *ALWAYS replace used o-rings with new o-rings to ensure proper sealing.*

5. Clean and reinstall the transmission drain plug, using a new o-ring, into the transmission housing. Torque the drain plug to 26 lb/ft (35 Nm).
6. Remove the transmission oil filter (**2**) and dispose of properly. Clean the mating surface where the filter mounts.
7. Apply a thin film of clean oil to the new filter gasket. Install the new filter.
8. Transmission oil may be added through the dipstick tube (**3**). Remove the dipstick and fill with approximately 12 quarts (11,4 liters) of oil (see the following chart for oil recommendations). Check the level by taking intermittent dipstick readings as outlined in Transmission Oil Level Check. **DO NOT** overfill. Reinstall the dipstick when finished.

Recommended Transmission Oil/Temperature Range



9. Close the engine compartment cover.



2.13.11 Axle Oil

a. Axle Oil Level Check

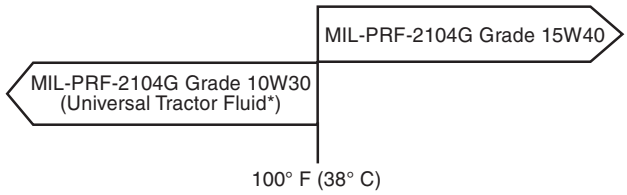


MS21702


OT0460

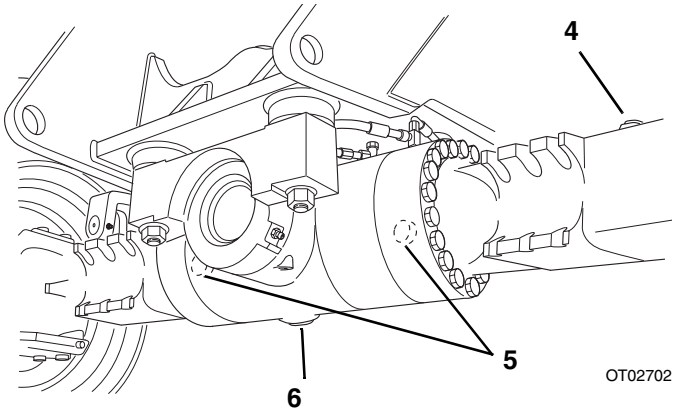
1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Clean the area around the axle fill (**4**), and level plugs (**5**) then remove the plugs from the axle housing.
3. Add oil (see the following chart for oil recommendations) to bring the oil level up, even with the bottom of the level plug holes.

Recommended Axle Oil/Temperature Range



*John Deere (JDM J20C Hy-Gard)
*Ford/New Holland ESN-M2C134-D (Hydraulic Oil 134)
*Massey Ferguson M-1141 (Permatran III)
*Chevron 1000 THF

OM1680



OT02702

Note: *ALWAYS replace used o-rings with new o-rings to ensure proper sealing.*

4. Reinstall the axle fill (**4**) and level (**5**) plugs into the axle housing using new o-rings. Torque the axle fill and level plugs to 96 lb/ft (130 Nm).

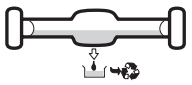
b. Axle Oil Change



OH26701



MS21902

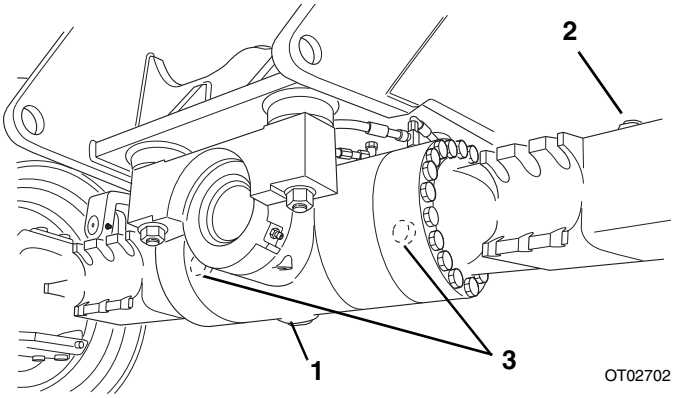

OT0440

1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Clean the area around both the axle fill (**4**), axle level plugs (**5**) and the axle drain plug (**6**).
4. Place a suitable receptacle under the axle drain plug (**6**). Remove the plug from the axle housing and allow the axle oil to drain completely.
5. Transfer the oil to a container with a cover and label the container as used axle oil. Dispose of used oil at an approved recycling facility.
6. Remove the axle fill/level plug (**4**) from the axle housing.

7. Check brake disc wear. (Refer to *Section 2.13.12, Brake Disc Wear Check*.)

Note: *ALWAYS replace used o-rings with new o-rings to ensure proper sealing.*

8. Clean and reinstall the drain plug (**1**) using a new o-ring. Torque the drain plug to 96 lb/ft (130 Nm).
9. Fill the axle with oil. Refer to the recommended axle oil/temperature range chart on page 2.45 for proper oil to use. Filling is accomplished through the axle fill hole (**2**). Fill axle slowly, the oil has to run across the differential. Allow time for the oil to run across the differential. Fill until the axle oil level is even with the level plug holes (**3**). The axle capacity is 10.5 quarts (10,0 liters).
10. Reinstall the axle fill and level plugs (**2** and **3**) into the axle housing using new o-rings. Torque the level plugs to 96 lb/ft (130 Nm).



2.13.12 Brake Disc Wear Check





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

If the brake discs require service due to wear, detailed axle service instructions (covering axle, brakes and wheel-end safety, repair, disassembly, reassembly, adjustment and troubleshooting information) are provided in the ZF Axle Repair Manuals, Model MS-T 3060, front axle with parking brake (ZF part # 5871 560 002, **JLG** part # 8990430) or Model MS-T 3045, rear axle without parking brake (ZF part # 5871 550 002, **JLG** part # 8990419).

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

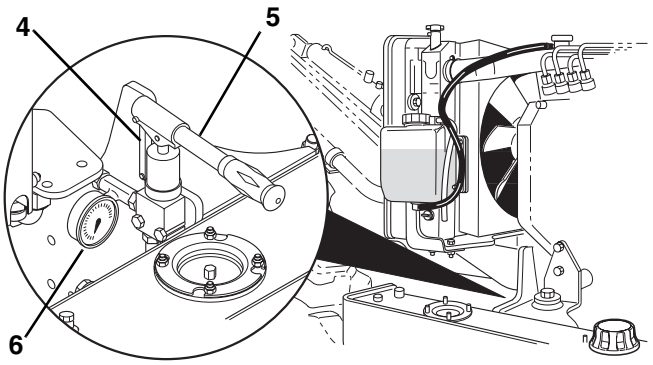
a. Front Axle

WARNING: BLOCK ALL FOUR WHEELS. Failure to do so could result in death or serious injury from vehicle roll-away.

1. **Block all four wheels** to help prevent the vehicle from moving after the parking brake is disabled.
2. Turn the ignition switch to the ON position (with the engine not running), release the parking brake switch, and have the operator seated in the seat.
3. Open the engine compartment cover. Allow the hydraulic oil to cool.
4. Locate the emergency towing pressurizing valve (**4**) located under the radiator on the mounting bracket.

5. Use the handle (**5**) on the emergency towing valve to pump pressure into the system. Watch the pressure gauge (**6**) while pumping pressure into the park brake system. **DO NOT** exceed 650 psi (45 bar).

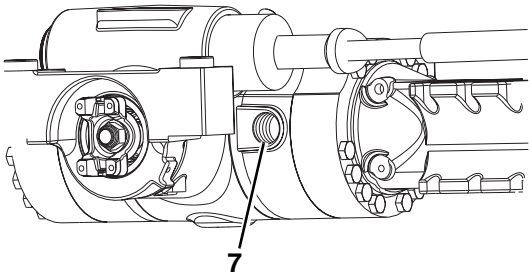
> CAUTION: **DO NOT** exceed 650 psi (45 bar) when pressurizing the park brake. Applying too much pressure may damage the brake seals.



OM1051

6. Working through the level plug hole (**7**), carefully use a screwdriver to spread the brake discs apart.

***IMPORTANT: DO NOT** damage the surfaces of the brake discs when spreading the brake discs.*

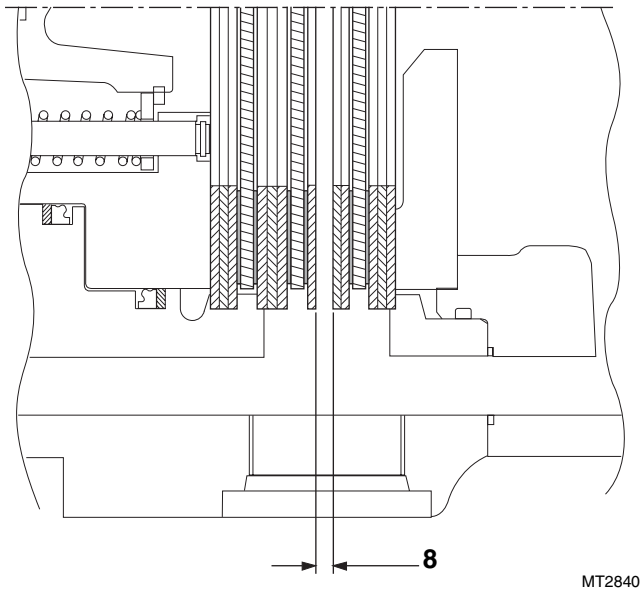


MT2850

7. Using a feeler gauge, check the gap (**8**) between the brake discs. If the gap is greater than .26" (6,75 mm), replace the brake discs.

***Note:** If the brake discs are worn beyond .26" (6,75 mm), the brake disc must be replaced on both sides of the axle at the same time.*

8. Repeat Steps 6-7 for the other side of the axle.



MT2840

9. If the brake wear is within specifications; continue the **axle oil change** procedure at Step 8 (refer to *Section 2.13.11, b. Axle Oil Change*).

b. Rear Axle

***IMPORTANT: DO NOT** damage the surfaces of the brake discs when spreading the brake discs.*

1. Working through the level plug hole (**7**), carefully use a screwdriver to spread the brake discs apart.
2. Using a feeler gauge, check the gap (**8**) between the brake discs. If the gap is greater than .167" (4,25 mm), replace the brake discs.

***Note:** If the brake discs are worn beyond .167" (4,25 mm), the brake disc must be replaced on both sides of the axle at the same time.*

3. Repeat Steps 1 and 2 for the other side of the axle.
4. If the brake wear is within specifications; continue the **Axle Oil Change** procedure at Step 8 (refer to *Section 2.13.11, b. Axle Oil Change*).

2.13.13 Wheel End Oil

WARNING: **DO NOT** perform service or maintenance on this vehicle with the engine running. Contact with moving parts can cause death or serious injury.

a. Wheel End Oil Level Check



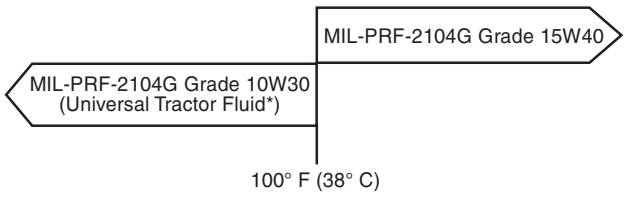
MS21702



OT0430

1. With the vehicle on level ground, move forward or backward enough to ensure that the lower edge of the wheel end fill/drain plug hole (**1**) is positioned horizontally.
2. Ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
3. Clean the area around the wheel end fill/drain plug (**1**). Slowly remove the plug; pressure may be present. Check the oil level. It should be even with the bottom edge of the hole.
4. As required, add oil (see the following chart for oil recommendations) to bring the level up and even with the plug hole.

Recommended Wheel End Oil/Temperature Range

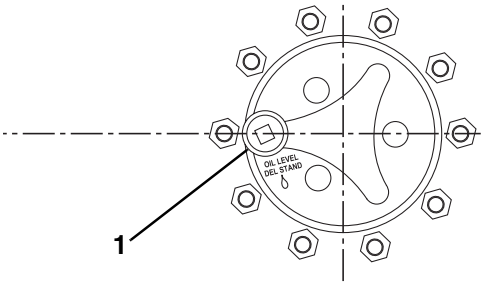


*John Deere (JDM J20C Hy-Gard)
*Ford/New Holland ESN-M2C134-D (Hydraulic Oil 134)
*Massey Ferguson M-1141 (Permatran III)
*Chevron 1000 THF

OM1680

Note: *ALWAYS replace used o-rings with new o-rings to ensure proper sealing.*

5. Clean and reinstall the wheel end fill/drain plug (**1**) using new o-rings. Torque the plug to 96 lb/ft (130 Nm).



OT02802

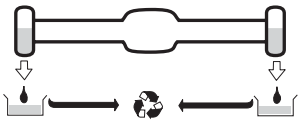
b. Wheel End Oil Change



OH26701

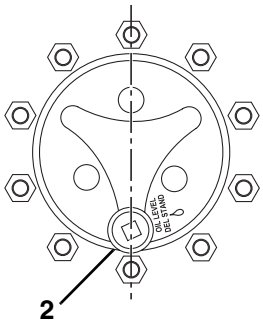


MS21902



OT0450

1. Position the vehicle on level ground and move the vehicle forward or backward to place the wheel end fill/drain plug (**2**) in the six o'clock position.



OT02902

2. Ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
3. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
4. Clean the area around the wheel end fill/drain plug (**2**). Slowly loosen the plug. Hold a receptacle under the wheel end and remove the plug from the wheel end.
5. Allow the oil to drain completely into the receptacle. Transfer the oil to a container with a cover and label the container as used oil. Dispose of used oil at an approved recycling facility.
6. Reposition the vehicle so the oil level line is placed horizontally (**1**).

7. Fill the wheel end with oil. Refer to the recommended wheel end oil/temperature range on page 2.48 for proper oil to use. The wheel end is full when the oil is level with the bottom of the plug hole. Wheel end oil capacity is approximately 1.3 quarts (1,2 liters).

Note: *ALWAYS replace used o-rings with new o-rings to ensure proper sealing.*

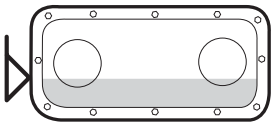
8. Clean and reinstall the wheel end fill/drain plug (**1**) using a new o-ring. Torque the plug to 96 lb/ft (130 Nm).

2.13.14 Transfer Case Oil

a. Transfer Case Oil Level Check

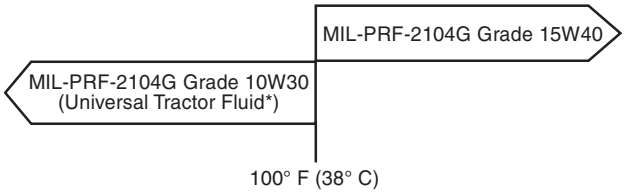


MS21702


OT0420

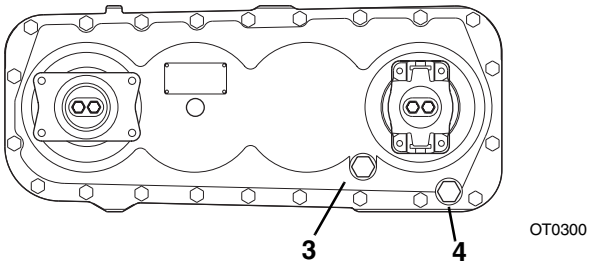
1. Level the vehicle, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Clean the area around the transfer case oil fill/level plug (**3**).
3. Remove the oil fill/level plug (**3**) from the transfer case and check the oil level.
4. Add oil (see the following chart for oil recommendations) as required through the oil fill/level hole. Bring the oil level up and even with the oil fill/level plug hole.
5. Clean and reinstall the oil fill/level plug (**3**). Torque the plug to 52 lb/ft (70 Nm).

Recommended Transfer Case Oil/Temperature Range



*John Deere (JDM J20C Hy-Gard)
*Ford/New Holland ESN-M2C134-D (Hydraulic Oil 134)
*Massey Ferguson M-1141 (Permatran III)
*Chevron 1000 THF

OM1680



OT0300

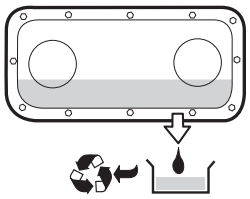
b. Transfer Case Oil Change



OH26701



MS21902


OT0410

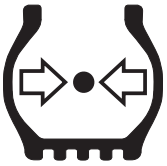
1. Level the vehicle, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Clean the area around the transfer case oil fill/level plug (**3**) and oil drain plug (**4**).
4. Place a receptacle beneath the transfer case drain plug.
5. Remove the drain plug (**4**) from the transfer case.
6. Allow the oil to drain completely into the receptacle. Transfer the oil into a container with a cover and label as used oil. Dispose of used oil at an approved recycling facility.
7. Clean and reinstall the transfer case drain plug (**4**). Torque the plug to 52 lb/ft (70 Nm).
8. Remove the oil fill/level plug (**3**).
9. Fill the transfer case with oil. Refer to the recommended transfer case oil/temperature range on this page for proper oil to use. The transfer case is full when oil is level with the bottom of the oil fill/level plug hole. Total transfer case oil capacity is 1.5 qt (1,4 liters).
10. Replace the oil fill/level plug (**3**). Torque the plug to 52 lb/ft (70 Nm). Wipe up any spilled oil.

2.13.15 Wheels and Tires

a. Tire Pressure Check



MS21402



OS0900

DANGER: LOW TIRE PRESSURE can result in vehicle tipover. **MAINTAIN** proper tire pressure at all times.

Check all four tires:

1. Remove the valve stem cap.
2. Check tire pressure using a premium-quality gauge. Proper inflation pressure cannot be determined visually. Pressure should be: 87 psi (600 kPa).
3. Add air as required. **DO NOT** overinflate.
4. Replace the valve stem cap.

b. Wheel Lug Nut Torque Check



OH26702



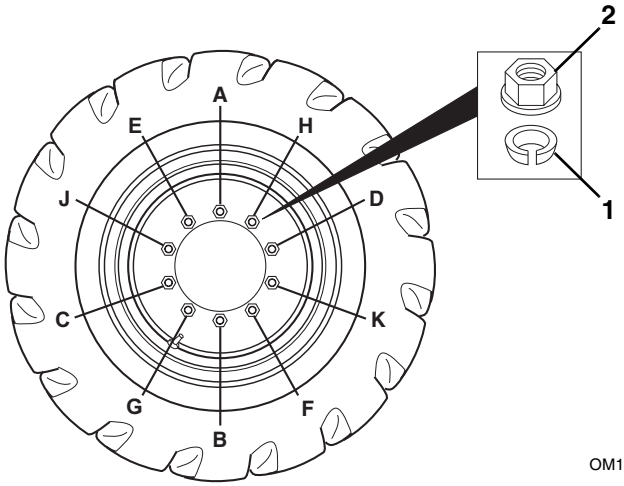
OM14002

1. Wire brush the area around the lugs if necessary. Foreign material such as dirt, concrete, mud, etc. can prevent an accurate torque reading. There are separate lockwashers (**1**) under the lug nuts (**2**). Be sure the lockwashers are installed under each lug nut.
2. Use the torque sequence diagram (**A** thru **K**), to alternately check the torque of each of the ten lug nuts. The recommended torque is 430-470 lb/ft (583-637 Nm).

c. Replacing Tires

WARNING: Mis-matched tire sizes and PLY ratings may compromise vehicle stability and may result in vehicle tipover.

IMPORTANT: *The specified size and ply rating for this vehicle is 15.5R25, L-2, 2 Star. Make sure any replacement tire is of the same size and ply rating.* ***DO NOT*** *use lower PLY rated tires on this vehicle.*



OM1620

2.13.16 Emergency Tire Inflation System

a. Inspect Air Compressor Intake Filter



MS21402

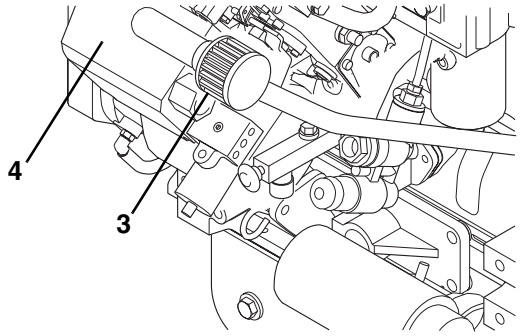


OM1580

Note: *Shorten the maintenance interval if operating in extremely dusty conditions.*

1. Place the vehicle on level ground, ground the attachment, level the vehicle, place the travel select lever in (N) NEUTRAL, move the neutral lock lever to the (N) NEUTRAL LOCK position, engage the parking brake switch and shut off the engine.

2. Unlatch and open the engine hood.
3. Locate the air compressor intake filter (**3**) located on the air compressor (**4**).
4. Visually inspect the air filter. If the filter appears extremely dirty, the filter element requires cleaning and re-oiling and/or replacement.



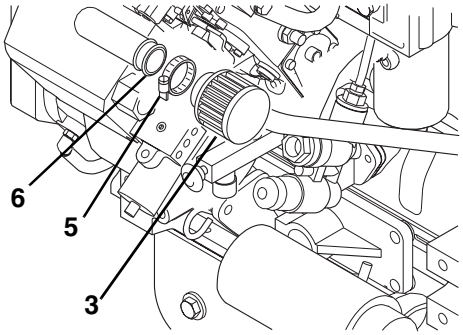
OM1321

b. Air Intake Filter Assembly Cleaning

Note: *The air intake filter assembly must be replaced after every 25 cleanings or if damaged.*

To clean and recharge the filter you will need a filter cleaner/recharger kit. The kit can be ordered by calling **JLG** at (717) 458-5161 domestically or (877) 554-5438 internationally. This kit contains a 12 oz bottle of filter cleaner and a 6.5 oz spray can of oil.

1. Clean the area around the base of the intake filter assembly where it attaches to the air compressor.
2. Loosen the clamp (**5**) holding the intake filter assembly (**3**) to the air compressor and remove the filter assembly from the barbed fitting. Save the clamp for reassembly. If you are replacing the intake filter assembly, the clamp can be discarded.
3. Tap the filter assembly to dislodge any embedded dirt, then gently brush with a soft bristle brush.
4. Spray the outside of the filter assembly with filter cleaner from the filter cleaner/recharger kit. Let the filter soak for 10 minutes.
5. Thoroughly rinse the filter assembly from the inside out using water at low pressure. DO NOT use high pressure water to rinse the filter.
6. Shake off all excess water and allow the filter to dry naturally.
7. After cleaning the filter assembly always re-oil before using. Spray the air filter oil down into each pleat with one pass per pleat. Wait 10 minutes and re-oil any white spots showing.
8. Reassemble the filter (**3**) onto the barbed fitting (**6**) and secure in place with the clamp (**5**). Tighten the clamp securely.



OM1590

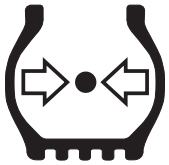
c. Air Intake Filter Assembly Replacement

1. Before installing the replacement filter assembly, use the filter oil provided with the new filter and oil the outside of the element. Be sure to cover the entire filter element. Wait 10 minutes and re-oil any white spots showing.
2. Place the new clamp onto the inlet of the filter and assemble to the barbed fitting on the air compressor. Tighten the clamp securely.

d. Drain Water From Emergency Tire Inflation Tank

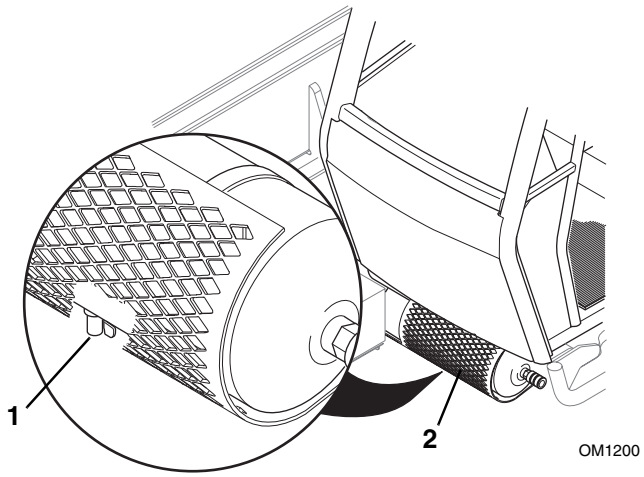


MS21402



OS0900

Daily, drain the water from the tank. Open the petcock (**1**) on the bottom of the tank (**2**) to remove any water that has accumulated inside the tank. Close the petcock after all water has been removed.

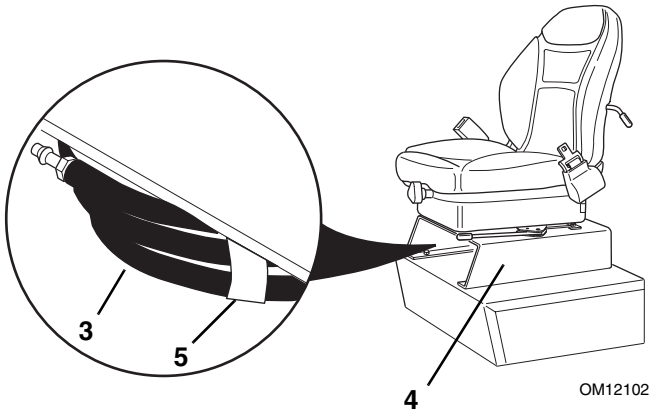


OM1200

e. Tire Inflation

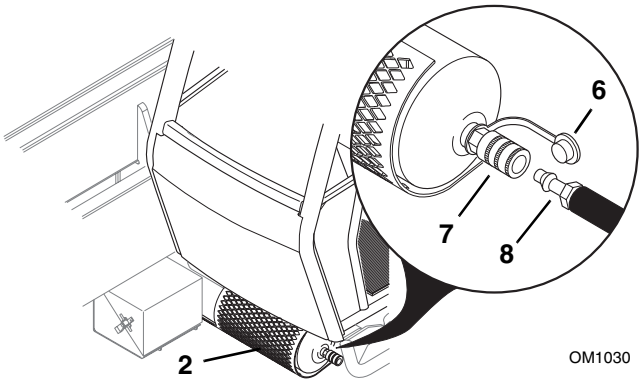
The tire inflation system will enable the tires on this vehicle to be inflated to the proper air pressure without going back to a maintenance area.

1. Place the vehicle on level ground, ground the carriage, level the vehicle, place the travel select lever in (N) NEUTRAL, move the neutral lock lever to the (N) NEUTRAL LOCK position, engage the parking brake switch.
2. Shut the engine OFF.
3. The tire inflation hose (**3**) is stored inside the seat riser (**4**). The hose is coiled up and secured in place with velcro strips (**5**). Remove the hose coil from the seat riser and then remove the velcro straps from around the hose coil.



OM12102

4. The air storage tank (**2**) is located at the front underside of the operators cab.
5. Remove the dust plug (**6**) from the quick disconnect (**7**) on the end of the air storage tank.
6. Insert the male end of the tire inflation hose (**8**) into the quick disconnect (**7**) on the side of the air storage tank. Push the outside of the quick disconnect back toward the tank, insert the male end into the quick disconnect and release the outside of the quick disconnect to secure the air hose in the disconnect.



7. Enter the operators cab and start the engine.
8. Exit the cab and inflate the tire or tires to the proper pressure. The hose is able to reach all four tires.
9. Inflate the tire(s) to: 87 psi (600 kPa).

   Check the tire pressure using a good quality tire gauge.
10. Turn the engine OFF before disconnecting the tire inflation hose.
11. Remove the tire inflation hose from the quick disconnect and coil and remount the hose (**3**) inside the seat riser (**4**). Be sure to secure the coil of hose to the velcro strips (**5**) inside the seat riser.
12. Reassemble the dust plug (**6**) back into the quick disconnect.

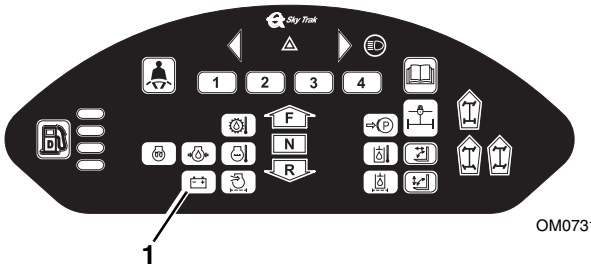
2.13.17 Batteries

a. Batteries Inspection, Testing and Service

WARNING: Lead-acid batteries produce flammable and potentially explosive gases. To avoid personal injury when checking, testing or charging the batteries:

- **DO NOT** use smoking materials near batteries.
- Keep arcs, sparks and open flames away from batteries.
- Provide adequate ventilation and wear safety glasses.

The batteries are of maintenance-free design. The batteries are filled with electrolyte and charged when shipped with the vehicle. A warning indicator light (**1**) on the operator's display panel illuminates when the alternator is no longer able to charge the batteries, or there is a problem in the charging system.



To service the batteries:

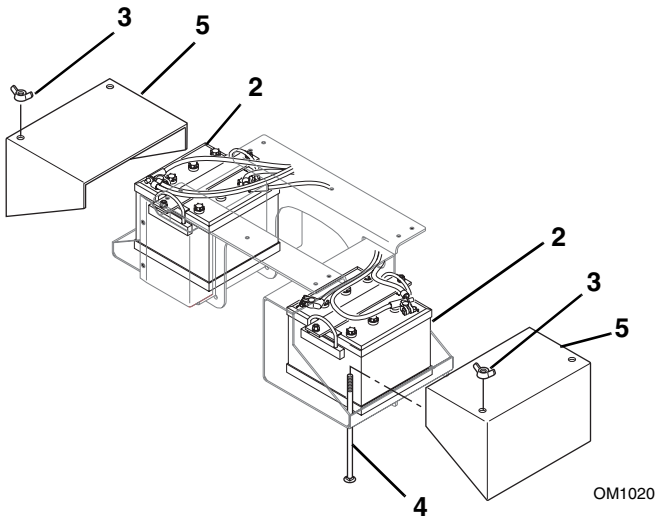
1. Level the vehicle, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. The batteries (**2**) are located under the main frame one on each side of the frame. Remove the wing nuts (**3**) from the carriage bolts (**4**). Remove the battery box covers (**5**).
3. Wear safety glasses and visually inspect the batteries. Check terminals for corrosion. Check the cable connections to ensure proper tightness. Replace a battery if it has a cracked, melted or damaged case.

WARNING: Fluid (electrolyte) in electric storage batteries contains sulfuric acid, a **POISON** that can cause **SEVERE CHEMICAL** BURNS. Avoid all contact of fluid with eyes, skin or clothing. Use proper protective gear when handling batteries. **DO NOT** tip a battery beyond a 45° angle in any direction. If contact with battery fluid does occur, follow the First Aid suggestions in the "Battery Fluid (electrolyte) First Aid" box below.

Battery Fluid (Electrolyte) First Aid:

- **External Contact —** Flush with water.
- **Eyes —** Flush with water for at least 15 minutes and get medical attention immediately.
- **Internal Contact —** Drink large quantities of water. Follow with Milk of Magnesia, a beaten egg or vegetable oil. Get medical attention immediately. **DO NOT** take fluids that induce vomiting.

IMPORTANT! *In case of internal contact,* ***DO NOT*** *give fluids that would induce vomiting!*



b. Battery Charging

> **WARNING:** **DO NOT** charge a frozen battery. A frozen battery could explode and cause death or serious personal injury. Allow the battery to thaw before “slave starting” the vehicle or connecting a battery charger.

Under normal operating conditions, the alternator will keep the batteries charged. The alternator may not be able to charge a battery that has been completely discharged for an extended period of time. Under this condition, a battery charger or a “slave start” is required to recharge the battery.

An attempt to “slave start” the vehicle and let the engine run so the alternator charges the battery can be made before using a battery charger.

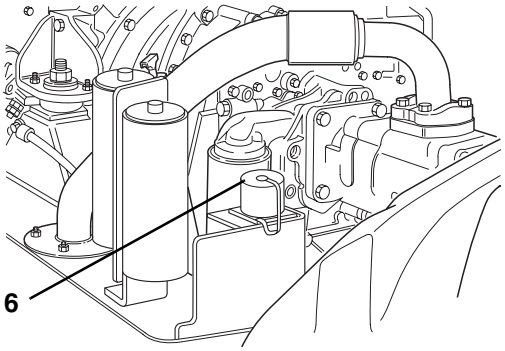
c. Slave Starting

> **WARNING:** **NEVER** slave start the vehicle directly at the starter motor or starter solenoid. Death or serious personal injury could result from the vehicle lurching forward or backward and running over personnel attempting to slave start the vehicle.

> **WARNING:** To help avoid personal injury when slave starting with another vehicle, **DO NOT** allow the vehicles to contact each other. **NEVER** salve-start a frozen battery. A frozen battery could explode and cause death or serious personal injury. Keep arcs, sparks, lighted smoking materials and open flames away from the batteries. Lead acid batteries produces flammable and potentially explosive gases. Wear safety glasses when working near a batteries.

This vehicle is equipped with a 24 volt, negative ground electrical system. The NATO slave receptacle (**6**) is located under the engine cover in front of the transmission. Ensure that both disabled and booster vehicles are equipped with a NATO slave receptacle.

1. Connect the slave cable to the booster vehicle slave receptacle.
2. Connect the other end of the slave cable to the disabled vehicle slave receptacle.
3. Run the booster vehicle at a speed just above idle.



OM1221

4. From the operator’s seat with the seat belt fastened, check that the parking brake switch is engaged. Place the travel select lever in the [N] NEUTRAL position and place the neutral lock lever in the [N] NEUTRAL LOCK position.
5. Turn the ignition switch to the START position (fully clockwise) to crank the engine. Release the ignition when the engine starts. If the engine fails to start on the first try, wait until the engine and starter come to a complete stop before engaging the starter again.

IMPORTANT: ***DO NOT*** *crank the starting motor continuously for more than 30 seconds. Stop cranking the starter and allow the starter to cool for two minutes before engaging the starter again.*

> **WARNING:** **DO NOT** start the engine unless you are in the seat with the seat belt fastened around you. Death or serious personal injury could result if the belt is not securely fastened.

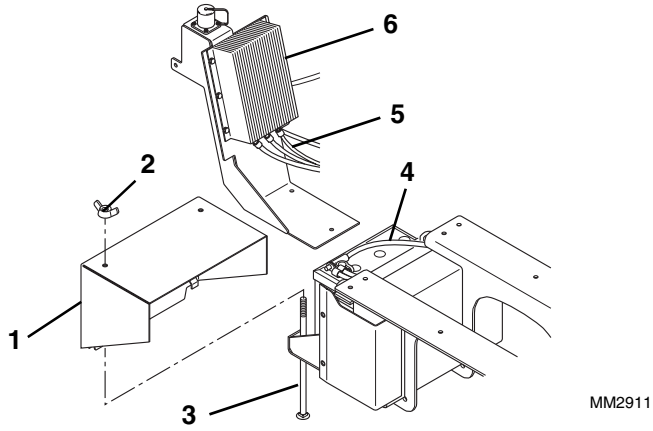
6. After starting the disabled vehicle, return the booster vehicle to idle.
7. Remove the slave cable from the disabled vehicle first and then from the booster vehicle.
8. Run engine at partial throttle for 30 to 60 seconds before operating the vehicle. Return to idle before engaging the travel or range select levers.

2.13.18 Fuse and Relay Replacement

IMPORTANT: *Shut off the engine and follow the battery disconnect procedure below, before checking the electrical system. Use an ohmmeter to check the resistance of wires and components.*

a. Disconnect Batteries

1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).

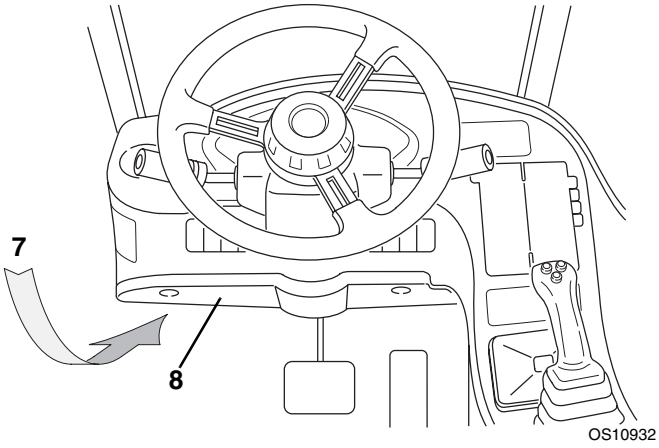


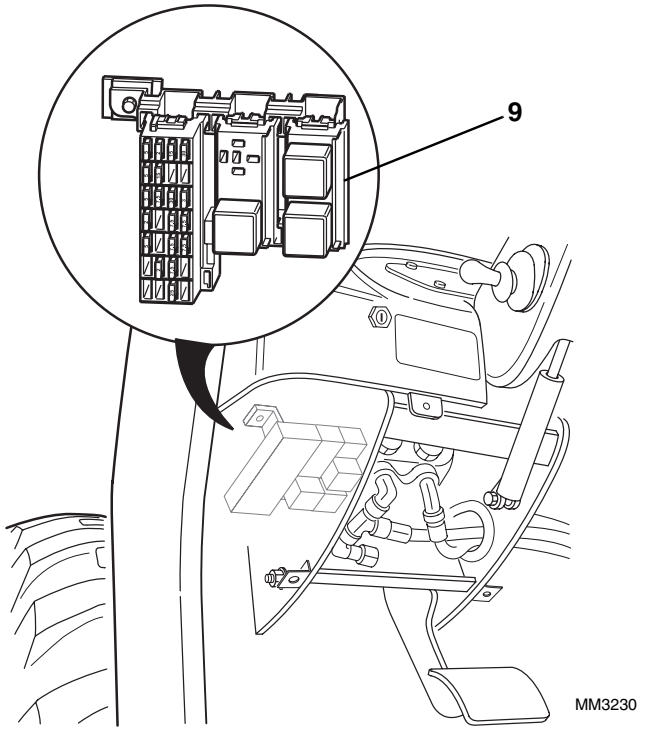
Fuses and relays help to protect the electrical system. In general, a failed fuse is symptomatic of another electrical problem. Simply replacing the fuse often will not solve the problem. Failed fuses usually are due to simple causes, including loose or corroded connections, or a defective relay.

The main causes of failed fuses include a shorted or grounded wire in the applicable circuit, or a defective electrical component. Visually check the condition of the fuse, wires, connections and components in the involved circuit before replacing a fuse. Check the circuit for shorts, grounding or defective electrical components.

b. Fuses and Relay (Fuse Block)

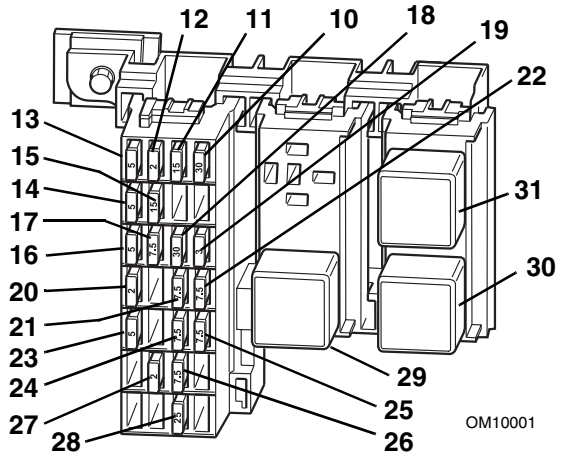
The fuses and relays in this vehicle protect the electrical system. The fuse and relay block is mounted under the lower left side of the operators dash panel (**7**). To gain access, remove the three screws that secure the lower dash panel (**8**) in place. Refer to the following chart for the locations of fuses and relays within the fuse block (**9**).





Before checking a malfunctioning electrical circuit, examine the applicable wiring diagram (refer to *Section 10, Electrical System*) to help identify the components involved. Problems can often be identified by noting whether other components related to the circuit are functioning properly. When several components or circuits fail at one time, the problem is probably related to a poor ground connection, because several circuits share that same connection.

Refer to *Section 10, Electrical System* for further information.



No.	Amp/Volt	Circuit Protected
10	30 Amp	Main
11	15 Amp	Ignition - Preheat
12	2 Amp	Hourmeter
13	5 Amp	Transmission Gear
14	5 Amp	Transmission Direction
15	15 Amp	Front Dash Display Panel
16	5 Amp	Parking Brake
17	7.5 Amp	Joystick Logic Panel
18	30 Amp	Power Window
19	3 Amp	LMI (Load Moment Indicator)
20	2 Amp	Service Brake
21	7.5 Amp	Front Wiper/Washer
22	7.5 Amp	Left Fork Shift
23	5 Amp	Steer Mode
24	7.5 Amp	Top Wiper/Washer
25	7.5 Amp	Right Fork Shift
26	7.5 Amp	Rear Wiper
27	2 Amp	Switch Lamps
28	25 Amp	Heater
29	40 Amp	Neutral Engage Relay
30	12 Volt	Door Window Relay
31	12 Volt	Closed Cab Accessory Power Relay

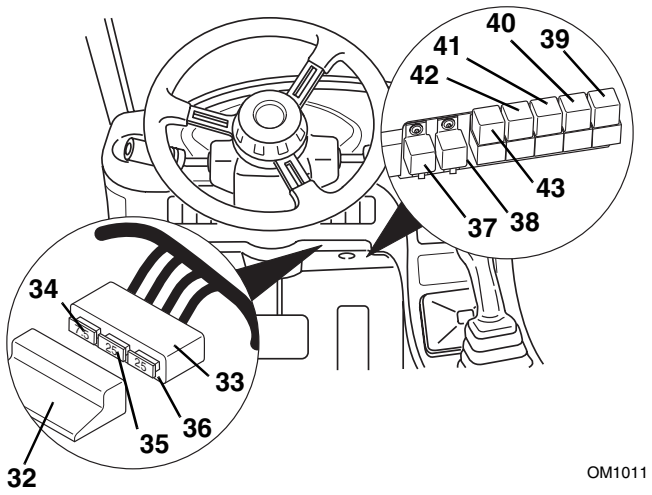
c. Fuses, Relays and Circuit Breaker (Right Side Dash)

There is a separate fuse holder under the right side of the dash containing three fuses. This fuse holder is located in the cab wire harness. To gain access, remove the three screws that secure the lower dash panel (**8**) in place.

To gain access to the fuses remove the cover (**32**) from the fuse holder (**33**).

Refer to the following chart for the size of the fuse and circuit protected.

There are seven relays (**37** through **43**) mounted to the front of the cab. Refer to the following chart for the voltage rating of each relay and circuit that they control.



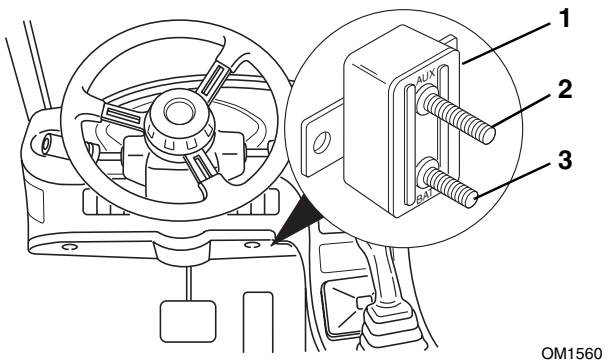
No.	Amp/Volt	Circuit Protected
34	7.5 Amp	Horn
35	25 Amp	Normal Lights
36	25 Amp	Blackout Lights
37	24 Volt	Relay - Work Light Power
38	24 Volt	Relay - High Beam Power
39	12 Volt	Relay - Brake Light
40	12 Volt	Relay - Light Power
41	12 Volt	Relay - Blackout Ignition
42	12 Volt	Relay - Normal Lights Ignition
43	12 Volt	Relay - Reverse Signal

There is one circuit breaker (**1**) located under the right side of the dash that protects the keyless ignition circuit. It is mounted to the side of the steering column mount just below the flasher.

This circuit breaker will trip if there is a short or grounded wire in the applicable circuit. The circuit breaker will automatically reset once it cools. If the circuit breaker continually trips, check the system for shorts, grounds or defective electrical components.

Under normal operating conditions the circuit breaker should never need replacement. however, if a circuit breaker does not automatically reset, the breaker is defective and replacement is required.

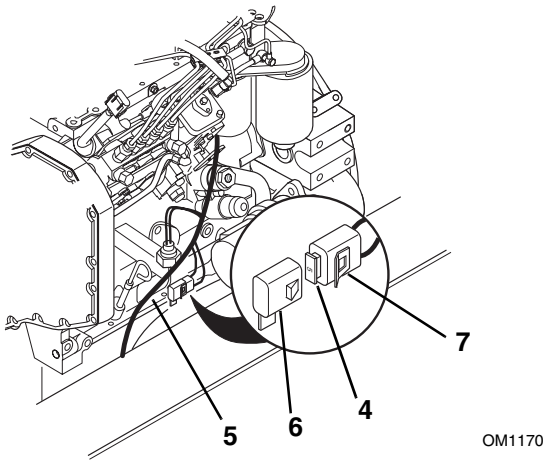
IMPORTANT: *The circuit breaker has a long terminal (**2**) and a short terminal (**3**). The short terminal is labeled "BAT" and the long terminal is labeled "AUX". Connect the wires from the battery to the "BAT" terminal and connect the other wires to the "AUX" terminal. If the wires are connected to the wrong terminals and the circuit breaker trips because of a short or grounded wire in the circuit, the contacts in the circuit breaker will melt together and the circuit breaker will not protect the circuit because it cannot open.*



d. Fuse and Relay (Fuel Shut Off Solenoid)

There is one fuse (**4**) located under the engine cover. Open the engine cover to gain access to this fuse.

The fuse is a 5 amp fuse which protects the fuel shut off solenoid, located in the engine harness (**5**). To gain access to the fuse, remove the protective cover (**6**) from the fuse holder (**7**).

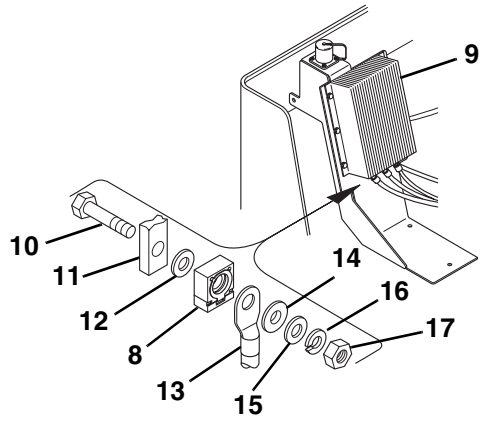


There are two fuses (**8**) located on the bottom side of the equalizer (**9**). These two fuses are 125 amp fuses and are located on the 12V and 24V positive terminals of the equalizer. These fuses protect the 12V and 24V circuits of the equalizer. You will require a small telescoping mirror to check these two fuses.

If a 125 amp fuse blows, the fuse along with the mounting hardware will have to be replaced as a kit.

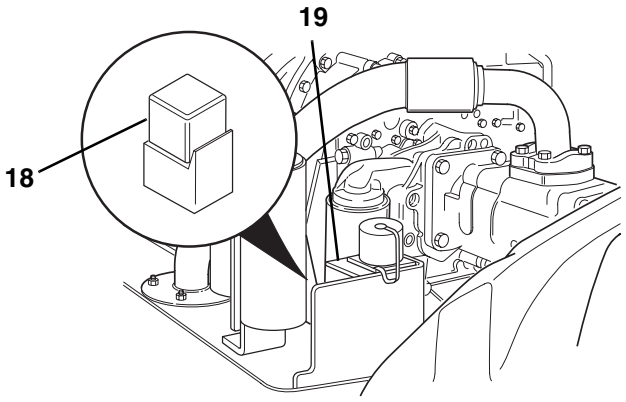
Replace a 125 amp fuse as follows:

1. Remove the blown fuse and associated hardware. Discard all items.
2. Insert the new capscrew (**10**) through the tab (**11**) on the equalizer (**9**).
3. Place a flat washer (**12**) and new fuse (**8**) onto the capscrew. Position fuse as required to best see through the clear window.
4. Place the positive cable (**13**) onto the capscrew.
5. Place the nylon shoulder washer (**14**) onto the capscrew and place against the positive cable with the hub toward the cable.
6. Secure in place with a flat washer (**15**), lockwasher (**16**) and hex nut (**17**). Torque the hex nut to a maximum of 100 lbs/in (11 Nm).



OM1570

There is one relay (**18**) located behind the battery equalizer mounting bracket (**19**). This relay is a 12 volt relay that controls the fuel shut off solenoid.



OM1351

e. Relay and Fuse (Air Conditioner Condenser Fan Motor)

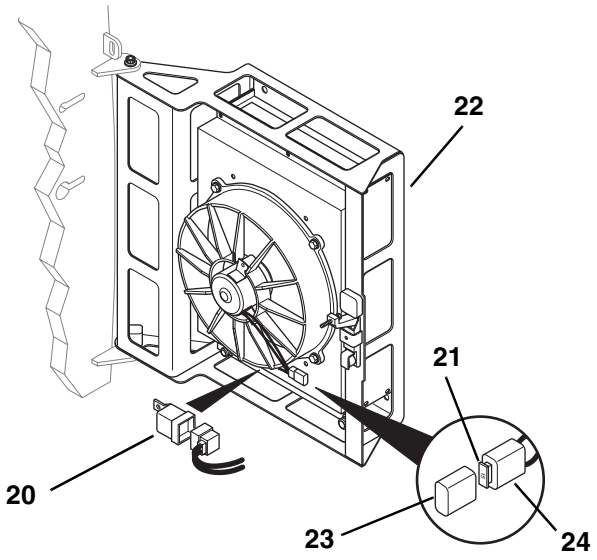
There is one relay (**20**) and one fuse (**21**) located inside the rear door (**22**). The relay is a 12 volt relay that controls the fan on the air conditioner condenser.

The fuse is a 15 amp fuse that protects the fan motor on the air conditioner condenser.

> **WARNING:** **DO NOT** open the rear door with the ignition switch in the RUN position. Contact with moving parts can cause death or serious personal injury.

Unlatch and open the rear door. The relay is mounted to the fan shroud.

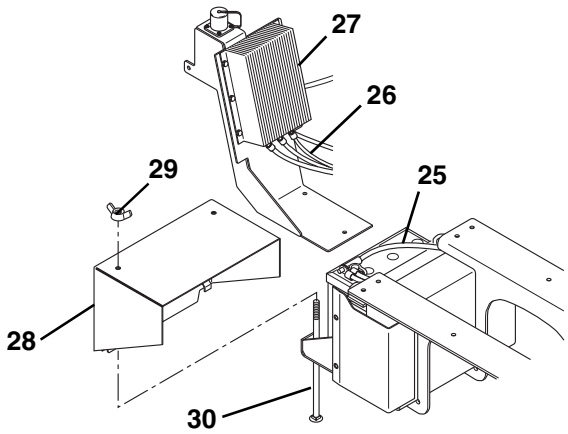
Remove the protective cover (**23**) from the fuse holder (**24**) to gain access to the 15 amp fuse.



OM1660

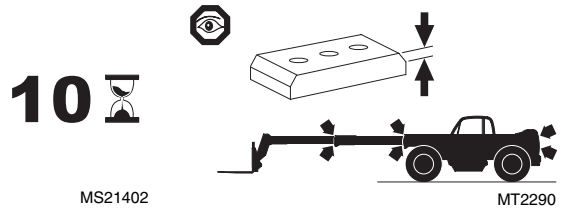
f. Re-connect Batteries

1. Connect the negative (-) battery cable (**25**) at the battery negative (-) terminal on the battery in the engine side battery box.
2. Connect the negative (-) battery equalizer cable (**26**) at the bottom of the battery equalizer (**27**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
3. Replace engine side battery box cover (**28**). Use the wing nuts (**29**) and carriage bolts (**30**) to secure the cover in place.



MM2911

2.13.19 Boom Wear Pad Maintenance



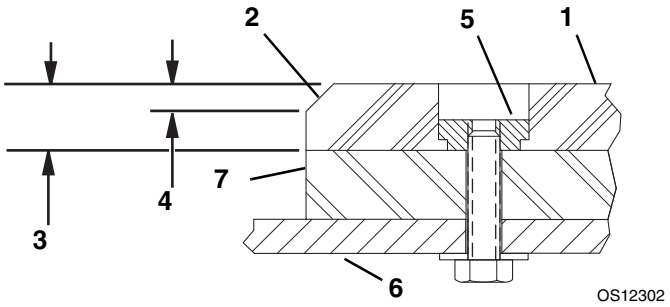
MS21402 MT2290

a. Boom Wear Pad Check

Every 10 hours of engine operation, visually inspect the boom wear pads (**1**), between the boom sections at the rear and front of the boom for excessive wear.

The average expected service life of boom wear pads varies depending on the particular location of each wear pad within the boom, vehicle use, operating conditions, and the load weight.

If load weights are at, or near, maximum capacity, or if the vehicle is operating in very dirty or dusty conditions, the boom wear pads will wear at a much faster rate.



1. Wear pad
2. Angle-cut wear pad indicator
3. 0.625" (15,9 mm)
4. 0.375" (9,5 mm)
5. Metal insert
6. Boom plate
7. Wear pad spacer

The boom wear pads that are under the most stress from weight of the load will also wear faster than other pads. For example, the lower pads at the front of the boom are under much more stress than the pads attached at the top front or sides of the boom. Consequently, the lower pads will require service more often.

b. Boom Wear Pad Replacement

Each boom wear pad (**1**), is manufactured with a convenient wear pad indicator (**2**). This is the angled cut at each end of all boom wear pads. The total thickness of a new boom wear pad is 0.625" (15,9 mm) (**3**). The angled cut will provide a total wear thickness of 0.25" (6,4 mm) (**4**). This will leave approximately 0.375" (9,5 mm) of total unused base material.

The pads must **NEVER** be worn past the angled cut indicator, or the metal pad insert (**5**) that holds the pads in place will begin to wear into the boom pad sliding surfaces. Pads worn past this point will gouge the boom surfaces. This will result in premature wear of any new boom wear pads installed, eventually requiring, expensive replacement of the boom. Replacement of boom wear pads must be performed when the boom wear pads indicate.

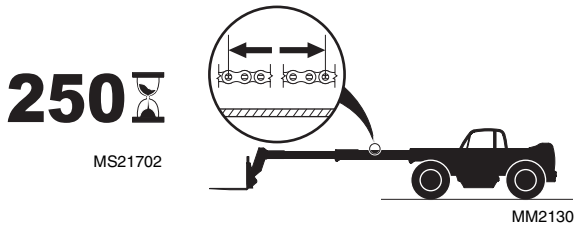
c. Boom Wear Pad Lubrication

IMPORTANT: *The boom has been factory lubricated for proper wear pad break-in and will normally not require further lubrication. However, after replacing any wear pad(s), or after prolonged periods of inoperation, light lubrication of the boom wear surfaces with a rust inhibitor/lubricant is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended in salt air climates, and when the vehicle is stored, to help prevent rusting.*

One such rust inhibitor that is specifically formulated for this purpose is LPS 3. It is marketed by:

LPS Laboratories, Inc.
4647 Hugh Howell Rd.
Tucker GA 30085-5052 USA
Phone: 1-800-241-8334
Fax: (770) 493-9206

2.13.20 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 vehicle instability and could cause death or serious injury and/or property damage.

Under normal operating conditions the boom chains will need to be inspected every 250 hours of operation. Environmental conditions and dynamic impulse/shock loads can drastically affect normal operating conditions.

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

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

Dynamic shock loading 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.

Environmental conditions and load cycles make it impossible to predict chain life. Each specific application should be evaluated, based on the degree of exposure, the areas of possible operation and the types of load cycles.

A chain replacement schedule should be established to prevent chain failure. This schedule can be established by frequent inspection. Based on the observations, the frequency of inspection can be changed.

This inspection procedure development should go on until a projected time of replacement can be predicted. A chain by its very nature and exposure should be considered an expendable item and a safe chain replacement schedule established.

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

Inspection Guidelines

1. Park the vehicle on level ground. Place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and raise the boom to a horizontal (level) position.
2. Fully extend the boom until the extend chain is taut. Shut the engine off.

   The extend chains will be visible for inspection with the vehicle in this state. The retract chain can be visually inspected, at the rear of the boom, as the boom is slowly retracted.

   While doing the chain inspection, check all chain clevis ends for distortion or cracking and sheaves for bearing wear or grooving from the chain.
3. Inspect the chains for the following conditions:

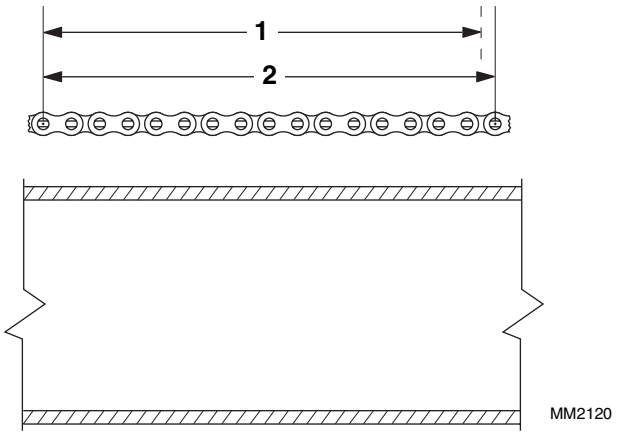
Elongation

When the original length (**1**) of 12.00" (305 mm) per foot of new chain has elongated from wear to a length (**2**) of 12.36" (313 mm), the chain should be discarded and replaced. (Refer to *Section 4.3.6, c. Chain Replacement*.)

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

Measure across a span of 17 pins (16 links) at the center of the extend chain. Measure from pin center to pin center. Because the retract chain is inside the boom you will not be able to measure the chain.

The maximum measurement allowed is12.36" (313 mm). If the measurement is more than 12.36" (313 mm), the chain should be replaced. (Refer to *Section 4.3.6, c. Chain Replacement*.)

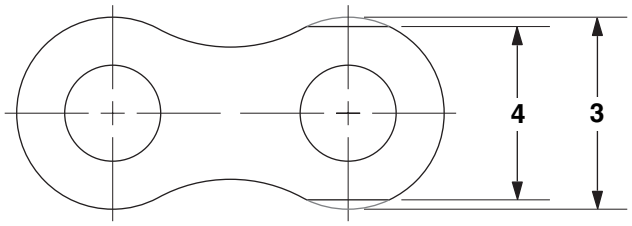


MM2120

Edge Wear

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

The new chain link measures .713" (18 mm) (**3**). If the measurement of the worn chain is less than .677" (17 mm) (**4**), the chain should be replaced. (Refer to *Section 4.3.6, c. Chain Replacement*.)



MM2050

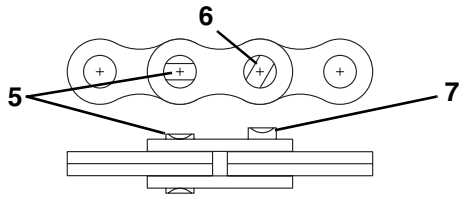
Turning or Protruding Pins

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 (**5**). Chain with rotated/displaced heads (**6**) or abnormal pin protrusion (**7**) should be replaced immediately. (Refer to *Section 4.3.6, c. Chain Replacement*.)

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.



MM2060

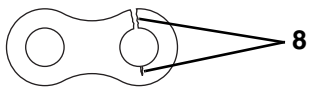
Cracked Plates

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. (Refer to *Section 4.3.6, c. Chain Replacement*.)

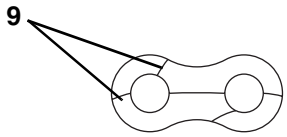
It is important, however to determine the cause of the crack before installing a new chain so the condition does not repeat itself.

- **Fatigue Cracking -** Fatigue cracks (**8**) are a result of repeated cyclic loading beyond the chain’s endurance limit. The size of the load and the frequency of its occurrence are factors which determine when fatigue failure will occur. The loading can be continuous or intermittent (impulse load).
- **Stress Corrosion Cracking -** The outside link plates are particularly susceptible to stress corrosion cracking (**9**). Like fatigue cracks, these initiate at the point of highest stress but tend to extend in an arc-like path between holes in the pin plate. More than one crack can often appear on a link plate. In addition to rusting, this condition can be caused by exposure to an acidic or caustic medium or atmosphere.

  Stress corrosion is an environmentally assisted failure. Two conditions must be present: corrosive agent and static stress. In the chain, static stress is present at the aperture due to the press fit pin. No cyclic motion is required, and the plates can crack during idle periods.
- **Corrosion Fatigue Cracking -** Corrosion fatigue cracks are very similar to fatigue cracks (**8**) in appearance. They generally begin at the aperture and grow perpendicular to the chain pitch line. Corrosion fatigue is not the same as stress corrosion. Corrosion fatigue is the combined action of an aggressive environment and cyclic stress not a static stress alone, as in stress corrosion).



MM2070



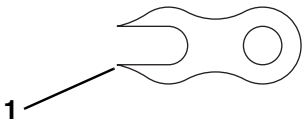
MM2080

Other Modes of Failure

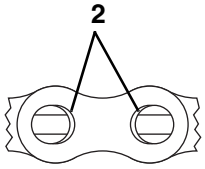
- **Ultimate Strength Failure -** These types of failures are caused by overloads far in excess of the design load. Either fractured plates (**1**) or enlarged holes (**2**) can occur. If either of these failures occurs, chain should be replaced immediately. (Refer to *Section 4.3.6, c. Chain Replacement*.)
- **Tight Joints -** All joints in the chain should flex freely. Tight joints (**3**) resist flexing and increase internal friction, thus increasing chain tension required to lift a given load. Increased tension accelerates wear and fatigue problems.

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

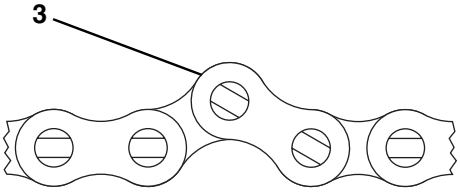
  If the problem is caused by corrosion and rust or bent pins, replace the chain. (Refer to *Section 4.3.6, c. Chain Replacement*.)



MM2090



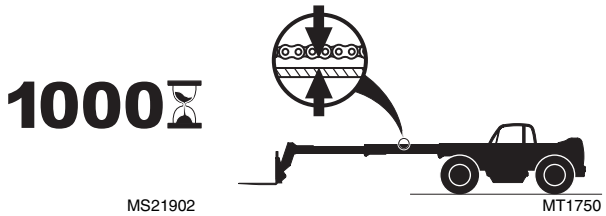
MM2100



MM2110

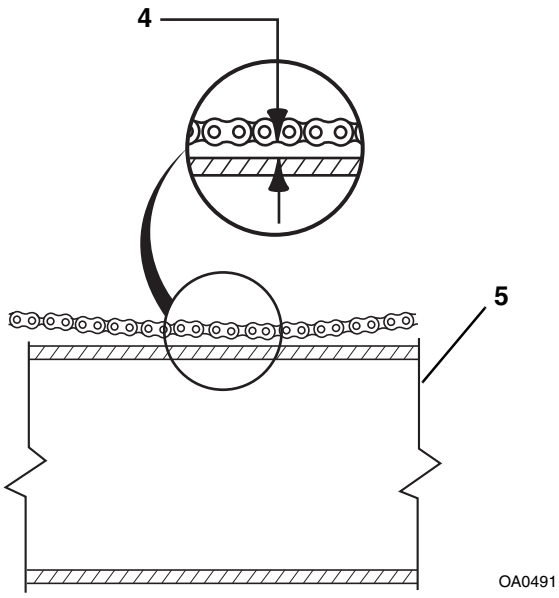
2.13.21 Boom Chain Tension & Adjustment

a. Boom Chain Tension Check



MS21902 MT1750

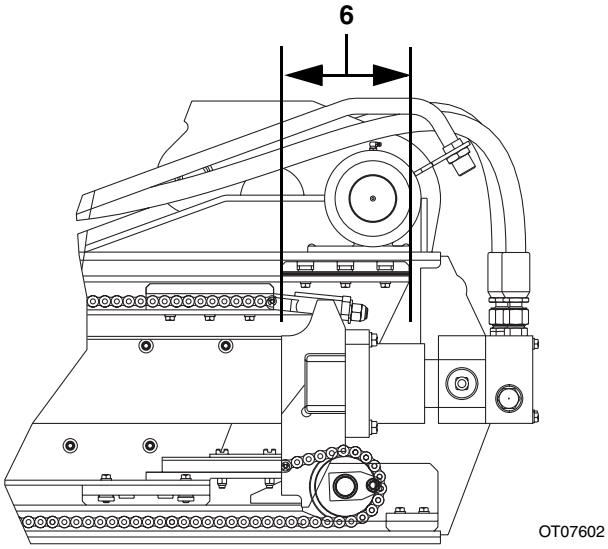
1. Park the vehicle on level ground. Place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and raise the boom to a horizontal (level) position.
2. Fully extend the boom, then retract it 2" (51 mm) (one inch per section). Shut the engine off.
3. Measure the sag (**4**) in the top extend chains between the bottom of the chains and the top of the intermediate boom (**5**) at their closest point. Acceptable boom chain sag is between 1.5-2.5" (38-64 mm). If the measurement is less than 1.5" (38 mm), the boom chains may need to be adjusted. Before making any adjustment to the extend chains, check the following measurement at the rear of the boom, as described in Steps 4-9.

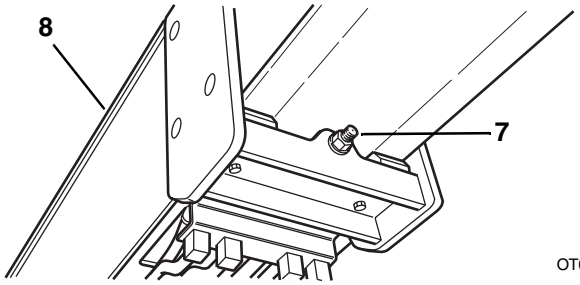


4. Start the engine, retract the boom completely and turn the engine OFF.
5. Open the door at the rear of the vehicle.
6. Check the measurement (**6**) from the rear of the intermediate boom to the rear of the inner boom. This measurement should be in the range of 8.5-9.0" (216-229 mm).

   If the intermediate boom to the inner boom measurement is less than 8.5" (216 mm), the boom may require extensive adjustment and/or repair. Contact the **JLG** Service Department or the nearest **JLG** Authorized Service Center (ASC).

   If the intermediate boom to the inner boom measurement is greater than 9.0" (229 mm), tighten the retract chain locknut (**7**) located on the bottom front of the outer boom (**8**).



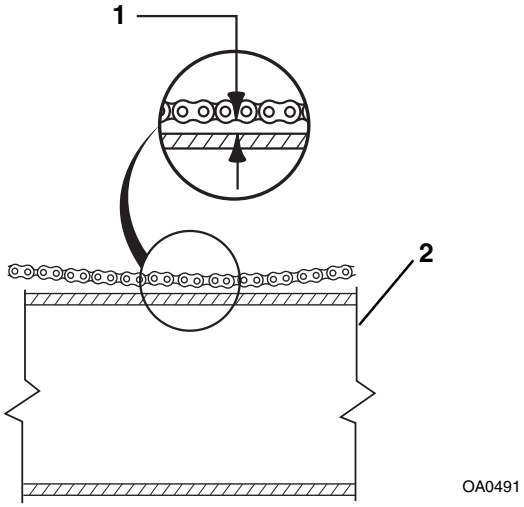


7. Start the vehicle and cycle the boom in and out several times. Then with the boom horizontal, retract the boom completely. Turn the engine OFF.
8. Recheck the measurement (**6**) at the rear of the boom between the intermediate and inner boom. If the measurement is still more than 9.0" (229 mm), repeat Steps 2-6.

Note: *If by adjusting the retract chain locknut (**7**) you cannot obtain the measurement within the range of 8.5-9.0" (216-229 mm), the boom (**8**) may require extensive adjustment and/or repair. Contact the **JLG** Service Department or the nearest **JLG** Authorized Service Center (ASC).*

If the measurement is within the range of 8.5-9.0" (216-229 mm), measure the top boom extend chain sag again.

9. Start the vehicle, cycle the boom in and out several times. With the boom horizontal, fully extend the boom and then retract it 2" (51 mm) (one inch per section). Turn the engine OFF.



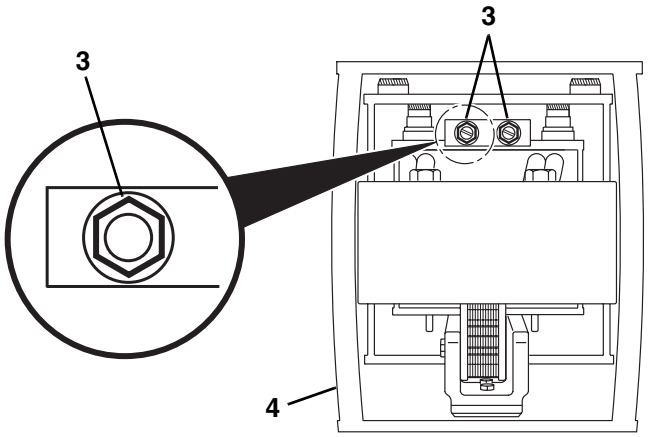
10. Measure the sag (**1**) in the top extend chains between the bottom of the chains and the top of the intermediate boom (**2**) at their closest point. Acceptable boom chain sag is between 1.5-2.5" (38-64 mm). If the measurement is less than 1.5" (38 mm), the top boom extend chains may need to be adjusted. (Refer to *Section 2.13.21, b. Extend Chain Adjustment*.)

b. Extend Chain Adjustment

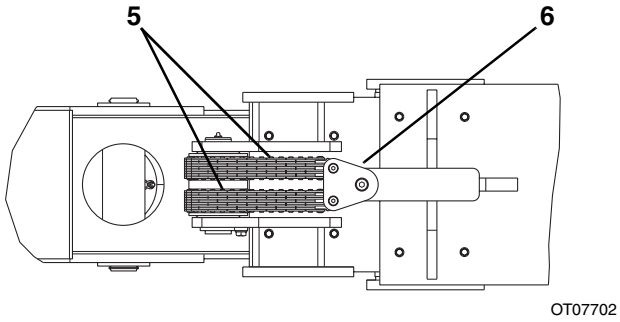
Note: *Always perform the "Boom Chain Tension Check" Refer to Section 2.13.21, a. Boom Chain Tension Check, before adjusting the boom chain tension.*

1. Park the vehicle on level ground. Place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and raise the boom to a horizontal boom. Retract the boom completely and turn the engine OFF.

2. Adjust the top extend boom chains by tightening the locknuts (**3**), located at the rear of the boom (**4**). Be sure each locknut is tightened equally, so that each chain maintains the same tension.



3. Equal boom extend chain (**5**) tension can be checked by the position of the yoke (**6**) on the outer boom. The front of the yoke should be parallel with the front of the front edge of the outer boom.



4. Start the engine and cycle the boom in and out several times. With the boom horizontal, fully extend the boom and then retract it 2" (51 mm) (one inch per section). Turn the engine OFF.
5. Measure the chain sag. Acceptable boom chain sag is between 1.5-2.5" (38-64 mm). If the measurement is less than 1.5" (38 mm), repeat Steps 2-5 until the sag is within acceptable range.

Note: *If the top boom extend chain sag cannot be adjusted within the acceptable range of 1.5-2.5" (38-64 mm), the boom may require extensive adjustment and/or repair. Contact the* ***JLG*** *Service Department or the nearest* ***JLG*** *Authorized Service Center (ASC).*

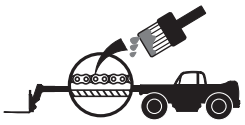
IMPORTANT: *With the boom extended fully, apply "LUBRIPLATE" Chain & Cable Fluid, "LPS3" or equivalent or equivalent to the two extend chains.*

6. Close the rear door.

2.13.22 Chain Lubrication



MS21902



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After inspection and before being returned to service, chains must be lubricated with a quality chain lubricant ("LUBRIPLATE" Chain & Cable Fluid, "LPS3" or equivalent).

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.

Lubrication of chains on vehicles working consistently in extreme hot or cold conditions requires special consideration. It is important that a reputable lubrication specialist, an authorized **JLG** Authorized Service Center (ASC) or the vehicle distributor be consulted for guidance.

2.13.23 Short Term Storage

Less Than Two Months Duration

a. Before Storing

Perform the following steps prior to placing the vehicle in storage:

1. Clean the entire vehicle. **DO NOT** remove the grease coating from the boom chains.
2. Lubricate all grease fittings as described in *Section 2.13.1, c. 250 Hour Intervals*.
3. Prepare the engine for storage (refer to the engine manual).
4. Apply multi-purpose grease to all exposed hydraulic cylinder rods.
5. Apply Teflon based lubricant to the fork shafts and the fork slide plates.
6. If the ambient temperature, anytime during the storage period is expected to drop to a point that the batteries could freeze, remove the batteries from the vehicle. Store the batteries in a dry place where they are not subject to temperatures near or below freezing.
7. If the ambient temperature is expected to remain above freezing and the vehicle is to be stored less than one month, the batteries can remain connected and no further disconnection of the equalizer is required.
8. If the ambient temperature is expected to remain above freezing and the vehicle is to be stored more than one month, but less than two months, the batteries can remain connected. However, the NEGATIVE (-) lead to the bottom of the equalizer must be disconnected to prevent electrical draw on the batteries. Save the capscrew, lockwasher and hex nut for reassembly. Isolate the cable away from the equalizer.
9. If the ambient temperature is expected to drop below freezing at anytime during the storage period, make sure the engine coolant is either completely drained from the radiator and engine block or that the amount of anti-freeze in the system is adequate to keep the coolant from freezing.
10. Preferably, store the vehicle inside where it will remain dry. If it must be stored outside, park it on lumber laid on flat level ground or on a concrete slab and cover with a tarp.

b. B. Removing From Storage

After removing the vehicle from storage and before operating it, perform the following steps:

1. Reinstall a properly charged batteries (if removed). Secure the hold-down brackets and attach battery cables.
2. If the NEGATIVE (-) lead to the equalizer was disconnected, reconnect the lead to the NEGATIVE (-) terminal and secure with the capscrew, lockwasher and hex nut saved from putting the vehicle into storage. Torque the hex nut to 100 lb/in (11 Nm).
3. Change the engine oil and filter to remove condensation or other residuals.
4. If the vehicle has been stored for two years or more, drain the coolant from the engine block and radiator and refill with a 50/50 mixture of fresh anti-freeze and water. For detailed information, see *Section 2.13.4, b. Drain and Flush the Radiator*.
5. Wipe off any multi-purpose grease that was applied to vehicles hydraulic cylinder rods prior to storing.
6. Refer to *Section 2.13.1, a. 10 Hour Intervals* and perform all the maintenance checks listed under the 10 Hour Intervals.
7. Review and familiarize yourself and any other operator with all the safe and proper operating procedures contained in the Sky Trak MMV Telescopic Material Handler Owners/Operators Manual.

2.13.24 Long Term Storage

Two Months Duration or More

a. Before Storing a Vehicle

Perform the following steps prior to placing the vehicle in storage:

1. Clean the entire vehicle. Clean and dry all surfaces to be sprayed with transit coat, but **DO NOT** remove the grease coating from the boom chains.
2. Lubricate all grease fittings as described in *Section 2.13.1, c. 250 Hour Intervals*.
3. Thoroughly clean all four tires (side walls and tread area) removing all dirt and debris. Be sure the tires are free of grease and oil residue.

4. Coat the tires with a anti-ozone protectant coating. One of the recommended coatings is #G9588 “Black Rubber Preservative” from the Akron Paint and Varnish Company. Apply the protectant coating per the application instructions on the container.

   Akron Paint and Varnish Company
   1390 Firestone Parkway
   Akron, OH 44301
   Phone: (216) 773-8911

5. Allow the coating to dry per instructions on the container, rotate the tires by moving the vehicle forward or backward. Coat the area of each tire that was in contact with the ground.
6. Prepare the engine for storage (refer to the engine manual).
7. Apply multi-purpose grease to all exposed hydraulic cylinder rods.
8. Seal all other exposed unpainted and plated metal with transit coat including surfaces that are accessible with boom, hydraulic tank, engine and transmission covers open or battery covers removed. Unpainted surfaces include boom chains and chain clevis’. Plated surfaces including pin ends, fastener hardware, hydraulic tubes, fittings and hose ends should also be coated.
9. Apply a coating thickness of .003" to .005" (0,08 to 0,1 mm). Allow one to fifteen minutes to dry, depending on temperature, humidity and coating thickness.

Note: *Overspray will not harm paint, rubber and glass and will be easily removed.*

10. Apply Teflon based lubricant to the fork shafts and the fork slide plates.
11. Disconnect the battery cables. Remove the batteries from the vehicle and store in a dry place where they are not subject to temperatures near or below freezing.
12. If the ambient temperature is expected to drop below freezing at anytime during the storage period, make sure the engine coolant is either completely drained from the radiator and engine block or that the amount of anti-freeze in the system is adequate to keep the coolant from freezing.
13. Preferably, store the vehicle inside where it will remain dry. If it must be stored outside, park it on lumber laid on flat level ground or on a concrete slab and cover with a tarp.

b. Removing Vehicle from Storage

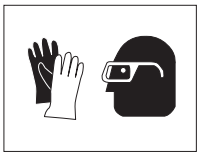
After removing the vehicle from storage and before operating it, perform the following steps:

Parts of this vehicle have been sprayed with a clear protective “transit” coating prior to being stored. Removing the transit coating will prevent discoloration. If you do not remove the transit coating it will not harm the vehicle.

The transit coating has been sprayed primarily onto plated metal parts such as brackets, pulleys, hose connections, pipe fittings and hardware. Some overspray will have settled on the surrounding areas. Before removing the transit coating, read all removal information and material data safety sheets supplied with the transit coating decoater gun.

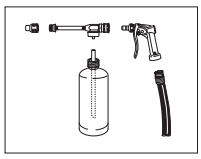
1. To remove the transit coating, refer to the following steps.

   a. Wear the recommended safety equipment, rubber gloves and eye protection.



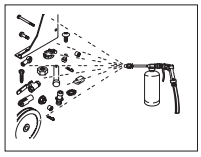
OM1410

   b. Assemble the transit coating decoater gun.



OM1420

   c. Dilute the transit coating remover with water 1:6. Position the vehicle in a shaded area. **DO NOT** pre-rinse with water. Spray the coated areas thoroughly.



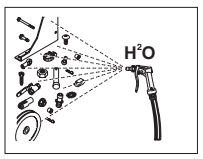
OM1430

   d. Wait two - three minutes, keeping the coated areas wet the full two - three minutes.



OM1440

   e. Remove the transit coating remover bottle and rinse the vehicle thoroughly with water.



OM1450

2. Reinstall the properly charged batteries. Secure the hold-down brackets and attach battery cables.
3. Change the engine oil and filter to remove condensation or other residuals.
4. If the vehicle has been stored for two years or more, drain the coolant from the engine block and radiator and refill with a 50/50 mixture of fresh anti-freeze and water. For detailed information, see *Section 2.13.4, b. Drain and Flush the Radiator*.
5. Wipe off any multi-purpose grease that was applied to the vehicles hydraulic cylinder rods prior to storing.
6. Refer to *Section 2.13.1, a. 10 Hour Intervals* and perform all the maintenance checks listed under the 10 Hour Intervals.
7. Review and familiarize yourself and any other operator with all the safe and proper operating procedures contained in the Sky Trak MMV Telescopic Material Handler Owners/Operators Manual.

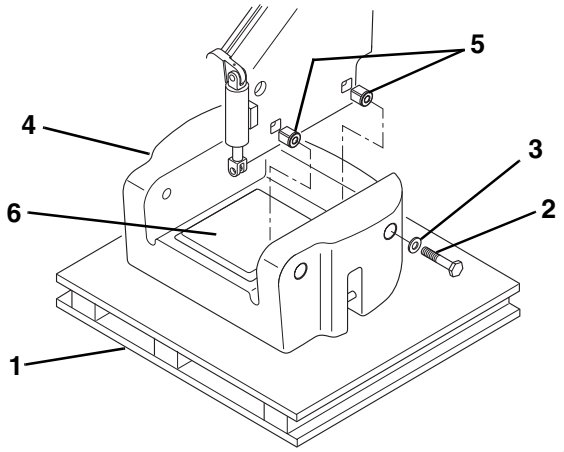
2.13.25 Counterweight Removal and Reassembly

a. Removal

Certain transport applications will require counterweight removal. When removing the counterweight, another piece of equipment (such as another MMV) capable of lifting 5,000 lbs (2268 kg) will be required.

1. Park the vehicle on level ground, frame sway the vehicle to 0° and ground the carriage.
2. Place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and turn the engine OFF.
3. Using another piece of equipment, lift a pallet (**1**) up underneath the counterweight. Lift the pallet up to the counterweight, but **DO NOT** put pressure on the counterweight.
4. Remove the four capscrews (**2**) and flat washers (**3**) securing the counterweight (**4**) to the vehicle frame. Remove and clean any Loctite® threadlocker residue from the threads of each capscrew and bushing.

Note: *If a white, powdery residue is present on the threads, it can be removed. Use "Methylene Chloride" to soften the residue and clean the residue from the threads with a soft brass wire brush.*



OM1160

Note: *Record the number of flat washers on each capscrew as they are removed. The correct number of flat washers must be reassembled in the same locations to ensure proper capscrew protrusion during reassembly of the counterweight.*

5. The four threaded bushings (**5**) will remain in place in the frame until the counterweight has been removed.
6. Lower the counterweight down with the pallet.
7. Remove the four threaded bushings (**5**) from the frame.

Note: *When securing the counterweight to the pallet, be sure to secure the counterweight insert (**6**). The counterweight insert is located in a "pocket" inside the counterweight. The insert weighs 500 lbs (227 kg).*

b. Assembly

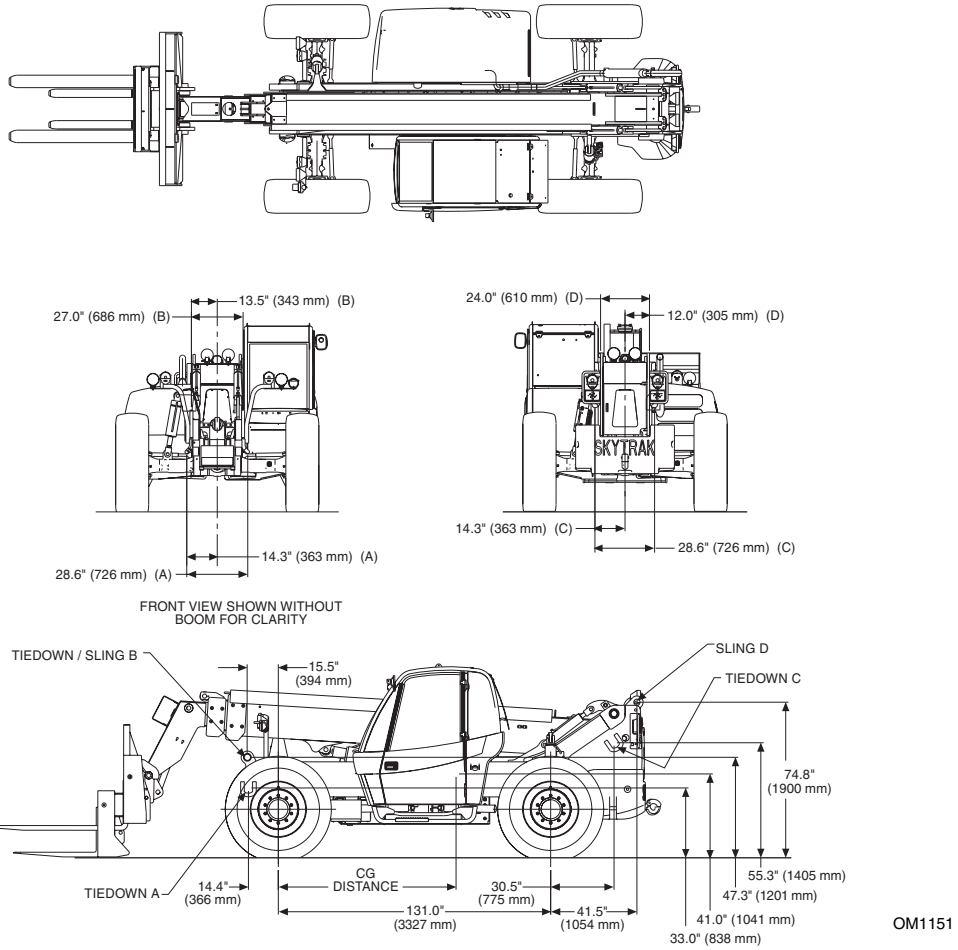
IMPORTANT: *When applying the Loctite® threadlocker to the threads of the bushing and the capscrews you have a maximum of ten minutes to line the counterweight up and insert all four capscrews. The threadlocker will start to set-up after ten minutes.*

1. Insert the four threaded bushings (**5**) into the square holes in the vehicle frame. Apply a few drops of Loctite® threadlocker #277 to the threads of each bushing.
2. Be sure the counterweight insert (**6**) is in place in the “pocket” inside the counterweight.
3. With the counterweight on the transport pallet (**1**), use another piece of equipment to lift the pallet up. Line up the holes in the counterweight (**4**) with the threaded bushings.
4. Apply Loctite® threadlocker #277 to 1-1/2" of the engaging threads of each capscrew (**2**).
5. Assemble the flat washers (**3**) onto the capscrews (**2**) and insert the capscrews with flat washers into the mounting holes in each side of the counterweight. Thread the capscrews into the threaded bushings (**5**) in the frame. Torque all capscrews to 680 lb/ft (922 Nm).

2.13.26 Transport

When transporting the vehicle, make use of all tiedown/ lift point locations on the vehicles frame.

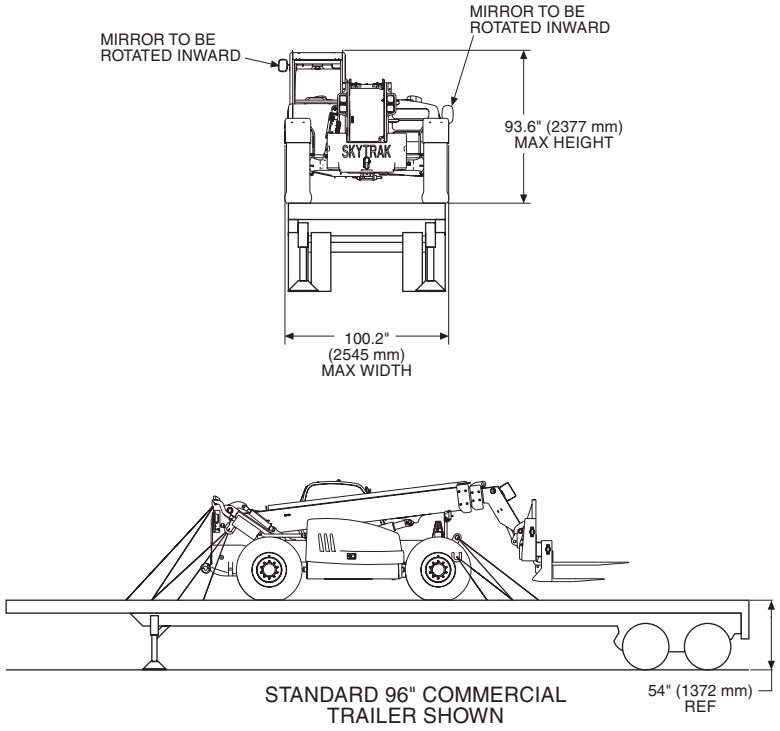
Note: *The user assumes all responsibility for choosing the proper method of transportation, and the proper selection and use of transportation and tiedown devices, making sure the equipment used is capable of supporting the weight of the vehicle being transported and that all manufacturer's instructions and warnings, regulations and safety rules of their employer, the Department of Transportation and/or any other state or federal laws are followed.*



For the different modes of transportation, refer to the proper section required. The different modes are.

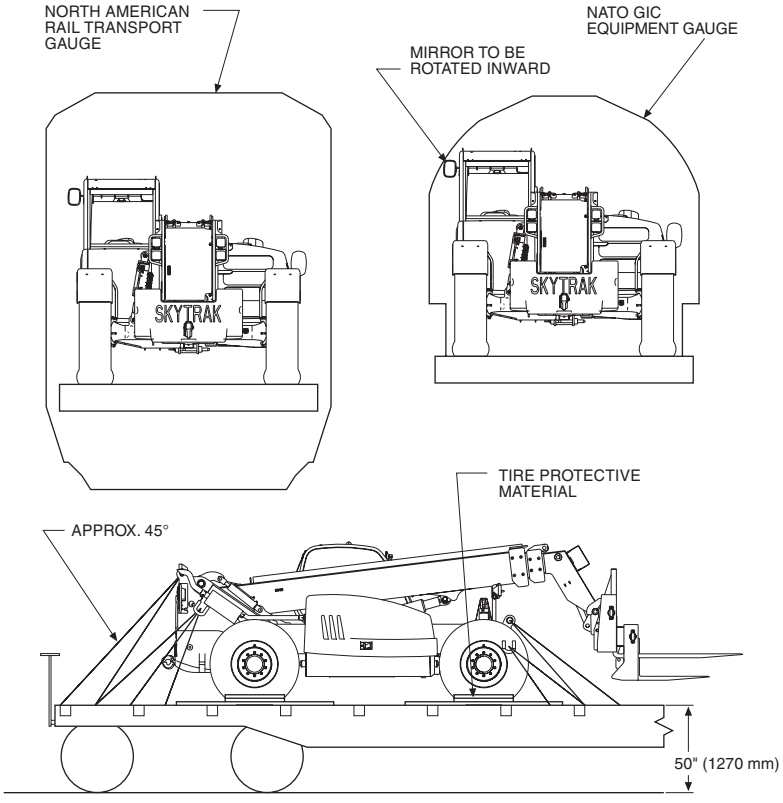
- Truck Transportabilty. Refer to "Truck Transportability" on page 2.73.
- Rail Transportability and GIC Clearance. Refer to "Rail Transportability and GIC Clearance" on page 2.73.
- Air Transport, C-17, C141 or C-5 Tiedowns. Refer to "Air Transport, C-17, C141 or C-5 Tiedowns" on page 2.74.
- Air Transport, C-130 Configuration. Refer to "Air Transport, C-130 Configuration" on page 2.75.
- Marine Transportability. Refer to "Marine Transportability" on page 2.76.
- External Transport/Slinging. Refer to "External Transport/Slinging" on page 2.76.

a. Truck Transportability



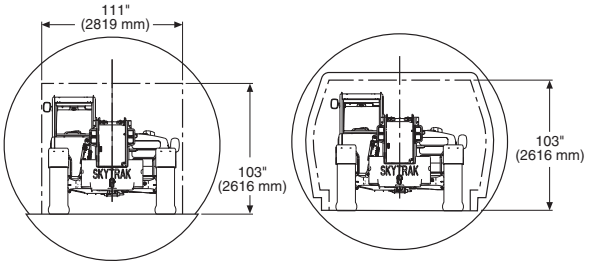
OM1251

b. Rail Transportability and GIC Clearance



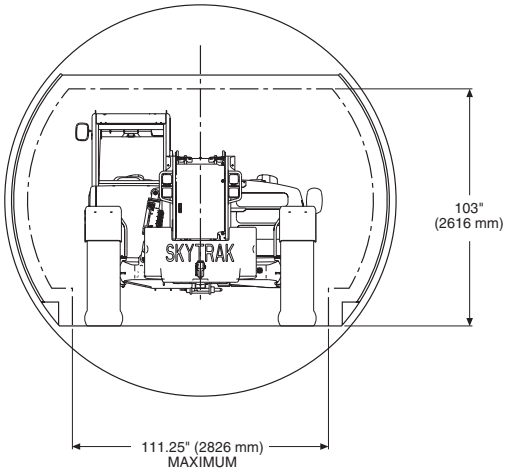
OM1261

c. Air Transport, C-17, C141 or C-5 Tiedowns



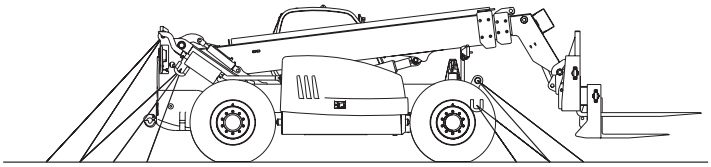
AFT OPENING DESIGN LIMITS

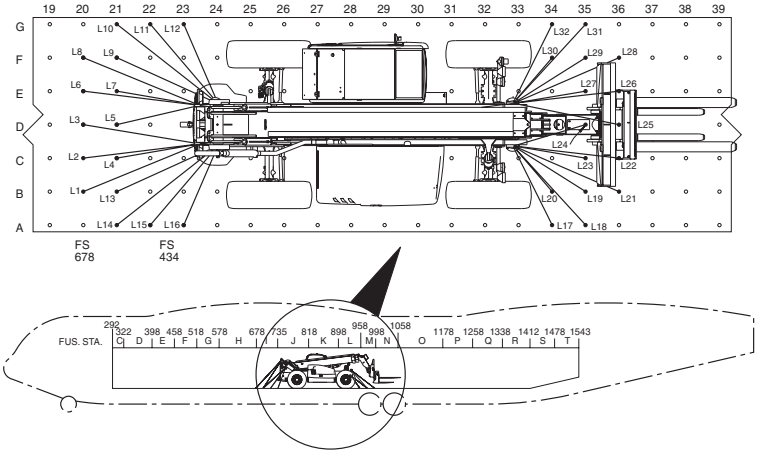
FS 734, 958, 998 & 1058



TYPICAL SECTION

OM1280

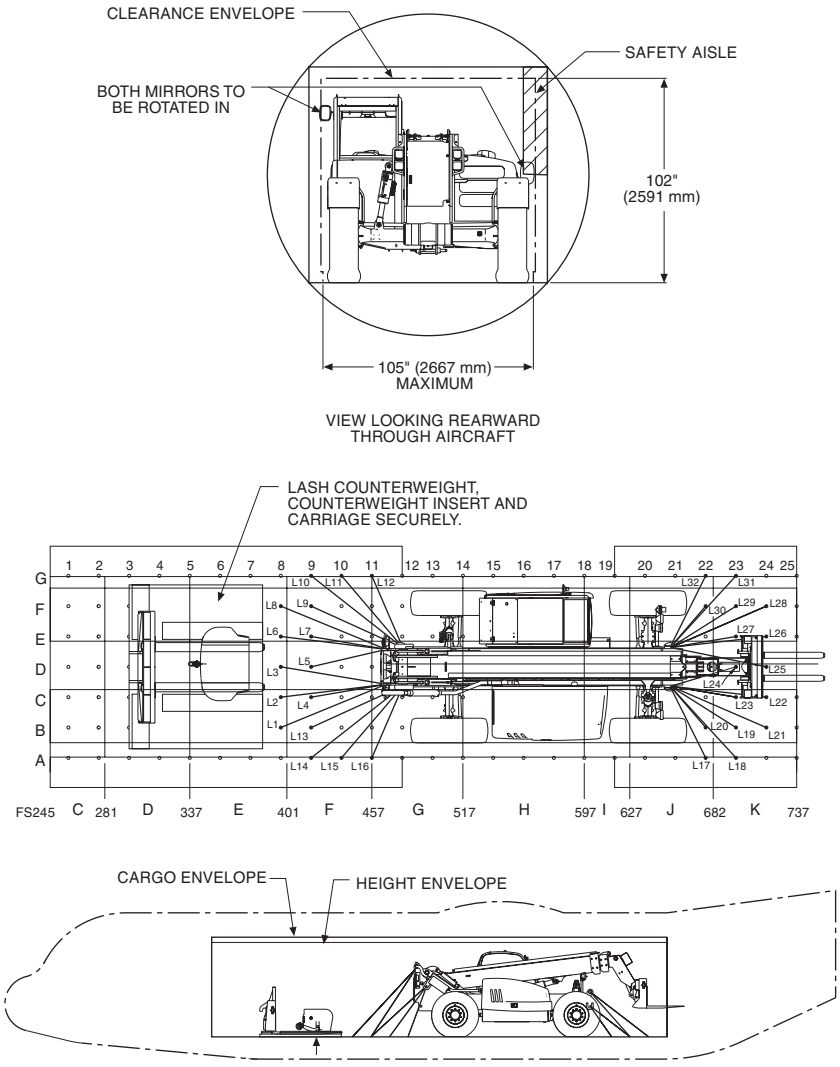




Axle and Tire Data		
Axle	Rear	Front
Axle Load	15,700 lbs (7.121 Kg)	14,800 lbs (6.713 Kg)
Load/Tire	7,850 lbs (3.561 Kg)	7,400 lbs (3.357 Kg)
Footprint Area @ 87 psi	123 sq in (793 cm^2)	119 sq in (768 cm^2)

OM1271

d. Air Transport, C-130 Configuration



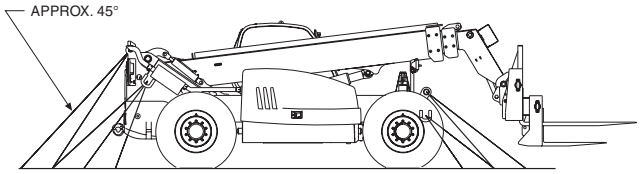
For axle and pallet weights refer to the following tables.

Axle and Tire Data		
Axle	Rear	Front
Axle Load	11,100 lbs (5.035 Kg)	12,200 lbs (5.534 Kg)
Load/Tire	5,550 lbs (2.517 Kg)	6,100 lbs (2.767 Kg)
Footprint Area @ 87 PSI	101 sq in (652 cm^2)	105 sq in (677 cm^2)

463L Pallet Data	
463L Pallet Weight	290 lbs (131 Kg)
7,000 lb Fork Carriage Weight	2,500 lbs (1134 Kg)
Counterweight Assembly Weight	4,200 lbs (1905 Kg)
Counterweight Insert Weight	500 lbs (227 Kg)
Total Weight	7,490 lbs (3397 Kg)

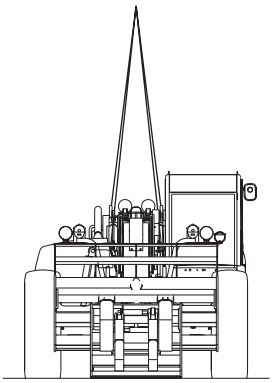
OM1291

e. Marine Transportability

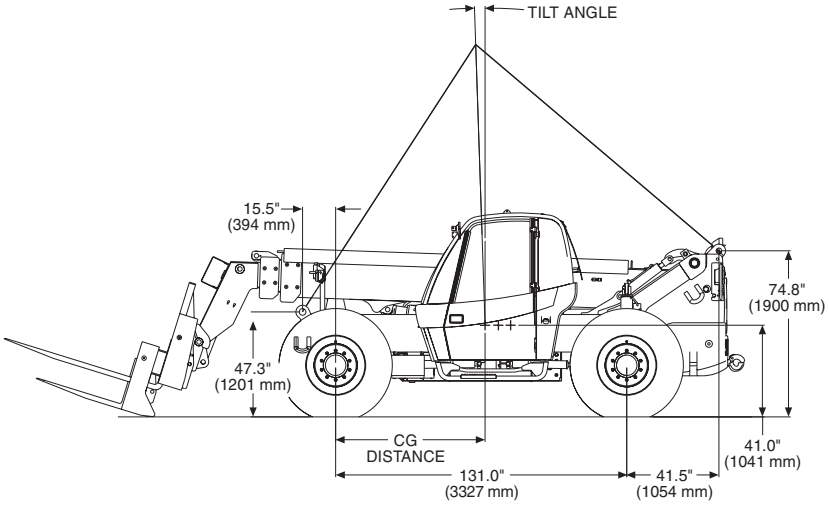


OM1331

f. External Transport/Slinging



Carriages	CG Distance	Tilt Angle	Weight	
Both Carriages	67.25" (1708 mm)	2.0°	30,500 lbs (13.835 Kg)	CH-53 Not Allowed
(7 K) 48" Load Center Carriage	73.25" (1860 mm)	5.0°	29,300 lbs (13.290 Kg)	CH-53 Not Allowed
(11 K) 24" Load Center Carriage	78.75" (2000 mm)	7.0°	28,100 lbs (12.746 Kg)	CH-53 Approved



OM1341

2.14 EMERGENCY OPERATIONS

2.14.1 Towing a Disabled Vehicle Short Distances

Towing a disabled vehicle should only be attempted as a last resort, after exhausting all other options. Every effort should be made to repair the vehicle and move it under its own power. Towing the vehicle improperly can result in damage to the vehicle drivetrain.

IMPORTANT! *In the event the vehicle is disabled and cannot be moved under engine power, the situation must be properly evaluated and dealt with on an individual basis. Contact your local* **JLG** *Authorized Service Center (ASC) or the* **JLG** *Service Department at (877) 554-5438 for specific instructions for your particular situation.*

If it is necessary to tow the vehicle a short distance to avoid a potentially hazardous situation such as being in an unsafe area on the worksite or on a roadway, prepare the vehicle for towing as follows;

1. Remove the load from the vehicle.
2. Fully retract the boom. Position forks approximately 24" above ground. (Refer to *Section 4.3.10, Emergency Boom Lowering and Retracting* for proper procedure if required.)
3. Open the engine compartment cover. Allow the hydraulic oil to cool.

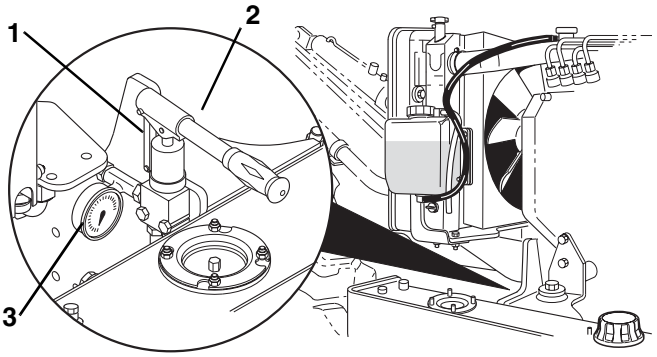
WARNING: BLOCK ALL FOUR WHEELS. Failure to do so could result in death or serious injury from vehicle roll-away.

4. **Block all four wheels** to help prevent the vehicle from moving after the parking brake is disabled.
5. Locate the emergency towing pressurizing valve (**1**) located under the radiator on the mounting bracket.
6. Turn the ignition switch to the ON position (with the engine not running), release the parking brake switch.

Note: *With the ignition switch in the ON position, the low brake pressure buzzer will sound continuously until the towing operation is complete and ignition switch turned to the OFF position.*

7. Use the handle (**2**) on the emergency towing valve to pump pressure into the system. Watch the pressure gauge (**3**) while pumping pressure into the park brake system. **DO NOT** exceed 650 psi (45 bar).

CAUTION: DO NOT exceed 650 psi (45 bar) when pressurizing the park brake. Applying too much pressure may damage the brake seals.

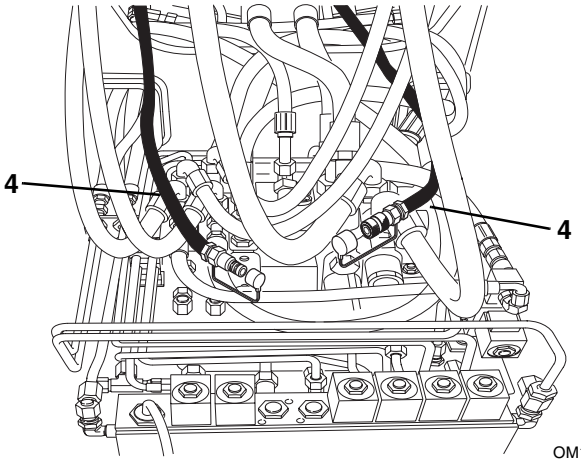


OM1051

8. Turn the steering wheel until the front tires are pointed in a straight ahead position.

WARNING: DO NOT open the rear door with the air conditioner rocker switch in the ON position and the fan switch turned to the ON position. Contact with moving parts can cause death or serious personal injury.

9. Open the rear door. Connect the steer cylinder crossover tow hoses (**4**) together. The two hoses are located inside the rear of the frame.



OM1080

10. Remove the dust cap (**1**) from the “male” nipple on one crossover hose. Remove the dust cap (**2**) from the “female” quick disconnect on the other crossover hose. Couple the quick disconnects together. Close the rear door.
11. With the crossover hoses (**3**) coupled together, the rear wheels will be free to steer, thus “tracking” as the vehicle is being towed.

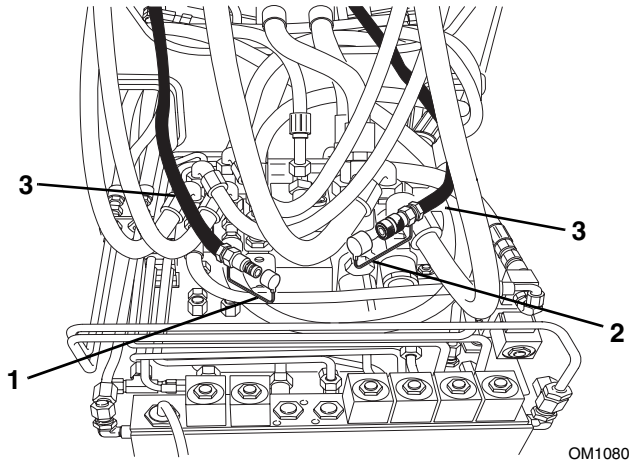
> **WARNING:** **DO NOT** tow at speeds over 20 mph. Carefully move the towing vehicle into position. Always use a ground guide and any device necessary to lift the tow bar into position without standing directly between vehicles. Failure to comply could result in vehicle damage, or injury or death to personnel.

12. Clear the area of any unnecessary personnel.
13. Carefully remove the wheel blocks from each of the four tires. Tow the vehicle to a secure location.
14. Have an operator seated in the seat.
15. The vehicle can now be towed out of the way using the pintle hook provided on the rear of the vehicle. ***Tow or push the vehicle at a very slow speed!***

> **WARNING:** Always disconnect the steer cylinder crossover hoses before resuming normal operation. Failure to disconnect the crossover hoses will result in the inability to steer the rear wheels. If the vehicle is driven in this condition, control of the rear wheels will be unpredictable.

> **WARNING:** **DO NOT** open the rear door with the air conditioner rocker switch in the ON position and the fan switch turned to the ON position. Contact with moving parts can cause death or serious personal injury.

16. Before placing the vehicle back into service, disconnect the steer cylinder crossover hoses (**3**) by removing the “male” nipple from the “female” coupler. Re-install both dust caps (**1** and **2**). Perform the steer indexing procedures. (Refer to *Section 9.9, Steer Indexing Procedures*.)



2.14.2 Towing a Disabled Vehicle Long Distances

Towing a disabled vehicle should only be attempted as a last resort, after exhausting all other options. Every effort should be made to repair the vehicle and move it under its own power. Towing the vehicle improperly can result in damage to the vehicle drivetrain.

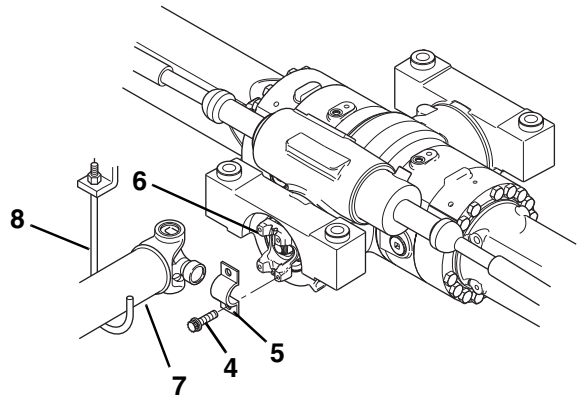
IMPORTANT! *In the event the vehicle is disabled and cannot be moved under engine power, the situation must be properly evaluated and dealt with on an individual basis. Contact your local* **JLG** *Authorized Service Center (ASC) or the* **JLG** *Service Department at (877) 554-5438 for specific instructions for your particular situation.*

If it is necessary to tow the vehicle a long distance to a repair facility, prepare the vehicle for towing as follows;

1. Remove the load from the vehicle.
2. Fully retract the boom. Position forks approximately 24" above ground. (Refer to *Section 4.3.10, Emergency Boom Lowering and Retracting* for proper procedure if required.)

WARNING: BLOCK ALL FOUR WHEELS. Failure to do so could result in death or serious injury from vehicle roll-away.

3. **Block all four wheels** to help prevent the vehicle from moving after the parking brake is disabled.
4. Remove the four bolts (**4**) and two straps (**5**) securing the bearing crosses to the front and rear axle input yokes (**6**).
5. Secure the unattached end of the drive shaft (**7**) in hanger hook (**8**) provided underneath the frame of the vehicle. Rotate the hanger hooks into position to hold the driveshaft. The hanger hooks have spring tension applied to hold them in position



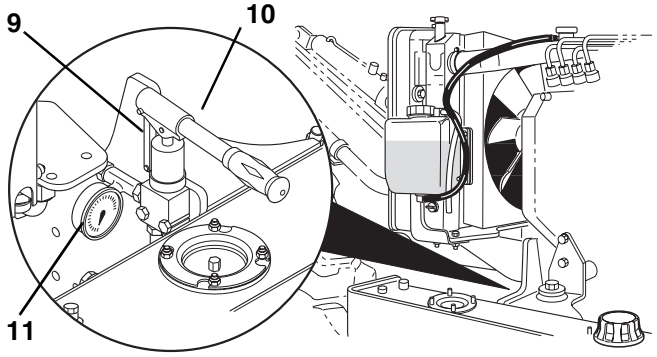
MM2220

6. Turn the ignition switch to the ON position (with the engine not running), release the parking brake switch.

Note: *With the ignition switch in the ON position, the low brake pressure buzzer will sound continuously until the towing operation is complete and ignition switch turned to the OFF position.*

7. Open the engine compartment cover. Allow the hydraulic oil to cool.
8. Locate the emergency towing pressurizing valve (**9**) located under the radiator on the mounting bracket.
9. Use the handle (**10**) on the emergency towing valve to pump pressure into the system. Watch the pressure gauge (**11**) while pumping pressure into the park brake system. **DO NOT** exceed 650 psi (45 bar).

CAUTION: DO NOT exceed 650 psi (45 bar) when pressurizing the park brake. Applying too much pressure may damage the brake seals.



OM1051

10. Turn the steering wheel until the front tires are pointed in a straight ahead position.

WARNING: DO NOT open the rear door with the air conditioner rocker switch in the ON position and the fan switch turned to the ON position. Contact with moving parts can cause death or serious personal injury.

11. Open the rear door. Remove the dust cap (**1**) from the “male” nipple on one crossover hose. Remove the dust cap (**2**) from the “female” quick disconnect on the other crossover hose. Couple the quick disconnects together.
12. With the crossover hoses (**3**) coupled together, the rear wheels will be free to steer, thus “tracking” as the vehicle is being towed.

13. Close the rear door.

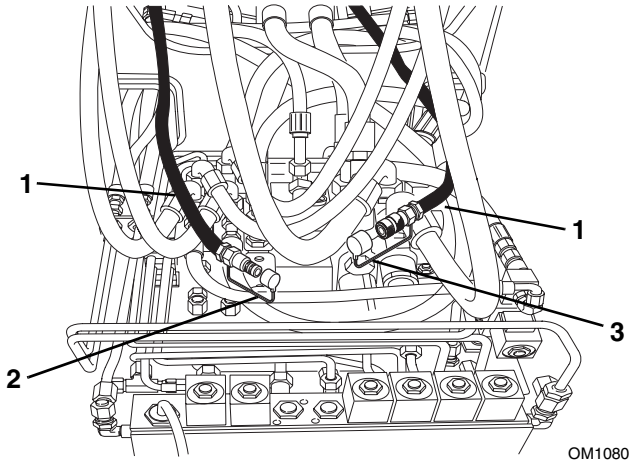
> **WARNING:** **DO NOT** tow at speeds over 20 mph. Carefully move the towing vehicle into position. Always use a ground guide and any device necessary to lift the tow bar into position without standing directly between vehicles. Failure to comply could result in vehicle damage, or injury or death to personnel.

14. Position the towing vehicle in place. Using the tow lugs, located at the rear of the vehicle, connect the tow bar to the disabled vehicle.
15. Clear the area of any unnecessary personnel.
16. Carefully remove the wheel blocks from each of the four tires. Tow the vehicle to a secure location.
17. Have an operator seated in the seat.

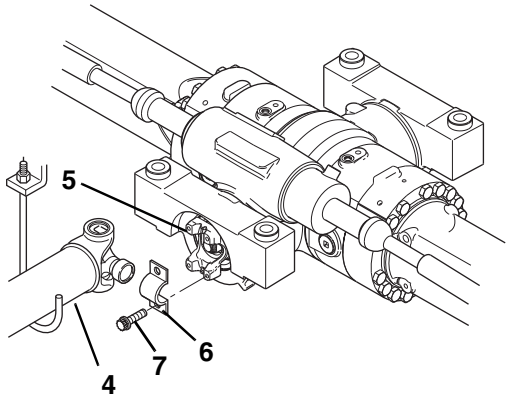
IMPORTANT! *Tow or push the vehicle at a very slow speed!*

> **WARNING:** **DO NOT** open the rear door with the air conditioner rocker switch in the ON position and the fan switch turned to the ON position. Contact with moving parts can cause death or serious personal injury.

18. Before placing the vehicle back into service, disconnect the steer cylinder crossover hoses (**1**) by removing he “male” nipple from the “female” coupler. Re-install both dust caps (**2** and **3**).



19. Re-install the ends of the drive shafts (**4**) to the front and rear axle input yokes (**5**) using the straps (**6**) and bolts (**7**) removed in step 4. Torque the M12 bolts to 156 lb/ft (212 Nm). Rotate the driveshaft hanger hooks out of the way and install the driveshafts to the front and rear axles.



20. Perform the steer indexing procedures. (Refer to *Section 9.9, Steer Indexing Procedures*.)

2.14.3 Boom Lowering and Retracting

In the event of total loss of engine power or hydraulic pump failure, emergency boom lowering procedures are listed in *Section 4.3, Boom Assembly Maintenance*. Two types of conditions requiring emergency boom lowering are addressed; Engine or Hydraulic Pump Failure (refer to *Section 4.3.10, a. Engine or Hydraulic Pump Failure*) or Hydraulic Line Failure (refer to *Section 4.3.10, b. Hydraulic Line Failure*).

IMPORTANT: *In the event of total loss of engine power or hydraulic pump failure with an elevated load, properly evaluate and deal with each situation on an individual basis. Contact the nearest* ***JLG*** *Authorized Service Center (ASC) or the* ***JLG*** *Service Department for specific instructions.*

2.15 PARKING BRAKE/TRANSMISSION DE-CLUTCH TEST PROCEDURES

To check that the parking brake/transmission de-clutch system is functioning properly, perform the following tests.

IMPORTANT: *These tests should be performed in [1] FIRST gear only.*

> **WARNING:** **DO NOT** operate this vehicle unless you are in the seat with the seat belt fastened around you. Death or serious personal injury could result if the belt is not securely fastened.

Test 1 - Transmission De-Clutch

Step 1

a. Place the vehicle on a level surface.
b. Clear the area in front and behind the vehicle of any obstacles.
c. Fasten your seat belt.
d. Push and turn the ignition switch and start the engine.
e. With the parking brake applied, move the range select lever to [1] FIRST gear.
f. Move the travel select lever to [F] FORWARD.
g. Depress the throttle pedal fully. The unit should not move.

Step 2

a. Remove your foot from the throttle pedal.
b. Move the travel select lever to [R] REVERSE.
c. Depress the throttle pedal fully. The unit should not move.
d. Remove your foot from the throttle pedal.
e. Move the travel select lever to (N) NEUTRAL.

Test 2 - Transmission De-Clutch/Parking Brake Activation

a. With the vehicle unloaded, disengage the parking brake.
b. Move the travel select lever to [F] FORWARD.
c. Move the unit **slowly** in a forward direction (approximately 1 mph [1,6 kmh]).
d. Engage the parking brake. The unit should stop abruptly.

Test 3 - Park Brake Hold Performance

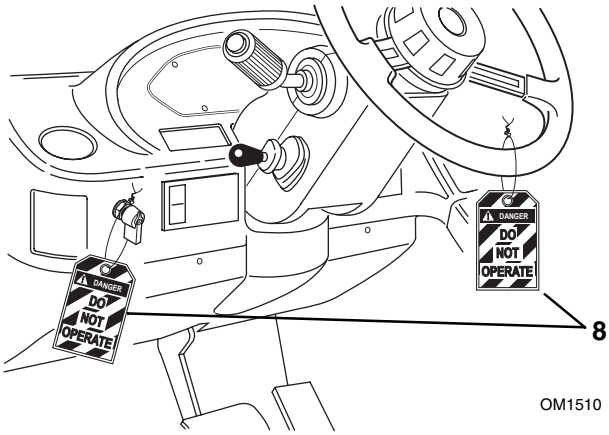
a. With the rated load of 11,000 lbs (4.989 Kg) on the forks, drive the vehicle forward up a 15% grade (15 ft. rise over 100 ft. run).
b. Stop the vehicle using the service brakes, apply the park brake, shift the transmission into NEUTRAL (N).
c. Take your foot off the service brake pedal. The vehicle should not move.
d. Apply the service brakes, shift the transmission into REVERSE [R], move the park brake switch to the OFF position and back down off the grade.
e. Repeat “Test 3” by backing up the grade and checking the park brake holding performance.

If the parking brake or transmission de-clutch does not pass these tests, do the following.

1. **Immediately** remove the vehicle from service.

> **WARNING:** **BLOCK ALL FOUR WHEELS.** Failure to do so could result in death or serious personal injury from vehicle roll away.

2. Block all four wheels to prevent the vehicle from moving.
3. Place the accident prevention tags (**8**) on the ignition switch and the steering wheel.
4. Service the parking brake immediately or contact your local **JLG** Authorized Service Center (ASC) to repair the system.



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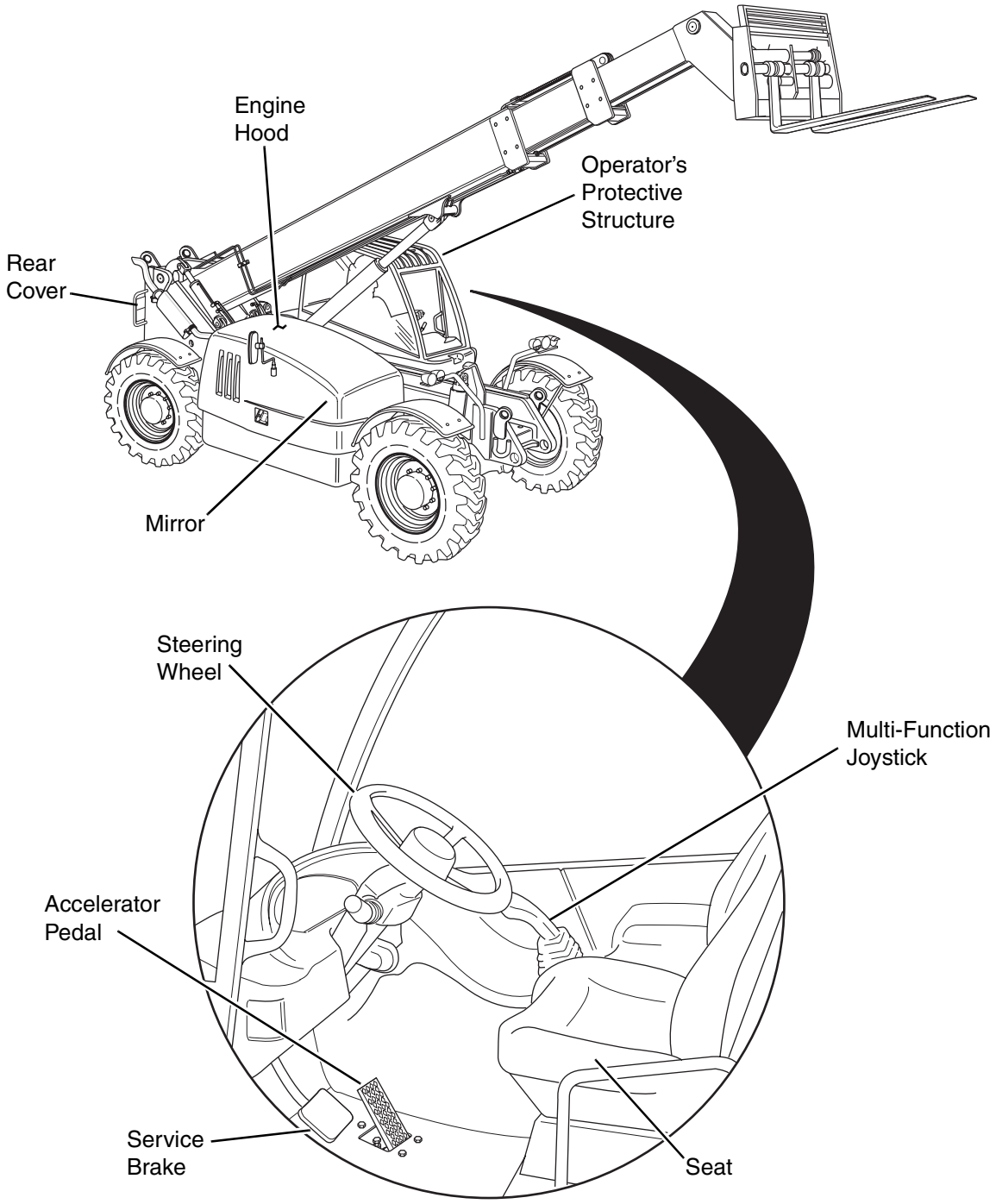
Section 3
Cab, Covers and Mirrors

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3.1 OPERATOR'S 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 name and location of the major assemblies of the vehicle cab and covers. The following illustration identifies the components that are referred to throughout this section.





> **WARNING:** **DO NOT** service the vehicle without following all safety precautions as outlined in the “Safety Practices” section of this manual. Failure to follow the safety practices may result in death or serious injury.

3.2 OPERATOR’S CAB

3.2.1 Operator’s Cab Description

The welded metal cab features European styling and a modular design, allowing for a relatively quick, simple exchange of the entire cab and/or component parts. The cab is bolted to the cab mount, which in turn is bolted to the frame.

The cab is set-up as an enclosed cab configuration. The enclosed cab includes a heater/window defroster system, and windshield, roof and rear window wipers.

The operator’s cab is a protective structure. The cab itself contains roll-over protective and falling object protective structures (ROPS/FOPS) for the operator.

> **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. The lives of the operator and others are potentially at stake.

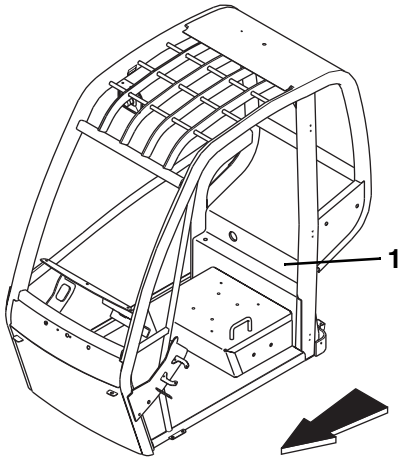
To help ensure optimum safety, protection and performance, replace the cab if it is damaged. Refer to the appropriate parts manual for ordering information.

The cab contains the seat, operating controls, numerous panels, steering and brake components, and more.

Covers and mirrors on the vehicle exist for safety, protection and appearance. They are relatively simple to remove and replace.

3.2.2 Serial Number Decal

The cab serial number decal (**1**) is located on the left side of the cab, behind the seat. Information specified on the serial number plate includes the cab model number, the cab serial number and other data. Write this information down in a convenient location to use in cab correspondence.



MM2180

3.2.3 Cab Maintenance

a. Replacement

WARNING: Risk of death or serious personal injury. **NEVER** modify, weld or drill the cab.

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.

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

Before performing any inspection, maintenance or service operation, thoroughly clean the vehicle. **DO NOT** spray water or cleaning solution in, on, near or around the operator's dash panels and electrical components.

Inspect the cab, its welds and mounts. If modification, damage, a cracked weld and/or fatigued metal is discovered, replace the cab. Contact the **JLG** Service Department or the local **JLG** Authorized Service Center (ASC) with any questions about the suitability or condition of a cab.

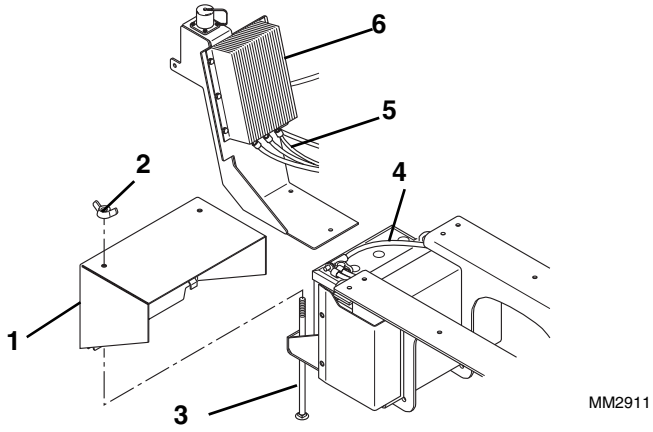
b. Cab Removal

WARNING: Wear protective footwear with reinforced toe caps and slip-resistant soles. Failure to comply can result in foot injury from falling objects or other bodily injury from slipping or falling.

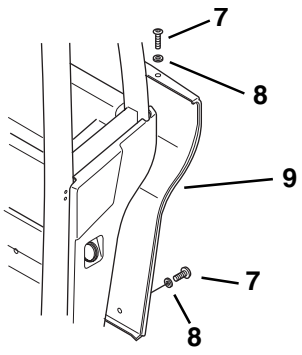
WARNING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling or hoist. Failure to comply can result in death or serious personal injury.

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

1. Park the vehicle on a firm, level surface. Allow sufficient overhead and side clearance for cab removal. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Open the engine hood. Allow the engine and hydraulic fluid to cool.
2. Remove engine side battery box cover (**1**). Remove wing nut (**2**) and carriage bolt (**3**) and set cover and mounting hardware aside for later re-assembly.
3. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
4. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).

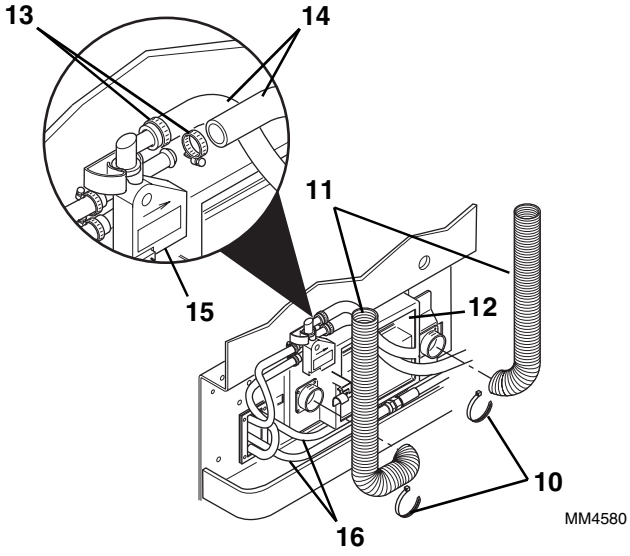


5. Remove the joystick assembly (refer to *Section 3.5.2, b. Joystick Assembly Replacement*). Label, disconnect and cap the six hydraulic hoses mounted at the base of the joystick assembly.
6. Drain coolant from the radiator (refer to *Section 2.13.4, b. Drain and Flush the Radiator*). The coolant capacity is approximately 3 gallons (11,4 liters). Allow the coolant to drain into a clean container and save for putting back into the radiator at a later time.
7. Working from the outside rear of the cab, remove the four button head capscrews (**7**) and flat plastic washers (**8**) and remove the rear cab panel (**9**).



SS1230

8. Remove the seat assembly from the seat support (refer to *Section 3.3.2, Seat Replacement*). Remove the two elastic locknuts and rebound washers from the rear of the cab and leave the tethers attached to the seat.
9. On the back side of the cab, clip the two tie wraps (**10**) securing the two flexible heater hoses (**11**) to the plenum (**12**).

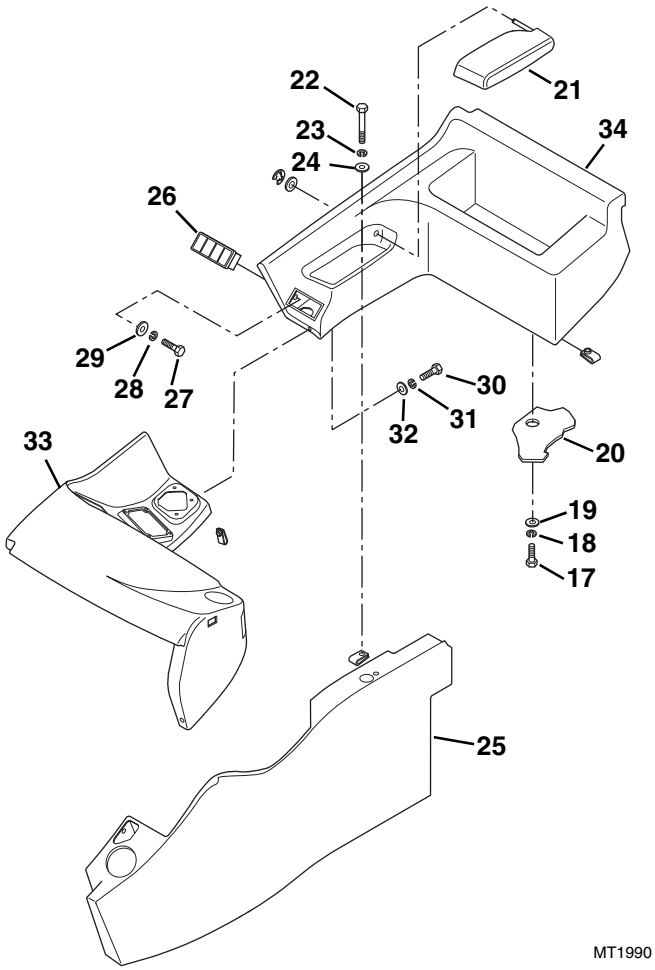


MM4580

10. Loosen both hose clamps (**13**) securing the heater hoses (**14**) to heater valve (**15**). Disconnect and label both hoses.

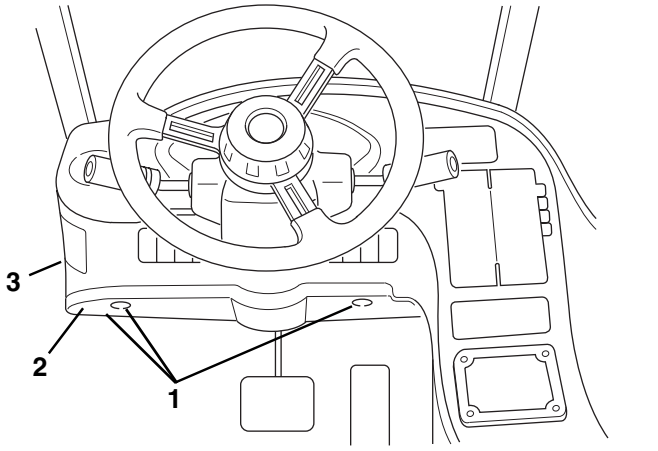
IMPORTANT: *Before the cab can be removed from the vehicle, the air conditioning hoses (**16**) need to be disconnected from the heater/air conditioning blower beneath the seat. This procedure must be completed by an authorized air conditioning service technician. This service technician will also need to be available when the cab is re-installed to re-install the air conditioning hoses to the heater/air conditioning blower.*

11. Remove two capscrews (**17**), lockwashers (**18**) and rebound washers (**19**) from the rear of the cab (**20**).
12. Open the armrest (**21**) and remove capscrew (**22**), lockwasher (**23**) and rebound washer (**24**) securing the rear tool bin (**34**) to the console support (**25**).
13. Carefully pry the switch bezel assembly (**26**) out of the panel. Label and disconnect the switch wiring connector(s).
14. Remove capscrew (**27**), lockwasher (**28**) and flat washer (**29**), securing the rear tool bin (**34**) to the side of the cab.
15. Remove capscrew (**30**), lockwasher (**31**), and rebound washer (**32**), securing the rear tool bin (**34**) to the front dash (**33**).
16. Remove rear tool bin (**34**).



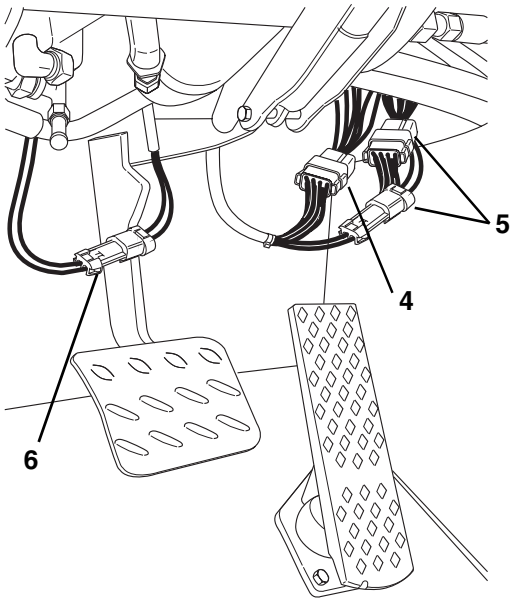
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17. Remove the three self-drilling screws (**1**) (one screw is not visible in illustration) securing the lower dash cover (**2**) to the front dash (**3**).
18. Remove the lower dash cover (**2**).



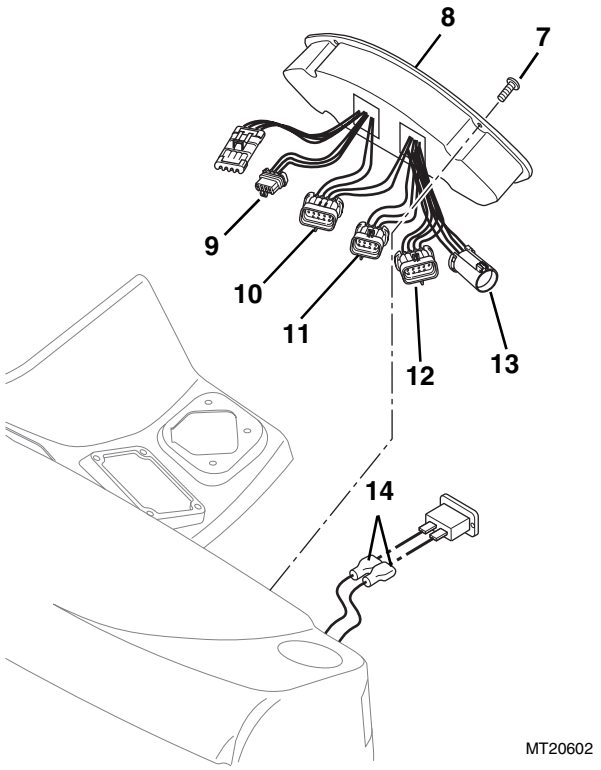
MT2050

19. Label and disconnect the transmission range selector switch wiring connector (**4**), turn signal/ lights wiring connectors (**5**) and brake switch connector (**6**).



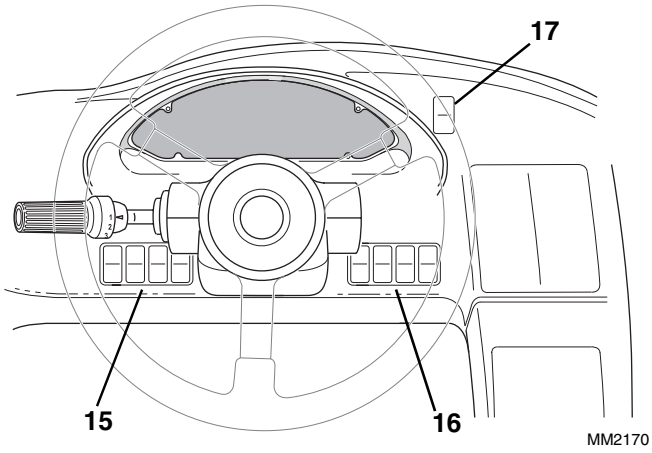
MT1890

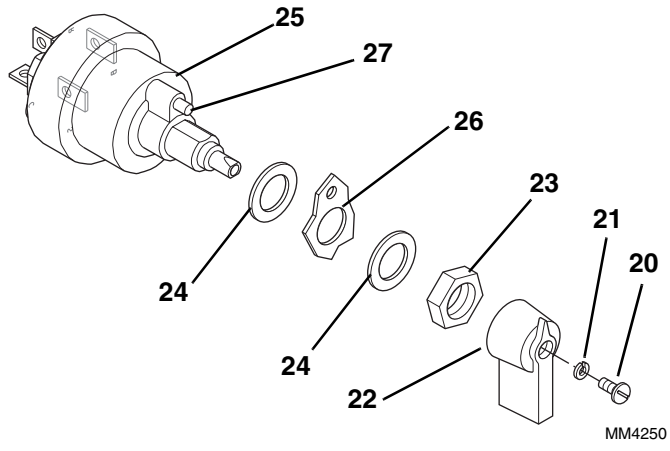
20. Remove the four button head screws (**7**) from the display panel (**8**) in the front dash. Carefully pull display panel forward and lay aside.
21. Label and disconnect the 8-pin male (**9**), 10-pin gray female (**10**), 8-pin female (**11**), 10-pin black female (**12**) and 7-pin female (**13**) display panel connectors from the harness and remove display panel from the front dash.



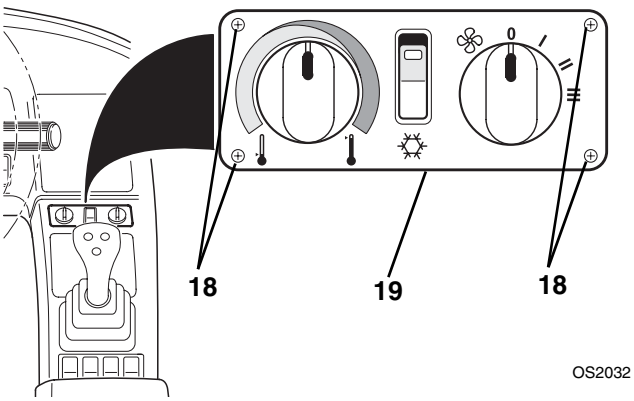
MT20602

22. Remove the four screws securing the logic panel to the side console. Carefully lift the logic panel from the side console and tag the wire connectors as they are removed. Remove the logic panel from the side console. Save all hardware for reassembly.
23. Working through the display panel opening, label and disconnect the wiring connectors (**14**) at the hourmeter.

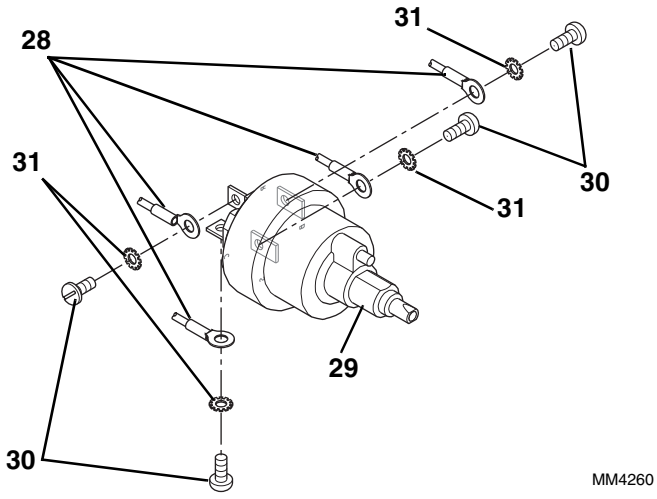




24. Pull out switch banks (**15** and **16**), located to the left and right of the steering column, and hazard switch (**17**), above and to the right of the display panel opening. Label and disconnect the wiring connectors, from the switches, as they are removed.
25. Remove the four screws (**18**) holding the cab heater and air conditioning controls panel (**19**) in place. Pull the entire control panel out and label and disconnect the wiring connectors from the switches. Set the panel and screws aside for later reassembly.

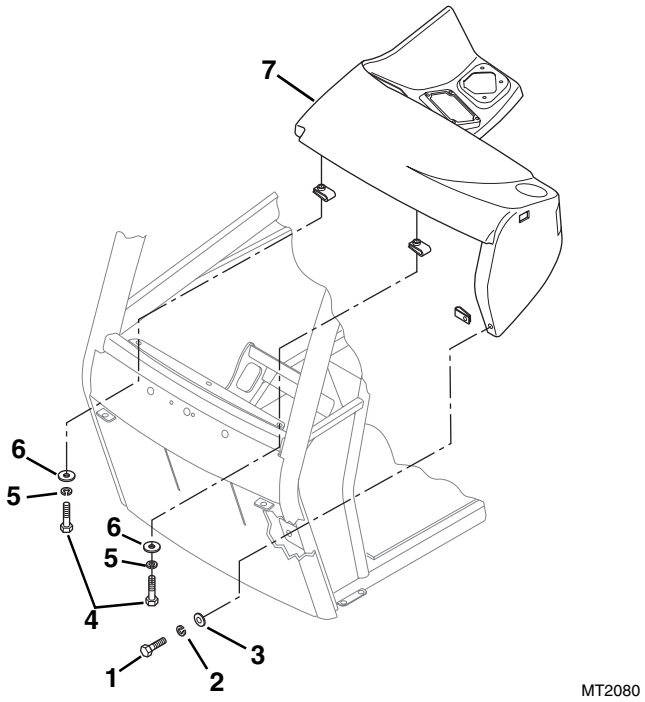


26. Remove the screw (**20**) and lockwasher (**21**) holding the knob (**22**) in place.
27. Remove the hex nut (**23**) and both flat washers (**24**) securing the ignition switch (**25**) to the mounting hole (**26**) in the dash.
28. Reach up and under the dash to work the ignition switch and wiring out from behind the dash panel.
29. Label and disconnect the wires (**28**) connected to the ignition switch (**29**). Remove the screws (**30**) and external tooth lockwashers (**31**) securing the wires to the pins on the back of the switch. Save the hardware for later re-assembly. Remove the switch from the vehicle.



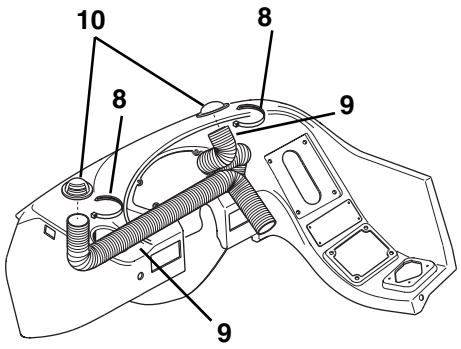
30. Remove capscrew (**1**), lockwasher (**2**), and flat washer (**3**) securing the lower left corner of the front dash panel to the cab.
31. Working from the underside of the dash, remove the two capscrews (**4**), lockwashers (**5**), and rebound washers (**6**) securing the dash panel (**7**) to the cab. Carefully tip the top of the dash panel into the cab.

    HINT! It may be necessary to loosen or remove the fuse block from the mounts for easier access to the upper left capscrew.



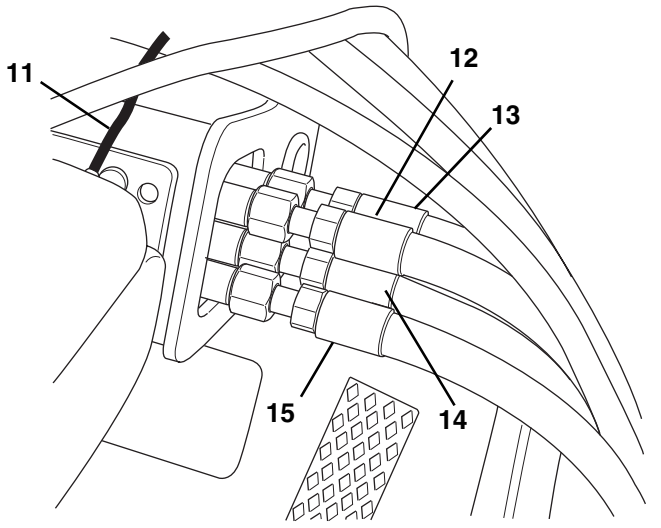
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32. With the dash panel tipped into the cab, clip the tie wraps (**8**) securing the heater flexible hose (**9**) to the ball vents (**10**) on the dash panel (**7**). Lift and remove the front dash panel.



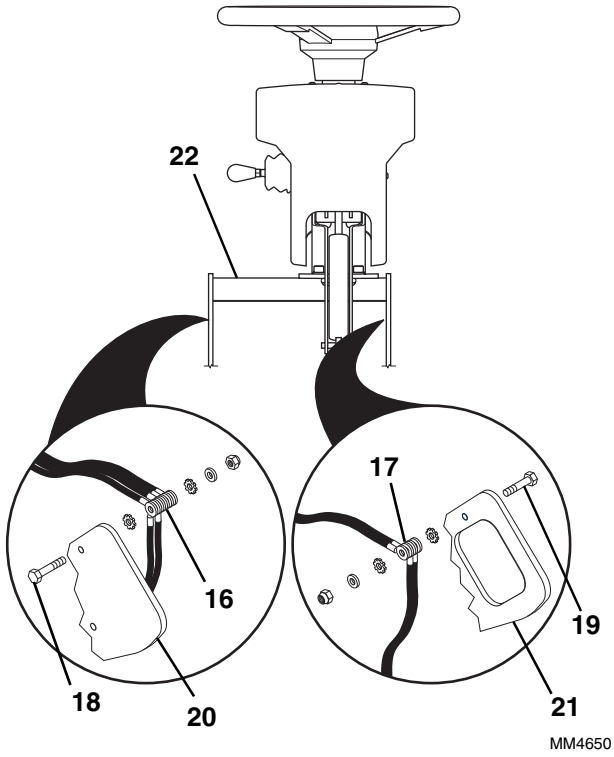
SS3090

33. Label and disconnect the horn switch wiring connector (**11**).

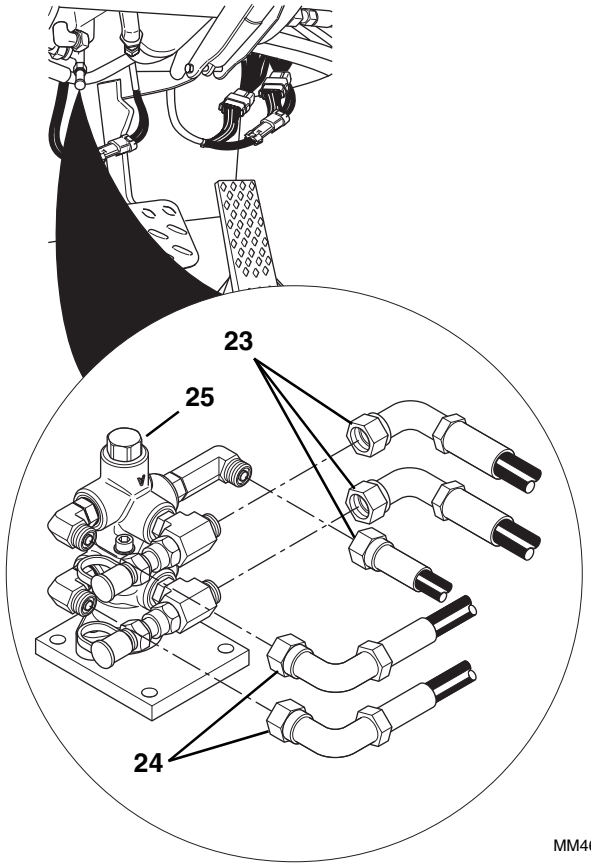


MM4680

34. Label and disconnect the ground wires (**16** and **17**). There are two ground screws (**18** and **19**) located on the two side plates (**20** and **21**) of the steering column support (**22**). There are six wires (**16**) attached to the left side plate (**20**) and four (**17**) attached to the right side plate (**21**). Save screws and washers for later re-assembly.



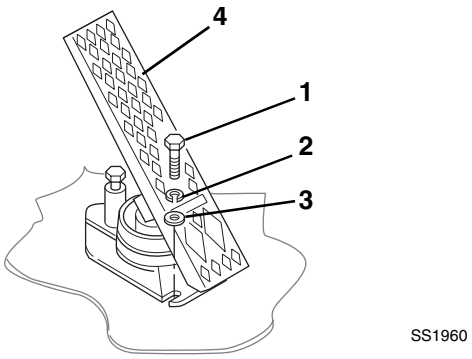
MM4650



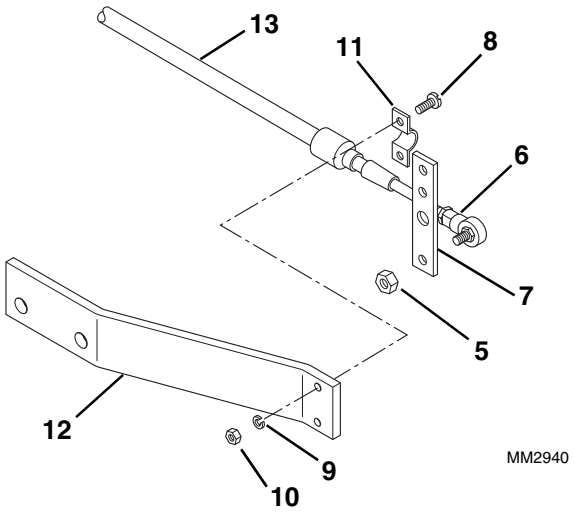
MM4620

35. Label, disconnect and cap the four steering valve hoses (**12**-**15**).
36. Label, disconnect and cap the five hoses (**23** and **24**) connected to the brake valve (**25**). Access the three top hoses (**23**) through the display panel opening in the dash. Access the bottom two hoses (**24**) from under the dash.

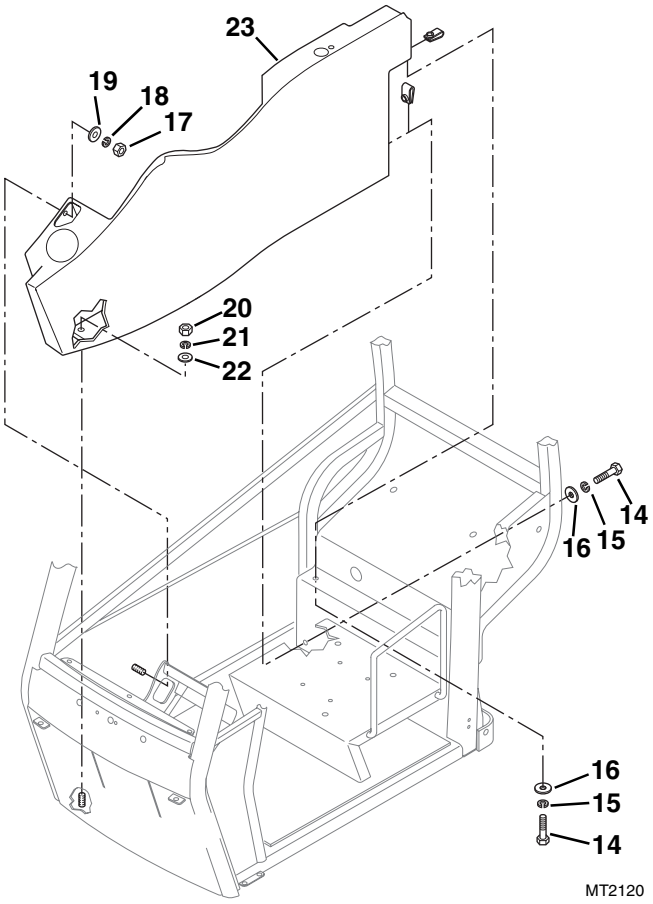
37. Remove the three capscrews (**1**), lockwashers (**2**) and flat washers (**3**) holding the throttle pedal (**4**) to the floor of the cab. Save all the hardware for reassembly.



38. Remove elastic locknut (**5**). Disconnect the throttle cable rod end (**6**) at the throttle lever extension bracket (**7**). **DO NOT** remove the throttle cable rod end (**6**) from the throttle cable. Save all the hardware for reassembly.
39. Remove the two slotted pan-head screws (**8**), lockwashers (**9**), nuts (**10**) and clamp (**11**) from the throttle cable bracket (**12**). Route the throttle cable (**13**) out of the engine compartment.

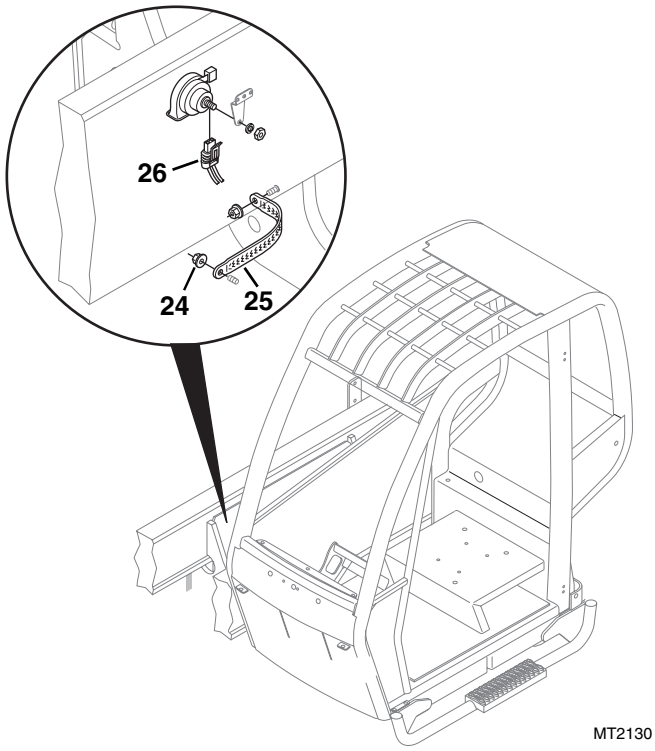


40. Pull the throttle pedal up and out of the hole in the cab floor. It may be necessary to remove some of the tie wraps that hold the throttle cable in place under the frame to get enough slack in the cable. Lay the throttle pedal on the cab floor to the left of the throttle pedal hole.
41. Remove the two capscrews (**14**), lockwashers (**15**) and rebound washers (**16**) securing the console support to the rear of the cab. Access the lower right capscrew through the right tube on the heater plenum.
42. Remove elastic locknut (**17**), lockwasher (**18**), and rebound washer (**19**) from the weld stud at the top front corner of the console support.
43. Remove elastic locknut (**20**), lockwasher (**21**), and flat washer (**22**) from the weld stud at the bottom front corner of the console support.
44. Remove the console support (**23**).



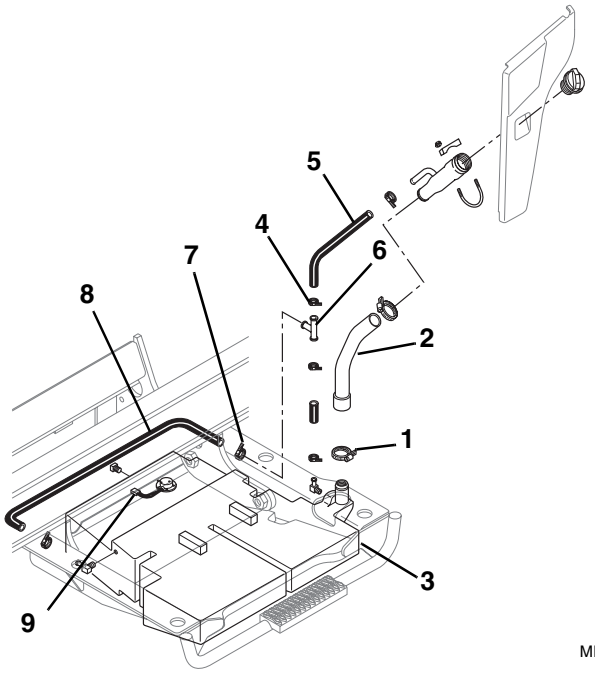
MT2120

45. Route the joystick, power steering and service brake hydraulic hoses out of and away from the cab. Cut and dispose of plastic wire ties as needed. Wipe up any spilled hydraulic fluid.
46. Remove the elastic locknut (**24**) and disconnect the ground strap (**25**).
47. Disconnect the horn wiring connector (**26**).
48. Route the wiring harness out of and away from the cab. Cut and dispose of plastic wire ties as needed. Secure the wiring harness against the frame, safely away from the cab.



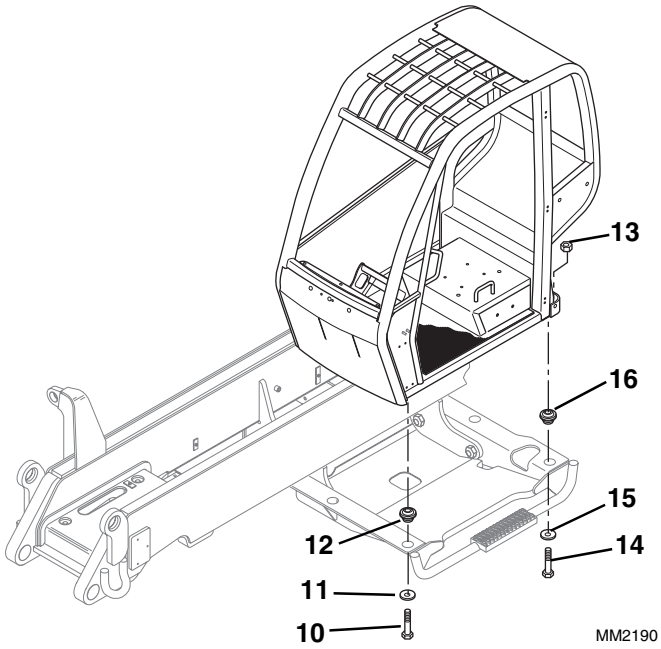
MT2130

49. From behind the cab, loosen the lower clamp (**1**) securing the fuel hose (**2**) to the fuel tank (**3**). Remove the lower end of the fuel hose from the fuel tank. Cap or safely cover the fuel tank opening.
50. Loosen the clamp (**4**) securing the fuel breather hose (**5**) to the top of the beaded hose tee (**6**). Remove the lower end of the fuel breather hose from the hose tee. Cap or safely cover the hose tee opening.
51. Loosen the clamp (**7**) securing the lower fuel breather hose (**8**) to the beaded hose tee (**6**). Remove the lower end of the fuel breather hose from the hose tee. Cap or safely cover the hose tee opening.
52. Disconnect the fuel sender wire (**9**).
53. Route the lower fuel breather hose (**8**) and fuel sender wire out and away from the cab.



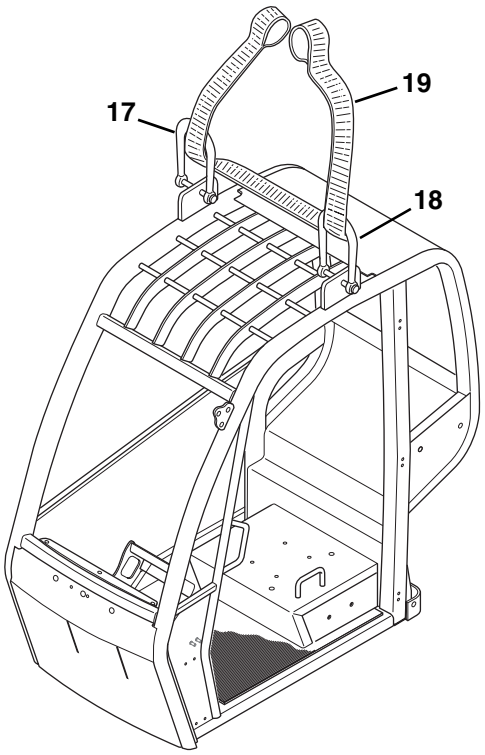
MM4690

54. Remove the front cab to cab mount attaching hardware. Remove two capscrews (**10**), and rebound washers (**11**) from the cab isolators (**12**).
55. Remove the rear cab to cab mount attaching hardware. Remove two elastic locknuts (**13**), capscrews (**14**) and rebound washers (**15**). Tap the capscrews out of the cab isolators (**16**) from above, as required.



MM2190

56. Remove the mirrors (refer to *Section 3.6.2, Mirror Replacement*) and all other cab components, as needed, if not previously removed.
57. Attach a clevis (**17** and **18**) to each of the cab lifting brackets. Route a sling (**19**) with a minimum lifting capacity of 2000 lbs. (907 kgs.) through the clevis' to a hoist or overhead crane. Make sure the sling is centered between the clevis' to ensure even lifting.



MM2200

58. Carefully begin to lift the cab. Stop and check that all wiring, fuel tank components, hydraulic hoses and fasteners are disconnected or removed. If the throttle cable is still attached to the cab, reposition or remove the throttle cable as necessary.
59. When all wiring (engine, lighting harnesses and all leads from the cab harness), hydraulic hoses and fasteners are disconnected or removed, carefully and slowly lift the cab and remove it from the cab mount. Readjust the position of the sling as needed to help balance the cab during removal.
60. When the cab is completely clear of the vehicle, 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 removed from the vehicle.
61. Inspect the condition of the fuel tank, fuel hoses, fittings, clamps, hydraulic hoses, cab isolators, etc. Replace parts as indicated by their condition.
62. Inspect and replace other vehicle parts that are exposed with the cab removed. Repair or replace as required.

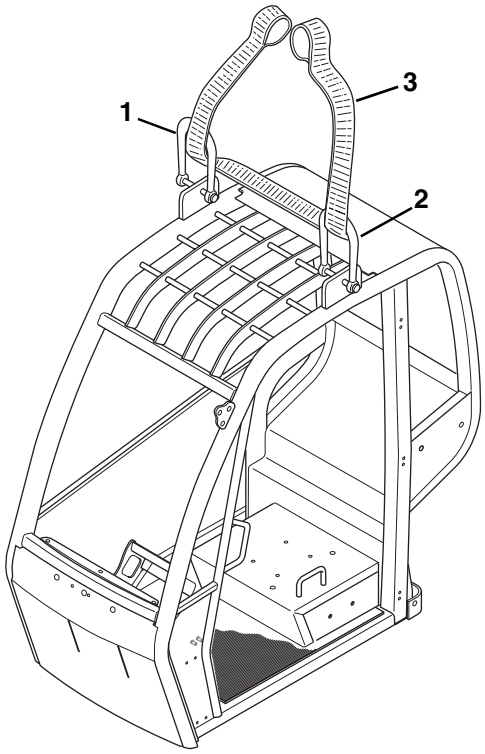
c. Cab Installation

WARNING: Cap or safely cover the fuel tank and beaded hose tee openings. Failure to comply can cause an explosion or fire hazard, that can result in death or serious personal injury.

WARNING: Wear protective footwear with reinforced toe caps and slip-resistant soles. Failure to comply can result in foot injury from falling objects or other bodily injury from slipping or falling.

WARNING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling or hoist. Failure to comply can result in death or serious personal injury.

1. Block all four wheels to help prevent the vehicle from moving. Assure that there is sufficient overhead and side clearance for cab installation.



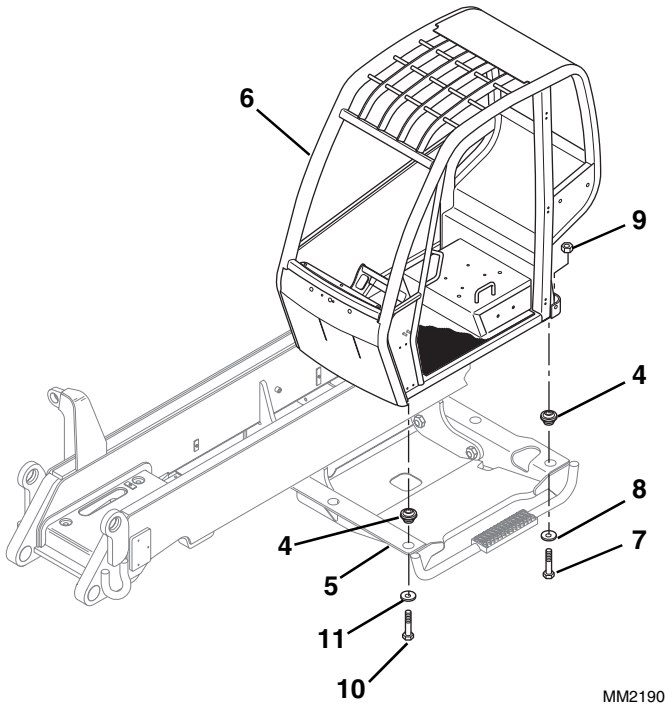
MM2200

2. Attach a clevis (**1** and **2**) to each of the cab lifting brackets. Route a sling (**3**) with a minimum lifting capacity of 2,000 lbs. (907 kgs.) through the clevis' to a hoist or overhead crane. Make sure the sling is centered between the clevis' to ensure even lifting.
3. Install four cab isolators [2-Front and 2-Rear] (**4**) into the mounting holes on the cab mount (**5**).
4. Use a hoist or overhead crane and sling attached to the cab (**6**). Carefully begin to lower the cab onto the cab mount. Stop and check that wiring, fuel tank components, hydraulic hoses, etc., will not be pinched or damaged as the cab is lowered.
5. Route the throttle cable from beneath the cab to the engine compartment by simply positioning the cable under the frame, then up between the transmission and engine. Bring the cable across the side of engine to the throttle cable bracket. **DO NOT** attach the cable to the throttle lever extension on the engine at this time.
6. Carefully and slowly lower the cab (**6**) onto the cab mount (**5**). Align the cab with the cab isolators (**4**) as the cab is lowered. Readjust the position of the sling as needed to help balance the cab during installation.

7. Install the rear cab to cab mount attaching hardware. Install but **DO NOT** tighten two 3/4-10 x 3-3/4" capscrews (**7**), two rebound washers (**8**) and two new 3/4-10 elastic locknuts (**9**). Tap the capscrews into the cab isolators (**4**) from below, as required, but **DO NOT** distort or damage the cab isolators.

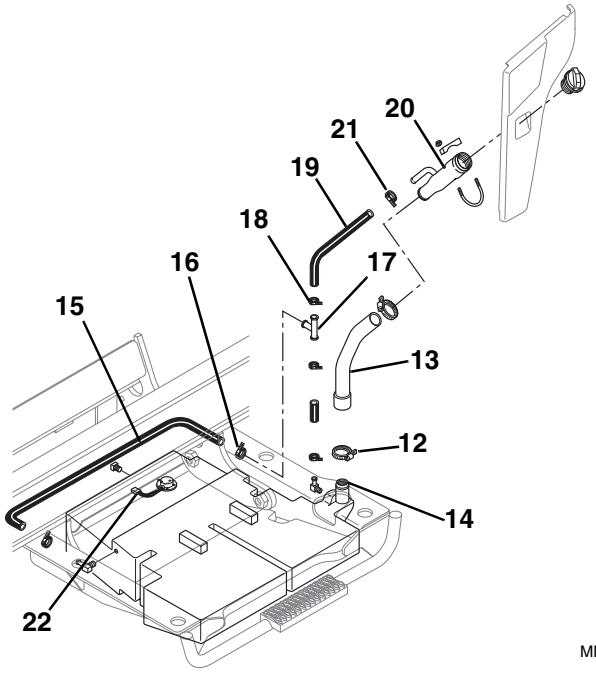
Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

8. Install the front cab to cab mount attaching hardware. Install but **DO NOT** tighten two 3/4-10 x 3-3/4" capscrews (**10**) and two rebound washers (**11**). Tap the capscrews into the cab isolators (**4**) from below, as required, but **DO NOT** distort or damage the cab isolators.



MM2190

9. From behind the cab, position the lower clamp (**12**) on the fuel hose (**13**). Remove any cap or safety cover from the fuel tank opening. If needed, secure the fuel filler (**20**) to the cab and the top end of the fuel hose (**13**) to the fuel filler (**20**).
10. Slip the lower end of the fuel hose (**13**) onto the fuel hose neck (**14**) on the fuel tank and tighten the lower clamp (**12**).
11. Route the lower breather hose (**15**) through the opening at the rear of the cab and position a clamp (**16**) on the hose. Remove any cap or safety cover from the beaded hose tee (**17**). Secure the lower fuel breather hose to the beaded hose tee (**17**).
12. Position a clamp (**18**) on the fuel breather hose (**19**). Remove any cap or safety cover from the beaded hose tee (**17**). If needed, secure the top end of the fuel breather hose to the fuel filler (**20**) with another clamp (**21**). Secure the bottom end of the fuel breather hose to the beaded hose tee (**17**).
13. Reconnect the fuel sender wire (**22**) to the cab harness.

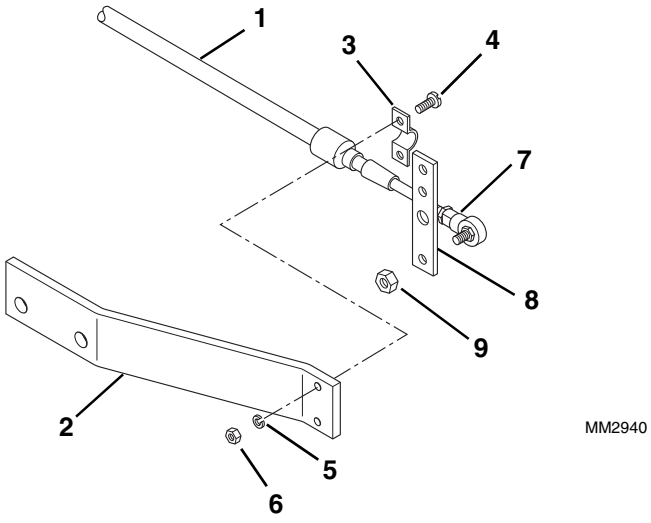


MM4690

14. Route the joystick, power steering and service brake hydraulic hoses from the frame into the cab.
15. From beneath the cab, route and connect all wiring (engine, lighting harnesses and all leads from the cab harness). Install plastic conduit as required to protect the wiring as it passes through metal openings. Secure wiring with plastic wire ties as needed.
16. Route the throttle cable, still attached to the pedal, through the hole in the bottom of the cab. **DO NOT** install the throttle pedal at this time. Leave it lay on the floor of the cab next to the hole.
17. Install the throttle cable (**1**) on the throttle cable bracket (**2**), using a clamp (**3**) and two #10-24 x 3/4" slotted pan-head screws (**4**), #10 lockwashers (**5**) and #10 nuts (**6**).

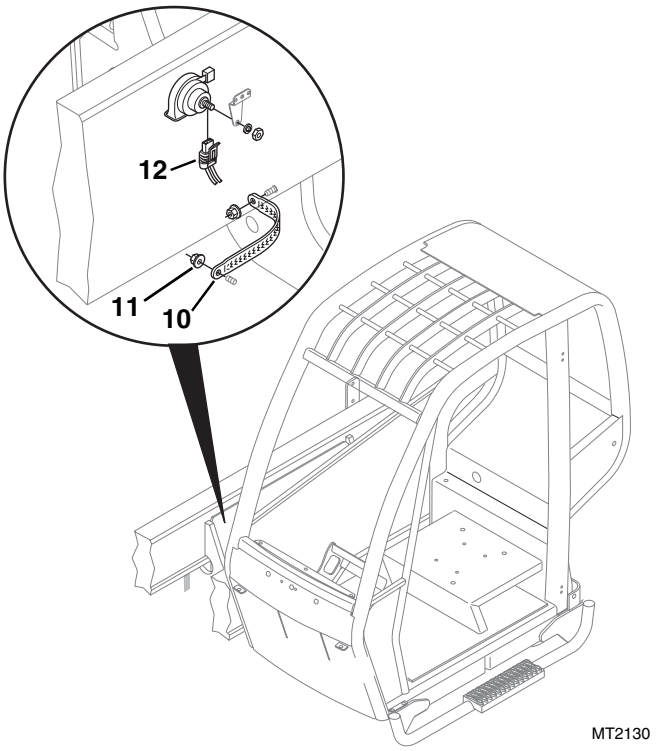
Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

18. Connect the throttle cable rod end (**7**) to the throttle lever extension bracket (**8**). Secure the rod end with a new 1/4-28 NF elastic locknut (**9**).



Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

19. Connect the ground strap (**10**) to the cab and secure with a new 3/8-16 elastic locknut (**11**).
20. Connect the horn wiring connector (**12**).



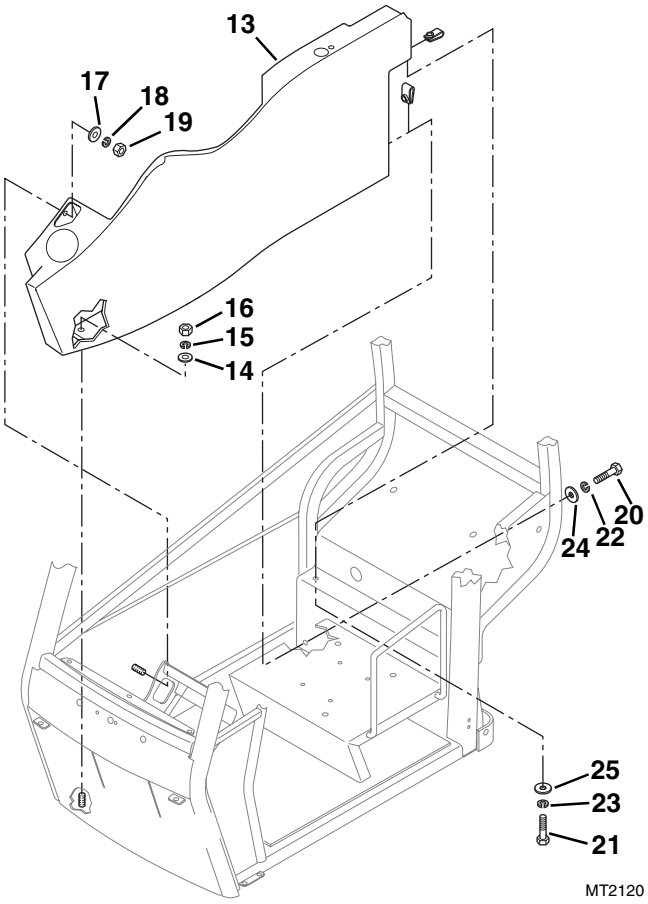
21. Install the console support (**13**).

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

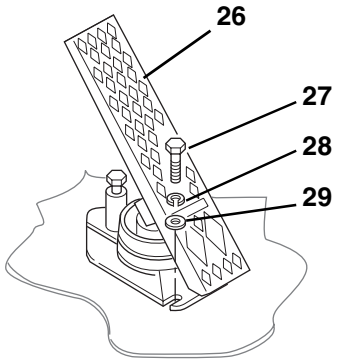
22. Install one 5/16" flat washer (**14**), one 5/16" lockwasher (**15**), and one 5/16-18" elastic locknut (**16**) on the weld stud at the bottom front corner of the console support.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

23. Install one rebound washer (**17**), one 5/16" lockwasher (**18**), and one 5/16-18" elastic locknut (**19**) on the weld stud at the top front corner of the console support.
24. Install two 5/16-18 x 1-1/4" capscrews (**20** and **21**), two 5/16" lockwashers (**22** and **23**) and two rebound washers (**24** and **25**) at the rear of the cab. Access the lower right capscrew (**20**) through the right tube on the heater plenum.

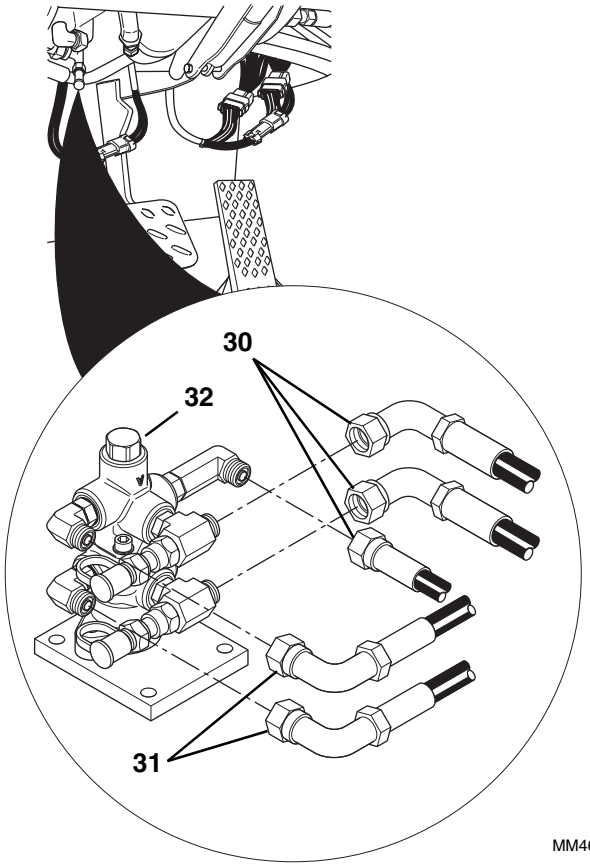


25. Reposition the throttle pedal (**26**) in the hole in the cab floor. Use three 1/4-20 x 1-1/4" capscrews (**27**), 1/4" lockwashers (**28**) and 1/4" flat washers (**29**) to secure in place.



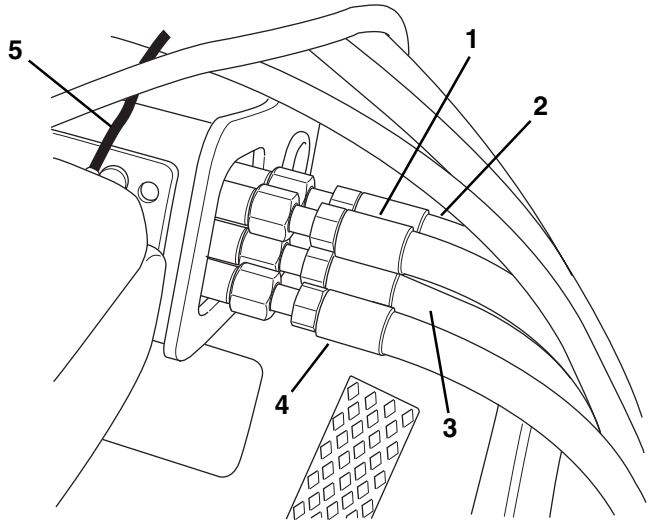
Note: *ALWAYS use new o-rings when servicing the vehicle.*

26. Install new o-rings into the fittings. Lubricate the o-rings with clean hydraulic oil.
27. Install the five hoses (**30** and **31**) to the brake valve (**32**). Access the three top hoses (**30**) through the display panel opening in the dash. Access the bottom two hoses (**31**) from under the dash.

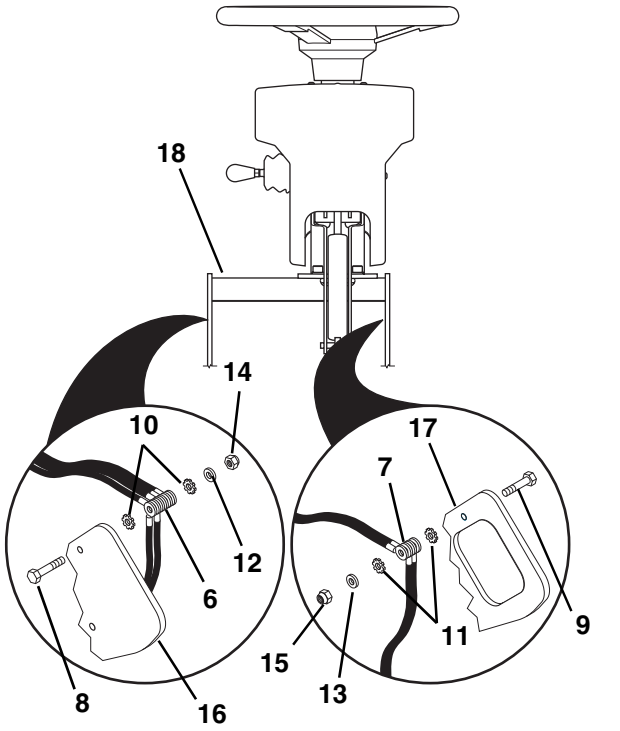


Note: *ALWAYS use new o-rings when servicing the vehicle.*

28. Install new o-rings into the fittings. Lubricate the o-rings with clean hydraulic oil.
29. Connect the four steering valve hoses (**1**-**4**).

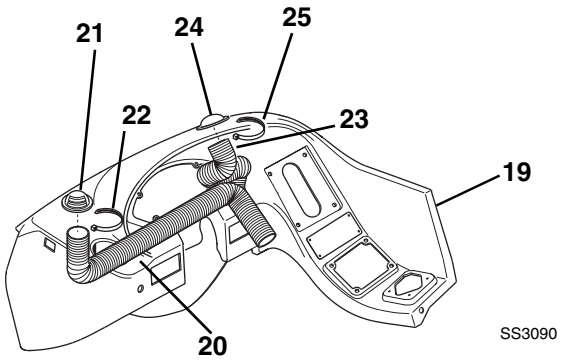


MM4680



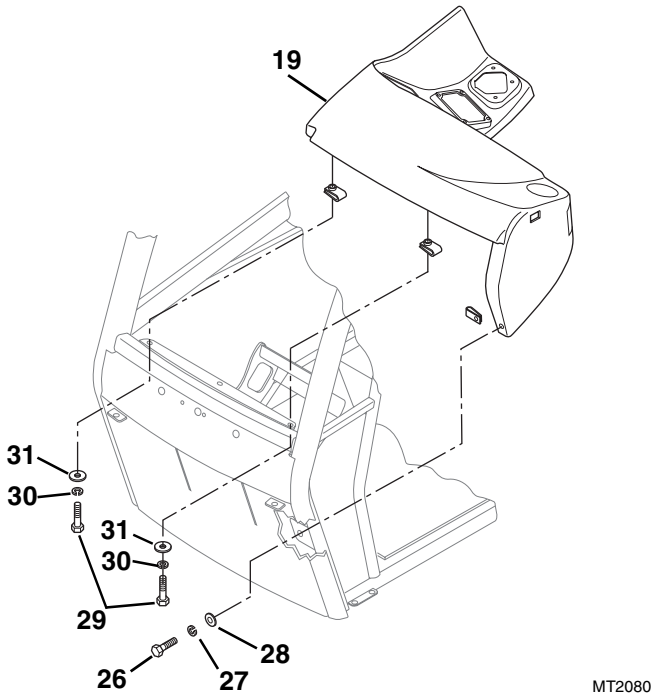
MM4650

30. Connect the horn switch wiring connector (**5**).
31. Connect the ground wires (**6** and **7**). Use one 1/4-20 x 1-1/4" capscrew (**8** and **9**), two 1/4" external tooth lockwashers (**10** and **11**), one 1/4" flat washer (**12** and **13**) and one new 1/4-20 elastic locknut (**14** and **15**) on each of the two side plates (**16** and **17**) of the steering column support (**18**). Make sure the order of the hardware is as shown. One of the external tooth lockwashers should be against the side plates and the other should be under the flat washer.
32. With the dash panel (**19**) tipped into the cab, route the flexible hose (**20**) from the upper tube on the vent manifold over the steering column support and over to the left side of the dash. Push the flexible hose onto the retainer half of the ball vent (**21**) and secure in place with a tie wrap (**22**).



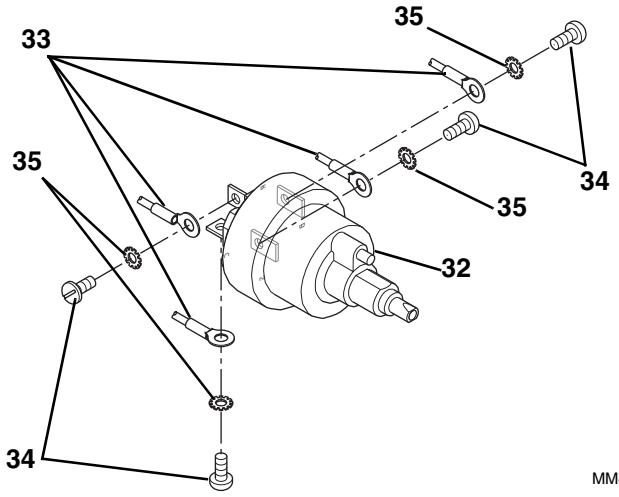
SS3090

33. Route the flexible hose (**23**) from the lower tube on the vent manifold up to the right side of the dash. Push the flexible hose onto the retainer half of the ball vent (**24**) and secure in place with a tie wrap (**25**). Install the front dash panel (**19**).
34. Install one 5/16-18 x 1-1/4" capscrew (**26**), 5/16" lockwasher (**27**), and 5/16" flat washer (**28**) to secure the lower left corner of the dash panel to the cab.
35. Install two 5/16-18 x 1-1/4" capscrews (**29**), 5/16" lockwashers (**30**), and rebound washers (**31**) to secure the dash panel to the cab.

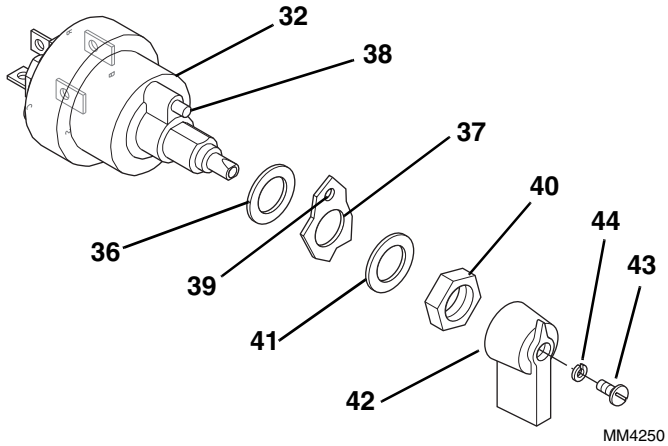


MT2080

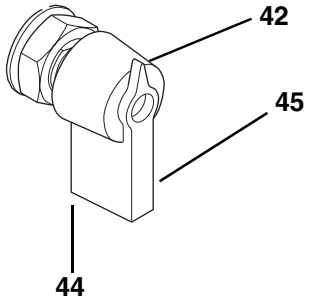
36. Connect the ignition switch (**32**) to the wire ends (**33**) of the cab harness. Use the screws (**34**) and external tooth lockwashers (**35**) to secure the wires to the pins on the back of the switch.
37. Install one of the flat washers (**36**) onto the threaded portion of the ignition switch (**32**).
38. Reach up and under the dash to work the threaded portion of the ignition switch (**32**), with the flat washer (**36**), into the ignition switch mounting hole (**36**) on the left side of the dash. Make sure that the alignment tab (**38**) goes into the small hole (**39**) above the ignition switch mounting hole. Install the flat washer (**41**) and hex nut (**40**) to secure the ignition switch to the dash. DO NOT overtighten.



MM4260



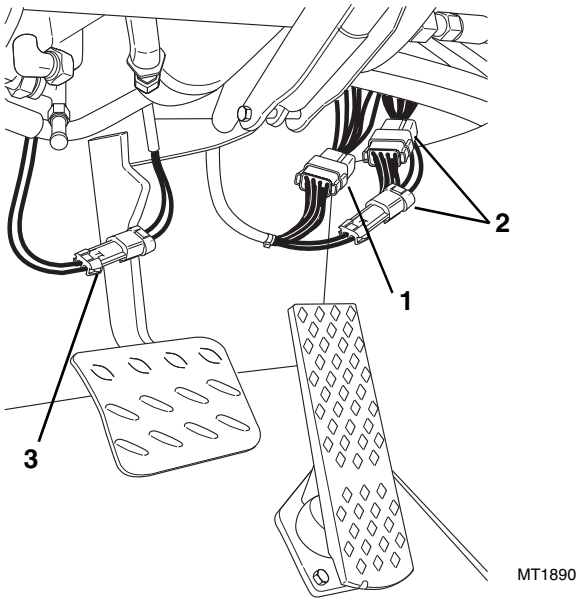
MM4250



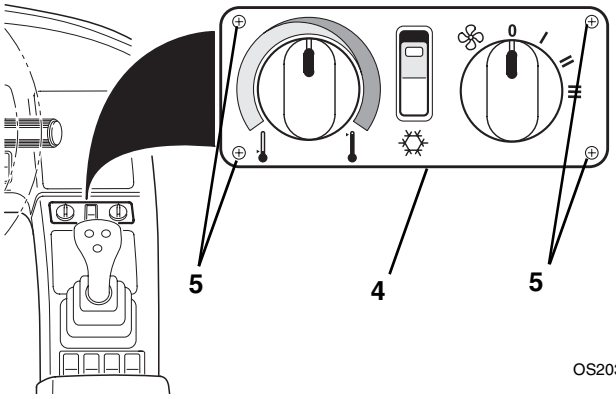
MM4760

39. Align the ignition switch knob (**42**) so that when the ignition switch is in the OFF position (**44**), the tab (**45**) is positioned vertically (straight up and down). Install the screw (**43**) and lockwasher (**44**) to secure the knob (**42**) in place.

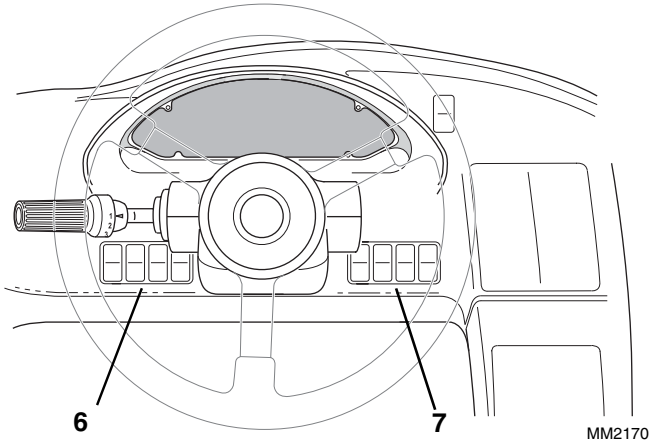
40. Connect the transmission selector switch wiring connector (**1**), turn signal/lights lever wiring connectors (**2**) and brake switch connector (**3**).



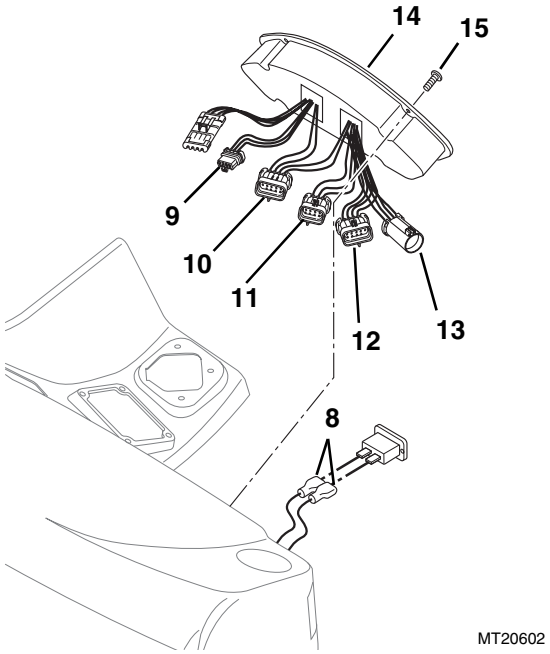
41. Pull the cab heater and air conditioning controls panel (**4**) wiring harness connectors through the openings in the dash and connect to the appropriate controls.Install the control panel using the four #8-32 x1/2" self-tapping screws (**5**).Pull the entire control panel out and label and disconnect the wiring connectors from the switches. Set the panel and screws aside for later reassembly.



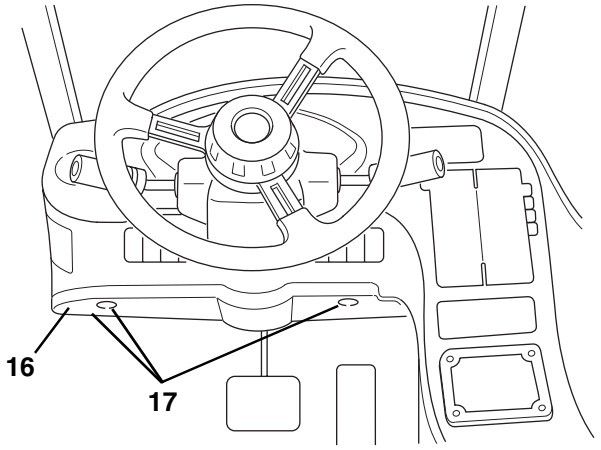
42. Pull the switch bank wiring harness connectors through the openings in the dash to the right and left of the steering column and connect to the appropriate switches. Install the switch banks (**6** and **7**) into the dash.



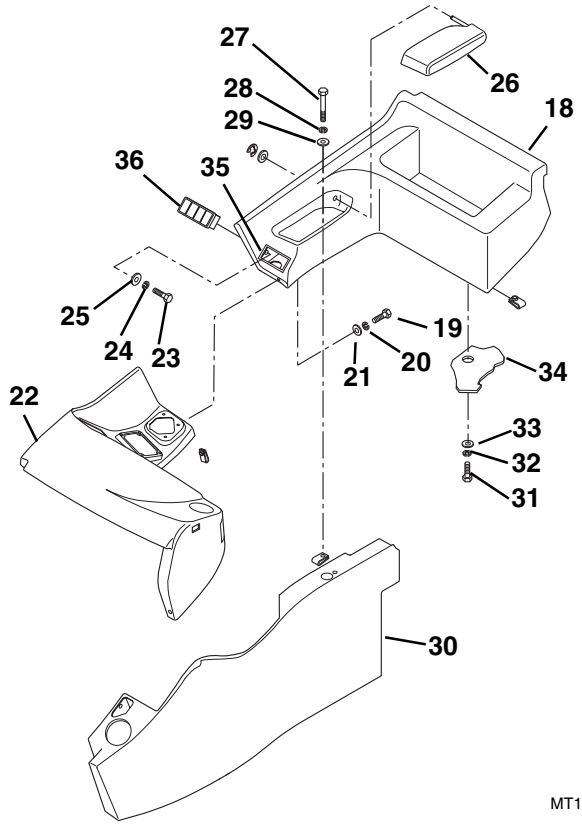
43. Working through the display panel opening, connect the hourmeter wiring connectors to the hourmeter (**8**).



44. Connect the 8-pin male (**9**), 10-pin gray female (**10**), 8-pin female (**11**), 10-pin black female (**12**) and 7-pin female (**13**) display panel connectors from the harness and remove display panel from the front dash.
45. Install the display panel (**14**) and secure with four #10-32 x 3/4" button head screws (**15**).
46. Install the lower dash cover (**16**) and secure with three #12-14 x 1" self-drilling screws (**17**) (one screw not visible in illustration).

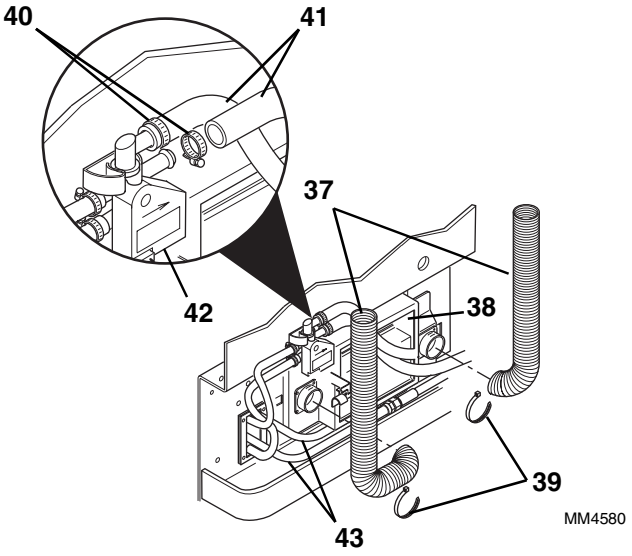


MT2050



MT1990

47. Install the rear tool bin (**18**).
48. Install one 5/16-18 x 1-1/4" capscrew (**19**), 5/16" lockwasher (**20**), and rebound washer (**21**), securing the rear tool bin to the front dash (**22**).
49. Install one 5/16-18 x 3/4" capscrew (**23**), 5/16" lockwasher (**24**) and 5/16" flat washer (**25**), securing the rear tool bin to the side of the cab.
50. Open the armrest (**26**) and install one 5/16-18 x 2" capscrew (**27**), 5/16" lockwasher (**28**), and rebound washer (**29**) securing the rear tool bin to the console support (**30**).
51. Install two 5/16-18 x 1-3/4" capscrews (**31**), 5/16" lockwashers (**32**) and rebound washers (**33**) securing the rear tool bin to the rear of the cab (**34**).
52. On the backside of the cab, assemble the two flexible hoses (**37**) to the outlet tubes on the plenum (**38**). Push the hose, on the right side, onto the tube on the right side of the plenum and secure in place with a tie wrap (**39**). Push the hose, on the left side, onto the tube on the left side of the plenum and secure in place with a tie wrap (**39**).



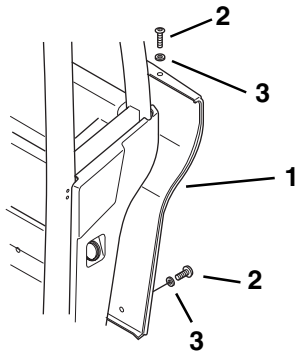
MM4580

53. Slide both hose clamps (**40**) onto the heater hoses (**41**) going to the heater valve (**42**). Slide the hoses onto the barbed fittings and secure with the clamps.

IMPORTANT: *The air conditioning hoses (**43**) need to be connected to the heater/air conditioning blower beneath the seat. This procedure must be completed by an authorized air conditioning service technician.*

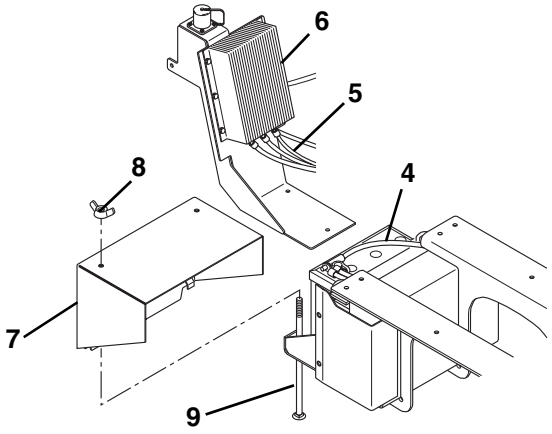
54. Pull the switch bank wiring connector through the opening (**35**). Connect the wiring connector(s) to the appropriate switch(es). Install the switch bank (**36**) into the opening.

55. Install the joystick assembly (refer to *Section 3.5.2, b. Joystick Assembly Replacement*).
56. Check that the cab is not distorting, pinching, crushing or damaging the throttle cable, wiring or hydraulic hoses. Make adjustments as necessary.
57. Fill the radiator completely with a 50/50 mixture of ethylene glycol and water. Replace the radiator cap. Add coolant to the overflow bottle until the bottle is half to three-quarters full. This “overfilling” will compensate for any air in the cooling system.
58. Tighten the cab to cab mount hardware installed in Steps 8 and 9. Torque the elastic locknuts and capscrews to 280 lb/ft (380 Nm).
59. After the cab is securely mounted to the vehicle, install the mirrors as required (refer to *Section 3.6.2, Mirror Replacement*).
60. Attach the rear cab panel (**1**) to the cab with four 5/16-18 x 1” button head capscrews (**2**) and 5/16" plastic washers (**3**).



SS1230

61. Connect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
62. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
63. Replace engine side battery box cover (**7**). Use the wing nuts (**8**) and carriage bolts (**9**) to secure the cover in place.



MM2911

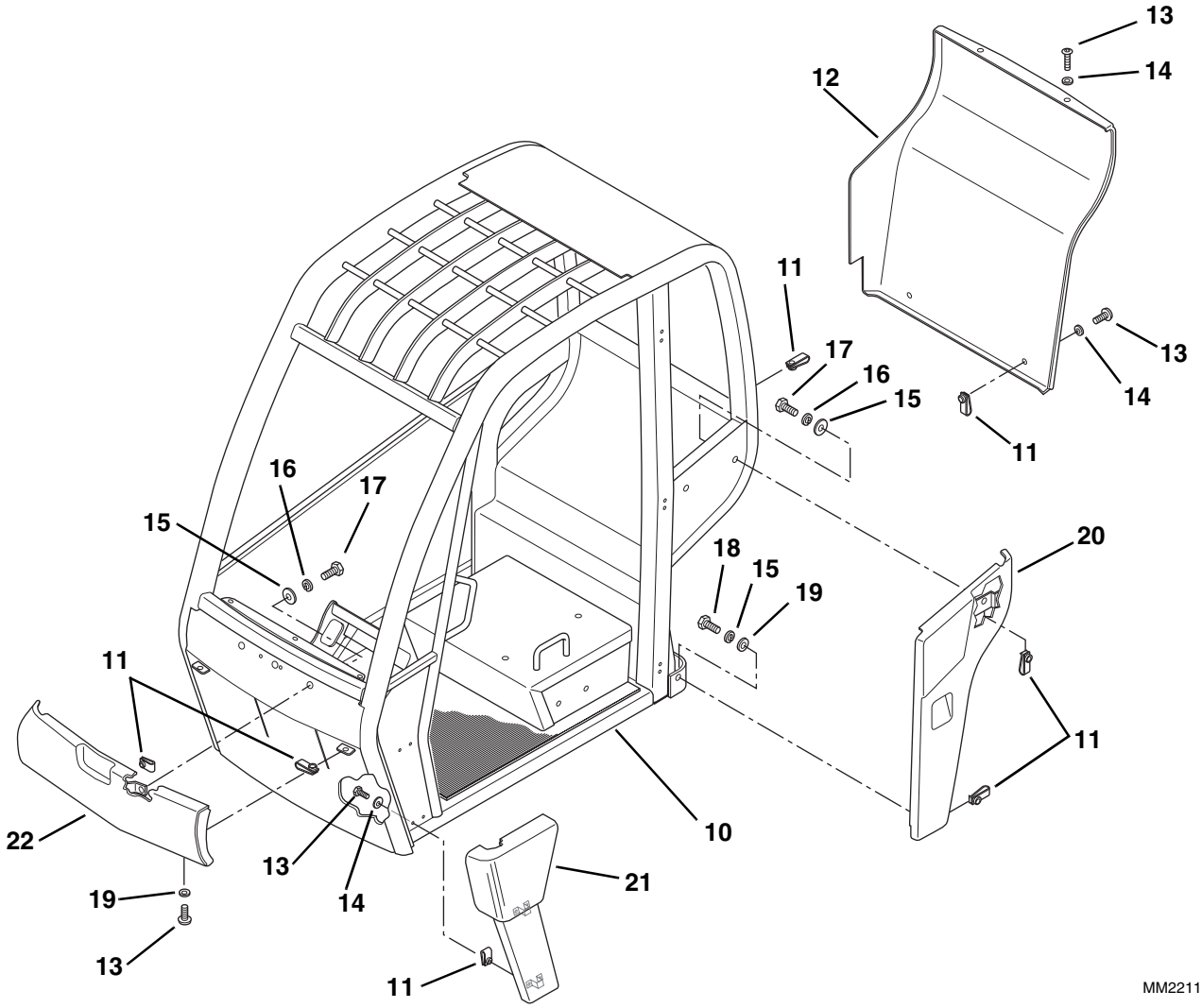
64. Carefully examine all cab components, fasteners, etc., one last time before engine start-up. Rectify any faulty conditions.

WARNING: Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

65. 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.

d. Cab Outer Panel Replacement

The cab is equipped with various outer panels, as shown in illustration below. Removal and installation are easily accomplished by observing the mounting configurations as shown in the illustration.

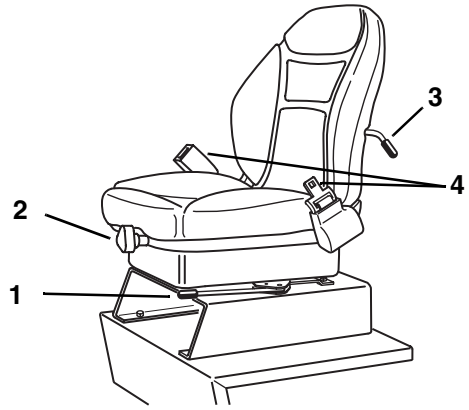


10. Operator's protective structure ROPS/FOPS
11. Retaining nut (13)
12. Cab rear panel (1)
13. Button-head capscrew (10)
14. Flat plastic washer (8)
15. Rebound washer (4)
16. Lockwasher (5)
17. Capscrew (4)
18. Capscrew (1)
19. Flat washer (3)
20. Cab panel, left rear (1)
21. Cab panel, left front (1)
22. Cab panel, front (1)

3.3 OPERATOR'S SEAT AND SEAT BELT

3.3.1 Seat Description

The seat assembly consists of upper (backrest) and lower (bottom) cushions mounted on an adjustable suspension unit. Three seat adjustments can be made: fore and aft position (**1**), suspension stiffness (**2**) and backrest angle (**3**). Seat adjustment information is contained in the Owners/Operators Manual. The seat belt (**4**) is attached to the seat assembly.



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1. Fore & aft adjustment handle
2. Suspension adjustment knob
3. Backrest angle adjustment lever
4. Seat belt

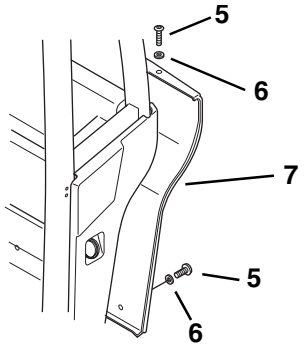
3.3.2 Seat Replacement

The seat can be removed from the cab by removing the fasteners, including two tether cables, which secure the seat to the cab. The seat belt is also easily removed by removing the nuts, spacers, washers and capscrews securing it to the seat frame. The seat tethers are secured to the seat with the seat belt capscrews.

The seat and seat slides may be removed from the suspension unit and mounting plate by removing four locknuts and flat washers that attach the seat slides to the suspension unit.

a. Seat Removal

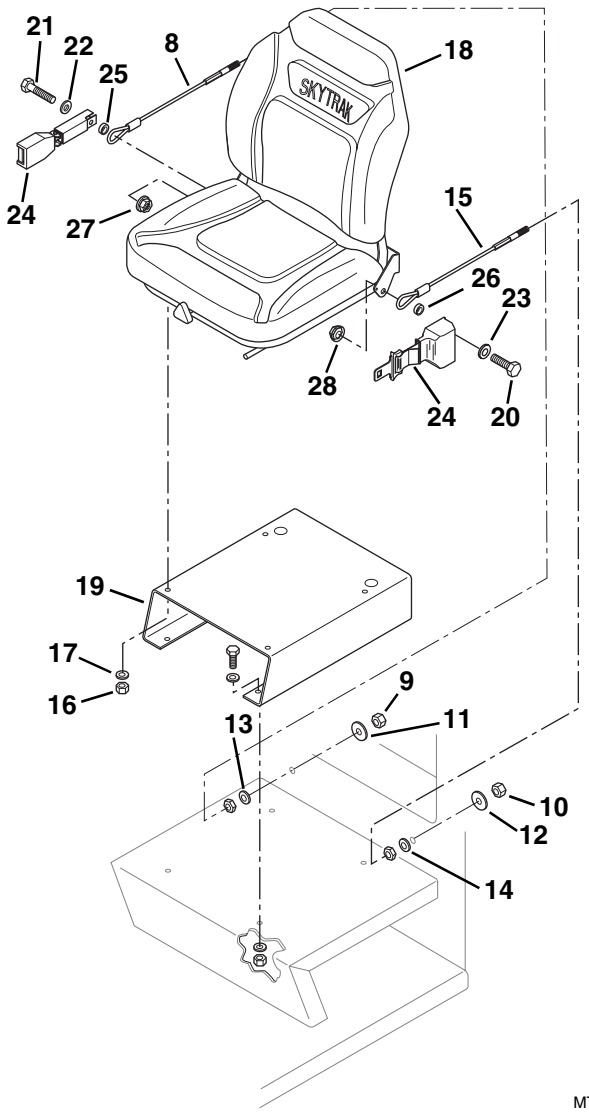
1. Working from the outside rear of the cab, remove the four button head capscrews (**5**) and flat plastic washers (**6**) and remove the rear cab panel (**7**) to gain access to the seat tether mounting hardware.



SS1230

Note: *Access to the right-side tether (**8**) is restricted due to the close proximity of the seat to the cab wall. Move the seat all the way forward, and tip the seat back all the way forward to gain access as needed to the tether mounting hardware from inside the cab. If necessary, remove the seat base mounting hardware before removing the right-side tether.*

2. Remove two elastic locknuts (**9** and **10**), rebound washers (**11** and **12**) and flat washers (**13** and **14**) securing the tethers (**8**-Right and **15**-Left) to the rear of the cab.
3. Remove four elastic locknuts (**16**) and narrow flat washers (**17**) securing the seat (**18**) to the seat support (**19**).
4. Carefully remove the seat (**18**) from the cab.
5. If the seat is to be replaced: Remove two capscrews (**20** and **21**), washers (**22** and **23**), seat belt assembly (**24**), spacers (**25** and **26**), tethers (**8**-Right and **15**-Left) and nuts (**27** and **28**). Transfer these parts to the replacement seat with the seat out of the cab.



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b. Seat Installation

1. Install two spacers (**25** and **26**), tethers (**8**-Right and **15**-Left), seat belt assembly (**24**), washers (**22** and **23**), capscrews (**20** and **21**) and two nuts (**27** and **28**) to the seat (**18**).
2. Within the cab, access to the right-side tether (**8**) is restricted due to the closeness of the seat to the cab wall. Move the seat all the way forward, and tip the seat back all the way forward to gain access as needed to the tether mounting hardware from inside the cab. If necessary, install the right-side tether before securing the seat base mounting hardware.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

3. Position the seat (**18**) on the seat support (**19**). Align the seat bracket mounting holes with the holes in the seat support. Secure the seat to the seat support with four 5/16" narrow flat washers (**17**), and new 5/16-18 elastic locknuts (**16**). Torque nuts to 20 lb/ft (27 Nm).

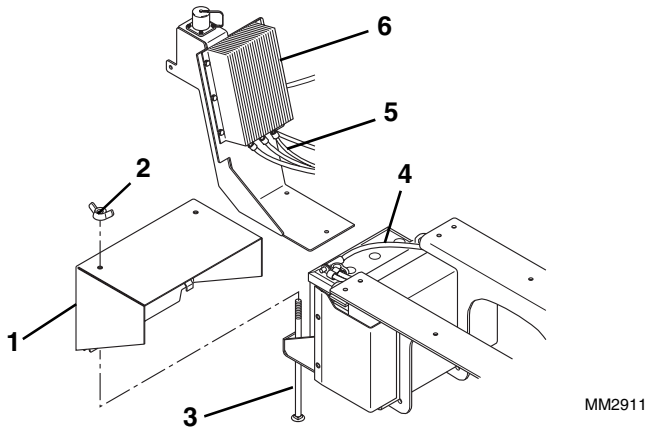
Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

4. Working at the outside rear of the cab with the rear cab panel removed, secure the tethers (**8**-Right and **15**-Left) to the cab with two 3/8" flat washers (**13** and **14**), rebound washers (**11** and **12**), and new 3/8-16 elastic locknuts (**9** and **10**). Torque nuts to 20 lb/ft (27 Nm).
5. Attach the rear cab panel (**7**) to the cab with four 5/16-18 x 1" button head capscrews (**5**) and four 5/16" plastic washers (**6**).

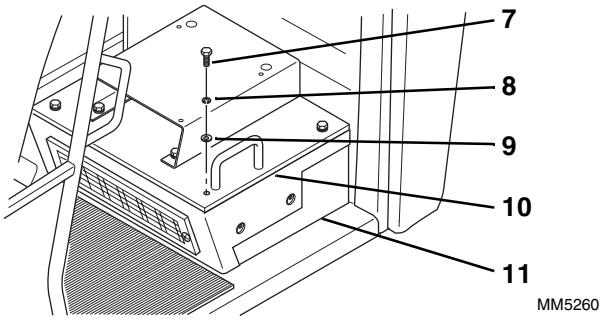
3.4 CAB HEATER/AIR CONDITIONING BLOWER BOX

3.4.1 Blower Box Removal

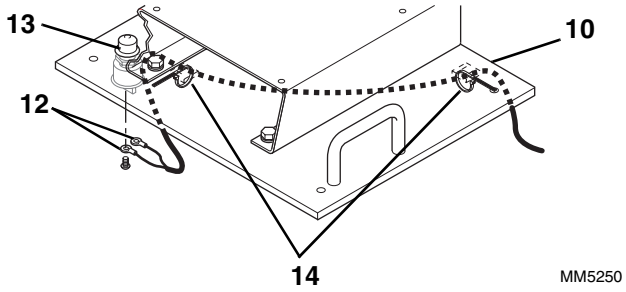
1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



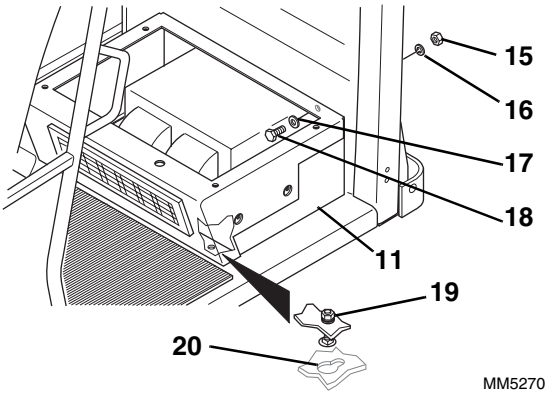
4. Remove seat from seat base. Refer to *Section 3.3.2, Seat Replacement*
5. Remove the four capscrews (**7**), lockwashers (**8**), and flat washers (**9**) securing the seat support plate (**10**) to the seat support base (**11**).



6. Carefully lift the seat plate (**10**) up far enough to tag and disconnect the two wires (**12**) attached to the cold start button (**13**) and clip the two wire ties (**14**) attached to the tie mounts on the plate. Remove plate from the vehicle. Pull the wire harness through the back of the cab to keep it out of the way when lifting the blower box out of the cab.

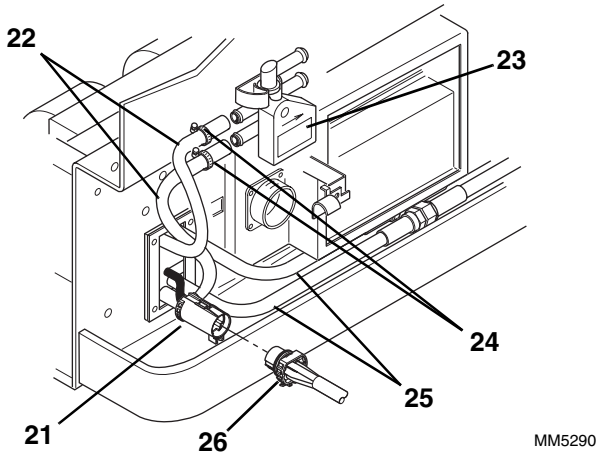


7. Remove seat support base (**11**). Remove the two capscrews (**15**), flat washers (**16**), lockwashers (**17**) and nuts (**18**) securing the back of the seat support base to the rear wall of the cab.



IMPORTANT: *It is very important that you **DO NOT** remove the nut securing the front of the seat support base to the cab. You will drop the carriage bolt down between the cab and the fuel tank.*

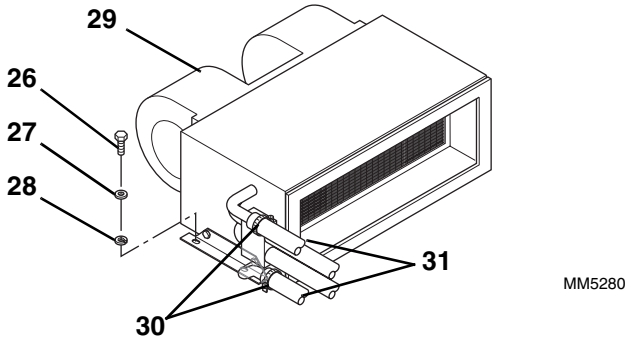
8. Loosen the nut (**19**) at the front of the seat support base just far enough to be able to slide the support forward in the key slot (**20**) so the base can be removed.
9. Remove the seat support base (**11**) from the vehicle.
10. Disconnect the blower harness connector (**21**) from the cab harness connector (**26**).



11. Disconnect the two heater hoses (**22**) from the valve (**23**) on the back of the cab. Loosen hose clamps (**24**) and slide the hoses and clamps off of the valve.

IMPORTANT: *Before the heater box can be removed from the vehicle, the air conditioning hoses (**25**) need to be disconnected from the rest of the air conditioning system. This procedure must be completed by an authorized air conditioning service technician. This service technician will also need to be available when the heater box is re-installed to re-install the air conditioning hoses to the rest of the air conditioning system.*

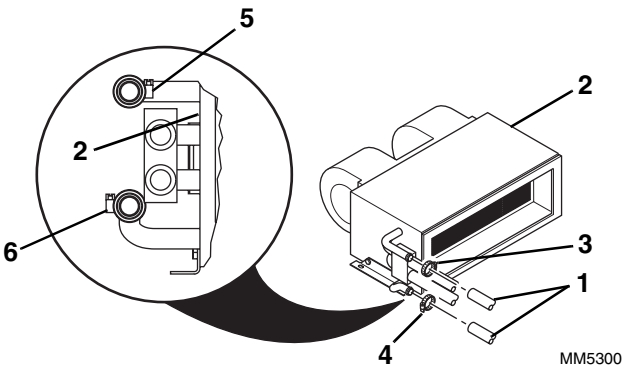
12. Remove the four capscrews (**26**), lockwashers (**27**) and flat washers (**28**) securing the heater box (**29**) to the cab.



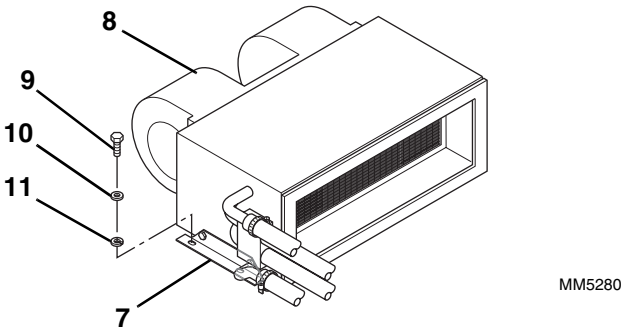
13. Carefully remove the heater box. Pull the hoses through the grommet in the rear of the cab as you are removing the heater box.
14. Loosen the two hose clamps (**30**) securing the two heater hoses (**31**) to the heater box (**29**). Remove the hoses and clamps and save for later assembly to the new heater box.

3.4.2 Blower Box Installation

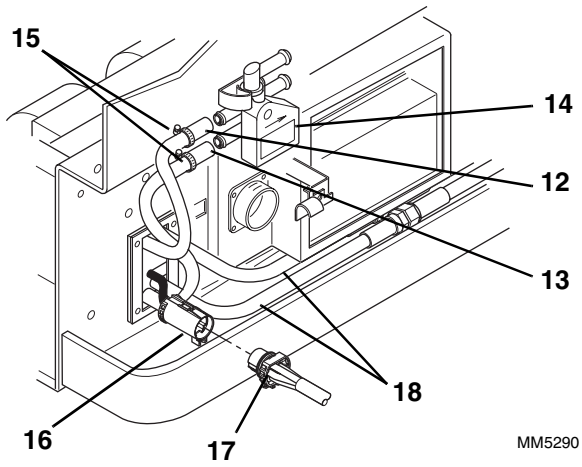
1. Attach the two heater hoses (**1**) to the heater box (**2**). Slide the hose clamp (**3** or **4**) over the hose and then slide the end of the hose over the tube on the heater box. Push the hose onto the tube far enough so that the clamp will be positioned behind the mounting bead on the tube.
2. Make sure that the top hose clamp (**3**) is placed with the screw for tightening orientated towards (**5**) the blower box and the bottom hose clamp (**4**) is placed with the screw orientated away (**6**) from the blower box. Tighten the clamp securely. Repeat for other hose.



3. Push the two heater hoses and the two air conditioning hoses through the grommet at the back of the cab while placing heater box into the cab.
4. Line up the holes in the mounting flanges (**7**) with the holes in the floor of the cab. Secure the heater box (**8**) with four capscrews (**9**), lockwashers (**10**) and SAE flat washers (**11**).



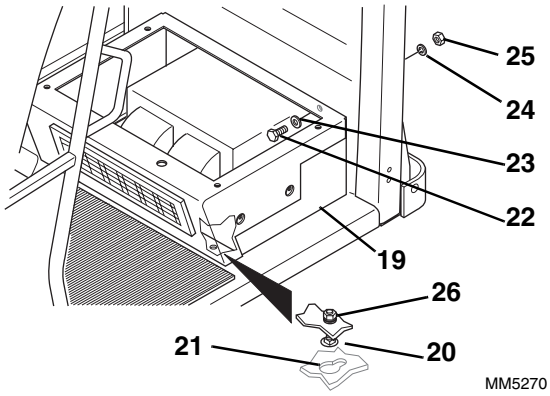
5. Connect the two heater hoses to the valve on the back of the cab.



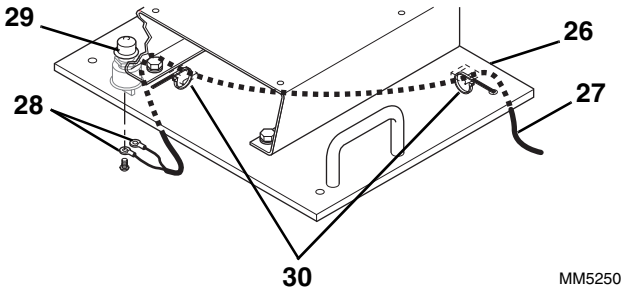
6. Assemble the two hoses (**12** and **13**) from the heater unit to the connectors on the left side of the heater valve (**14**). Place a hose clamp (**15**) onto each hose and assemble the hoses to the valve. Assemble the upper hose (**12**) from the heater unit to the top connector on the heater valve (**14**). Push the hose all the way onto the connector and tighten the clamp securely. Assemble the lower hose (**13**) to the bottom connector on the heater valve (**14**). Push the hose all the way onto the connector and tighten the hose clamp securely.
7. Connect the blower harness connector (**16**) to the cab harness connector (**17**).

IMPORTANT: *Before the heater box installation can be completed, the air conditioning hoses (**18**) need to be connected to the heater/air conditioning hoses from the rest of the air conditioning system. This procedure must be completed by an authorized air conditioning service technician.*

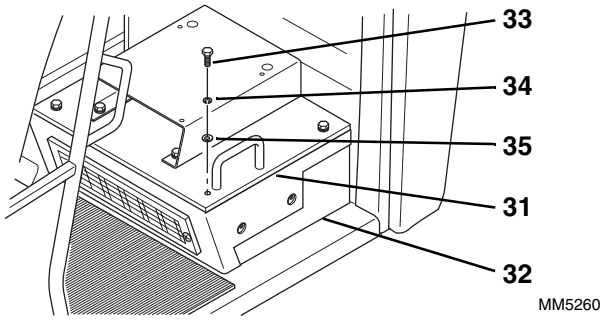
8. Place the seat support base (**19**) inside the cab and insert the carriage bolt heads (**20**) into the key hole slots (**21**) in the floor of the cab. Be sure the carriage bolts are in the slots and push the seat support against the rear of the cab. Line up the two holes in the rear mounting lip with the holes in the cab and secure in place with two bolts (**22**) and flat washers (**23**) inserted from the inside. Secure in place on the outside with two lockwashers (**24**) and nuts (**25**). Tighten the two back nuts (**25**) first and then tighten the two front nuts (**26**) securely.



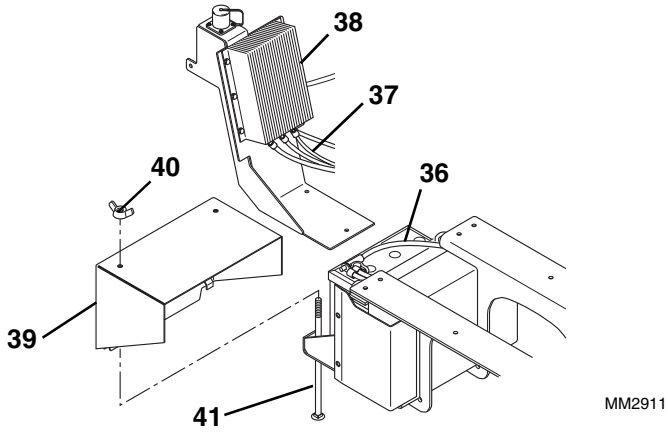
9. Place the seat support plate (**26**) back into the cab. Tilt the plate toward the back of the cab and block up in this position using blocks of wood or some other means. Block up far enough to allow you to attach the two wires to the momentary push button switch and to tie wrap the wire harness to the tie wrap mounts as described in the next two steps.



10. Pull the wire harness (**27**) back through the grommet in the rear of the cab. Secure the two wires (**28**) from the harness to the terminals on the cold start button switch (**29**).
11. Secure the wire harness to the tie wrap mounts using two tie wraps (**30**).

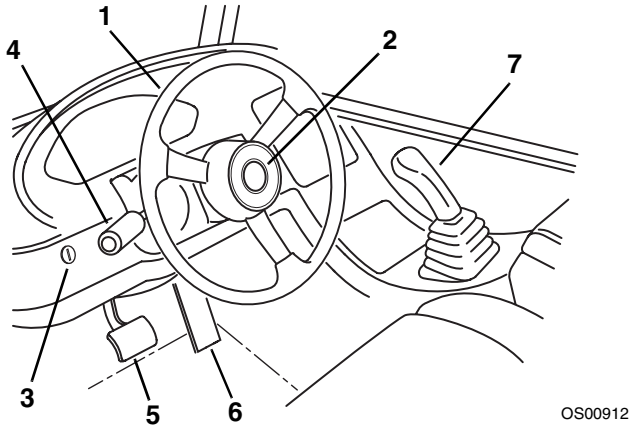


12. Line up the four mounting holes in the seat support plate (**31**) with the holes in the seat support base (**32**). Secure in place using four capscrew (**33**), lockwashers (**34**) and flat washers (**35**).
13. Replace the seat to the seat base. Refer to *Section 3.3.2, Seat Replacement*
14. Connect the negative (-) battery cable (**36**) at the battery negative (-) terminal on the battery in the engine side battery box.
15. Connect the negative (-) battery equalizer cable (**37**) at the bottom of the battery equalizer (**38**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
16. Replace engine side battery box cover (**39**). Use the wing nuts (**40**) and carriage bolts (**41**) to secure the cover in place.



3.5 CONTROLS

Operator's cab controls include the steering wheel (**1**), horn button (**2**), ignition switch (**3**), travel and gear select lever (**4**), service brake pedal (**5**), accelerator pedal (**6**) and multi-function joystick (**7**).



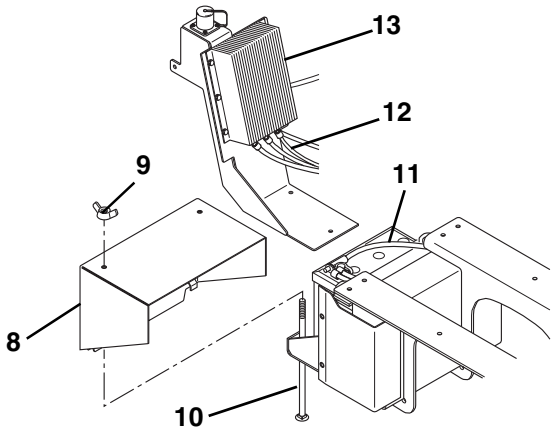
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3.5.1 Steering Wheel, Column and Shifter

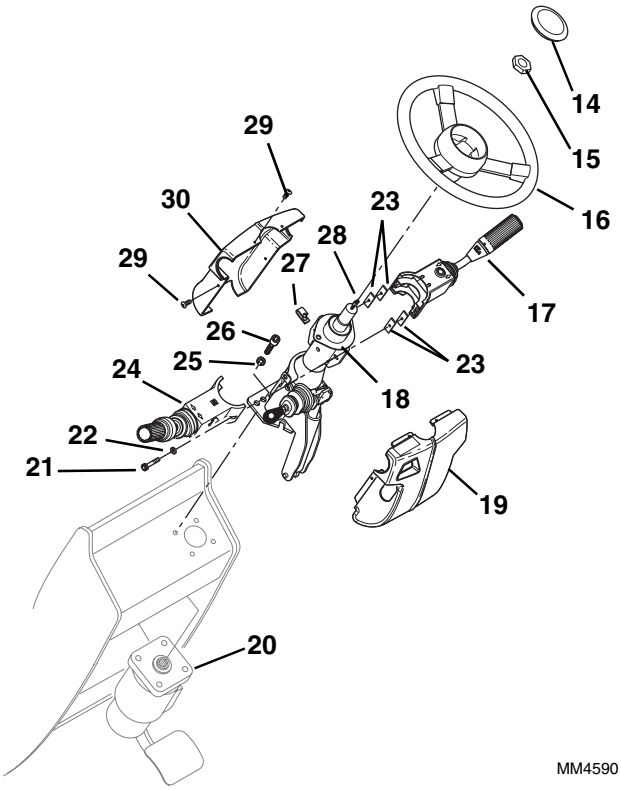
The steering wheel and transmission shift control switch are components of the steering column (**18**).

a. Steering Wheel Removal

1. Remove engine side battery box cover (**8**). Remove wing nuts (**9**) and carriage bolts (**10**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**11**) at the negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**12**) at the bottom of the battery equalizer (**13**).



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14. Horn Button Cover (1)
15. Thin Nut (1)
16. Steering wheel (1)
17. Turn Signal/Lights Lever (1)
18. Steering Column (1)
19. Steering Column Bottom Cover (1)
20. Power Steering Valve (1)
21. Phillips Pan-Head Screw (2)
22. Lockwasher (2)
23. Spacer (4)
24. Transmission Range Selector (1)
25. Lockwasher (4)
26. Socket-head Capscrew (4)
27. J-Nut (4)
28. Horn Switch Lead (1)
29. Button-Head Capscrew (4)
30. Steering Column Top Cover (1)

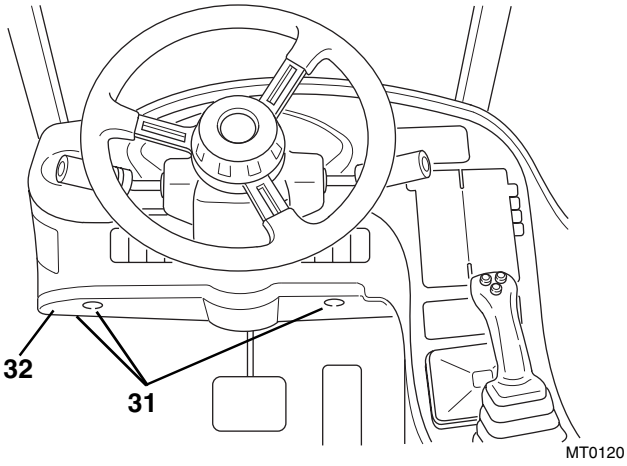
4. Carefully pry the horn button cover (**14**) out of its recess in the steering wheel. Disconnect the horn switch lead (**28**).
5. Mark the steering wheel and shaft to ensure proper installation. Remove the M18-1,5 thin nut (**15**) securing the steering wheel (**16**) to the splined steering column shaft.
6. Use a steering wheel puller to remove the steering wheel (**16**) from the splined shaft.

b. Steering Wheel Installation

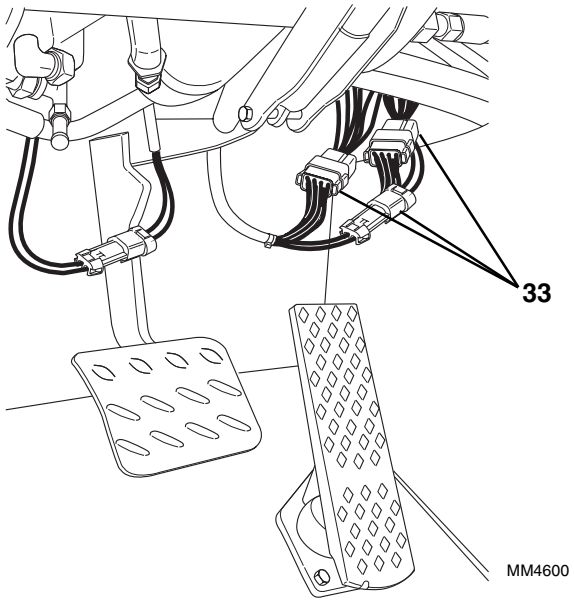
1. Install the steering wheel (**16**) onto the splined steering column shaft.
2. Secure the steering wheel with a M18-1,5 thin nut (**15**). Torque the nut to 50 lb/ft (68 Nm).
3. Connect the horn wire lead (**28**), then press the horn button cover (**14**) into its recess in the steering wheel.
4. Connect the negative (-) battery cable (**11**) at the negative (-) terminal on the battery in the engine side battery box.
5. Connect the negative (-) battery equalizer cable (**12**) at the bottom of the battery equalizer (**13**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
6. Replace battery box cover (**8**). Use the wing nuts (**9**) and carriage bolts (**10**) to secure the cover in place.

c. Transmission Range Selector and Turn Signal/Lights Lever Removal

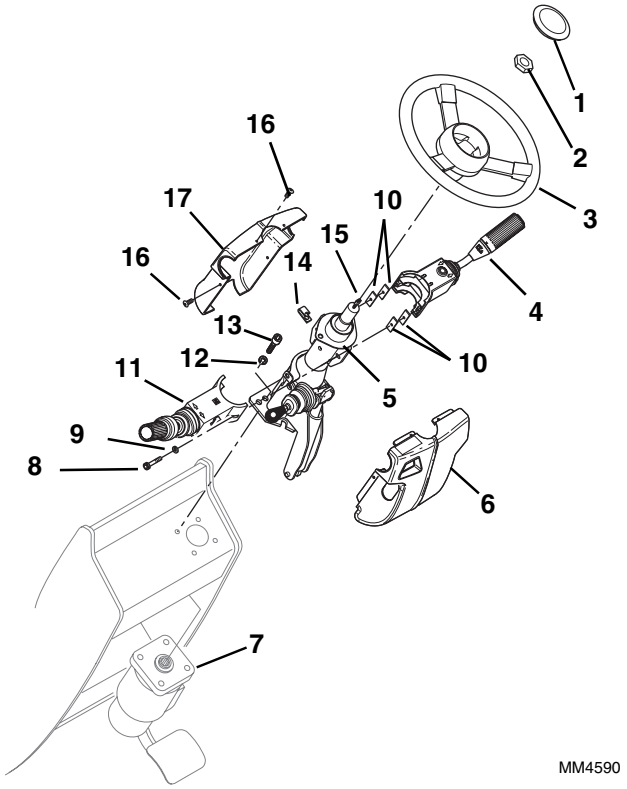
1. Remove engine side battery box cover (**8**). Remove wing nuts (**9**) and carriage bolts (**10**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**11**) at the negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**12**) at the bottom of the battery equalizer (**13**).
4. Remove the three #12-14 x 1" self-drilling screws (**31**)(one screw not visible in illustration) securing the lower dash cover (**32**) to the cab.
5. Remove the lower dash cover (**32**).



6. Label and disconnect the transmission range selector and turn signal/lights lever wiring connectors (**33**).



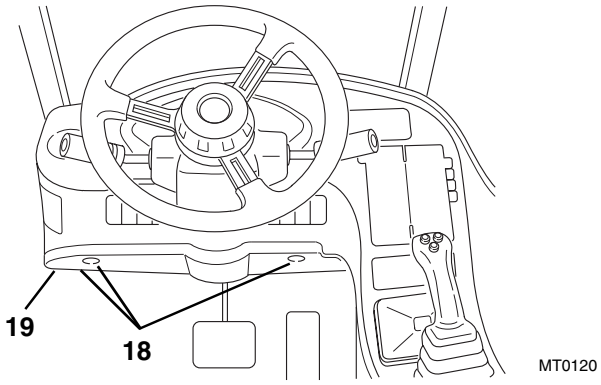
7. Remove four button head screws (**16**) and J-nuts (**14**) securing the steering column bottom (**6**) and top (**17**) covers onto the steering column (**5**).
8. Remove two phillips pan-head screws (**8**), lockwashers (**9**) and four spacers (**10**) securing the transmission range selector (**11**) and turn signal/ lights lever (**4**) to the steering column (**5**).
9. Remove the transmission range selector (**11**).



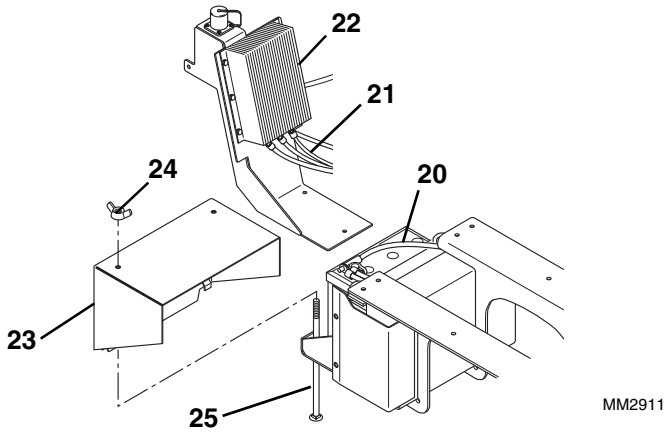
1. Horn Button Cover (1)
2. Thin Nut (1)
3. Steering wheel (1)
4. Turn Signal/Lights Lever (1)
5. Steering Column (1)
6. Steering Column Bottom Cover (1)
7. Power Steering Valve (1)
8. Phillips Pan-Head Screw (2)
9. Lockwasher (2)
10. Spacer (4)
11. Transmission Range Selector (1)
12. Lockwasher (4)
13. Socket-head Capscrew (4)
14. J-Nut (4)
15. Horn Switch Lead (1)
16. Button-Head Capscrew (4)
17. Steering Column Top Cover (1)

d. Transmission Range Selector and Turn Signal/Lights Lever Installation

1. Position the transmission range selector (**11**) and turn signal/lights lever (**4**) onto the steering column (**5**).
2. Attach the transmission range selector and turn signal/lights lever with two M4-0,7 x 20 mm phillips pan-head screws (**8**), two M4 lockwashers (**9**) and four spacers (**10**). Tighten the screws securely, but **DO NOT** overtighten. Overtightening will cause the range selector or turn signal/lights lever to break.
3. Plug the electrical connectors (**26**) into the harness connectors.
4. Install the steering column bottom (**6**) and top (**17**) covers onto the steering column. Secure with four #10-24 x 5/8" button head screws (**16**) and J-nuts (**14**). **DO NOT** overtighten.
5. Install the lower dash cover (**18**), and secure using three #12-14 x 1" self-drilling screws (**19**)(one screw not visible in illustration).



6. Connect the negative (-) battery cable (**20**) at the negative (-) terminal on the battery in the engine side battery box.
7. Connect the negative (-) battery equalizer cable (**21**) at the bottom of the battery equalizer (**22**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
8. Replace battery box cover (**23**). Use the wing nuts (**24**) and carriage bolts (**25**) to secure the cover in place.

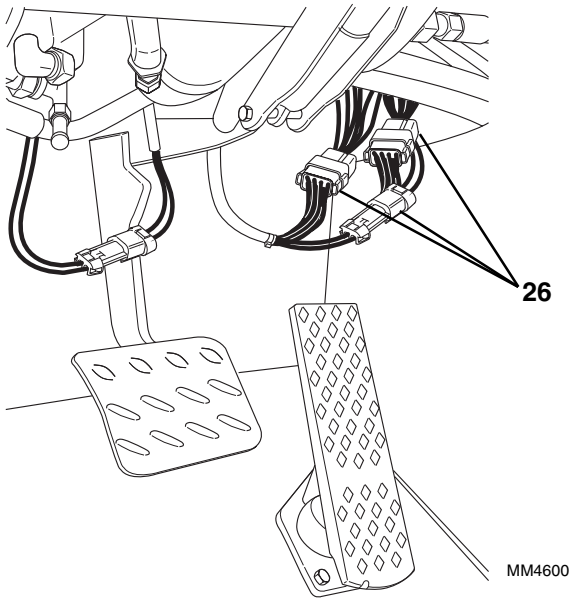


e. Steering Column Removal

1. Remove engine side battery box cover (**23**). Remove wing nuts (**24**) and carriage bolts (**25**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**20**) at the negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**21**) at the bottom of the battery equalizer (**22**).
4. Remove four #10-24 x 5/8" button head screws (**16**) and J-nuts (**14**) securing the steering column bottom (**6**) and top (**17**) covers onto the steering column.
5. Carefully pry the horn button cover (**1**) out of its recess in the steering wheel. Disconnect the horn switch lead (**15**).
6. Label and disconnect the transmission range selector and turn signal/lights lever wiring connectors (**26**) from the wiring harness.
7. Remove the four hex socket-head screws (**13**) and lockwashers (**12**) securing the steering column (**5**) to the steering valve (**7**).
8. Remove the steering column (**5**) from the cab.

f. Steering Column Installation

1. Position the steering column (**5**) within the cab and engage the splined lower end of the steering shaft with the power steering valve (**7**). Press the steering column shaft down into the power steering valve. Fully engage the splines.
2. Align the four steering column mounting holes with the dash panel and power steering valve mounting holes. Secure the steering column with four 3/8-16 x 1" hex socket-head screws (**13**) and 3/8" lockwashers (**12**). Torque to 31 lb/ft (42 Nm).
3. Plug the electrical connectors (**26**) into the harness connectors.
4. Connect the horn switch wire lead (**15**), then press the horn button cover (**1**) into its recess in the steering wheel.
5. Install the steering column bottom (**6**) and top (**17**) covers onto the steering column. Secure with four #10-24 x 5/8" button head screws (**16**) and J-nuts (**14**).
6. Connect the negative (-) battery cable (**20**) at the negative (-) terminal on the battery in the engine side battery box.
7. Connect the negative (-) battery equalizer cable (**21**) at the bottom of the battery equalizer (**22**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
8. Replace battery box cover (**23**). Use the wing nuts (**24**) and carriage bolts (**25**) to secure the cover in place.

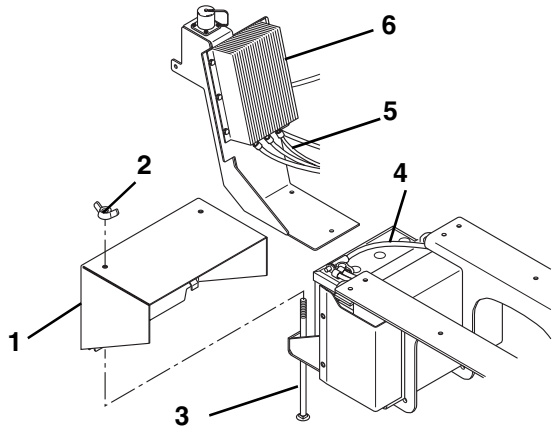


3.5.2 Joystick Replacement

a. Joystick Handle Replacement

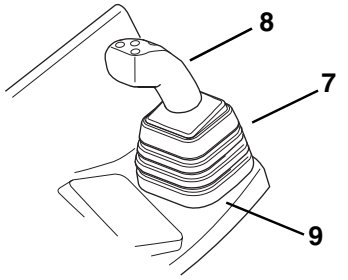
Joystick Handle Removal

1. Park the vehicle on a firm, level surface. Set the park brake, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake and turn the ignition OFF.



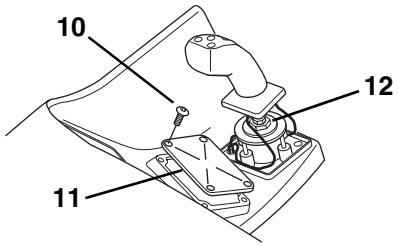
MM2911

2. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
3. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
4. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).
5. Remove the rubber boot (**7**) from the joystick (**8**). Pull the boot off the base (**9**) and remove the boot from the handle.



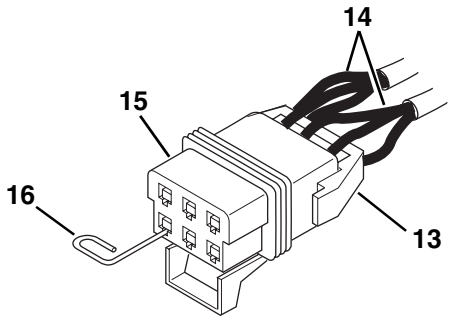
SS1190

6. Remove the four button head capscrews (**10**) securing the logic panel (**11**) to the side console. Carefully pry the logic console upward. Label, then disconnect the wiring harness leads at the logic panel. Remove the logic panel from the vehicle.
7. Loosen the upper hex nut (**12**).



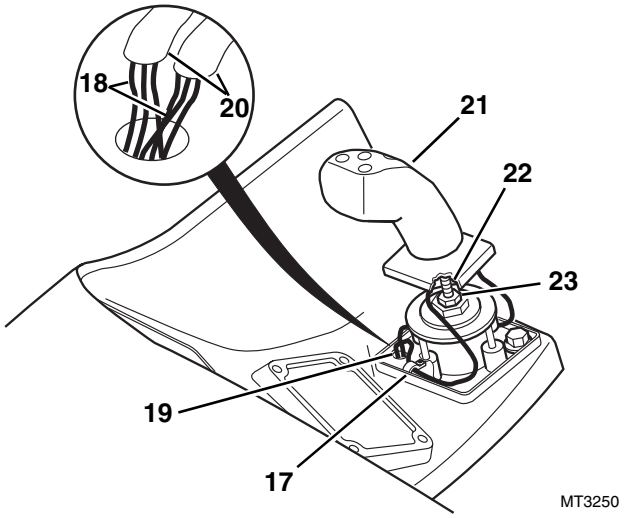
SS1210

8. Reach through the logic panel opening in the console and pull the joystick connector through the opening.
9. Remove the gray secondary lock (**13**) from the joystick wiring connector, by gently prying up on each side of the lock with a small screwdriver. Remove the lock from the wires and save the lock for reassembly.
10. Note the position of the wires (**14**) for reassembly, and remove the wires from the joystick connector (**15**). Use a small paper clip (**16**) or a small pick to release the locking tabs on each wire. Pull the wires (**14**) all the way out of the connector, the weather-tight seals can remain on the wires. Save the connector for reassembly.
11. Loosen the screws holding the wire clamps (**17**).
12. Carefully pull the joystick wires (**18**) through the small hole (**19**) in the mounting plate, until the sleeves (**20**), surrounding the wires, are out of the hole. One at a time, carefully pull the wires through the hole. **DO NOT** damage the terminals while pulling the wires out of the hole.



SS0250

13. Turn the joystick handle (**21**) counterclockwise until the threaded shaft (**22**) is free of the base.
14. Remove the hex nut (**23**) from the threaded shaft. Save the nut for reassembly.



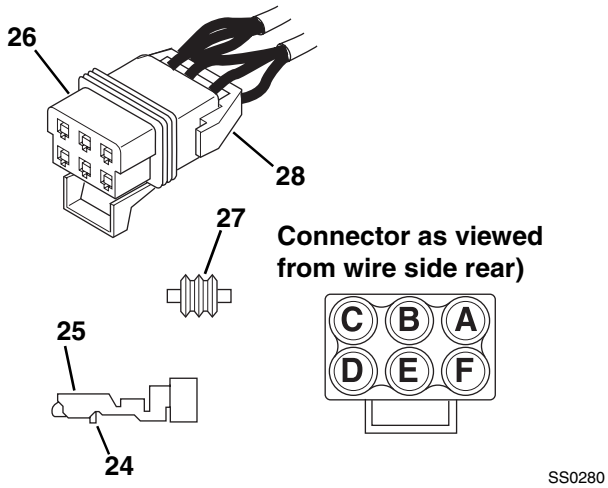
15. Use a 3/8-16 tap to clean the excess Loctite® from the threaded hole in the top of the valve.

Joystick Handle Installation

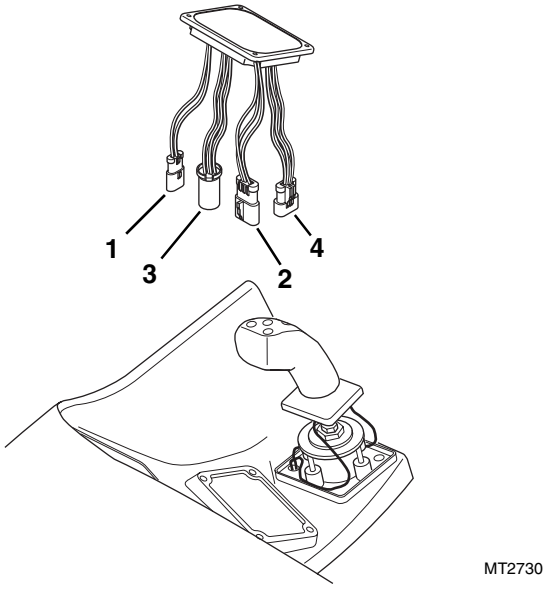
1. Assemble the hex nut (**23**), saved in Step 14 of the "Removal" procedure, onto the threaded stud of the new handle assembly. Turn the hex nut all the way up.
2. Apply Loctite® #272 (red) to the threaded shaft (**22**) on the joystick handle (**21**).
3. Position the threaded shaft (**22**) into the base mounting hole and turn the handle to thread it into the valve. Turn the handle approximately halfway into the thread hole. Align the joystick in the forward position. Secure the joystick by tightening the jam nut.
4. Carefully thread the joystick wires (9) through the small hole (**19**) in the mounting plate. **DO NOT** damage the terminals while pushing the wires through the hole.
5. Pull the wires through the logic panel opening in the console.
6. Place the wires under the clamps (**17**) mounted to the joystick mounting plate. Position the wires so that they do not interfere with the joystick handle movement and the wires have enough slack when the handle is moved in either direction from center. Tighten the clamps.
7. Make sure that the locking tabs (**24**) on the terminals (**25**) of the new joystick handle wires are in the OUT position.
8. Reuse the connector (**26**) removed in Step 10 of the "Removal" procedure and insert the new joystick wires into the rear of the connector. Insert the wires into the cavities, as marked at the rear of the connector. Push the wires in, until they lock in place.
   - RED wire to cavity A
   - WHITE wire to cavity B
   - BLUE wire to cavity C
   - GREEN wire to cavity D
   - YELLOW wire to cavity F

Note: *Cavity E should have a cavity plug (**27**) installed. Replace the plug if it is missing.*

9. Install the gray secondary lock (**28**) removed in Step 9 of the "Removal" procedure onto the rear of the connector. Place the wires into the cutouts of the lock and then snap the lock onto the connector. **DO NOT** pinch any of the wires.

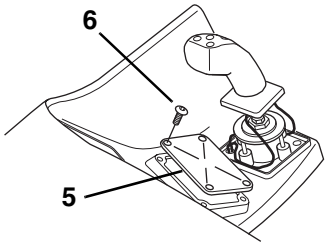


10. Connect the 2-pin (**1**), 3-pin (**2**), and 7-pin (**3**) logic panel connectors to the harness and the 6-pin connector (**4**) to the joystick harness connector on the logic panel.



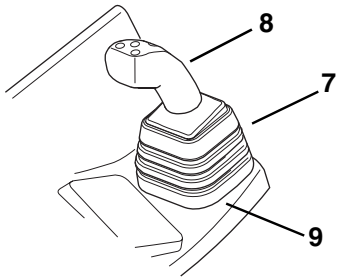
MT2730

11. Install the logic panel (**5**) with the graphic symbols oriented properly as viewed from the operator's position. Secure the panel to the side console with four #10-32 x 3/4" button head capscrews (**6**).



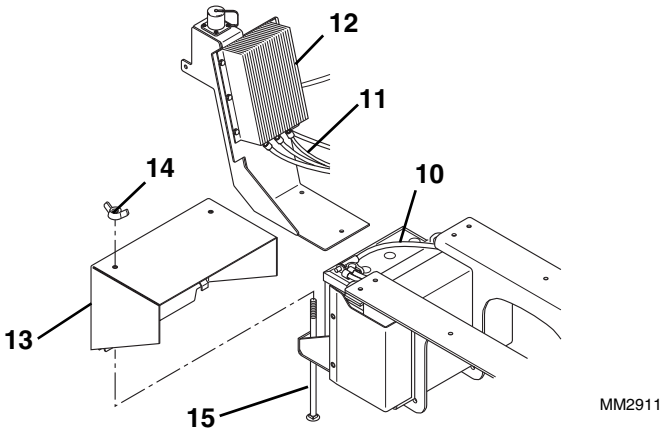
SS1210

12. Install the joystick boot (**7**) by pulling the boot over the joystick handle (**8**) and down onto the base (**9**). Properly seat the boot "lip" within the grooves in the joystick base to help provide a watertight seal.



SS1190

13. Connect the negative (-) battery cable (**10**) at the negative (-) terminal on the battery in the engine side battery box.
14. Connect the negative (-) battery equalizer cable (**11**) at the bottom of the battery equalizer (**12**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
15. Replace battery box cover (**13**). Use the wing nuts (**14**) and carriage bolts (**15**) to secure the cover in place.



MM2911

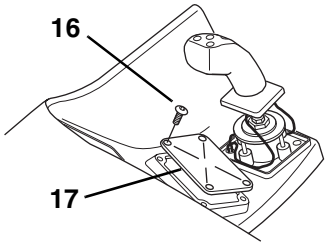
16. Check for proper operation of all joystick functions.

b. Joystick Assembly Replacement

Joystick Assembly Removal

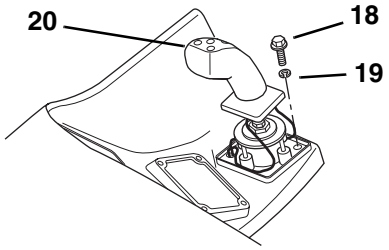
1. Park the vehicle on a firm, level surface. Set the park brake, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake and turn the ignition OFF.

2. Remove engine side battery box cover (**13**). Remove wing nuts (**14**) and carriage bolts (**15**) and set cover and mounting hardware aside for later re-assembly.
3. Disconnect the negative (-) battery cable (**10**) at the negative (-) terminal on the battery in the engine side battery box.
4. Disconnect the negative (-) cable (**11**) at the bottom of the battery equalizer (**12**).
5. Remove the boot (**7**) from the joystick (**8**) by pulling the boot off the base (**9**).
6. Remove the four button head capscrews (**16**) securing the logic panel (**17**) to the side console. Carefully pry the logic console upward. Label, then disconnect the wiring harness leads at the logic panel. Remove the logic panel from the vehicle.



SS1210

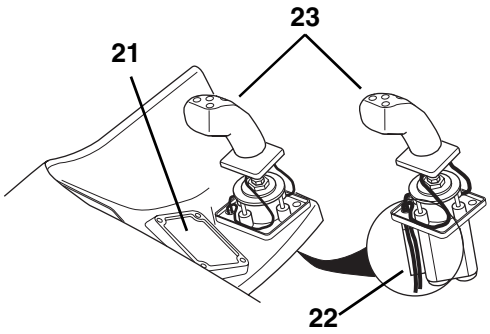
7. Remove three flange-head capscrews (**18**) and lockwashers (**19**) securing the joystick assembly (**20**) to its mounting hole in the side console. Save the three flange-head capscrews and lockwashers for reuse later.



SS1200

8. Reach through the logic panel opening (**21**) and position the joystick wires (**22**). Raise the joystick (**23**) enough to expose and allow access to the hydraulic hose fittings connected to the joystick control valve on the underside of the joystick.

Note: *As required, remove tie wraps securing the joystick hydraulic hoses together beneath the vehicle frame. Removing the tie wraps will allow the hoses to be pulled further out of the joystick opening in the console.*



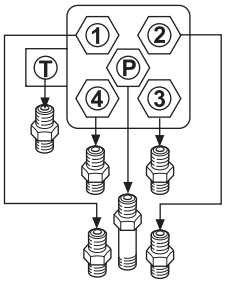
SS1270

WARNING: Hydraulic fluid leaking under pressure can penetrate the skin, cause infection, gangrene, and death or serious personal injury. If injured, see a doctor immediately.

Relieve all pressure before disconnecting any component, part, line or hose. Slowly loosen parts and allow release of residual pressure before removing any parts or component.

WARNING: Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic oil can cause severe burns.

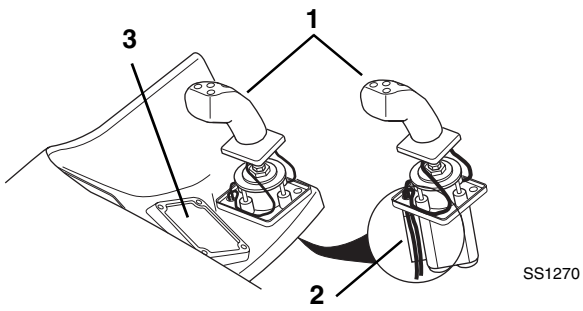
9. Use labels, tape or some type of permanent paint or marker to mark the six hoses on the underside of the joystick valve as shown in illustration below (Detail in illustration shows ports viewed from bottom side of joystick valve).



MM4770

10. Remove and plug the hose ends to help prevent excess hydraulic fluid spillage and to prevent contaminants from entering the hydraulic system.

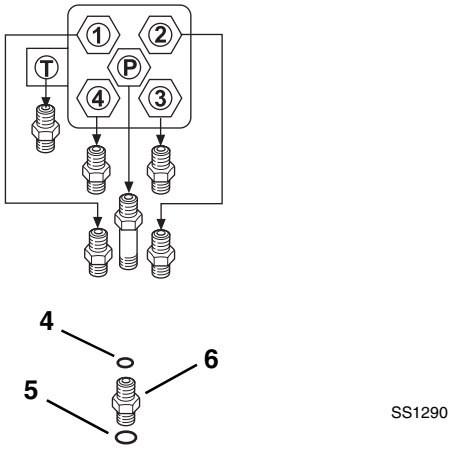
11. Remove the joystick assembly (**1**) from the vehicle.



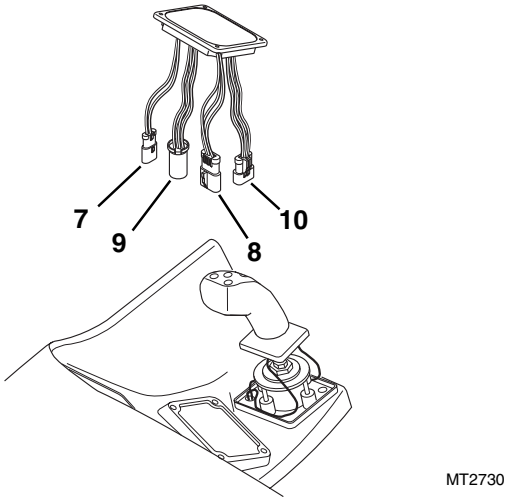
12. Place the joystick in a vise or other suitable device. Remove the six straight fittings from the joystick valve ports. Remove and discard all of the small (**4**) and large o-rings (**5**) from the joystick valve and fittings (**6**) (to help avoid leaky connections, always use new o-rings when servicing the vehicle).

Joystick Assembly Installation

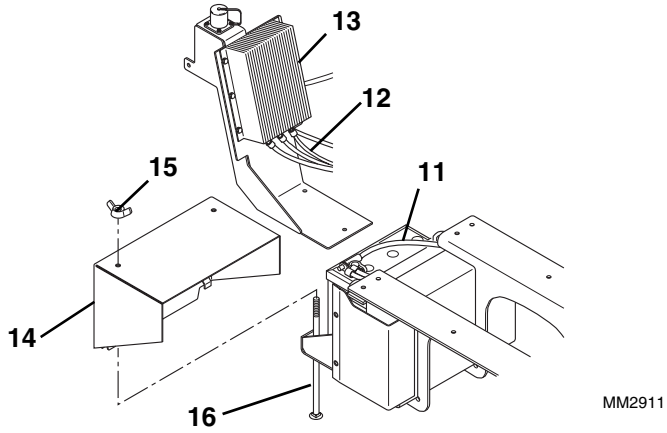
Note: *If installing a new joystick assembly, label or permanently mark the hose ports on the underside as shown in illustration above. Remove any port plugs before proceeding.*



1. As required, carefully remove the rubber boot from the joystick by pulling the boot (**7**) off the joystick base (**9**) and lifting it over the joystick handle (**8**). Save the boot for installation later.
2. Place the joystick in a vise or other suitable device. Lubricate and install new small (**4**) and large o-rings (**5**) and the six straight fittings (**6**) into the joystick valve ports if necessary. To help avoid leaky connections, ALWAYS use new o-rings when servicing the vehicle.
3. Position the joystick assembly (**1**) above its mounting hole in the console. Remove the plug from the hose labeled “P” and secure the hose to the “P” port of the joystick valve (see detail in illustration below).
4. Remove the plug from the hose labeled “T” and secure the hose to the “T” port of the joystick valve. Remove the plugs from the remaining hoses one at a time and secure each hose as labeled to the proper fitting on the joystick control valve (see detail in illustration below). Tighten all fittings securely.
5. Position the lower joystick wires (**2**). Reach in through the logic panel opening and guide the wires up through the logic panel opening (**3**) while lowering the joystick assembly (**1**) down into its mounting hole in the console.
6. Connect the 2-pin (**7**), 3-pin (**8**), and 7-pin (**9**) logic panel connectors to the harness and the 6-pin connector (**10**) to the joystick harness connector on the logic panel. Set the logic panel in its mounting hole, but **DO NOT** secure with fasteners at this time.



7. Connect the negative (-) battery cable (**11**) at the negative (-) terminal on the battery in the engine side battery box.
8. Connect the negative (-) battery equalizer cable (**12**) at the bottom of the battery equalizer (**13**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
9. Replace battery box cover (**14**). Use the wing nuts (**15**) and carriage bolts (**16**) to secure the cover in place.

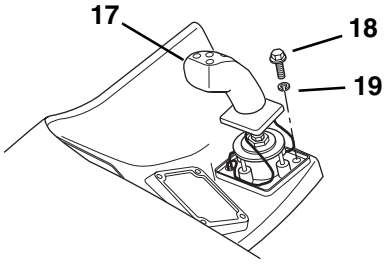


MM2911

10. Check all joystick functions for proper operation.
11. Start the engine and move the joystick handle rearward, activating the boom hoist function. The boom should RAISE.
12. Move the joystick handle forward; activating the boom lower function. The boom should LOWER.
13. Move the joystick handle to the right, activating the boom extend function. The boom should EXTEND.
14. Move the joystick handle to the left, activating the boom retract function. The boom should RETRACT.
15. If any of the functions fail to work as described, a hydraulic hose is most likely connected to the wrong joystick valve port. Relocate hoses as required to attain proper joystick function.

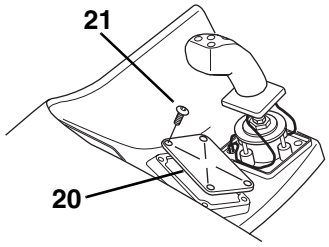
WARNING: Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check the hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

16. Check for hydraulic fluid leaks. Check the hydraulic fluid level in the tank and add fluid as required.
17. Align the joystick assembly mounting holes with the console. Secure the joystick assembly (**17**) to the side console with three 1/4-20 x 3/4" flange-head capscrews (**18**) and 1/4" lockwashers (**19**).



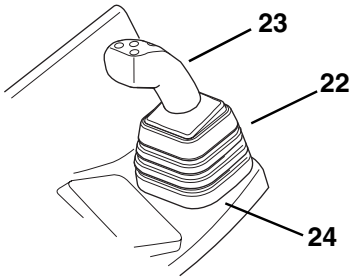
SS1200

18. Install the logic panel (**20**) with the graphic symbols oriented properly as viewed from the operator's position. Secure the panel to the side console with four #10-32 x 3/4" button head capscrews (**21**).



SS1210

19. Install the joystick boot (**22**) by pulling the boot over the joystick handle (**23**) and down onto the base (**24**). Properly seat the boot "lip" within the grooves in the joystick base to help provide a watertight seal.



SS1190

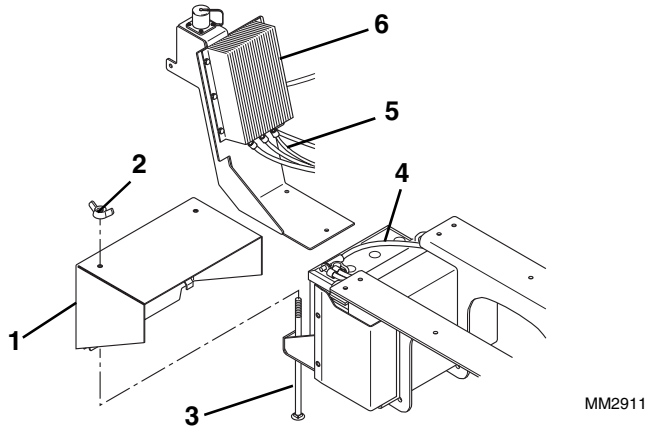
Note: *If any tie wraps were removed from the joystick hydraulic hoses beneath the vehicle frame, bundle the hoses and secure with new tie wraps as required to prevent the hoses from contacting any sharp edges or moving parts.*

20. Wipe up any spilled hydraulic oil.

3.5.3 Service Brake Pedal Replacement

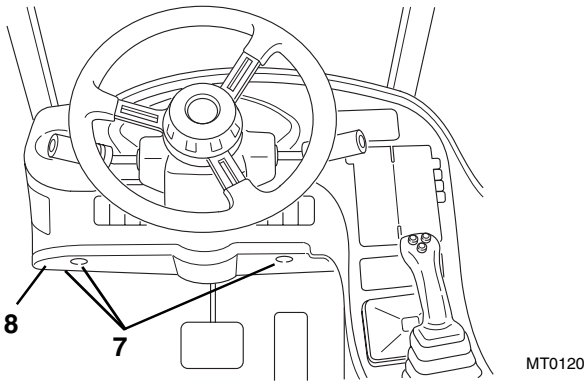
a. Service Brake Pedal Removal

1. Park the vehicle on a firm, level surface. Allow sufficient overhead and side clearance for cab removal. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Open the engine hood. Allow the engine and hydraulic fluid to cool.
2. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
3. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
4. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).

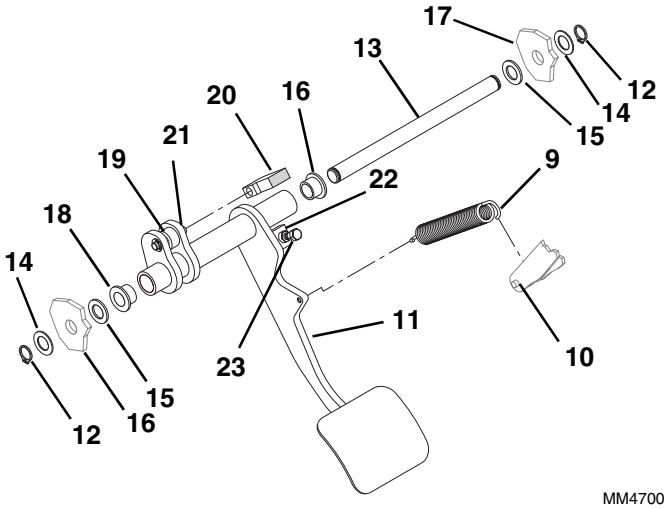


MM2911

5. Remove the three self-drilling screws (**7**) (one screw not visible in illustration) securing the lower dash cover (**8**) to the cab.
6. Remove the lower dash cover (**8**).



MT0120



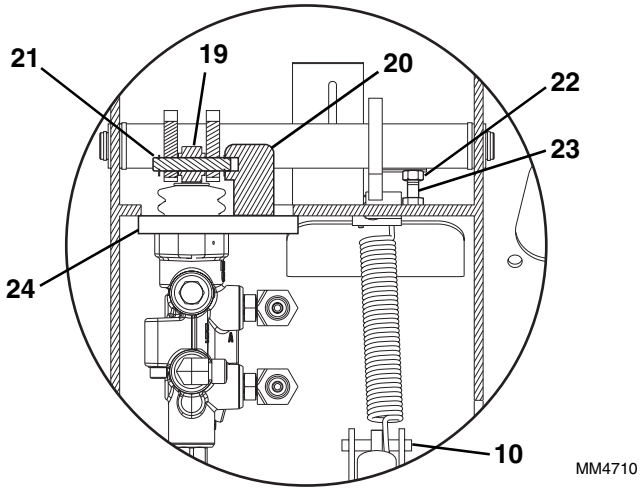
MM4700

7. Remove the spring (**9**) from the pin in the steering column (**10**) and the hole in the service brake pedal assembly (**11**).
8. Remove the snap ring (**12**) on one end of the brake pedal shaft (**13**).
9. Carefully slide the shaft out of the brake pedal, making sure to mark all shims (**14** and **15**) for correct re-assembly order.
10. Remove the service brake pedal assembly (**11**) from between the two steering column plates (**16** and **17**).
11. Inspect the two bushings (**18**) and the roller (**19**) for wear. Replace if necessary.

b. Service Brake Pedal Installation

1. Remove all necessary pieces from the old service brake pedal assembly and mount onto the new service brake pedal assembly.
2. Position the service brake pedal assembly (**11**) in its mounting location between the two steering column plates (**16** and **17**).
3. Slide the brake pedal shaft (**13**) through the hole in the steering column plate (**16** or **17**) and the service brake pedal assembly (**11**), making sure that the shims (**14** and **15**) are placed in the same order as noted during removal.

4. Place snap ring (**12**) onto the end of the brake pedal shaft (**13**) to secure the service brake pedal assembly to the steering column plates (**16** and **17**).
5. Slide the brake pedal adjustment block (**20**), onto the roller pin (**21**). Make sure that the adjustment hex nut (**22**) is loose and adjust the brake pedal adjustment screw (**23**) so the base of the block mates squarely with the valve mounting plate (**24**).
6. Tighten hex nut securely once the proper adjustment has been reached. Remove adjustment block from roller pin.
7. Hook the wide opening of the spring (**9**) onto the pin in the steering column (**10**) and the narrow opening of the spring into the hole in the service brake pedal assembly (**11**).

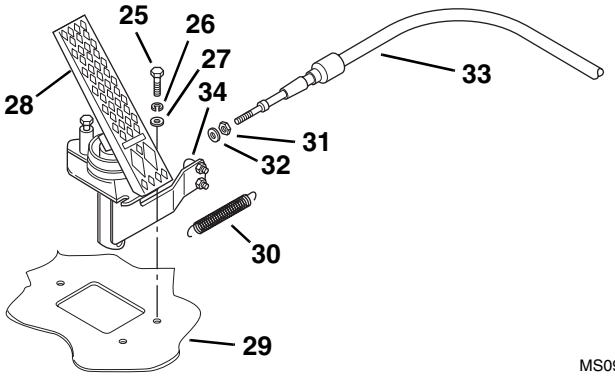


8. Install and secure the lower dash cover (**8**) with three #12-14 x 1" self-drilling screws (**7**) (one screw not visible in illustration).
9. Adjust the brake switch as needed (refer to *Section 10.13.6, Service Brake Switch*).
10. Connect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
11. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
12. Replace battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.

3.5.4 Throttle Pedal Replacement

a. Throttle Pedal Removal

1. Park the vehicle on a firm, level surface. Allow sufficient overhead and side clearance for cab removal. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Open the engine hood. Allow the engine and hydraulic fluid to cool.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
4. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
5. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).
6. Remove three capscrews (**25**), lockwashers (**26**) and flat washers (**27**) securing the throttle pedal assembly (**28**) to the cab floor (**29**).

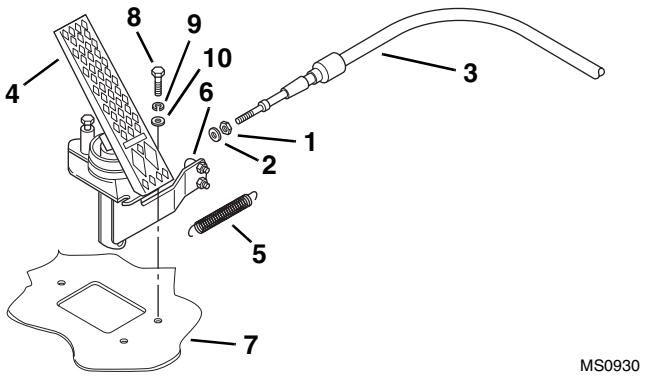


7. Remove the extension spring (**30**) as required from the throttle pedal assembly.
8. Remove the jam nut (**31**) and flat washer (**32**) securing the throttle cable (**33**) to the accelerator pedal assembly (**28**).
9. Remove the accelerator pedal assembly (**28**) from the cab.

b. Throttle Pedal Installation

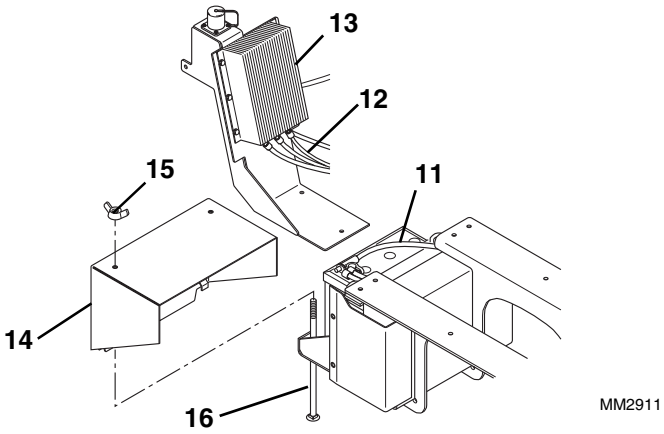
1. Install the 1/4-28 NF hex jam nut (**1**) and 1/4" SAE flat washer (**2**) onto the end of the throttle cable (**3**). Secure the cable to the throttle pedal (**4**).

Note: *If throttle cable (**3**) replacement is required, the cab must be unbolted from its mount and raised slightly to permit cable removal. (Refer to Section 3.2.3, b. Cab Removal.)*



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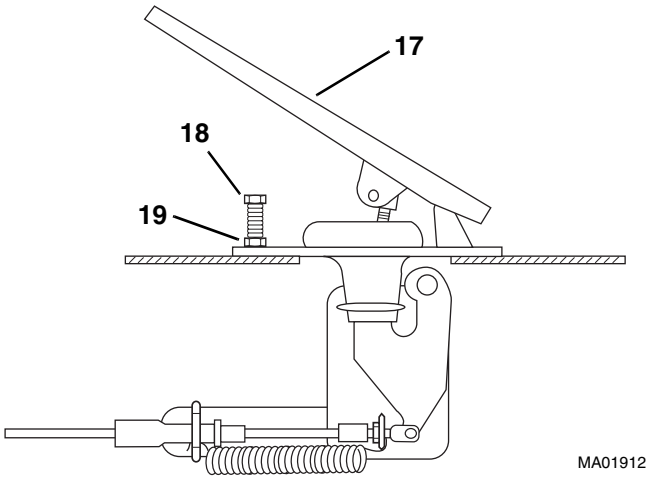
2. If needed, attach one end of the extension spring (**5**) to the throttle pedal lever beneath the pedal. Attach the other end of the spring to the cable clamp (**6**).
3. Align the throttle pedal assembly (**4**) with its mount holes in the cab floor (**7**).
4. Install three 1/4-20 x 1-1/4" capscrews (**8**), lockwashers (**9**) and flat washers (**10**) securing the throttle pedal assembly to the cab floor (**7**). Torque the capscrews to 9 lb/ft (12 Nm).
5. Connect the negative (-) battery cable (**11**) at the battery negative (-) terminal on the battery in the engine side battery box.
6. Connect the negative (-) battery equalizer cable (**12**) at the bottom of the battery equalizer (**13**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
7. Replace engine side battery box cover (**14**). Use the wing nuts (**15**) and carriage bolts (**16**) to secure the cover in place.



MM2911

c. Throttle Adjustment

1. From within the cab, lightly depress the accelerator pedal (**17**) to full-throttle position. As needed, adjust the limit-stop screw (**18**) until it touches the pedal. Tighten the locknut (**19**) to 120-125 lb/in (13,6-14,1 Nm).



MA01912

IMPORTANT: *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.*

2. Check the engine rpm at full throttle. If the rpm is not 2600-2800 rpm, readjust the throttle limit-stop screw at the throttle pedal within the cab.

3.6 MIRRORS

3.6.1 Mirror Location

The vehicle is equipped with three rear-view mirrors. These include two cab-mounted mirrors; one on the left (**20**), another on the top right (**21**), and an engine hood mounted mirror (**22**).

Keep the mirrors clean for optimal operator performance.

3.6.2 Mirror Replacement

> **WARNING:** A mirror with cracked glass can cause cuts. Handle a cracked or broken mirror with care to help avoid personal injury.

Replace any mirror with cracked glass as vehicle use and vibration will eventually, if not immediately, cause the crack(s) to worsen or the mirror glass to fall out.

The mirror mounted on the left side of the cab (**20**) and the hood-mounted, convex mirror head (**22**) are attached to mirror arm assemblies (**23** - hood-mounted) or (**24** - left side of the cab). These mirror heads can be replaced independently of the arm and mounting hardware.

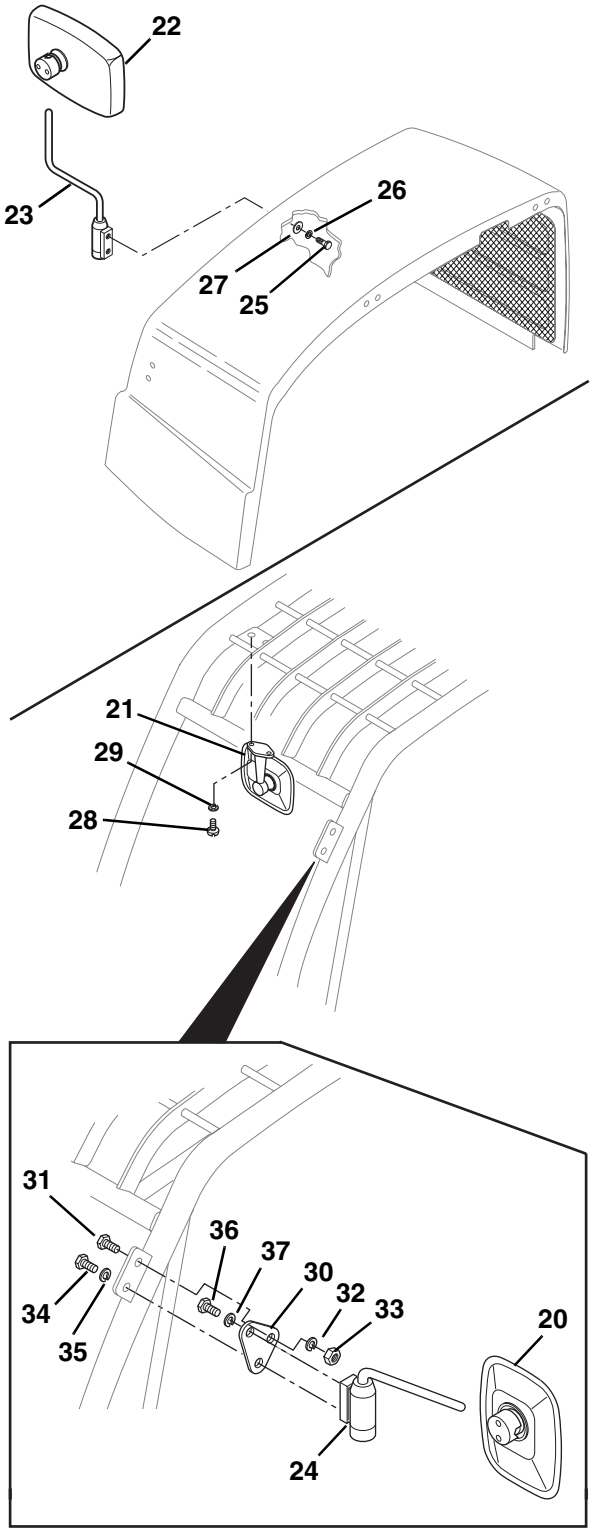
The hood-mounted mirror arm assembly (**23**) is secured to the hood with two M6-1 x 19 mm capscrews (**25**), M6 lockwashers (**26**) and 1/4" SAE light flat washer (**27**).

The mirror (**21**) at the top right of the cab is secured to the cab with two #10-24 x 5/8" round-head slotted screws (**28**) and #10 lockwashers (**29**).

The mirror arm assembly (**24**) on the left side of the cab, is mounted using a bracket (**30**). The bracket is secured to the cab at the top mounting hole using one M6-1 x 19 mm capscrew (**31**), M6 lockwasher (**32**) and M6-1 nut (**33**).

The bottom bracket hole also secures the bottom mirror arm assembly mounting hole. Use an M6-1 x 19 mm capscrew (**34**) and an M6 lockwasher (**35**) in the bottom mounting hole of the mirror arm assembly.

The top mirror arm assembly (**24**) mounting hole is secured with one M6-1 x 14 mm capscrew (**36**) and M6 lockwasher (**37**).



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3.7 ACCESS PANELS, COVERS AND GUARDS

3.7.1 Cover and Guard Replacement

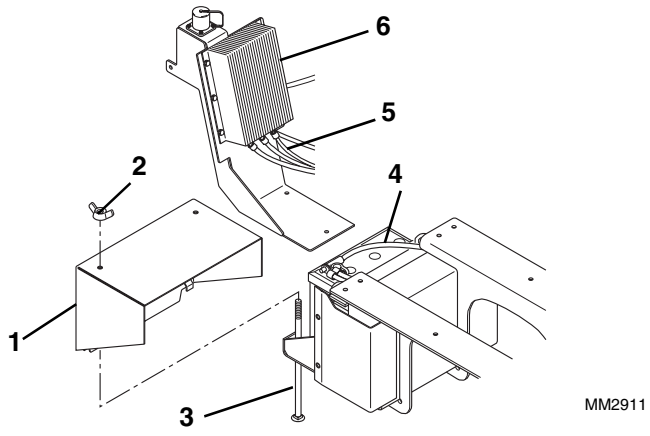
The vehicle is equipped with various covers and guards. Removal and installation are easily accomplished by observing he mounting configurations as shown in illustration on next page.

3.7.2 Engine Hood

a. Engine Hood Removal

> **WARNING:** Contact with hot engine or other components will cause burns. Allow the engine and components to cool completely before proceeding. Failure to comply will result in personal injury.

1. Park the vehicle on a firm, level surface. Allow sufficient overhead clearance for engine hood removal. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Open the engine hood. Allow the engine and hydraulic fluid to cool.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.



4. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
5. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).

Note: *If performing this procedure outside where blowing wind is a factor, control hood movement at all times. Wind can cause the hood to move unexpectedly.*

6. Raise the engine cover(**7**).
7. Support the hood in a suitable manner. Disconnect the top spring clip (**17**) from the gas spring (**18**). Reattach the spring clip to the gas spring and lower the gas spring down out of the way. It is not necessary to detach the lower spring clip or to remove the gas spring.
8. Remove two cotter pins (**25**) and 3/8" narrow flat washers (**24**) from the clevis pins (**13**). Remove the clevis pins.
9. With the help of at least one assistant, carefully lift and remove the cover (**7**).
10. Store the cover securely to help prevent damage.

b. Engine Hood Installation

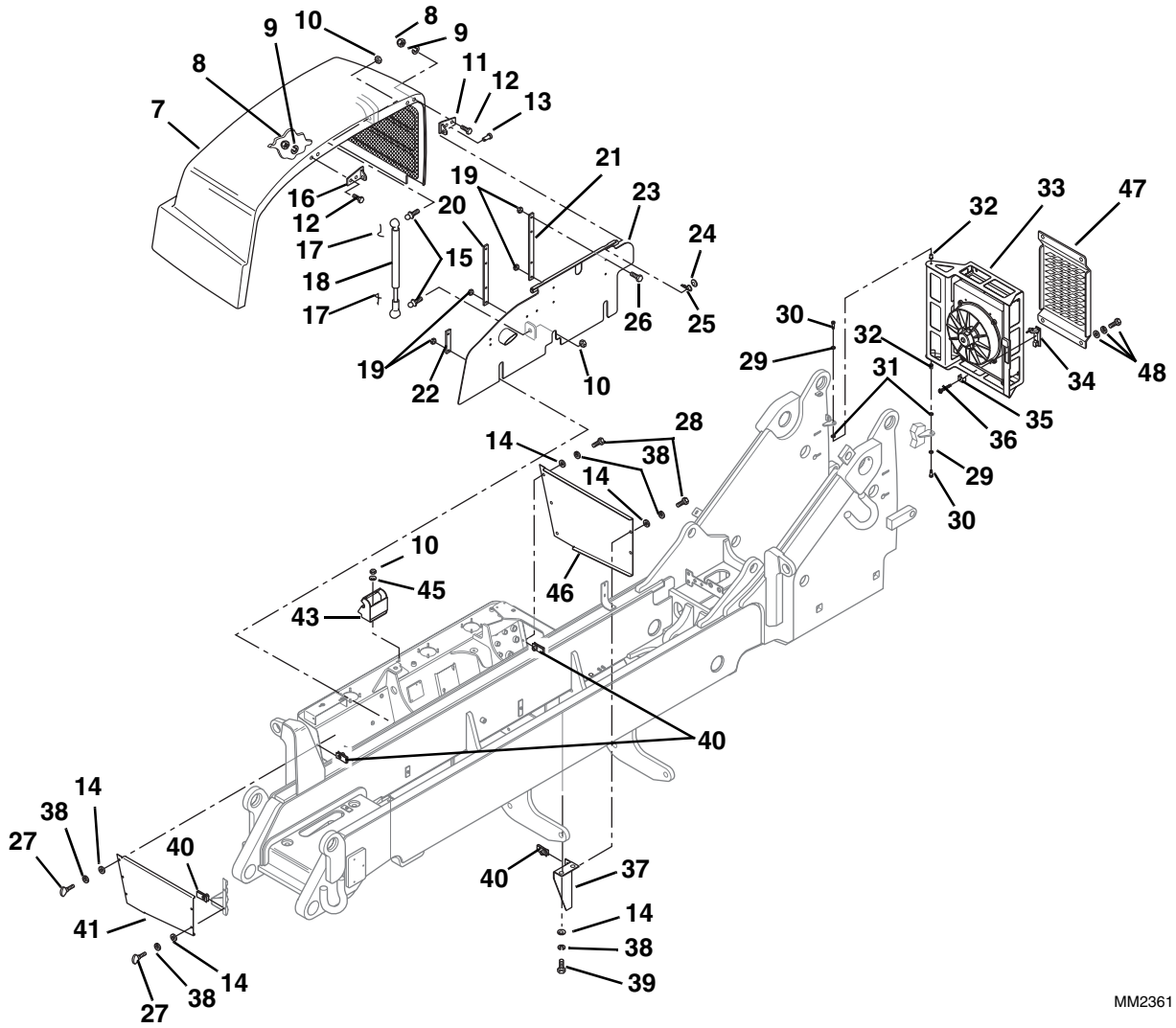
> **WARNING:** Contact with hot engine or other components will cause burns. Allow the engine and components to cool completely before proceeding. Failure to comply will result in personal injury.

1. Park the vehicle on a firm, level surface. Allow sufficient overhead clearance for engine hood installation. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF. Allow the engine and hydraulic fluid to cool.

Note: *If performing this procedure outside where blowing wind is a factor, control hood movement at all times. Wind can cause the hood to move unexpectedly.*

2. With the help of at least one assistant, lift the hood into position, aligning the hinges (**11** and **16**) over their mounts on the engine panel (**23**).
3. Insert the clevis pins (**13**) through the hinges and engine panel mount. Secure with 3/8" narrow flat washers (**24**) and cotter pins (**25**).
4. Support the hood in a suitable manner. Attach the gas spring (**18**). Secure the gas spring with spring clips (**17**). Remove the support.
5. Close the cover slowly and carefully, checking for, and correcting, any obstruction or hinge binding.
6. Connect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.

7. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
8. Replace battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.
9. Close the cover. Pull up on the cover and assure it is securely latched.



7. Engine Cover (1)
8. Elastic Locknut (4)
9. Light Flat Washer (4)
10. Elastic Locknut (6)
11. Rear Hood Hinge (1)
12. Capscrew (4)
13. Clevis Pin (2)
14. Flat Washer (12)
15. Ball Stud (4)
16. Front Hood Hinge (1)
17. Spring Clip (4)
18. Gas Spring (2)
19. Elastic Locknut (10)
20. Flat Stiffener (1)
21. Flat Stiffener (1)
22. Flat Stiffener (1)
23. Engine Panel (1)
24. Flat Narrow Washer (2)
25. Cotter Pin (2)
26. Capscrew (4)
27. Thumbscrew (5)
28. Capscrew (5)
29. Heavy Flat Washer (2)
30. Capscrew (2)
31. Flat Washer (A/R)
32. Bushing (2)
33. A/C Condenser (1)
34. Adjustable Trigger Latch (1)
35. Latch Plate (1)
36. Pan-head Screw (1)
37. Rear Cover Bracket (1)
38. Lockwasher (12)
39. Capscrew (2)
40. Retainer Nut (10)
41. Front Engine Cover (1)
42. Hex Nut (3)
43. Striker Bracket (1)
44. Hex Nut (2)
45. Flat Washer (2)
46. Rear Engine Cover (1)
47. A/C Condenser Guard (1)
48. Mounting Hardware (4)

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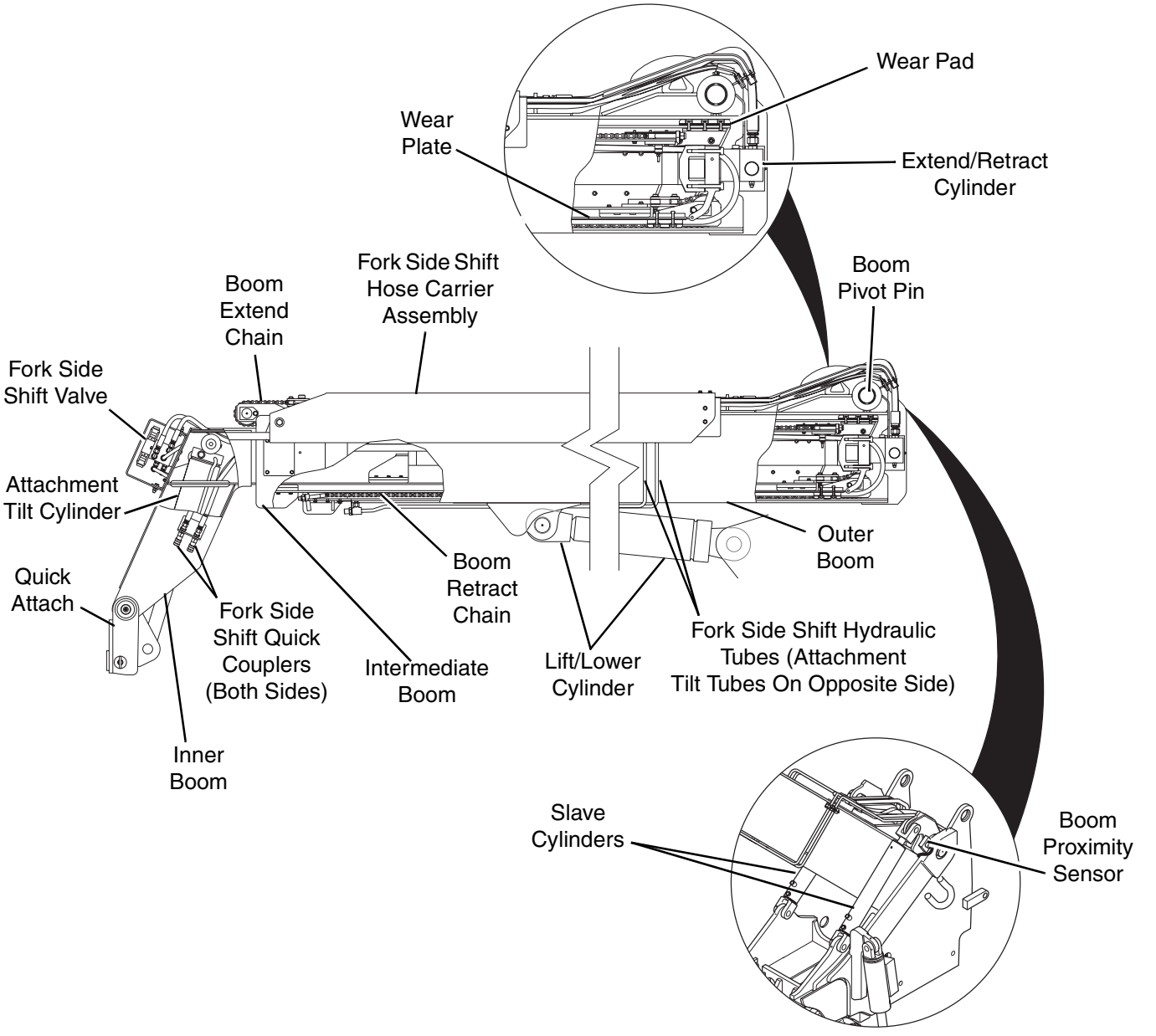
Section 4
Boom

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4.1 BOOM SYSTEM 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 name and location of the major assemblies of the boom system. The following illustration identifies the components that are referred to throughout this section.





WARNING: **DO NOT** service the vehicle without following all safety precautions as outlined in the “Safety Practices” section of this manual. Failure to follow the safety practices may result in death or serious injury.

4.2 BOOM SYSTEM

4.2.1 Boom System Description

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

4.2.2 Boom System Operation

The boom assembly consists of inner, intermediate, and outer booms. Boom extension and retraction is accomplished via hydraulic power and chain movement.

As the extend/retract hydraulic cylinder, which is anchored at the rear of the intermediate boom and the rear of the outer boom begins to extend, it forces the intermediate boom out of the outer boom.

The inner and outer booms are connected by extend and retract chains. These chains are routed around sheaves on the intermediate boom. As the intermediate boom is forced out, the extend chain pulls the inner boom out of the intermediate boom.

As hydraulic pressure is applied to the retract port on the extend/retract cylinder, the intermediate boom is pulled back into the outer boom, and the retract chain pulls the inner boom back into intermediate boom.

This mechanical linkage formed by the chains and supporting hardware, extends and retracts the intermediate and inner booms at the same rate.

The outer boom does not extend or retract, but lifts and lowers via action of the lift/lower cylinder.

4.3 BOOM ASSEMBLY MAINTENANCE

The boom assembly consists of the inner, intermediate, and outer booms and supporting hardware.

IMPORTANT: *Boom replacement must be completed in sequence, one boom section at a time, as described in these instructions. Replacement of two or more boom sections as a unit requires special considerations that are not covered in these instructions.*

The inner, intermediate, and outer boom removal instructions must be completed in sequence. The fork side shift hose carrier assembly needs to be disconnected from the inner boom before the inner boom can be removed. The fork side shift hose carrier assembly and inner boom must be removed before removing the intermediate boom. The fork side shift hose carrier assembly, inner boom and intermediate boom must be removed one at a time before removing the outer boom.

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

After servicing the boom, perform the following:

1. Check wear pads. (Refer to *Section 4.3.7, Boom Wear Pads*.)
2. Check chain wear and tension adjustment. (Refer to *Section 4.3.6, Boom Chains*.)
3. Apply grease at all lubrication points (grease fittings). (Refer to *Section 4.3.8, Boom Lubrication Points*.)
4. Check for proper operation by operating all boom functions through their full range of motion several times.

4.3.1 Fork Side Shift Hose Carrier Assembly Replacement

a. Fork Side Shift Hose Carrier Assembly Removal

1. Remove the carriage from the quick attach assembly. (Refer to *Section 4.4.1, Disconnecting from a Carriage*.)
2. Park the vehicle on a hard, level surface. Move the boom to a horizontal (level) position. Extend (or retract) the boom until the boom is extended approximately two feet (610 mm). Retract the quick attach to the horizontal position. Place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake and shut the engine OFF. Allow the hydraulic oil to cool before proceeding.

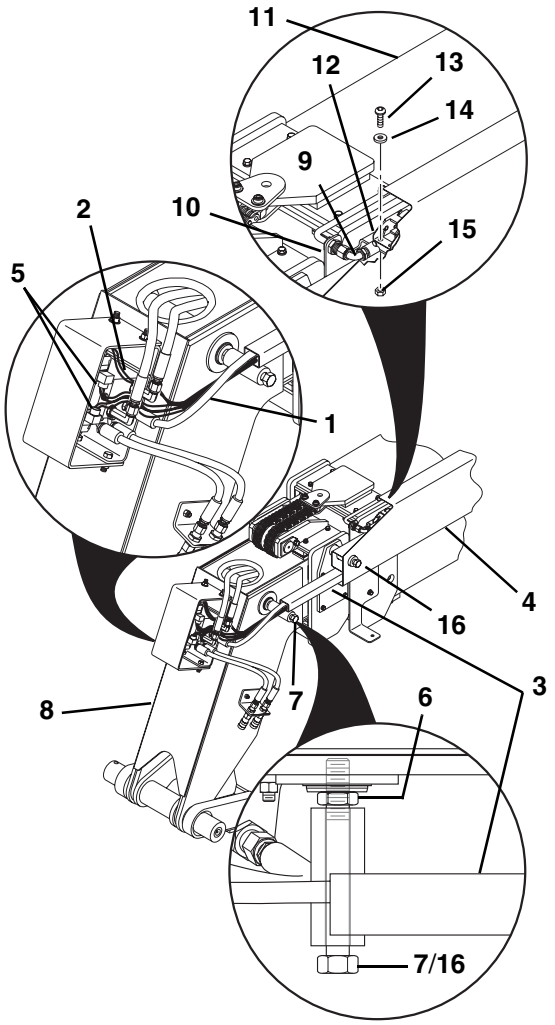
WARNING: Hydraulic fluid leaking under pressure can penetrate the skin, cause infection, gangrene, and death or serious personal injury. If injured, see a doctor immediately.

Relieve all pressure before disconnecting any component, part, line or hose. Slowly loosen parts and allow release of residual pressure before removing any parts or component.

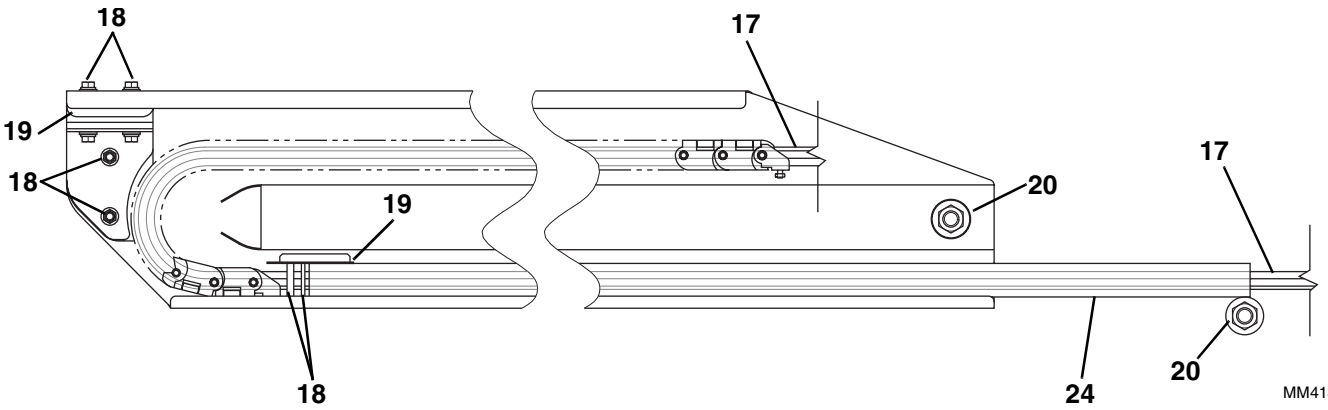
WARNING: Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic oil can cause severe burns.

3. Label and disconnect the hose (**1**) coming from the fork side shift valve (**2**) to the wire/hose support tube (**3**) of fork side shift hose carrier assembly (**4**). Plug the hose end and cap the fitting to prevent dirt and debris from entering the hydraulic system.
4. Label and disconnect the wires (**5**) coming from both sides of the fork side shift valve (**2**) to the wire/hose support tube (**3**) of fork side shift hose carrier assembly (**4**).
5. Loosen jam nut (**6**) and remove the screw (**7**) which secures the end of the wire/hose support tube (**3**) to the inner boom gooseneck (**8**).
6. If the inner boom assembly is the only section of the boom being removed, skip the remaining steps in these removal instructions and proceed to *Section 4.3.2, Inner Boom Replacement* and follow the inner boom removal instructions.

   However, if the intermediate or outer boom sections are to be removed, the entire fork side shift hose carrier assembly must be removed from the boom before proceeding. Follow the remaining steps in this removal procedure before proceeding.
7. Label and disconnect the hose (**9**) coming from the bracket (**10**) on the outer boom (**11**). Plug the hose end and cap the fitting to prevent dirt and debris from entering the hydraulic system.



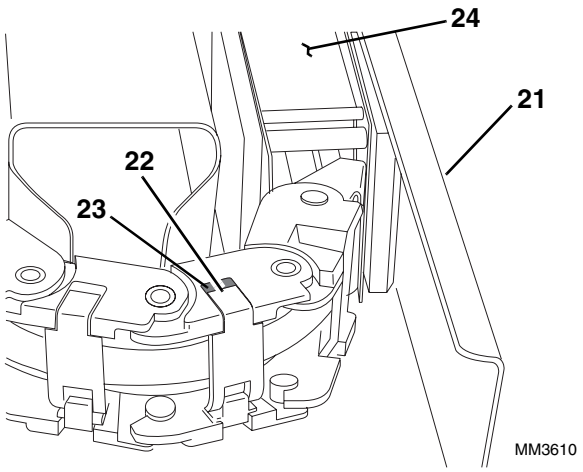
MM3540



8. Disconnect the hose/wire track assembly (**12**) from the bracket (**10**) on the outer boom (**11**). Remove the two button head screws (**13**), washers (**14**) and jam nuts (**15**). Set aside hardware for later re-assembly.
9. Loosen jam nut and remove the screw (**16**) which secures the end of fork side shift hose carrier assembly (**4**) to the intermediate boom.
10. Remove the hose carrier from the boom. Slide the assembly back along the hose track guide until the rear wear pads are clear and then lift the assembly off the outer boom.
11. Carefully lower the fork side shift hose carrier assembly onto suitable supports, or work surface.
12. Inspect hose and wires (**17**), hardware (**18**), wear pads (**19**), mounting points (**20**), and other components visible with the fork side shift hose carrier assembly off the boom. Replace components if damaged.

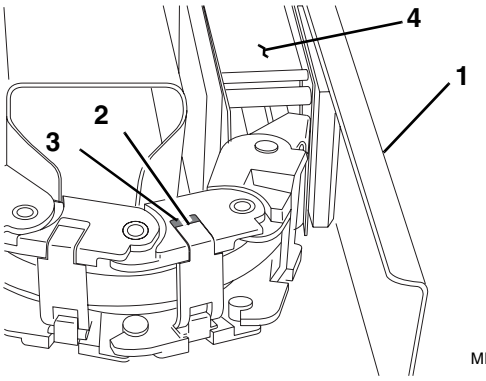
b. Hose and Wire Replacement

1. With track assembly (**21**) laid flat on work surface, open tabs (**22**) securing the wires and hose into the hose/wire track assembly. Insert a flat screwdriver into the space (**23**) provided and flip up all the tabs on the hose/wire track assembly.
2. If replacement of the wires or hose is required, measure amount hanging out of the front of the wire/hose support tube (**3**). Measure and tape the same amount on the new wire or hose to be installed. Also make sure that you have the new wires labeled the same as the old wires for later reassembly to the fork side shift valve.
3. Tie new hose or wire to old hose or wire and pull the old hose or wire out through the rear part of the wire/hose support tube (**24**). Pull the wire or hose until the previously taped mark gets to the front of the tube assembly.
4. Route the hose or wire into the hose/wire track assembly. Snap tabs back into place to secure the wires and hose into the hose/wire track assembly.

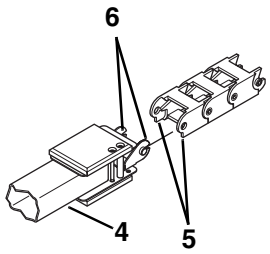


c. Hose/Wire Track Replacement

1. With track assembly (**1**) laid flat on work surface, open tabs (**2**) securing the wires and hose into the hose/wire track assembly. Insert a flat screwdriver into the space (**3**) provided and flip up the tabs on the hose/wire track assembly.

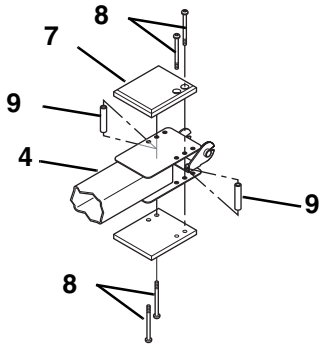


2. Pull the wires and hose out of the track assembly and allow to hang down from the tube assembly (**4**).
3. Use a flat screw driver and pry the tabs (**5**) on the track assembly off the ears (**6**) of the tube assembly (**4**).
4. Open the first tab on the track assembly and install new track assembly by snapping the tabs (**5**) of the track assembly over the ears (**6**) of the tube assembly (**4**).
5. Open the remaining tabs on the track assembly and route the wires and hose into the track assembly.



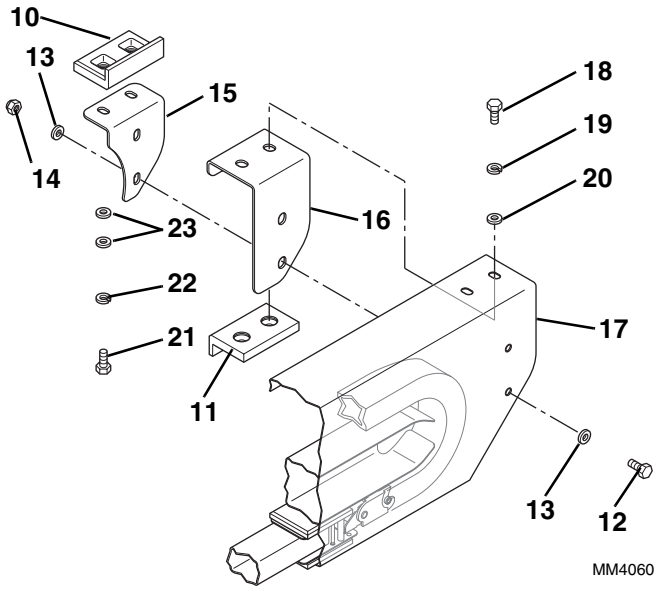
d. Tube Assembly Wear Pad Replacement

1. Inspect tube assembly wear pads (**7**). If replacement is necessary, remove the four button head capscrews (**8**) and two spacers (**9**). Remove wear pads from the tube assembly (**4**).
2. Install new wear pads (**7**) using four #10-32 x 3/4" black button head capscrews (**8**) and two spacers (**9**). Make sure that the spacers are installed in the front holes on each side of the wear pad and the center holes of the tube assembly (**4**).

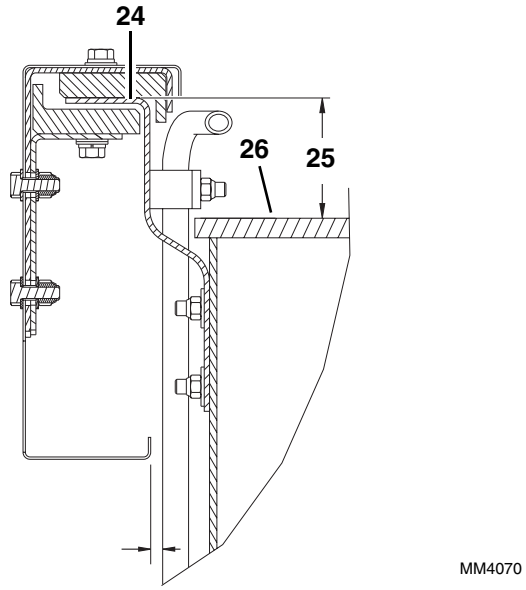


e. Track Housing Assembly Wear Pad Replacement

1. Inspect hose track housing wear pads (**10** and **11**). If replacement is necessary, remove the two capscrews (**12**), four flat washers (**13**) and two elastic locknuts (**14**) securing the housing retainer (**15**) and the housing support bracket (**16**) to the side of the hose track housing (**17**).



2. Remove the two capscrews (**18**), lockwashers (**19**) and flat washers (**20**) securing the housing support bracket (**16**) and wear pad (**11**) to the top of the hose track housing (**17**).
3. Remove the two capscrews (**21**), lockwashers (**22**) and four flat washers (**23**) securing the wear pad (**10**) to the housing retainer (**15**).
4. Install new wear pad (**10**) to the housing retainer (**15**) using two 3/8-16 x 3/4" capscrews (**21**), 3/8" lockwashers (**22**) and four 3/8" flat washers (**23**). DO NOT tighten the hardware fully at this time.
5. Install a new wear pad (**11**) and the housing support bracket (**16**) to the top of hose track housing (**17**) using two 3/8-16 x 3/4" capscrews (**21**), 3/8" lockwashers (**22**) and 3/8" flat washers (**23**). DO NOT tighten the hardware fully at this time.

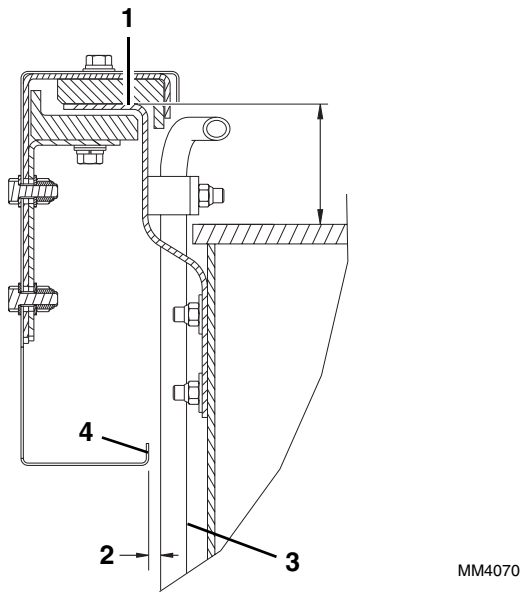


Note: ALWAYS *replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

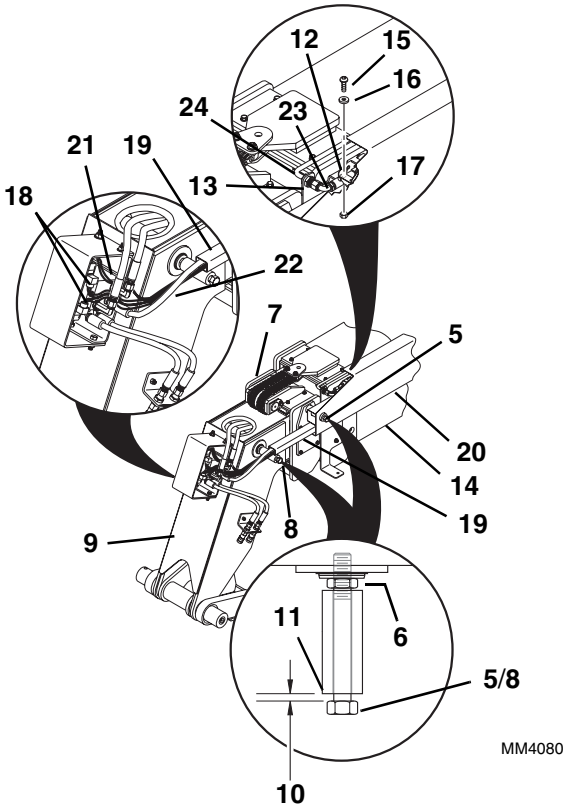
6. Install the housing retainer (**15**) with the wear pad (**10**) to the side of the hose track housing (**17**). Use the two 3/8-16 x 1" capscrews (**12**), four 3/8" flat washers (**13**) and two new 3/8-16 elastic locknuts (**14**). DO NOT tighten the hardware fully at this time.
7. Make sure that the top surface of the hose track guide (**24**), mounted on the side of the outer boom, is 3.07" (**25**) above the top surface (**26**) of the outer boom.

a. Fork Side Shift Hose Carrier Assembly Installation

1. Carefully lift the entire fork side shift hose carrier assembly and place onto the surface of the hose track guide (**1**). Slide the assembly forward so that the hose track guide slides between the two wear pads.



2. Install 3/4-10 x 5-1/2" capscrew (**5**) and 3/4-10 jam nut (**6**) to the intermediate boom (**7**) and the 3/4-10 x 6-1/2" capscrew (**8**) and 3/4-10 jam nut (**6**) to the inner boom gooseneck (**9**). Adjust the jam nuts so that there is 3/8" gap (**10**) between the head of the capscrews (**5** or **8**) and the hose carrier boss (**11**).
3. Connect the hose/wire track assembly (**12**) to the bracket (**13**) on the outer boom (**14**). Use two 1/4-20 x 1/2" black button head capscrews (**15**), 1/4" flat washers (**16**) and 1/4-20 jam nuts (**17**).
4. Connect the wires (**18**) coming from the wire/hose support tube (**19**) of fork side shift hose carrier assembly (**20**) to both sides of the fork side shift valve (**21**).
5. Connect the hose (**22**) coming from the wire/hose support tube (**19**) of fork side shift hose carrier assembly (**20**) to the straight fitting in the “S” port on the fork side shift valve (**21**).
6. Connect the hose (**23**) coming from the top of the fork side shift hose carrier assembly (**20**) to the tube assembly (**24**) mounted to the bracket (**13**) on the outer boom (**14**).
7. Adjust the wear pads with the housing retainer and the housing support bracket so that there is 9/32" (7 mm) (**2**) clearance between the two fork side shift tube assemblies (**3**) on the side of the boom and the bottom lip (**4**) of the fork side shift hose carrier assembly.



4.3.2 Inner Boom Replacement

WARNING: Wear protective footwear with reinforced toe caps and slip-resistant soles. Failure to comply can result in foot or other bodily injury from slipping or falling.

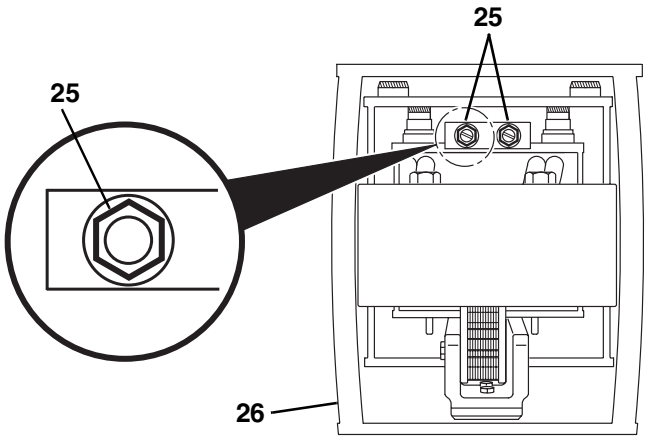
WARNING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist. Failure to comply can result in death or serious personal injury.

a. Inner Boom Removal

1. Remove the carriage from the quick attach assembly. (Refer to *Section 4.4.1, Disconnecting from a Carriage*.)

Note: *This procedure will require a clear space of approximately 16 feet at the front and rear of the vehicle.*

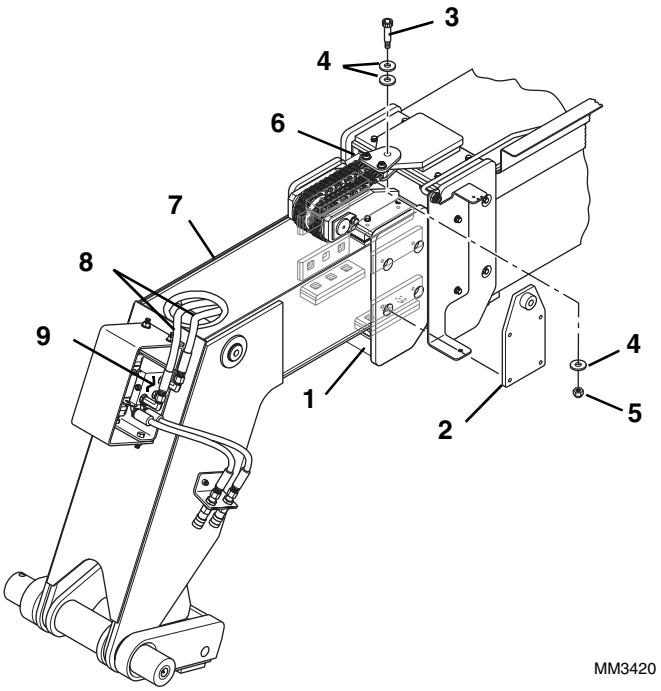
2. Park the vehicle on a hard, level surface. Move the boom to a horizontal (level) position. Extend (or retract) the boom until the boom is extended approximately two feet (610 mm). Retract the quick attach to the horizontal position. Place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake and shut the engine OFF. Allow the hydraulic oil to cool before proceeding.
3. Open the rear cover.
4. Loosen the extend chains, by loosening the two locknuts (**25**), located at the rear of the outer boom (**26**). The locknuts must remain fully engaged with the threads of the extend chain clevis'.



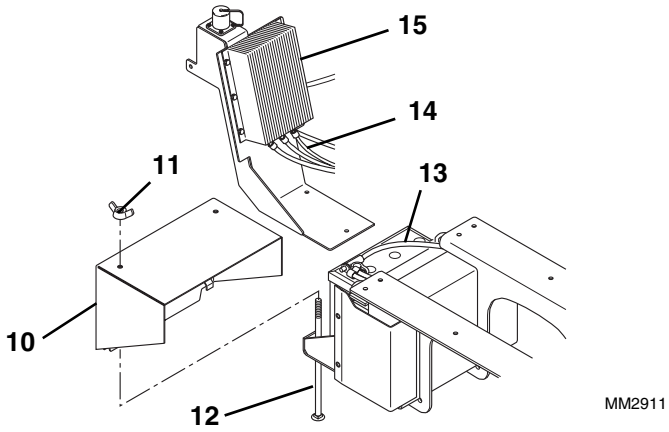
OT0501

5. Remove or disconnect the fork side shift hose carrier assembly. (Refer to *Section 4.3.1, Fork Side Shift Hose Carrier Assembly Replacement*.)

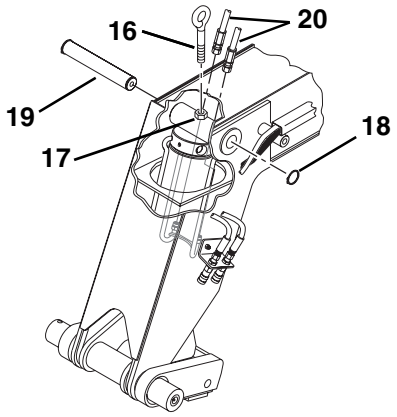
6. Remove the top and side wear pads and spacers attached to the front of the intermediate boom (**1**). Tape and mark each pad, spacer and fasteners for return to its original position upon reinstallation. The housing support bracket (**2**) will come off when the left side wear pads are removed.



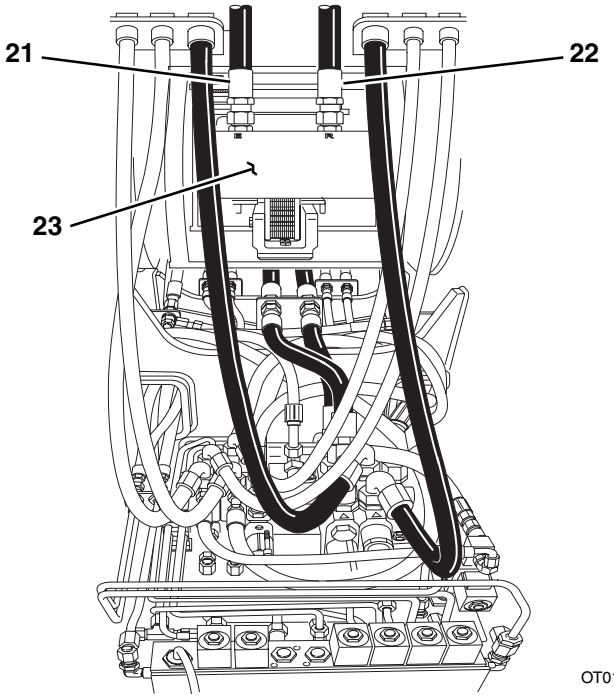
7. Return to the cab, fasten your seat belt and start the engine. Retract the boom slightly until slack is noticed in the extend chain. Shut the engine OFF.
8. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
9. Open the engine compartment cover. Allow the engine, transmission and hydraulic fluid to cool before proceeding.
10. Remove engine side battery box cover (**10**). Remove wing nuts (**11**) and carriage bolts (**12**) and set cover and mounting hardware aside for later re-assembly.
11. Disconnect the negative (-) battery cable (**13**) at the negative (-) terminal on the battery in the engine side battery box.
12. Disconnect the negative (-) cable (**14**) at the bottom of the battery equalizer (**15**).



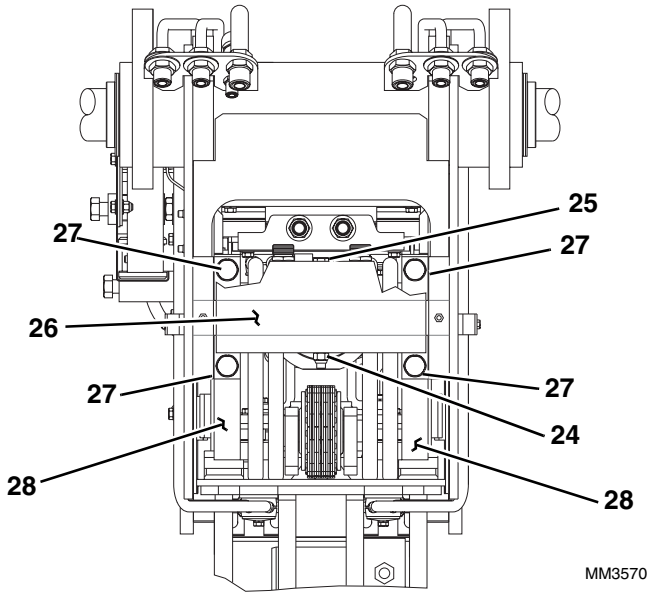
13. Remove one socket-head shoulder screw (**3**), three shim washers (**4**) and one elastic locknut (**5**) to disconnect the extend chain yoke (**6**) from the outer boom. Lay the chain assembly flat against the inner boom (**7**).
14. Label, disconnect and plug the fork side shift valve hoses (**8**) coming from the fork side shift valve (**9**) to the hole in the top of the inner boom.
15. Install a lifting eye (**16**) to the hex nut on the attachment tilt cylinder (**17**). Attach suitable overhead lifting device and sling to the lifting eye.
16. Remove the retaining ring (**18**) from the upper attachment pin (**19**), and remove the pin.
17. Carefully lower the cylinder until you can access the hose ends on the lower part of the cylinder. Label, disconnect and plug the hoses (**20**). Once the hoses are disconnected carefully lift the cylinder and reinstall the upper attachment pin (**19**) and retaining ring (**18**).
18. Tie at least 40' (12,2 m) of wire or string onto each of the four hoses (**8** & **20**) that run down the inside of the inner boom. This wire will be used to re-route the hoses during re-assembly.



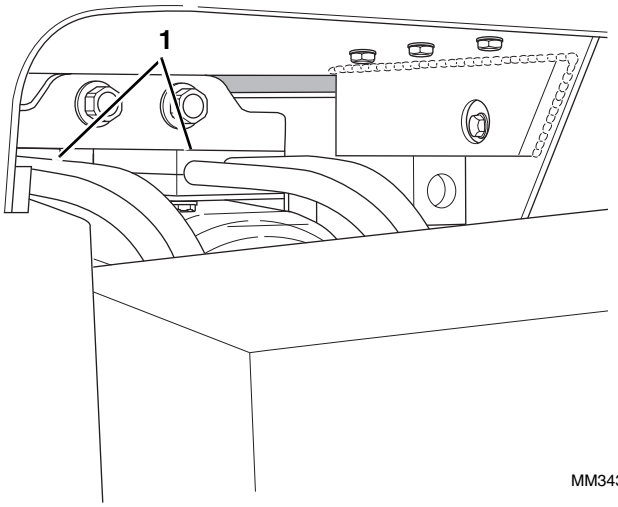
19. Label, disconnect and plug the extend (**21**) and retract (**22**) hoses and the extend/retract cylinder (**23**). Cap the fittings on the extend/retract cylinder.



20. Remove one elastic locknut (**24**) and one capscrew (**25**).
21. Remove the trunnion pin (**26**) from the base of the extend/retract cylinder.
22. Use a socket wrench and long extension to remove the four capscrews (**27**) (two-upper and two-lower) and four lockwashers securing the cylinder trunnion clamps (**28**) to the intermediate boom.

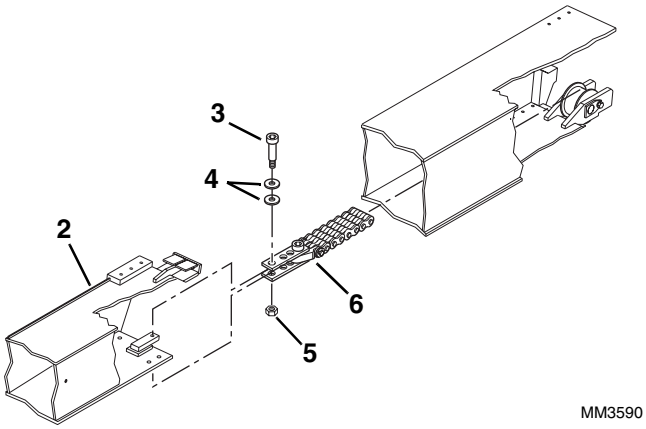


23. Remove the attachment tilt and fork side shift hydraulic hose clamps (**1**), located at the rear of the inner boom section. Save mounting hardware for later reassembly. Pull the hoses toward the rear of the vehicle, to gain clearance when removing the extend/retract cylinder.



24. Use a suitable overhead lifting device and sling, attached to the extend/retract cylinder, push all hoses aside and carefully withdraw the cylinder from the inner boom. Readjust the position of the sling as needed to help balance the cylinder during withdrawal. When the cylinder is clear of the vehicle, carefully lower it to the ground.

25. At the rear of the inner boom (**2**), remove one socket head shoulder bolt (**3**), two washers (**4**), and one elastic locknut (**5**) securing the retract chain (**6**) to the anchor link. Disconnect the retract chain.



26. From the rear of the boom, pull the attachment tilt and fork side shift hydraulic hoses through the boom. Lay the hoses, still attached to the wire, out behind the boom assembly.
27. Use a suitable overhead lifting device and sling attached to the inner boom; remove slack from the hoist sling, and withdraw the inner boom approximately two feet (610 mm).
28. Remove the lower wear pads and spacers attached to the front of the intermediate boom. Tape and mark each pad, spacer and fastener for return to its original position upon reinstallation.

29. Reposition the sling at the approximate center of the inner boom, and then continue withdrawing the boom until it clears the vehicle.
30. Carefully lower the inner boom onto suitable supports, or to the ground.

> **WARNING:** **NEVER** weld or drill the boom or frame. Failure to comply can result in death or serious personal injury.

31. Inspect the boom and welds. Contact the **JLG** Service Department or the local **JLG** Authorized Service Center (ASC) if structural damage is detected.
32. Inspect hoses, hardware, wear pads, mounting points, chains and other components visible with the inner boom removed. Replace if damaged.

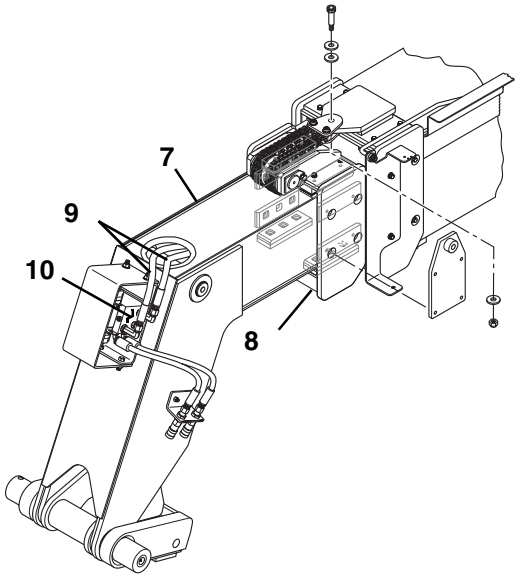
b. Inner Boom Installation

> **WARNING:** Wear protective footwear with reinforced toe caps and slip-resistant soles. Failure to comply can result in foot or other bodily injury from slipping or falling.

> **WARNING:** **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist. Failure to comply can result in death or serious personal injury.

IMPORTANT: *Light lubrication of the boom wear surfaces with a rust inhibitor/lubricant such as LPS 3 or equivalent is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended in salt air climates, and when the vehicle is stored, to help prevent rusting.*

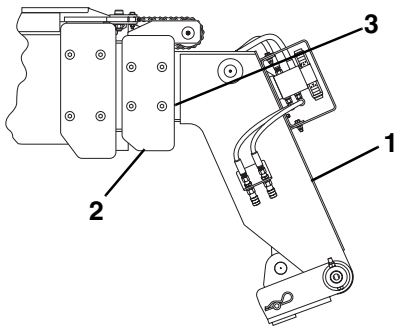
1. Place the extend chains and clevis, as an assembly, onto the top of the inner boom and allow the chains and clevis to overhang the gooseneck. **DO NOT** allow the chain to twist or kink.
2. Use a suitable overhead lifting device and sling attached to the inner boom (**7**). Remove slack from the hoist or sling. Raise the inner boom and begin inserting it into the intermediate boom (**8**) at the front of the vehicle.
3. Readjust the position of the sling as needed to help balance the boom during installation. Insert the inner boom into the intermediate boom until the gooseneck is approximately two feet (610 mm) from the intermediate boom. Make sure to pull the wires attached to the attachment tilt and fork side shift hoses.
4. Install lower wear pads and spacers at the front of the intermediate boom. Coat the wear pad capscrews with Loctite® 242 (blue). **DO NOT** allow Loctite® to come into contact with wear pads.



MM3420

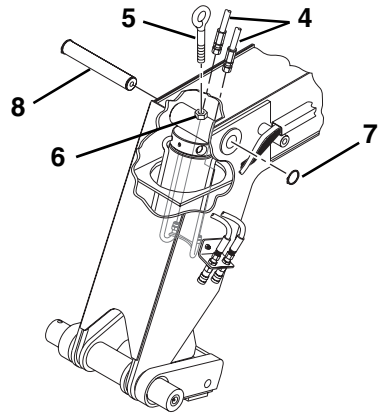
5. Slide the inner boom (**1**) into the intermediate boom (**2**) until the rear of the gooseneck weldment (**3**) on the inner boom contacts the front of the intermediate boom. Remove the sling and hoist.

Note: *If new hoses have been installed, or if excessive twisting in the hoses is noted, the hoses will have to be "indexed" (refer to Section 4.3.3, Attachment Tilt and Fork Side Shift Hydraulics Hose Indexing Procedure).*



MM3440

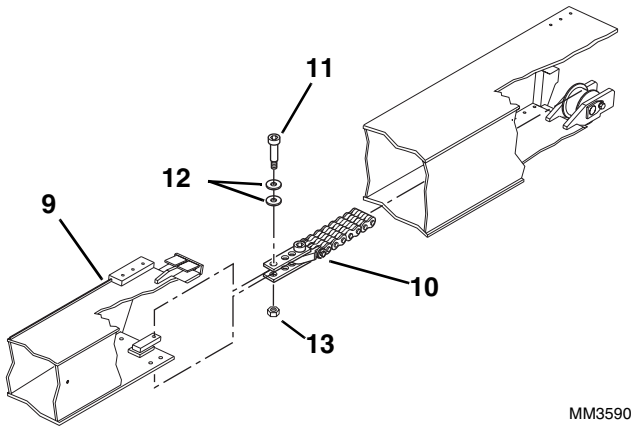
6. At the front of the inner boom (**7**), pull the wires, attached to the fork side shift hoses (**9**), until the hoses are properly routed into the channel on the left side of the inner boom.
7. Connect the fork side shift hoses (**9**) to the fittings on the left side of the fork side shift valve (**10**).
8. Pull the wires, attached to the attachment tilt hoses (**4**), until the hoses are properly routed into the channel on the right side of the inner boom.
9. Install a lifting eye (**5**) to the hex nut (**6**) on the attachment tilt cylinder. Attach suitable overhead lifting device and sling to the lifting eye.
10. Remove the retaining ring (**7**) from the upper attachment pin (**8**), and remove the pin.
11. Carefully lower the cylinder until you can access the fittings on the lower part of the cylinder. Connect the hoses (**4**) to the fittings on the cylinder. Once the hoses are connected, carefully lift the cylinder, coat the upper attachment cylinder mount pin (**8**) with anti-seize compound and reinstall the pin and retaining ring (**7**).



MM3580

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

12. At the rear of the inner boom (**9**), attach the retract chain (**10**) to the hole in the anchor using one .50 x 1.75 x 3/8-16 hex socket head shoulder bolt (**11**), two 1/2" SAE narrow plain washers (**12**), and a new 3/8-16 elastic locknut (**13**).



MM3590

13. Use a suitable overhead lifting device and sling attached to the extend/retract cylinder to carefully raise and position the cylinder near the rear of the inner boom.

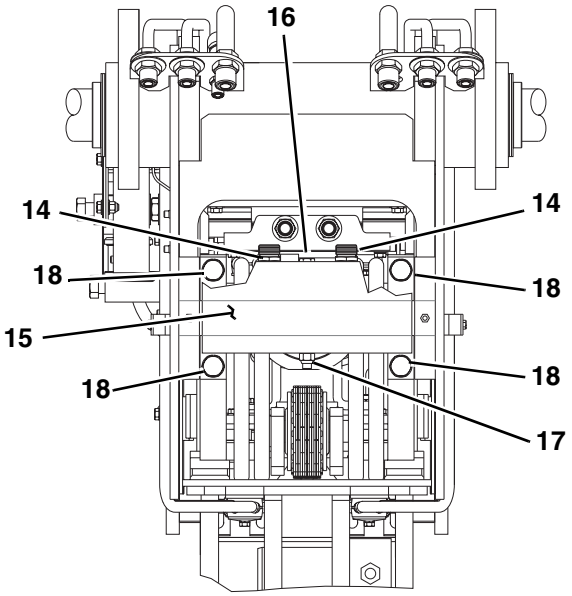
Note: *Install the extend/retract cylinder into the boom with the hose connections (**14**) toward the top of the boom.*

14. Push the hoses aside and carefully insert the extend/retract cylinder into the inner boom.

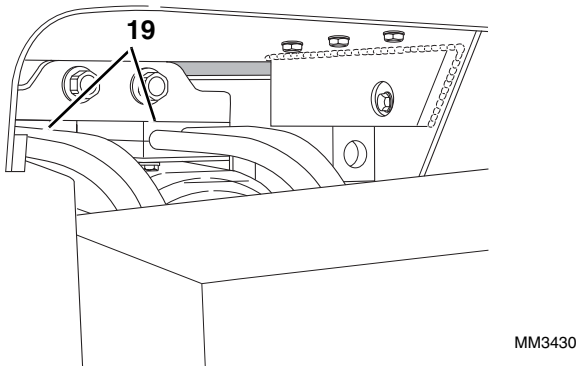
15. Readjust the sling as needed to help balance the cylinder in the sling during installation. When the cylinder is properly inserted within the inner boom, carefully lower the cylinder and remove the sling and hoist.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

16. Install the trunnion pin (**15**), one 1/2-13 x 6.00" capscrew (**16**), and a new 1/2-13 elastic locknut (**17**).
17. Position one of the two extend cylinder trunnion clamps against its mounting boss within the intermediate boom. Use a long extension and socket wrench to install two 3/4-10 x 4-1/2" capscrews (**18**) and 3/4" lockwashers to secure the extend cylinder trunnion clamps to the intermediate boom. Install the other trunnion clamp.

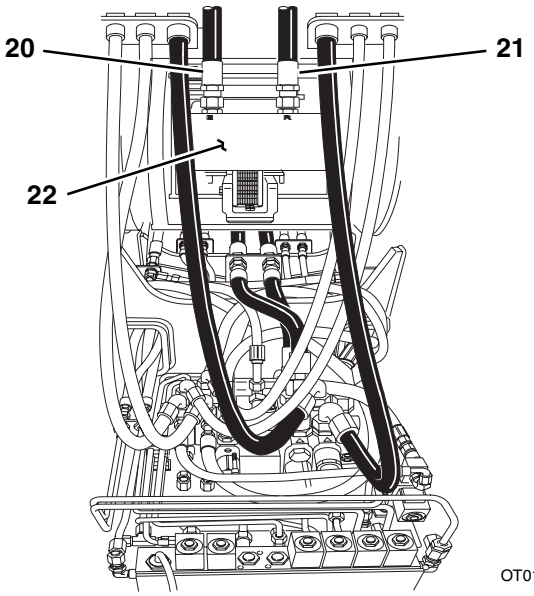


18. Working from the rear of the boom, pull the attachment tilt and fork side shift hydraulic hoses back until there is approximately a 2" (51 mm) gap between the extend/retract cylinder trunnion and the hoses.
19. Reinstall the attachment tilt and fork side shift hose clamps (**19**) at the rear of the intermediate boom.



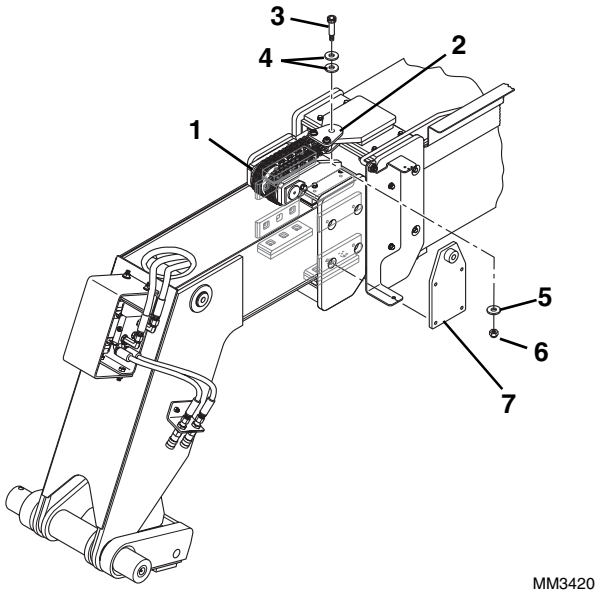
Note: *ALWAYS use new o-rings when servicing the vehicle.*

20. Install new o-rings into the fittings. Lubricate o-rings with clean hydraulic oil.
21. Remove the plugs and caps from the hoses and fittings and connect the extend (**20**) and retract (**21**) hoses to the extend/retract cylinder (**22**).



Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

22. If needed, pull the boom out slightly to align the extend chain yoke with the bracket. Route the extend chain yoke and chains around the sheave (**1**) on the intermediate boom, and connect the yoke (**2**) to the bracket on the outer boom. Secure the yoke to the bracket with one 1.00 x 1.75 x 3/4-10 socket head screw (**3**), two 1.00 x .50 x 1.50" shim washers (**4**), one 1.00 x .045 x 1.50" shim washer (**5**) and a new 3/4-10 elastic locknut (**6**).



MM3420

23. Install the top and side wear pads and spacers to the front of the intermediate boom. Coat the intermediate boom wear pad capscrews with Loctite® 242 (blue). **DO NOT** allow Loctite® to come into contact with wear pads. Make sure that the housing support bracket (**7**) gets installed with the wear pads and spacers on the left side of the intermediate boom.

24. Measure all wear-pad gaps (refer to *Section 4.3.7, Boom Wear Pads* for wear pad gap dimensions and wear pad thickness requirements). Add or remove shims as required. Replace the wear pads with new parts, if needed.

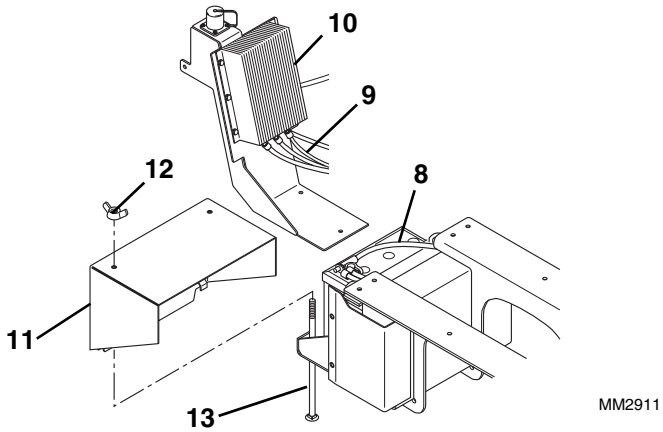
25. Check and adjust the boom chain. (Refer to *Section 4.3.6, Boom Chains* for measurement and adjustment procedures.)

26. Clean up all debris, hydraulic fluid, etc., in, on, near and around the vehicle.

27. Connect the negative (-) battery cable (**8**) at the negative (-) terminal on the battery in the engine side battery box.

28. Connect the negative (-) battery equalizer cable (**9**) at the bottom of the battery equalizer (**10**). Torque the nut to a maximum of 100 lbs/in (11 Nm).

29. Replace battery box cover (**11**). Use the wing nuts (**12**) and carriage bolts (**13**) to secure the cover in place.



MM2911

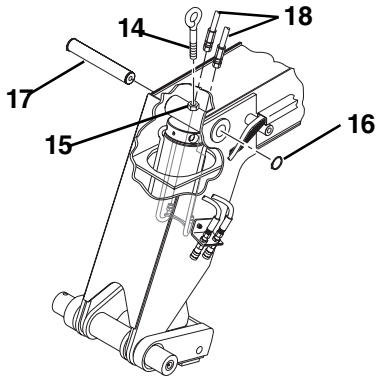
> **WARNING:** Avoid prolonged engine operation in closed areas without adequate ventilation. Ffailure to properly ventilate exhaust fumes can result in death or serious personal injury.

> **WARNING:** Hydraulic fluid leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

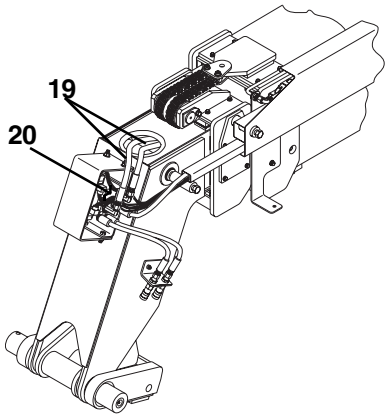
30. Start the engine and operate all boom functions several times. Check the chain tension again and adjust as necessary (refer to *Section 4.3.6, Boom Chains*). Check for leaks, and check the hydraulic fluid level in the tank; add fluid if required.
31. Apply grease to all lubrication points (grease fittings). (Refer to *Section 4.3.8, Boom Lubrication Points*.)

4.3.3 Attachment Tilt and Fork Side Shift Hydraulics Hose Indexing Procedure

1. Install a lifting eye (**14**) to the hex nut (**15**) on the attachment tilt cylinder. Attach suitable overhead lifting device and sling to the lifting eye.
2. Remove the retaining ring (**16**) from the upper attachment pin (**17**), and remove the pin.
3. Lower the attachment tilt cylinder (**15**) to gain access to the hose connections. Loosen the attachment tilt hose (**18**) connections at the cylinder.
4. Raise the cylinder back into position and temporarily install the upper attachment pin (**17**).
5. Loosen the fork side shift hoses (**19**) at the fittings on the fork side shift valve (**20**).
6. Remove twists from the attachment tilt (**18**) and fork side shift hoses and tighten the fork side shift hoses (**19**) at the fittings on the fork side shift valve (**20**).
7. Remove the attachment pin (**17**) from the top of the attachment tilt cylinder (**15**), and lower the cylinder to gain access to the attachment tilt hose (**18**) connections. Tighten the fittings.
8. Raise the attachment tilt cylinder into position. Coat the upper attachment cylinder mount pin (**17**) with anti-seize compound. Install the pin and retaining ring (**16**).



MM3580



MM4090

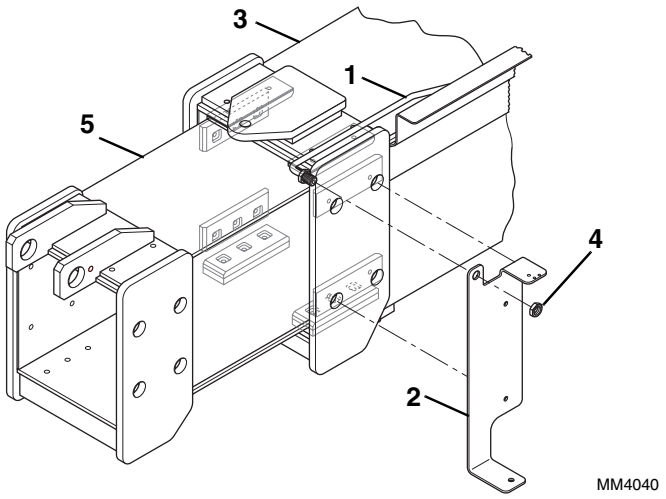
4.3.4 Intermediate Boom Replacement

WARNING: Wear protective footwear with reinforced toe caps and slip-resistant soles. Failure to comply can result in foot or other bodily injury from slipping or falling.

WARNING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist. Failure to comply can result in death or serious personal injury.

a. Intermediate Boom Removal

1. Remove the fork side shift hose carrier assembly. (Refer to *Section 4.3.1, Fork Side Shift Hose Carrier Assembly Replacement*.)
2. Remove the inner boom as described in *Section 4.3.2, Inner Boom Replacement*.
3. Disconnect the tube (**1**) attached to the hose track bracket (**2**) on the left side of the outer boom (**3**) by removing the bulkhead nut (**4**). Re-thread the nut back on the tube to be used for reassembly later.
4. Remove the top and side wear pads and spacers attached to the front of the outer boom. Tape and mark each pad, spacer and fasteners for return to its original position for reinstallation. The hose track bracket (**2**) will come off with the front mounting hardware on the left side wear pads.
5. Working from the front of the vehicle, use a suitable overhead lifting device and sling attached to the intermediate boom (**5**); remove slack from the hoist sling, and withdraw the intermediate boom approximately two feet (610 mm).
6. Remove the lower wear pads and spacers attached to the front of the outer boom. Tape and mark each pad, spacer and fastener for return to its original position upon reinstallation.



7. Reposition the sling at the approximate center of the intermediate boom, and then continue withdrawing the boom until it clears the vehicle. Carefully lower the intermediate boom onto suitable supports or to the ground.

WARNING: **NEVER** weld or drill the boom or frame. Failure to comply can result in death or severe personal injury.

8. Inspect the boom and welds. Contact the **JLG** Service Department or the local **JLG** Authorized Service Center (ASC) if structural damage is detected.
9. Inspect hoses, hardware, wear pads, mounting points, chains and other components visible with the intermediate boom removed. Replace if damaged.

b. Intermediate Boom Installation

WARNING: Wear protective footwear with reinforced toe caps and slip-resistant soles. Failure to comply can result in foot or other bodily injury from slipping or falling.

WARNING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist. Failure to comply can result in death or serious personal injury.

IMPORTANT: *Light lubrication of the boom wear surfaces with a rust inhibitor/lubricant such as LPS 3 or equivalent is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended in salt air climates, and when the vehicle is stored, to help prevent rusting.*

1. If the retract chain sheave and its attaching hardware at the rear of the intermediate boom are not installed, install these items before proceeding.
2. If needed, install the wear pads on the rear of the intermediate boom before inserting the intermediate boom into the outer boom. (Refer to *Section 4.3.7, Boom Wear Pads*.) Coat the boom wear pad capscrews with Loctite® 242 (blue). **DO NOT** allow Loctite® to come into contact with wear pads. Use the bolts and washers to secure the wear pads and shims to the boom.
3. Use a suitable overhead lifting device and sling attached to the intermediate boom (**5**); remove slack from the hoist sling. Working from the front of the vehicle, raise the intermediate boom and insert it into the outer boom (**3**) a few feet (decimeters) at a time, then reposition the sling. Continue inserting the intermediate boom until it extends approximately two feet (610 mm) from the outer boom.
4. Install the top, side and lower wear pads and spacers on the outer boom. Coat the wear pad capscrews with Loctite® 242 (blue). **DO NOT** allow Loctite® to come into contact with wear pads.
5. Make sure that the hose track bracket (**2**) gets installed with the front bolts for the left side wear pads. Secure the fork side shift tube (**1**) with the bulkhead nut (**4**).
6. Continue installing the intermediate boom until it makes contact with the outer boom. Remove the overhead lifting device and sling.
7. Install the inner boom, extend/retract cylinder and extend chain and attaching hardware. (Refer to *Section 4.3.2, b. Inner Boom Installation*.)
8. Clean up all debris, hydraulic fluid, etc., in, on, near and around the vehicle.

WARNING: Avoid prolonged engine operation in closed areas without adequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious personal injury.

9. Start the engine and operate all boom functions several times. Check the chain tension again and adjust as necessary (refer to *Section 4.3.6, a. Boom Chain Tension Check* and *Section 4.3.6, b. Extend Chain Adjustment*). Check for leaks, and check the hydraulic fluid level in the tank; add fluid if required.
10. Apply grease at all lubrication points (grease fittings). (Refer to *Section 4.3.8, Boom Lubrication Points*.)

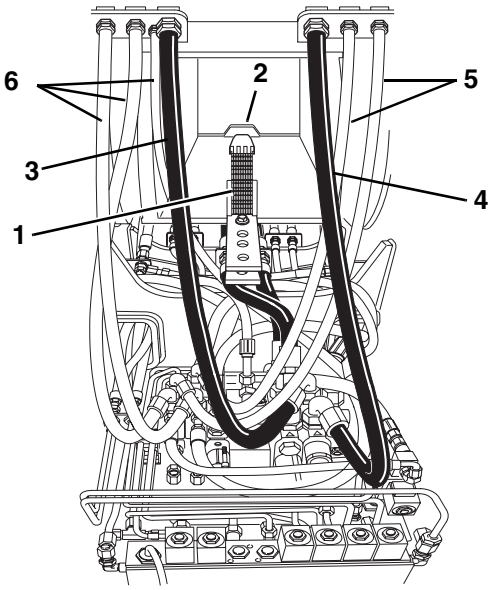
4.3.5 Outer Boom Replacement

WARNING: Wear protective footwear with reinforced toe caps and slip-resistant soles. Failure to comply can result in foot or other bodily injury from slipping or falling.

WARNING: **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist. Failure to comply can result in death or serious personal injury.

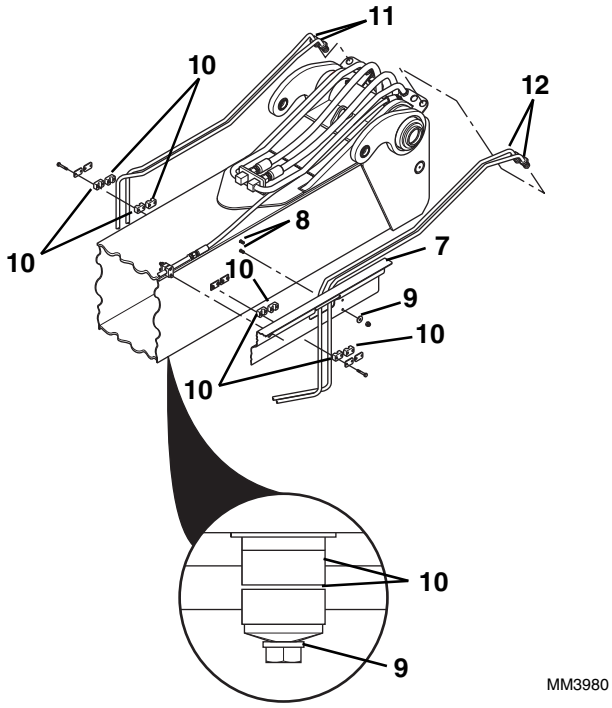
c. Outer Boom Removal

1. Remove both the inner boom and intermediate boom as described in *Section 4.3.2, a. Inner Boom Removal* and *Section 4.3.4, a. Intermediate Boom Removal*.
2. If the boom section is to be replaced, remove the retract chain (**1**), by removing the locknut (**2**) at front of the outer boom.



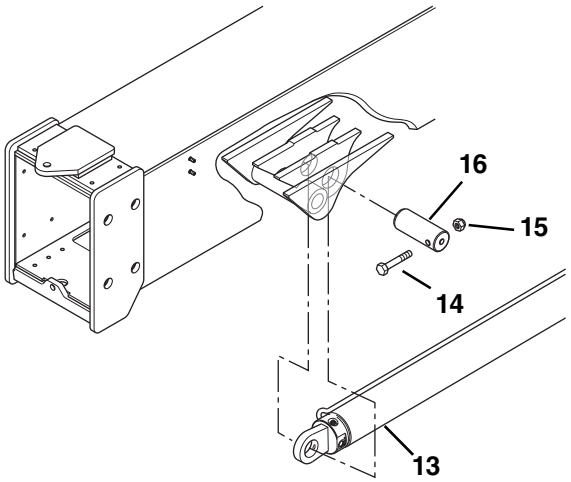
MM3990

3. Label, disconnect and plug the extend (**3**), retract (**4**), attachment tilt (**5**), and fork side shift (**6**) hoses. Cap the fittings on the boom tubes.
4. Remove all clamps (**10**) securing the attachment tilt (**11**) and fork side shift tube assemblies (**12**) to the outer boom and frame. (The clamps (**10**) shown in the bubble are on the underside of the boom in two places.) Save the mounting hardware. Label and remove the tube assemblies.
5. Remove the hose track guide (**7**) from the studs (**8**) on the side of the outer boom. Save flat washers (**9**).
6. Use a suitable overhead lifting device and sling attached to the outer boom; raise and support the outer boom at a slight angle. Allow room to remove the lift/lower cylinder attaching hardware.



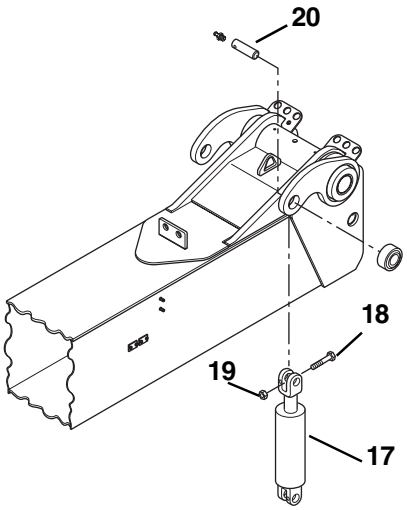
MM3980

7. Place blocks or supports beneath the outer boom and lower the boom onto the blocks or supports. Remove the sling from around the boom.
8. Use a suitable overhead lifting device and sling attached to the lift/lower cylinder (**13**); remove slack from the sling.
9. Remove capscrew (**14**) and elastic locknut (**15**) securing the lift/lower cylinder pin (**16**) at the outer boom lift/lower cylinder mount boss on the underside of the outer boom.
10. Carefully extract the lift/lower cylinder pin (**16**).



MM4000

11. Lower the lift/lower cylinder into the chassis cavity, onto a suitable support placed at the front of the cylinder.
12. Working from the top of each slave cylinder (**17**), remove capscrew (**18**) and elastic locknut (**19**) at the cylinder mount pin (**20**).

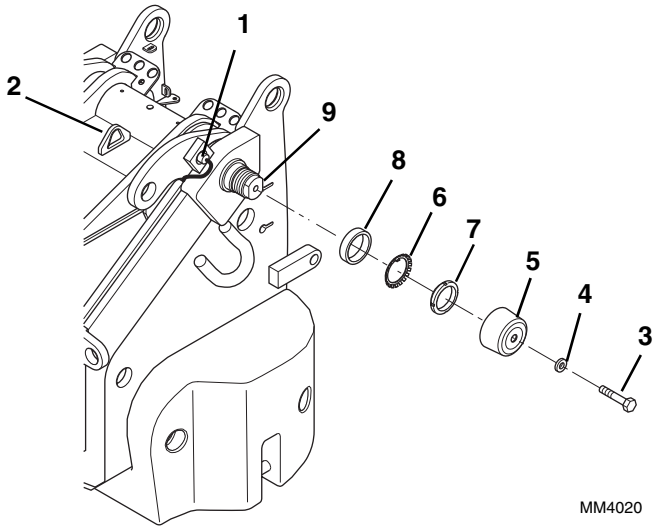


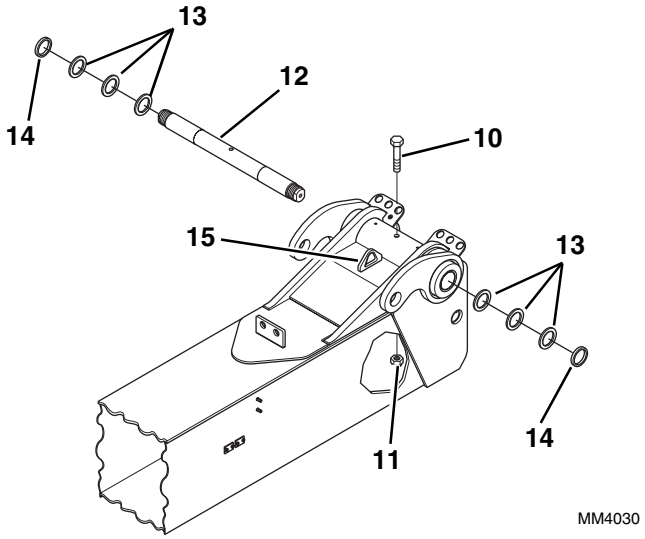
MM4010

13. Remove the slave cylinder mount pin (**20**) through the circular opening in the chassis weldment. A long bolt of the same thread size as the tapped hole in the cross pin may be threaded into the cross pin to aid in removal. Carefully rest each slave cylinder down onto the chassis. **DO NOT** stretch or damage the slave cylinder hydraulic hoses or tubes.

14. Remove the boom proximity sensor (**1**) from the tab at the top of the frame.
15. Use a suitable overhead lifting device and sling attached to the loop (**2**) on top of the outer boom. Attach another sling around the outer boom near the center point and secure it to the hoist. Remove slack from the slings.
16. Remove capscrew (**3**), plain washer (**4**) and cover (**5**) from each side of the pivot pin.
17. Bend the tabs on the external tooth lockwasher (**6**) out of the slots in the bearing nut (**7**), and remove the bearing nut (**7**), external tooth lockwasher (**6**) and spacer (**8**) from each side of the pivot pin (**9**).
18. Remove capscrew (**10**) and elastic locknut (**11**) securing the boom pivot pin (**12**) to the outer boom.
19. Remove the boom pivot pin (**12**), shims (**13**) and spacer rings (**14**).

Note: *Record the number, thickness, and position of shims (**13**) to ensure correct installation.*





20. Withdraw the outer boom from the vehicle. Carefully lower the outer boom onto suitable supports or to the ground.

> **WARNING:** **NEVER** weld or drill the boom or frame. Failure to comply can result in death or severe personal injury.

21. Inspect the boom and welds. Contact the **JLG** Service Department or the local **JLG** Authorized Service Center (ASC) if structural damage is detected.
22. Inspect hoses, hardware, wear pads, mounting points, chains, and other components visible with the outer boom removed. Replace if damaged.

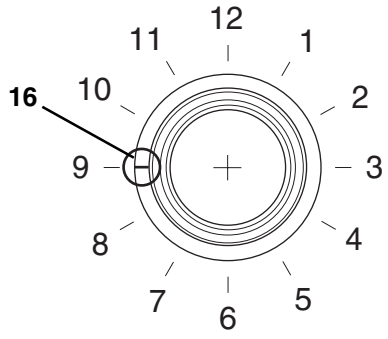
d. Outer Boom Installation

> **WARNING:** Wear protective footwear with reinforced toe caps and slip-resistant soles. Failure to comply can result in foot or other bodily injury from slipping or falling.

> **WARNING:** **NEVER** lift a heavy object without the help of at least one assistant or a suitable sling and hoist. Failure to comply can result in death or serious personal injury.

IMPORTANT: *Light lubrication of the boom wear surfaces with a rust inhibitor/lubricant such as LPS 3, or equivalent, is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended in salt air climates, and when the vehicle is stored, to help prevent rusting.*

Note: *If new boom pivot bearings have been installed in the vehicle frame, the fracture (**16**) in the bearing race must be positioned at the position shown in the illustration.*



MT08212

1. Use a suitable overhead lifting device and sling attached to the loop (**15**) on top of the outer boom. Attach another sling around the outer boom near the center point and secure it to the hoist. Remove slack from the slings.
2. Carefully raise the outer boom into position on the vehicle chassis.
3. Coat the boom pivot pin (**12**) with anti-seize compound and install the boom pivot pin (**12**), spacer rings (**14**) and the number of shims (**13**) as previously noted in the removal procedure.

   Add or remove shims as required until a maximum total gap of .10" (2.5 mm) is obtained. Balance the number and thickness of shims equal on both sides, if an additional (odd) shim must be added to obtain the proper gap, add to the right side of the boom.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

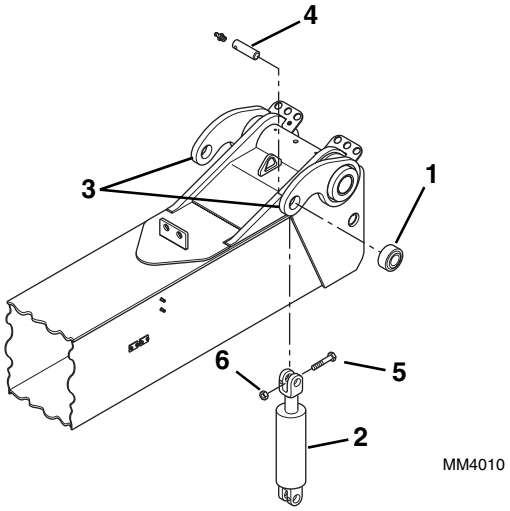
4. Secure the pivot pin with a 5/8-11 x 7" capscrew (**10**) and a new 5/8-11 elastic locknut (**11**). Torque nut to 150 lb/ft (203 Nm).

Note: *ALWAYS use a new external tooth lockwasher to help ensure proper fastening.*

5. Install one spacer (**8**), one new external tooth lockwasher (**6**) and one bearing nut (**7**) on each side of the pivot pin. Torque the bearing nut (**7**) to 80 lb/ft (108 Nm). Bend the tabs on the external tooth lockwasher (**6**) in the open slots in the bearing nut.
6. Install one cover (**5**), one washer (**4**) and one capscrew (**3**), on each side of the pivot pin (**9**).
7. Place a block or support within the chassis near the front of the outer boom.
8. Lower the outer boom onto the block or support and remove the slings and hoist or overhead crane.
9. Install the boom proximity sensor (**1**) into the tab at the top of the frame.

Note: *If new slave cylinder bearings (**1**) have been installed in the outer boom or vehicle frame, the fracture (**7**) in the bearing race must be positioned at the position shown in the illustration.*

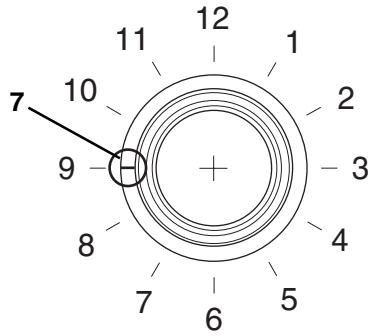
10. Raise each slave cylinder (**2**) into position at the outer boom slave-cylinder mounting bosses (**3**). **DO NOT** stretch or damage the slave cylinder hydraulic hoses.



11. Coat each slave cylinder mount pin (**4**) with anti-seize compound. Insert each mount pin through its circular opening in the chassis weldment and through the outer boom and slave cylinder mount eye. A long bolt of the same thread size as the tapped hole in the cross pin may be threaded into the cross pin to aid in installation.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

12. Working from above, insert a 5/16-18 x 3-1/2" capscrew (**5**) through each slave cylinder mount pin. Secure the capscrew with a new 5/16-18 elastic locknut (**6**). Torque to 18 lb/ft (24 Nm).



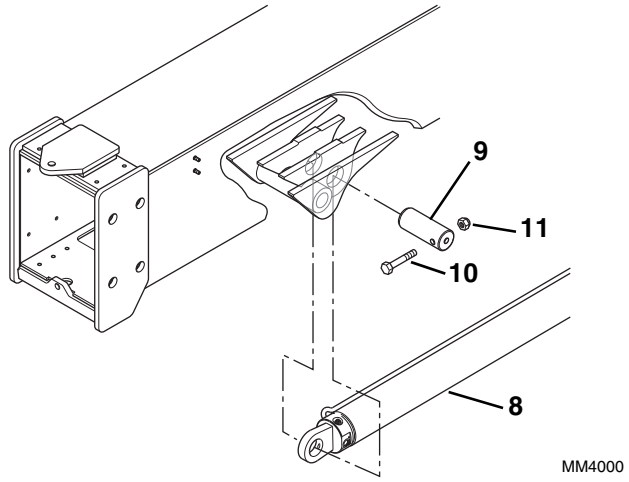
13. Use a suitable overhead lifting device and sling attached to the lift/lower cylinder; remove slack from the hoist sling, and raise the lift/lower cylinder (**8**) into its mount boss on the underside of the outer boom.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

14. Coat the lift/lower cylinder pivot pin (**9**) with anti-seize compound. Install the pin through the lower boom mounting boss and lift/lower cylinder eye and secure with one 1/2-13 x 4" capscrew (**10**) and a new 1/2-13 elastic locknut (**11**). Torque nut to 75 lb/ft (102 Nm).
15. Remove the sling from the lift/lower cylinder, and remove the blocks or supports from beneath the cylinder.
16. Use a suitable overhead lifting device and sling attached to the outer boom; raise the outer boom slightly, and remove the blocks or supports from beneath the outer boom. Lower the outer boom and remove the sling and hoist or overhead crane.

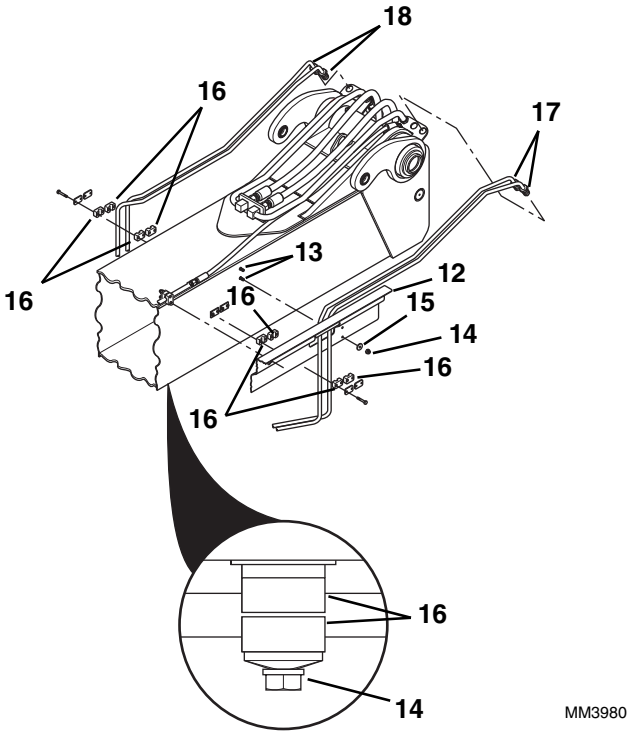
Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

17. Install wire/hose track guide (**12**) to the studs (**13**) on the side of the outer boom. Use eight new 3/8-16 elastic locknuts (**14**) and 3/8" flat washers (**15**).
18. As required, install the hydraulic clamps (**16**) on the outer boom and secure the fork side shift (**17**) and attachment tilt (**18**) hydraulic tubes within the clamps on the boom. Connect the metal hydraulic tubes at the rear bulkheads on the outer boom. Reconnect all hydraulic tubes and fittings.

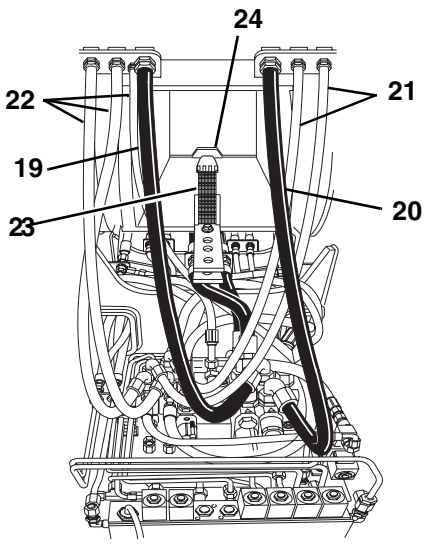


Note: *ALWAYS use new o-rings when servicing the vehicle.*

19. Install new o-rings into the fittings. Lubricate o-rings with clean hydraulic oil.



20. Remove the plugs and caps from the hoses and fittings and connect the extend (**19**), retract (**20**), attachment tilt (**21**) and fork side shift hydraulic (**22**) hoses to the boom tubes.



Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

21. Install retract chain (**23**) at the front (**24**) of the outer boom. Use a 3/4" flat washer and a new 3/4-16 elastic locknut.
22. Install the intermediate boom. (Refer to *Section 4.3.4, Intermediate Boom Replacement*.)
23. Install the inner boom, extend/retract cylinder and extend chain and attaching hardware. (Refer to *Section 4.3.2, Inner Boom Replacement*.)
24. Clean up all debris, hydraulic fluid, etc., in, on, near, and around the vehicle.

> **WARNING:** Avoid prolonged engine operation in closed areas without adequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious personal injury.

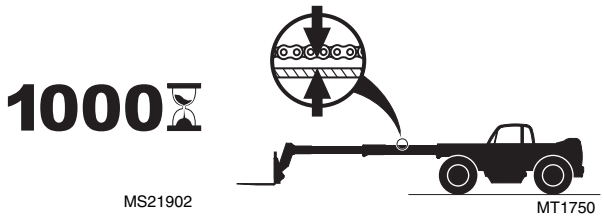
25. Start the engine and operate all boom functions several times. Check the chain tension again and adjust as necessary (refer to *Section 4.3.6, Boom Chains*). Check for leaks, and check the hydraulic fluid level in the tank; add fluid if required.
26. Apply grease at all lubrication points (grease fittings). (Refer to *Section 4.3.8, Boom Lubrication Points*.)

4.3.6 Boom Chains

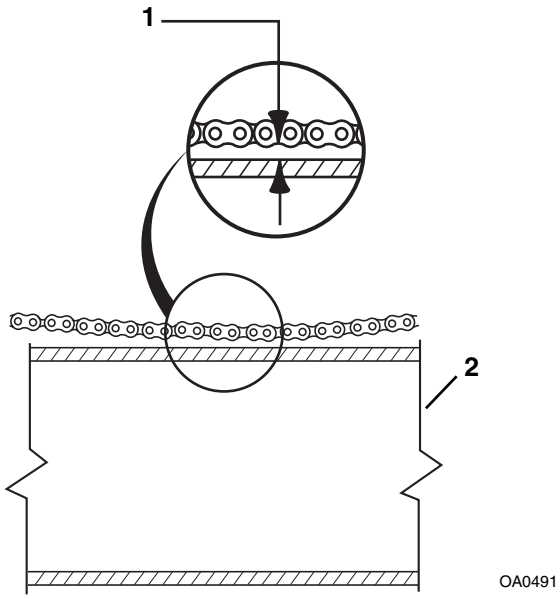
This vehicle uses double extend chains to extend the boom and a single retract chain to retract the boom. The extend and retract chains are constructed of 3/4" pitch links with 6 x 6 leaf lacing.

***IMPORTANT: DO NOT** attempt to service or repair a chain. Replace a stretched or damaged chain with a new part. When replacing a chain, also replace both clevis' and chain-to-clevis attaching pins with new parts.*

a. Boom Chain Tension Check



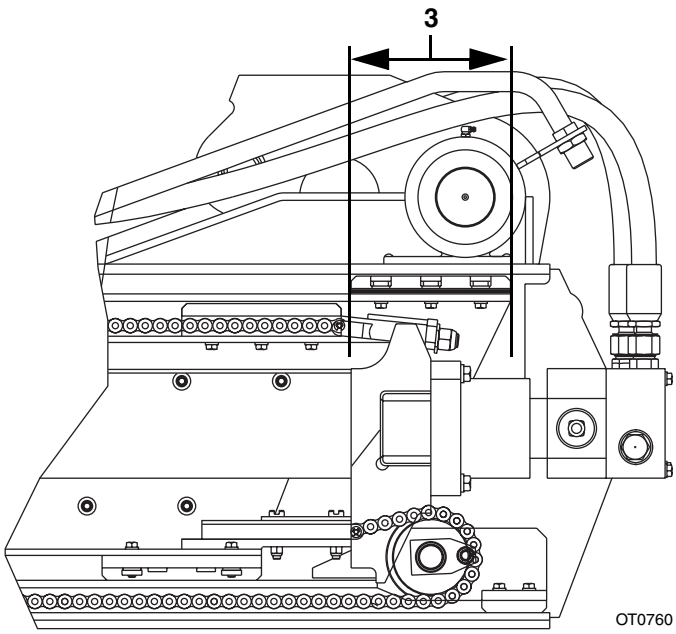
1. Park the vehicle on level ground. Place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and raise the boom to a horizontal (level) position.
2. Fully extend the boom, then retract it 2" (51 mm) (one inch per section). Shut the engine OFF.
3. Measure the sag (**1**) in the top extend chains between the bottom of the chains and the top of the intermediate boom (**2**) at their closest point. Acceptable boom chain sag is between 1.5-2.5" (38-64 mm). If the measurement is less than 1.5" (38 mm), the boom chains may need to be adjusted. Before making any adjustment to the extend chains, check the following measurement at the rear of the boom.



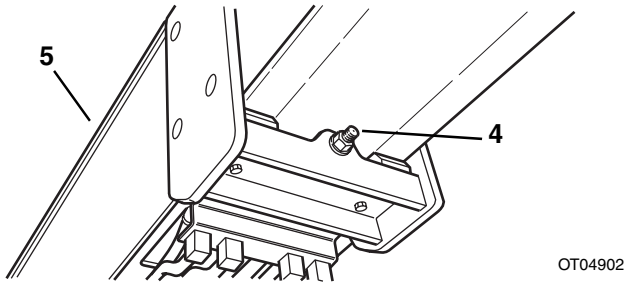
4. Start the engine, retract the boom completely and turn the vehicle OFF.
5. Go to the rear of the vehicle, open the rear door.
6. Check the measurement (**3**) from the rear of the intermediate boom to the rear of the inner boom. This measurement should be in range of 8.5-9" (216-229 mm).

***Note:** If the intermediate boom to inner boom measurement is less than 8.5" (216 mm); the boom may require extensive adjustment and/or repair. Contact the **JLG** Service Department or the nearest **JLG** Authorized Service Center (ASC).*

7. If the intermediate boom to inner boom measurement is greater than 9" (229 mm): Tighten the retract chain locknut (**4**) located on the bottom front of the outer boom (**5**).



8. Start the vehicle and cycle the boom in and out several times. Then with the boom horizontal, retract the boom completely. Turn the vehicle OFF.



9. Recheck the measurement at the rear of the boom between the intermediate and inner boom. If the measurement is still more than 9" (229 mm), repeat Steps 4-6.

Note: *If, by adjusting the retract chain locknut (**4**), you cannot obtain the measurement within the range of 8.5-9" (216-229 mm), the boom may require extensive adjustment and/or repair. Contact the **JLG** Service Department or the nearest **JLG** Authorized Service Center (ASC).*

10. Start the vehicle, cycle the boom in and out several times. With the boom horizontal, fully extend the boom and then retract it 2" (51 mm) (one inch per section). Turn the vehicle OFF.

IMPORTANT: *With the boom fully extended, apply "LPS3", "LUBRIPLATE" chain and cable fluid or equivalent to the two extend chains.*

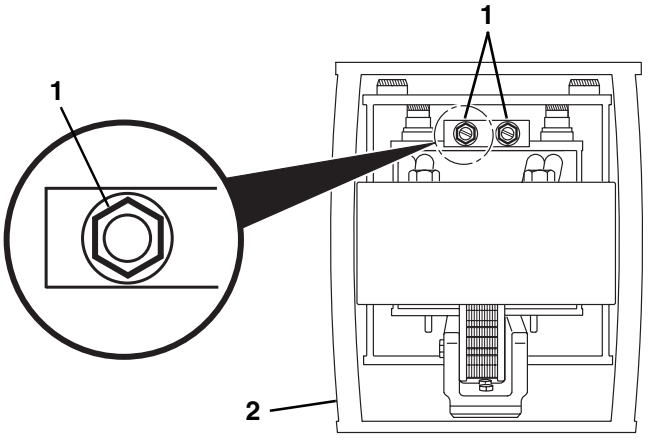
11. Measure the sag (**1**) in the top extend chains between the bottom of the chains and the top of the intermediate boom (**2**) at their closest point. Acceptable boom chain sag is between 1.5-2.5" (38-64 mm).

    If the measurement is less than 1.5" (38 mm), the top boom extend chains may need to be adjusted. Refer to *Section 4.3.6, b. Extend Chain Adjustment*.

b. Extend Chain Adjustment

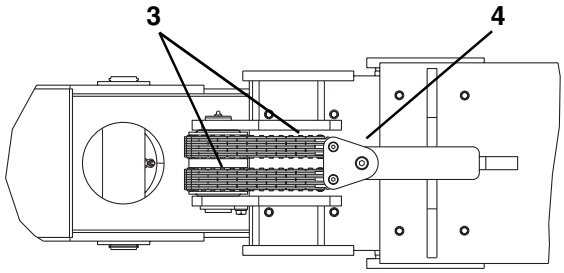
Note: *Always perform the "Boom Chain Tension Check" Refer to Section 4.3.6, a. Boom Chain Tension Check, before adjusting the top boom chain tension.*

1. Park the vehicle on level ground. Place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and raise the boom to a horizontal (level) position. Retract the boom completely and shut the vehicle OFF.
2. Adjust the top extend boom chains by tightening the locknuts (**1**), located at the rear of the boom (**2**). Be sure each locknut is tightened equally, so that each chain maintains the same tension.



OT05002

3. Equal boom extend chain (**3**) tension can be checked by the position of the yoke (**4**) on the outer boom. The front of the yoke should be parallel with the front of the front edge of the outer boom.
4. Start the vehicle and cycle the boom in and out several times. With the boom horizontal, fully extend the boom and then retract it 2" (51 mm) (one inch per section). Turn the vehicle OFF.
5. Measure the chain sag. Acceptable boom chain sag is between 1.5-2.5" (38-64 mm). If the measurement is less than 1.5" (38 mm); repeat Steps 1-5 until the sag is within acceptable range.



OT07702

Note: *If the top boom extend chain sag cannot be adjusted within the acceptable range of 1.5-2.5" (38-64 mm), the boom may require extensive adjustment and/or repair. Contact the **JLG** Service Department or the nearest **JLG** Authorized Service Center (ASC).*

IMPORTANT: *With the boom extended fully, apply "LUBRIPLATE" Chain & Cable Fluid, "LPS3" or equivalent or equivalent to the two extend chains.*

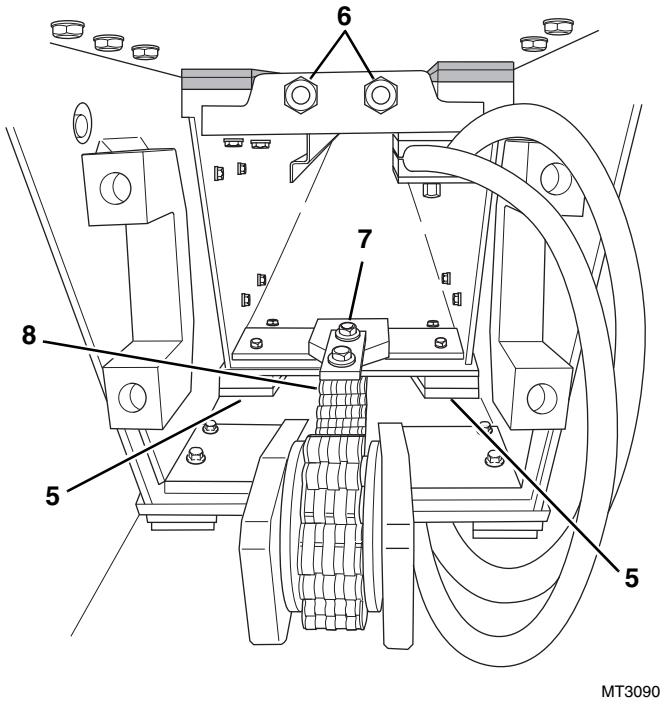
6. Close the rear door.

c. Chain Replacement

IMPORTANT: *Chains and clevis' are wear items and experience the same stress. **DO NOT** attempt to service or repair a chain or clevis. Always replace a stretched or damaged chain or clevis with a new chain assembly, which includes the chain and both clevis ends.*

Extend Chain Removal

1. Removal of the extend/retract cylinder is required to remove the extend chain. Refer to *Section 4.3.2, a. Inner Boom Removal*. Follow Steps 1-24.
2. Remove the lower rear wear pads and spacers (**5**) from the inner boom.
3. Remove the two elastic locknuts and two washers (**6**) from the extend chain clevis'.



MT3090

4. Attach a wire or small-diameter rod to the extend chain clevis'. The string, wire or rod must be long enough to pull the clevis' and chains through the boom. This will be used to pull the new chain through the boom during installation.
5. Remove the complete extend chains and clevis' as an assembly from the front of the boom.
6. Inspect wear and condition of the booms, chains, clevis', chain sheaves, extend/retract cylinder, chain rods, clevis anchors and all mounting hardware. Replace any worn or damaged parts. **DO NOT** attempt to make any repairs to the chain.

IMPORTANT: *Chains and clevis' are wear items and experience the same stress.* ***DO NOT*** *attempt to service or repair a chain or clevis. Always replace a stretched or damaged chain or clevis with a new chain assembly, which includes the chain and both clevis ends.*

Extend Chain Installation

1. Assemble the extend chains and anchor hardware.
2. Working at the front of the boom, attach the extend chain clevis' to the wire or small-diameter rod used in Step 4 of the removal procedure.
3. From the rear of the outer boom, pull the extend chains through the boom.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

4. Install the extend chain clevis' into the holes in the inner boom and install two 3/4" plain washers and two 3/4-16 elastic locknuts (**6**). Tighten the elastic locknuts only until the threads of the elastic locknuts are fully engaged with the clevis'.
5. Install the lower rear wear pads and spacers onto the inner boom. Coat the intermediate boom wear pad capscrews with Loctite® 242 (blue). **DO NOT** allow Loctite® to come into contact with wear pads.
6. Install the extend/retract cylinder. Refer to *Section 4.3.2, b. Inner Boom Installation*. Follow Steps 13-22.
7. Check and adjust the boom chain. (Refer to *Section 4.3.6, Boom Chains* for measurement and adjustment procedures.)

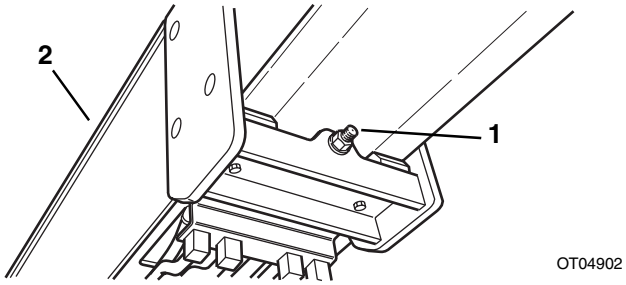
Retract Chain Removal

1. Removal of the extend/retract cylinder is required to remove the retract chain. Refer to *Section 4.3.2, a. Inner Boom Removal*. Follow Steps 1-24.

Note: *Record the mounting hole location of socket-head shoulder bolt (**7**), to ensure correct installation.*

2. At the rear of the inner boom, remove the socket-head shoulder bolt (**7**), two washers, and elastic locknut securing the retract chain (**8**) to the anchor on the inner boom. Disconnect the retract chain.

3. Remove the retract chain clevis elastic locknut (**1**) and washer at the front of the outer boom (**2**).



4. Attach a string, wire or small-diameter rod to the retract chain clevis. The string, wire or rod must be long enough to pull the clevis and chain through the outer boom. This will be used to pull the new chain through the boom during installation.
5. Remove the complete retract chain and clevis as an assembly from the rear of the boom.
6. Inspect wear and condition of the booms, chains, clevis', chain sheaves, extend/retract cylinder, chain rods, clevis anchors and all mounting hardware. Replace any worn or damaged parts. **DO NOT** attempt to make any repairs to the chain.

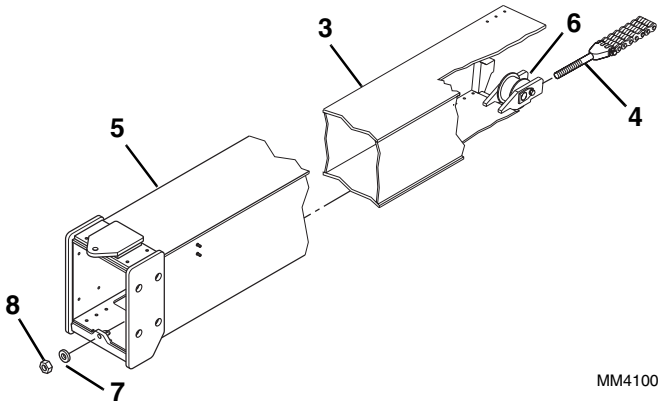
IMPORTANT: *Chains and clevis' are wear items and experience the same stress.* ***DO NOT*** *attempt to service or repair a chain or clevis. Always replace a stretched or damaged chain or clevis with a new chain assembly, which includes the chain and both clevis ends.*

Retract Chain Installation

1. Assemble the retract chain and anchor hardware.
2. At the rear of the intermediate boom (**3**), attach the retract chain front clevis (**4**) to the string, wire or small-diameter rod used in Step 4 of the removal procedure.
3. From the front of the outer boom (**5**), pull the wire or rod, retract chain clevis (**4**) and retract chain underneath the retract chain sheave (**6**). Work the wire or rod forward to the front of the outer boom.

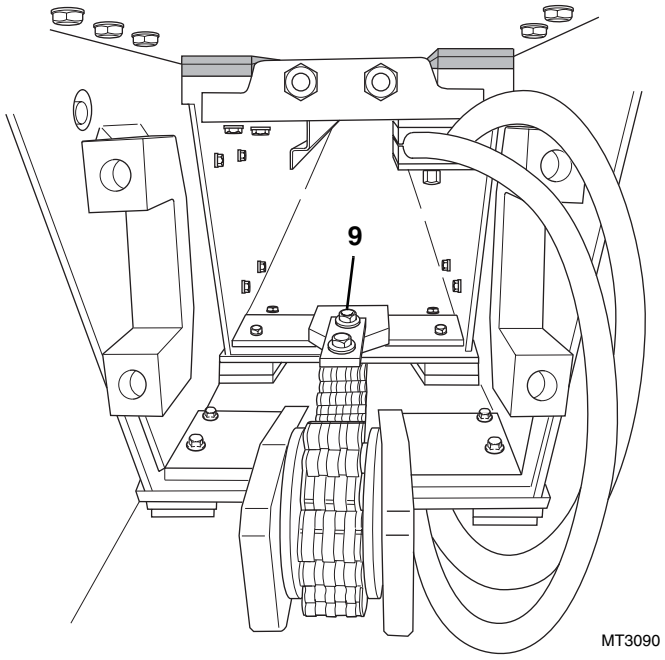
Note: *ALWAYS use new elastic locknuts to help ensure proper fastening.*

4. Insert the retract chain clevis (**4**) into its mounting hole at the bottom front of the outer boom (**5**). Secure the clevis with a 3/4" narrow flat washer (**7**) and a new 3/4-16 elastic locknut (**8**) but **DO NOT** tighten at this time.



Note: *ALWAYS use new elastic locknuts to help ensure proper fastening.*

5. At the rear of the inner boom, position the retract chain anchor links on the mounting tab. Coat a 3/8-16 x 1/2" x 1-1/2" socket-head shoulder bolt (**9**) with anti-seize compound, and install the shoulder bolt in the same hole as previously noted in the removal procedure. Secure the links with the shoulder bolt and a new 3/8-16 elastic locknut. Torque nut to 31 lb/ft (42 Nm).

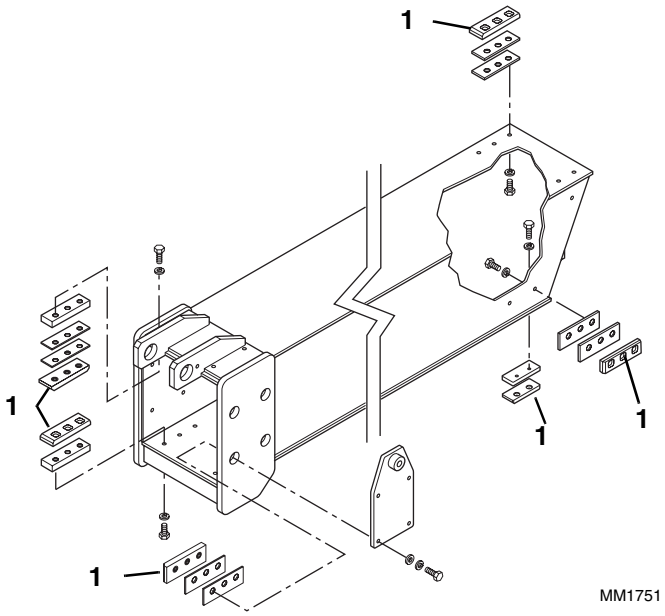


6. Install the extend/retract cylinder. Refer to *Section 4.3.2, b. Inner Boom Installation*. Follow Steps 13-22.
7. Check and adjust the boom chain. (Refer to *Section 4.3.6, Boom Chains* for measurement and adjustment procedures.)

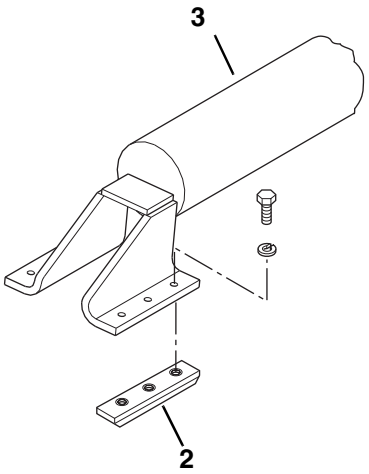
4.3.7 Boom Wear Pads

The wear pads used on this vehicle are flat rectangular wear pads with metal inserts (**1**).

The inserts are special metal hardware that will scratch the boom if the wear pads are worn beyond usable limits. (Refer to *Section 4.3.7, Boom Wear Pads*.)



A total of 32 wear pads are installed on the outer, intermediate and inner booms. Eight wear pads are attached to the inner boom, 16 to the intermediate boom (including two at the lower rear), and eight to the outer boom. Two additional wear pads (**2**) are attached to the front of the extend/retract cylinder (**3**).



At the front of the boom, shims are used to maintain a minimum gap of .07-.13" (1,8-3,3 mm) between the wear pads and the booms.

Wear Pad Gaps:

FRONT, outer boom to intermediate boom and intermediate boom to inner boom:

TOP:..... .07-.13" (1,8-3,3 mm), minimum

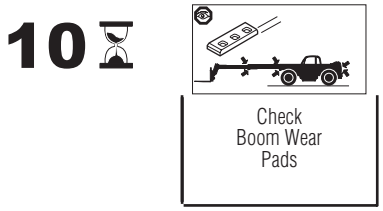
SIDE:..... .07-.13" (1,8-3,3 mm), minimum

Note: *Shim front upper and side wear pads to maintain minimum gap in both vertical and horizontal directions.*

REAR, intermediate boom to outer boom and inner boom to intermediate boom:

UPPER PADS: Shim upper rear wear pads to maintain a maximum gap of .06" (1,7 mm) at the rear edge of the upper pads, and to maintain a total minimum gap of .07-.13" (1,8-3,3 mm) in the vertical direction.

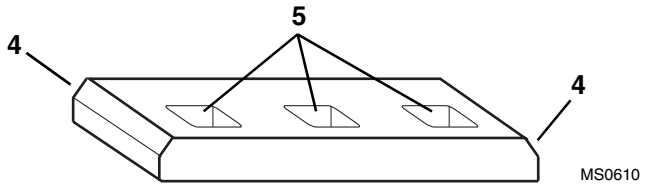
a. Boom Wear Pad Check



MS06002

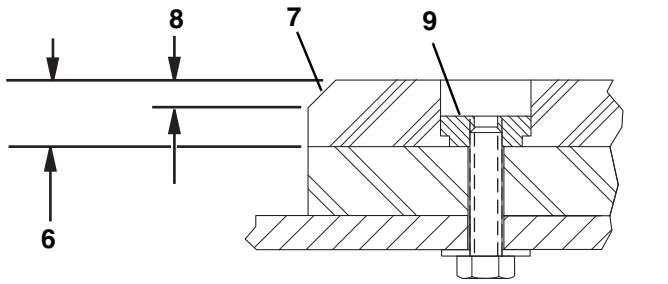
At ten-hour intervals, check boom wear pad thickness. Replace wear pads that are less than 3/8" thick (.375" or 9,5 mm). The angled cut (**4**) at each end of the flat wear pads serves as a wear pad indicator.

When replacing inner boom wear pads, fill the pockets (**5**) of the top rear boom wear pads with multi-purpose grease. Use Loctite® 242 (blue) on all wear pad cap-screws. **DO NOT** allow Loctite® to come into contact with wear pads.



MS0610

The total thickness of a new flat wear pad (**6**) is .625" (15,9 mm). The angled cut (**7**) provides a total wear thickness of .25" (6,4 mm). This leaves approximately 3/8" (.375" or 9,5 mm) (**8**) of total unused material. **DO NOT** allow wear pads to wear past the angled cut indicator or the metal inserts (**9**) will damage the boom and begin to wear into the boom pad sliding surfaces. Pads worn past this point will gouge the boom surfaces, resulting in premature wear of any new boom wear pads installed and requiring eventual, expensive replacement of the boom. Replacement of boom wear pads must be performed when the boom wear pads indicate.



OS12302

When conducting the daily or 10-hour inspection, visually check the boom wear pads between the boom sections at the rear and front of the boom for excessive wear, gouging or other damage.

The average expected service life of boom wear pads varies depending on the particular location of each wear pad within the boom, vehicle use, load weight and operating conditions.

If load weights are at or near maximum capacity, or if the vehicle is operating in very dirty or dusty conditions, the boom wear pads will wear at a much faster rate.

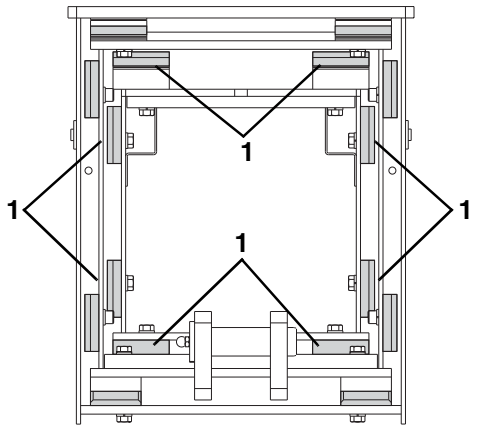
The boom wear pads that are under the most stress from the weight of the load will also wear faster than other pads. For example, the lower pads at the front and top pads at the rear of the boom are under much more stress than the pads attached at the lower rear (channel wear pads), top front or sides of the boom. Consequently, the lower pads will require service more often.

b. Boom Wear Pad Replacement

When installing a wear pad on one surface of a boom, replace the wear pad on the opposite surface. Usually, shimming will remain the same when installing new wear pads. All wear pads are secured to the boom using different capscrews and lockwashers. When installing new wear pads, apply Loctite® #242 (blue) to all wear pad mounting capscrews and torque to 31 lb/ft (42 Nm). **DO NOT** allow Loctite® to come into contact with wear pads.

Inner Boom

All inner boom wear pads (**1**) are mounted on the rear outside of the inner boom. The inner boom must be removed from the vehicle in order to replace the wear pads. Refer to *Section 4.3.2, Inner Boom Replacement* for information on removing the inner boom.

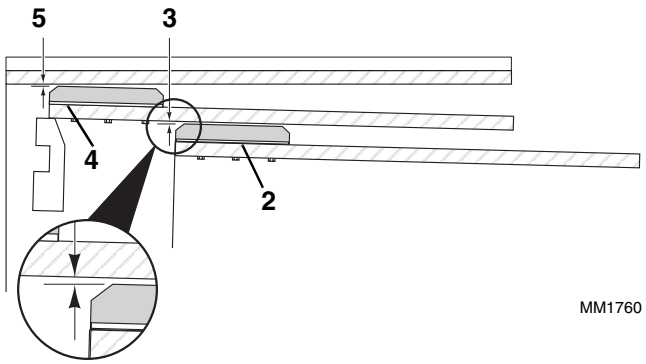


MT1380

When removing pads, mark or otherwise label each pad, spacer/shim and hardware set for ease of installation later. Use Loctite® 242 (blue) on all wear pad capscrews. **DO NOT** allow Loctite® to come into contact with wear pads.

Use shims (**2**) under the upper rear wear pads as required to maintain a maximum gap of .06" (1,7 mm) (**3**) at the rear edge of the pads and maintain a total minimum gap of .7-.13" (1,8-3,3 mm) in the vertical direction.

Use shims as required to maintain a total minimum gap of .7-.13" (1,8-3,3 mm) between the side wear pads and boom surfaces.

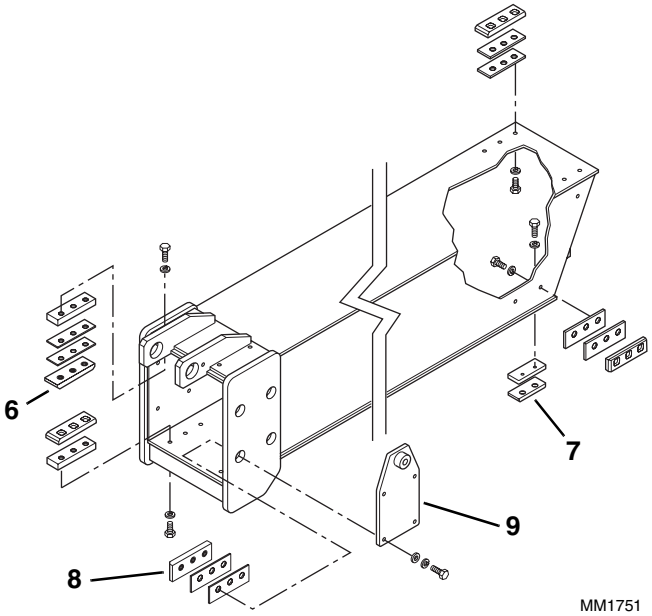


MM1760

Intermediate Boom

IMPORTANT: *The wear pads installed on the top, front (**6**) and bottom rear (**7**) intermediate boom are special wear pads. Be sure to replace them with the correct wear pads. The two wear pads (**8**) on the left side of the intermediate boom are secured to the boom with the housing support bracket (**9**), capscrews, lockwashers and flat washers.*

The inner boom and extend/retract cylinder must be removed from the vehicle to allow removal of the rear wear pads on the rear top and rear sides of the intermediate boom, and the wear pads on the rear bottom of the intermediate boom. Refer to *Section 4.3.2, Inner Boom Replacement* for information on removing the inner boom and extend/retract cylinder. Coat all wear pad capscrews with Loctite 242® (blue) before installation. **DO NOT** allow Loctite® to come into contact with wear pads.



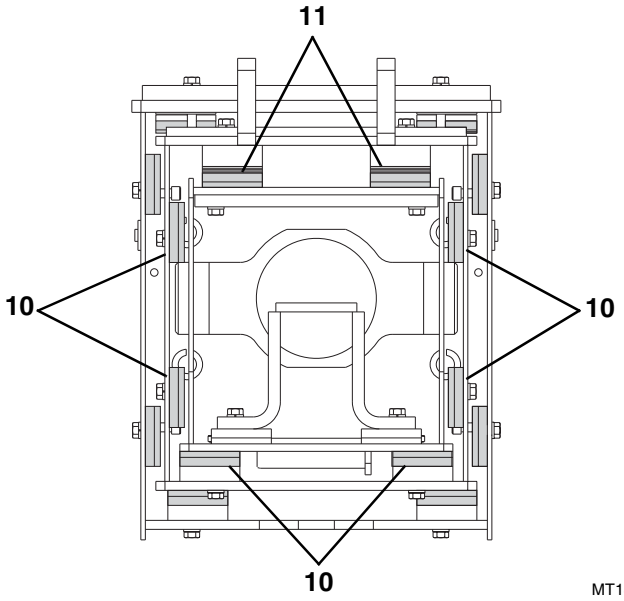
MM1751

The wear pads (**10** and **11**) on the front of the intermediate boom can be replaced by removing the fasteners securing them to the top, sides and bottom of the boom.

When removing pads, move the boom sections as needed to gain access for removal and installation of wear pads. Mark or otherwise label each pad, spacer/shim and hardware set for ease of installation later. Use Loctite® 242 (blue) on all wear pad capscrews. **DO NOT** allow Loctite® to come into contact with wear pads.

Use shims (**4**) under the upper rear wear pads as required, to maintain a maximum gap of .06" (1,7 mm) (**5**) at the rear edge of the pads and maintain a total minimum gap of .7-.13" (1,8-3,3 mm) in the vertical direction.

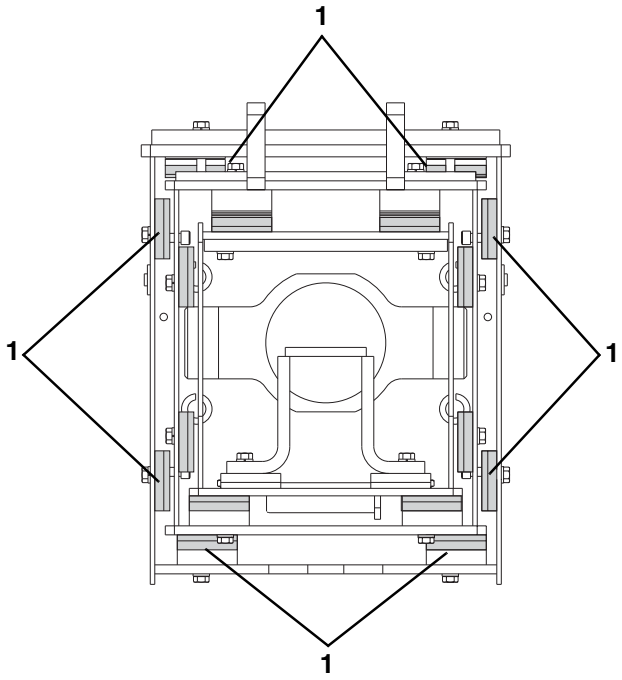
Use shims as required to maintain a total minimum gap of .7-.13" (1,8-3,3 mm) between the side wear pads and boom surfaces. Also, mount the housing support bracket (**9**) along with the left side wear pads, shims and spacers.



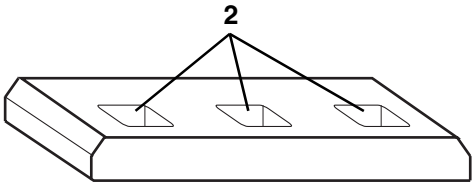
MT1390

Outer Boom

All outer boom pads (**1**) are mounted on the front of the outer boom. Remove the top wear pads before removing the bottom wear pads. Lower the gooseneck to the ground until the intermediate boom raises up, providing clearance for removing the bottom pads. Fill the grease pockets (**2**) of the top rear boom wear pads with multi-purpose grease. Use Loctite® 242 (blue) on all wear pad capscrews. **DO NOT** allow Loctite® to come into contact with wear pads.

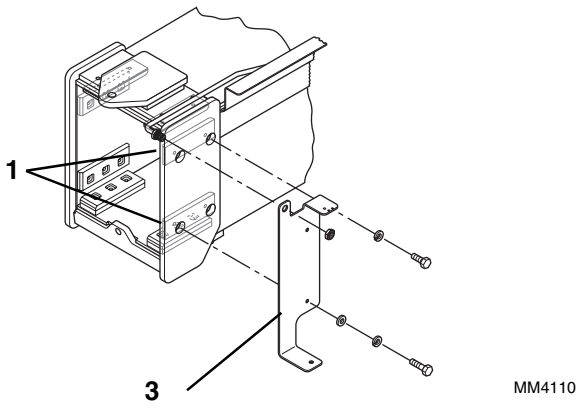


MT1390



MS0610

Use shims as required to achieve a total minimum gap of .7-.13" (1,8-3,3 mm) between top and side wear pads and boom surfaces. Also, mount the hose track bracket (**3**) along with the left side wear pads, shims and spacers.



MM4110

Extend/Retract Cylinder

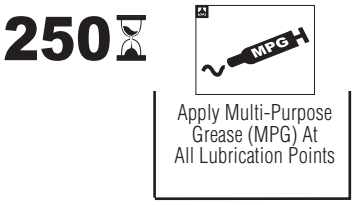
The extend/retract cylinder must be removed from the vehicle to allow removal of the wear pads on the front of the cylinder. Refer to *Section 4.3.2, a. Inner Boom Removal*, Steps 1-24 for information on removing the extend/retract cylinder. Coat all wear pad capscrews with Loctite 242® (blue) before installation.

c. Boom Wear Pad Lubrication

The boom has been factory lubricated for proper wear pad break-in and will normally not require further lubrication. However, after replacing any wear pad(s), or after prolonged periods of inoperation, light lubrication of the boom wear surfaces with a rust inhibitor/lubricant such as LPS 3, or equivalent, is recommended to keep the boom wear surfaces lubricated properly. Light lubrication of the boom wear surfaces is also recommended in salt air climates, and when the vehicle is stored, to help prevent rusting.

4.3.8 Boom Lubrication Points

In general, lubricate the boom with multi-purpose grease every 250 hours, more often as required by operating conditions, and after servicing the boom.



MS06502

Apply a premium grade of lithium-based multi-purpose grease (MPG) via the grease fittings at these locations:

A. Boom pivot pins .....4 points

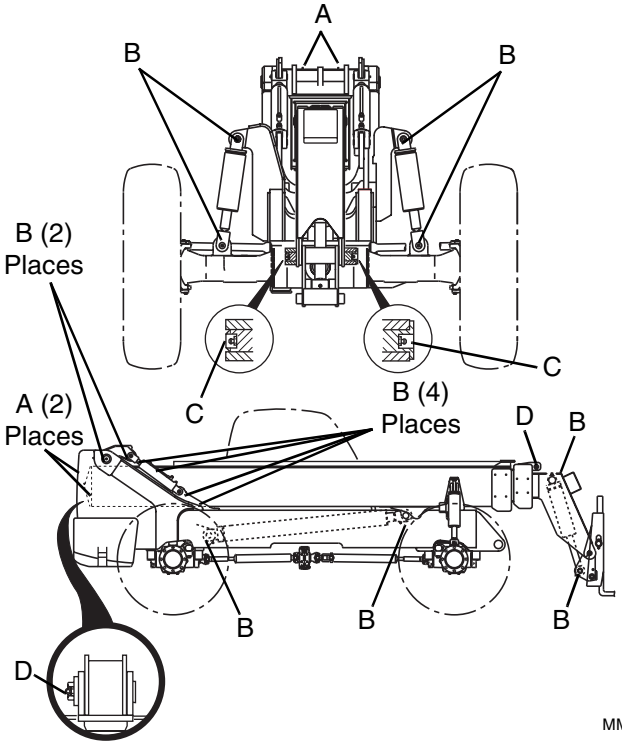
B. Hydraulic cylinder pins .....14 points

C. Quick attach pivot pin .....2 points

D. Chain sheave.....2 points

Note: *Shorten the lubrication interval on all lube points when operating under severe conditions or during high cycling operation.*

IMPORTANT: *With the boom fully extended, apply "LPS3", "LUBRIPLATE" chain and cable fluid or equivalent to the two extend chains.*

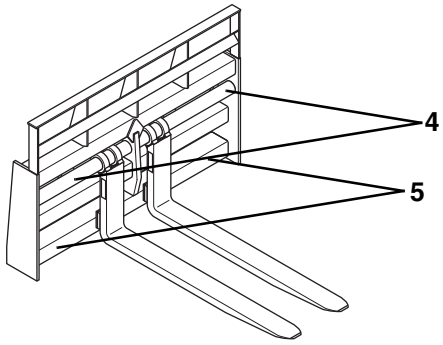


MM4140

4.3.9 Carriage Fork Shafts and Wear Bar Lubrication

Use ONLY Teflon Lube to coat the entire fork shaft (**4**) and the wear bar (**5**). **DO NOT** apply grease or any other type of petroleum based lubricant to these areas. Grease and petroleum based lubricants attract debris which will prematurely wear the fork bushings and/or wear pads.

Apply Teflon Lube as needed to keep forks sliding side-to-side smoothly, when putting vehicle into storage or when Teflon Lube appears to be worn off or rust starts to appear on the fork shaft or wear bar.



OM0940

4.3.10 Emergency Boom Lowering and Retracting

This section covers emergency boom lowering procedures. Two types of conditions requiring emergency boom lowering are addressed; Engine or Hydraulic Pump Failure (refer to *Section 4.3.10, a. Engine or Hydraulic Pump Failure*) or Hydraulic Line Failure (refer to *Section 4.3.10, b. Hydraulic Line Failure*).

Note: *In all of the Emergency Boom Lowering Procedures that follow, the low-pivot boom configurations are shown. The high-pivot boom hose configurations are similar, but are connected at different locations at the rear of the boom. All procedures should be followed for either boom configuration.*

a. Engine or Hydraulic Pump Failure

IMPORTANT: *In the event of total loss of engine power or hydraulic pump failure with an elevated load, properly evaluate and deal with each situation on an individual basis. Contact the nearest **JLG** Authorized Service Center (ASC) or the **JLG** Service Department for specific instructions.*

Secure the vehicle until the situation has been properly evaluated by following the procedures below:

1. Clear the area of any unnecessary personnel.
2. Block all four wheels.
3. Section off a large area under the boom with string or tape to restrict any personnel from entering this potentially dangerous area.

> **WARNING:** **DO NOT** get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing that requires the boom to be up.

4. Temporarily block up or support the outer boom so it cannot be lowered.
5. If the load can be removed safely, completely remove the load from the carriage. If the load cannot be removed, leave the load in place.
6. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)

b. Hydraulic Line Failure

In the event of hydraulic line failure, follow these step-by-step procedures to assist in safely retracting and then lowering the boom. Read this information from start to finish before performing any of these procedures to fully understand the process and the danger involved. If unsure about any part of these procedures, contact the nearest **JLG** Authorized Service Center (ASC) or the **JLG** Service Department for specific instructions.

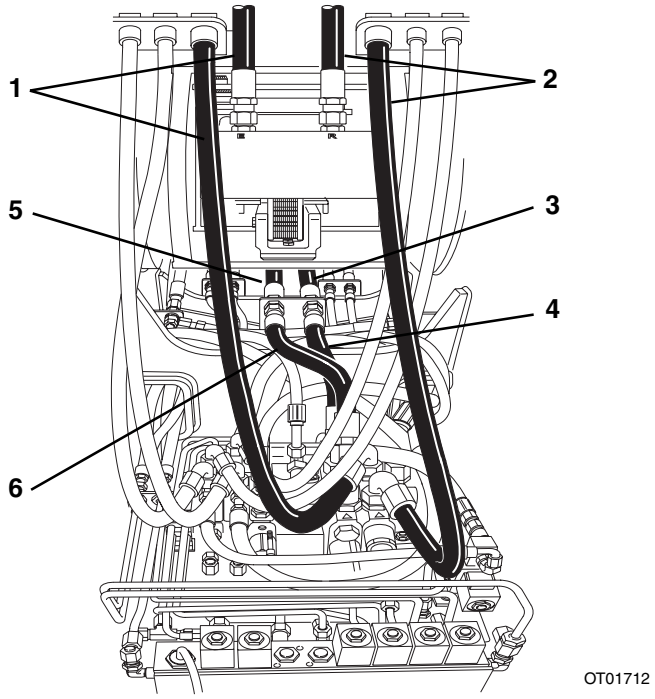
Every attempt should be made to repair a hydraulic line failure, and to retract and then lower the boom in its normal fashion. However, this is not always possible. Step-by-step procedures are listed here (STEP 3 and STEP 4) for when the boom must be retracted and lowered immediately and replacement hydraulic lines or other parts are not available. Only resort to these procedures (STEP 3 and STEP 4) only when absolutely necessary.

IMPORTANT: *The boom must first be retracted, and then lowered, to avoid vehicle tipover.*

Whenever there is hydraulic line failure, it is critical to correctly identify which hydraulic line has failed. Identify the hydraulic line that has failed and use the following table to help determine which step to follow to retract and lower the boom.

Boom troubleshooting steps to follow for hydraulic line failure and for EMERGENCY OPERATIONS.

		NORMAL STEPS		EMERGENCY STEPS
Fig. Reference	**HYDRAULIC LINE THAT FAILED**	FOLLOW THIS STEP IF PARTS ARE AVAILABLE	FOLLOW THIS STEP IF PARTS ARE NOT AVAILABLE	⚠ FOLLOW THIS STEP AS A LAST RESORT
3	BOOM **LIFT** LINE (LIFT CYLINDER TO BULKHEAD)	STEP 1	STEP 2	
4	BOOM **LIFT** LINE (BULKHEAD TO CONTROL VALVE)	STEP 1	STEP 2	
5	BOOM **LOWER** LINE (LIFT CYLINDER TO BULKHEAD)	STEP 1		STEP 3
6	BOOM **LOWER** LINE (BULKHEAD TO CONTROL VALVE)	STEP 1		STEP 3
1	BOOM **EXTEND** LINE	STEP 1	STEP 2	
2	BOOM **RETRACT** LINE	STEP 1		STEP 4



STEP 1

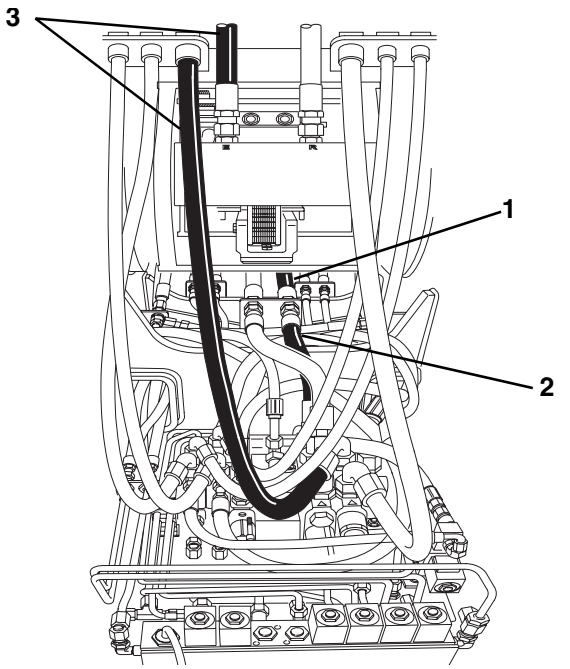
1. Clear the area of any unnecessary personnel.
2. Block all four wheels.

> **WARNING:** **DO NOT** get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing that requires the boom to be up.

3. If the load is in a position where it can be removed safely, completely remove the load from the carriage; otherwise, leave the load in place.
4. Temporarily block up or support the outer boom.

> **WARNING:** Wear protective clothing and proper eye protection when working with or around hydraulic oil. Wait for hydraulic oil to cool before attempting to repair the failure. Hot hydraulic oil can cause severe burns and other serious injuries.

5. Replace the failed hydraulic line (identified in the table and illustration on previous page) with a new part.
6. Check the hydraulic oil level. Add hydraulic oil if needed.
7. Remove the blocking or support from the outer boom.
8. Return to the cab, fasten your seat belt and start the engine.
9. Tilt the carriage upward if necessary for clearance before retracting the boom.
10. Slowly retract the boom.
11. Slowly lower the boom and ground the carriage.
12. Shut off the engine.
13. Completely remove the load from the carriage if you haven't already done so.
14. Return to the cab, fasten your seat belt and start the engine.
15. Cycle the lift and extend cylinders several times to bleed air from the system. Check for leaks.
16. Recheck the hydraulic oil level. Add oil if necessary.



STEP 2

USE IN CASE OF:

Boom Lift Line Failure (Lift Cylinder to Bulkhead) (1)

Boom Lift Line Failure (Bulkhead to Control Valve) (2)

Boom Extend Line Failure (3)

1. Clear the area of any unnecessary personnel.
2. Block all four wheels.

WARNING: Wear protective clothing and proper eye protection when working with or around hydraulic oil. Wait for hydraulic oil to cool before attempting to repair the failure. Hot hydraulic oil can cause severe burns and other serious injuries.

3. Place a container under the failed hydraulic hose to catch hydraulic oil that may escape during this procedure.
4. Return to the cab, fasten your seat belt and start the engine.
5. Slowly retract the boom.
6. Slowly lower the boom and ground the carriage.
7. Shut off the engine.
8. Completely remove the load from the carriage.
9. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
10. Have the vehicle serviced immediately. Replace any failed hydraulic lines with new hydraulic parts.
11. Return to the cab, fasten your seat belt and start the engine.
12. Cycle the lift/lower cylinder several times to bleed air from the system. Check for leaks.
13. Recheck the hydraulic oil level. Add oil as needed.
14. Transfer any wasted hydraulic oil to a covered container and label as used oil. Dispose of used oil at an approved recycling facility.

STEP 3

Boom Lower Line Failure (Lift Cylinder to Bulkhead) (4)

Boom Lower Line Failure (Bulkhead to Control Valve) (5)

1. Clear the area of any unnecessary personnel.
2. Block all four wheels.

WARNING: **DO NOT** get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing that requires the boom to be up.

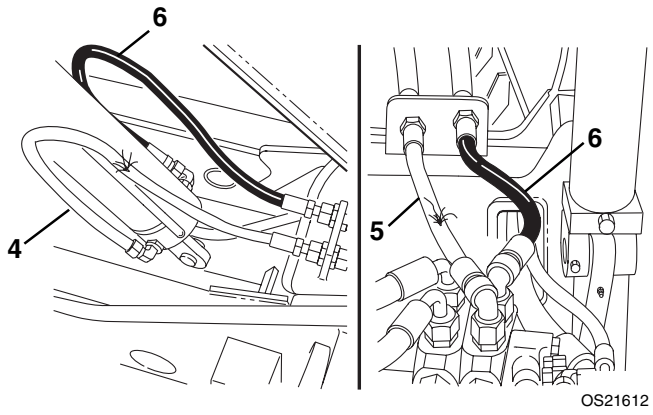
3. Temporarily block up or support the outer boom.

4. If the load is in a position where it can be removed safely, completely remove the load from the carriage; otherwise leave the load in place.
5. Place a 10 gallon (40 liter) container under the vehicle to catch hydraulic oil that will escape during this procedure.

> **WARNING:** Wear protective clothing and proper eye protection when working with or around hydraulic oil. Wait for hydraulic oil to cool before attempting to repair the failure. Hot hydraulic oil can cause severe burns and other serious injuries.

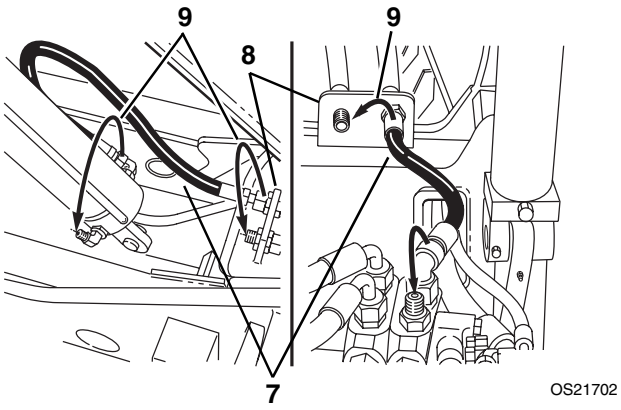
Note: *If a replacement hose is not available, the adjacent boom lift line (**6**) can be used to replace the failed boom lower line.*

6. Remove the individual failed boom lower line (**4** or **5**) from the circuit.



7. Remove and temporarily reposition the adjacent boom lift line (**7**) on the opposite side of the bulkhead (**8**). In an emergency situation, this line can be used to lower the boom.
8. Attach the boom lift line where the failed boom lower line was previously connected (**9**).

IMPORTANT: *Once either boom lift line is removed and the boom is retracted during the remaining steps, hydraulic oil will drain out of the base end of the boom cylinder. The escaping oil should be deflected by some means (the failed hose could be used) directing the oil into the drain container.*



9. Check the hydraulic oil level and add oil if needed.
10. Remove the blocking or support from the outer boom.
11. Return to the cab, fasten your seat belt, and start the engine.

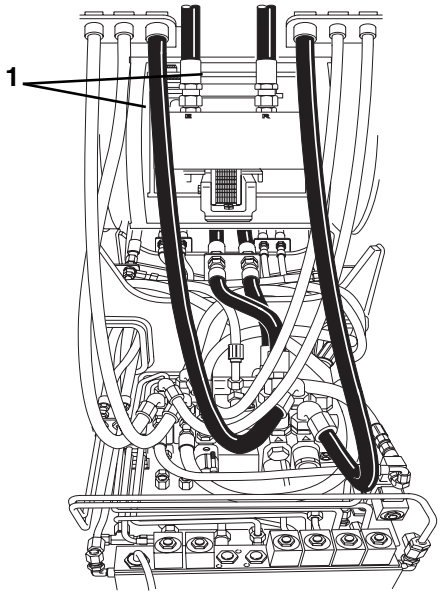
IMPORTANT: *Have the vehicle serviced and hoses replaced as soon as the boom has been lowered and the vehicle is in a secure location.*

12. Tilt the carriage upward if necessary for clearance before retracting the boom.
13. **SLOWLY RETRACT** the boom.
14. **SLOWLY LOWER** the boom and ground the carriage.
15. Completely remove the load from the carriage if you haven't already done so.
16. Have the vehicle serviced immediately.

17. Replace any faulty hydraulic lines.
18. Return to the cab, fasten your seat belt and start the engine.
19. Cycle the lift cylinder several times to bleed air from the system. Check for leaks.
20. Transfer any wasted hydraulic oil to a container with a cover and label as used hydraulic oil. Dispose of used oil at an approved recycling facility.
21. Check the hydraulic oil level again. Add hydraulic oil if necessary.

STEP 4

BOOM RETRACT LINE FAILURE (1)



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1. Clear the area of any unnecessary personnel.
2. Block all four wheels.

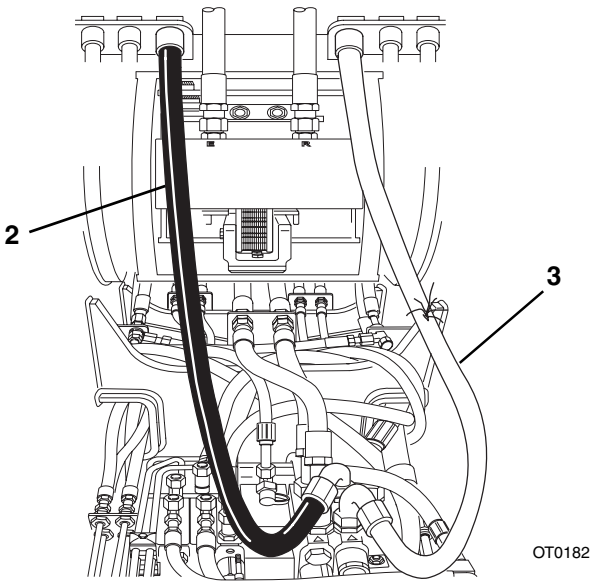
WARNING: **DO NOT** get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing that requires the boom to be up.

3. If the load is in a position where it can be removed safely, completely remove the load from the carriage, otherwise leave the load in place.
4. Place a 10 gallon (40 liter) container under the vehicle to catch hydraulic oil that may escape during this procedure.

WARNING: Wear protective clothing and proper eye protection when working with or around hydraulic oil. Wait for hydraulic oil to cool before attempting to repair the failure. Hot hydraulic oil can cause severe burns and other serious injuries.

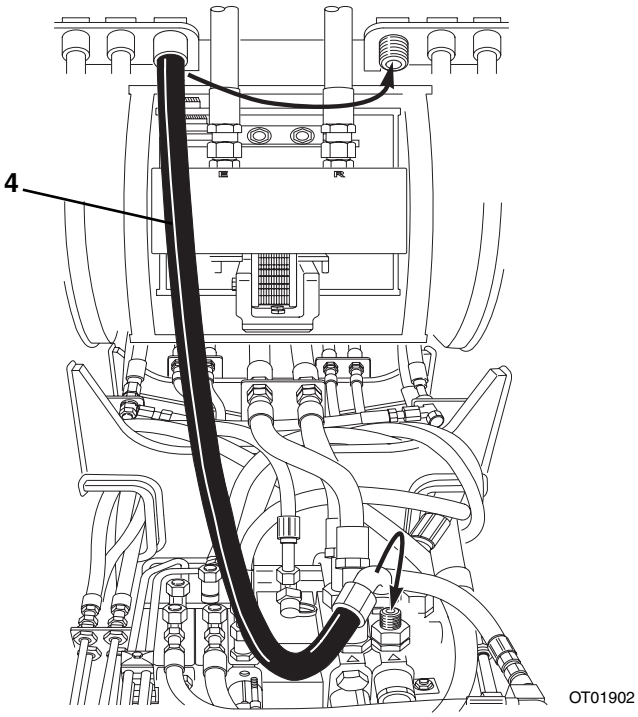
Note: *If a replacement hose is not available, the adjacent boom extend line (**2**) can be used to replace the failed boom retract line.*

5. Remove the failed boom retract line (**3**) from the circuit.



OT0182

6. Remove and temporarily reposition the adjacent boom extend line (**4**) in place of the failed boom retract line.



IMPORTANT: *During the remaining steps, hydraulic oil will drain out of the base end of the boom cylinder. The escaping oil should be deflected by some means (the failed hose could be used) directing the oil into the drain container.*

7. Check the hydraulic oil level. Add hydraulic oil if needed.
8. Return to the cab, fasten your seat belt and start the engine.
9. Tilt the carriage upward if necessary for clearance before retracting the boom.
10. **SLOWLY RETRACT** the boom.
11. **SLOWLY LOWER** the boom and ground the carriage.
12. Have the vehicle serviced immediately.
13. Replace any failed hydraulic lines.
14. Return to the cab, fasten your seat belt, and start the engine.
15. Cycle the lift cylinder several times to bleed air from the system. Check for leaks.
16. Transfer any wasted hydraulic oil to a container with a cover and label as used hydraulic oil. Dispose of used oil at an approved recycling facility.
17. Check the hydraulic oil level again. Add hydraulic oil if necessary.

4.4 QUICK ATTACH ASSEMBLY

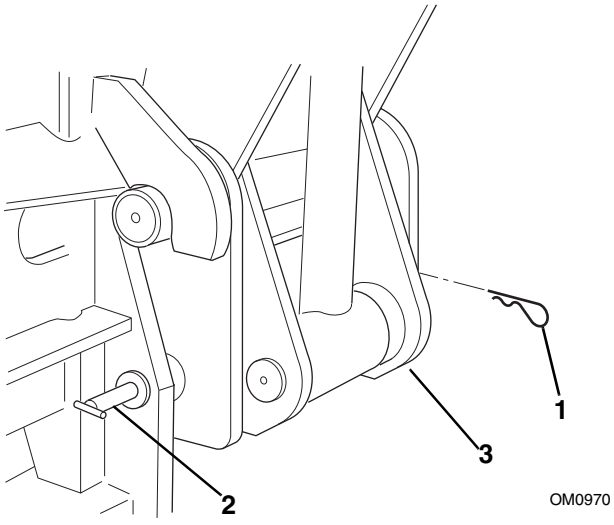
This vehicle is equipped with a quick attach system for easy carriage changes.

4.4.1 Disconnecting from a Carriage

1. Park the vehicle on hard, level ground.

Note: *Ensure the forks of the carriage being removed are in a position other than fully shifted inboard or outboard to minimize trapped hydraulic pressure.*

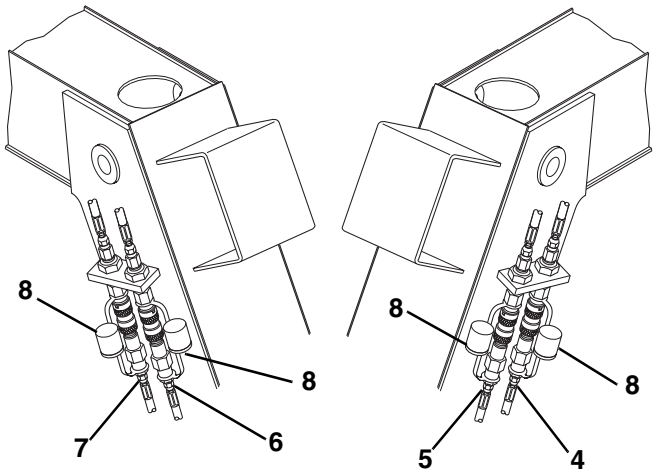
2. Ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, and engage the parking brake switch.
3. Extend the boom approximately 10' (3,05 m) and tilt the carriage backward.
4. Exit the vehicle using both hand holds.
5. Remove the spring clip pin (**1**) from the quick attach pin (**2**) and pull the pin out of the bottom of the quick attach link (**3**).



6. Remove the four hydraulic quick disconnects between the carriage and the vehicle. Remove the disconnects in the following order:

   Disconnect the RED (**4**) then the BLACK (**5**) on the left side. Disconnect the GREEN (**6**) then the YELLOW (**7**) on the right side.

7. Install the “Male” and “Female” protective caps (**8**) on all four quick disconnects.



8. Return to the operator’s compartment, fasten the seat belt and lower the carriage to the ground in a level position. Tilt the carriage forward. This will rotate the quick attach link back away from the carriage.
9. Lower and then retract the boom until the carriage pivot pins have disconnected from the carriage.

4.4.2 Connecting to a Carriage

1. Perform this procedure on level ground only. Position the vehicle directly behind the carriage to be mounted.
2. Tilt the quick attach backward.
3. Extend the boom approximately 10' (3,05 m) and drive the vehicle forward until the carriage pivot pins are below and between the two hooks on the carriage.
4. Raise the boom until the carriage pivot pins have seated fully in the hooks on the carriage.
5. Tilt the carriage up slightly. The quick attach link should be tight up against the rear of the carriage and the holes in the link and the carriage should be aligned.

6. Place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch, unbuckle the seat belt and exit the vehicle using both hand holds.
7. Insert the quick attach pin (**2**) completely through the attachment and the quick attach link (**3**). Insert the spring clip pin (**1**) through the quick attach pin.
8. Remove the protective caps (**8**) from the quick couplers:

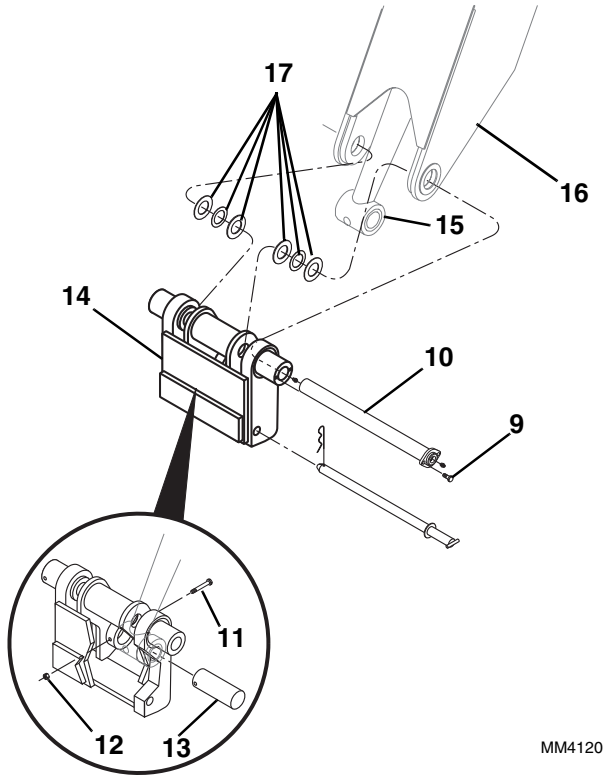
   Connect the quick couplers in the following order: Connect the YELLOW (**7**) then the GREEN (**6**) on the right side. Connect the BLACK (**5**) then the RED (**4**) on the left side.
9. In the event there is trapped pressure in one of the carriage hydraulic hoses, connect the quick coupler(s) with a firm constant motion. This will allow the (specially designed) male quick coupler to drain the trapped pressure through to the female coupler and into the hydraulic system.

> **WARNING:** **DO NOT** operate the vehicle unless you are in the operator's seat with the seat belt fastened around you. Death or serious injury could result if the seat belt is not securely fastened.

10. Return to the cab, fasten the seat belt and resume operation.

4.4.3 Quick Attach Removal

1. Remove two socket head capscrews (**9**) from the flange in the upper pin (**10**). Tap out upper pin.
2. Remove one 1/2-13 x 5" capscrew (**11**) and elastic locknut (**12**). Tap out lower attachment tilt cylinder pin (**13**).
3. Remove the quick attach assembly (**14**) from the attachment tilt cylinder (**15**) and inner boom gooseneck (**16**); retain shim washers (**17**) for reinstallation.



Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

4.4.4 Quick Attach Installation

1. Tap upper (**10**) and lower (**13**) pins through quick attach assembly (**14**), and shim washers (**17**) (equally placed on both sides as required), attachment tilt cylinder (**15**) and inner boom gooseneck (**16**).
2. Secure the lower attachment tilt cylinder pin with one 1/2-13 x 5" capscrew (**11**) and a new 1/2-13 elastic locknut (**12**).
3. Secure the upper pin with two 1/2-13 x 1"socket head capscrews (**9**). Line up the holes in the flange on the pin with the mounting holes in the hub of the quick attach assembly (**14**).

4.5 TROUBLESHOOTING

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

Boom Troubleshooting

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 and/or electrical system(s) not operating properly.	2. Refer to *Section 9.8, Hydraulic Circuits and Troubleshooting* and/or *Section 10.7.18, Boom Extend/Retract Circuit and Troubleshooting*.
	3. Faulty Extend/Retract cylinder.	3. Repair cylinder. (Refer to *Section 9.14.6, Extend/Retract Cylinder*
	4. Broken chains or anchors.	4. Replace chains or anchors as needed. (Refer to *Section 4.3.6, c. Chain Replacement*.)
2. Dropping chain, or jerky boom extend or retract functions.	1. Chain(s) tension not properly adjusted.	1. Adjust chain(s). (Refer to *Section 4.3.6, b. Extend Chain Adjustment*.)
	2. Chain(s) stretched or binding.	2. Replace chain(s) as needed. (Refer to *Section 4.3.6, c. Chain Replacement*.)
	3. Wear pads loose, contaminated, excessively worn or damaged.	3. Replace wear pads. (Refer to *Section 4.3.7, b. Boom Wear Pad Replacement*.)
	4. Contaminated, corroded or rusted wear pad sliding surfaces.	4. Remove contamination and/or corrosion from wear pad sliding surfaces and lubricate. (Refer to *Section 4.3.7, c. Boom Wear Pad Lubrication*.) If the surfaces cannot be reconditioned, replace the boom section(s).
	5. Extend/Retract hydraulic and/or electrical system(s) not operating properly.	5. Refer to *Section 9.8, Hydraulic Circuits and Troubleshooting* and/or *Section 10.7.18, Boom Extend/Retract Circuit and Troubleshooting*.
	6. Damaged boom section.	6. Replace the damaged boom section. (Refer to *Section 4.3, Boom Assembly Maintenance*.)



Boom Troubleshooting (Continued)

Problem	Cause	Remedy
3. 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 and/or electrical system(s) not operating properly.	2. Refer to *Section 9.8, Hydraulic Circuits and Troubleshooting* and/or *Section 10.7.19, Boom Lift/Lower Circuit and Troubleshooting*.
	3. Faulty lift/lower cylinder.	3. Repair cylinder. Refer to *Section 9.14.7, Lift/Lower Cylinder*.
	4. Seized boom pivot pin bearing.	4. Replace bearing.
4. Boom shifts to right or left when extending.	1. Boom pivot pin improperly shimmed.	1. Re-shim the boom to a maximum total gap of .10" (2.5 mm) with shims distributed evenly on both sides of the boom pivot pin.
	2. Incorrect wear pad gap or shimming, or wear pads excessively worn.	2. Shim wear pads to correct gap. (Refer to *Section 4.3.7, a. Boom Wear Pad Check*.) Replace wear pads as needed. (Refer to *Section 4.3.7, b. Boom Wear Pad Replacement*.)
5. Excessive boom pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. (Refer to *Section 4.3.8, Boom Lubrication Points*.) Replace worn pins as needed.
	2. Worn bearing(s).	2. Replace bearing(s) and lubricate at regular intervals. (Refer to *Section 4.3.8, Boom Lubrication Points*.)
6. Excessive slave cylinder pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. (Refer to *Section 4.3.8, Boom Lubrication Points*.) Replace worn pins as needed.
	2. Worn bearing(s).	2. Replace bearing(s) and lubricate at regular intervals. (Refer to *Section 4.3.8, Boom Lubrication Points*.)
7. Excessive lift/lower cylinder pivot pin noise and/or wear.	1. Insufficient lubrication.	1. Lubricate at regular intervals. (Refer to *Section 4.3.8, Boom Lubrication Points*.) Replace worn pins as needed.
	2. Worn self-aligning bearing(s).	2. Replace bearing(s) and lubricate at regular intervals. (Refer to *Section 4.3.8, Boom Lubrication Points*.)

Boom Troubleshooting (Continued)

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 4.3.7, a. Boom Wear Pad Check*.)
	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. (Refer to *Section 4.3.7, c. Boom Wear Pad Lubrication*.) If the surfaces cannot be reconditioned, replace the boom section(s).
	4. Operating in extremely dusty/ abrasive conditions.	4. Clean equipment frequently.
12. Fork Side Shift hydraulics will not operate.	1. Fork Side Shift hydraulic or electrical system(s) not operating properly.	1. Refer to *Section 9.8, Hydraulic Circuits and Troubleshooting* and/or *Section 10.7.21, Left Fork - Side Shift Left, Circuit and Troubleshooting* and/or *Section 10.7.23, Right Fork - Side Shift Left, Circuit and Troubleshooting*.
13. Excessive chain wear.	1. Improper chain adjustment.	1. Adjust to correct tension. (Refer to *Section 4.3.6, b. Extend Chain Adjustment*.) Replace chain(s) as needed. (Refer to *Section 4.3.6, c. Chain Replacement*.)
	2. Chain sheave(s) not properly lubricated.	2. Lubricate chain sheave. (Refer to *Section 4.3.8, Boom Lubrication Points*.)
	3. Chain sheave(s) not rotating freely.	3. Lubricate chain sheave. (Refer to *Section 4.3.8, Boom Lubrication Points*.) Repair or replace chain sheave(s) as needed.
	4. Improper chain lubrication.	4. Lubricate at regular intervals (refer to Owners/Operators manual). Replace chain(s) as needed (refer to *Section 4.3.6, c. Chain Replacement*).

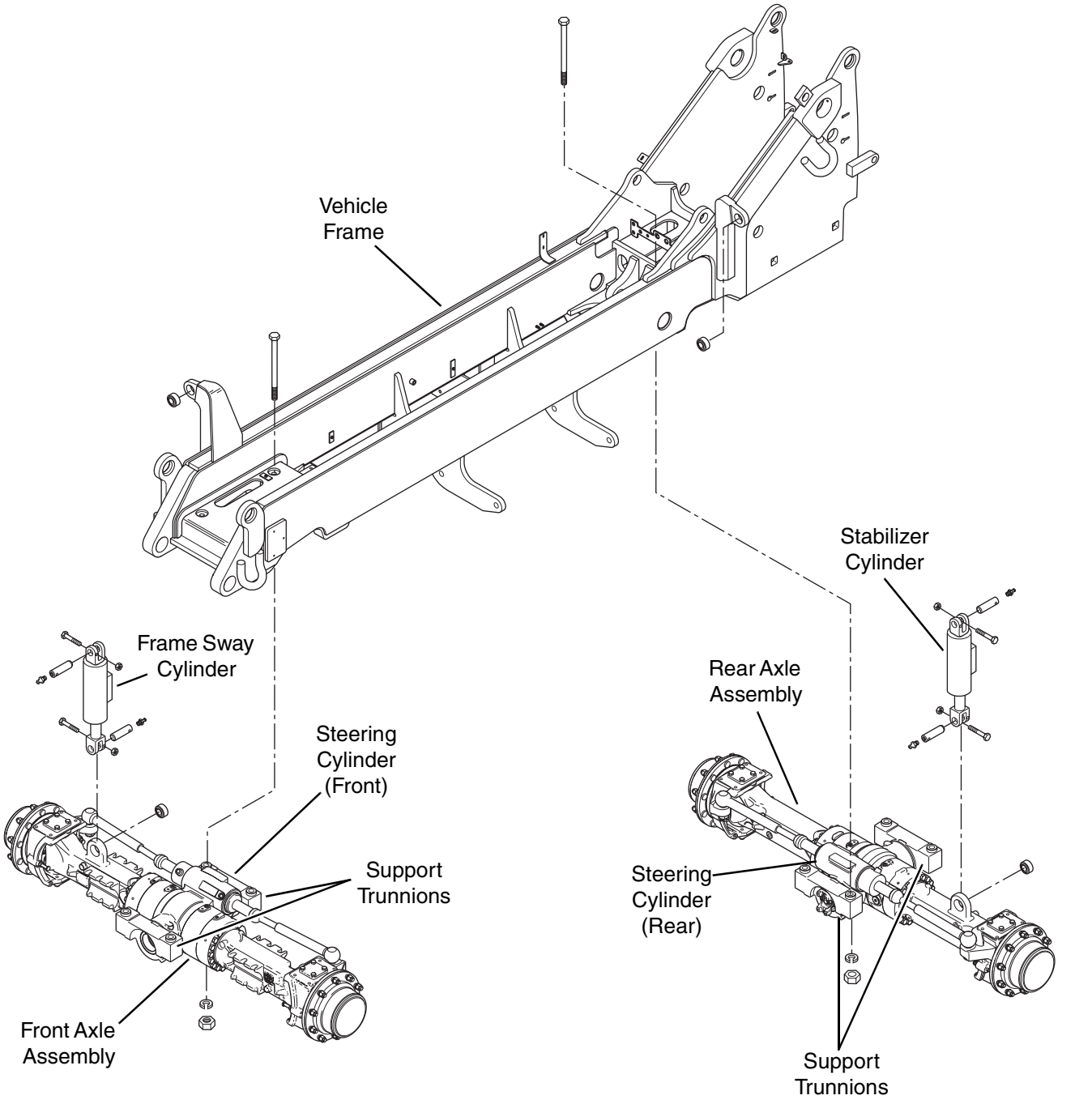
Section 5
Axles, Wheels and Tires

Contents

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5.1 AXLE 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 name and location of the major assemblies of the axle, wheel and tires. The following illustration identifies the components that are referred to throughout this section.



MM2370



WARNING: **DO NOT** service the vehicle without following all safety precautions as outlined in the “Safety Practices” section of this manual. Failure to follow the safety practices may result in death or serious injury.

5.2 AXLE ASSEMBLIES

5.2.1 Axle Assembly Description

The front (parking-brake equipped) and rear (no parking brake) ZF axles are designed for heavy-duty, off-road industrial use. Each axle consists of a beam-type axle case, housing the differential center section, inboard wet-disc brakes, a pair of trumpet-like shaft housings, and stub-axle/wheel-hub units at each end. O-rings and oil seals retain fluid within the axle. The axles have a semi-floating mounting configuration. Each axle center is secured to the vehicle frame with semi-rotating front and rear supports, and at one side with a cylinder, anchor and pins.

The frame sway cylinder is mounted on the right side of the front axle and the stabilizer cylinder is mounted on the left side of the rear axle. Steering cylinders and ball joints are mounted inboard on each axle.

5.2.2 Axle Assembly Operation

Power from the engine is transmitted through the torque converter and transmission, the transfer case by way of a driveshaft. The transfer case distributes power through the output drive shafts to the front and rear axle differentials. The axles work through gearing to turn the wheel and tire assemblies and to ultimately cause the vehicle to move.

The front differential is equipped with limited-slip, self-locking gears, supported by bearings. The design of the differential permits adjustment to the bevel gear set. Internal axle service and adjustment procedures are not the scope of this publication and are thoroughly covered in the appropriate ZF axle manual. The beveled ring gear is adjusted by means of ring nuts located opposite each other. The position of the pinion, supported by two bearings, is adjusted through the addition or subtraction of adjusting shims.

The wheel hubs containing the planetary reduction gears are supported by two tapered roller bearings. The oil-bath (wet) disc type brakes are located in the center housing, and are operated by an annular piston. The parking brake is located in the center section of the front axle. The brake is Spring Applied, Hydraulically Released (SAHR). The parking brake uses the same discs as the service brakes.

A double-rod hydraulic steering cylinder is mounted on the differential support. Directional steering input is transmitted to the axles by means of articulated track rods that allow toe-in adjustments.

The axles are supported with two specially designed support trunnions (one at the front and one at the rear of each axle), attached to the axle center and chassis. The trunnions allow the axle to pivot freely, each limited by the hydraulic cylinder attached to one of the bridge casting bearing lugs.

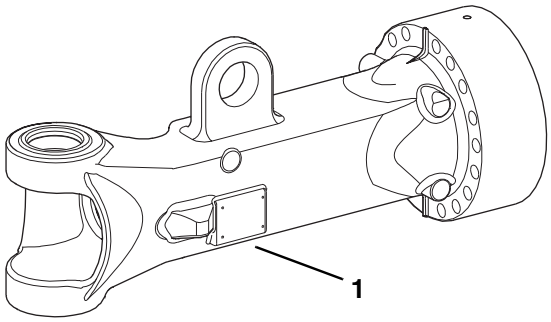
Note: *Detailed axle service instructions (covering axle, brakes and wheel-end safety, repair, disassembly, reassembly, adjustment and troubleshooting information) are provided in the ZF Axle Repair Manuals, Model MS-T 3060, front axle with parking brake (ZF part number 5871 560 002,* ***JLG*** *part number 8990430) or Model MS-T 3045, rear axle without parking brake (ZF part number 5871 550 002,* ***JLG*** *part number 8990419).*

The MMV uses a wheel with nominal dimensions of 13" x 25". The wheels are a one-piece design with ten one-inch diameter holes equally spaced on a 13.188" diameter bolt circle.

An L2, 2 Star (or better) tire, 15.5R25 size, can be used on the MMV. Tires are filled only with air when the vehicle is shipped from the factory.

5.2.3 Axle Serial Number Plate

The front axle serial number plate (**1**) is located on a mounting pad on the inboard portion of the right beam trumpet. The rear axle serial number plate is located on a mounting pad on the inboard portion of the left beam trumpet. Information on the serial number plate is required in correspondence regarding the axle.



MT0220

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

5.2.4 Axle Specifications

General axle specifications are found in *Section 2, General Information, Specifications and Maintenance*. Axle (differential housing) fluid information is found in *Section 2.6.1, Axles (Differential Housings) and Transfer Case*. Wheel end fluid information is found in *Section 2.6.2, Wheel Ends*.

5.2.5 Axle Maintenance

Note: *Detailed axle service instructions (covering axle, brakes and wheel-end safety, repair, disassembly, reassembly, adjustment and troubleshooting information) are provided in the ZF Axle Repair Manuals, Model MS-T 3060, front axle with parking brake (ZF part number 5871 560 002,* ***JLG*** *part number 8990430) or Model MS-T 3045, rear axle without parking brake (ZF part number 5871 550 002,* ***JLG*** *part number 8990419).*

Several special axle service tools are required to properly service the axle assemblies. Contact the local **JLG** Authorized Service Center (ASC) or ZF dealer for ordering information.

CAUTION: Risk of personal injury. Exercise extreme care when using snap rings or spring-loaded retention devices.

WARNING: Risk of death or serious personal injury if components are assembled improperly, if incompatible, worn or damaged components are used, or if components are used in a non-approved application. Obtain proper training, follow recommended procedures, and use proper tools and safety equipment. Wear safety glasses at all times when working on the vehicle and vehicle components.

WARNING: An improperly supported vehicle can fall, causing death or serious injury. When removing the axle assembly from the vehicle, properly support the vehicle. If servicing axle components with the axle attached to the vehicle, securely support the carrier, differential, pinion assemblies and wheel ends.

IMPORTANT: *When replacing a fastener, replace it with one of equal or higher grade and quality. Torque fasteners to the specified value for the application.*

IMPORTANT: *The use of replacement parts provided by other than the original manufacturer is not recommended, as such use may cause axle failure and effect vehicle safety.*

- Some service operations require the use of tools specifically designed for the purpose. Use the special tools when and as recommended.
- **DO NOT** pound, beat or hammer on end yokes and flanges to remove or to install them. Damage to axle components can occur. Remove and install end yokes and flanges by following the recommended procedures in the appropriate ZF axle service manual.
- **DO NOT** attempt carrier and differential removal and installation, and differential and pinion disassembly and assembly, without thoroughly understanding the instructions in the appropriate ZF publications.
- Before disassembling any parts inside the carrier, remove the entire axle assembly from the vehicle and securely support it with the pinion facing up in an appropriate stand or rack.
- **DO NOT** reuse oil or grease seals.

CLEANING: Clean parts with machined or ground surfaces (such as gears, bearings, and shafts) with emulsion cleaners or petroleum-based cleaners. **DO NOT** steam clean internal components and the interior of the planetary hub and axle housing. Water can cause corrosion of critical parts. Rust contamination in the lubricant can cause gear and bearing failure. Remove old gasket material from all surfaces.

DRYING: Use clean, lintless towels to dry components after cleaning. **DO NOT** dry bearings by spinning them with compressed air. This can damage mating surfaces due to lack of lubrication. After drying, lightly coat components with oil or a rust-preventive chemical to help protect them from corrosion. If storing components for a prolonged period, wrap them in wax paper.

PERIODIC OPERATION REQUIREMENT: Every two weeks, drive the vehicle far enough to cause the drive-train components to make several complete revolutions. This will help assure that internal components receive lubrication to minimize deterioration caused by environmental factors such as high humidity.

SUBMERSION: If the vehicle has been exposed to water deep enough to cover the hubs, disassemble the wheel ends and inspect for water damage and contamination. If the carrier housing was submerged in water, especially if the water level was above the vent tube (breather), drain the axle and inspect internal parts for water damage and contamination. Before assembling and refilling the unit with the specified lubricant(s), clean, examine and replace damaged parts as necessary.

Note: *Use a suitable puller for bearing removal. Clean, inspect and lubricate all bearings just prior to reassembly. If replacement of a damaged bearing cup or cone is necessary, replace the cup and cone as a set.*

5.2.6 Axle Replacement

a. Removal

> **WARNING:** An improperly supported vehicle can fall, causing death or severe personal injury. Safely raise and adequately support the vehicle so that it will remain stable and in place before attempting to remove an axle.

> **WARNING:** Hot hydraulic fluid can cause severe burns. Wait for the hydraulic fluid to cool before servicing any hydraulic component.

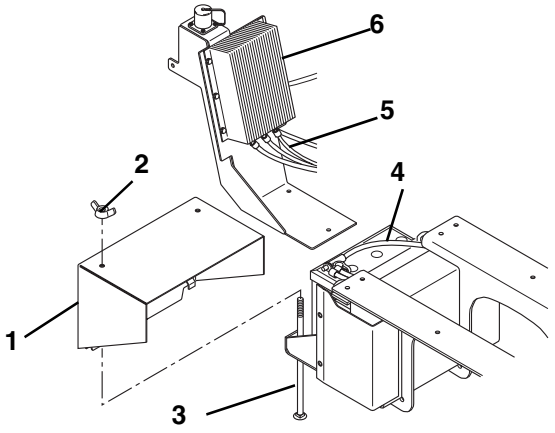
> **WARNING:** Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

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

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

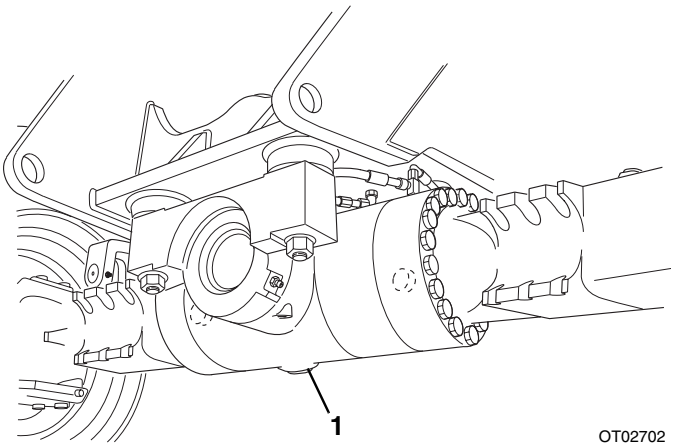
IMPORTANT: *Clear the work area of all debris, unnecessary personnel, etc. Allow sufficient space to raise the vehicle and to remove the axle.*

1. Park the vehicle on a firm, level surface, level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch, straighten all wheels and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover. Allow the engine, transmission and hydraulic fluid to cool.
4. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
5. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
6. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).

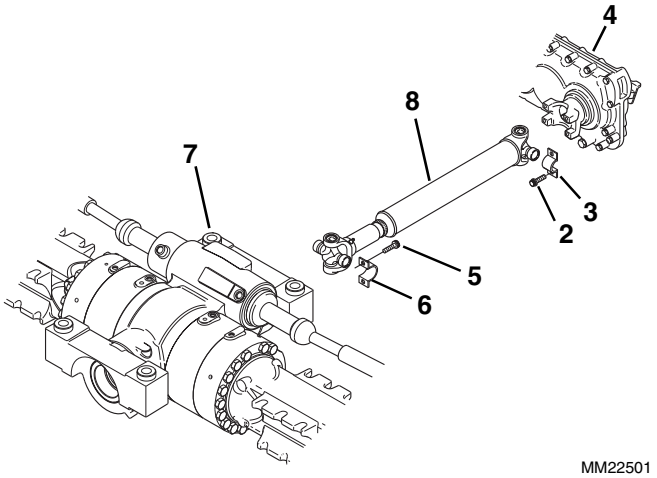


MM2911

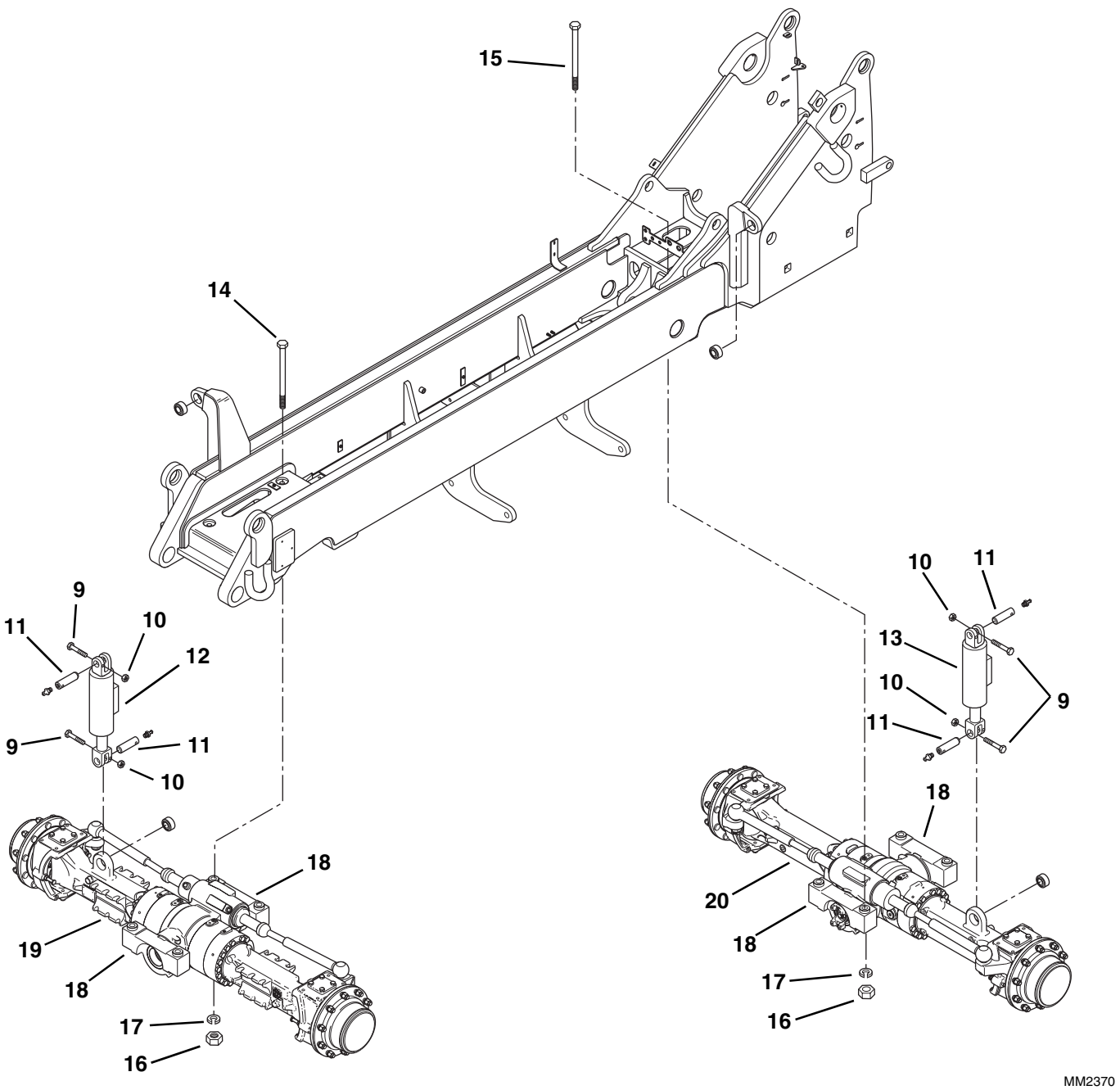
7. If the axle will be disassembled after removal, place a suitable receptacle under the axle drain plug (**1**). Remove the drain plug and allow the axle oil to drain into the receptacle. Transfer the used axle oil into a suitable covered container and label the container as used oil. Dispose of used oil at an approved recycling facility.



8. Label, disconnect and cap the steering and brake lines at the axle. Wipe up any spilled oil.
9. **Rear axle only:** Remove the cover from the LMI sender on the right side “beam” of the axle. Disconnect the pigtail on the sender from the wire harness.
10. Block the front and rear of both tires on the axle that is not being removed. Ensure that the vehicle will remain in place during axle removal before proceeding.
11. Raise the vehicle using a suitable jack or hoist. Place suitable supports under both sides of the frame and lower the vehicle onto the supports. Ensure that the vehicle will remain in place during axle removal.
12. Support the axle that is being removed with a suitable jack, hoist or overhead crane and sling. **DO NOT** raise the axle or the vehicle.
13. Mark and remove both wheel and tire assemblies from the axle that is being removed.
14. The drive shaft assembly is a balanced assembly. Mark the yoke and axle, transmission, transfer case, and the shaft and slip yoke so that these components can be returned to their original positions when reinstalled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.
15. Remove the four capscrews (**2**) and straps (**3**) securing the bearing crosses to the transfer case (**4**).
16. Remove the four capscrews (**5**) and straps (**6**) securing the bearing crosses to the axle (**7**).
17. Remove the drive shaft assembly (**8**).



18. Remove the capscrew (**9**) and elastic locknut (**10**) securing the lower position cylinder-mount pin (**11**) to the cylinder (**12**-Front or **13**-Rear). Tap the cylinder mount pin out, and move the cylinder to prevent it from interfering with axle removal.
19. Remove the four capscrews (**14**-Front or **15**-Rear), elastic locknuts (**16**), and lockwashers (**17**) securing the front and rear axle supports (rotating trunnions) (**18**) to the vehicle frame.
20. Remove the axle (**19**-Front or **20**-Rear), from the vehicle using the jack, hoist or overhead crane and sling supporting the axle. **DO NOT** raise or otherwise disturb the vehicle while removing the axle. Balance the axle and prevent it from tipping, turning or falling while removing it from beneath the vehicle. Place the axle on a suitable support or holding stand.



MM2370

b. Axle Inspection, Internal Service and Repair

Detailed axle service instructions (covering axle, brakes and wheel-end safety, repair, disassembly, reassembly, adjustment and troubleshooting information) are provided in the ZF Axle Repair Manuals, Model MS-T 3060, front axle with parking brake (ZF part number 5871 560 002, **JLG** part number 8990430) or Model MS-T 3045, rear axle without parking brake (ZF part number 5871 550 002, **JLG** part number 8990419).

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

c. Installation

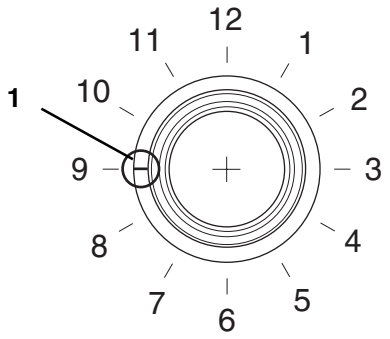
The front and rear axle assemblies differ in that the front axle assembly is equipped with a parking-brake mechanism and limited-slip feature; the rear axle has neither. The steps below outline a typical axle installation procedure, suitable for either the front or the rear axle assembly.

1. Before proceeding, ensure that the vehicle will remain in place during axle installation. Block the front and rear of both tires on the axle that is already installed on the vehicle.
2. If applicable, raise the vehicle using a suitable jack or hoist. Place suitable supports beneath the frame and lower the vehicle onto the supports, allowing enough room for axle installation. Ensure that the vehicle will remain in place during axle installation.
3. Using a suitable jack, hoist or overhead crane and sling, remove the axle from its support or holding stand. Balance the axle (**12**-Front or **13**-Rear) and prevent it from tipping, turning or falling while positioning it beneath the vehicle. **DO NOT** raise or otherwise disturb the vehicle while installing the axle. Keep the axle supported and balanced on the jack, hoist or overhead crane and sling throughout the installation procedure.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

4. Install the four 1-8 x 14" capscrews (**7**-Front) or 1-8 x 11" capscrews (**8**-Rear), four new 1-8 elastic locknuts (**9**), and four 1" lockwashers (**10**) securing the front or rear axle supports (**11**) to the vehicle frame. Torque to 680 lb/ft (922 Nm).

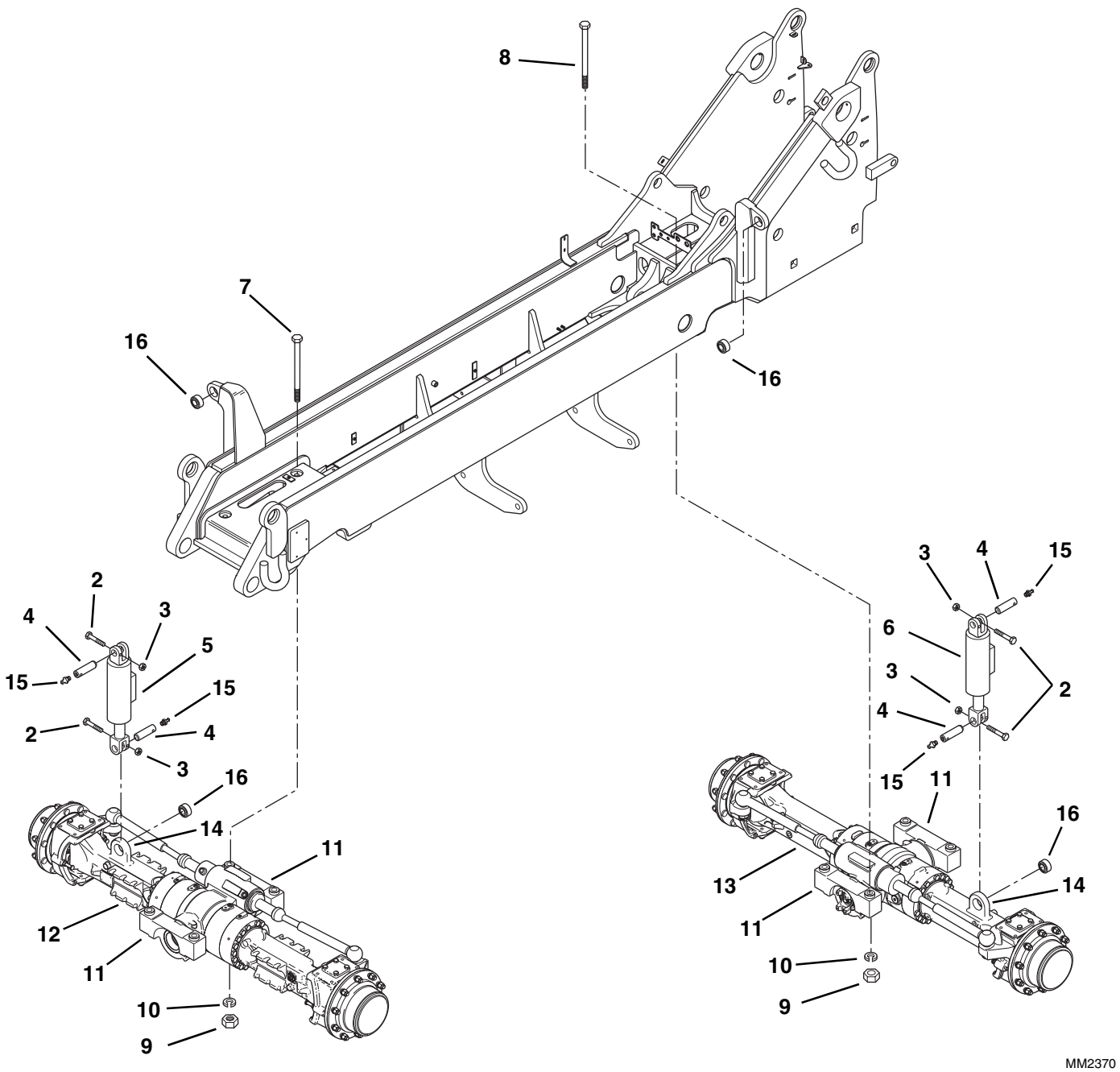
Note: *If new frame sway (front) or stabilizer (rear) cylinder bearings (**16**) have been installed in the axles or vehicle frame, the fracture (**1**) in the bearing race must be positioned at the position shown in illustration below.*



MT08212

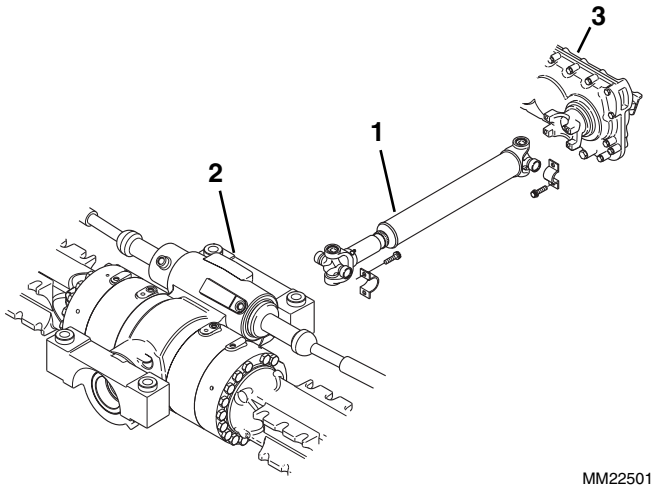
Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

5. Move the cylinder (**5**-Front or **6**-Rear) into position on the axle cylinder anchor (**14**). Insert a cylinder-mount pin (**4**) through the cylinder and cylinder anchor. Secure the cylinder-mount pin (**4**) with one 5/16-18 x 3-1/2" capscrew (**2**) and a new 5/16-18 elastic locknut (**3**).
6. Apply multi-purpose grease through the self-tapping lube fitting (**15**) to lubricate the self-align bearing (**16**) and the cylinder-mount pin (**4**).


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MM2370

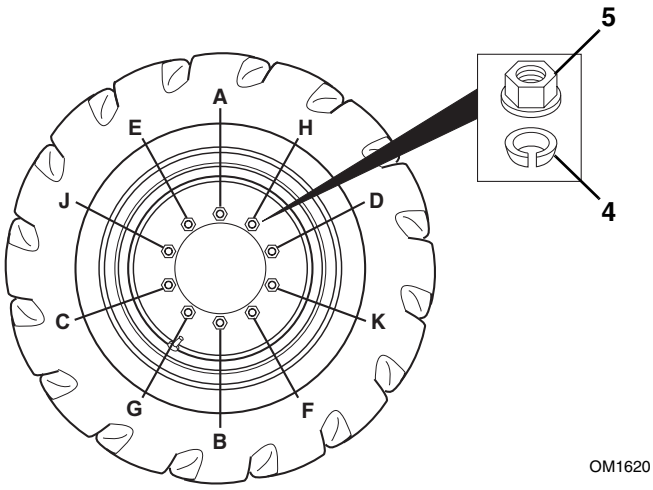
7. If reinstalling an axle previously removed from the vehicle, position the driveshaft (**1**) yoke on the axle (**2**) according to the alignment marks made earlier. If installing a new axle, note the position of the driveshaft yoke at the transfer case (**3**). Align the driveshaft yoke on the axle (**2**) in the same plane as the yoke on the transfer case (**3**).



MM22501

8. If the steer angle adjustment spacers were removed during internal service and repair procedure, re-insall the spacers and re-adjust the steer angle. (Refer to

9. Install the wheel and tire assemblies.
10. Install wheel lug nuts. Be sure to install the lockwashers (**4**), with narrow side toward the rim, under the lug nuts (**5**).
11. Use the torque sequence diagram (**A** - **K**), to alternately check the torque of each of the ten lug nuts. The recommended torque is 430-470 lb/ft (583-637 Nm).



OM1620

12. Carefully remove the jack, hoist or overhead crane and sling supporting the axle.
13. Carefully raise the vehicle using a suitable jack or hoist. Remove the supports from beneath the frame and lower the vehicle to the ground.
14. Remove the blocks from the front and rear of both tires on the other axle.
15. Uncap and connect the steering and brake lines at their axle fittings.

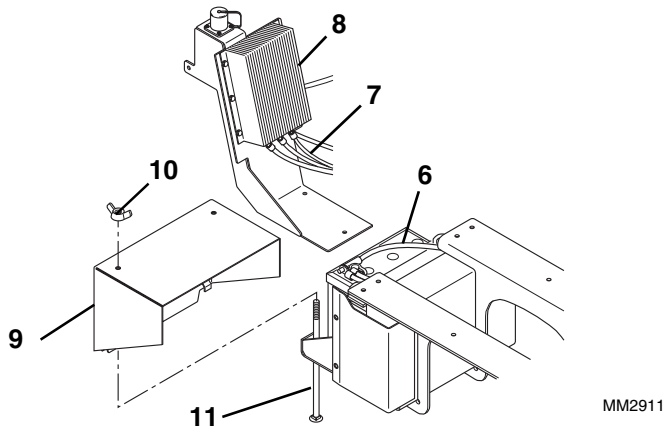
Note: *Always use new flat-faced o-rings when connecting hydraulic fittings.*

16. Check wheel end oil levels. Refer to Wheel End Oil Level Check, page 2.48
17. Check hydraulic reservoir oil levels. Refer to Hydraulic Oil Level Check, page 2.41

WARNING: Avoid prolonged engine operation in closed areas without adequate ventilation. Failure to properly ventilate exhaust fumes can result in death or severe personal injury.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Before starting the engine, tighten all hydraulic connections and remove all tools from the vehicle. **NEVER** check for leaks using any part of the human body; use a piece of cardboard or wood instead. Wear heavy, protective gloves and eye protection.

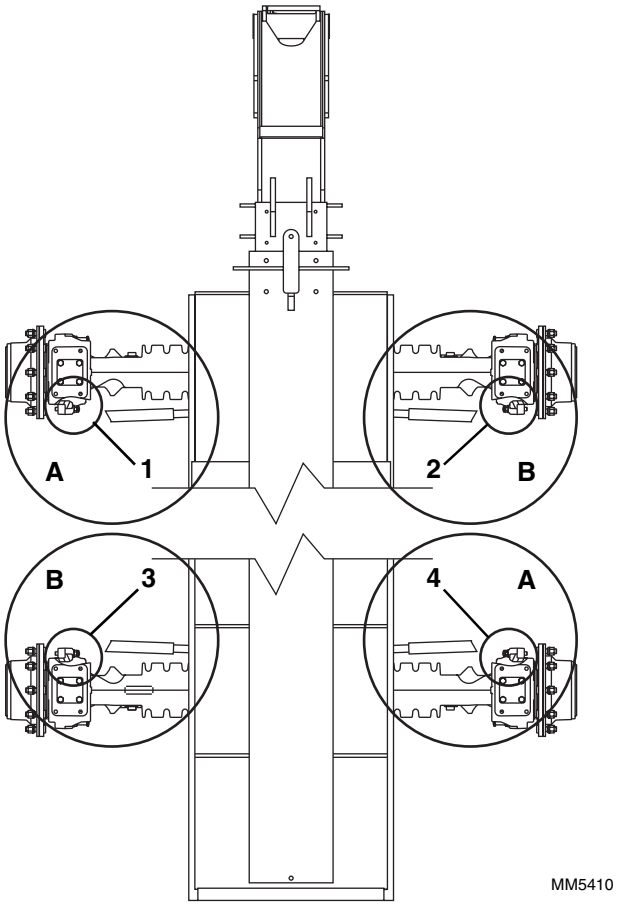
18. Connect the negative (-) battery cable (**6**) at the negative (-) terminal on the battery in the engine side battery box.
19. Connect the negative (-) battery equalizer cable (**7**) at the bottom of the battery equalizer (**8**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
20. Replace battery box cover (**9**). Use the wing nuts (**10**) and carriage bolts (**11**) to secure the cover in place.



21. Start the engine. Turn the steering wheel several times lock to lock, operate the frame sway function several times in both directions, and check the function of the brakes. Check for hydraulic leaks and tighten or repair as necessary.

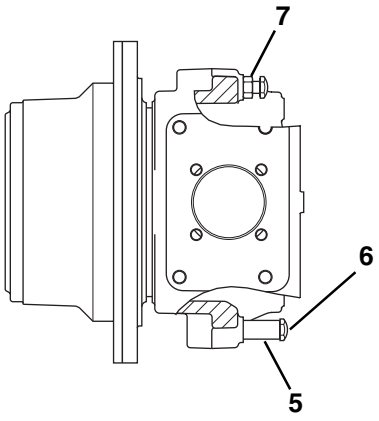
5.2.7 Steer Angle Adjustment

Whenever the steering knuckles are replaced or major axle or wheel end service is done, the steer angle may require re-setting. To re-set the steer angle, adjustments will need to be made with the vehicle in two different positions, **A** and **B,** on all four wheel ends at locations **1**, **2**, **3** and **4**.



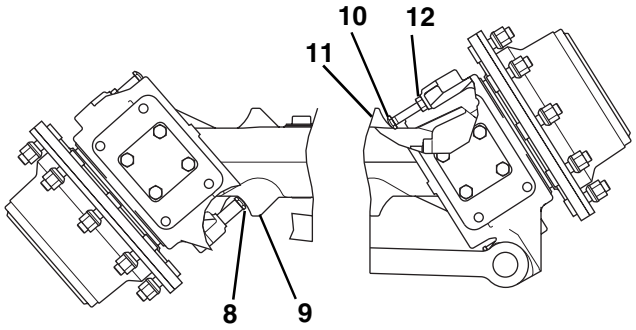
MM5410

1. Install the spacer (**5**) over capscrew (**6**). Apply Loctite® 242 (blue) to screw threads. Install the screw and spacer into axle knuckle positions **1**, **2**, **3** and **4**.



MM5420

2. Loosen the nuts (**7**) on the screws on the opposite sides of the axle knuckles.



MM5430

3. With vehicle steering set to 4-wheel steer, turn the wheel all the way to the left to adjustment position (**A**), where the adjustment screw head (**8**), in locations **1** and **4**, are in full contact with bridge casting (**9**).
4. Turn opposing adjustment screw (**10**), in both positions (**A**), until the head of the screw is firmly pressing against the bridge casting (**11**). Tighten the nut (**12**).
5. Repeat steps 1 through 4, this time turning the wheel all the way to the right to adjustment position (**B**) and adjust the steer angle stops in locations **2** and **3**.

5.2.8 Axle Service and Troubleshooting

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

Note: *Contact the **JLG** Service Department at 1-717-485-6417 (Domestic) or 1-877-554-5438 (International), if internal axle repair is required during the warranty period.*

Detailed axle service instructions (covering axle, brakes and wheel-end safety, repair, disassembly, reassembly and adjustment information) are provided in the ZF Axle Repair Manuals, Model MS-T 3060, front axle with parking brake (ZF part number 5871 560 002, **JLG** part number 8990430) or Model MS-T 3045, rear axle without parking brake (ZF part number 5871 550 002, **JLG** part number 8990419).

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

5.2.9 Axle Assembly Troubleshooting

Problem	Cause	Remedy
1. Excessive axle noise while driving.	1. Oil level too low.	1. Fill oil to correct level (refer to *Section 2.13.11, a. Axle Oil Level Check*).
	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 Universal Tractor Fluid (refer to *Section 2.13.11, b. Axle Oil Change* and/or *Section 2.13.13, b. Wheel End Oil Change*).
	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 Universal Tractor Fluid (refer to *Section 2.13.11, b. Axle Oil Change* and/or *Section 2.13.13, b. Wheel End Oil Change*).
	8. Axle housing damaged.	8. Replace damaged parts.
2. Intermittent noise when travelling.	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.

5.2.9 Axle Assembly Troubleshooting (Continued)

Problem	Cause	Remedy
3. 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 ZF Repair Manuals.
	5. Axle casing to brake housing and/or brake housing to differential assembly o-rings and/or seals worn or damaged.	5. Replace o-rings and seals.
	6. Axle housing mounting nuts and capscrews loose.	6. Tighten housing nuts and capscrews to 288 lb/ft (390 Nm).
	7. Differential and/or axle housing(s) damaged.	7. Replace housing(s) as needed.
4. 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).
5. 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.

5.2.9 Axle Assembly Troubleshooting (Continued)

Problem	Cause	Remedy
6. Axle overheating.	1. Oil level too high.	1. Fill oil to correct level with Universal Tractor Fluid (refer to *Section 2.13.11, a. Axle Oil Level Check*).
	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 Universal Tractor Fluid (refer to *Section 2.13.11, b. Axle Oil Change* and/or *Section 2.13.13, b. Wheel End Oil Change*).
7. High steering effort required.	1. Steering (hydraulic) system not operating properly.	1. Refer to *Section 9.8, Hydraulic Circuits and Troubleshooting*.
	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.
8. Slow steering response.	1. Steering (hydraulic) system not operating properly.	1. Refer to *Section 9.8, Hydraulic Circuits and Troubleshooting*.
	2. Steering cylinder leaking internally.	2. Repair or replace steering cylinder as needed.
9. Excessive noise when brakes are engaged.	1. Brake discs worn.	1. Check brake discs for wear (refer to *Section 2.13.12, Brake Disc Wear Check*).
	2. Brake discs damaged.	2. Replace brake discs.
10. Brakes will not engage.	1. Brake (hydraulic) system not operating properly.	1. Refer to *Section 9.8, Hydraulic Circuits and Troubleshooting*.
	2. Brake piston o-rings and seals damaged (leaking).	2. Replace o-ring and seals.
11. Brakes will not hold the vehicle or braking power reduced.	1. Brake discs worn.	1. Check brake discs for wear (refer to *Section 2.13.12, Brake Disc Wear Check*).
	2. Brake (hydraulic) system not operating properly.	2. Refer to *Section 9.8, Hydraulic Circuits and Troubleshooting*.
	3. Brake piston o-rings and seals damaged (leaking).	3. Replace o-ring and seals.

5.2.10 Axle Internal Component Troubleshooting

Note: *The following conditions may be noticed when inspecting parts during axle repair. Perform all remedies that apply to the conditions noticed.*

Problem	Cause	Remedy (See Note)
1. Differential ring gear teeth broken on the heel of the tooth.	1. Incorrect alignment of ring and pinion gears (excessive play). 2. Incorrect pinion (input) shaft bearing preload.	• Replace ring and pinion gears. • Adjust ring and pinion alignment and bearing preload as described in the ZF Repair Manuals.
2. Differential ring gear teeth broken on the toe of the tooth.	1. Incorrect alignment of ring and pinion gears (insufficient play). 2. Incorrect pinion (input) shaft bearing preload.	• Replace ring and pinions gears. • Adjust ring and pinion alignment and bearing preload as described in the ZF Repair Manuals.
3. Rapid differential ring and pinion gear teeth wear.	1. Insufficient lubrication. 2. Lubricant contaminated. 3. Incorrect lubricant.	• Replace ring and pinion gears. • Drain axle and fill to correct level with Universal Tractor Fluid (refer to *Section 2.13.11, b. Axle Oil Change*).
4. Differential ring and pinion gear teeth overheated.	1. Insufficient lubrication. 2. Lubricant contaminated. 3. Incorrect lubricant or level.	• Determine the cause of the problem and correct. • Replace ring and pinions gears. • Drain axle and fill to correct level with Universal Tractor Fluid (refer to *Section 2.13.11, b. Axle Oil Change* and/or *Section 2.13.13, b. Wheel End Oil Change*).
5. Gear teeth pitted.	1. Insufficient lubrication. 2. Lubricant contaminated. 3. Foreign objects in oil.	• Determine the cause of the problem and correct. • Replace gears. • Drain axle and fill to correct level with Universal Tractor Fluid (refer to *Section 2.13.11, b. Axle Oil Change* and/or *Section 2.13.13, b. Wheel End Oil Change*).
6. Worn or pitted bearings.	1. Incorrect bearing preload. 2. Insufficient lubrication. 3. Lubricant contaminated.	• Determine the cause of the problem and correct. • Replace bearings. • Adjust bearing preload as described in the ZF Repair Manuals. • Drain axle and fill to correct level with Universal Tractor Fluid (refer to *Section 2.13.11, b. Axle Oil Change* and/or *Section 2.13.13, b. Wheel End Oil Change*).

5.3 WHEELS AND TIRES

WARNING: Risk of death or serious personal injury. Mismatched tire sizes, star ratings or mixing of tire types (radial tires with bias-ply tire) may compromise vehicle stability and may cause vehicle to tip over.

Welded 13.00LR-25 steel wheels are used on the MMV.

The specified size and star rating for this vehicle is 15.5R25, L-2, 2 Star. Make sure the replacement tire is of the same size and star rating as all the other tires. A higher star rating can be used, but only when all four tires have the same star rating.

The tires are filled with air only when the vehicle leaves the factory. 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.

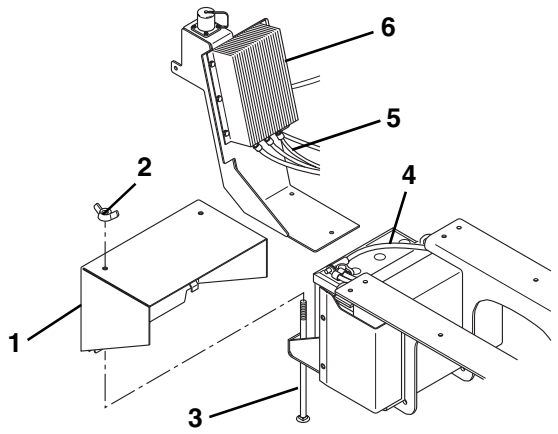
5.3.1 Removing Wheel and Tire Assembly from Vehicle

Wheel Removal Instructions:

- Position the vehicle on a flat, hard surface and support the vehicle with approved jack stands or suitable supports.
- Use appropriate safety glasses, safety shoes and appropriate clothing and equipment.
- **DO NOT** wear rings or jewelry. **DO NOT** wear hair or clothing that could become caught in machinery or pinch points such as those created between the tire and the hub.

WARNING: Risk of death or serious personal injury, if proper safety procedures are not followed. When removing wheel and tire assembly from the vehicle, follow the instructions in the “Wheel Removal Instruction” box that follows:

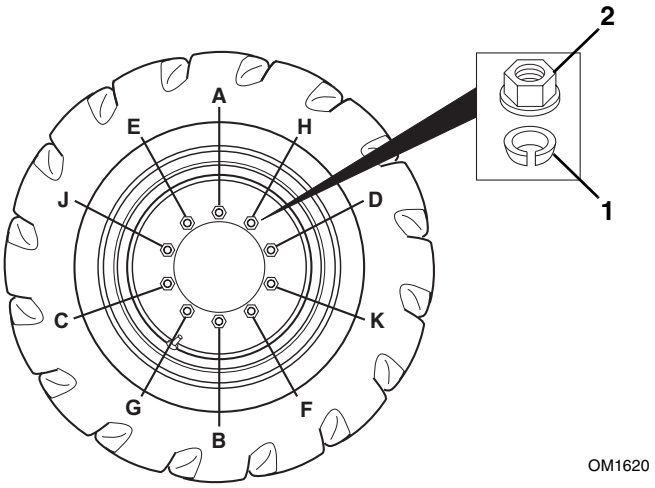
1. Park the vehicle on a firm, level surface. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch, straighten all wheels and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)



MM2911

3. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
4. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
5. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).
6. Loosen but **DO NOT** remove the lug nuts on the wheel and tire assembly to be removed.
7. Place a suitable jack under the axle pad closest to the wheel being removed. Raise the vehicle and position a suitable support beneath the axle. Allow sufficient room to lower the vehicle onto the support and to remove the wheel and tire assembly.
8. Lower the vehicle onto the support.

9. Remove lug nuts in an alternating pattern (**A** - **K**). There are separate lockwashers (**1**) under the lug nuts (**2**). Be sure the to save both the lockwashers and lug nuts for reassembly.



10. Remove the wheel and tire assembly from the vehicle.

5.3.2 Wheel Cleaning

WARNING: Dirt and rust prevent the tire from seating properly on the wheel, which could result in an explosive separation. Such explosions could result in death or severe personal injury to the tire installer and to those in the area.

Remove all rust, corrosion, dirt and other foreign material from all metal surfaces. In particular, the bead area (tire-to-wheel mounting surface) must be especially clean.

5.3.3 Wheel Inspection and Replacement

WARNING: Damaged, modified, repaired or mis-matched wheels and tires, or dirt and rust prevent the tire from seating properly on the wheel, which could result in an explosive separation. Such explosions could result in death or severe personal injury.

- **NEVER** rework, heat, weld or braze a wheel rim.
- Clean and inspect the wheel rim before installing a new tire. Verify that the wheel rim diameter exactly matches the tire rim diameter molded into the tire.
- Inspect the inside of the tire for dirt, foreign material, loose cords, cuts, penetrating objects, and other damage. **DO NOT** use tires with irreparable damage.

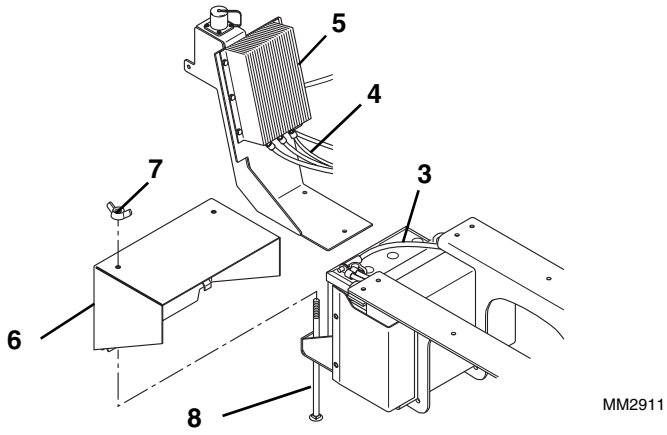
Check all surfaces of the wheel for rust, corrosion, cracks, bent flanges, deep marks or gouges. Replace a damaged, worn or cracked wheel. **NEVER** rework, heat, weld or braze a wheel rim.

Inspect the valve core and stem. Replace the entire valve if either component is damaged.

5.3.4 Installing Wheel and Tire Assembly onto Vehicle

1. Position wheel onto studs on wheel end of axle.
2. Install wheel lug nuts. Be sure to install the lockwashers (**1**), with narrow side toward the rim, under the lug nuts (**2**).
3. Use the torque sequence diagram (**A** - **K**), to alternately check the torque of each of the ten lug nuts. The recommended torque is 430-470 lb/ft (583-637 Nm).

4. Connect the negative (-) battery cable (**3**) at the negative (-) terminal on the battery in the engine side battery box.
5. Connect the negative (-) battery equalizer cable (**4**) at the bottom of the battery equalizer (**5**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
6. Replace battery box cover (**6**). Use the wing nuts (**7**) and carriage bolts (**8**) to secure the cover in place.



5.3.5 Tires

a. Dismounting Tire from Wheel

WARNING: Risk of death or serious personal injury. Using incorrect tire mounting methods, or using damaged or dirty components could result in an explosive separation. When dismounting a tire from a wheel, follow the instructions in the "Wheel Dismounting Instruction" box that follows.

Wheel Dismounting Instructions:

- Use safety chains, or place the wheel and tire assembly in a safety cage when deflating a tire or when inflating a newly mounted tire.
- Deflate tire completely before servicing. **NEVER** attempt to unseat the beads of an inflated tire.
- **NEVER** re-inflate a tire that has been run flat or seriously under-inflated. Without removing the tire from the wheel and checking for tire and wheel (rim) damage.
- **NEVER** hit a tire or wheel rim with a hammer or ANY object.
- Use the appropriate specialty tools and equipment for mounting a tire to a wheel or for dismounting a tire from a wheel, or have a qualified professional perform the work. **DO NOT** attempt to mount or dismount a tire without the proper tools, training and equipment.
- **NEVER** rework, heat, weld or braze a wheel rim with tire mounted.

b. Wheel Inspection and Replacement

WARNING: Damaged, modified, repaired or mis-matched wheels and tires, or dirt and rust prevent the tire from seating properly on the wheel, which could result in an explosive separation. Such explosions could result in death or severe personal injury.

- **NEVER** rework, heat, weld or braze a wheel rim.
- Clean and inspect the wheel rim before installing a new tire. Verify that the wheel rim diameter exactly matches the tire rim diameter molded into the tire.
- Inspect the inside of the tire for dirt, foreign material, loose cords, cuts, penetrating objects, and other damage. **DO NOT** use tires with irreparable damage.

Replace any tire that is worn or cut through the cords. When replacing a tire, follow the recommendations of the tire manufacturer.

c. Tire and Wheel Lubrication

WARNING: Risk of death or serious personal injury. Use an approved tire-mounting lubricant only. **NEVER** use anti-freeze, silicones or petroleum-based lubricants.

Prior to mounting the tire on the rim, apply a suitable lubricant to the bead-seat area of the wheel rim and tire bead. Use a lubricant specified by the wheel and tire manufacturers.

d. Mounting Tire onto Wheel

WARNING: Risk of death or serious personal injury. Using incorrect tire mounting methods, or using damaged or dirty components could result in an explosive separation. When mounting a tire onto a wheel, follow the "Wheel Mounting Instructions" box below.

1. Read, understand and follow the above warning message.

Wheel Mounting Instructions:

- Use the appropriate specialty tools and equipment for mounting a tire to a wheel or for dismounting a tire from a wheel, or have a qualified professional perform the work. **DO NOT** attempt to mount or dismount a tire without the proper tools, training and equipment.
- Clean and inspect the wheel rim before installing a new tire. Verify that the wheel rim diameter exactly matches the tire rim diameter molded into the tire.
- Inspect the inside of the tire for dirt, foreign material, loose cords, cuts, penetrating objects, and other damage. **DO NOT** use tires with irreparable damage.
- Use an approved tire-mounting lubricant only. **NEVER** use anti-freeze, silicones or petroleum-based lubricants.
- Use safety chains, or place the wheel and tire assembly in a safety cage when deflating a tire or when inflating a newly mounted tire.
- Inflate the tire to the cold-operating pressure recommended by the tire manufacturer.

2. Clean, inspect and replace the wheel if necessary. **DO NOT** use a damaged or cracked wheel.
3. Orient the tire in the direction of forward travel required.
4. Lubricate the inner tire and rim beads with an approved tire-mounting lubricant only. **NEVER** use anti-freeze, silicones or petroleum-based lubricants.
5. Push the inner bead of the tire over and around as much of the wheel rim as possible. Use tire irons or a suitable, commercially available pneumatic tire installation machine to work the bead completely over the rim in small increments. Be careful not to damage the bead.
6. Lubricate the outer tire and rim beads with an approved tire-mounting lubricant.
7. Starting opposite the valve hole, use tire irons to work the outer tire bead over the wheel rim. Work the bead completely over the rim in small increments (**DO NOT** damage the bead).



8. Install a new valve stem into the valve stem hole on the wheel.
9. Center the tire on the wheel. Inflate the tire until it fully seats on the wheel rim or to 35 psi (241,1 kPa). **DO NOT** exceed 35 psi (241,1 kPa). Use an extension hose with a clip-on air chuck and pressure gauge to permit the installer to stand at a safe distance from the tire. Each tire bead will usually snap or pop into place, indicating that the bead is seated.

Note: *If either bead should fail to seat at 35 psi (241,1 kPa), the tire may be pinched or another source may be interfering with proper mounting.* ***DO NOT*** *increase inflation pressure to seat the beads. Remove the valve core and completely deflate the tire. Break both beads loose from the rim and inspect the tire, rim and inner tube, if applicable. Lubricate the tire bead, install the valve core and repeat the 35 psi (241,1 kPa) inflation procedure until the beads seat properly.*

10. After the beads have seated, remove the valve core and fully deflate the tire, but **DO NOT** break the bead or separate the tire from the wheel. Re-install the valve core and inflate the tire to 87 psi (600 kPa).

e. Tire Speed and Road Surface Limitations

The tires on this vehicle are designed for low-speed operations not to exceed 25 mph (40 km/hr). If the vehicle is towed at high speeds, high temperatures may develop under the tread bars, causing a shifting of the tread bars and a weakening of the tire material and cord fabric. There may be no visible evidence of this type of damage, but later, a failure can occur. If tires are to operate for any length of time on a paved road, highway or other hard surface, increase pressure in the tire to the maximum amount recommended by the tire manufacturer to help reduce the chances of damage, or arrange to have the vehicle transported on a flat-bed truck.

f. Care and Storage of Tires

Store unmounted tires vertically, standing on their tread. If stored for an extended period of time, rotate the tires periodically to help reduce stress concentrations in the ground contact area of the tread. Tires should not be stored flat or stacked vertically (“stove piped”) as they will become flattened and distorted, making mounting difficult, particularly for tubeless tires.

Store mounted tires as noted above, but reduce the inflation pressure to 10 psi (68,9 kPa).

Store tires indoors in a cool, dark, dry area away from drafts. Heat and light can cause oxidation on the tire surface, which leads to decomposition (“crazing”) and weather checking. **NEVER** store tires on oily surfaces or in contact with oil, grease, petroleum-based substances, anti-freeze or solvents. Tires should not be stored near volatile substances. Tires absorb volatile substances, which damage and weaken the tire.

Tires should not be stored outside or in direct sunlight. If there is no other alternative, tires stored outside must be covered or otherwise protected from sunlight, wind and rain. Use an unbroken, opaque covering to help protect tires stored outdoors.

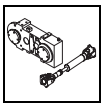
Store tires away from electric motors, generators, arc welders, etc., as these generate ozone, which attacks rubber and causes crazing and weather checking.

Exposure to weather will also cause cracking or crazing of the rubber as well as deterioration of the tire carcass, particularly where rainwater is permitted to accumulate in the tire.

When extended vehicle storage is anticipated, the vehicle should be placed on suitable supports with the tires raised out of ground contact. Inflation pressure in the tire should then be reduced to 10 psi (68,9 kPa). Keep the tires out of contact with sunlight, wind and rain as noted above.

If it is not possible to raise the vehicle, increase tire inflation pressure by 25 percent. Move the vehicle periodically to change the location of stress concentrations in the tire ground contact area.

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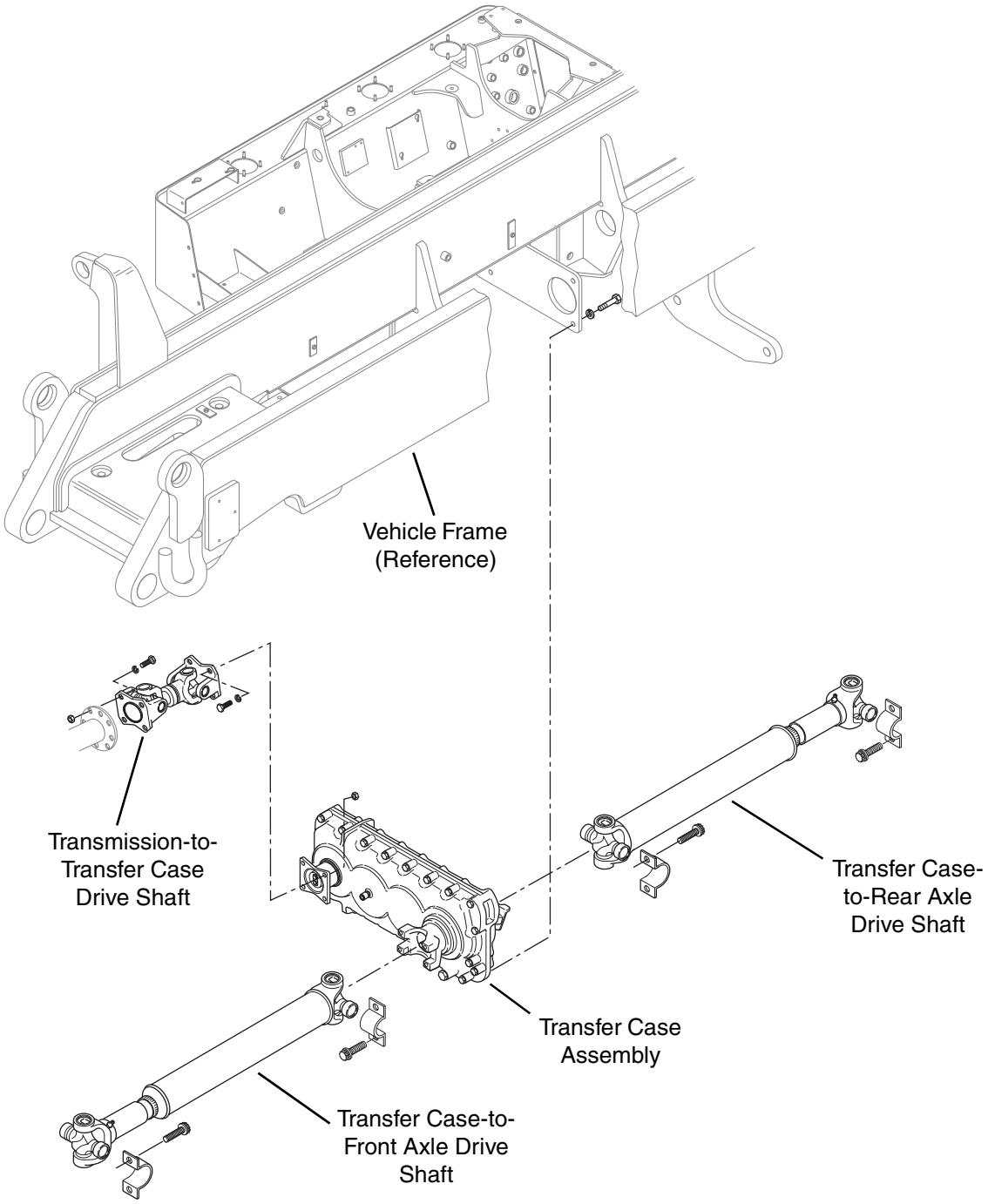
Section 6
Transfer Case and Drive Shafts

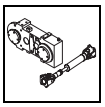
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6.1 TRANSFER CASE AND DRIVE SHAFT COMPONENT TERMINOLOGY

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





> **WARNING:** **DO NOT** service the vehicle without following all safety precautions as outlined in the "Safety Practices" section of this manual. Failure to follow the safety practices may result in death or serious injury.

6.2 GENERAL INFORMATION

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

Before performing any inspection, maintenance or service operation, thoroughly clean the unit. The transfer case and drive shafts should be checked and repaired only by experienced service technicians who are aware of all safety instructions and particular component features.

Use suitable products to thoroughly clean all disassembled mechanical parts to help prevent personal injury to the worker and damage to the parts. Carefully inspect the integrity of all moving parts (bearings, yokes, tubes, gears, shafts, etc.) and fasteners (nuts, bolts, washers, etc.) as they are subject to major stress and wear. Always replace elastic locknuts and any damaged, worn, cracked, seized, or otherwise improper parts that could affect the safe and proper functioning of the vehicle, transfer case and drive shafts.

6.3 TRANSFER CASE

6.3.1 Transfer Case Description

The ZF Model TB 92-432 transfer case is a single-speed, mechanical unit designed for heavy-duty commercial use. The transfer case is located beneath the frame of the vehicle, mounted to the vehicle frame, behind the transmission and ahead of the rear axle.

6.3.2 Transfer Case Operation

Torque (twisting power) is transferred through a single output shaft from the transmission, to the transfer case, and out to the drive axles via two drive shafts, one for the front axle, one for the rear axle. The transfer case is equipped with a set of four gears having a 1:1 drive ratio. The drive shafts are of commercial-duty, welded-steel, tube-type design, supported by Cardan-type cross and bearing tapered roller bearing assemblies (universal joints) secured to flanges and slip yokes.

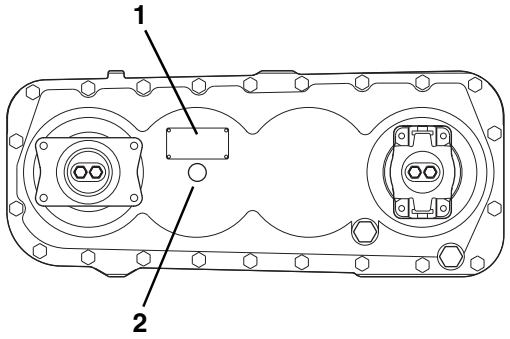
Detailed transfer case service instructions covering repair, disassembly, reassembly, adjustment and troubleshooting information is provided in the ZF Model TB 92-432 Transfer Case Operating and Repair Manual (ZF part number 32.70.4950.6002, **JLG** part number 8990423). For example, transfer case shaft bearing adjustment is accomplished during disassembly/reassembly procedures not covered in this manual; consult the ZF manual for information.

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

The transfer case and drive shafts should be checked and repaired only by experienced service technicians who are aware of all safety instructions and particular component features.

6.3.3 Serial Number Plate

The ZF serial number plate (**1**) is riveted to the front of the transfer case above the breather (**2**). Information specified on the serial number plate includes Type (TB 92-432), Serial Number, ZF reference number, Oil Specification (oil type), and Ratios (final gear ratio, 1.0083:1). Write this information down in a convenient location to use in transfer case correspondence.



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6.3.4 Transfer Case Specifications

General transfer case and drive shaft specifications are found in *Section 2, General Information, Specifications and Maintenance*. Transfer case fluid information is found in *Section 2.6.1, Axles (Differential Housings) and Transfer Case*.

6.3.5 Further Information

Detailed transfer case service instructions covering repair, disassembly, reassembly, adjustment and troubleshooting information is provided in the ZF Model TB 92-432 Transfer Case Operating and Repair Manual (ZF part number 32.70.4950.6002, **JLG** part number 8990423).

6.3.6 Technical Data

1.	Transfer Case Type:	ZF Model TB 92-432
2.	Description:	Single-speed transfer case
3.	Forward Reduction Ratio:	1:1
4.	Reverse Reduction Ratio:	1:1
5.	Total Reduction Ratio:	1:1
6.	Input Rotation:	Reversible; clockwise and counter-clockwise
7.	Maximum Input RPM:	3,300
8.	Maximum Input Torque:	1832 lb/ft (2485 Nm)
9.	Oil Capacity:	1.5 quarts (1,4 liters)
10.	Oil Type:	Universal Tractor Fluid
11.	Oil Operating Temperature	176-230°F (80-110°C)
12.	Bearing End Play:	.035-.055" (0,09-0,14 mm)
13.	Sealing Compounds:	Loctite® 270, 518

Note: *Transfer case shaft bearing adjustment procedures are not covered in this manual. Refer to the ZF Model TB 92-432 Transfer Case Operating and Repair Manual (ZF part number 32.70.4950.6002, **JLG** part number 8990423).*

6.3.7 Transfer Case Inspection and Service

Whenever servicing the vehicle, conduct a visual inspection of the transfer case. A few moments spent doing this can help prevent further problems and down time later.

Inspect the transfer case in its entirety, especially the main casting, for any cracks, dents or other damage. Look for oil seepage or leaks around the drive shaft flange mounts. Check all bolts for proper torque.

While the vehicle is under warranty, **JLG** does not recommend the servicing of gears, shafts or bearings inside the transfer case. Attempts at disassembly of these internal transfer case items may void the warranty, cause damage to other parts and to the transfer case casting (housing) itself.

*Contact the **JLG** Service Department at 1-717-485-5161 (Domestic) or 1-877-554-5438 (International), if internal transfer case repair is required during the warranty period.*

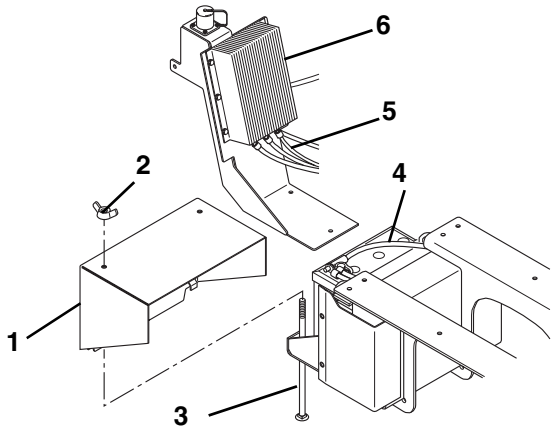
If service of internal transfer case components is required and the transfer case is not under warranty. Refer to the ZF Model TB 92-432 Transfer Case Operating and Repair Manual (ZF part number 32.70.4950.6002, **JLG** part number 8990423), or consult an authorized ZF repair center or dealer.

6.3.8 Transfer Case Maintenance

Information regarding checking the transfer case oil level and/or changing the transfer case oil is located in *Section 2.13.14, Transfer Case Oil*.

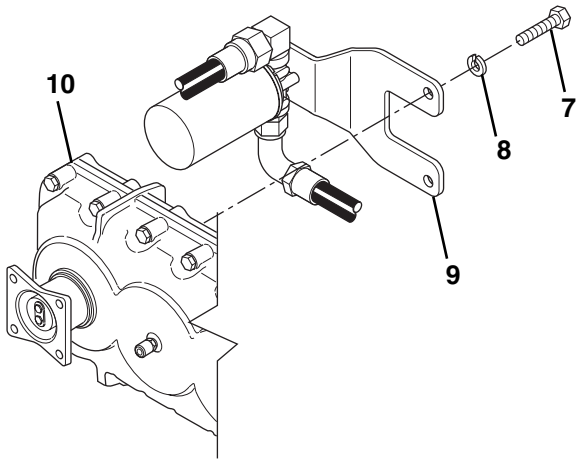
6.3.9 Transfer Case Removal

1. Level the vehicle, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover. Allow the engine, transmission and hydraulic fluid to cool.
4. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
5. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
6. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



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7. Remove the two capscrews (**7**) and lockwashers (**8**) securing the remote engine oil filter assembly (**9**) to the transfer case (**10**).

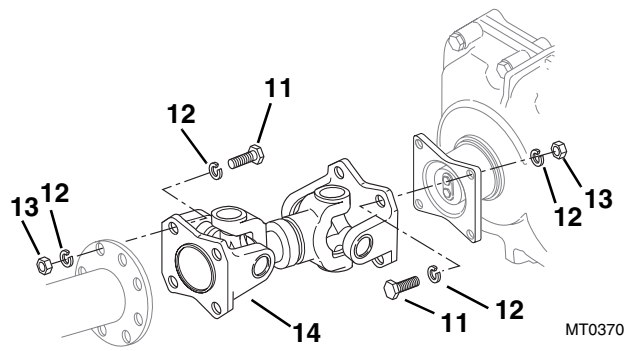


8. Leave the hoses and fittings connected to the filter head and allow the entire remote engine oil filter assembly (**9**) to hang down out of the way of transfer case removal.

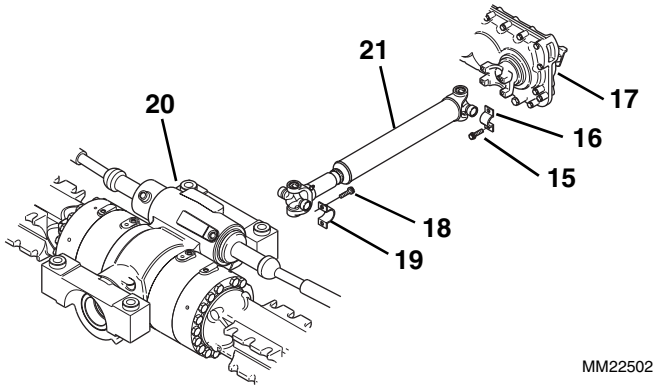
IMPORTANT: *To help ensure optimum performance, the drive shaft assemblies are specially balanced as a unit at the factory. When servicing any flange yoke, slip yoke or drive shaft tube, order a complete assembly if components are bent or damaged. Refer to the appropriate parts manual for ordering information.*

Note: *The drive shaft assemblies are balanced assemblies. Mark the yoke and transmission, transfer case, axles, and the shaft and slip yoke so that these components can be returned to their original positions when reinstalled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.*

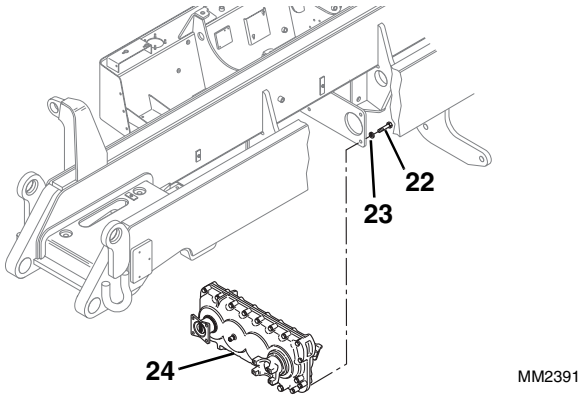
9. Remove the eight [4-Front and 4-Rear] capscrews (**11**), sixteen [8-Front and 8-Rear] lockwashers (**12**) and eight [4-Front and 4-Rear] nuts (**13**) securing the flange yokes to the transfer case and transmission.
10. Remove the drive shaft assembly (**14**).



11. Remove the four capscrews (**15**) and two straps (**16**) securing the bearing crosses to the tran sfer case (**17**).
12. Remove the four capscrews (**18**) and two straps (**19**) securing the bearing crosses to the rear axle (**20**).
13. Remove the rear drive shaft assembly (**21**).
14. Repeat Steps 11-13 to remove the front drive shaft assembly.



15. Position a transmission jack or suitable lifting device beneath the transfer case. Operate the jack to contact and support the transfer case, but **DO NOT** jack up or raise the transfer case itself. Secure the transfer case to the jack or lifting device with a sling.
16. Unbolt the four capscrews (**22**) and lockwashers (**23**) securing the transfer case (**24**) to the vehicle chassis. Carefully lower the transfer case and remove it from beneath the vehicle.



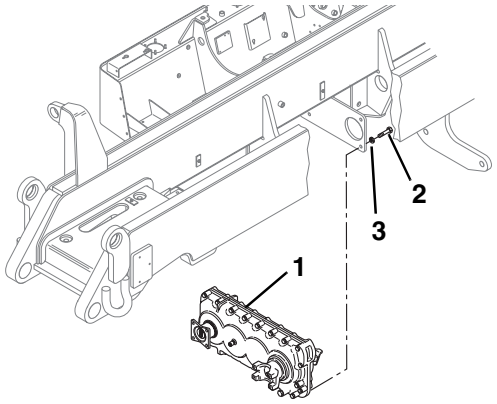
6.3.10 Internal Transfer Case Repair

Detailed transfer case service instructions covering repair, disassembly, reassembly, adjustment and troubleshooting information are provided in the ZF Model TB 92-432 Transfer Case Operating and Repair Manual (ZF part number 32.70.4950.6002, **JLG** part number 8990423).

6.3.11 Transfer Case Installation

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

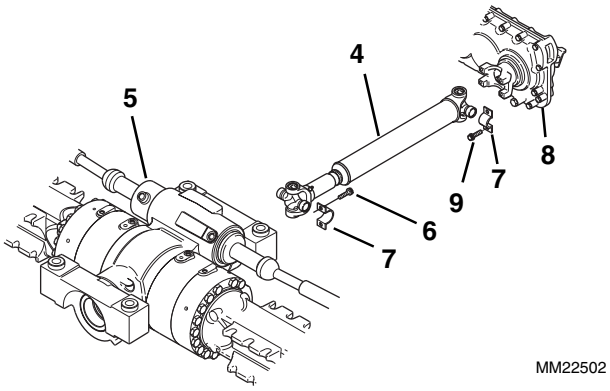
1. Secure the transfer case (**1**) to a suitable transmission jack or lifting device. Raise the transfer case into position under the vehicle, within the engine mount (subframe) and vehicle chassis. Use four new, Loctite® 242 (blue) coated M16 x 2 x 35 mm capscrews (**2**) and four M16 lockwashers (**3**) to fasten the transfer case to the chassis. Torque to 145 lb/ft (197 Nm).



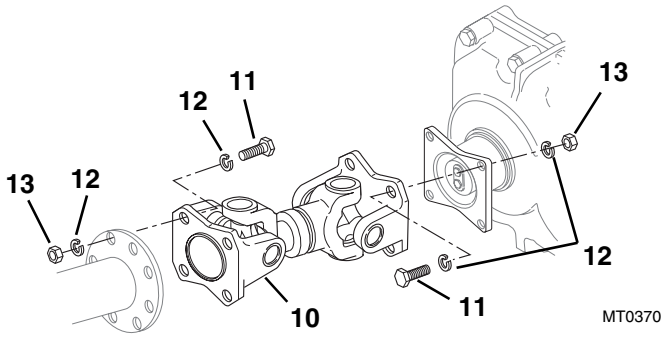
2. Install the front and rear axle drive shafts (**4**) to the transfer case (**8**) (according to the alignment marks made during removal, unless installing new drive shafts).

   Install the end of the drive shaft with the slip yoke to the axle (**5**). Secure the bearing cross to the yoke using four capscrews (**6**) and two straps (**7**). Torque to 60 lb/ft (81 Nm).

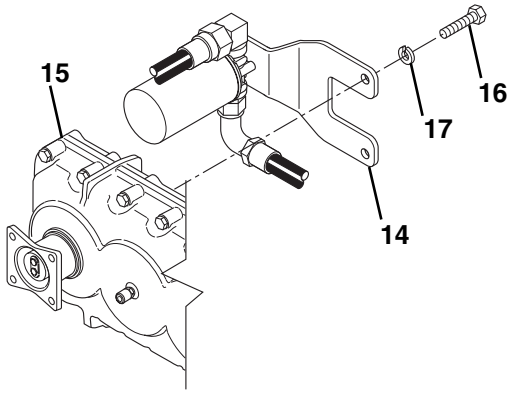
   Install the other end of the drive shaft to the transfer case (**8**) yoke and secure the bearing cross to the yoke using four capscrews (**9**) and two straps (**7**). Torque to 60 lb/ft (81 Nm).



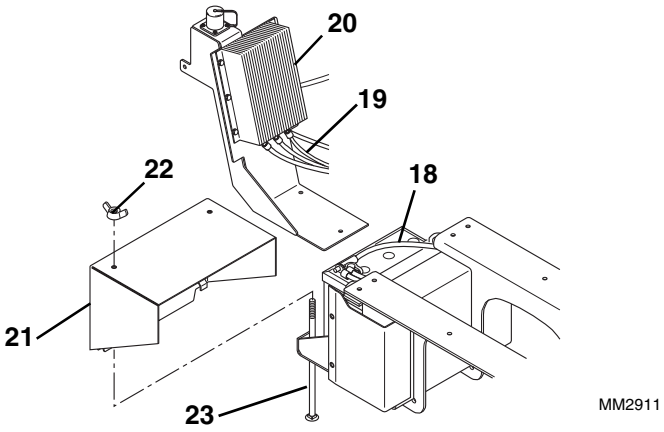
3. Install the transmission to transfer case input drive shaft (**10**) according to the reference marks made during removal. Bolt the flange yokes to the transfer box and to the transmission using eight [4-Front and 4-Rear] 1/2-20 x 2.0" NF Grade 8 capscrews (**11**), sixteen [8-Front and 8-Rear] 1/2" lockwashers (**12**) and eight [4-Front and 4-Rear] 1/2-20 NF nuts (**13**). Torque to 105 ±10 lb/ft (142 ±14 Nm).



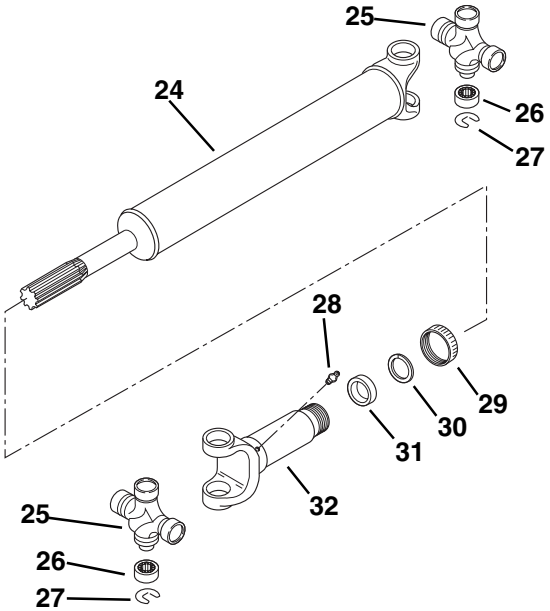
4. Install the remote engine oil filter assembly (**14**) to the transfer case (**15**). Secure in place using two M16 x 2 x 45 mm capscrews (**16**) and M16 lockwashers (**17**). Torque to 145 lb/ft (197 Nm).



5. Connect the negative (-) battery cable (**18**) at the negative (-) terminal on the battery in the engine side battery box.



6. Connect the negative (-) battery equalizer cable (**19**) at the bottom of the battery equalizer (**20**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
7. Replace engine side battery box cover (**21**). Use the wing nuts (**22**) and carriage bolts (**23**) to secure the cover in place.



24. Yoke shaft (1)
25. Cross (2)
26. Needle bearings and cap (8)
27. Snap ring (4)
28. Grease fitting (1)
29. Dust cap (1)
30. Washer (1)
31. Felt seal (1)
32. Slip yoke (1)

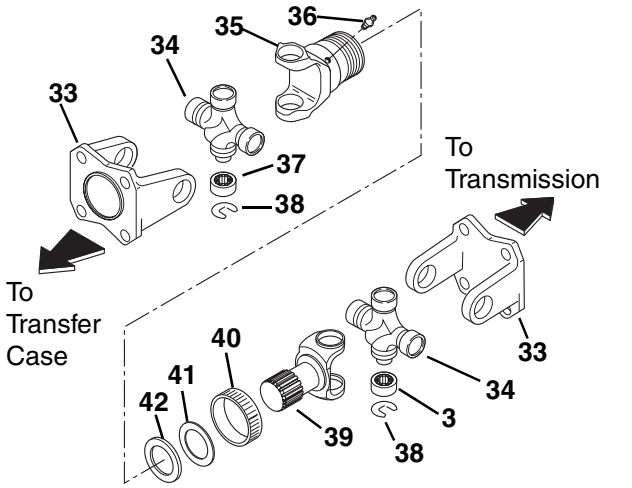
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6.4 DRIVE SHAFTS

6.4.1 Drive Shaft Inspection and Service

Whenever servicing the vehicle, conduct a visual inspection of the drive shafts and cross and bearing assemblies (universal joints, or U-joints). A few moments spent doing this can help prevent further problems and down time later.

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



33. Yoke flange (2)
34. Cross (2)
35. Slip yoke (1)
36. Grease fitting (1)
37. Needle bearings and cap (8)
38. Snap ring (4)
39. Yoke shaft (1)
40. Dust cap (1)
41. Washer (1)
42. Felt seal (1)

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1. Individually inspect each cross (**25** or **34**) the needle bearings and cap (**26** and **37**) for signs of wear or for missing parts.

Note: *Replace the cross and bearings as a complete assembly if any parts are worn or missing. If all parts of the cross and bearing assemblies are in good condition, pack the bearing caps with a premium grade of multi-purpose wheel-bearing grease. Reattach the bearing cap to the cross, assuring that all needle bearings are present. Then, reassemble the cross and bearing assembly into the drive shaft yoke.*

2. Replace the felt seal (**31** or **42**) if worn or damaged.
3. Replace the entire drive shaft assembly if any flange yoke, slip yoke or drive shaft tube is severely dented or damaged.
4. Cross assemblies should flex and be free from excessive binding. A slight amount of drag or resistance is desirable on a new cross and bearing assembly. Excessive looseness causes unbalance.

6.4.2 Drive Shaft Maintenance

Information regarding the lubrication of the grease fittings on the drive shafts is located in *Section 2.6.3, Lubrication Points (Grease Fittings)*.

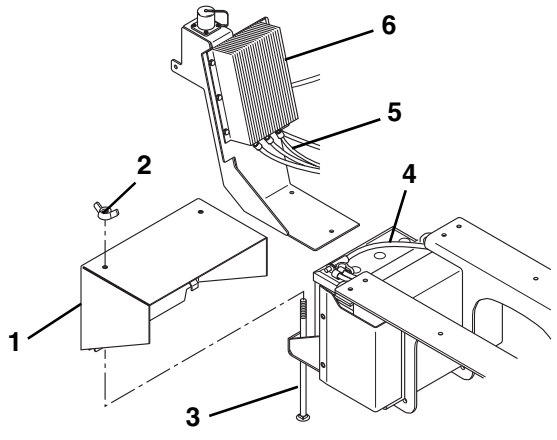
6.4.3 Drive Shaft Removal

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

Note: *The drive shaft assemblies are balanced assemblies. Mark the yoke and axle, transmission, transfer case, and the shaft and slip yoke so that these components can be returned to their original positions when reinstalled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.*

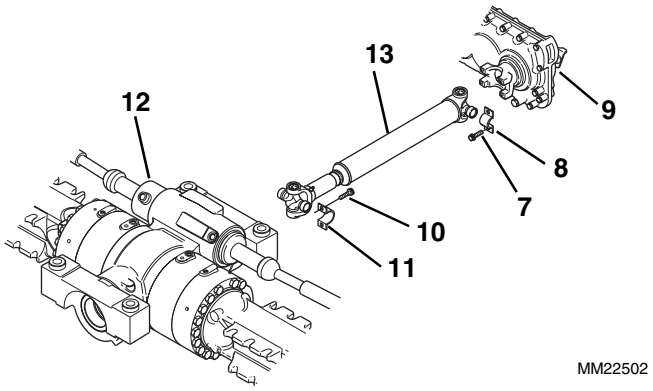
a. Transfer Case-to-Axle Drive Shafts

1. Level the vehicle, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover. Allow the engine, transmission and hydraulic fluid to cool.



MM2911

4. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
5. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
6. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).
7. Remove the four capscrews (**7**) and two straps (**8**) securing the bearing crosses to the transfer case (**9**).
8. Remove the four capscrews (**10**) and two straps (**11**) securing the bearing crosses to the rear axle (**12**).
9. Remove the drive shaft assembly (**13**).

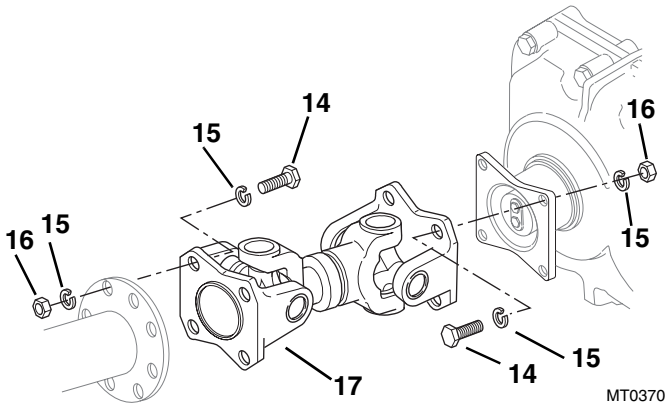


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b. Transmission-to-Transfer Case Drive Shaft

1. Level the vehicle, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover. Allow the engine, transmission and hydraulic fluid to cool.
4. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
5. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.

6. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).
7. Remove the eight [4-Front and 4-Rear] capscrews (**14**), sixteen [8-Front and 8-Rear] lockwashers (**15**) and eight [4-Front and 4-Rear] nuts (**16**) securing the flange yokes to the transfer box and transmission.
8. Remove the drive shaft assembly (**17**).



6.4.4 Drive Shaft Disassembly

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

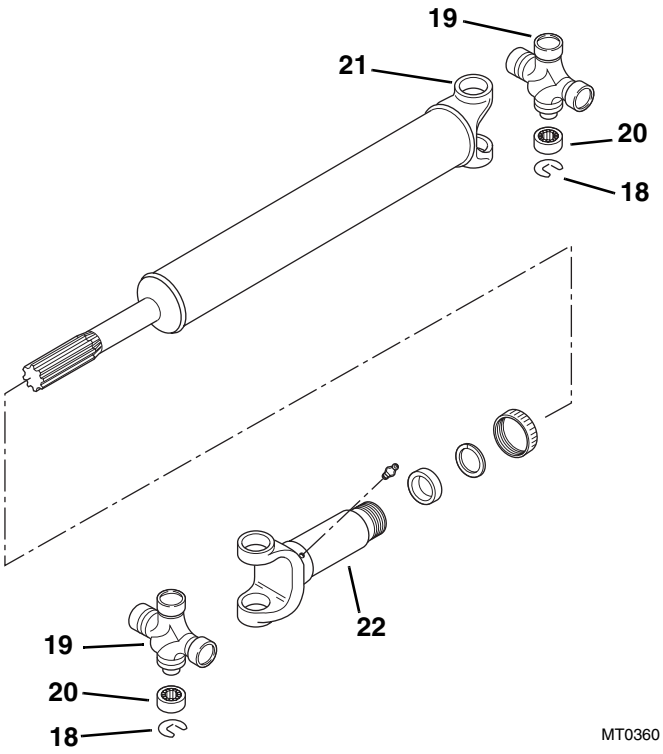
a. Transfer Case-to-Axle Drive Shafts

1. Use an approved, non-flammable cleaning fluid to thoroughly clean the drive shaft assembly with a brush. Wipe dry before disassembling.

	CAUTION: Avoid using excess force when clamping the drive shaft in a vise. Apply only enough force to hold the drive shaft securely. Excessive force can damage the drive shaft, resulting in an unbalanced condition.

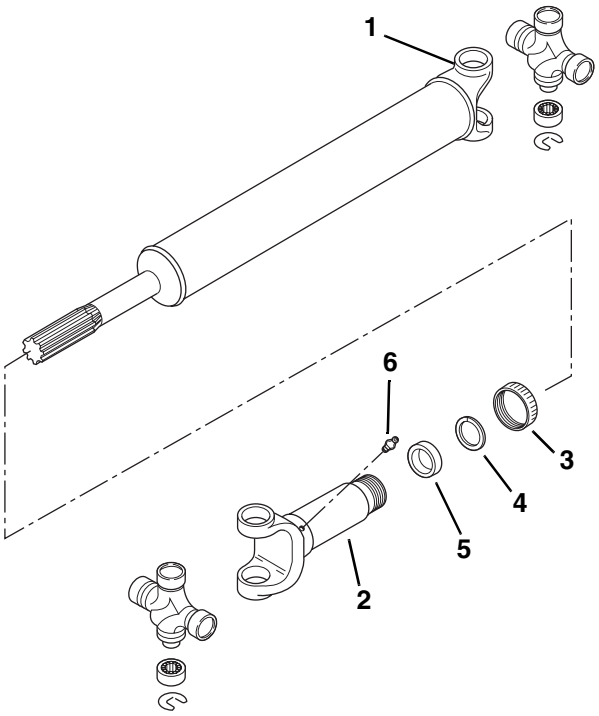
2. Place the drive shaft assembly in a bench vise.
3. Use a pair of pliers to pinch the ends of the snap rings (**18**) securing the cross (**19**) and bearing (**20**) assemblies to the yoke (**21** or **22**). Remove the snaps rings from their grooves in the yoke.

Note: *If the snap rings fail to readily snap out of their grooves in the yokes, tap the end of the bearing cap lightly to help relieve pressure against the snap rings.*



4. Use a soft, round drive pin with a flat face approximately 1/32 of an inch (0,8 mm) smaller than the hole diameter in the yoke to drive on one end of the cross and bearing assembly until the opposite bearing assembly comes out of the yoke.
5. Turn the yoke over and tap on the exposed end of the cross until the opposite bearing assembly comes out of the yoke.
6. Remove the cross (**19**) from the yoke (**21** or **22**).
7. Repeat Steps -6 to remove the cross and bearing assembly on the other end of the drive shaft.

8. Mark the yoke shaft (**1**) and slip yoke (**2**) so that they can be properly aligned when reassembled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.
9. Unscrew the dust cap (**3**) and slide the slip yoke (**2**) off of the drive shaft splines.
10. Remove the dust cap (**3**), split retaining ring (**4**), and felt seal (**5**) from the shaft assembly.



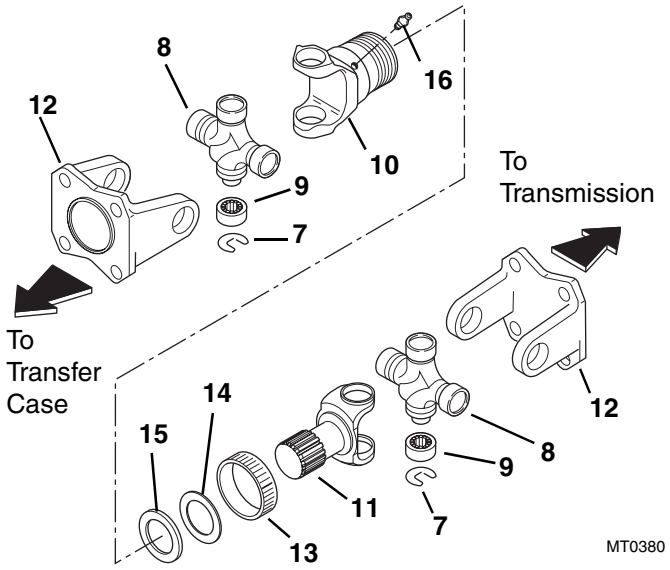
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b. Transmission-to-Transfer Case Drive Shaft

1. Use an approved, non-flammable cleaning fluid to thoroughly clean the drive shaft assembly with a brush. Wipe dry before disassembling.
2. Place the drive shaft assembly in a bench vise.
3. Use a pair of pliers to pinch the ends of the snap rings (**7**) securing the cross (**8**) and bearing (**9**) assemblies to the yokes (**10** or **11**). Remove the snap rings from their grooves in the yokes.

Note: *If the snap rings fail to readily snap out of their grooves in the yokes, tap the end of the bearing cap lightly to help relieve pressure against the snap rings.*

4. Use a soft, round drive pin with a flat face approximately 1/32 of an inch (0,8 mm) smaller than the hole diameter in the yoke to drive on one end of the cross and bearing assembly until the opposite bearing assembly comes out of the yoke.
5. Turn the yoke over and tap on the exposed end of the cross until the opposite bearing assembly comes out of the yoke.
6. Remove the cross from the yoke.
7. Repeat Steps 2-6 to remove the cross and bearing assembly on the other end of the drive shaft.
8. Use a pair of pliers to pinch the ends of the snap rings (**7**) securing the cross (**8**) and bearing (**9**) assemblies to the flange yoke (**12**). Remove the snap rings from their grooves in the yokes.
9. Use a soft, round drive pin with a flat face approximately 1/32 of an inch (0,8 mm) smaller than the hole diameter in the yoke to drive on one end of the cross and bearing assembly until the opposite bearing assembly comes out of the yoke.
10. Repeat Steps 8 and 9 to remove the cross and bearing assembly on the other flange yoke.
11. Mark the shaft and slip yoke so that they can be properly aligned when reassembled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.
12. Unscrew the dust cap (**13**) and slide the slip yoke (**11**) off of the drive shaft splines.
13. Remove the dust cap (**13**), split retaining ring (**14**), and felt seal (**15**) from the shaft assembly.



6.4.5 Drive Shaft Cleaning and Drying

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

6.4.6 Drive Shaft Assembly

1. Install the dust cap (**3** or **13**), split retaining ring (**4** or **14**), and felt seal (**5** or **15**) onto the splines of the drive shaft tube assembly.

IMPORTANT: *Ensure that the reference marks made before removal on the drive shaft and slip yoke are aligned. The drive shaft and yokes must be in the same plane to help prevent excessive vibration.*

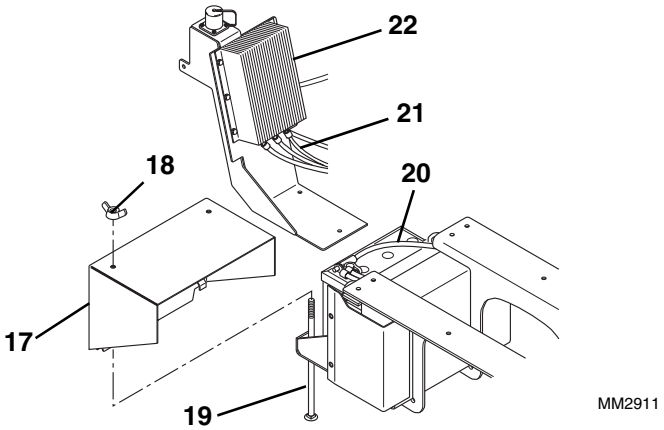
2. Align the reference marks made before removal on the drive shaft and slip yoke.
3. Slide the slip yoke (**2** or **10**) onto the splines of the drive shaft and tighten the dust cap (**3** or **13**) securely. **DO NOT** overtighten or the cap will break.
4. Install the cross and bearing assembly into the yoke.
5. Secure the cross and bearing assembly in the yoke with snap rings. Pinch each snap ring with a pliers and insert them into their grooves in the yoke.
6. Apply grease to grease fitting (**6** or **16**). (Refer to *Section 2.6.8, Drive Shaft Splines*.)

6.4.7 Drive Shaft Installation

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

a. Transfer Case-to-Axle Drive Shafts

1. Level the vehicle, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover. Allow the engine, transmission and hydraulic fluid to cool.
4. Remove engine side battery box cover (**17**). Remove wing nuts (**18**) and carriage bolts (**19**) and set cover and mounting hardware aside for later re-assembly.

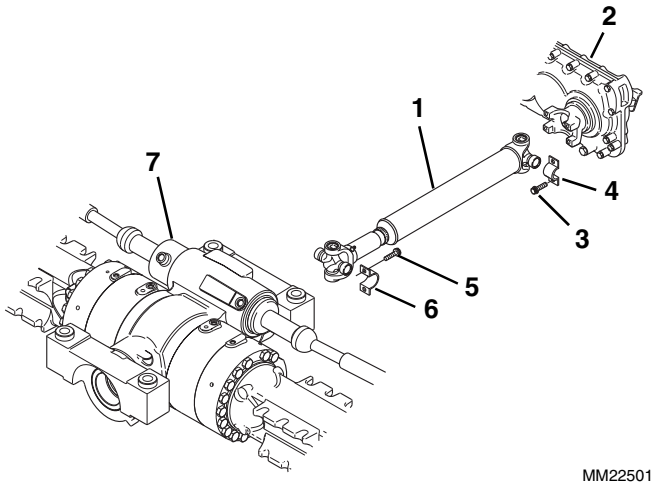


5. Disconnect the negative (-) battery cable (**20**) at the negative (-) terminal on the battery in the engine side battery box.
6. Disconnect the negative (-) cable (**21**) at the bottom of the battery equalizer (**22**).

7. Raise the drive shaft assembly (**1**) into position. The slip-yoke end of the drive shaft mounts toward the transfer case (**2**). If reinstalling a drive shaft previously removed, align the flange yokes according to the alignment marks made during removal.

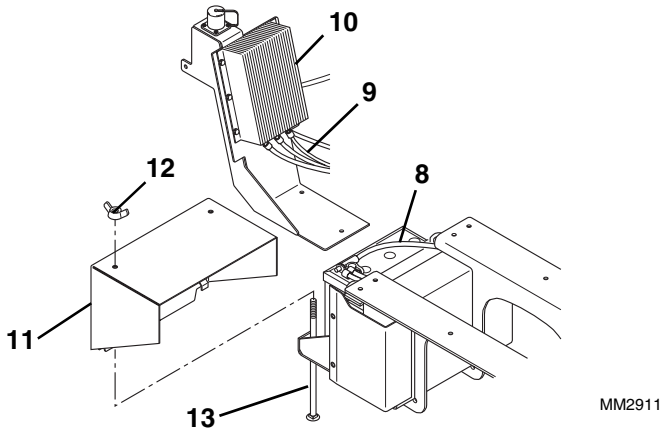
IMPORTANT: *Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.*

8. Install the four capscrews (**3**) and two straps (**4**) securing the bearing crosses to the transfer case (**2**).
9. Install the four capscrews (**5**) and two straps (**6**) securing the bearing crosses to the axle (**7**). Torque to 60 lb/ft (81 Nm).



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10. Connect the negative (-) battery cable (**8**) at the negative (-) terminal on the battery in the engine side battery box.



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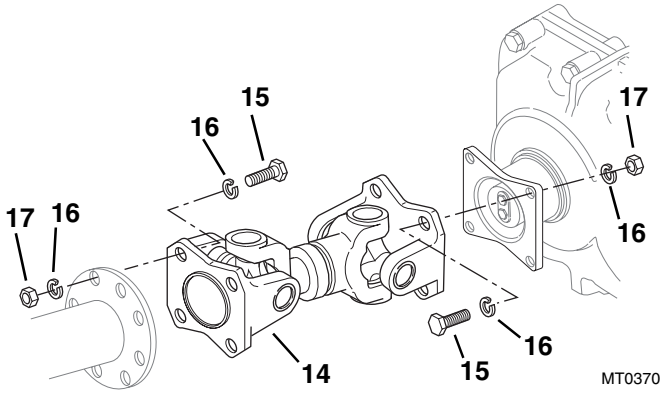
11. Connect the negative (-) battery equalizer cable (**9**) at the bottom of the battery equalizer (**10**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
12. Replace engine side battery box cover (**11**). Use the wing nuts (**12**) and carriage bolts (**13**) to secure the cover in place.

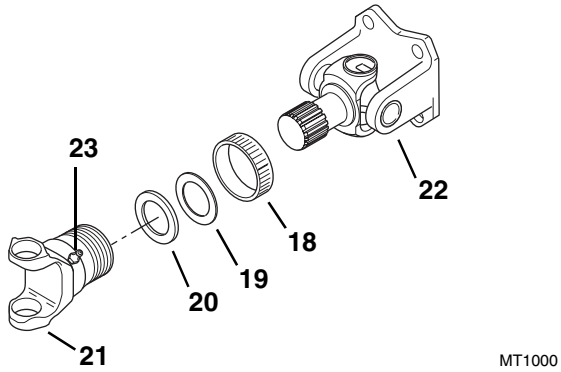
b. Transmission-to-Transfer Case Drive Shaft

1. Level the vehicle, ground the carriage, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the parking brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover. Allow the engine, transmission and hydraulic fluid to cool.
4. Remove engine side battery box cover (**11**). Remove wing nuts (**12**) and carriage bolts (**13**) and set cover and mounting hardware aside for later re-assembly.
5. Disconnect the negative (-) battery cable (**8**) at the negative (-) terminal on the battery in the engine side battery box.
6. Disconnect the negative (-) cable (**9**) at the bottom of the battery equalizer (**10**).
7. Raise the drive shaft assembly (**14**) into position. The slip-yoke end of the drive shaft mounts toward the transfer case. If reinstalling a drive shaft previously removed, align the flange yokes according to the alignment marks made during removal.

IMPORTANT: *Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.*

8. Install the eight [4-Front and 4-Rear] 1/2-20 x 2.0" NF capscrews (**15**), sixteen [8-Front and 8-Rear] 1/2" lockwashers (**16**) and eight [4-Front and 4-Rear] 1/2-20 NF nuts (**17**) securing the flange yokes to the transfer case and transmission. Torque to 105 ±10 lb/ft (142 ±14 Nm).





9. Connect the negative (-) battery cable (**8**) at the negative (-) terminal on the battery in the engine side battery box.
10. Connect the negative (-) battery equalizer cable (**9**) at the bottom of the battery equalizer (**10**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
11. Replace engine side battery box cover (**11**). Use the wing nuts (**12**) and carriage bolts (**13**) to secure the cover in place.

6.4.8 Slip Yokes

a. Slip Yoke Inspection

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

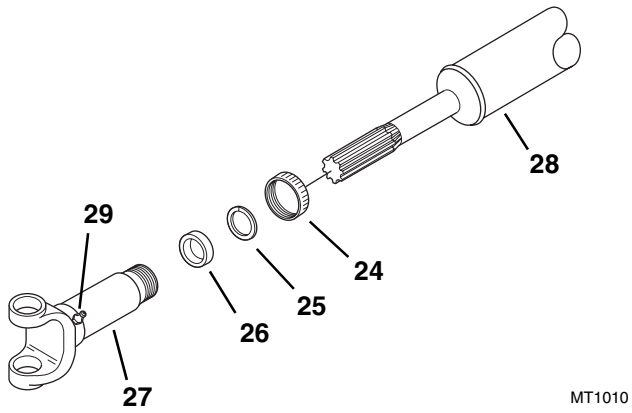
Replace slip yokes if worn or damaged.

b. Slip Yoke Removal and Replacement

1. Remove the cross and bearing assembly securing the slip yoke to the flange yoke (refer to *Section 6.4.4, Drive Shaft Disassembly,* Steps 3-6).
2. Remove the dust cap (**18** or **24**), split retaining ring (**19** or **25**) and felt seal (**20** or **26**) from the end of the slip yoke (**21** or **27**).
3. Remove the slip yoke (**21** or **27**), from the drive shaft (**22** or **28**).

c. Slip Yoke Installation

1. Install the dust cap (**18** or **24**), split retaining ring (**19** or **25**), and felt seal (**20** or **26**) on the drive shaft (**22** or **28**).
2. Install the slip yoke (**21** or **27**), onto the drive shaft splines.
3. Install the cross and bearing assembly securing the slip yoke to the flange yoke.
4. Apply grease to grease fitting (**23** or **29**). (Refer to *Section 2.6.8, Drive Shaft Splines.*)



6.5 TROUBLESHOOTING

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

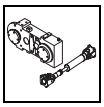
Note: *Contact the **JLG** Service Department at 1-717-485-5161 (Domestic) or 1-877-554-5438 (International), if internal transfer case repair is required during the warranty period.*

Detailed transfer case service instructions covering repair, disassembly, reassembly, adjustment and troubleshooting information is provided in the ZF Model TB 92-432 Transfer Case Operating and Repair Manual (ZF part number 32.70.4950.6002, **JLG** part number 8990423).

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

6.5.1 Transfer Case and Drive Shaft Troubleshooting

Problem	Cause	Remedy
1. Excessive transfer case noise.	1. Oil level too low.	1. Fill oil to correct level (refer to *Section 2.13.14, a. Transfer Case Oil Level Check*).
	2. Transfer case filled with incorrect oil.	2. Drain transfer case and fill to correct level with recommended oil (refer to *Section 2.13.14, b. Transfer Case Oil Change*).
	3. Excessive bearing “end play.”	3. Check bearing end play and correct with shims as needed.
	4. Worn or damage bearings.	4. Replace bearings as needed.
	5. Worn or broken gear teeth.	5. Replace gears as needed.
	6. Contamination in the transfer case.	6. Check for foreign particles.
	7. Incorrect assembly of parts.	7. Check assembly of transfer case components.
2. Oil leaking from transfer case.	1. Breather blocked.	1. Clean or replace breather.
	2. Plugs or fittings loose.	2. Tighten plugs and fittings.
	3. Incorrect oil level.	3. Fill oil to correct level (refer to *Section 2.13.14, a. Transfer Case Oil Level Check*).
	4. Gaps in sealant between housing halves.	4. Clean housing mating surfaces, apply new sealant (Loctite® 518) and torque housing capscrews to 34 lb/ft (46 Nm).
	5. Worn, damaged or improperly seated seals and/or worn or damaged input/output shaft sealing surfaces.	5. Replace seals and/or input/output gear assemblies as needed.
	6. Damaged housing.	6. Replace housing.



6.5.1 Transfer Case and Drive Shaft Troubleshooting (Continued)

Problem	Cause	Remedy
3. Vibration or intermittent noise when traveling.	1. Universal joint assembly(ies) incorrectly tightened. 2. Universal joint(s) worn or damaged. 3. Drive shaft(s) damaged/ unbalanced.	1. Tighten capscrews to correct torque. 2. Repair or replace universal joints as needed. 3. Replace drive shaft(s) as needed.
4. Noise when coasting: even slight transfer case noise can be heard when vehicle is coasting.	1. Worn splines on input flange and/or gears.	1. Replace worn parts as needed.
5. Transfer case overheating (oil above 230° F [110° C]).	1. Build-up of mud and/or debris on the exterior of transfer case. 2. Oil level too high or low. 3. Transfer case filled with incorrect oil or oil contaminated. 4. Incorrect bearing “end play.” 5. Worn or damage bearings.	1. Remove mud and/or debris from the transfer case exterior. 2. Fill oil to correct level with recommended oil (refer to *Section 2.13.14, a. Transfer Case Oil Level Check*). 3. Drain transfer case and fill to correct level with recommended oil (refer to *Section 2.13.14, b. Transfer Case Oil Change*). 4. Check bearing end play and correct with shims as needed. 5. Replace bearings as needed.

6.5.2 Transfer Case Internal Component Troubleshooting

Note: *The following conditions may be noticed when inspecting parts during transfer case repair. Perform all remedies that apply to the conditions noticed.*

Problem	Cause	Remedy (See Note)
1. Gear teeth worn or grooved.	1. Insufficient lubrication.	• Replace gear(s) as needed. • Fill transfer case with to correct level with recommended oil (refer to *Section 2.13.14, a. Transfer Case Oil Level Check*).
2. Gear teeth overheated.	1. Prolonged operation at high temperatures (transfer case oil above 230° F [110° C]). (Refer to *Section 6.5.1, Transfer Case and Drive Shaft Troubleshooting*, Step 5, Transfer case overheating.)	• Replace gear(s) as needed. • Fill transfer case to correct level with recommended oil (refer to *Section 2.13.14, b. Transfer Case Oil Change*).
3. Gear teeth pitted.	1. Insufficient lubrication. 2. Lubricant contaminated.	• Replace gear(s) as needed. • Fill transfer case to correct level with recommended oil (refer to *Section 2.13.14, b. Transfer Case Oil Change*).
4. Worn inside cup or worn tapered roller bearing.	1. Incorrect bearing “end play.” 2. Insufficient lubrication. 3. Lubricant contaminated.	• Replace bearing. • Check end play. • Fill transfer case to correct level with recommended oil (refer to *Section 2.13.14, b. Transfer Case Oil Change*).

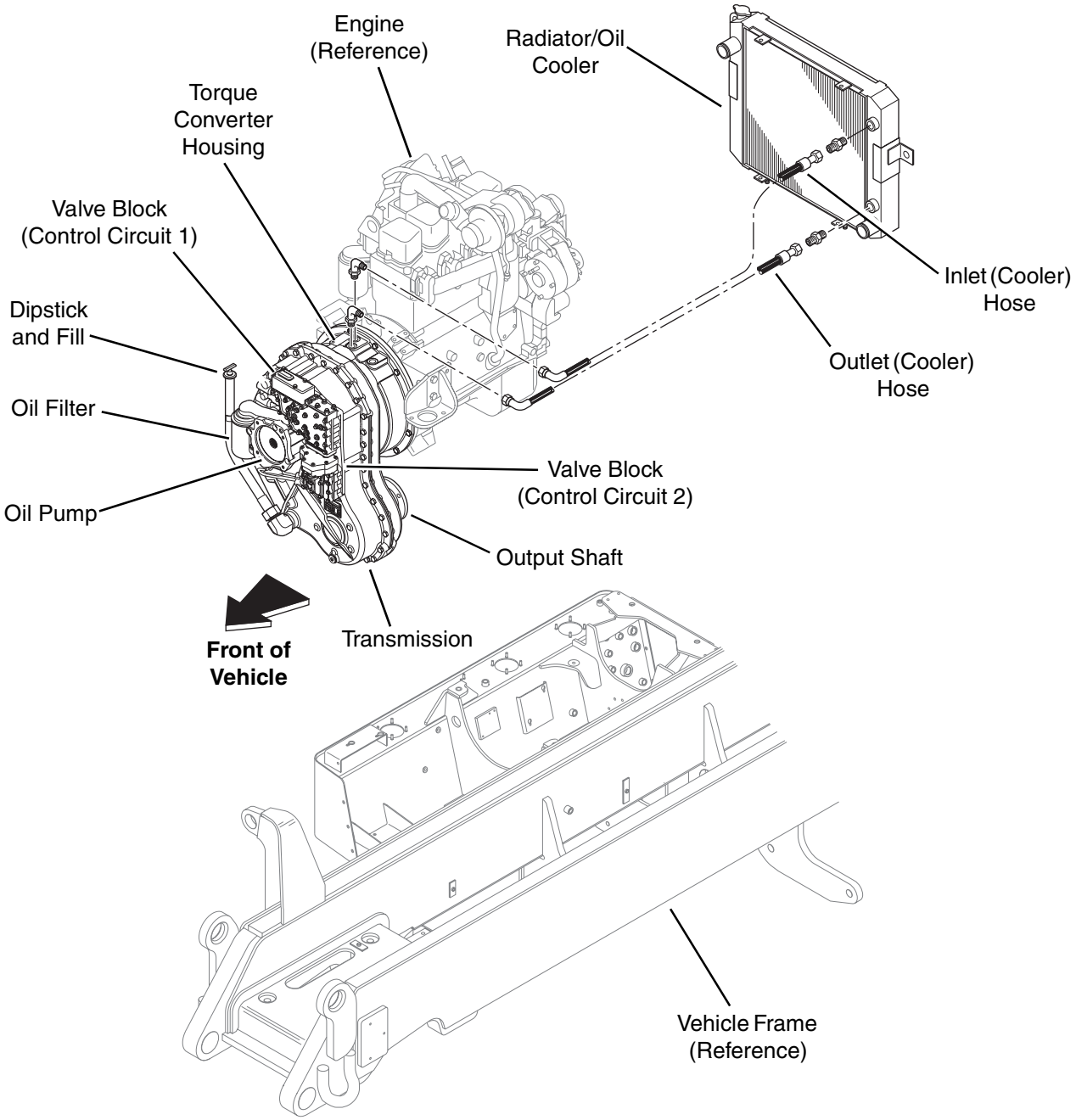
Section 7
Transmission: ZF 4 WG-98 TS

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7.1 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 name and location of the major assemblies of the transmission. The following illustration identifies the components that are referred to throughout this section.



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WARNING: **DO NOT** service the vehicle without following all safety precautions as outlined in the “Safety Practices” section of this manual. Failure to follow the safety practices may result in death or serious injury.

7.2 TRANSMISSION DESCRIPTION

Instructions in this section pertain mainly to general specifications, towing, maintenance information, and transmission removal and installation procedures. Internal transmission service instructions and detailed specifications are provided in the ZF 4 WG-98 TS Transmission Repair Manual (ZF part number 5871 139 002, **JLG** part number 8990418).

The ZF 4 WG-98 TS Transmission used in this vehicle is a four-speed configuration. The “intermediate drop” designation refers to the relative top-to-bottom length of the transmission case, chosen for its compatibility with vehicle chassis and operating requirements. Intermediate drop does not refer to an operational rpm shift or drop.

7.3 TRANSMISSION OPERATION

The transmission is mounted to the engine by a bellhousing. Power from the engine is transmitted the to the transmission by means of a torque converter, bolted to the engine flywheel and diaphragms. The transmission in turn transmits power to the transfer case and drive shafts, driving the front and rear axles.

The torque converter consists of three main components, the impeller (driver), stator and turbine (driven) in an oil-filled, enclosed housing. As the torque converter is driven by the engine flywheel, the impeller (pump) wheel rotates, forcing oil through the stator, which is held stationary by the stator shaft bolted to the transmission housing. This directs the moving oil onto the vanes of the turbine (driven) wheel, causing the turbine wheel to rotate. The turbine wheel is connected to the transmission input shaft, and transfers power to the transmission. Oil from the turbine wheel is then returned to the impeller wheel to repeat the process. This process results in an increase in the torque available at the transmission input shaft.

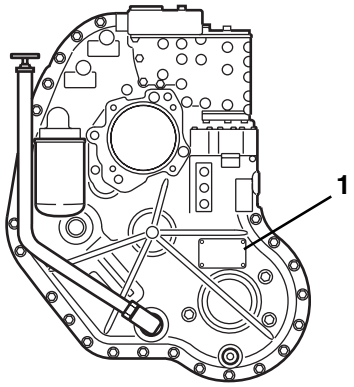
The transmission and torque converter are powered by their own internal hydraulic (“transmission fluid”) system, separate from the vehicle hydraulic system. Pressurized oil for the valve control circuits and torque converter is supplied by a pump located at the rear of the transmission. The pump is driven by the central shaft, which in turn is connected to the impeller of the torque converter. The transmission is equipped with an external oil cooler, mounted in the engine heat exchanger (radiator).

The transmission gear (or “speed”) select lever, an electric shift control, is located on the left side of the steering column in the operator’s cab. Movement of the gear select lever energizes the selected transmission shift solenoid valves, which, in turn, direct the transmission fluid under pressure to the selected forward or reverse valve, and to the designated range (gear or “speed”) clutch. Several factors, including terrain, loading, engine rpm, axle/wheel-end gearing and the selected transmission gear determine actual vehicle speed.

To engage the clutch, the gear select lever is placed in the desired direction (forward or reverse) and range (gear or “speed”) position. Gear select lever movement energizes the selected direction and range (gear) solenoids, allowing transmission fluid under pressure to flow through tubes and passages to the selected clutch shafts. Oil sealing rings are located on the clutch shaft; these rings direct oil under pressure through a drilled passageway in the shaft to a desired clutch. Hydraulic pressure forces the piston and discs against the back-up plate. Discs, with edge tangs, clamp against toothed discs on the inner diameter, enabling the hub and the clutch shaft to lock together and drive as a unit, providing output power.

7.4 TRANSMISSION SERIAL NUMBER

The transmission serial number plate (**1**) is located on the pump side (rear) of the transmission at the bottom right, toward the vehicle frame. Information specified on the serial number plate includes the transmission model number, the transmission serial number and other data. Information on the serial number plate is required in correspondence regarding the transmission.



MT0560

7.5 TRANSMISSION SPECIFICATIONS

7.5.1 Transmission General Specifications

General transmission specifications are found in *Section 2, General Information, Specifications and Maintenance*. Transmission fluid information is found in *Section 2.6.6, Transmission*.

7.5.2 Transmission Performance Specifications

Performance criteria is based on full throttle engine speed unless otherwise specified or not applicable.

Travel Speed (standard tires, no load)

First gear ..... 3.5 mph (5,6 km/hr)

Second gear ..... 6 mph (9,7 km/hr)

Third gear ..... 14 mph (23 km/hr)

Fourth gear ..... 20 mph (32 km/hr)

7.5.3 Transmission Lubrication

a. Transmission Fluid

Complete transmission fluid information is found in *Section 2.6.6, Transmission*.

b. Transmission Fluid (Oil) Capacity

Capacity w/ filter change ..... 12 qt (11,4 liters)

Filter..... 1 qt (1 liters)

7.5.4 Transmission-Related Fuse Ratings

Display Panel.....15 amps

Neutral Engage Relay .....40 amps

Transmission Direction .....5 amps

Transmission Gear .....5 amps

7.6 TRANSMISSION MAINTENANCE

7.6.1 Maintenance Introduction

WARNING: To help avoid severe burns, **DO NOT** attempt this procedure when the engine, cooling, and hydraulic systems are hot. Wait until they have cooled before proceeding.

- Follow the manufacturers instructions to avoid health hazards when using solvents and caustic cleaners.
- Exercise extreme care when using a steam cleaner to help avoid burns.

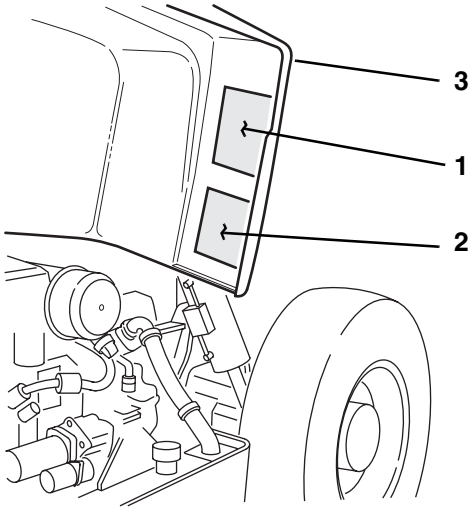
IMPORTANT: *These instructions cover only the routine maintenance of the transmission. Refer to the ZF 4 WG-98 TS Transmission Repair Manual (ZF part number 5871 139 002,* ***JLG*** *part number 8990418), for information on transmission internal component replacement.*

Refer to the ZF 4 WG-98 TS Transmission Technical Data and Maintenance Manual (ZF part number 5872 132 002, ***JLG*** *part number 8990450), for information on transmission diagnosis and internal schematics.*

Cleanliness is of extreme importance. Before attempting any repairs, thoroughly clean the exterior of the transmission to help prevent dirt from entering while performing maintenance checks and procedures.

Section 7.6.2, Transmission Maintenance Schedule, provides a suggested maintenance schedule with references to pertinent procedures and instructions in this manual. To help prevent transmission problems before they occur, follow the maintenance schedule.

Note: *Lubrication (**1**) and maintenance chart (**2**) decals are located inside the engine compartment cover (**3**). These decals contain a general maintenance schedule that should be followed to maintain the vehicle in good operating condition (refer to Section 2, General Information, Specifications and Maintenance). The same schedule information is presented in Section 2.13.10, Transmission Oil and Filter, with a detailed account of how to perform the procedures.*



OS1171

7.6.2 Transmission Maintenance Schedule

Complete transmission maintenance information is located in *Section 2.13.10, Transmission Oil and Filter*.

- At ten hour intervals, check the transmission oil level. (Refer to *Section 2.13.10, Transmission Oil and Filter*.)
- When the vehicle completes its first 50 hours of use, change the transmission filter. Change the filter only; **DO NOT** change the transmission oil at the first 50 hour maintenance level. (Refer to *Section 2.13.10, Transmission Oil and Filter*.)
- At 1,000 hour intervals, change the transmission oil and filter. (Refer to *Section 2.13.10, Transmission Oil and Filter*.)

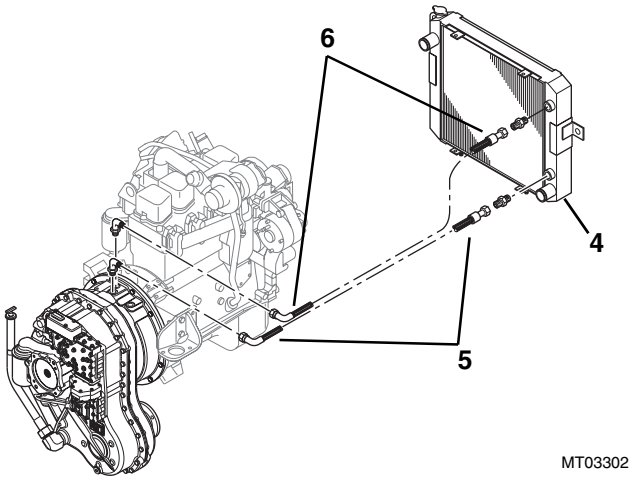
Periodically, depending on operating conditions and other factors, back flush the transmission oil cooler, which is part of the radiator (**4**). ALWAYS back flush the transmission oil cooler after removing the transmission for repair or replacement.

The transmission oil cooler outlet hose (**5**), routed to the lower radiator fitting, is located on the top of the transmission. The transmission oil cooler inlet hose (**6**), routed to the upper radiator fitting, is located on the top of the transmission. (Refer to *Section 8.6.3, Radiator/Oil Cooler and Engine Block Heater Replacement*, for replacement procedures.)

CAUTION: **DO NOT** exceed 165 psi (39.6 bar) when back flushing the oil cooler. Applying too much pressure may damage the oil cooler/radiator.

Disconnect and back flush the oil cooler portion of the radiator with oil and compressed air until all foreign material is removed. If necessary, remove the radiator from the vehicle and clean the oil cooler circuit using oil, compressed air and steam.

IMPORTANT: ***DO NOT*** *use flushing compounds for cleaning purposes.*



MT03302

7.7 TRANSMISSION REPLACEMENT

Note: *Contact the* ***JLG*** *Service Department at 1-717-485-5161 (Domestic) or 1-877-554-5438 (International), if internal transmission repair is required during the warranty period.*

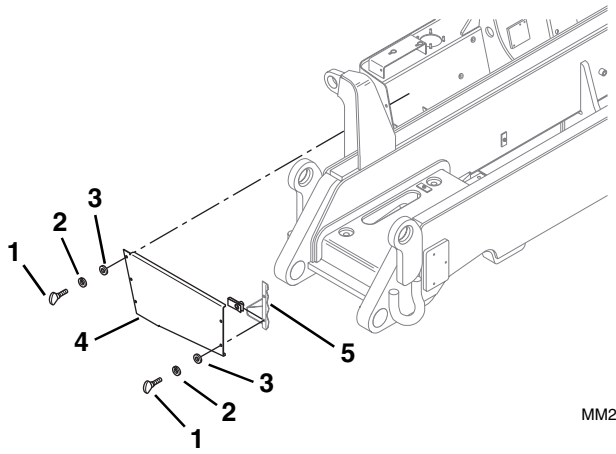
IMPORTANT: *To help ensure safety and optimum performance, replace the transmission if it is damaged. Refer to the appropriate parts manual for ordering information.*

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

7.7.1 Transmission Removal

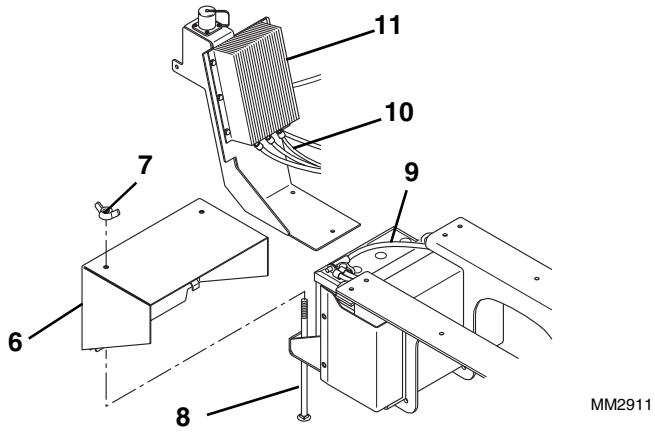
WARNING: Risk of severe personal injury. **NEVER** lift a transmission alone; enlist the help of at least one assistant or use a suitable hoist or overhead crane and sling.

1. Level the vehicle, ground the attachment, place the travel select lever in the [N] NEUTRAL position, place the neutral lock lever in the [N] NEUTRAL LOCK position, turn the wheels fully to the left, engage the parking brake switch, and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and steering wheel, stating that the vehicle should not be operated. (Refer to *Section 1.5, Accident Prevention Tag Usage*.)
3. Open the engine compartment cover. Allow the engine, transmission and hydraulic fluid to cool.
4. Remove the engine hood. (Refer to *Section 3.7.2, Engine Hood*.)
5. Remove the five thumbscrews (**1**), flat washers (**2**) and lockwashers (**3**) securing the front engine cover (**4**) to the hydraulic reservoir and the bracket (**5**) on the battery box. Remove the front engine cover.



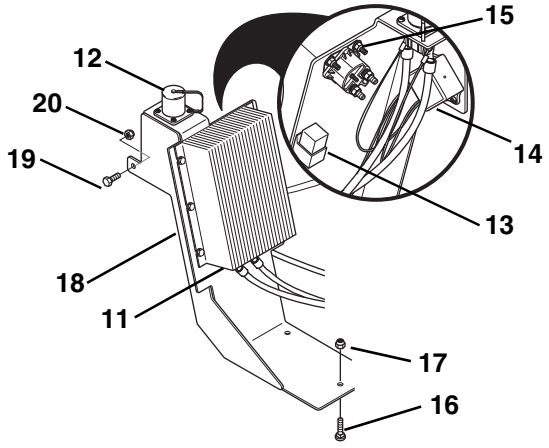
MM2971

6. Remove engine side battery box cover (**6**). Remove wing nuts (**7**) and carriage bolts (**8**) and set cover and mounting hardware aside for later re-assembly.
7. Disconnect the negative (-) battery cable (**9**) at the negative (-) terminal on the battery in the engine side battery box.
8. Disconnect the negative (-) cable (**10**) at the bottom of the battery equalizer (**11**).



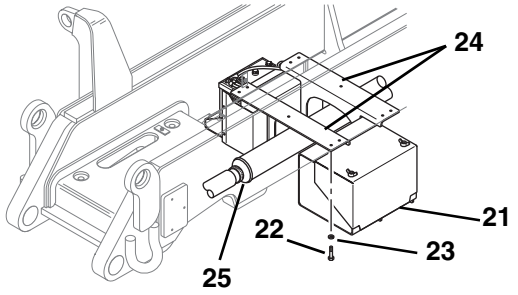
MM2911

9. Disconnect and label wires connected to the battery equalizer (**11**), NATO slave receptacle (**12**), fuel shut-off relay (**13**), solargizer control box (**14**) and starter solenoid (**15**).
10. Remove the three carriage bolts (**16**) and elastic locknuts (**17**) securing the bottom of the battery equalizer bracket (**18**) to the engine pod. Remove the capscrew (**19**) and elastic locknut (**20**) at the top right corner of the equalizer bracket and remove the entire bracket from the vehicle.



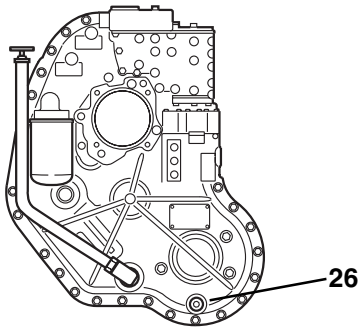
MM2931

11. Support the battery box assembly (**21**) with a hoist or some other means and remove the eight capscrews (**22**) and lockwashers (**23**) securing it to the frame. Move the battery box forward and left so that, when removed, the transmission can clear the battery. Support the battery boxes so that the battery box crossmembers (**24**) do not rest on the drive shaft (**25**).



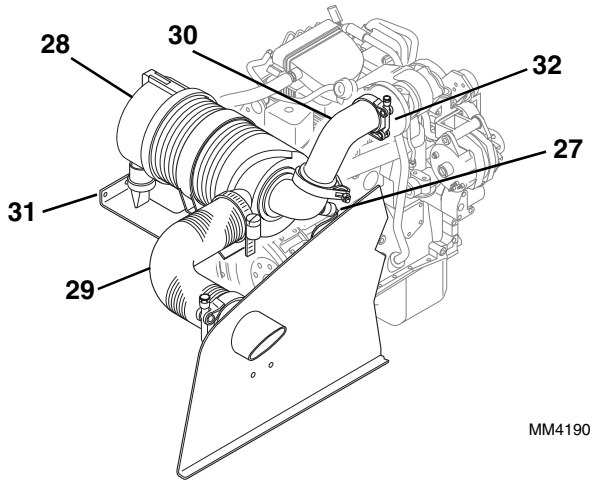
MM3151

12. Place a suitable receptacle under the transmission drain plug (**26**). Remove the transmission drain plug and allow the transmission oil to drain into the receptacle. Transfer the used transmission oil into a suitable covered container and label the container as used oil. Dispose of used oil at an approved recycling facility. Clean and reinstall the transmission drain plug.



MT0560

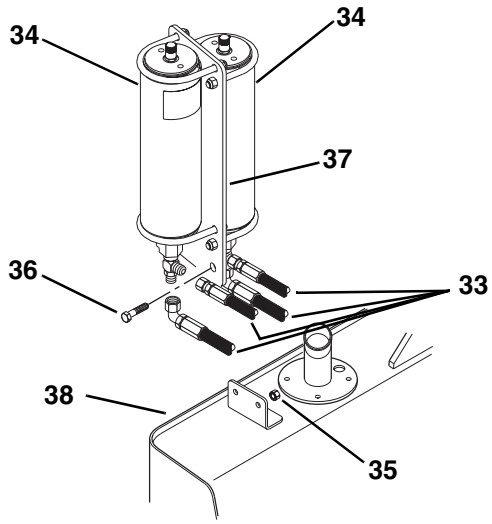
13. Disconnect the air filter restriction sensor wiring connector (**27**), and remove the engine air cleaner assembly (**28**), air intake hose (**29**), air cleaner hose (**30**) and the plate (**31**) supporting the air cleaner assembly. Cover the air inlet (**32**) to the turbocharger assembly.



MM4190

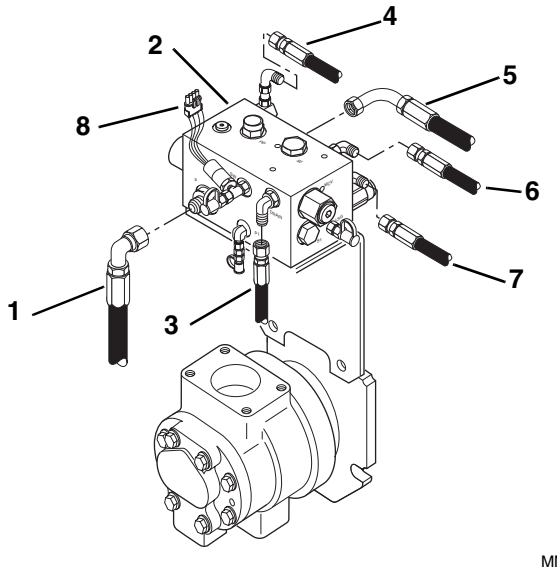
WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

14. Relieve all the pressure in the service brake system by pumping the service brake pedal until all hydraulic pressure is removed from the accumulators.
15. Label and disconnect the hoses (**33**) from the bottom of each accumulator (**34**). Cap the fittings on the accumulators and plug the hose ends.
16. Remove the elastic locknuts (**35**) and capscrews (**36**) holding the accumulator mounting bracket (**37**) to the hydraulic oil reservoir (**38**). Retain the capscrews and discard the locknuts. New elastic locknuts will be required for reassembly.



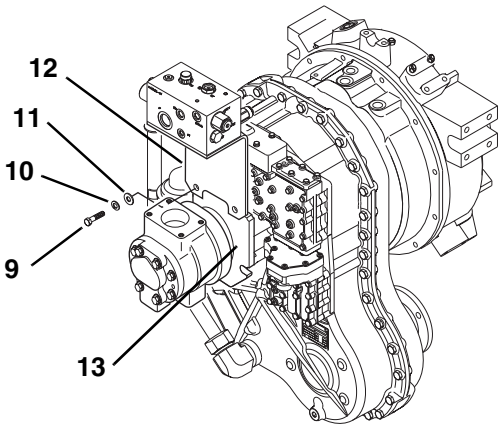
MM5120

17. Label and disconnect the hose (**1**) coming from the pump to the “P” port at the the accumualtor charge valve (**2**). Cap the fitting on the accumulator charge valve and plug the hose end.
18. Label and disconnect the hose (**3**) from the “Drain” port at the accumulator charge valve (**2**). Cap the fitting on the accumulator charge valve and plug the hose end.
19. Label and disconnect the hose (**4**) from the “PIL” port at the accumulator charge valve (**2**). Cap the fitting on the accumulator charge valve and plug the hose end.
20. Label and disconnect the hose (**5**) from the “CF” port at the accumulator charge valve (**2**). Cap the fitting on the accumulator charge valve and plug the hose end.
21. Label and disconnect the hose (**6**) from the “EF” port at the accumulator charge valve (**2**). Cap the fitting on the accumulator charge valve and plug the hose end.
22. Label and disconnect the hose (**7**) from the “LS” port at the accumulator charge valve (**2**). Cap the fitting on the accumulator charge valve and plug the hose end.
23. Unplug the pressure switch connector (**8**) from the wire harness.



MM5150

24. Remove the two capscrews (**9**), lockwashers (**10**) and flat washers (**11**) holding the accumulator charge valve bracket (**12**) to the pump flange (**13**). Remove the accumulator charge valve and bracket from the vehicle. The valve can remain assembled to the bracket. Save all hardware for reassembly.

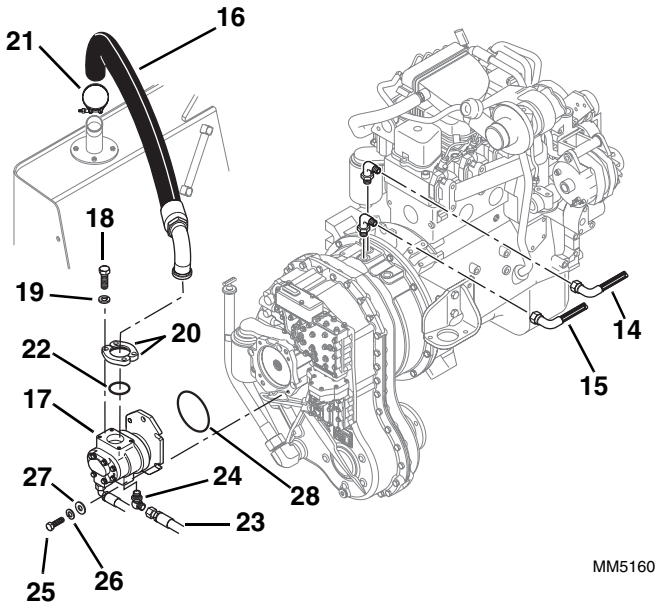


MM5130

25. Label, disconnect and cap the transmission oil cooler inlet (**14**) and outlet (**15**) hoses at the transmission. The transmission oil cooler outlet hose, routed to the lower radiator fitting, is located on the top of the transmission. The transmission oil cooler inlet hose, routed to the upper radiator fitting, is located on top of the transmission.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

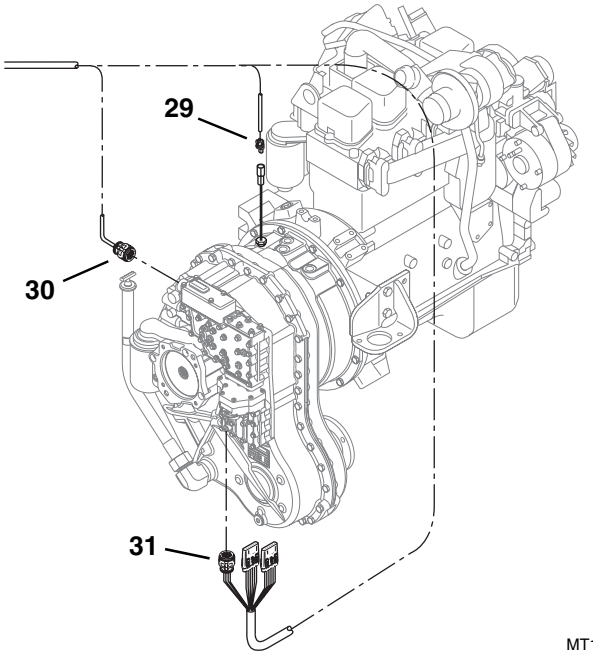
26. Label the inlet hose (**16**) at the hydraulic pump (**17**). Remove four capscrews (**18**), lockwashers (**19**) and two flange halves (**20**). Loosen the T-bolt clamp (**21**) and remove the inlet hose (**16**) and o-ring (**22**). Cover the opening on the hydraulic reservoir.
27. Label the outlet hose (**23**) at the main hydraulic pump (**17**). Disconnect and cap the outlet hose at the fitting (**24**).
28. Remove two capscrews (**25**), lockwashers (**26**) and plain washers (**27**). Remove the main hydraulic pump (**17**) and o-ring (**28**) from the transmission.



MM5160

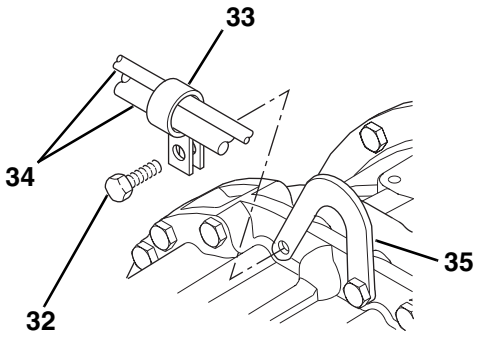
29. Wipe up any spilled hydraulic and transmission oil.

30. Label and disconnect the transmission temperature switch connector (**29**) and shift solenoid wiring harness connectors (**30** and **31**). Remove the clips securing the wiring harness to the transmission and move the wiring harness safely out of the way.



MT1050

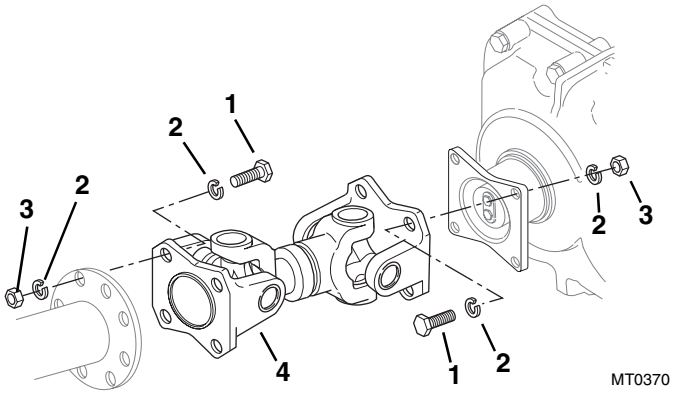
31. Remove transmission capscrew (**32**) holding clamp (**33**), compressor hoses (**34**) and right side of transmission lift plate (**35**). Remove the clamp and hoses and re-install the capscrew to secure the lift plate to the transmission.



MM3160

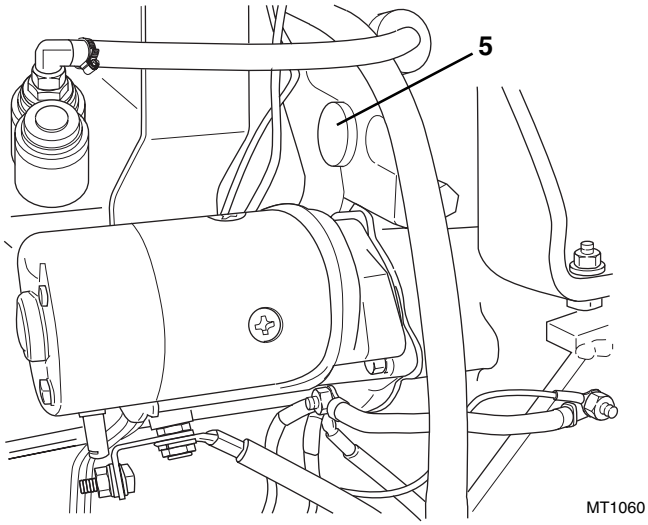
IMPORTANT: *To help ensure optimum performance, the drive shaft assemblies are specially balanced as a unit at the factory. Mark the drive shaft yoke at the transmission for return to its original position.*

32. The drive shaft assembly is a balanced assembly. Mark the yoke and transmission, transfer case, and the shaft and slip yoke so that these components can be returned to their original positions when reinstalled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.
33. Remove the eight [4-Front & 4-Rear] capscrews (**1**), sixteen [8-Front & 8-Rear] lockwashers (**2**) and eight nuts (**3**) securing the flange yokes to the transfer box and transmission.
34. Remove the drive shaft assembly (**4**).



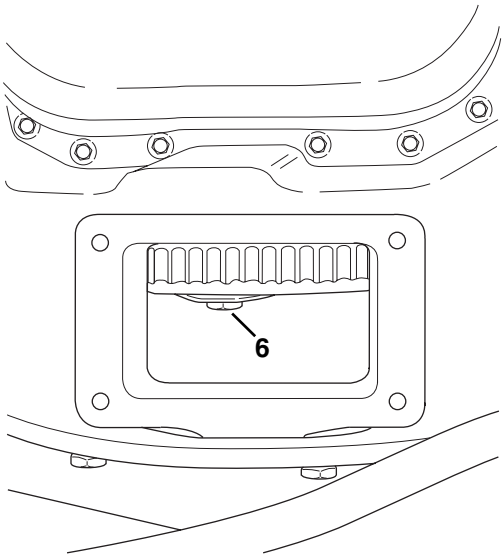
MT0370

35. Remove the rubber plug (**5**) from the flywheel housing, above the starter motor. Insert an engine barring tool (such as a Blue Point p/n YA 95655) into the opening. The tool will be used to advance, then lock, the flywheel to permit removal of the capscrews and washers securing the transmission drive plate to the flywheel.



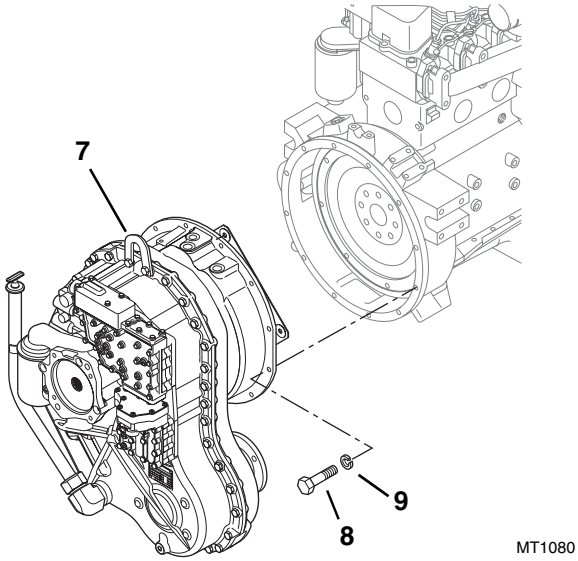
MT1060

36. Working through the flywheel access hole on the flywheel housing, remove the four capscrews (**6**) securing the converter diaphragms to the engine flywheel. Use the engine barring tool to prevent the flywheel from turning while removing the capscrews. Use the engine barring tool to rotate the flywheel to allow the access to the capscrews as needed.



MT1070

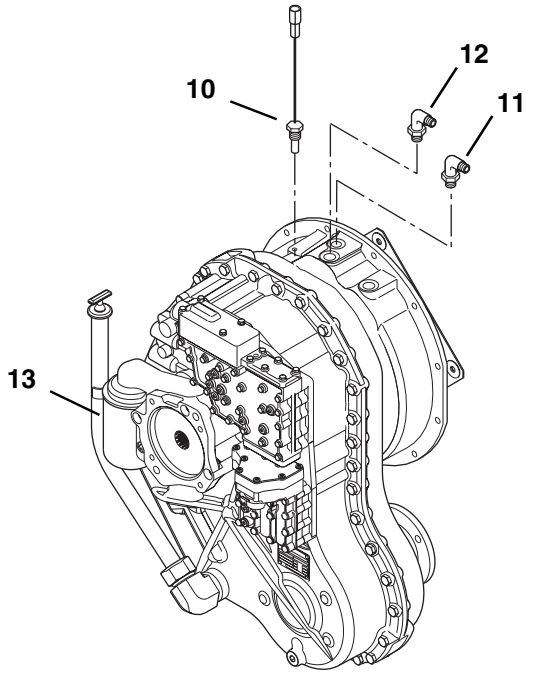
37. Connect a lifting strap or chain to the lifting eye (**7**) at the top of the transmission, and to a suitable hoist or overhead crane. Make sure that the air compressor hoses are on the engine side of the lifting strap (**7**). Operate the hoist or crane to remove slack from the chain, but **DO NOT** raise the transmission at this time.
38. Remove twelve capscrews (**8**) and twelve lockwashers (**9**) securing the transmission to the engine. Separate the transmission from the engine.



MT1080

WARNING: Risk of personal injury. The transmission may move while hoisting it out of the chassis. Carefully move the transmission and adjust the sling as needed. Keep fingers, hands, legs and other body parts clear of the transmission.

39. Carefully remove the transmission from the vehicle. Avoid causing damage to the transmission and to the drive plate. Reposition the lift strap as needed to adjust for load shifting during transmission removal.
40. Lift the transmission clear of the vehicle 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.
41. Remove any external transmission components as required, including the transmission temperature switch (**10**) and inlet (**11**) and outlet (**12**) cooler hose fittings. Cover the transmission temperature switch opening.
42. Remove the transmission oil filter (**13**) and dispose of properly. Clean the filter mounting surface. Cover or cap the oil filter mount.



MT1130

The transmission is now ready for inspection and/or further service. Refer to the ZF 4 WG-98 TS Transmission Repair Manual (ZF part number 5871 139 002, **JLG** part number 8990418) for information on transmission diagnosis and internal component repair or replacement.

7.7.2 Transmission Inspection and Internal Repair

Refer to the ZF 4 WG-98 TS Transmission Repair Manual (ZF part number 5871 139 002, **JLG** part number 8990418) for information on internal component repair or replacement. Refer to the ZF 4 WG-98 TS Transmission Technical Data Manual and Maintenance Manual (ZF part number 5872 132 002, **JLG** part number 8990450) for information on transmission diagnosis and internal schematics.

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

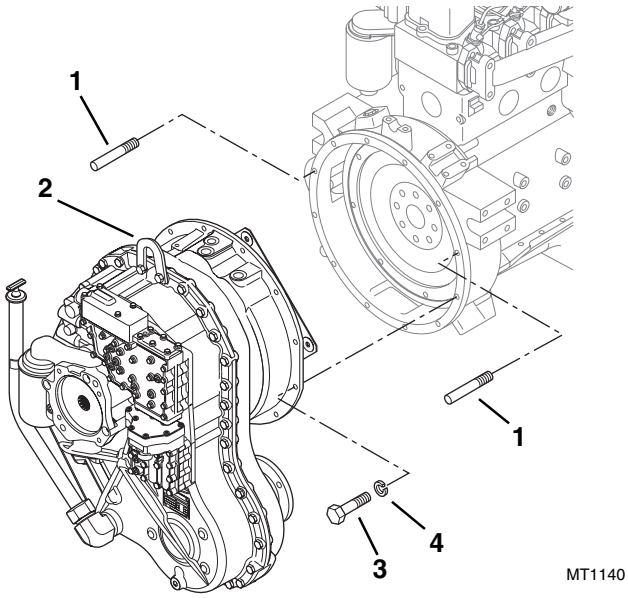
7.7.3 Transmission Installation

WARNING: Risk of severe personal injury. **NEVER** lift a transmission alone; enlist the help of at least one assistant or use a suitable hoist or overhead crane and sling.

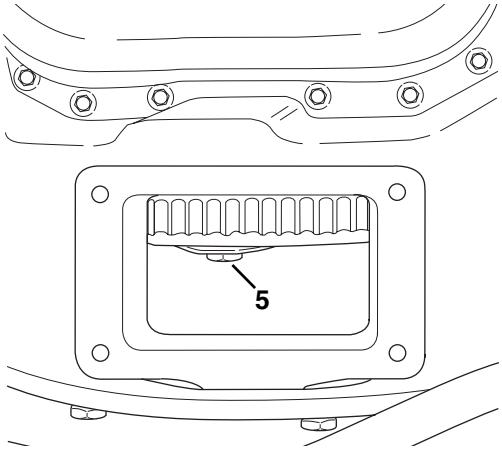
WARNING: The transmission must be properly installed using fasteners of the correct size and grade, and torqued to their specified value.

1. Clean all mating surfaces on both the engine and the transmission prior to assembly.
2. Temporarily thread two M10 x 1,5 x 63,5 mm guide studs (**1**) into the engine flywheel housing. These will be used as alignment dowels.
3. Use a hoist or overhead crane and sling attached to the lifting eye (**2**) at the top of the transmission. Raise and position the transmission within the chassis.
4. Position the transmission onto the two guide studs (**1**).
5. Begin securing the transmission to the flywheel housing with twelve M10 x 1,5 x 45 mm capscrews (**3**) and M10 lockwashers (**4**). Remove the two guide studs (dowels) after several capscrews and washers are installed. When installing the washers and capscrews, tighten bolts evenly in stages and assure that the transmission converter housing installs evenly against the engine flywheel housing.

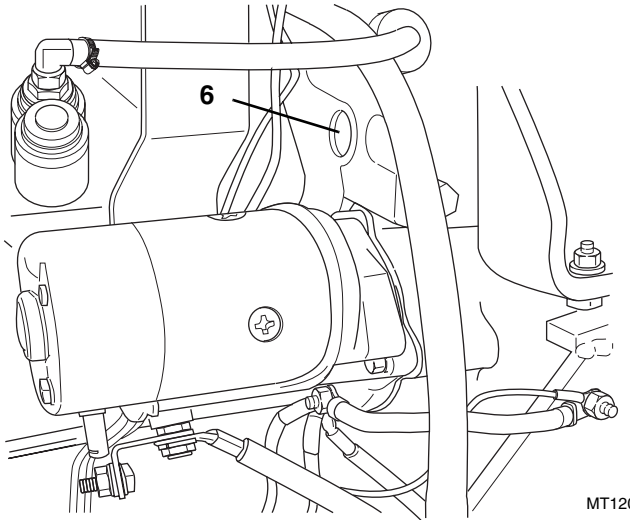
Note: *If the transmission is not aligned properly with the engine, the torque converter will angle against the drive plate and damage will occur when the engine is started.*



6. Working through the engine flywheel inspection and access hole, rotate and align a flywheel screw hole with a transmission diaphragm plate hole. Install four M10 x 1,5 x 25 mm capscrews (**5**) securing the converter diaphragms to the engine flywheel. Insert an engine barring tool (such as a Blue Point p/n YA 95655) into the access hole (**6**) in the flywheel housing to prevent the flywheel from turning while installing the capscrews.
7. Use the engine barring tool to advance the flywheel to the next diaphragm plate screw hole. Continue installing and partially tightening the remaining capscrews and washers and rotating the flywheel and diaphragm plate. Once all the capscrews have been installed, tighten the capscrews.
8. Install the rubber plug in the flywheel housing access hole.
9. Remove the hoist or overhead crane and sling.

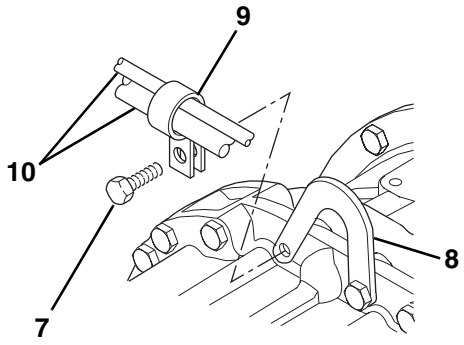


MT1070



MT1200

10. Remove transmission capscrew (**7**) holding the right side of transmission lift plate (**8**). Reinstall the clamp (**9**), compressor hoses (**10**) and the lift plate (**8**), with the transmission capscrew (**7**).

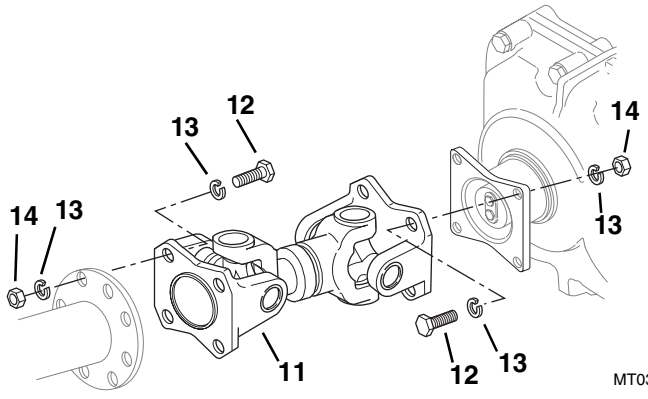


MM3160

11. Raise the transmission-to-transfer case drive shaft assembly (**11**) into position. The slip-yoke end of the drive shaft mounts toward the transfer case. If reinstalling a drive shaft previously removed, align the flange yokes according to the alignment marks made during removal.

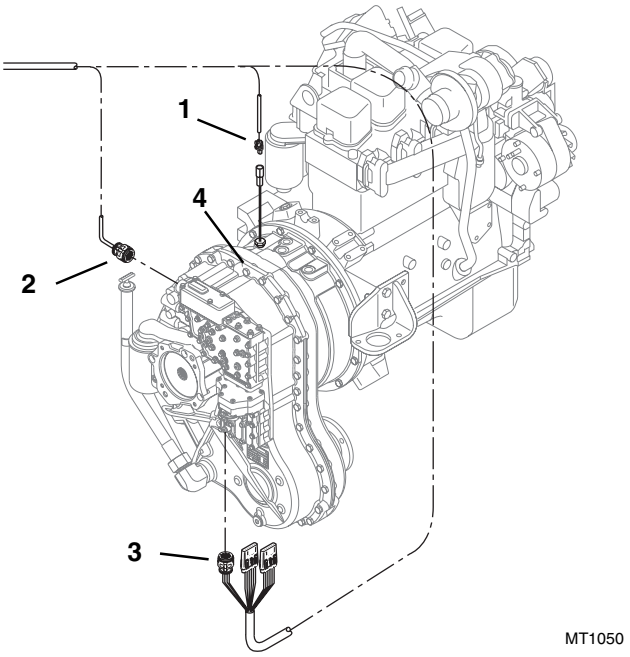
IMPORTANT: *Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.*

12. Install the eight [4-Front and 4-Rear] 1/2-20 x 2.0" NF Grade 8 capscrews (**12**), sixteen [8-Front & 8-Rear] 1/2" lockwashers (**13**) and eight [4-Front & 4-Rear] 1/2-20 NF Grade 5 nuts (**14**) securing the flange yokes to the transfer case and transmission. Torque nuts to 105 ±10 lb/ft (142 ±14 Nm).



MT0370

13. Connect the transmission temperature switch connector (**1**) and shift solenoid wiring harness connectors (**2** and **3**). Secure the wiring harness to the transmission using the clips attached to the transmission with the housing capscrews (**4**).



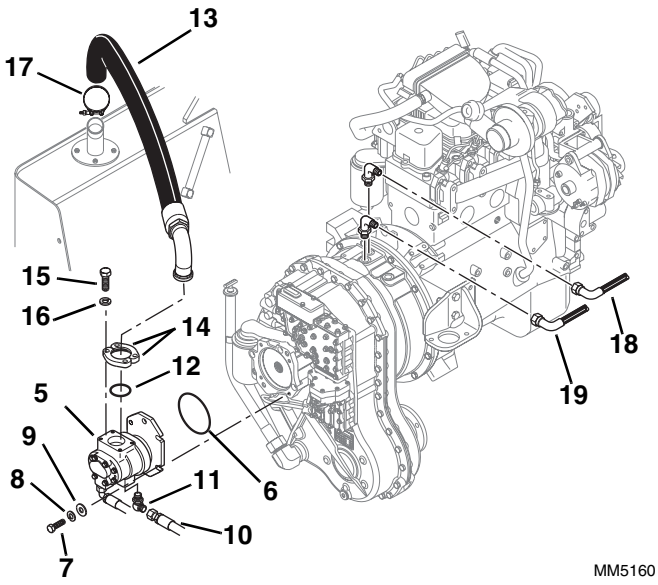
MT1050

14. Align the splined pump drive shaft with the transmission drive and install the main hydraulic pump (**5**) on the transmission using a new o-ring (**6**). Secure the pump to the transmission using two M12 x 1,75 x 40 mm capscrews (**7**), M12 lockwashers (**8**) and M12 plain washers (**9**) in the lower mounting holes only.
15. Connect the outlet hose (**10**) to the main hydraulic pump fitting (**11**).

IMPORTANT: *Before attaching the main pump hose to the reservoir, fill the pump with hydraulic fluid by hand to prime the pump at the inlet.*

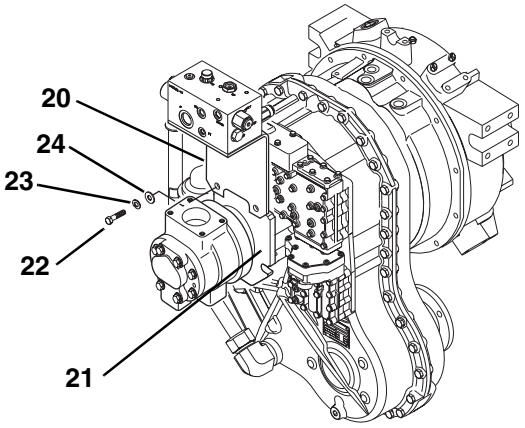
Note: *ALWAYS use new o-rings when servicing the vehicle.*

16. Lubricate a new o-ring (**12**) with clean oil.
17. Install the inlet hose (**13**) and a new o-ring (**12**) to the main hydraulic pump, using two flange halves (**14**), four 1/2-13 x 1.5" NC Grade 5 capscrews (**15**) and 1/2" lockwashers (**16**).
18. Install the T-bolt clamp (**17**) over the other end of the inlet hose (**13**), and slide the inlet hose over the tube on the hydraulic reservoir. Tighten the T-bolt clamp.
19. Connect the transmission oil cooler inlet (**18**) and outlet (**19**) hoses at the transmission.



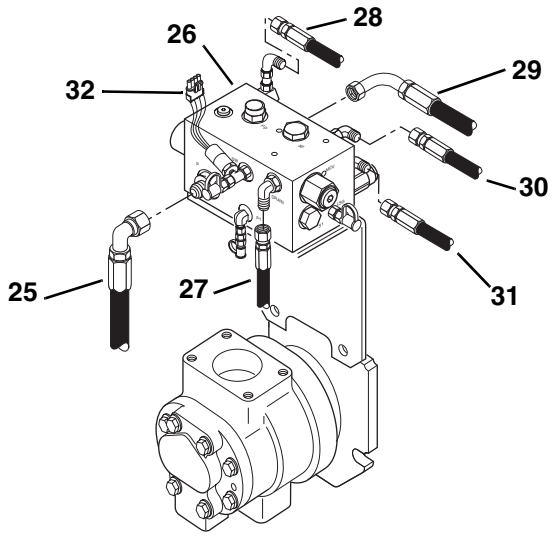
MM5160

20. Line up the two mounting holes in the accumulator charge valve bracket (**20**) with the two upper mounting holes in the pump flange (**21**). Secure the bracket to the pump flange with the two M12 x 1,75 x 50 mm capscrews (**22**), M12 lockwashers (**23**) and M12 plain washers (**24**).



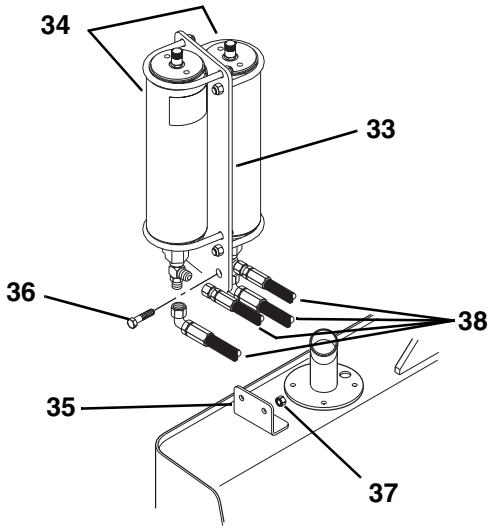
MM5130

21. Reassemble the hose (**25**) from the pump to the “P” port on the accumulator charge valve (**26**). Tighten the hose end securely.
22. Reassemble the hose (**27**) to the “Drain” port on the accumulator charge valve (**26**). Tighten the hose end securely.
23. Reassemble the hose (**28**) to the “PIL” port on the accumulator charge valve (**26**). Tighten the hose end securely.
24. Reassemble the hose (**29**) to the “CF” port on the accumulator charge valve (**26**). Tighten the hose end securely.
25. Reassemble the hose (**30**) to the “EF” port on the accumulator charge valve (**26**). Tighten the hose end securely.
26. Reassemble the hose (**31**) to the “LS” port on the accumulator charge valve (**26**). Tighten the hose end securely.
27. Plug the connector (**32**) from the pressure switch into the connector on the wire harness. Snap the two connectors together.



MM5150

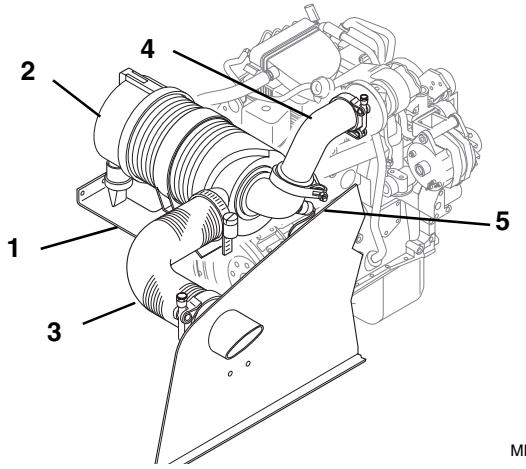
28. Place the accumulator bracket (**33**) with accumulators (**34**) against the front side of the mounting bracket (**35**) on the hydraulic oil reservoir. Be sure the branch of the tees point toward the pump.
29. Insert the two 1/2-13 x 1-1/2" capscrews (**36**) through the accumulator bracket (**33**) and the mounting bracket on the hydraulic oil reservoir. Secure in place with two new 1/2-13 elastic locknuts (**37**).
30. Reassemble the hoses (**38**) to the tee under each accumulator. Tighten all four hoses securely.



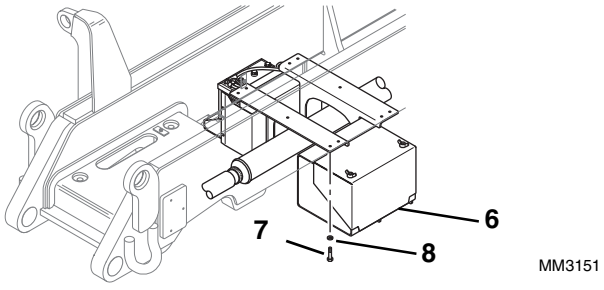
MM5120

31. Replace any tie wraps that were removed.

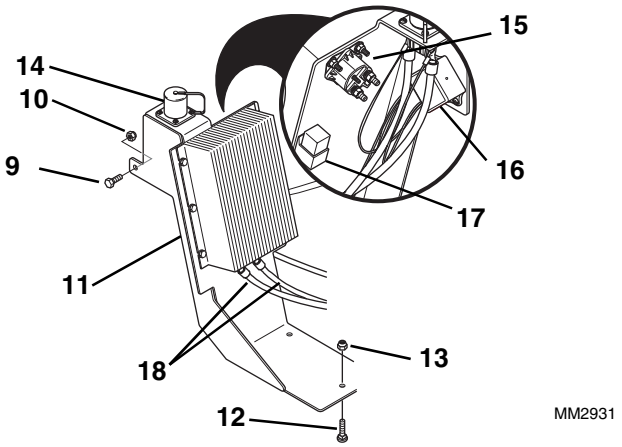
32. Install air cleaner mount plate (**1**), engine air cleaner assembly (**2**), air intake hose (**3**) and air cleaner hose (**4**). Connect the air filter restriction sensor wiring connector (**5**).



33. Clean the transmission oil filter mounting surface.
34. Apply a clean film of clean oil to the new transmission filter gasket. Install the new filter and torque to 20-25 lb/ft (27-34 Nm).
35. Transmission oil may be added through the dipstick tube. Remove the dipstick and add approximately 3 gallons (11 liters) of recommended oil. Check the oil level by taking intermittent dipstick readings as outlined in *Section 2.13.10, a. Transmission Oil Level Check*. **DO NOT** overfill. Reinstall the dipstick when finished.
36. Set the battery equalizer bracket (**11**) into the engine pod.
37. Lift the battery box assembly (**6**), with a hoist or some other means, into position and re-install the eight capscrews (**7**) and lockwashers (**8**) to secure it to the frame.



38. Install the capscrew (**9**) and elastic locknut (**10**) at the top right corner of the battery equalizer bracket (**11**).
39. Install the three carriage bolts (**12**) and elastic locknuts (**13**) securing the bottom of the equalizer bracket to the engine pod.

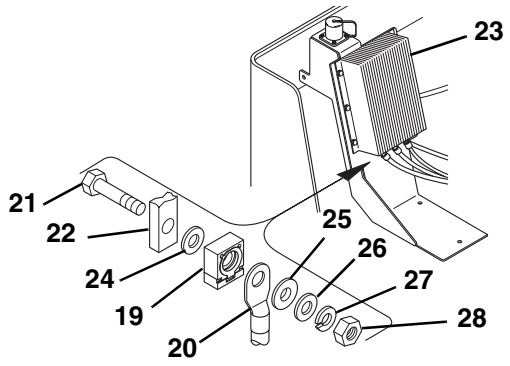


40. Connect the wires to the NATO slave receptacle (**14**), starter solenoid (**15**), solargizer control box (**16**) and fuel shut-off relay (**17**).

    Follow steps 41 through 45 when installing the two positive (+) battery equalizer cables (**18**).

Make sure the equalizer fuses (**19**) and positive (+) battery equalizer cables (**20**) are placed in the following order:

41. Insert the capscrew (**21**) through the tab (**22**) on the equalizer (**23**).
42. Place a flat washer (**24**) and fuse (**19**) onto the capscrew. Position fuse as required to best see the clear window.
43. Place the positive (+) battery equalizer cable (**20**) onto the capscrew.
44. Place the nylon shoulder washer (**25**) onto the capscrew and place against the positive (+) battery equalizer cable with the hub toward the cable.
45. Secure in place with a flat washer (**26**), lockwasher (**27**) and hex nut (**28**). Torque the hex nut to a maximum of 100 lbs/in (11 Nm).



CAUTION: Before starting the engine after an equalizer installation, be sure that both batteries are charged. The high starting current can cause the charged battery to reverse the voltage on a discharged battery. With the equalizer connected normally, it then "sees" a reverse power connection. Protection diodes inside the equalizer will then act to "blow" one of the fuses, or generate excessive heat.

Any 12V accessories, gauges, etc. connected to the discharged battery during starting, will also have the reverse voltage applied to their power connections. This may result in damage to these items.

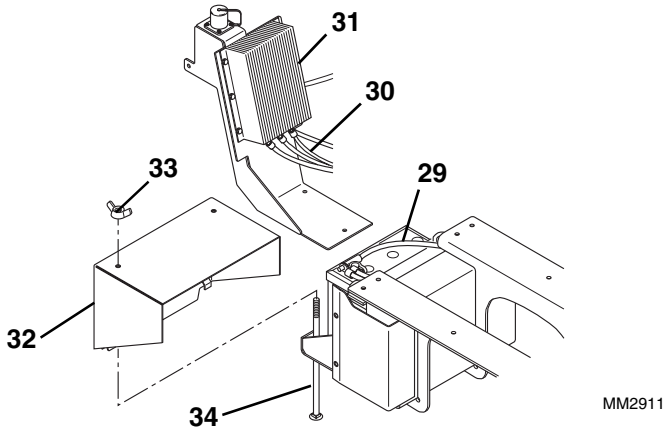
46. Connect the negative (-) battery cable (**29**) at the negative (-) terminal on the battery in the engine side battery box.
47. Connect the negative (-) battery equalizer cable (**30**) at the bottom of the battery equalizer (**31**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
48. Replace engine side battery box cover (**32**). Use the wing nuts (**33**) and carriage bolts (**34**) to secure the cover in place.

WARNING: Fluid (electrolyte) in electric storage batteries contains sulfuric acid, a **POISON** that can cause **SEVERE CHEMICAL BURNS**. Avoid all contact of fluid with eyes, skin or clothing. Use proper protective gear when handling batteries. **DO NOT** tip a battery beyond a 45° angle in any direction. If contact with battery fluid does occur, follow the First Aid suggestions in the "Battery Fluid (Electrolyte) First Aid" box below.

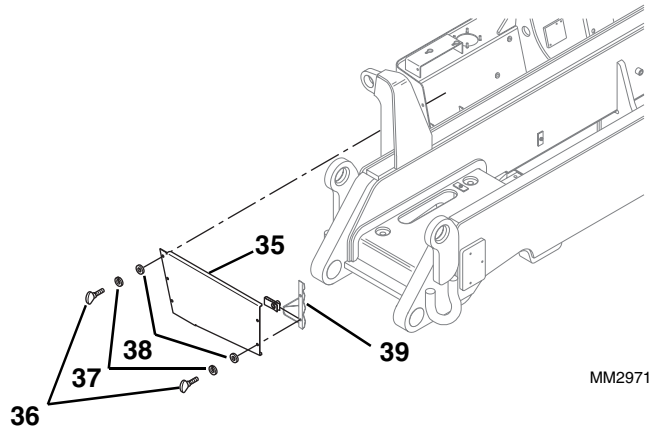
Battery Fluid (Electrolyte) First Aid:

- **External Contact —** Flush with water.
- **Eyes —** Flush with water for at least 15 minutes and get medical attention immediately.
- **Internal Contact —** Drink large quantities of water. Follow with Milk of Magnesia, a beaten egg or vegetable oil. Get medical attention immediately. **DO NOT** take fluids that induce vomiting.

IMPORTANT! *In case of internal contact,* ***DO NOT*** *give fluids that would induce vomiting!*



49. Install the front engine cover (**35**) to the hydraulic reservoir and the bracket (**39**) on the battery box. Use five 5/16-18 x 1" Grade 5, thumbscrews (**36**), 5/16" narrow flat washers (**37**) and 5/16" lockwashers (**38**).



50. Install the engine hood. (Refer to *Section 3.7.2, Engine Hood.*)
51. Wipe up any spilled fluids. Dispose of properly.

7.7.4 After Transmission Service or Replacement

Refer to the ZF 4 WG-98 TS Transmission Repair Manual (ZF part number 5871 139 002, **JLG** part number 8990418) for information on servicing the transmission after overhaul or repair. In general:

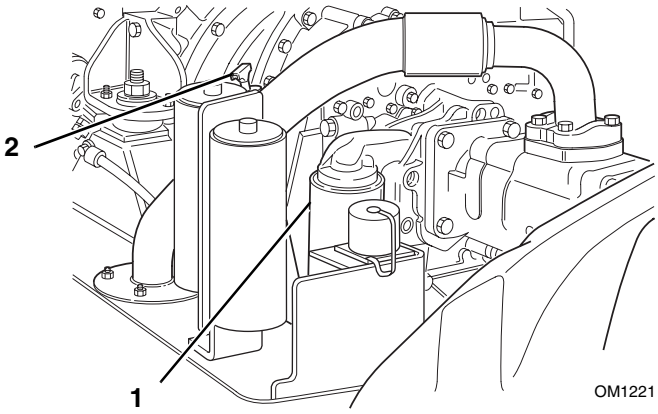
1. Check transmission oil level and add oil as required.
2. Install a new transmission filter (**1**).
3. Check the torque on the drive shaft yoke capscrews.
4. Wear suitable eye protection. When an overhauled or repaired transmission is installed, thoroughly clean the oil cooler lines to and from the transmission.
5. Drain and flush the entire system.
6. Disconnect and clean all transmission cooler hoses. When possible, remove transmission lines from the vehicle for cleaning.
7. Thoroughly clean transmission filter screens and cases, and replace transmission filter elements.

CAUTION: **DO NOT** exceed 165 psi (39.6 bar) when back flushing the oil cooler. Applying too much pressure may damage the oil cooler/radiator.

8. Back flush the transmission oil cooler portion of the radiator with oil and compressed air until all foreign material is removed. Flushing in the direction of normal oil flow does not adequately clean the cooler. If needed, remove the radiator from the vehicle.

***IMPORTANT: DO NOT** use flushing compounds for cleaning purposes.*

9. Reassemble all components and fill the transmission with clean recommended oil through the dipstick tube opening (**2**). Remove the dipstick and fill with approximately 12 quarts (11,4 liters) of recommended oil. Check the level by taking intermittent dipstick readings as outlined in *Section 2.13.10, a. Transmission Oil Level Check*. **DO NOT** overfill. Reinstall the dipstick when finished.



10. Run the engine for two minutes at idle (1,000-1,100 rpm) to help prime the torque converter and the transmission oil lines.
11. Recheck the level of the oil in the transmission with the engine running at idle (1,000-1,100 rpm).
12. Add recommended oil as necessary to bring the fluid level up until it reaches the FULL mark on the dipstick. Recheck the oil level when it reaches operating temperature (180-200° F or 83-94° C).
13. Recheck all drain plugs, lines, connections, etc., for leaks and tighten where necessary.

7.8 TOWING A DISABLED VEHICLE

Towing a disabled vehicle should only be attempted as a last resort, after exhausting all other options. Make every effort to repair the vehicle, and move it under its own power, before using the emergency towing procedures outlined in either *Section 2.14.1, Towing a Disabled Vehicle Short Distances* or *Section 2.14.2, Towing a Disabled Vehicle Long Distances*.

***IMPORTANT:** After the vehicle has been towed to a secure location, reactivate the parking brake. Carefully follow the procedures from start to finish. Consult your local **JLG** Authorized Service Center (ASC) or the **JLG** Service Department if you are unsure about any part of the procedure, or for specific instructions for your particular situation.*

7.9 TROUBLESHOOTING

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

Note: *Contact the **JLG** Service Department at 1-717-485-5161 (Domestic) or 1-877-554-5438 (International) if internal transmission repair is required during the warranty period.*

Detailed transmission service instructions (covering repair, disassembly, reassembly and adjustment information) are provided in the ZF 4 WG-98 Transmission Repair Manual, (ZF part number 5871 139 002, **JLG** part number 8990418).

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

7.9.1 Transmission Troubleshooting

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 recommended oil (refer to *Section 2.13.10, a. Transmission Oil Level Check*).
	2. Travel select lever not functioning properly and/or a fault in the wiring harness.	2. Refer to *Section 10.13.8, b. Travel Select Lever and Wiring Harness Testing*.
	2. Transmission valve body solenoids not functioning properly.	2. Refer to *Section 10.13.8, c. Upper and Lower Transmission Valve Body Solenoid Testing*.
	3. Pilot-operated shift valves not operating properly.	3. Clean the valve spool and housing. Replace return spring as needed.
	3. Pump output pressure low.	4. Refer to *Section 7.9.1, Transmission Troubleshooting,* Step 2, Low or no pump flow or pressure.
	4. Clutch piston o-rings damaged.	5. Replace o-rings.
	5. Clutch discs worn or damaged.	6. Replace clutch discs.
	6. Coupling shafts or gear teeth damaged.	7. Replace couplings.
2. Low or no pump flow or pressure.	1. Low oil level.	1. Fill transmission to correct level with recommended oil (refer to *Section 2.13.10, a. Transmission Oil Level Check*).
	2. Transmission filled with incorrect oil, or oil contaminated.	2. Drain transmission and fill to correct level with recommended oil (refer to *Section 2.13.10, b. Transmission Oil and Filter Change*).
	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.

7.9.1 Transmission Troubleshooting (Continued)

Problem	Cause	Remedy
3. Low clutch pressure.	1. Incorrect oil level.	1. Fill transmission to correct level with recommended oil (refer to *Section 2.13.10, a. Transmission Oil Level Check*).
	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 9.8, Hydraulic Circuits and Troubleshooting*.
	2. Low engine rpm causes converter stall.	2. Adjust the engine rpm to specifications (refer to Cummins 4BTA 3.9 Service Manual).
	2. Pump output pressure is low.	2. Refer to *Section 7.9.1, Transmission Troubleshooting,* Step 2, Low or no pump flow or pressure.
	3. Clutch discs worn or damaged.	3. Replace clutch discs.
	4. Transmission overheating.	4. Refer to *Section 7.9.1, Transmission Troubleshooting,* Step 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 recommended oil (refer to *Section 2.13.10, a. Transmission Oil Level Check*).
	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 recommended oil (refer to *Section 2.13.10, b. Transmission Oil and Filter Change*).
	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. Engine thermostat stuck.	7. Replace engine thermostat (refer to *Section 8.6.2, Thermostat Replacement*).

7.9.1 Transmission Troubleshooting (Continued)

Problem	Cause	Remedy
8. Grinding or "clunking" noise from transmission.	1. Oil level too low.	1. Fill oil to correct level (*Section 2.13.10, a. Transmission Oil Level Check*).
	2. Transmission filled with incorrect oil.	2. Drain transmission and fill to correct level with recommended oil (refer to *Section 2.13.10, b. Transmission Oil and Filter Change*).
	3. Incorrect clutch engagement.	3. Refer to *Section 10.13.8, Transmission Solenoid Valves*.
	4. Internal damage.	4. Repair or replace parts and needed.
	5. Broken diaphragm (flex plate).	5. Replace diaphragm (flex plate), (refer to *Section 7.7.1, Transmission Removal*).
	6. Loose diaphragm (flex plate) mounting capscrews.	6. Tighten capscrews.
4. 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 2.13.10, a. Transmission Oil Level Check*). 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-ring 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 capscrew not tight).	4. Replace gaskets and/or tighten capscrews to 7 lb/ft (9,5 Nm).
	5. Housing capscrews loose.	5. Tighten caps 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. Housing damaged.	9. Replace housing as needed.

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Section 8
Engine: Cummins 4BTA 3.9

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8.1 INTRODUCTION

8.1.1 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.

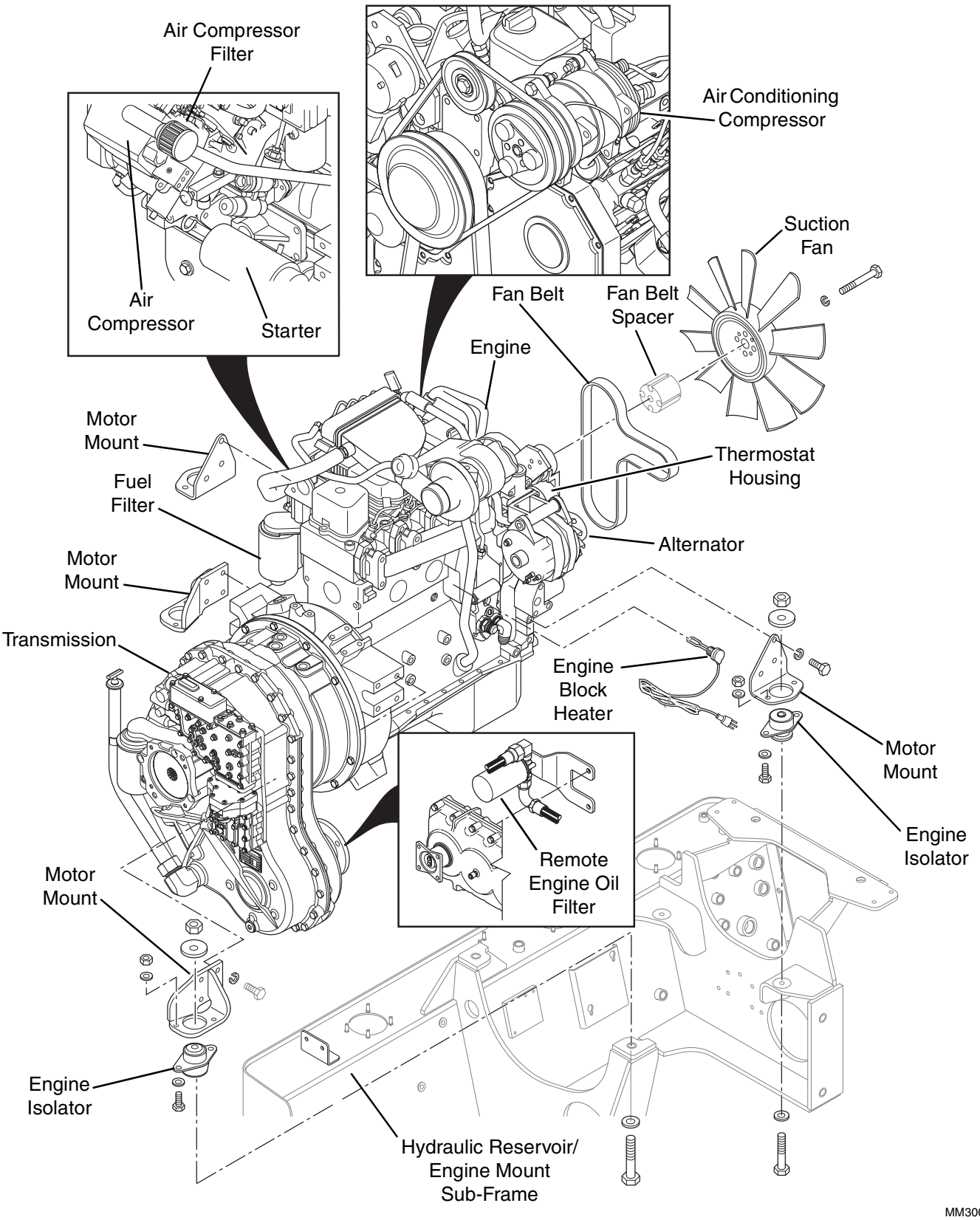
IMPORTANT: *These instructions cover only the routine maintenance, removal, installation and troubleshooting of the engine. Refer to the local Cummins Engine Distributor and the applicable Cummins engine service manual for assistance with comprehensive engine diagnosis, repair and component replacement.*

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.

Throughout this section, the left or right side of the engine is as viewed from the flywheel end.

8.1.2 Component Terminology

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


Air Compressor Filter
Air Conditioning Compressor
Suction Fan
Air Compressor
Starter
Fan Belt
Fan Belt Spacer
Engine
Motor Mount
Thermostat Housing
Fuel Filter
Alternator
Motor Mount
Transmission
Engine Block Heater
Motor Mount
Engine Isolator
Remote Engine Oil Filter
Motor Mount
Engine Isolator
Hydraulic Reservoir/ Engine Mount Sub-Frame
MM3001

8.2 SAFETY INFORMATION

General Vehicle Operation

WARNING: Before attempting to start the engine and/or operate the vehicle, read the Owners/Operators Manual.

- Before operating the engine and/or the vehicle, install any engine guards that were removed and clear all personnel from the immediate area.
- Check that the brakes are fully functional.
- **DO NOT** exceed the stability limits of the vehicle.
- Allow only ONE person to have control of the engine and the vehicle.

Preparation

WARNING: Wear protective glasses and protective shoes.

- **Verify that the work area** is capable of supporting the weight of the vehicle and the torque created by any suspended load.
- **DO NOT** work on an engine or a vehicle that is supported ONLY by a hoist or lift jacks. Use blocks or suitable stands.

Engine Operation

WARNING: Operate the engine in a well-ventilated area only. Assure that engine operation will not produce a concentration of toxic emissions.

- **DO NOT** operate the engine in the presence of a fuel spill or gas leak. Such combustible vapors, when drawn into the engine, can cause engine over-acceleration, explosion, fire and extensive personal injury and property damage. Before operating in any hazardous environment, consult a recognized authority (such as the engine distributor) on engine operation in hazardous environments.
- **DO NOT** smoke or operate the engine during refueling.

Cleaning

WARNING: When using steam cleaners and pressure washers, wear protective glasses, gloves and clothing to help prevent personal injury.

WARNING: **NEVER** use gasoline or other flammable materials for cleaning parts. Use only approved cleaning solvents.

Engine Coolant (anti-freeze/anti-boil over)

WARNING: **DO NOT** remove the radiator cap while the engine and coolant are hot. Hot coolant under pressure is dangerous and can injure the eyes and cause severe burns.

- Cooling system corrosion inhibitors contain alkali (chemicals that break down organic substances such as skin and eye tissue), **DO NOT** swallow. Avoid prolonged or repeated contact with corrosion inhibitors. In case of skin contact, immediately wash affected area with soap and water. In case of contact with eyes, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Obtain medical assistance immediately. Keep corrosion inhibitors out of the reach of children.
- **DO NOT** use salt water or other corrosive liquid in the cooling system.

Rotating Parts and Fan Blades

WARNING: Keep away from parts which rotate; the fan blades can appear invisible when the fan is rotating.

DO NOT pull or pry on the fan blades. This practice will cause fan failure. Use only approved methods and tools for manually rotating the engine.

Battery

WARNING: Keep sparks and fires away from batteries. Batteries produce hydrogen gas, which can explode and cause severe personal injury and property damage.

Battery fluid can burn the skin and injure the eyes. If you come in contact with battery acid, flush the affected area with large amounts of water and obtain medical assistance immediately.

Engine Oil

WARNING: Engine oil can cause skin disorders and other personal injury. Avoid prolonged or repeated contact with both new and used engine oil.

Diesel Fuel

WARNING: Diesel fuel can cause skin irritation. Use gloves or protective hand lotion when working on the fuel system.

Engine Repair

WARNING: Before beginning any adjustments or repairs, place accident prevention tags in the operator's compartment and on the controls, and disconnect the battery negative cable.

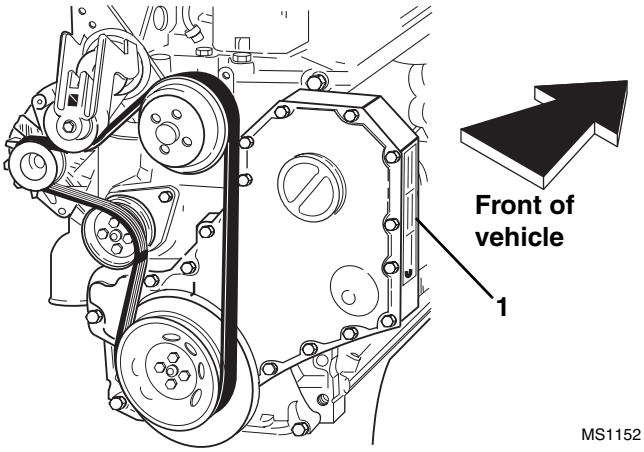
- **DO NOT** operate, clean, lubricate or adjust the engine without proper training.
- **NEVER** attempt to perform an adjustment or repair that is not understood.
- Before servicing, relieve pressure in fuel, oil, coolant and hydraulic lines. Obtain medical assistance immediately if a high-pressure jet of fuel, oil, coolant or hydraulic fluid strikes the skin.
- **DO NOT** permit loose clothing, hair, etc., near moving parts.
- Keep away from parts which rotate; fan blades can appear invisible when the fan is rotating.
- To help prevent burns, avoid contact with components that remain hot after power is turned off or disconnected.
- Some of the gaskets on the engine contain asbestos. Breathing asbestos dust is dangerous to health and may cause severe bodily harm. Avoid creating dust and follow local directives for handling and disposing of materials that contain asbestos.

Parts

WARNING: When replacement is necessary, **ALWAYS** use factory-approved fasteners and parts.

8.3 ENGINE SERIAL NUMBER

The Cummins 4BTA 3.9 serial number (**1**) is stamped on the front of the engine block, near the fan pulley. Information contained in the serial number is required in correspondence with the engine manufacturer.



Supply the engine serial number and/or data tag information when communicating about an engine or engine components.

8.4 SPECIFICATIONS AND MAINTENANCE INFORMATION

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

Note: *Detailed Cummins engine service instructions (covering disassembly, inspection, internal repair, assembly, adjustment and troubleshooting information) are provided in the appropriate Cummins engine service manual.*

8.5 STANDARD PRACTICES

8.5.1 Left and Right Sides of the Engine

Throughout this section, the left or right side of the engine is as viewed from the flywheel end.

8.5.2 Cleanliness

Cleanliness is very important during engine repair. Contamination of the engine during repair will reduce the life of an engine. Thoroughly clean the engine and engine compartment area before attempting to service or repair the engine.

DO NOT steam clean the following parts:

- Electrical Components
- Wiring
- Injectors
- Fuel Pump
- Belts and Hoses
- Bearings

During reassembly and inspection, thoroughly clean all parts, and, where present, remove burrs and scales.

8.5.3 Gaskets and O-rings

NEVER re-use a gasket or o-ring. Use new gaskets and o-rings. Thoroughly clean sealing surfaces before installing a new gasket or o-ring. ALWAYS install new flat-faced o-rings when servicing hydraulic fittings.

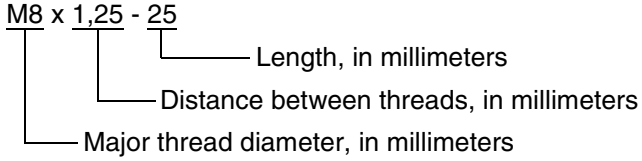
Cover any open ports of high-precision components (such as fuel system equipment) exposed by removal or disassembly to help prevent the entry of foreign material.

8.5.4 Capscrews and Metric Parts

When replacing capscrews, ALWAYS use a capscrew of the same size and strength as the capscrew being replaced. Incorrect capscrews can result in engine damage. Return capscrews removed from the engine to their original locations.

The Cummins 4BTA 3.9 engine uses parts that are of metric dimensions. Metric capscrews are described, in millimeters, in terms of major thread diameter, distance between threads, and overall length.

Metric capscrew dimensions:



Verify that the correct type of part is used at all times.

8.6 ENGINE COOLING SYSTEM

The engine cooling system is a closed, pressurized system that consists of coolant passages in the engine, plus the oil cooler, thermostat, water pump, engine block heater, hoses, radiator and radiator overflow bottle. The engine is cooled by the circulation of coolant through passages in the cylinder block, engine head and radiator. Circulation is by thermo-siphon action, assisted by an impeller-type water pump, driven by a fan belt from the crankshaft pulley. The water pump bearings are prepacked with a special grease and **DO NOT** require service. Replace a faulty water pump. General engine cooling specifications and maintenance procedures are listed in *Section 2, General Information, Specifications and Maintenance*.

8.6.1 Radiator Pressure Cap

The cooling system is designed to use a radiator pressure cap to help prevent the coolant from boiling. In addition, the pressure helps to eliminate the formation of steam pockets within the engine and ensures coolant circulation throughout all coolant passageways of the engine. For a 210° F (99° C) system, use a 13 psi (90 kPa) radiator cap. An incorrect or malfunctioning cap can result in the loss of coolant and a hot-running engine.

8.6.2 Thermostat Replacement

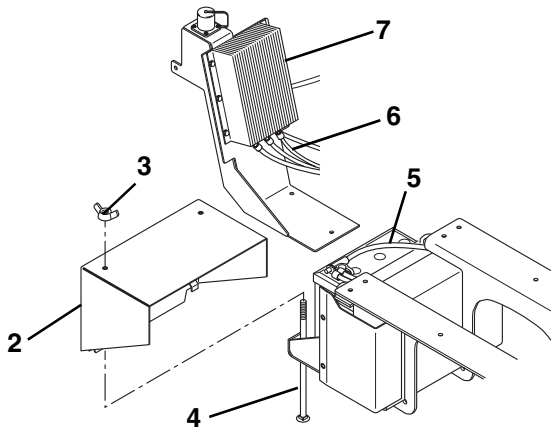
Before considering thermostat replacement, check the coolant level, fan belt tension and dash panel temperature indicator. If the engine seems to take a long time to warm up, the thermostat may be stuck in the open position and requires replacement. If the engine runs hot, check the temperature of the 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. Thermostat Removal

1. Level the vehicle, ground the attachment, place the travel select lever in NEUTRAL [N], engage the neutral lock lever, engage the parking brake switch and shut off the engine. Secure accident prevention tags to the steering wheel and ignition switch (refer to *Section 1.5, Accident Prevention Tag Usage*).

WARNING: **DO NOT** attempt this procedure when the engine is hot. Wait for the engine, muffler, and tailpipes to cool down before proceeding. Failure to do so could result in severe burns.

2. Unlatch and open the engine cover. Allow the engine to cool before proceeding. Draining the cooling system while the engine is hot can cause cracks in the engine block.
3. Remove engine side battery box cover (**2**). Remove wing nuts (**3**) and carriage bolts (**4**) and set cover and mounting hardware aside for later re-assembly.
4. Disconnect the negative (-) battery cable (**5**) at the negative (-) terminal on the battery in the engine side battery box.
5. Disconnect the negative (-) cable (**6**) at the bottom of the battery equalizer (**7**).

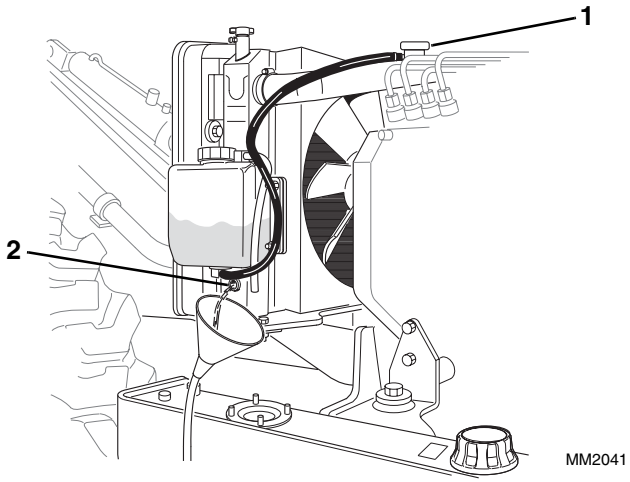


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6. Drain approximately two quarts (2 liters) of coolant.

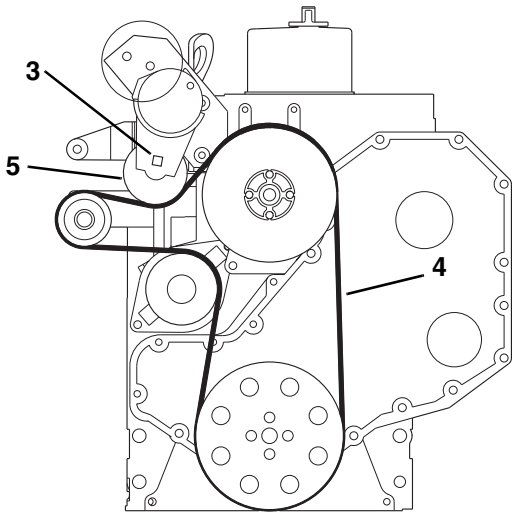
WARNING: Hot coolant can cause severe burns or eye injury. **NEVER** remove the radiator cap while the engine is hot. The cooling system is under pressure. Wear protective clothing and safety glasses.

7. Slowly turn the radiator cap (**1**), located in the upper radiator hose, to the first stop and allow any pressure to escape. Remove the radiator cap. Place a funnel at the base of the radiator to channel the drained coolant into a container. Open the radiator drain plug (**2**) or petcock and allow the coolant to drain into the funnel. Transfer the coolant into a properly labeled container. Dispose of properly. Close the radiator drain plug or petcock.

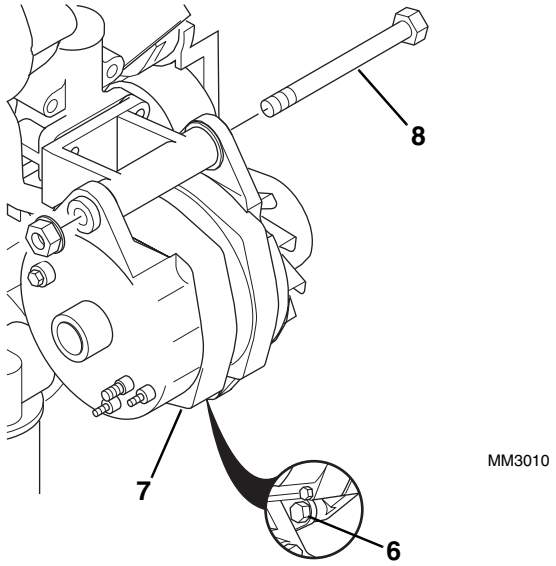


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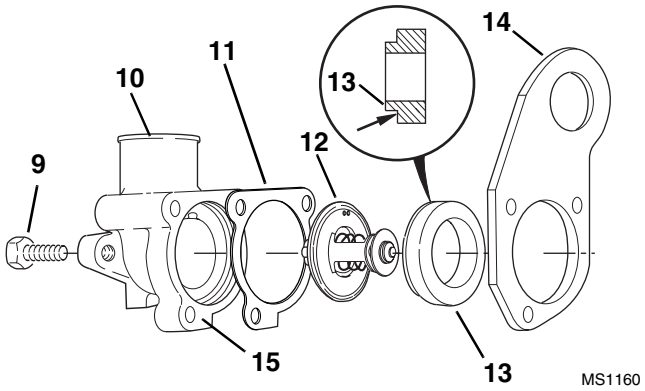
8. Insert a 1/2" drive ratchet or breaker bar into the automatic belt tensioner housing (**3**) and remove the tension from the fan drive belt (**4**).



9. While lifting the automatic belt tensioner (**5**) away from the belt, remove the fan drive belt (**4**).
10. Loosen the lower alternator bracket capscrew (**6**) on the bottom of the alternator (**7**). Remove the upper alternator mounting capscrew (**8**) and lower the alternator.



11. Remove the three capscrews (**9**) securing the thermostat housing (**10**) to the engine.



12. Remove the thermostat housing (**10**), old gasket (**11**), thermostat (**12**), thermostat seal (**13**) and engine lift bracket (**14**). Clean all gasket surfaces (**15**). **DO NOT** let any debris into the thermostat opening while the thermostat is removed.

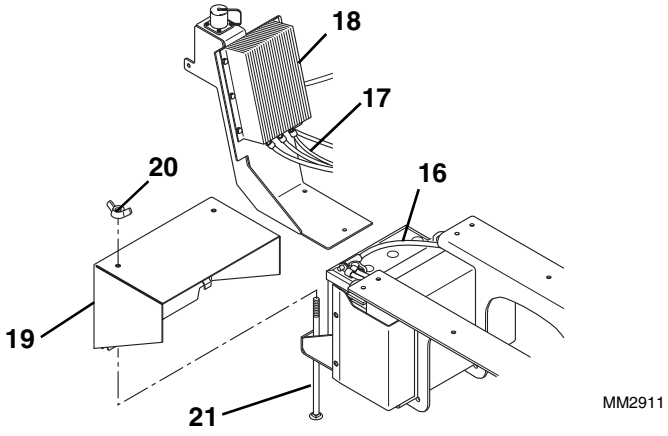
IMPORTANT: *ALWAYS use the correct thermostat and install a new gasket.* ***NEVER*** *operate the engine without a thermostat, or engine damage will result.*

b. Thermostat Installation

Note: *Ensure that notched edge of thermostat seal (**13**) is facing thermostat.*

1. Install the engine lift bracket (**14**), thermostat seal (**13**), thermostat (**12**) gasket (**11**) and thermostat housing (**10**). Secure with the three capscrews (**9**) removed earlier. Torque to 18 lb/ft (24 Nm).
2. Raise the alternator (**7**) and install the alternator mounting capscrew (**8**) and alternator link capscrew (**6**). Torque to 32 lb/ft (43 Nm).
3. Insert a 1/2" drive ratchet or breaker bar into the automatic belt tensioner housing (**3**) and lift the automatic belt tensioner (**5**). With the automatic tensioner lifted out of the way, install the fan drive belt (**4**).
4. Connect the negative (-) battery cable (**16**) at the negative (-) terminal on the battery in the engine side battery box.
5. Connect the negative (-) battery equalizer cable (**17**) at the bottom of the battery equalizer (**18**). Torque the nut to a maximum of 100 lbs/in (11 Nm).

6. Replace engine side battery box cover (**19**). Use the wing nuts (**20**) and carriage bolts (**21**) to secure the cover in place.



7. Run the engine to operating temperature. Visually check for leaks with the engine running. Check the coolant level in the overflow bottle and fill, or drain, as necessary.

8.6.3 Radiator/Oil Cooler and Engine Block Heater Replacement

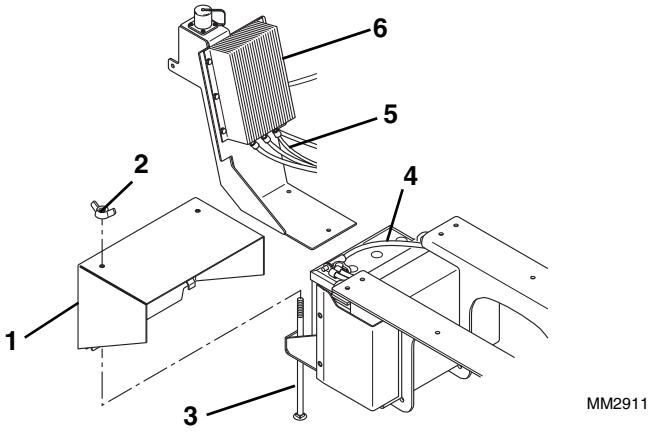
Before considering radiator or oil cooler replacement for other than obvious damage, conduct a cooling system pressure test, check the coolant specific gravity, coolant level, fan belt tension and dash panel temperature indicator. If the engine runs hot, check the temperature of the upper radiator hose. 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 and Oil Cooler Removal

1. Level the vehicle, ground the attachment, place the travel select lever in NEUTRAL [N] and engage the neutral lock lever, engage the parking brake switch and shut off the engine. Secure accident prevention tags to the steering wheel and ignition switch (refer to *Section 1.5, Accident Prevention Tag Usage*).

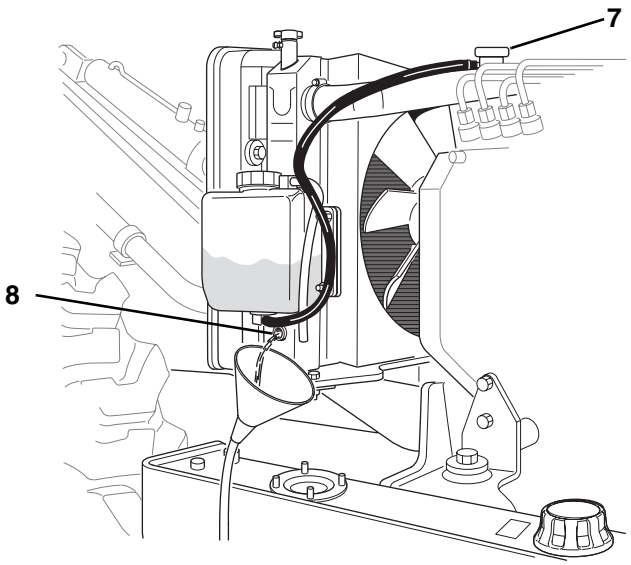
WARNING: **DO NOT** attempt this procedure when the engine is hot. Wait for the engine, muffler, and tailpipes to cool down before proceeding. Failure to do so could result in severe burns.

2. Unlatch and open the engine cover. Allow the engine to cool before proceeding. Draining the cooling system while the engine is hot can cause cracks in the engine block.
3. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
4. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
5. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



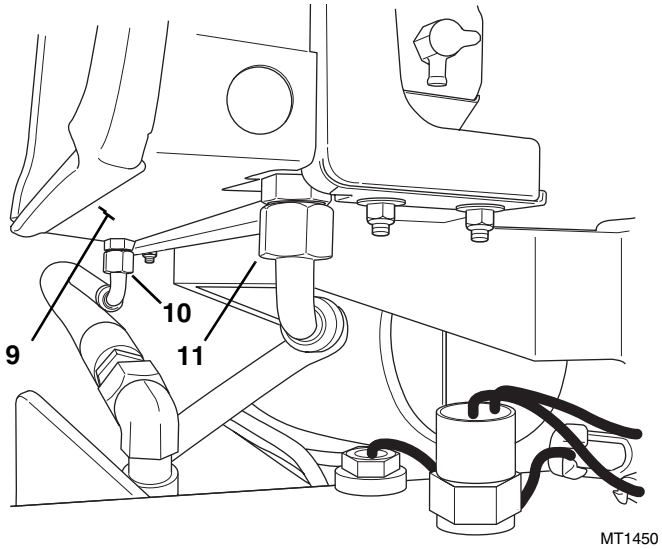
WARNING: Hot coolant can cause severe burns or eye injury. **NEVER** remove the radiator cap while the engine is hot. The cooling system is under pressure. Wear protective clothing and safety glasses.

6. Place a suitable container beneath the radiator petcock.
7. Slowly turn the radiator cap (**7**), located in the upper radiator hose, to the first stop and allow any pressure to escape. Remove the radiator cap.
8. Place a funnel at the base of the radiator to channel the drained coolant into the container. Open the radiator drain plug (**8**) or petcock and allow the coolant to drain into the funnel. Transfer the coolant into a properly labeled container. Dispose of properly if coolant needs to be replaced. Close the radiator drain plug or petcock.



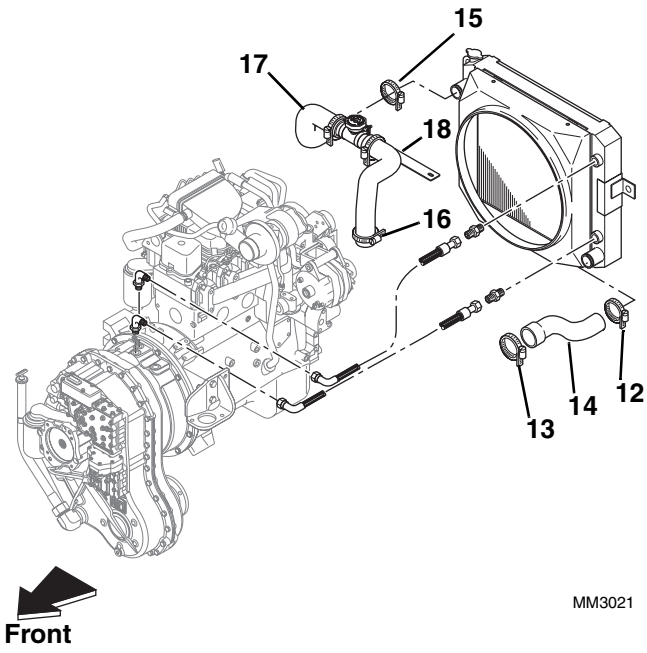
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9. At the bottom of the hydraulic system oil cooler (**9**), disconnect the two hoses (**10** and **11**). Remove and discard the flat-faced o-ring seals from the hose elbows. Cap both hoses.

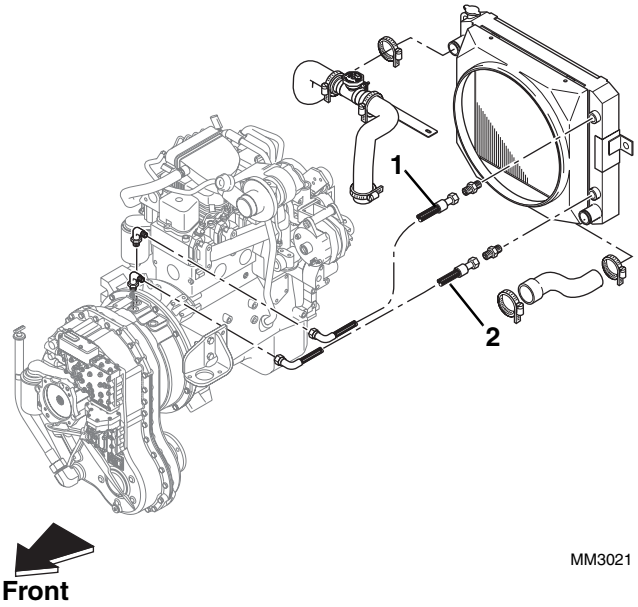


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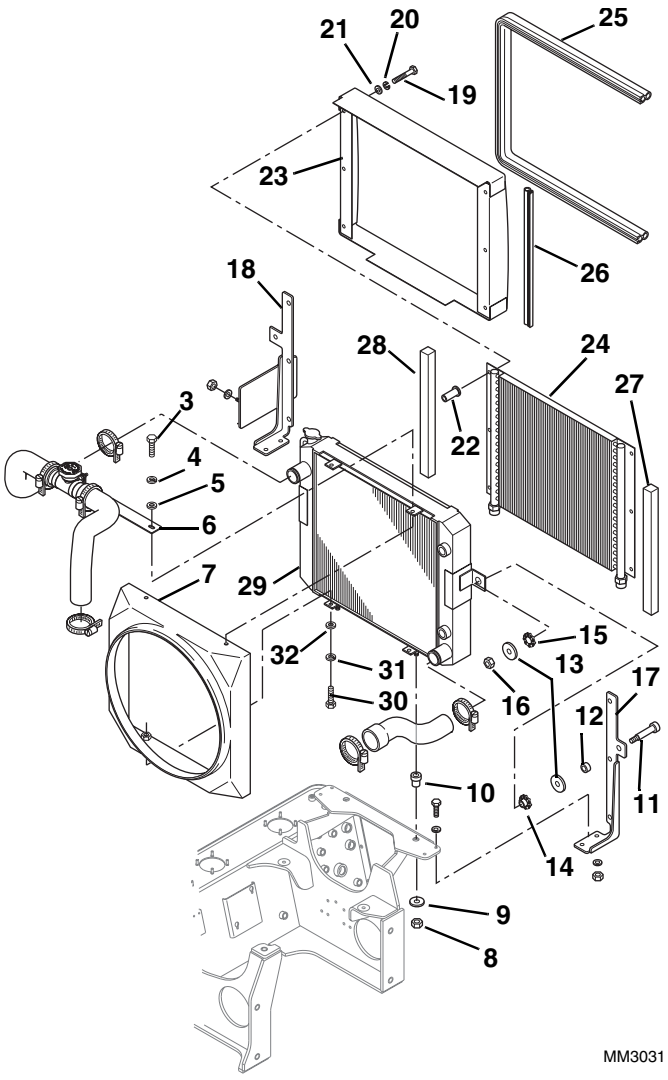
10. Loosen clamps (**12** and **13**) on the radiator return (lower) hose (**14**). Work the hose off the radiator. Position the hose out of the way to allow radiator removal, or remove the hose from the engine. Inspect the hose and replace if necessary.
11. Loosen both clamps (**15** and **16**) on the radiator input (upper) hose assembly (**17**). Work the hose assembly end off the radiator. The hose assembly bracket (**18**) is attached to the top of the radiator shroud. Wait to position the hose assembly out of the way until ready to remove the shroud and radiator. Inspect the hose components and replace if necessary.



12. Disconnect and cap the transmission inlet (**1**) and outlet (**2**) hoses.



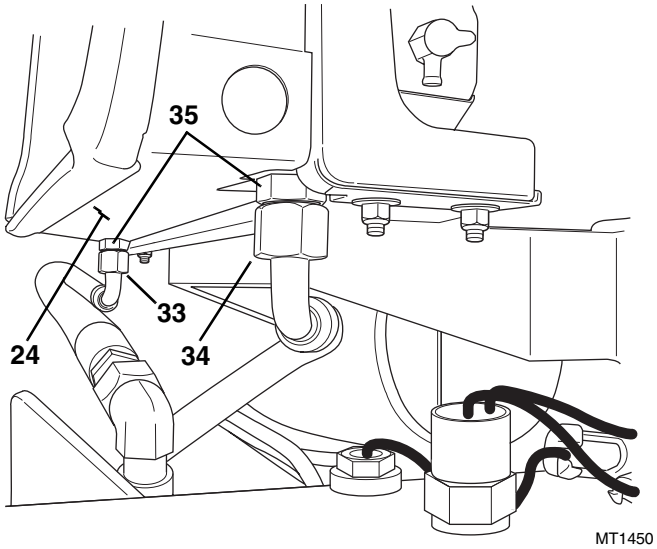
13. Working above the radiator (**29**), remove two capscrews (**3**), lockwashers (**4**) and flat washers (**5**) securing the radiator at the upper mounting tabs to the hose assembly (**6**) and radiator shroud (**7**).
14. Working below the radiator, remove two capscrews (**30**), lockwashers (**31**) and flat washers (**32**) securing the radiator at the lower mounting tabs to the radiator shroud (**7**).
15. Working from beneath the radiator, remove two locknuts (**8**), rebound washers (**9**) and rubber mounts (**10**) secured to the welded studs on the bottom of the radiator.
16. At the sides of the radiator, remove the socket head shoulder bolts (**11**), spacers (**12**), rebound washers (**13**), two radiator mount bushings (**14**), radiator mount rings (**15**), and elastic locknuts (**16**) securing the radiator at its side mounting tabs to the two radiator brackets(**17** and **18**). Carefully remove the radiator (**29**) from the vehicle.



17. Remove the six capscrews (**19**), lockwashers (**20**), flat wide washers (**21**) and well nuts (**22**) securing the radiator baffle assembly (**23**) to the hydraulic system oil cooler (**24**). Remove the hydraulic system oil cooler.
18. Remove, inspect and replace the bulb seal (**25**), bulb seal molding (**26**), and two foam baffles (**27** and **28**) as required.

b. Radiator and Oil Cooler Installation

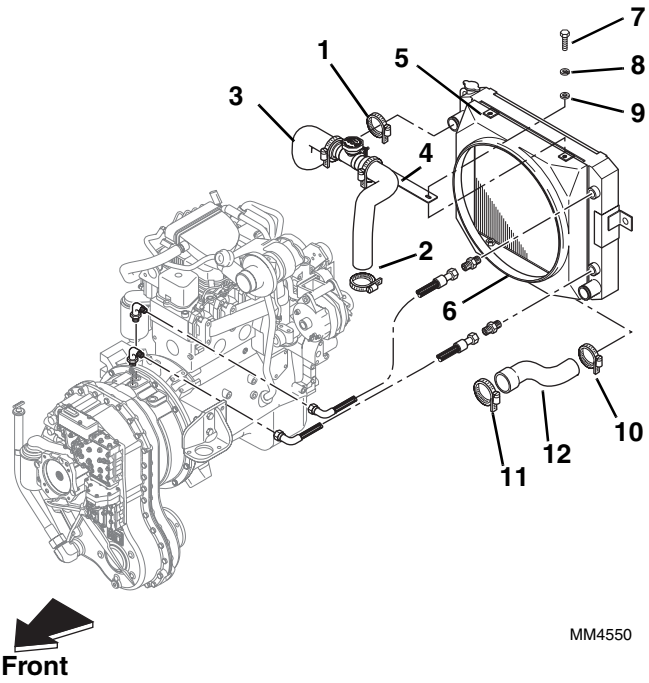
1. Install the bulb seal (**25**), bulb seal moulding (**26**), and two foam baffles (**27** and **28**) as required.
2. Position the oil cooler (**24**) within the radiator baffle assembly (**23**).
3. Install the six 1/4-20 x 1-1/2" capscrews (**19**), 1/4" lockwashers (**20**), 1/4" flat wide washers (**21**) and well nuts (**22**) securing the radiator baffle assembly (**23**) to the oil cooler (**24**). Torque to 9 lb/ft (12 Nm).



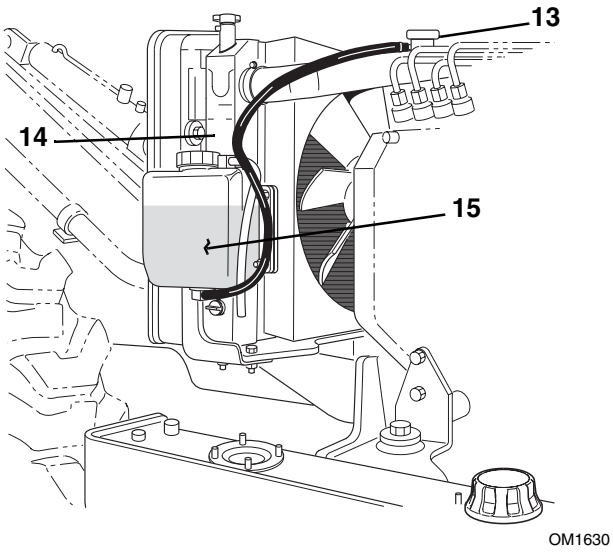
4. At the bottom of the hydraulic system oil cooler (**24**), install a new flat-faced oiled o-ring seal (#12 o-ring) in the 3/4" I.D. x 20.00" (**33**) and 3/4" I.D. x 30.50" (**34**) hose elbows and secure to the oil cooler. Using a back-up wrench to hold the upper fitting (**35**) torque both fittings to 155-165 lb/ft (210-224 Nm).
5. Install the rubber mounts (**10**) on studs before installing the radiator.
6. Carefully place the radiator (**29**), into position at the oil cooler.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

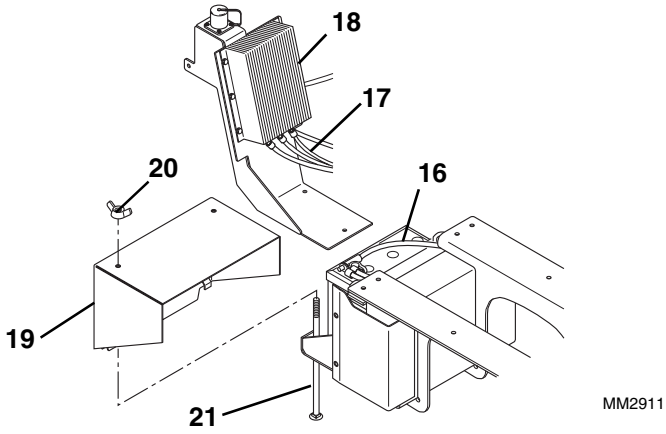
7. At the radiator sides, install the two 3/8 x 1-1/2 x 5/16-18 socket head shoulder bolts (**11**), spacers (**12**), 3/8" rebound washers (**13**), radiator mount bushings (**14**), radiator mount rings (**15**), and 5/16-18 elastic locknuts (**16**) securing the radiator (**29**) at its side mounting tabs to the radiator brackets (**17** and **18**).
8. Working from beneath the radiator, install two 3/8-16 locknuts (**8**), 3/8" rebound washers (**9**) to the welded studs on the bottom of the radiator. Torque to 31 lb/ft (42 Nm).
9. Working below the radiator, install two 5/16-18 x 3/4" Grade 5 capscrews (**30**), 5/16" lockwashers (**31**) and 5/16" narrow flat washers (**32**) securing the radiator at the lower mounting tabs to the radiator shroud (**7**). Torque to 18 lb/ft (24 Nm).
10. Uncap and connect the transmission inlet (**1**) and outlet (**2**) hoses.
11. Install clamps (**1** and **2**) on the radiator input (upper) hose (**3**) assembly. Work the hose onto both the engine and then the radiator. **DO NOT** tighten the clamps at this time.
12. Working above the radiator, line up the mounting holes in the hose assembly bracket (**4**) with the upper mounting tabs (**5**) on the radiator.and the radiator shroud (**6**). Install two 5/16-18 x 3/4" Grade 5 capscrews (**7**), 5/16" lockwashers (**8**) and 5/16" narrow flat washers (**9**) .Torque to 18 lb/ft (24 Nm). Fully secure both clamps (**1** and **2**) on the radiator input (upper) hose (**3**) assembly.
13. Install clamps (**10** and **11**) on the radiator return (lower) hose (**12**). Work the hose onto both the engine and then the radiator. Secure the clamps.



14. Open the radiator cap (**13**) and fill the radiator (**14**) completely with a 50/50 mixture of ethylene glycol and water. Replace and tighten the radiator cap. Add coolant to the overflow bottle (**15**) until the bottle is 1/2 to 3/4 full. This overfilling will compensate for any air in the cooling system.



15. Connect the negative (-) battery cable (**16**) at the negative (-) terminal on the battery in the engine side battery box.
16. Connect the negative (-) battery equalizer cable (**17**) at the bottom of the battery equalizer (**18**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
17. Replace engine side battery box cover (**19**). Use the wing nuts (**20**) and carriage bolts (**21**) to secure the cover in place.



18. Run the engine to operating temperature. Visually check for leaks with the engine running. Check the coolant level in the overflow bottle (**15**) and fill, or drain, as necessary.

c. Engine Block Heater Removal

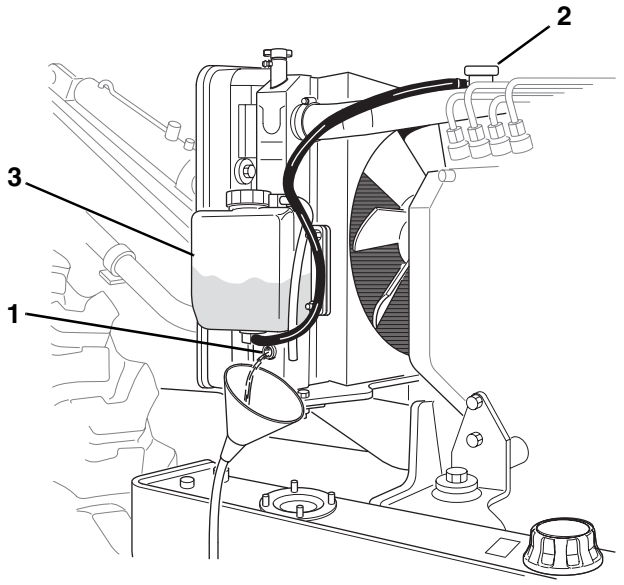
1. Level the vehicle, ground the attachment, place the travel select lever in NEUTRAL [N] and engage the neutral lock lever, engage the parking brake switch and shut off the engine. Secure accident prevention tags to the steering wheel and ignition switch (refer to *Section 1.5, Accident Prevention Tag Usage*).

WARNING: **DO NOT** attempt this procedure when the engine is hot. Wait for the engine, muffler, and tailpipes to cool down before proceeding. Failure to do so could result in severe burns.

2. Unlatch and open the engine cover. Allow the engine to cool before proceeding. Draining the cooling system while the engine is hot can cause cracks in the engine block.
3. Remove engine side battery box cover (**19**). Remove wing nuts (**20**) and carriage bolts (**21**) and set cover and mounting hardware aside for later re-assembly.
4. Disconnect the negative (-) battery cable (**16**) at the negative (-) terminal on the battery in the engine side battery box.
5. Disconnect the negative (-) cable (**17**) at the bottom of the battery equalizer (**18**).

WARNING: Hot coolant can cause severe burns or eye injury. **NEVER** remove the radiator cap while the engine is hot. The cooling system is under pressure. Wear protective clothing and safety glasses.

6. Place a suitable container beneath the radiator drain plug (**1**) or petcock. Slowly turn the radiator cap (**2**), located in the upper radiator hose, to the first stop and allow any pressure to escape. Remove the radiator cap.

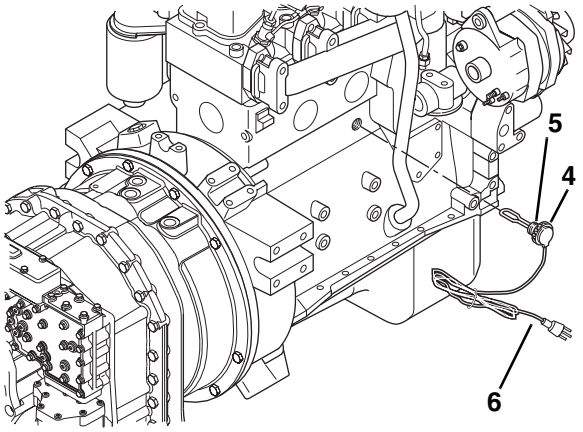


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7. Place a funnel at the base of the radiator to channel the drained coolant into the container. Open the radiator drain plug (**1**) or petcock and allow the coolant to drain into the funnel. Transfer the coolant into a properly labeled container. Dispose of properly if coolant needs to be replaced. Close the radiator drain plug or petcock.
8. Remove plastic retainer (**4**) from around engine block heater element (**5**) and 110 volt cord (**6**). Using a 29 mm socket, remove heating element from engine block.

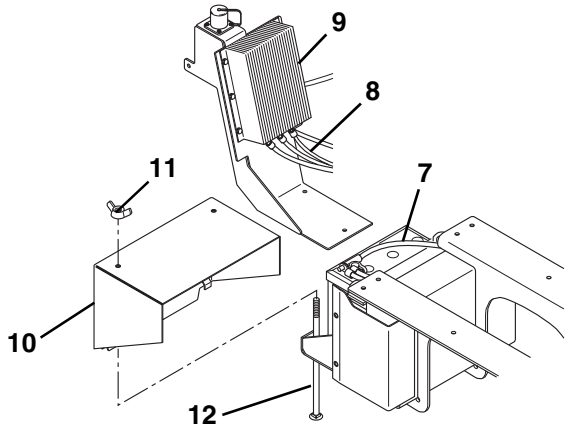
d. Engine Block Heater Installation

1. Apply Teflon tape to engine block heater element threads (**5**) and install element. **DO NOT** over tighten. Plug-in 110 volt cord (**6**) into heater element and install the knurled retainer (**4**) around coolant heater element and 110 volt cord (**6**).



MM5180

2. Connect the negative (-) battery cable (**7**) at the negative (-) terminal on the battery in the engine side battery box.
3. Connect the negative (-) battery equalizer cable (**8**) at the bottom of the battery equalizer (**9**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
4. Replace engine side battery box cover (**10**). Use the wing nuts (**11**) and carriage bolts (**12**) to secure the cover in place.



MM2911

5. Fill the cooling system. Run the engine to operating temperature. Visually check for leaks with the engine running. Check the coolant level in the overflow bottle (**3**) and fill, or drain, as necessary.

8.7 ENGINE ELECTRICAL SYSTEM

The engine electrical system, including the starter, alternator and primary wiring, is described in *Section 10, Electrical System*.

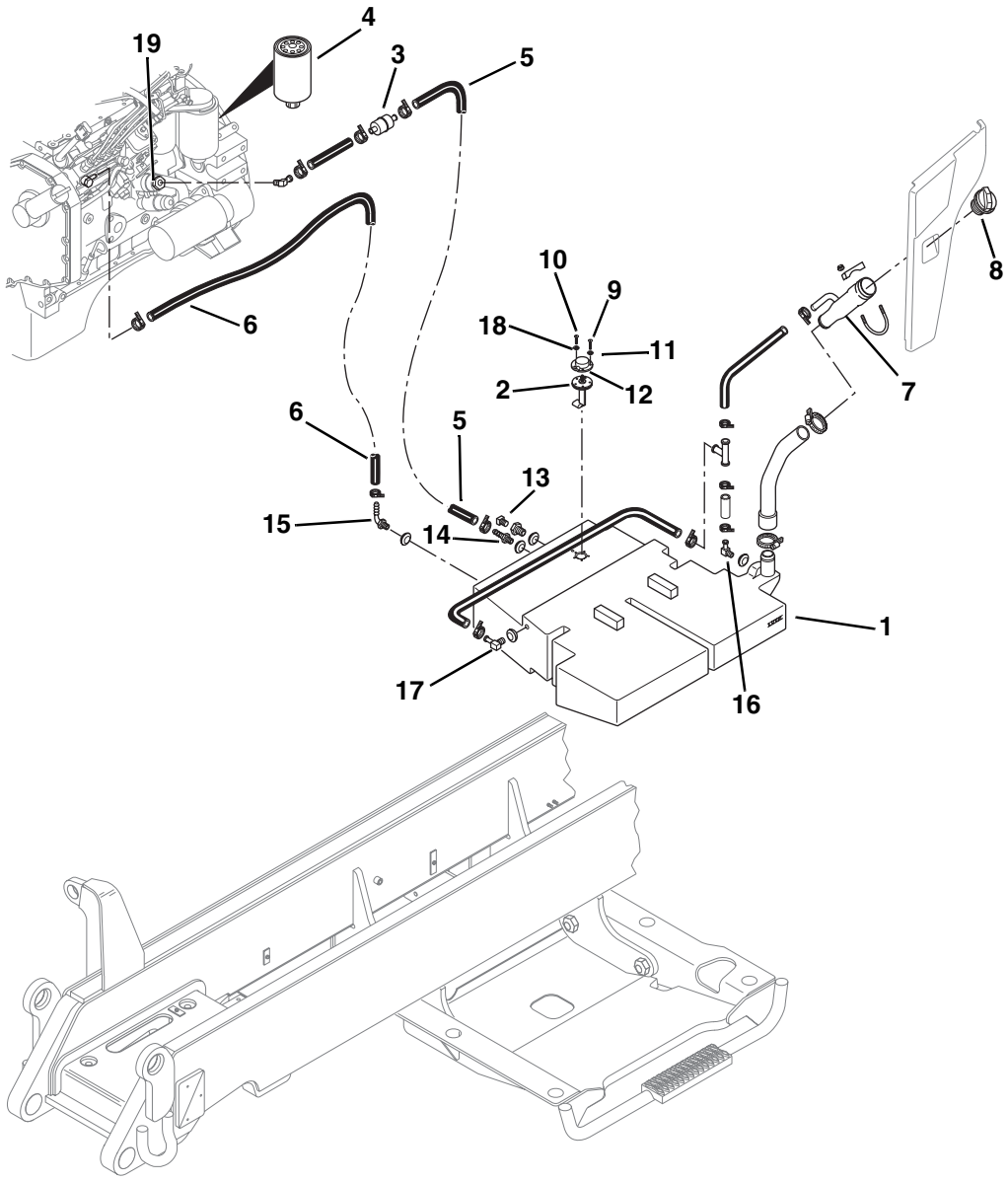
8.8 FUEL SYSTEM

The fuel system includes a fuel tank (**1**), fuel level sender with gasket (**2**), dash panel gauge, fuel strainer (**3**), fuel lift pump (**19**), fuel filter (**4**), fuel supply hose (**5**) and fuel return line (**6**).

The threaded fuel filler (**7**) has a fuel cap (**8**) and permits entry of diesel fuel into the tank.

The fuel level sender (**2**) and dash panel gauge are described in *Section 10.13.19, Fuel Level Indicator and Fuel Level Sender*.

A fuel supply hose (**5**) carries fuel from the tank to the engine lift pump (**19**) and then under pressure to the fuel filter (**4**). Filtered fuel is directed to the fuel injection pump and to the individual fuel injectors. Surplus fuel at the fuel injector pump is returned to the tank via the fuel return line (**6**).



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8.8.1 Diesel Fuel

WARNING: Engine fuel is ***flammable*** and can cause a fire or an explosion. Keep sparks and open flames away from the vehicle and **DO NOT** use smoking materials while refueling.

Fuel represents a major portion of vehicle 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.*

IMPORTANT: *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 No. 2 D fuel with a minimum Cetane rating of 40. No. 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 vehicle to use No. 2 D diesel fuel, unless ambient temperatures are below 32° F (0° C). When temperatures are below 32° F (0° C), a blend of No. 1 D and No. 2 D fuels (known as “winterized” No. 2 D) may be used.

Note: *No. 1 D fuel may be used, however, fuel economy will be reduced.*

WARNING: **DO NOT** mix gasoline or alcohol with diesel fuel. The mixture can cause an explosion.

Use a low-sulfur content fuel with a cloud point (the temperature at which wax crystals form in diesel fuel) at least 10° below the lowest expected fuel temperature. The viscosity of the fuel must be kept above 1.3 centistrokes to provide adequate fuel system lubrication.

Note: *When using diesel fuel with a sulfur content below 1.3 percent, the filter change interval must be reduced by 75 hours. The use of fuel with a sulfur content above 1.3 percent is not recommended.*

Alternate Fuel Types

The vehicle is also capable of operation on alternate military fuels including JP-5, JP-8 and Jet A-1. However, an up to 5% reduction in engine horsepower output can be expected when using alternate military fuels due to the lower BTU rating of these fuels.

8.8.2 Fuel Tank

The fuel tank (**1**) is located directly beneath the operator’s cab.

a. Removal

The operator’s cab must be partially removed in order to remove the fuel tank. Follow the directions for removing the operator’s cab in *Section 3.2.3, b. Cab Removal*, then remove the fuel tank. If a leaking fuel tank is suspected, check that all fuel tank inlets and outlets are not the cause of the leak before removing the fuel tank from the vehicle.

b. Disassembly

1. Disconnect the fuel level gauge wire from the fuel tank. Remove the five pan-head screws (**9** and **10**), and lockwashers (**11** and **18**) securing the fuel sender cover (**12**) and fuel sender with gasket (**2**) to the fuel tank (**1**).
2. Remove the square-head pipe plug (**13**), the hose connector (**14**), the hose elbow (**15**) and both hose barb elbows (**16** and **17**).

c. Cleaning and Drying

If contaminated fuel or foreign material is in the tank, the tank can usually be cleaned. Replace a leaking or damaged tank. **DO NOT** attempt to repair, plug or patch a leaking or damaged fuel tank. The tank is manufactured using an injection molding process and cannot be repaired. If a leak is detected at any of the grommets on the tank, replace both the grommet and fitting.
Contact JLG Inc. directly at: Domestic: **1-717-485-5161** International: **1-877-554-5438**

To clean the fuel tank:

1. Have a dry chemical (Class B) fire extinguisher near the work area.

> **WARNING:** **NEVER** drain or store fuel in an open container due to the possibility of explosion or fire. Discard the fuel in an approved manner.

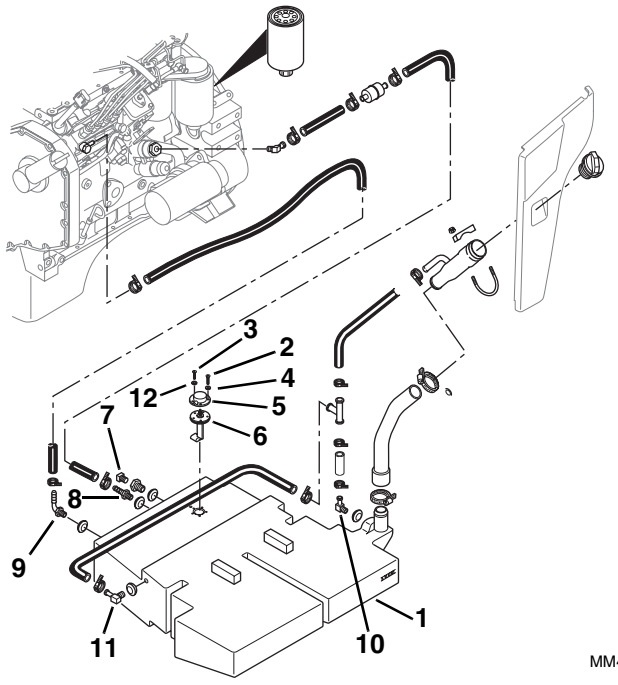
2. Invert and tilt the tank from side to side. Safely drain any fuel into a suitable container. Dispose of fuel properly.
3. Clean the fuel tank with a high-pressure washer, or flush the tank with hot water for five minutes. Invert the tank, tilt it from side to side, and drain the water.
4. If necessary, add a diesel fuel emulsifying agent to the tank. Refer to the manufacturer's instructions for the correct emulsifying agent-to-water mixture ratio. Refill the tank with water, and agitate the mixture for 10 minutes. Drain the tank completely.
5. Refill the fuel tank with water until it overflows. Completely flush the tank with water. Empty the tank and allow it to dry completely.

d. Inspection

1. Inspect the fuel tank thoroughly for any cracks, slices, leaks or other damage. Replace a leaking or damaged tank. **DO NOT** attempt to repair, plug or patch a leaking or damaged fuel tank. The tank is manufactured using an injection molding process and cannot be repaired. If a leak is detected at any of the grommets on the tank, replace both the grommet and fitting. Contact JLG Inc.directly at:
   Domestic: **1-717-485-5161**
   International: **1-877-554-5438**
2. With the fuel tank removed from the vehicle, plug all openings except one elbow fitting. Install the elbow fitting and apply approximately 1 to 1-1/2 psi (7 to 10 kPa) of air pressure through the elbow. Check the tank for leaks by applying a soap solution to the exterior of the tank, or by submerging the tank in water and looking for bubbles to appear at the cracked or damaged area.

e. Assembly and Replacement

1. Install the fuel sender with gasket (**6**) and the fuel sender cover (**5**) to the fuel tank (**1**). Secure with four #10-24 x 3/4" pan-head screws (**2**), and #10 lockwashers (**4**). Do not overtighten.
2. Install the 3/8" NPT square head pipe plug (**7**), the 3/8" barb hose connector (**8**), the 5/16" P 90° hose elbow (**9**) and both 5/8" hose barb elbows (**10** and **11**) into the fuel tank grommets.
3. Replace the fuel tank (**1**) in the cab mount subframe. Attach the fuel level gauge wire to the #10-24 x 5/8" pan-head screw (**3**), slide a #10 lockwasher (**12**) onto the screw and secure the screw to the fuel tank at the fuel sender cover.
4. Reconnect the fuel hoses and follow the directions in *Section 3.2.3, c. Cab Installation* to replace the other fuel system components and the cab.



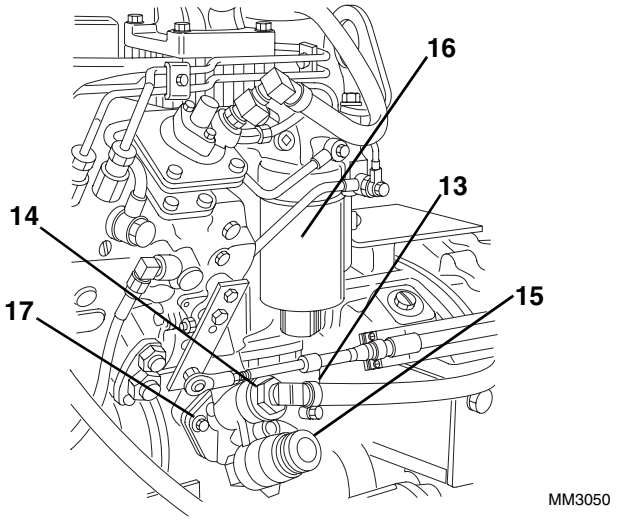
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8.8.3 Fuel Level Sender and Gauge

The fuel level sender and gauge assembly is described in *Section 10.13.19, Fuel Level Indicator and Fuel Level Sender*.

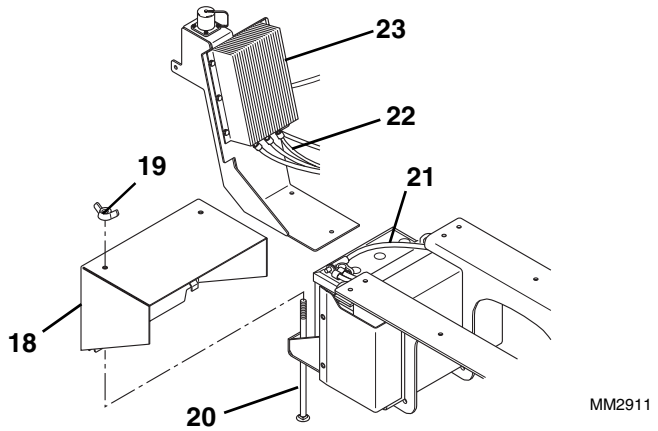
8.8.4 Fuel Lift Pump Testing

Inspect the camshaft lever and return spring for excessive wear. To test the diaphragm, remove the fuel inlet line (**13**) from the fuel lift pump (**14**). Block the fuel inlet with a finger and operate the hand plunger (**15**). A properly operating pump will provide suction that will remain until the finger is removed from the inlet.



a. Fuel Lift Pump Removal

1. Remove engine side battery box cover (**18**). Remove wing nuts (**19**) and carriage bolts (**20**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**21**) at the negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**22**) at the bottom of the battery equalizer (**23**).



4. Clean debris from around the lift pump (**14**).
5. Disconnect the fuel inlet line (**13**).
6. Remove the capscrews (**17**), gasket, and fuel lift pump (**14**).

b. Cleaning and Drying

Clean the exterior of the pump with mineral spirits and blow dry with compressed air.

Note: *Parts replacement is not practical. The fuel lift pump is serviced as an entire assembly.*

c. Fuel Lift Pump Installation

1. Clean the mounting surface on the cylinder block.
2. Install the fuel lift pump (**14**) with a new gasket. Install and torque the capscrews (5) to 18 lb/ft (24 Nm).
3. Connect the fuel line (**13**). Vent air from fuel system (refer to *Section 2.13.7, d. Venting Air from the Fuel System)*.
4. Connect the negative (-) battery cable (**21**) at the negative (-) terminal on the battery in the engine side battery box.
5. Connect the negative (-) battery equalizer cable (**22**) at the bottom of the battery equalizer (**23**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
6. Replace engine side battery box cover (**18**). Use the wing nuts (**19**) and carriage bolts (**20**) to secure the cover in place.

8.8.5 Fuel Filter

Refer to *Section 2.13.7, Engine Fuel System* for information on removing and replacing the fuel filter (**16**).

8.8.6 Venting Air from the Fuel System

Refer to *Section 2.13.7, d. Venting Air from the Fuel System*.

8.8.7 Fuel Injectors

The engine uses Bosch 17 mm closed nozzle hole-type injectors. The injectors have different part numbers for different engine ratings. The last four digits of the Cummins part number (stamped on the bottom portion of the injector) identify the injector.

IMPORTANT: *Use only the specified injector for the engine. Damage to engine can occur if incorrect injector's are used.*

During the injection cycle, high pressure from the injection pump rises to the operating (or "pop") pressure, which causes the needle valve in the injector to lift. Fuel is then injected into the cylinder. A shimmed spring is used to force the needle valve closed as the injection pressure drops below the pop pressure to seal off the nozzle after injection. Failure of the needle valve to lift and to close at the correct time, or a needle valve that is stuck open, can cause the engine to misfire and produce low power. Fuel leaking from the open nozzle can cause a fuel knock, poor performance, smoke, poor fuel economy, and rough running.

a. Locating Faulty Fuel Injectors

A faulty fuel injector can cause:

- Misfiring
- Knocking
- Overheating
- Loss of power
- Smoky (black) exhaust
- Increased fuel consumption

The particular faulty fuel injector(s) may be determined by releasing the pipe union nut on each fuel injector in-turn, with the engine running at a fast "tick-over." If, after slackening a pipe union nut, the engine revolutions remain constant, a faulty fuel injector has been identified.

To test a fuel injector:

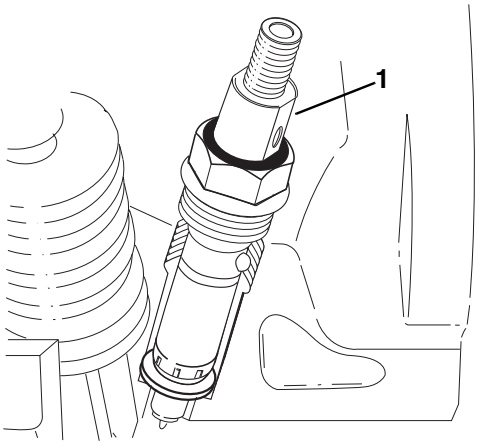
1. Remove the fuel injector (**1**) from the cylinder head (refer to *Section 8.8.7, b. Injector Replacement*).
2. Invert the fuel injector with the nozzle facing out, then retighten the unions.
3. Loosen the unions of the other fuel injector pipes (to help avoid the possibility of the engine starting).

WARNING: Diesel fuel under pressure can penetrate the skin and cause serious personal injury. Slowly loosen fittings and allow release of residual pressure before removing.

4. Operate the starter to turn the engine over until fuel sprays from the nozzle. Examine the shape of the spray. If the spray is unduly "wet" or "streaky", or obviously sprays to one side, or if the nozzle "dribbles" fuel, it may only be necessary to probe the nozzle holes to remove blockage.

IMPORTANT: DO NOT *attempt to adjust injection pressure without a testing pump and pressure gauge. It is not possible to accurately adjust the setting of fuel injectors without the proper equipment.*

A perfect fuel injector, when tested by pumping fuel through it in the open air, gives a short "pinging" sound as the fuel emerges from the holes. After the fuel injector has been in service for some time, the pinging changes to a crackling sound. It is not until the fuel injector sounds "dead" that its condition is likely to affect the running of the engine.

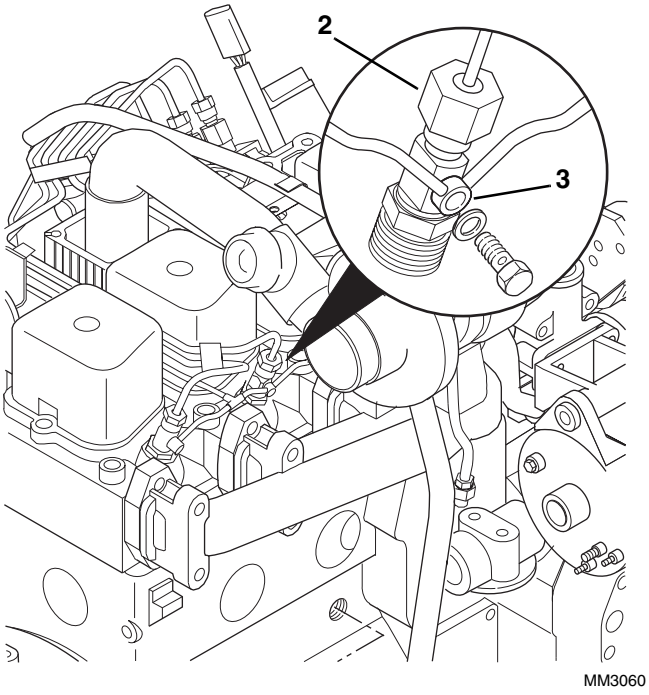


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b. Injector Replacement

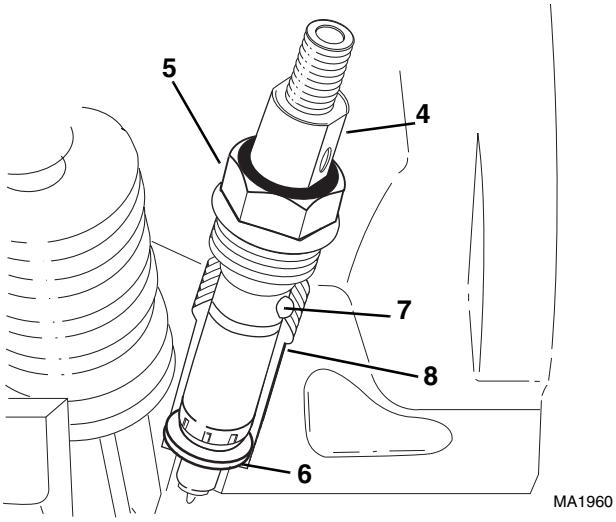
Preparatory steps:

- Thoroughly clean around the injector(s).
- Disconnect the high-pressure fuel lines (**2**).
- Disconnect the fuel drain manifold (**3**).



IMPORTANT: *The injector must not rotate in the bore of the cylinder head or damage to the cylinder head will occur. If rust has formed on the hold-down nut, soak the nut with rust-penetrating solvent for a minimum of three minutes. Then, tap the injector body with a drift pin to help loosen any rust.*

1. Use a 16 mm wrench to prevent the injector body (**4**) from turning. Loosen the hold-down nut (**5**) with a 24 mm box wrench.
2. Clean the injector nozzle bore.
3. Remove the injector hold-down nut from the injector body.
4. Apply a light coat of anti-seize compound to the new injector surface. Avoid getting anti-seize compound into the fuel drain hole.
5. Install the hold-down nut on the injector body.
6. Install a new o-ring into the recessed groove in the top of the hold-down nut. Make sure the o-ring is not cut or twisted during installation.
7. Apply a light coat of anti-seize compound to the threads of the injector hold-down nut.



8. Assemble the injector and new copper washer (**6**). Use only ONE copper washer. A light coat of clean 15W40 engine oil placed between the washer and the injector will help keep the washer from falling during installation.
9. Install the injector with the protrusion (**7**) on the side of the nozzle fitting into the notch (**8**) in the head.
10. Tighten the hold-down nut (**5**) and torque to 44 lb/ft (60 Nm).
11. Install the fuel drain manifold (**3**) and torque to 6 lb/ft (8 Nm).
12. Install the high-pressure fuel lines (**2**) and torque to 18 lb/ft (24 Nm).
13. Run the engine and check for fuel and air leakage.
14. Bleed the fuel system in accordance with the instructions in *Section 2.13.7, d. Venting Air from the Fuel System*.

8.8.8 After Fuel System Service

1. Drain and flush the fuel tank if it was contaminated.
2. Vent air from the fuel system (refer to *Section 2.13.7, d. Venting Air from the Fuel System*).
3. Fill the fuel tank with fresh, clean diesel fuel as required.

8.9 ENGINE EXHAUST SYSTEM

WARNING: Exhaust fumes contain carbon monoxide, a colorless, odorless gas which is fatal when inhaled in a confined area. Avoid breathing exhaust fumes and prevent engine operation from becoming a cause of toxic emissions. Exhaust system components reach high temperatures and can cause severe burns. **DO NOT** come into contact with hot exhaust system components.

The exhaust system is supported by the engine and the vehicle frame to help minimize the transfer of noise and vibration into the operator's cab. The tail pipe directs exhaust fumes to the right side of the vehicle, away from the cab.

Annoying rattles and noise vibrations in the exhaust system are usually caused by misalignment of parts. When aligning the system, leave all capscrews and nuts slightly loose until all parts are properly aligned, then tighten all fasteners working from the front of the system to the rear.

When replacing the muffler, also replace the tail pipe.

Before assembling components, use exhaust system sealer at all slip joint connections.

When installing exhaust system components, allow sufficient clearance between the components and other vehicle pipes, hoses and wiring that could be adversely affected by excessive heat.

When installing an exhaust system, provide for parts expansion when the system is hot.

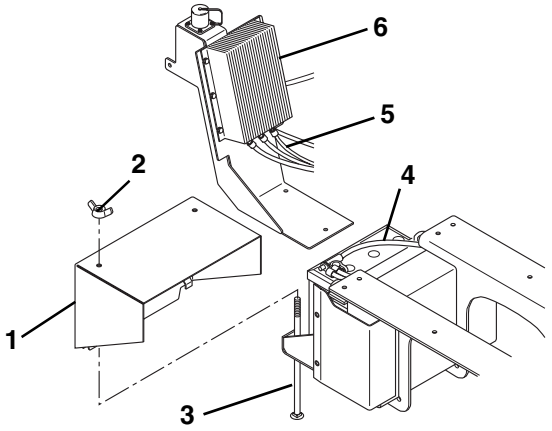
Whenever performing service on the vehicle, check the condition of the exhaust system. Check the entire exhaust system for broken, damaged, missing or improperly aligned parts, open seams, holes, loose connections and other deterioration which could permit exhaust fumes to seep into the operators cab. Correct any damaged areas immediately.

8.9.1 Exhaust System Removal

1. Level the vehicle, ground the attachment, place the travel select lever in NEUTRAL [N] and engage the neutral lock lever, engage the parking brake switch and shut off the engine. Secure accident prevention tags to the steering wheel and ignition switch (refer to *Section 1.5, Accident Prevention Tag Usage*).

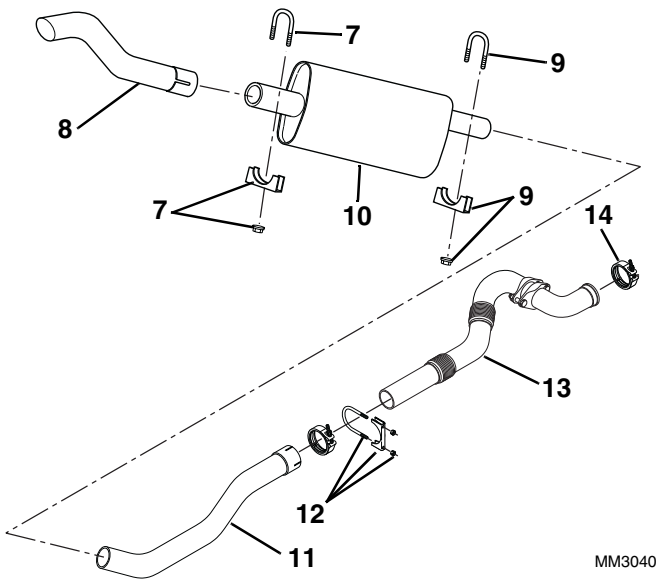
WARNING: **DO NOT** attempt this procedure when the engine is hot. Wait for the engine, muffler, and tailpipes to cool down before proceeding. Failure to do so could result in severe burns.

1. Unlatch and open the engine cover. Allow the engine to cool before proceeding.
2. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
3. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
4. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



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5. Disconnect and remove the 3" heavy duty muffler clamp (**7**) from the tail pipe (**8**). Disconnect and remove the U-type clamp (**9**) from between the muffler (**10**) and exhaust pipe (**11**). Disconnect and remove the U-type clamp (**12**) from between the exhaust pipe and turbo outlet exhaust pipe (**13**). Remove the tail pipe (**8**), muffler (**10**) and exhaust pipe (**11**) as a unit from the turbo outlet exhaust pipe (**13**). Loosen the V-band clamp (**14**) and remove the turbo outlet exhaust pipe along with the V-band clamp (8).



8.9.2 Exhaust System Installation

1. Install the turbo outlet exhaust pipe (**13**) onto the engine turbocharger outlet (not shown). Install but do not tighten the V-band clamp (**14**) around the turbo outlet exhaust pipe.
2. Install the exhaust pipe (**11**), muffler (**10**) and tail pipe (**8**) as a unit to the turbo outlet exhaust pipe (**13**). Install the U-type clamp (**12**) between the exhaust pipe (**11**) and turbo outlet exhaust pipe. Install the U-type clamp (**9**) between the muffler and exhaust pipe. Install the 3" heavy duty muffler clamp (**7**) between the muffler (**10**) and tail pipe (**8**). Align all components and tighten all clamps.
3. Connect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.

8.10 ENGINE REPLACEMENT

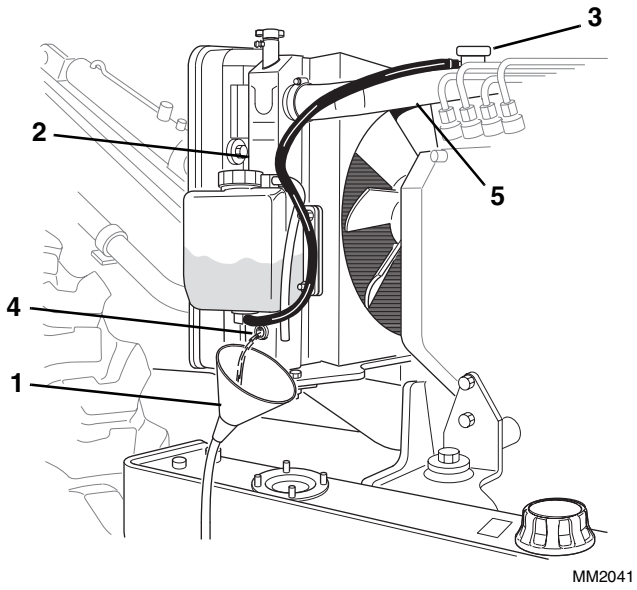
Removal and installation of the engine should be done with the transmission attached. For information on removing the transmission from, and installing it to, the engine (refer to *Section 7.7.1, Transmission Removal*).

8.10.1 Engine Removal

WARNING: To avoid severe burns, **DO NOT** attempt to remove the engine when the engine, cooling system and hydraulic system are hot. Wait until all parts and systems are cool before proceeding.

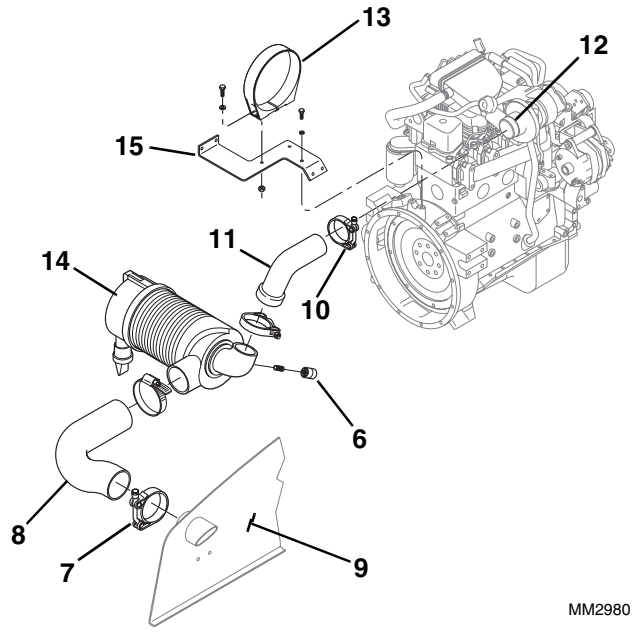
1. Level the vehicle, ground the attachment, place the travel select lever in NEUTRAL [N], engage the neutral lock lever, engage the parking brake switch and shut off the engine. Secure accident prevention tags to the steering wheel and ignition switch (refer to *Section 1.5, Accident Prevention Tag Usage*). Allow the engine, cooling system and hydraulic system to cool.
2. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
3. Disconnect the negative (-) battery cable (**4**) at the negative (-) terminal on the battery in the engine side battery box.
4. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).
5. Remove the engine compartment hood with the help of at least one assistant (refer to *Section 3.7.2, Engine Hood*).

6. Place a funnel (**1**) at the base of the radiator (**2**) to channel the drained coolant into a container. Remove the radiator cap (**3**), located in the upper radiator hose (**5**), and open the radiator drain petcock (**4**). Allow the coolant to drain into the container. Close petcock after draining. At the engine, loosen the upper and lower radiator hose clamp and pry the hoses away from the engine.



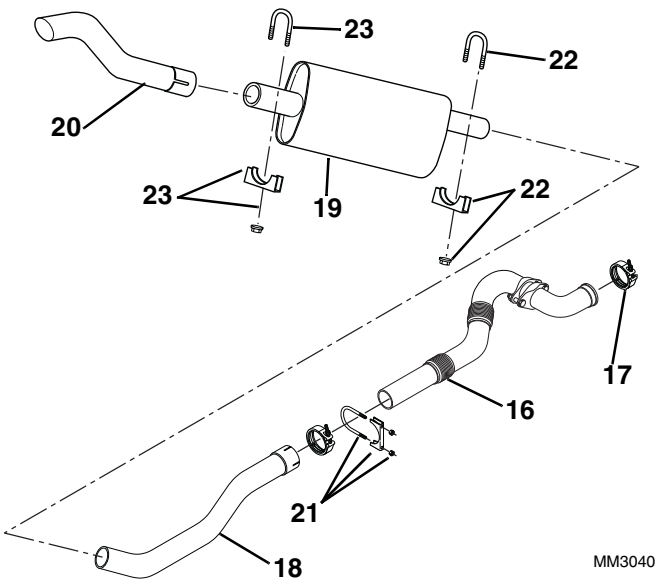
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7. Disconnect the air cleaner restriction sensor (**6**) wires. Loosen the clamp (**7**) securing the air intake hose (**8**) to the engine panel (**9**). Remove the hose at the engine panel. Cover opening to prevent debris from entering.
8. Loosen the heavy duty T-bolt clamp (**10**), securing the air cleaner hose (**11**) to the turbocharger intake on the engine (**12**).
9. Unscrew the clamp (**13**) securing the air cleaner assembly (**14**) to the mount plate (**15**) on the engine. Remove the complete air cleaner assembly and store securely. Cover the turbocharger opening on engine (**12**) to prevent debris from entering.

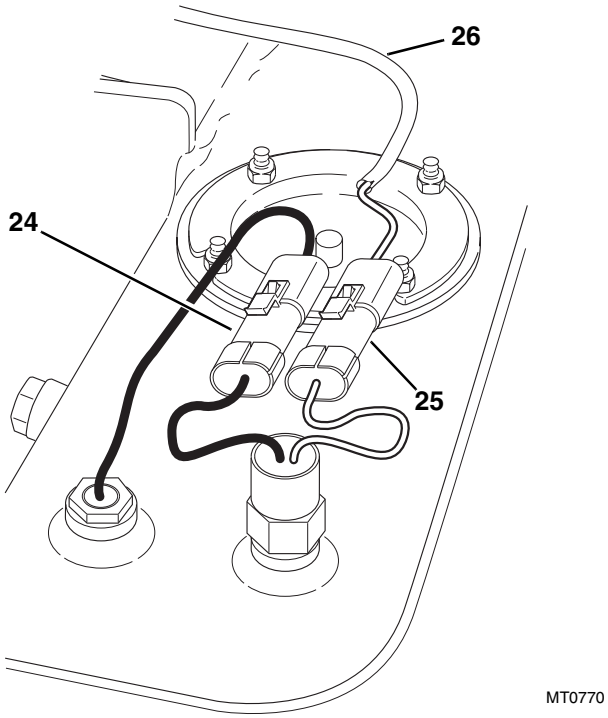


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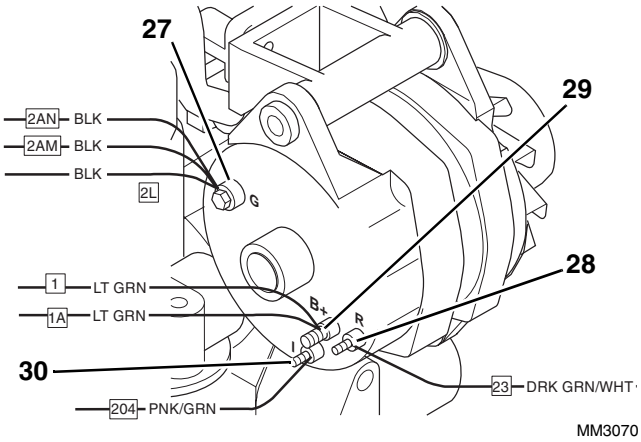
10. Disconnect and remove the 3" heavy duty muffler clamp (**23**) from the tail pipe (**20**). Disconnect and remove the U-type clamp (**22**) from between the muffler (**19**) and exhaust pipe (**18**). Disconnect and remove the U-type clamp (**21**) from between the exhaust pipe and turbo outlet exhaust pipe (**16**). Remove the tail pipe, muffler and exhaust pipe as a unit from the turbo outlet exhaust pipe.
11. Disconnect the V-band clamp (**17**) from the engine turbocharger outlet. Twist the turbo outlet exhaust pipe (**16**) out and off of vehicle.



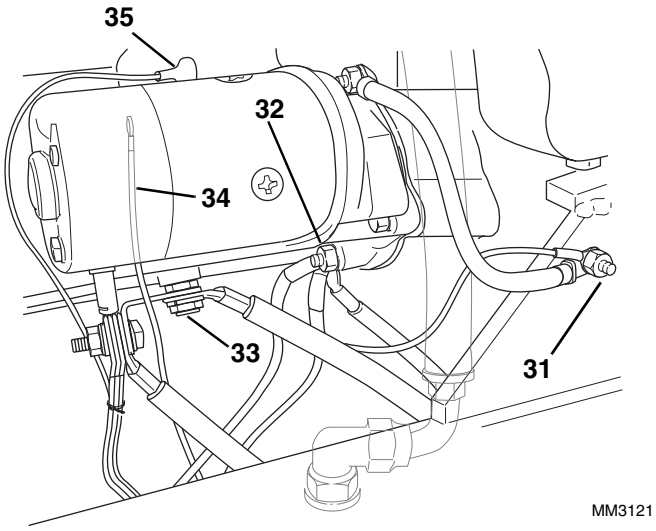
12. Disconnect (unplug) the hydraulic low temperature sending unit lead (**24**) and the hydraulic filter sending unit lead (**25**) from the wiring harness connector (**26**).



13. Label and disconnect the alternator ground (**27**), R (**28**), B+ (**29**), and I (**30**) wire leads.

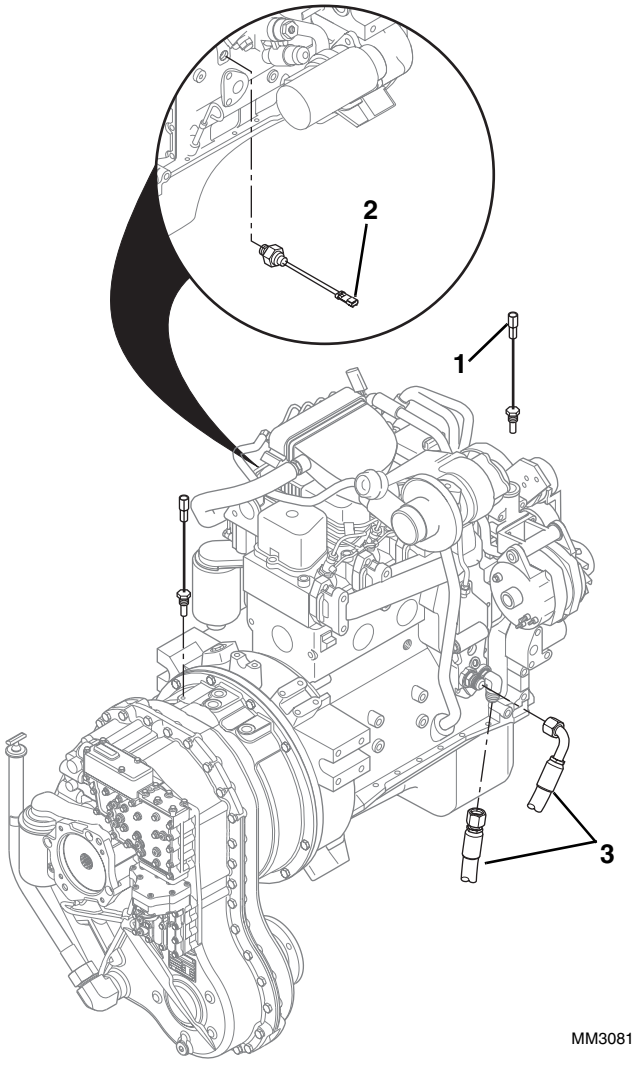


14. Label and disconnect the wires at the main ground stud (**31**) and starter ground stud (**32**).



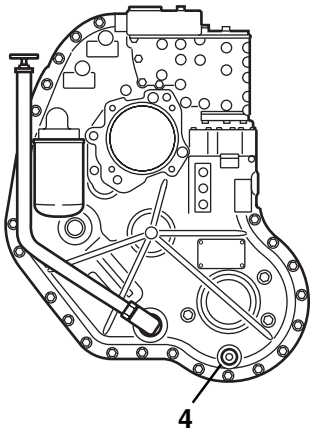
15. Label and disconnect the positive (+) battery cable wire leads (**33**) at the starter stud. Disconnect the blue wire (**34**) from the starter solenoid stud, located on the back of the starter, between the engine and the starter. Disconnect the white wire (**35**) from starter top boot connection.

16. Label and disconnect the engine coolant temperature switch lead (**1**) and oil pressure switch lead (**2**). (Refer to *Section 10.13.16, Engine Coolant High Temperature Sender* and *Section 10.13.15, Engine Low Oil Pressure Sender*.)



MM3081

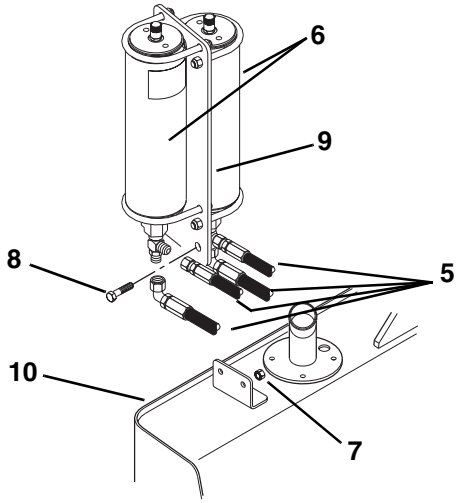
17. Disconnect and cap the two remote engine filter hoses (**3**) from the engine block.
18. Place a suitable receptacle under the transmission drain plug (**4**). Remove the transmission drain plug and allow the transmission oil to drain into the receptacle. Transfer the used transmission oil into a suitable covered container and label the container as used oil. Dispose of used oil at an approved recycling facility. Clean and reinstall the transmission drain plug.



MT0560

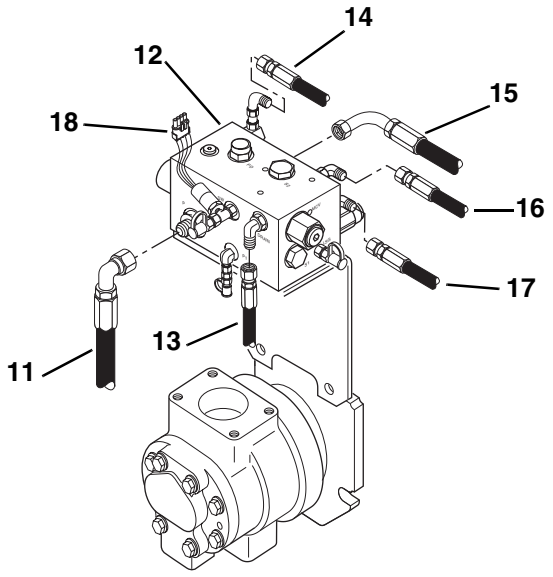
WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

19. Relieve all the pressure in the service brake system by pumping the service brake pedal until all hydraulic pressure is removed from the accumulators.
20. Label and disconnect the hoses (**5**) from the bottom of each accumulator (**6**). Cap the fittings on the accumulators and plug the hose ends.
21. Remove the elastic locknuts (**7**) and capscrews (**8**) holding the accumulator mounting bracket (**9**) to the hydraulic oil reservoir (**10**). Retain the capscrews and discard the locknuts. New elastic locknuts will be required for reassembly.



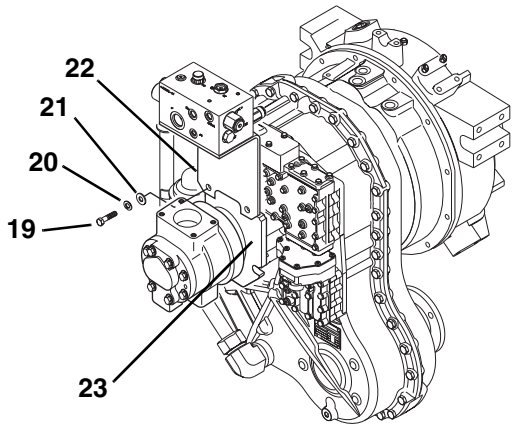
MM5120

22. Label and disconnect the hose (**11**) coming from the pump to the “P” port at the the accumualtor charge valve (**12**). Cap the fitting on the accumulator charge valve and plug the hose end.
23. Label and disconnect the hose (**13**) from the “Drain” port at the accumulator charge valve (**12**). Cap the fitting on the accumulator charge valve and plug the hose end.
24. Label and disconnect the hose (**14**) from the “PIL” port at the accumulator charge valve (**12**). Cap the fitting on the accumulator charge valve and plug the hose end.
25. Label and disconnect the hose (**15**) from the “CF” port at the accumulator charge valve (**12**). Cap the fitting on the accumulator charge valve and plug the hose end.
26. Label and disconnect the hose (**16**) from the “EF” port at the accumulator charge valve (**12**). Cap the fitting on the accumulator charge valve and plug the hose end.
27. Label and disconnect the hose (**17**) from the “LS” port at the accumulator charge valve (**12**). Cap the fitting on the accumulator charge valve and plug the hose end.
28. Unplug the pressure switch connector (**18**) from the wire harness.



MM5150

29. Remove the two capscrews (**19**), lockwashers (**20**) and flat washers (**21**) holding the accumulator charge valve bracket (**22**) to the pump flange (**23**). Remove the accumulator charge valve and bracket from the vehicle. The valve can remain assembled to the bracket. Save all hardware for reassembly.

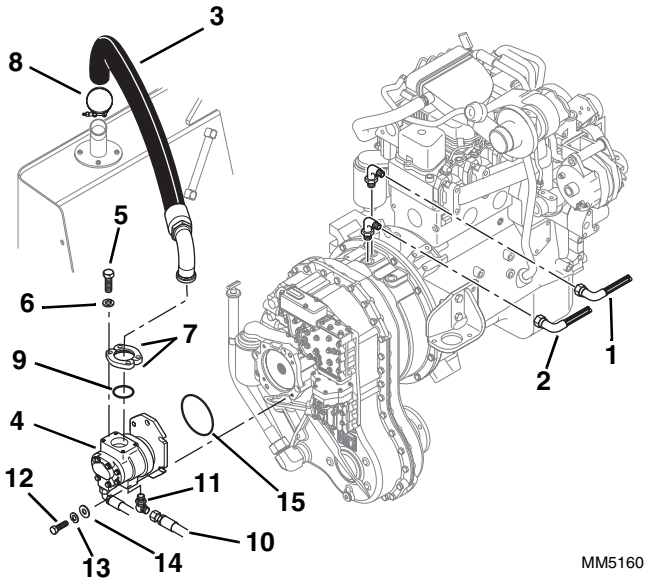


MM5130

30. Label, disconnect and cap the transmission oil cooler inlet (**1**) and outlet (**2**) hoses at the transmission. The transmission oil cooler outlet hose, routed to the lower radiator fitting, is located on the top of the transmission. The transmission oil cooler inlet hose, routed to the upper radiator fitting, is located on top of the transmission.

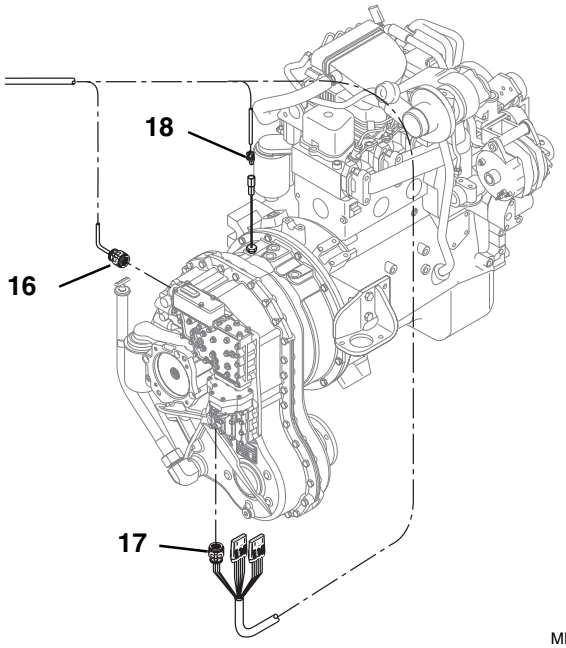
WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

31. Label the inlet hose (**3**) at the hydraulic pump (**4**). Remove four capscrews (**5**), lockwashers (**6**) and two flange halves (**7**). Loosen the T-bolt clamp (**8**) and remove the inlet hose (**3**) and o-ring (**9**). Cover the opening on the hydraulic reservoir.
32. Label the outlet hose (**10**) at the main hydraulic pump (**4**). Disconnect and cap the outlet hose at the fitting (**11**).
33. Remove two capscrews (**12**), lockwashers (**13**) and plain washers (**14**). Remove the main hydraulic pump (**4**) and o-ring (**15**) from the transmission.



MM5160

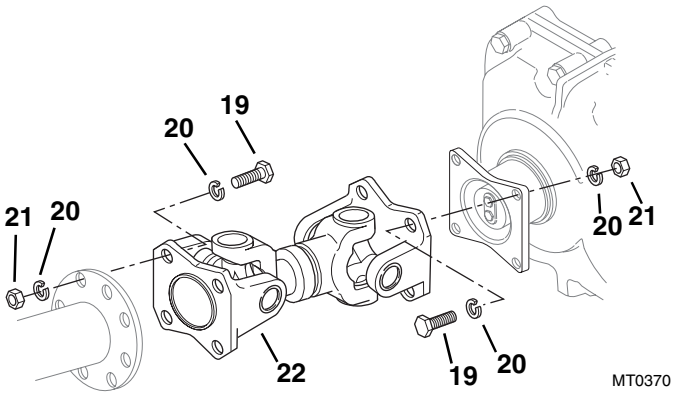
34. Label and disconnect the shift solenoid wiring harness connectors (**16** and **17**). Remove the transmission temperature switch lead (**18**). Remove the clips securing the wiring harness to the transmission and move the wiring harness safely out of the way.



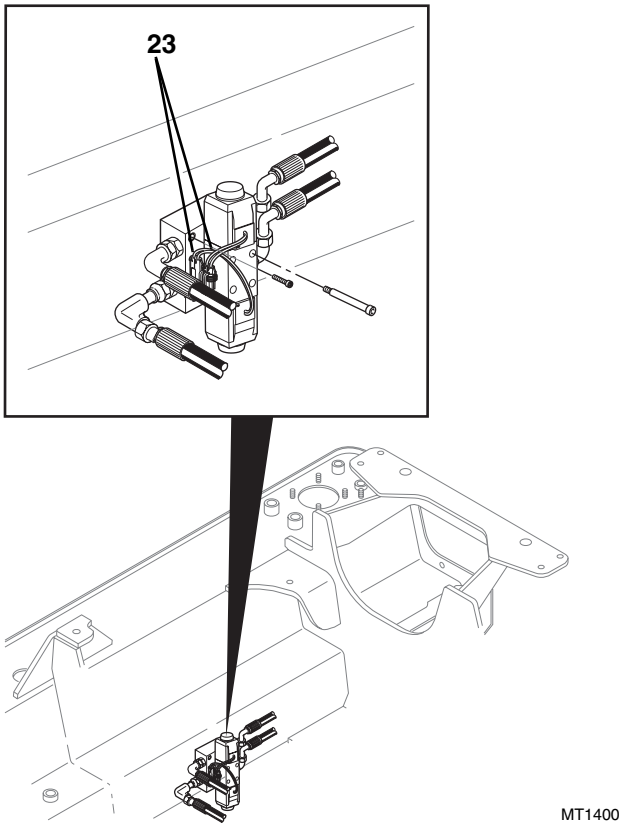
MM3090

IMPORTANT: *To help ensure optimum performance, the drive shaft assemblies are specially balanced as a unit at the factory. Mark the drive shaft yoke at the transmission for return to its original position.*

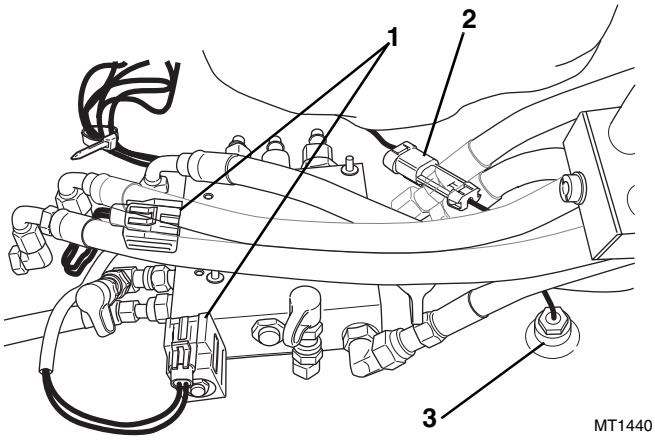
35. The drive shaft assembly is a balanced assembly. Mark the yoke and transmission, transfer case, and the shaft and slip yoke so that these components can be returned to their original positions when reinstalled. Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.
36. Remove the eight [4-Front and 4-Rear] capscrews (**19**), sixteen [8-Front and 8-Rear] lockwashers (**20**) and eight [4-Front and 4-Rear] nuts (**21**) securing the flange yokes to the transfer box and transmission.
37. Remove the drive shaft assembly (**22**).



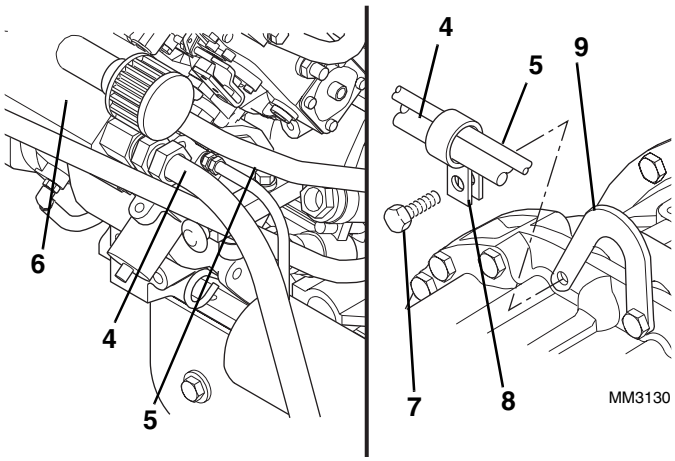
38. Label and disconnect the wiring leads (**23**) from the harness at the steer select valve.



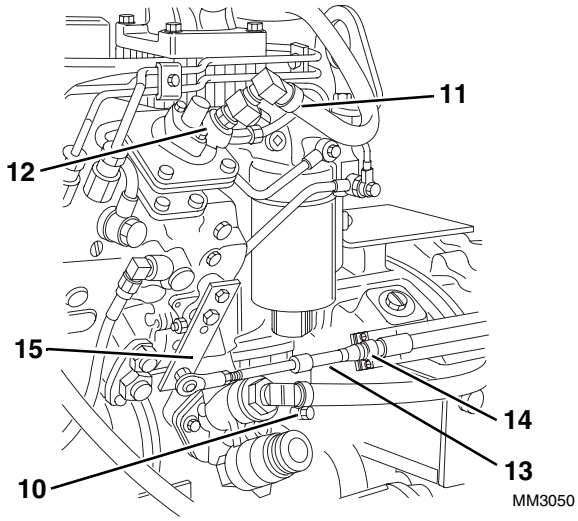
39. Label and disconnect the wiring connectors at the secondary function valve solenoids (**1**) located on the side of the hydraulic tank. Move all wiring out of the way to allow engine removal.
40. At the hydraulic fluid reservoir, disconnect the engine harness wire lead (**2**) from the hydraulic oil temperature sending unit (**3**) (viewed from bottom of hydraulic tank).



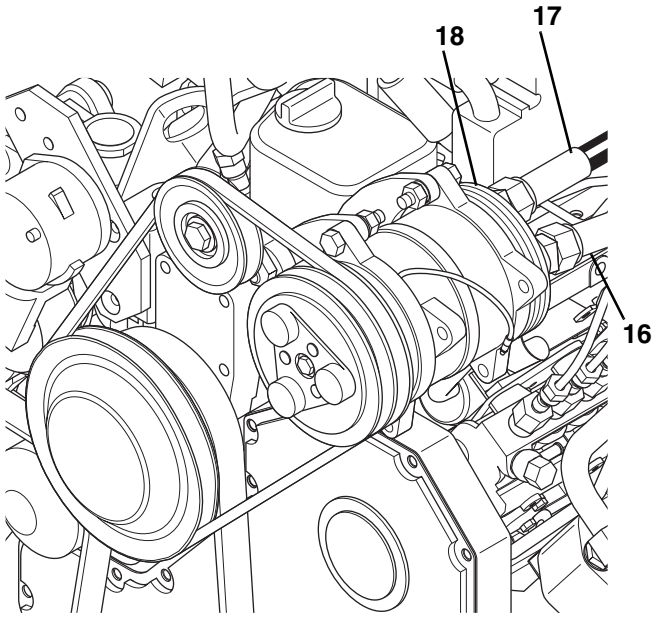
41. Label, disconnect and cap the discharge (**4**) and pilot (**5**) hoses at the compressor (**6**) on the engine.
42. Remove transmission capscrew (**7**) holding clamp (**8**) with compressor hoses (**4** & **5**) and right side of transmission lift plate (**9**). Remove the clamp and hoses and re-install the capscrew to secure the lift plate to the transmission.



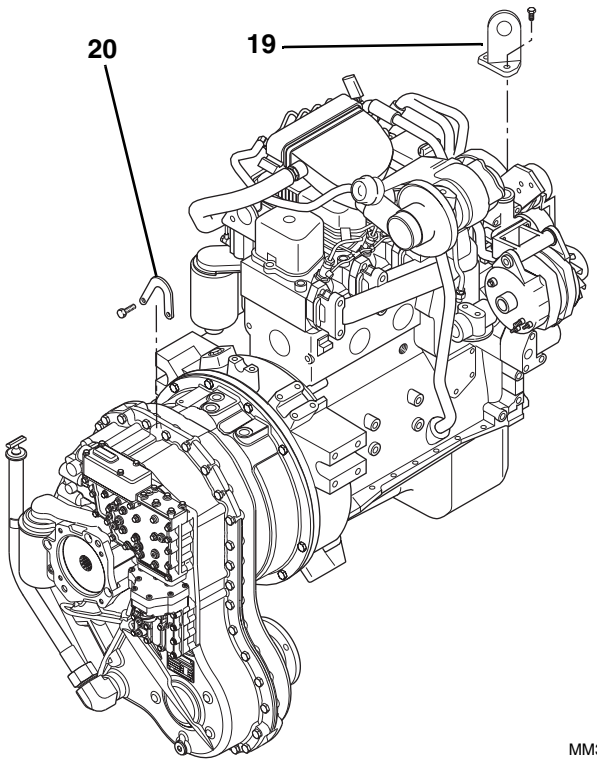
43. Disconnect the fuel inlet line (**10**) at the fuel lift pump. Install a plug in the end of fuel inlet line.
44. Disconnect the fuel return line (**11**) from the injector pump (**12**).
45. Mark the location of the throttle cable (**13**) at the throttle cable mount clamp (**14**). Remove bracket.
46. Disconnect the throttle cable (**13**) at the engine throttle lever (**15**).



IMPORTANT: *Before the engine can be removed from the vehicle, the air conditioning hoses (**16** and **17**) need to be removed from the air conditioning compressor (**18**). This procedure must be completed by an authorized air conditioning service technician. This service technician will also need to be available when the new engine is installed to re-install the air conditioning hoses (**16** and **17**) to the air conditioning compressor (**18**).*

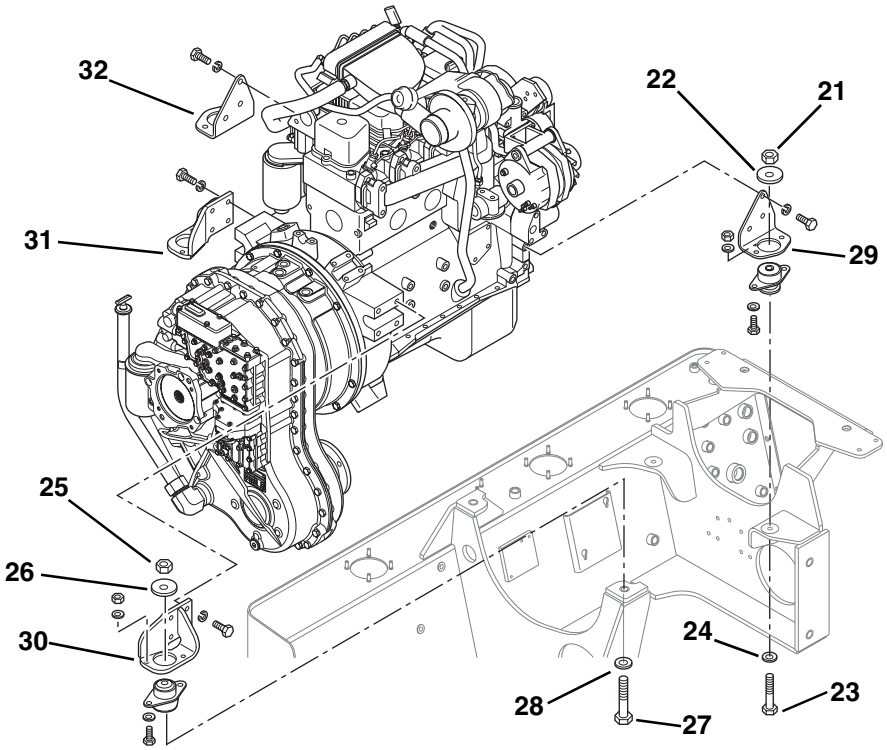


47. Connect a suitable engine hoist to the front engine lift plate (**19**) and transmission lift plate (**20**). Move engine harness away from lifting chain.



MM3100

48. At the front of the engine, remove the two elastic locknuts (**21**), rebound washers (**22**), capscrews (**23**) and flat washers (**24**) securing the front engine mounts (**29** and **31**) to the hydraulic reservoir/engine mount subframe.
49. At the rear of the engine, remove the two elastic locknuts (**25**), rebound washers (**26**), capscrews (**27**) and flat washers (**28**), securing the rear engine mounts (**30** and **31**) to the hydraulic reservoir/engine mount subframe.
50. Remove either the fan or the radiator to help prevent damage to the radiator when the engine is removed *(refer to Section 8.6.3, Radiator/Oil Cooler and Engine Block Heater Replacement).*
51. Begin removing the engine from the vehicle with the hoist or overhead crane.
52. As the engine is lifted away and removed, avoid damaging the oil filter and oil filter housing.
53. Carefully lift the engine and transmission out and away from the vehicle. Place the engine and transmission safely onto ground supports, or in a suitable engine stand. **DO NOT** allow the engine to rest on its oil pan, or damage will occur. **DO NOT** allow the transmission to rest on its case, or damage will occur.
54. The transmission can now be separated from the engine (refer to *Section 7.7.1, Transmission Removal*).

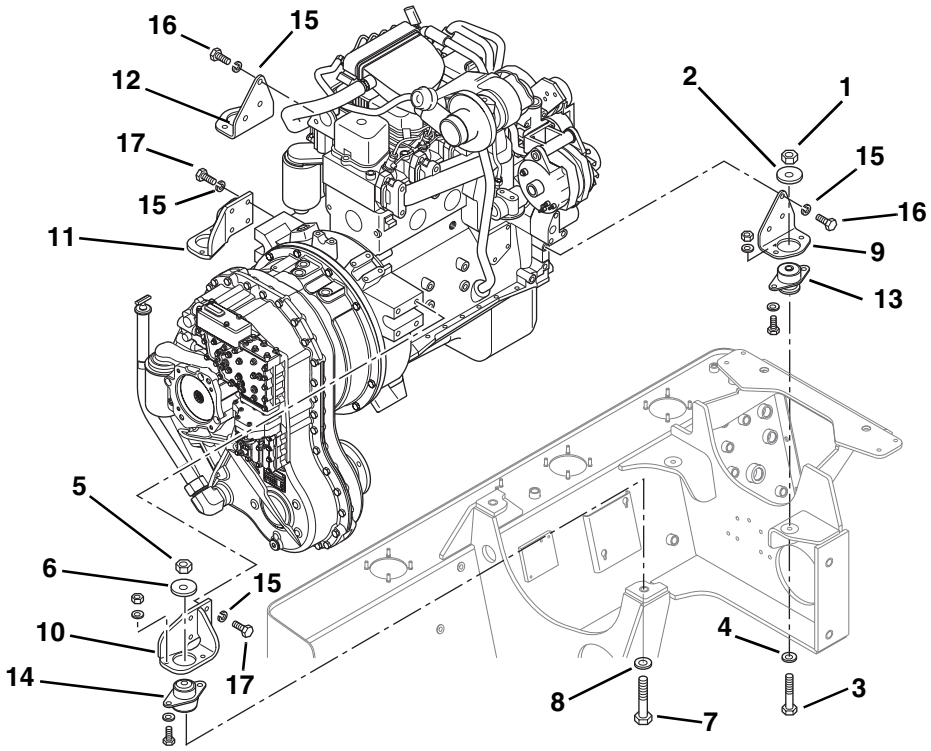


MM3110

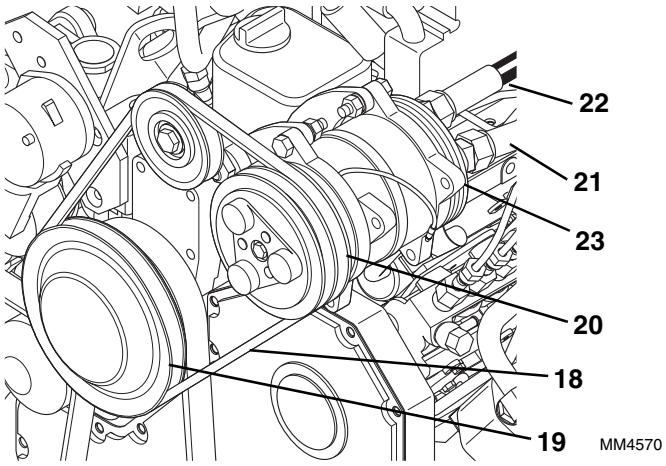
8.10.2 Engine Disassembly, Inspection and Service

Engine disassembly, internal inspection, service, repair and assembly procedures are covered in the Cummins 4BTA 3.9 service manual. Several special engine service tools are required to properly service the Cummins engine. Contact the local Cummins parts distributor for further information.

Note: *If the engine is being replaced and depending upon who you purchase the new engine from and the configuration of your replacement engine, there may be external components that will be required to be transferred from the original engine to the replacement engine. Refer to the appropriate Cummins user manual for detailed procedures that cover the transfer of original engine components to the replacement engine.*



MM3110



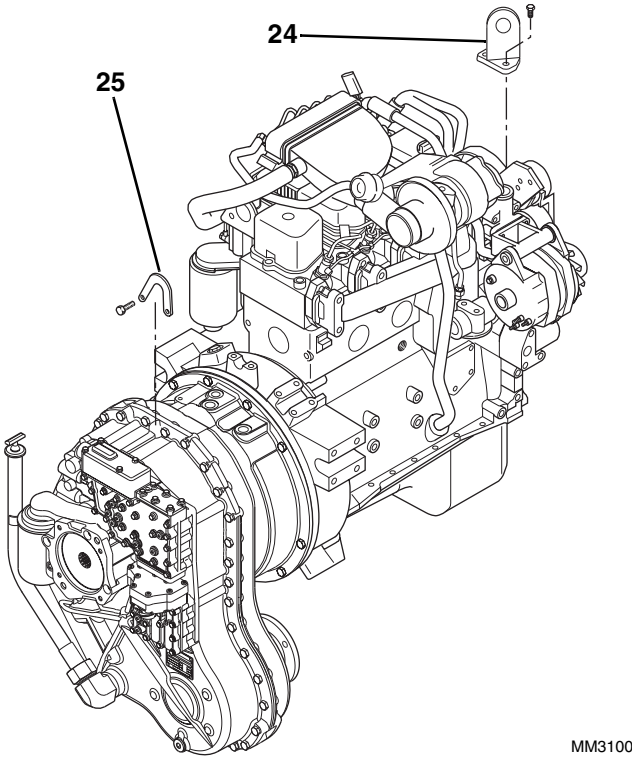
MM4570

IMPORTANT: *When re-installing the air conditioning compressor kit to the new engine, make sure to check the belt tension midway (**18**) between the fan pulley (**19**) and the pulley on the compressor (**20**). Deflection should be 3/16" (4,8 mm) with an applied force of 5-1/2 lb (2,5 kg).*

IMPORTANT: *When the engine is re-installed into the vehicle, the air conditioning hoses (**21** and **22**) need to be re-installed to the air conditioning compressor (**23**). This procedure must be completed by an authorized air conditioning service technician.*

8.10.3 Engine Installation

1. Attach the transmission to the engine by following the procedure in *Section 7.7.3, Transmission Installation*.
2. If removed during engine work, install the front engine mounts (**9** and **12**) using six M12-1,75 x 30 mm PC 8,8 capscrews (**16**) and M12 lockwashers (**15**) into the appropriate locations on the engine.
3. If removed during engine work, install the rear engine mounts (**10** and **11**) using six M12-1,75 x 40 mm PC 8,8 capscrews (**17**) and M12 lockwashers (**15**) into the appropriate locations on the engine.
4. If removed, attach a suitable engine hoist to the front engine lift plate (**24**) and transmission lift plate (**25**).



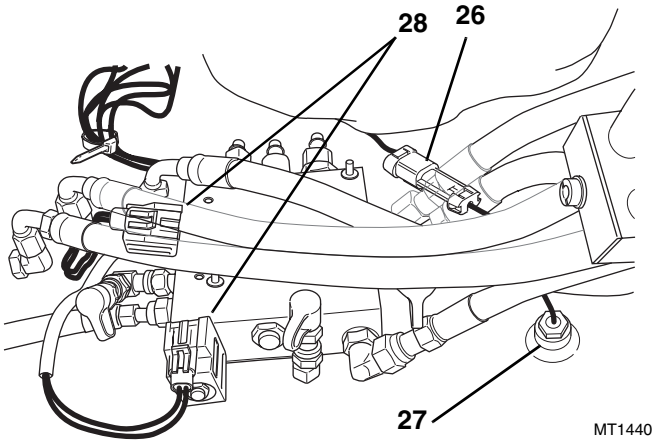
5. Carefully install the engine onto the engine isolators (**13** and **14**). Make sure the bracket-type engine mounts (**9**,**10**, **11**, and **12**) align properly with the engine mounts in the subframe.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

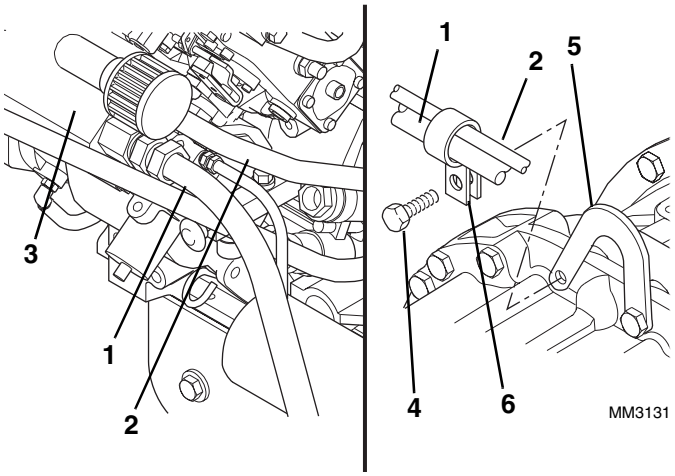
6. At the front of the engine, install two 7/16-14 x 3-1/4" capscrews (**3**) and 7/16" narrow flat washers (**4**) up from the bottom of the hydraulic reservoir/engine mount subframe and through the isolators (**13**). Install two 7/16" rebound washers (**2**) and new 7/16-14 elastic locknuts (**1**). Torque to 60 lb/ft (81 Nm).

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

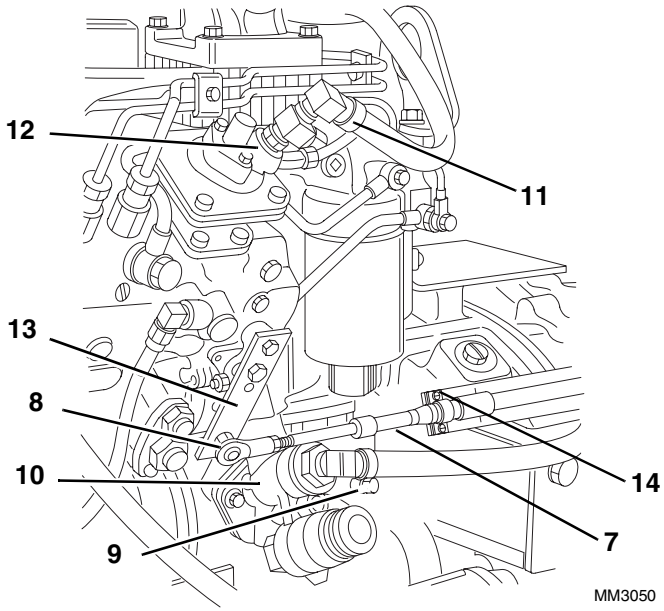
7. At the rear of the engine, Install two 5/8-16 x 1-1/2" capscrews (**7**) two 5/8" narrow flat washers (**8**) up from the bottom of the hydraulic reservoir/engine mount subframe and through the isolators (**14**). Install two 5/8" rebound washers (**6**) and new 5/8-11 elastic locknuts (**5**). Torque to 180 lb/ft (244 Nm).
8. Install the radiator/oil cooler and and engine block heater as required (refer to *Section 8.6.3, Radiator/ Oil Cooler and Engine Block Heater Replacement*).
9. At the hydraulic fluid reservoir, connect the engine harness wire lead (**26**) to the hydraulic oil temperature sending unit (**27**).
10. Attach the wiring connectors at the secondary function valve solenoids (**28**) located on the hydraulic tank.



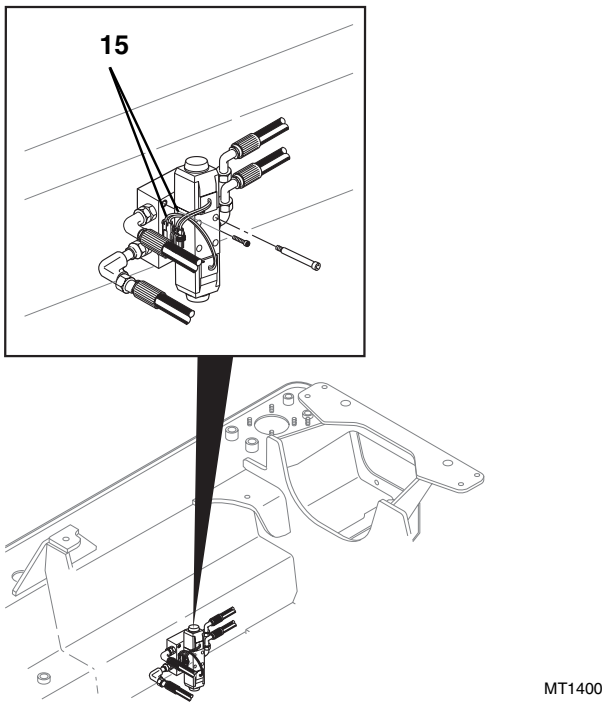
11. Reconnect the discharge (**1**) and pilot (**2**) hoses at the compressor (**3**) on the engine.
12. Remove transmission capscrew (**4**) holding the right side of transmission lift plate (**5**). Re-install the clamp (**6**) and compressor hoses (**1** & **2**) with the capscrew to secure the lift plate, clamp and hoses to the transmission.



13. Secure the throttle cable (**8**) to the engine throttle lever (**13**), located just above the starter.
14. Install the throttle cable mount clamp (**14**) over the throttle cable (**7**).



15. Connect the fuel inlet line (**9**) to the fuel lift pump (**10**).
16. Connect the fuel return line (**11**) to the fuel injector pump (**12**).
17. Connect the wiring harness leads to the steer select valve leads (**15**).



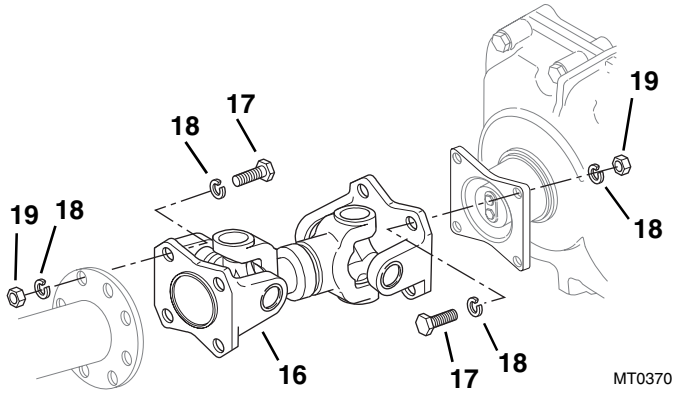
MT1400

18. Raise the transmission-to-transfer case drive shaft assembly (**16**) into position. The slip-yoke end of the drive shaft mounts toward the transfer case. If reinstalling a drive shaft previously removed, align the flange yokes according to the alignment marks made during removal.

IMPORTANT: *Yokes at both ends of the drive shaft must be in the same plane to help prevent excessive vibration.*

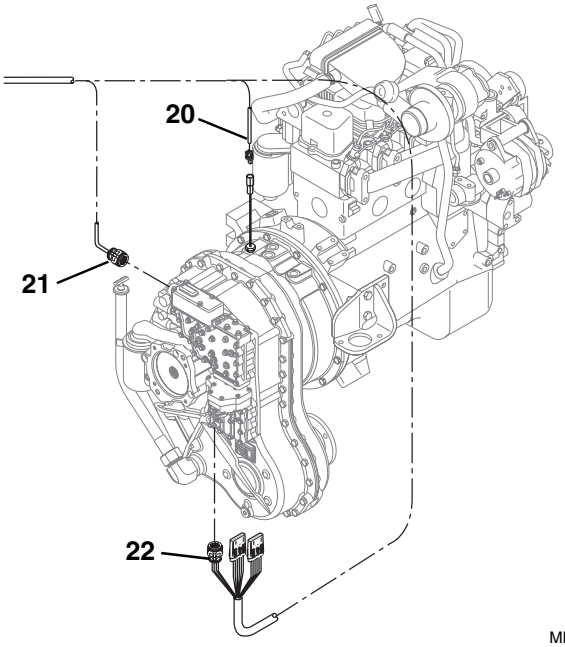
Note: *If installing a new drive shaft unit, special attention need not be applied to installation. New drive shaft units are balanced at the factory.*

19. Install the eight [4-Front and 4-Rear] 1/2-20 x 2.0" NF capscrews (**17**), sixteen [8-Front and 8-Rear] 1/2" lockwashers (**18**) and eight [4-Front and 4-Rear] 1/2-20 nuts (**19**) securing the flange yokes to the transfer case and transmission. Torque to 105 ±10 lb/ft (142 ±14 Nm).



MT0370

20. Connect the transmission temperature switch connector (**20**) and shift solenoid wiring harness connectors (**21**) and (**22**) using the harness hold down clips on the transmission.



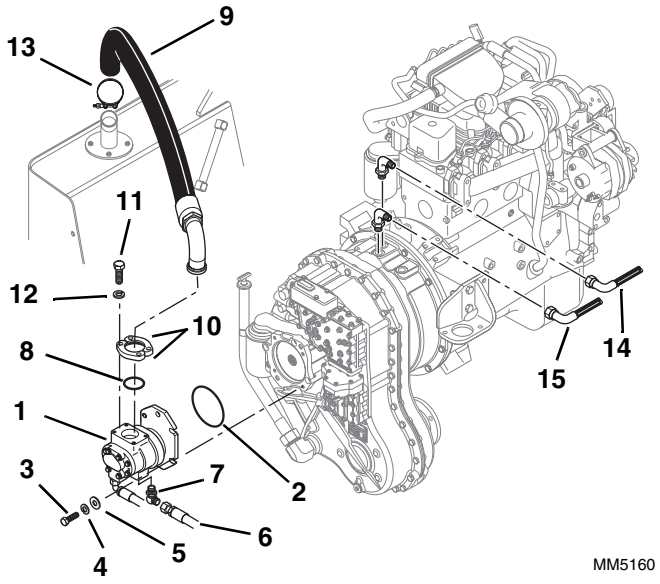
MM3090

21. Align the splined pump drive shaft with the transmission drive and install the main hydraulic pump (**1**) on the transmission using a new o-ring (**2**). Secure the pump to the transmission using two M12 x 1,75 x 40 mm capscrews (**3**), M12 lockwashers (**4**) and M12 plain washers (**5**) in the lower mounting holes only.
22. Connect the outlet hose (**6**) to the main hydraulic pump fitting (**7**).

IMPORTANT: *Before attaching the main pump hose to the reservoir, fill the pump with hydraulic fluid by hand to prime the pump at the inlet.*

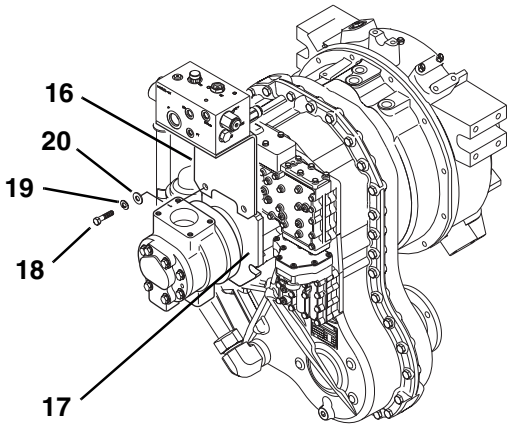
Note: *ALWAYS use new o-rings when servicing the vehicle.*

23. Lubricate a new o-ring (**8**) with clean oil.
24. Install the inlet hose (**9**) and a new o-ring (**8**) to the main hydraulic pump, using two flange halves (**10**), four 1/2-13 x 1.5" NC Grade 5 capscrews (**11**) and 1/2" lockwashers (**12**).
25. Install the T-bolt clamp (**13**) over the other end of the inlet hose (**9**), and slide the inlet hose over the tube on the hydraulic reservoir. Tighten the T-bolt clamp.
26. Connect the transmission oil cooler inlet (**14**) and outlet (**15**) hoses at the transmission.
27. Clean the transmission oil filter mounting surface.
28. Apply a film of clean oil to the new filter gasket. Install the new filter and torque 20-25 lb/ft (27-34 Nm).



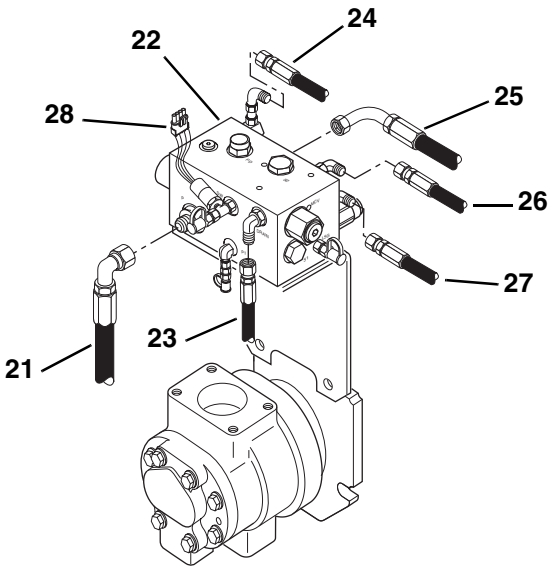
MM5160

29. Line up the two mounting holes in the accumulator charge valve bracket (**16**) with the two upper mounting holes in the pump flange (**17**). Secure the bracket to the pump flange with the two M12 x 1,75 x 50 mm capscrews (**18**), M12 lockwashers (**19**) and M12 plain washers (**20**).



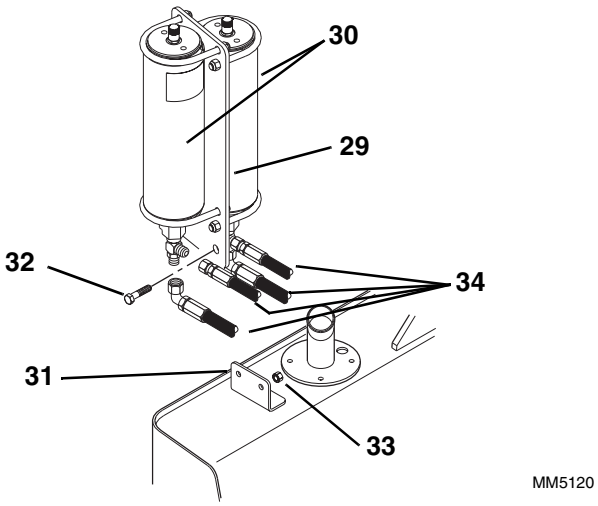
MM5130

30. Reassemble the hose (**21**) from the pump to the “P” port on the accumulator charge valve (**22**). Tighten the hose end securely.
31. Reassemble the hose (**23**) to the “Drain” port on the accumulator charge valve (**22**). Tighten the hose end securely.
32. Reassemble the hose (**24**) to the “PIL” port on the accumulator charge valve (**22**). Tighten the hose end securely.
33. Reassemble the hose (**25**) to the “CF” port on the accumulator charge valve (**22**). Tighten the hose end securely.
34. Reassemble the hose (**26**) to the “EF” port on the accumulator charge valve (**22**). Tighten the hose end securely.
35. Reassemble the hose (**27**) to the “LS” port on the accumulator charge valve (**22**). Tighten the hose end securely.
36. Plug the connector (**28**) from the pressure switch into the connector on the wire harness. Snap the two connectors together.



MM5150

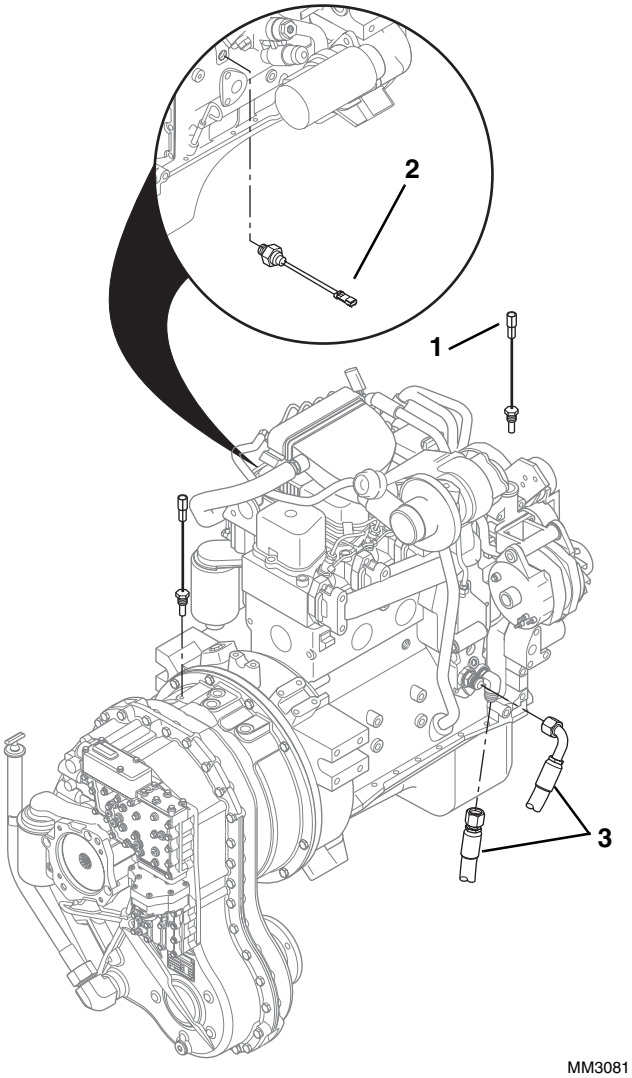
37. If transmission oil was drained, oil may be added through the dipstick tube. Remove the dipstick and add approximately 3 gallons (11 liters) of recommended oil. Check the oil level by taking intermittent dipstick readings (refer to *Section 2.13.10, a. Transmission Oil Level Check*). **DO NOT** overfill. Reinstall the dipstick when finished.
38. Place the accumulator bracket (**29**) with accumulators (**30**) against the front side of the mounting bracket (**31**) on the hydraulic oil reservoir. Be sure the branch of the tees point toward the pump.
39. Insert the two 1/2-13 x 1-1/2" capscrews (**32**) through the accumulator bracket (**29**) and the mounting bracket on the hydraulic oil reservoir. Secure in place with two new 1/2-13 elastic locknuts (**33**).
40. Reassemble the hoses (**34**) to the tee under each accumulator. Tighten all four hoses securely.



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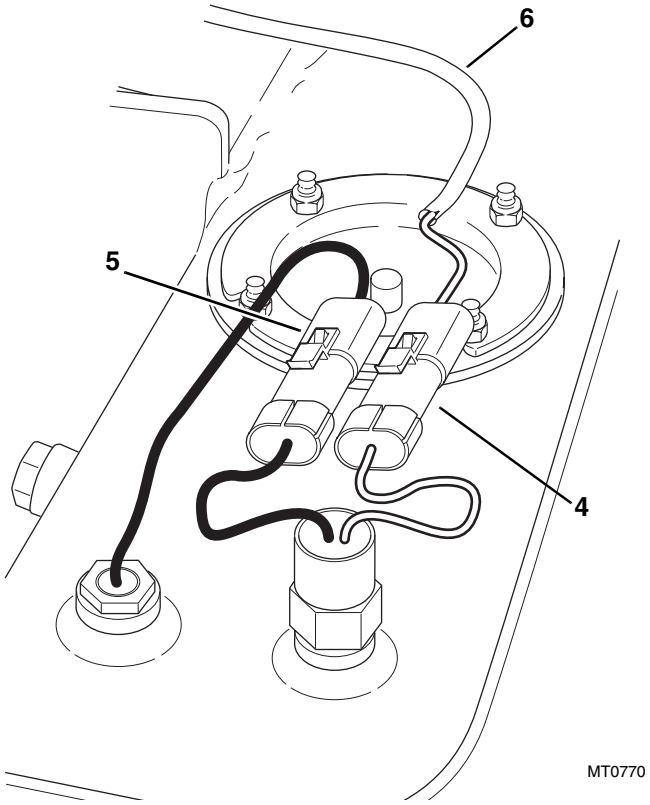
41. Replace any tie wraps that were removed.

42. Connect the engine coolant temperature switch lead (**1**) and oil pressure switch lead (**2**). (Refer to *Section 10.13.16, Engine Coolant High Temperature Sender* and *Section 10.13.15, Engine Low Oil Pressure Sender*.)

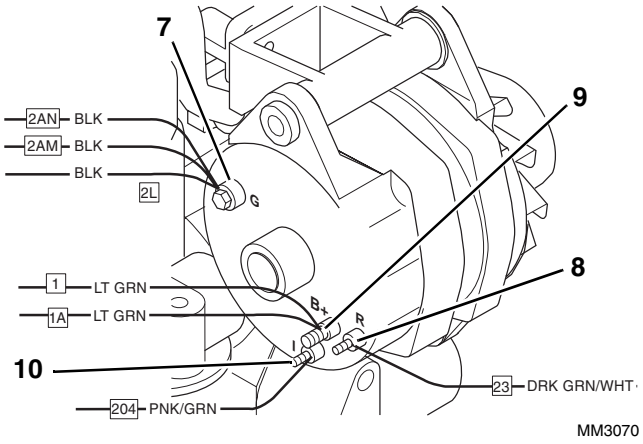


43. Uncap and re-connect the two remote engine filter hoses (**3**) to the engine block.

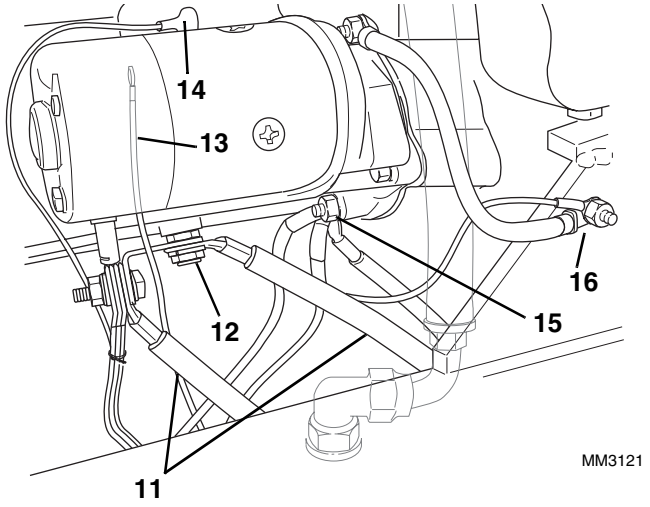
44. Connect the hydraulic low temperature sending unit lead (**4**) and the hydraulic filter sending unit lead (**5**) to the wiring harness connector (**6**).



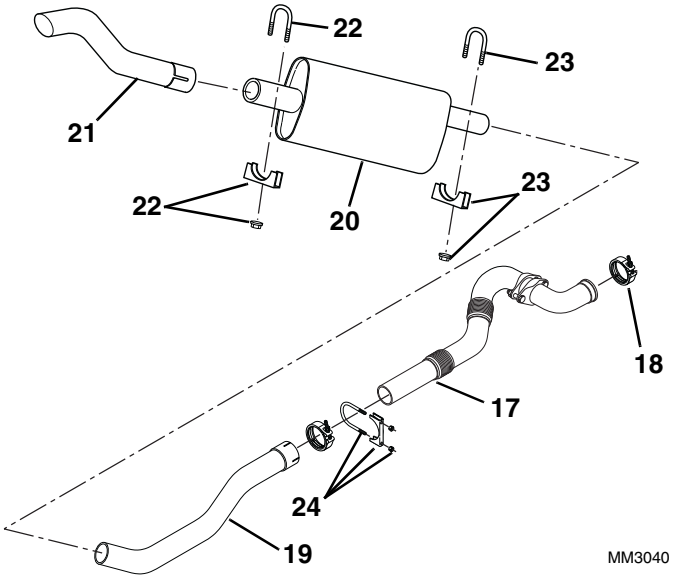
45. Connect the alternator ground (**7**), R (**8**), B+ (**9**), and I (**10**) wire leads.



46. Connect the positive (+) battery cable leads (**11**) to the starter post (**12**), then to the battery. Connect the blue wire lead (**13**) to the starter solenoid stud, located on the backside of the starter, between the engine and the starter. Connect the white wire lead to the starter top boot connector (**14**). **DO NOT** connect the negative (-) lead at this time.



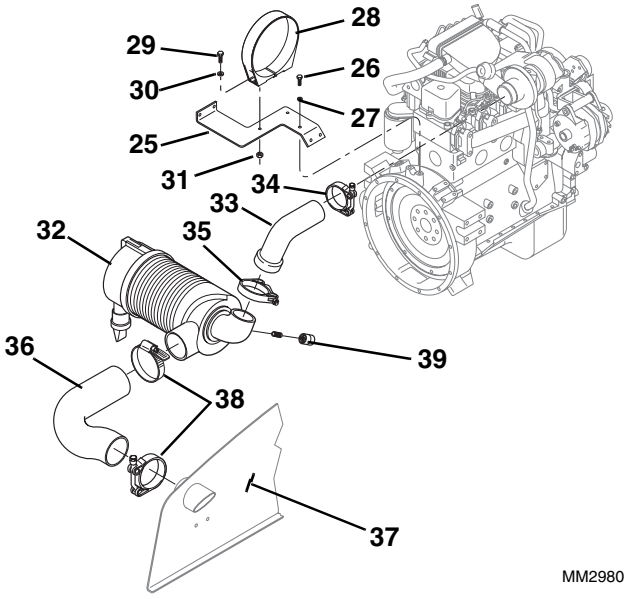
47. Twist the turbo outlet exhaust pipe (**17**) through the side shield and on to the engine turbo outlet. Install but **DO NOT** tighten the V-band clamp (**18**) to the turbo outlet exhaust pipe and engine turbo outlet. As one unit, fit the exhaust pipe (**19**), muffler (**20**) and tail pipe (**21**) onto the turbo outlet exhaust pipe. Install the 3" heavy duty tail pipe clamp (**22**), and both U-type clamps (**23** and **24**). Position exhaust system and tighten all clamps.



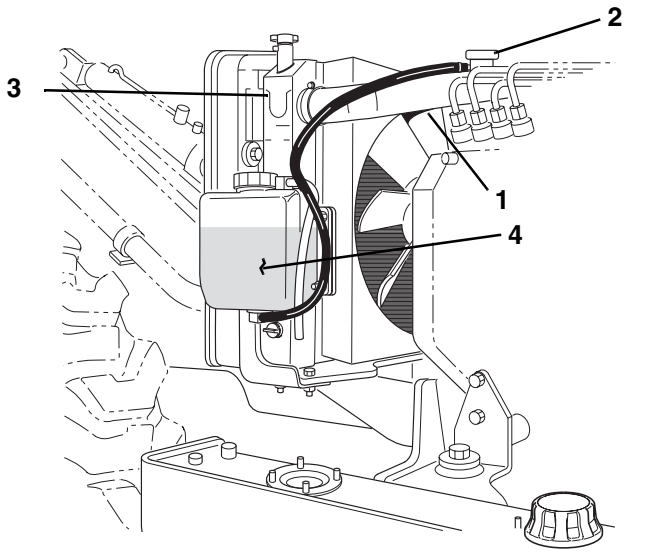
48. If removed during engine work, secure the air cleaner mount plate (**25**) to the engine with three 3/8-16 x 1-1/4" Grade 5 capscrews (**26**) and 3/8" lockwashers (**27**). Torque to 31 lb/ft (42 Nm).

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

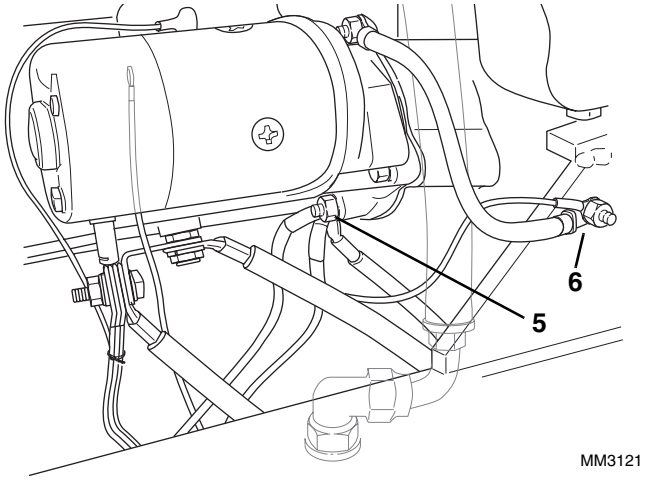
49. Secure the air cleaner mount band assembly (**28**) to the mount plate (**25**) using two 5/16-18 x 1" capscrews (**29**), 5/16" narrow flat washer (**30**) and new 5/16-18" elastic locknuts (**31**). Torque to 18 lb/ft (24 Nm).
50. Install the air cleaner assembly (**32**) in its entirety.
51. Install the air cleaner hose (**33**) between the turbocharger intake port and air cleaner assembly using T-bolt clamp (**34**) and a heavy duty T-bolt clamp (**35**).
52. Install the air intake hose (**36**) between the air cleaner assembly (**32**) and engine panel (**37**) using two T-bolt clamps (**38**). Secure T-bolt clamps. Connect the air cleaner restriction sensor (**39**) wires.



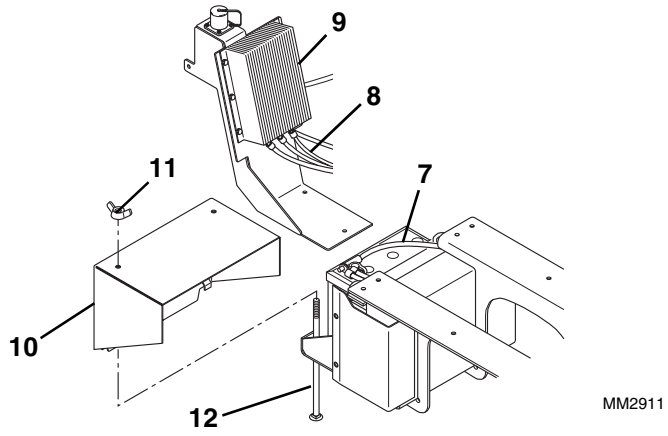
53. At the engine attach the upper radiator hose (**1**) using the radiator clamp saved during removal. Attach the lower radiator hose with clamp.



54. Open the radiator cap (**2**), located in the upper radiator hose, and fill the radiator (**3**) completely with a 50/50 mixture of ethylene glycol and water. Replace and tighten the radiator cap. Add coolant to the overflow tank (**4**) until the bottle is 1/2 to 3/4 full. This overfilling will compensate for any air in the cooling system.
55. Install the hood with the help of at least one assistant (refer to *Section 3.7.2, Engine Hood*).

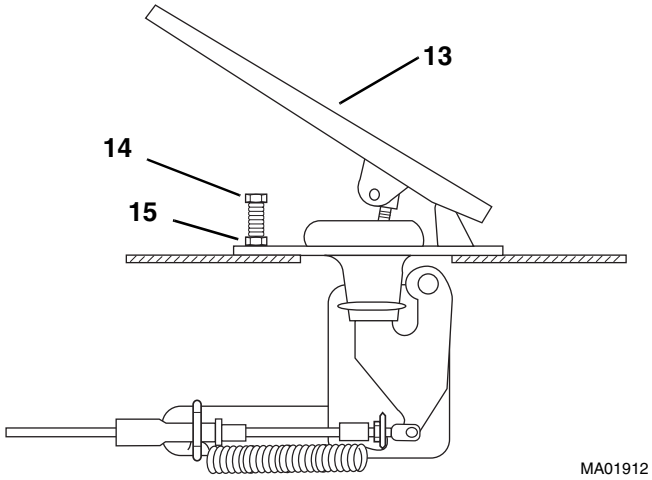


56. Connect the negative (-) battery ground cable lead (**5**) to the starter mounting bolt and the negative frame ground cable (**6**) to the frame stud.
57. Connect the negative (-) battery cable (**7**) at the negative (-) terminal on the battery in the engine side battery box.
58. Connect the negative (-) battery equalizer cable (**8**) at the bottom of the battery equalizer (**9**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
59. Replace engine side battery box cover (**10**). Use the wing nuts (**11**) and carriage bolts (**12**) to secure the cover in place.



60. Check that all hydraulic system, electrical system, cooling system, fuel system, and exhaust system connections are correct and connected tightly.

61. From within the cab, lightly depress the throttle pedal (**13**) to full-throttle position. As needed, adjust the limit-stop screw (**14**) until it touches the pedal. Tighten the locknut (**15**) to 120-125 lb/in (13,6-14,1 Nm).



62. Have an assistant stand by with a Class B fire extinguisher. Start and idle the engine.
63. Run engine to normal operating temperature then shut off the engine. While the engine is cooling, check for leaks.
64. Allow the engine to cool. Check the radiator coolant level and top off with a 50/50 mixture of ethylene glycol and water. Replace the radiator cap.
65. The overflow tank (**4**) should be 1/4 to 1/2 full. If not, fill to this level with a 50/50 mixture of ethylene glycol and water. Replace and tighten overflow tank cap.
66. Check for leaks from the engine, main hydraulic pump and lines, transmission, hydraulic reservoir and fuel tank. Check the levels of all fluids and lubricants. Fill as required.

IMPORTANT: *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 NEUTRAL [N].*

67. Obtain and connect an appropriate engine analyzer or tachometer. Check the engine rpm at full throttle. If the rpm is not 2600-2800 rpm, readjust the throttle limit-stop screw at the throttle pedal within the cab.
68. Purge the hydraulic system of air by operating all boom functions through their entire range of motion several times. Check the hydraulic oil level.
69. Check for proper operation of all components.
70. Turn the engine OFF.

8.11 ENGINE STORAGE

If the engine is properly protected and stored according to the following recommendations, no corrosion damage will normally occur. Cummins Engine Company, Inc. and **JLG** are not responsible for any damage that occurs in relation to a service storage period.

Use the following procedures immediately upon removing engine from service if being stored for an extended period of time.

1. Clean the outside of the engine.
2. When using a preservative fuel, drain the fuel system and fill with the preservative fuel. When not using preservative fuel, keep the fuel system charged with regular fuel, which, along with the fuel filter, will have to be drained and discarded at the end of the storage period.
3. Run the engine to operating temperature. Correct any fuel, fluid, oil or air leaks. Stop the engine and drain the oil.
4. Replace the oil filter.
5. Fill the crankcase (sump) to the FULL mark on the dipstick with new, clean oil or with an approved preservative fluid. If a preservative fluid is used, it must be drained and replaced with regular lubricating oil before the engine is returned to service.
6. Drain the cooling system. To provide protection against corrosion, fill the cooling system with a coolant containing a corrosion inhibitor. If frost protection is needed, use the appropriate mixture of anti-freeze and water. If frost protection is not required, use an appropriate mixture of water with an approved corrosion mixture.
7. Run the engine for a short period to distribute lubricating oil and coolant throughout the engine.
8. Clean out the engine breather pipe (where fitted) and seal the end of the pipe.
9. Remove the fuel injectors and spray clean engine lubricating oil into cylinder bores, 4 oz (118,3 ml) of lubricating oil divided evenly between the four cylinders.
10. Remove the air filter and any pipe installed between the air filter and the induction manifold. Seal the manifold with waterproof tape.
11. Remove the exhaust pipe. Seal the manifold with waterproof tape.
12. Disconnect the battery and store it safely, in a fully charged condition. Before the battery is put into storage, give the battery terminals a protection against corrosion with a light coating of dielectric grease or petroleum jelly.
13. Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.
14. Remove and store the fan drive belt.

Note: *Before starting the engine after storage, operate the starter motor with one of the fuel shut-off solenoid wires disconnected for 15 seconds or until the dash panel low oil pressure warning indicator goes out. This will allow oil to be circulated throughout the engine to prevent damage to internal components.*

8.12 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 9
Hydraulic System

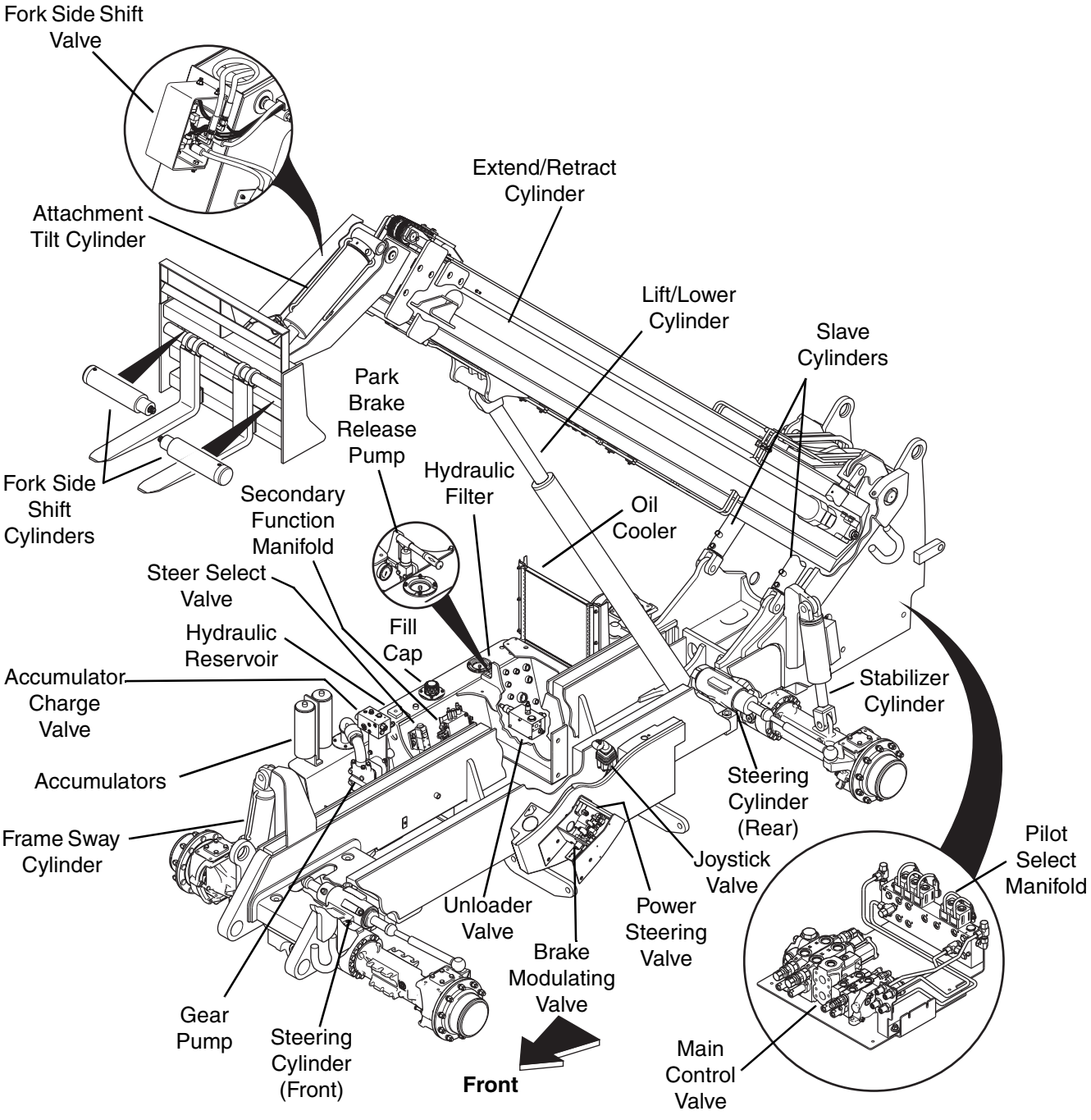
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9.1 HYDRAULIC COMPONENT TERMINOLOGY

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



MM3182

9.2 SAFETY INFORMATION

WARNING: **DO NOT** service the vehicle without following all safety precautions as outlined in the “Safety Practices” section of this manual. Failure to follow the safety practices may result in death or serious injury.

WARNING: Wait for hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

Petroleum-based hydraulic fluids are used in this vehicle. The temperature of hydraulic fluid increases during the operation of various hydraulic functions. A heated petroleum-based hydraulic fluid presents a fire hazard, especially when an ignition source is present. 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.

WARNING: Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing death or serious injury.

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

To relieve hydraulic pressure:

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

WARNING: Before starting the engine, verify that all hydraulic connections are properly tightened. Escaping hydraulic fluid under pressure can penetrate the skin causing death or serious injury.

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

A major cause of hydraulic component failure is contamination. Keeping the hydraulic fluid as clean as possible will help avoid downtime and repairs. Sand, grit and other contaminants can damage the finely machined surfaces within hydraulic components. If operating in an exceptionally dirty environment, change filters and inspect the fluid more often. When servicing the system, cap or plug hydraulic fittings, hoses and tube assemblies. Plug all cylinder ports, valves, and the hydraulic reservoir and pump openings until installation occurs. Protect threads from contamination and damage.

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 10.7, Electrical System Troubleshooting* in this manual.

9.3 SPECIFICATIONS

Refer to *Section 2.5, Specifications* for hydraulic system specifications.

9.4 HYDRAULIC FLUID

General information and specifications pertaining to hydraulic fluid are found in *Section 2.5.9, Hydraulic System*.

Use only clean, filtered fluid in the hydraulic system.

After servicing or replacing a hydraulic system component, cycle all vehicle functions several times to remove (purge or "bleed") air from the hydraulic system. **DO NOT** build maximum pressure at the end of stroke by continuing to hold the joystick function.

Inspect the hydraulic system and fluid frequently, and look for problems or conditions including the following:

Aeration

Aeration is the presence of air bubbles in hydraulic fluid. Sudden, violent inward collapse of the air (known as implosion) can occur when compressed air bubbles are subjected to system pressure. Aeration can thus lead to damage and overheating of components.

Pump aeration will produce a loud crackling sound, as though rocks or marbles were being forced through the pump. Excessive aeration will give the hydraulic fluid a cloudy or milky appearance, and cause erratic operation of hydraulic system components.

Aeration is caused by air being introduced into the system, possibly through a leaky seal or joint in the pump or elsewhere in the system. Check for leaky hydraulic cylinders and threaded fittings by introducing a special dye, visible under fluorescent light, which may be helpful in determining the source of the leak.

Cavitation

Cavitation occurs when hydraulic fluid fails to entirely fill an existing space. Cavitation, like aeration, can produce a loud crackling sound, as though rocks or marbles were being forced through the system. Cavitation can be due to a low hydraulic oil level in the reservoir, a restricted intake line, or improperly high fluid viscosity.

Contamination

Contamination, or dirt, can be any material other than hydraulic fluid that causes harm or decreases the performance of the system. Contaminants include solids, liquids and gases. Most contaminants are abrasive in nature, causing rapid wear or damage to the system.

Excessive heat

Excessive heat is a relative thermal condition that effects fluid viscosity. Extreme operating conditions, such as excessive operation, outside air temperature and other factors including aeration, cavitation, contamination and over-pressurization can cause fluid and component temperatures to go beyond their specified limits. Excessive heat causes oxidation in hydraulic fluid to occur more rapidly, breaking down its viscosity. A chain reaction then results and can lead to component damage or failure. The true cause of an excessive heat condition must be diagnosed and cured, or the problem will recur.

Implosion

An implosion is a sudden, violent inward collapse, and can often cause a vacuum effect. Imploding air bubbles within a hydraulic system can cause component damage.

Over-pressurization

Over-pressurization is pressure greater than that for which a component was engineered to withstand or operate under. Over-pressurization can cause equipment damage. **DO NOT** attempt to adjust or tamper with pressure cartridges, settings, etc. unless otherwise specified.

Viscosity

Viscosity is the property of a fluid or semi-fluid that enables it to develop and maintain shearing stress dependent upon flow rate (velocity), and to offer continued resistance to flow. In other words, viscosity is a measurement of fluid resistance to flow (internal friction).

9.5 HOSES, TUBE LINES, FITTINGS, ETC.

There are numerous hydraulic hoses, tubes, fittings, etc. used on this vehicle. Periodically inspect all of these and carefully examine any signs of wear, abrasion and/or deterioration. Determine whether any further use of the component would constitute a hazard. If in doubt, replace the component.

9.5.1 Replacement Considerations

Conditions including, but not limited to, the following are sufficient for considering component replacement:

1. Any evidence of hydraulic fluid leakage at the surface of a flexible hose or its junction with the metal and couplings
2. Any blistering or abnormal deformation to the outer covering of a hydraulic hose
3. Hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening or other recommended procedures.
4. Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or hydraulic fitting. Modification must be made to eliminate the interference of the elements in contact with one another, or to otherwise protect the components from contact with one another. Slightly moving a hose or adjusting a plastic tie wrap may often be all that is necessary to eliminate interference; evaluate each situation and proceed as required by the individual circumstances.

9.5.2 Hose, Tube, Line and Fitting Replacement

Before removing a hydraulic hose or component, always mark or otherwise label the related parts and the exact location of the hose or component to aid in proper re-installation. Hydraulic fluid is a good cleaner and can remove most liquid-ink type markings, so make sure the mark or label will remain intact. Alternative methods to using markers include color-coded tie wraps, number-tag sets, alpha-numeric stampings or markings and suitably labeled pieces of tape. Select an appropriate marking method for the conditions and proceed accordingly.

NEVER replace a hydraulic hose or other component with a part not specifically designed for this vehicle. For example, replacing a hydraulic hose rated for use in a 3700 psi (255 bar) circuit with a common garden hose can result in an exploded garden hose, hydraulic fluid spray and other damage or personal injury. Use only factory approved parts for best performance and safety.

Removal and replacement of hoses, tube lines, fittings, etc. usually involves straightforward procedures. When removing a hydraulic hose or other component, be aware that o-rings are used throughout the hydraulic system. ALWAYS replace a used o-ring with a new part.

Check all routing of hoses, wiring and tubing for sharp bends, or interference with any rotating members. Install appropriate protective devices such as tie wraps and conduit to help shield hoses from damage. All tube and hose clamps must be tight.

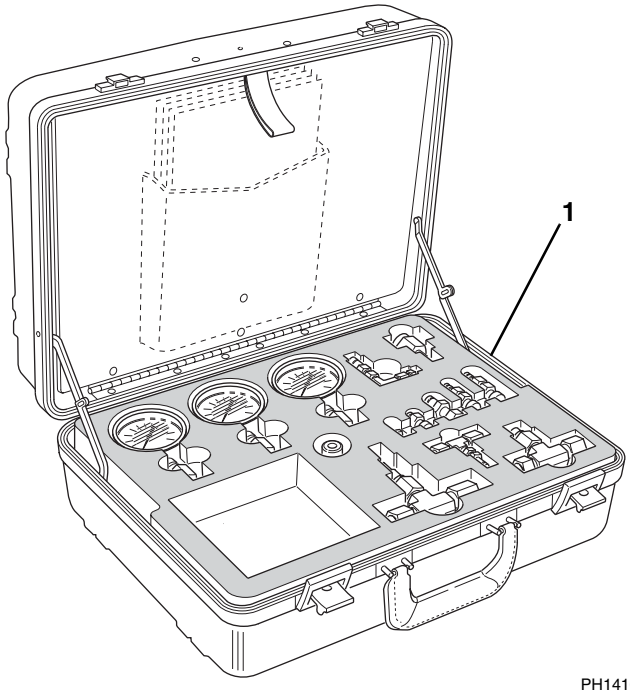
9.6 HYDRAULIC PRESSURE DIAGNOSIS

JLG Inc. has two kits available to use for hydraulic system maintenance and troubleshooting; the Sky Trak Pressure Test Kit and the Sky Trak Flowmeter Kit. The kits are contained in a durable polyethylene carrying case for demanding field service conditions.

Pressure Test Kit

The hydraulic pressure test kit (**1**) 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
- Laminates of test diagrams and test procedures
- 13" x 18" x 7" durable carrying case

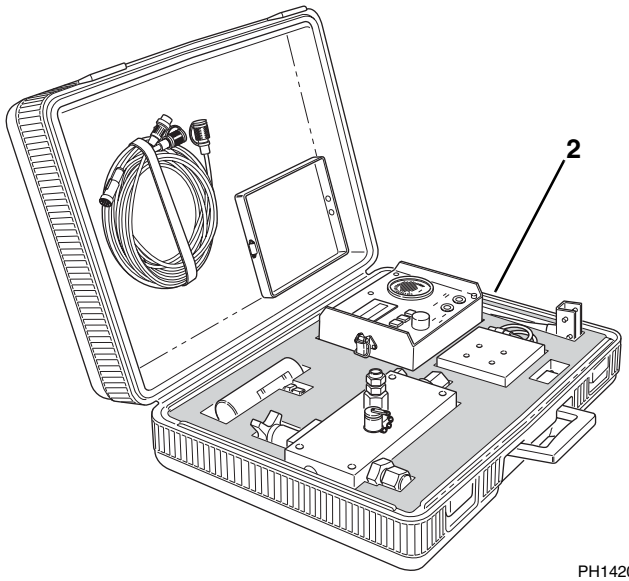


PH14102

Flowmeter Kit

The flowmeter test kit (**2**) is used to pinpoint hydraulic system faults. It includes a flowmeter with load valve, magnetic base, photo tachometer head and flex arm. The kit features:

- Bi-directional for unrestricted connection and simplified testing
- Internal by-pass to protect system and tester from over-pressure
- Measures up to 60 GPM and 6000 psi
- 16" x 22" x 7" durable carrying case



PH14202

Contact JLG Inc. at (717) 485-5161 domestically or (877) 554-5438 internationally for ordering information.

Part Number	Description	Approximate Weight	Price and Availability
7133413	Hydraulic Pressure Test Kit	16 lbs.	Consult Factory
1321107	Hydraulic Flowmeter Kit	28 lbs.	Consult Factory

9.6.1 Pressure Checks and Adjustments

When diagnosing trouble in the hydraulic system, use the hydraulic testing information in *Section 9.7, Hydraulic System Testing*.

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

1. Park the vehicle on a firm, level surface. Engage the park brake, place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, level the boom and turn the engine OFF.
2. Pressure tee fittings are conveniently located in each hydraulic circuit. Install a pressure gauge capable of measuring at least 10% more pressure than that which the circuit being checked operates under.

> **WARNING:** Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

3. Start the engine. Operate vehicle functions several times to allow hydraulic oil to reach operating temperature. The hydraulic oil temperature should be between 100-120° F (38-49° C). If a temperature gauge or thermometer is unavailable, the hydraulic oil reservoir should be warm to the touch.
4. Refer to *Section 9.7, Hydraulic System Testing* for testing procedures.
5. Fully depress the accelerator pedal as required. Place and hold the joystick in the position needed to operate the particular vehicle function being checked. Continue holding the joystick in position until pressure readings are taken.
6. Check the pressure gauge reading. It should read as specified in the Pressure Readings column of the charts found in *Section 9.7, Hydraulic System Testing*. 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. As a last resort, adjust the appropriate relief valve, if applicable. Turning the adjustment screw clockwise will increase the pressure; turning the screw counterclockwise will decrease the pressure.

> **WARNING:** Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

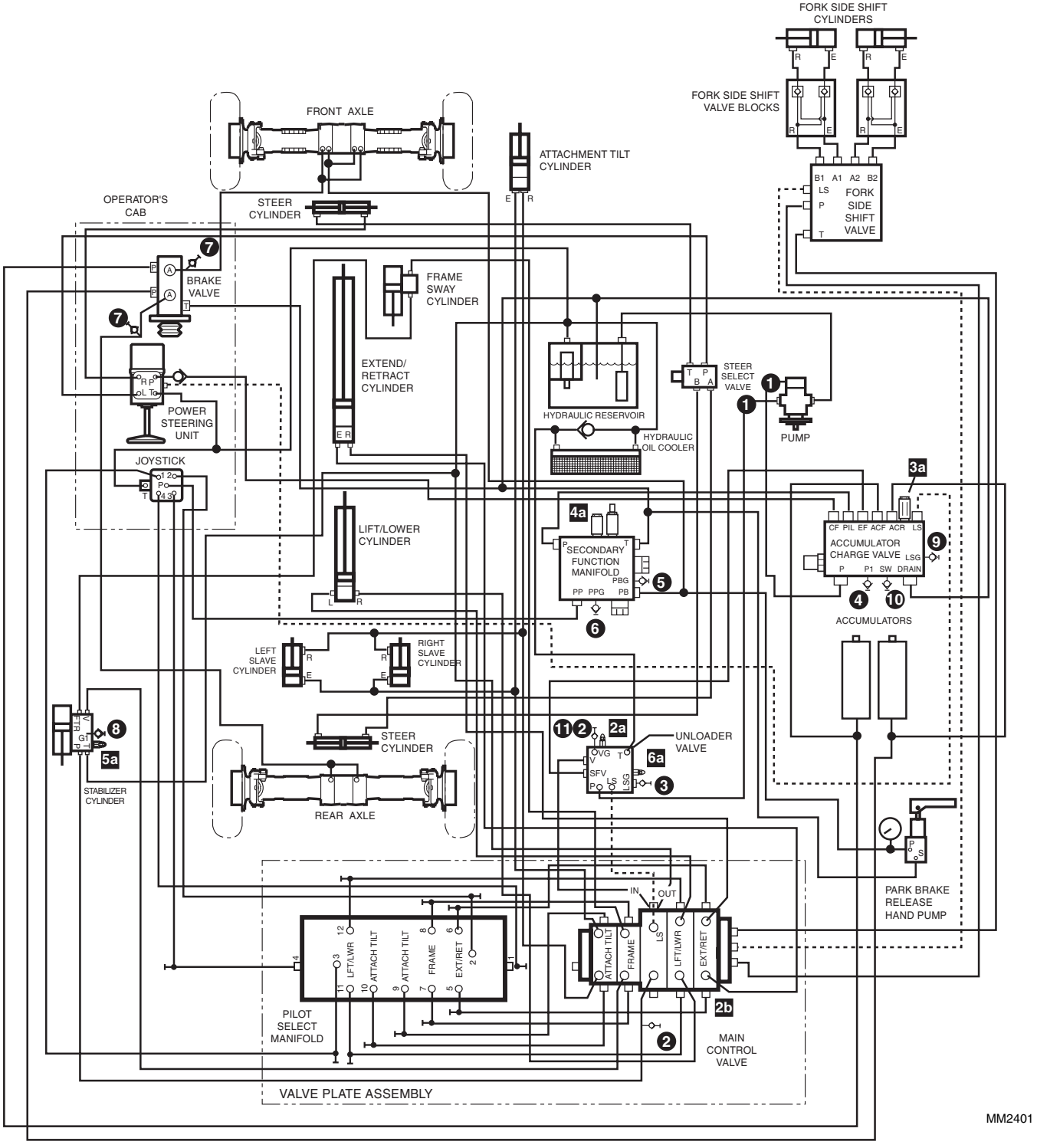
8. Start the engine and check the pressure again. Turn the engine OFF, then disconnect or remove the pressure gauge from the vehicle.



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9.7 HYDRAULIC SYSTEM TESTING

9.7.1 Hydraulic Testing



Engine Information

Idle. . . . . 1,050 ±50 rpm

Full Speed . . . . . 2,750 ±100 rpm

Hydraulic Oil Information

Oil Type - Meets MIL-PRF-2104G Specifications

Capacity - Reservoir . . . . . 28.5 gal. (108 liter)

Capacity - System . . . . . 41.3 gal. (156 liter)

Note: To adjust relief settings, pressure reducing settings or standby pressure, turn the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.
The hydraulic oil temperature for the pump flow test should be between 100-120° F (38-49° C) (tank hot to the touch) during testing.

Equipment Needed To Perform Tests From Hydraulic Diagnostic Test Kit

Circuit	Gauge	Fittings
2 3 4 9 10	5,000 psi gauge (345 bar)	Unit equipped with fittings from factory.
5 6 7	2,000 psi gauge (138 bar)	Unit equipped with fittings from factory.
8 11	300 psi gauge (20,7 bar)	#4 O-Ring Boss Fitting with Diagnostic Nipple Required for Stabilizer Cylinder

TEST LOCATION	Hydraulic Pump Flow Test
1	**To check flow readings a flow meter capable of measuring 60 gpm (227 ltr/min) and a load valve capable of 6,000 psi (413,4 bar) will be required (not included with Hydraulic Diagnostic Test Kit).** Test both pumps separately. When testing the pumps, return the oil from the flow meter directly into the tank fill. 2,000 psi (137,8 bar) load @ Engine Speed of 2,500 ±25 rpm — Flow rate should be 16.5-19.5 GPM (62,5-73,8 ltr/min).

TEST LOCATION	ADJUST. LOCATION	COMPONENT DESCRIPTION	PRESSURE READINGS	PRESSURE TEST PROCEDURES
2	2a	Unloader Valve	Main System Relief 3,500 ±100 psi (241 ±6,9 bar)	With engine at FULL throttle, boom retracted, use the joystick to fully lower the boom. Hold over relief. Check readings. If incorrect, adjust or replace cartridge. **Note:** Perform this test with carriage removed.
2	2b	Main Control Valve	Extend/Retract Base Port Relief 3,200 ±100 psi (220,6 ±6,9 bar)	With engine at FULL throttle, use the joystick to extend boom fully. Hold over relief. Check readings. If incorrect, adjust or replace cartridge.
2	N/A	Attachment Tilt Relief/ FORWARD or REARWARD	3,500 ±100 psi (241 ±6,9 bar)	CONSULT FACTORY
3	N/A	Unloader Valve	Load Sense 3300 +200/-100 psi (227 +14/-7 bar)	With engine at idle, load sense is 0 psi. With engine at FULL throttle, use the joystick to fully retract the boom. Hold over relief.
4	3a	Accumulator Charge Valve	Steering Relief 2,500 ±100 psi (172,3 ±7 bar)	With engine at FULL throttle, turn the steering wheel all the way to one direction and hold while checking pressure. If pressure is not correct, adjust or replace the pressure relief valve cartridge.
5	N/A	Secondary Function Manifold	Park Brake Release 550 ±100 psi (37,9 ±7 bar)	With engine at idle, turn the park brake switch to disengaged position with secondary function held over relief. Check pressure. This pressure is not adjustable.
6	4a	Secondary Function Manifold	Pilot Pressure 550 ±100 psi (37,9 ±7 bar)	With engine at FULL throttle, move joystick to boom retract position. Hold joystick over relief and check pressure. If pressure is not correct, adjust or replace the cartridge in the secondary function manifold. If cartridge cannot be adjusted, consult factory.
6	N/A	Brake Valve (Manual Brake Pressure)	600 ±50 psi (41,4 ±3,4 bar)	With engine OFF, depress and hold brake pedal. **DO NOT** overstroke the brake pedal. Check both front and rear service brakes at the individual test nipples on the brake valve. If pressure is incorrect, check for external leaks. If no leaks are found, check accumulator pressure at test location 10.
7	N/A	Brake Valve (Service Brake Pressure)	600 ±50 psi (41,4 ±3,4 bar)	With engine at idle, depress and hold brake pedal. **DO NOT** overstroke the brake pedal. Check both front and rear service brakes at the individual test nipples on the brake valve. Check pressure. If pressure is not correct, check accumulator pressure at test location 10.
8	5a	Stabilizer Cylinder	75-150 psi (5,2-10,3 bar)	With the engine at idle, check the pressure on the stabilizer cylinder. If pressure is not correct, adjust or replace the cartridge.
9	N/A	Accumulator Charge Valve	Load Sense 0-2600 psi (0-179 bar)	With engine at FULL throttle, turn the steering wheel all the way one direction, and hold while checking pressure. This pressure is not adjustable.
10	N/A	Accumulator Charge Valve	See “Pressure Test Procedures” for Pressure Readings	At start up, the pressure should stop momentarily at 700 psi (48 bar), which is the pre-charge pressure. The pressure should then continue to rise to 1950 ±50 psi (134 ±3,4 bar) which is the accumulator charge pressure. Let the system bleed down naturally with engine at idle (minimum of 2 minutes). The accumulator charge pressure should recharge at 1050 ±50 psi (72 ±3,4 bar).
11	6a	Unloader Valve	Standby Pressure 200 ±50 psi (13,8 ±3,4 bar)	With engine at idle, check standby pressure. If pressure is not correct, adjust or replace the differential pressure sense cartridge on the unloader valve.

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9.8 HYDRAULIC CIRCUITS AND TROUBLESHOOTING

This section covers the hydraulic circuits and includes a circuit drawing, troubleshooting chart, and description of the circuit for each function.

Typically, the circuit drawings illustrate the flow of oil for the hydraulic function being shown.

The troubleshooting charts cover some common problems that can occur during the operation of the hydraulic system. Electrical and hydraulic functions are often related. Verify that the electrical components of the circuit are functioning properly whenever troubleshooting the hydraulic circuit.

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

1. Check the hydraulic oil level in the reservoir. Oil level should be in the middle of the 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 the hydraulic system.

   Erratic machine performance and/or spongy cylinder operation are signs of air in the hydraulic system.



WARNING: Wait for hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.



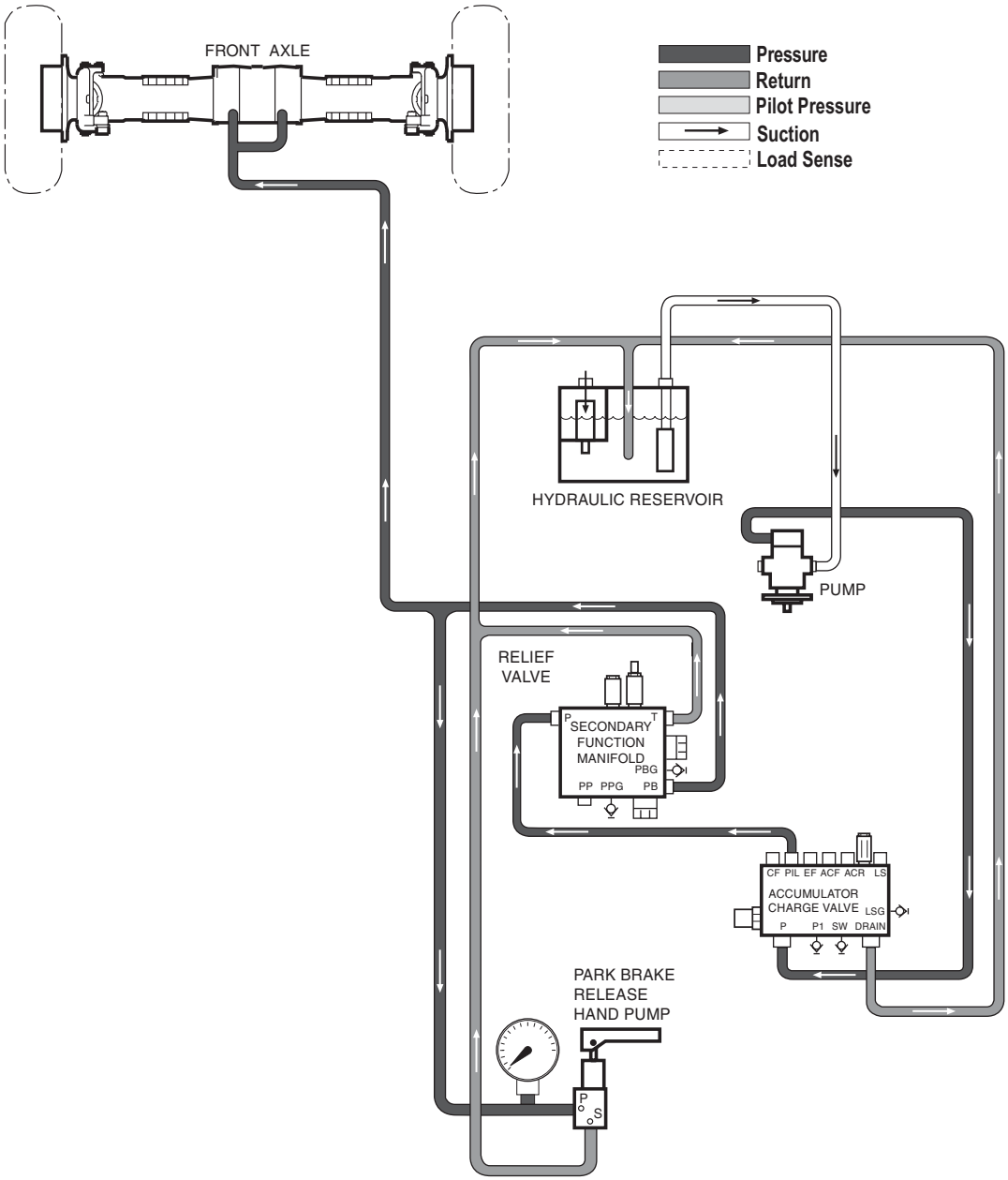
WARNING: Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing death or serious injury. When checking for air in the hydraulic system, wear safety glasses and gloves to help provide protection from spraying hydraulic oil.

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

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

9.8.1 Park Brake Circuit and Troubleshooting

Refer to *Section 9.8.24, Brake Circuit Description* for a more detailed explanation of this circuit.)



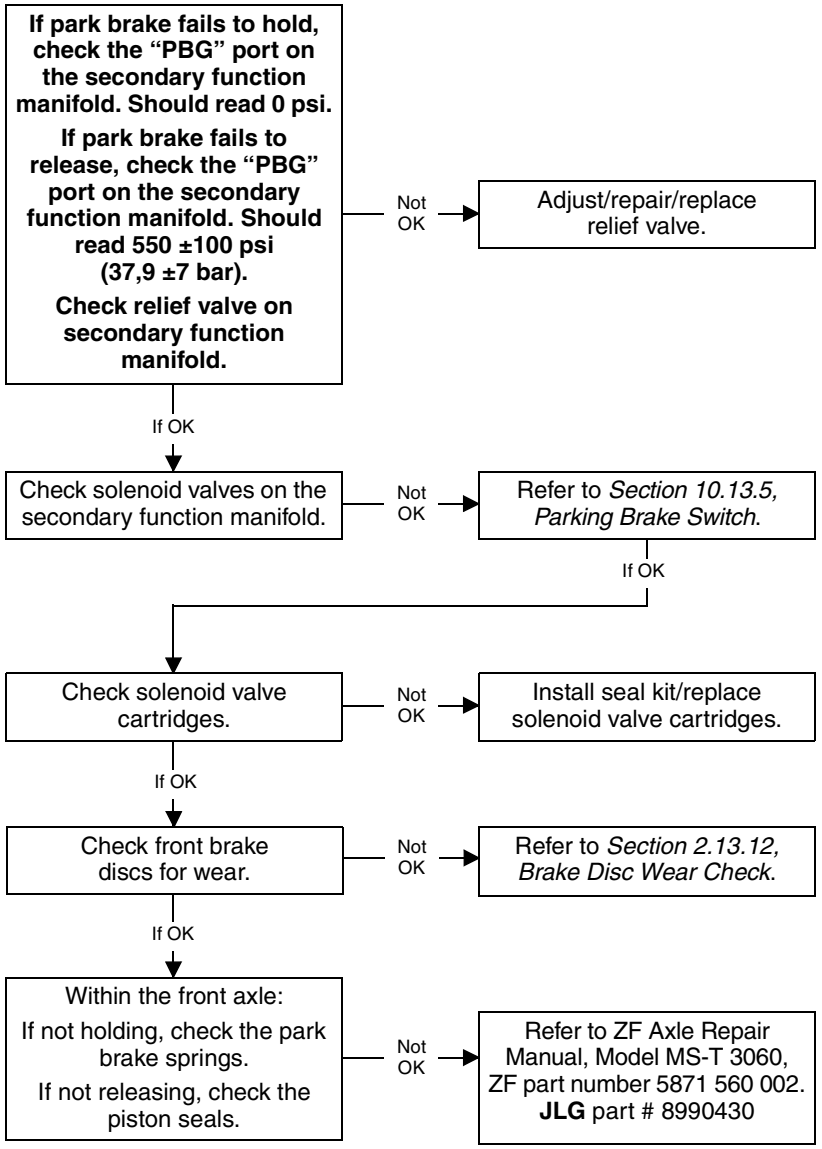
MM4790

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

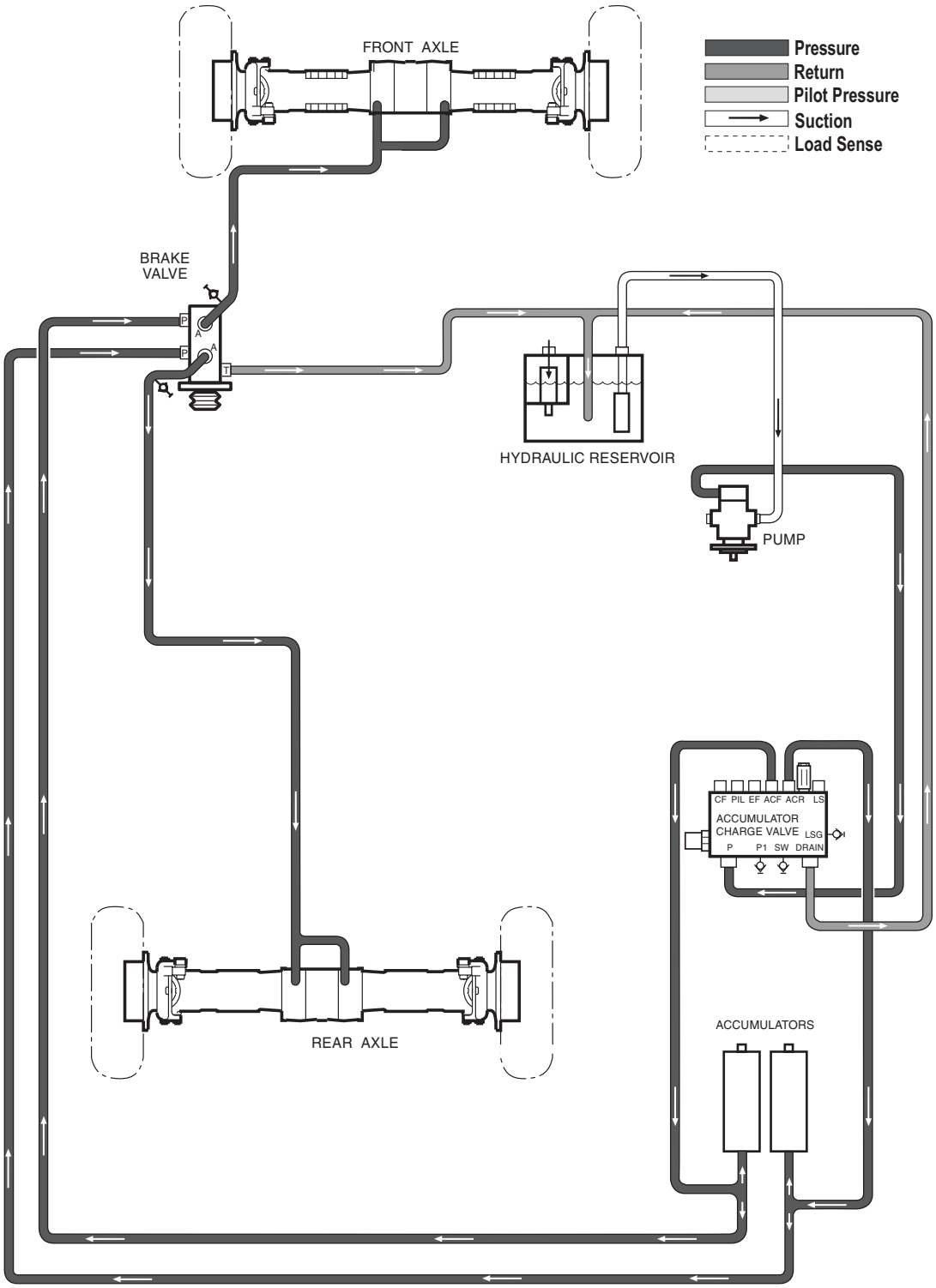
NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



9.8.2 Service Brake Circuit and Troubleshooting

(Refer to *Section 9.8.24, Brake Circuit Description* for a more detailed explanation of this circuit.)

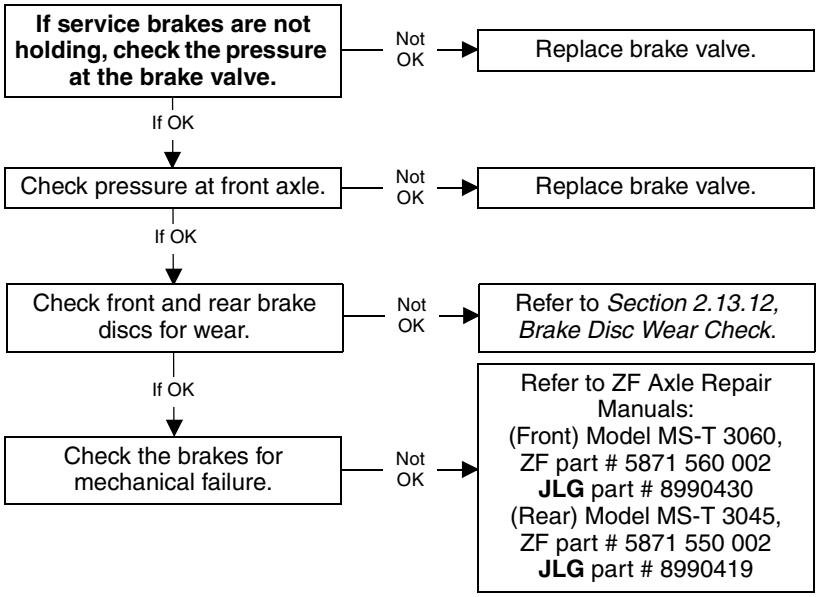


Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

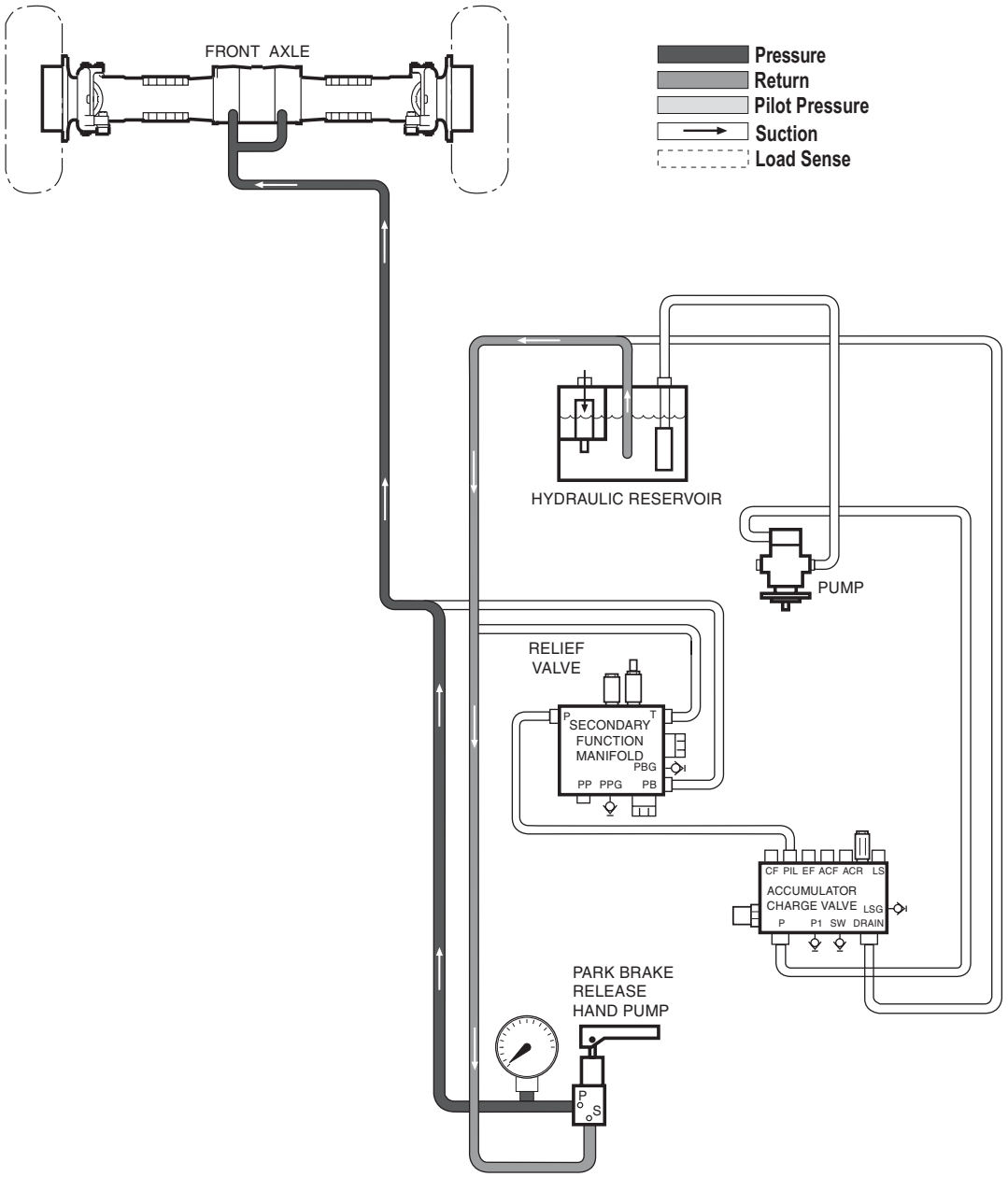
NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



9.8.3 Emergency Towing Park Brake Release Circuit and Troubleshooting

(Refer to *Section 9.8.24, Brake Circuit Description* for a more detailed explanation of this circuit.)



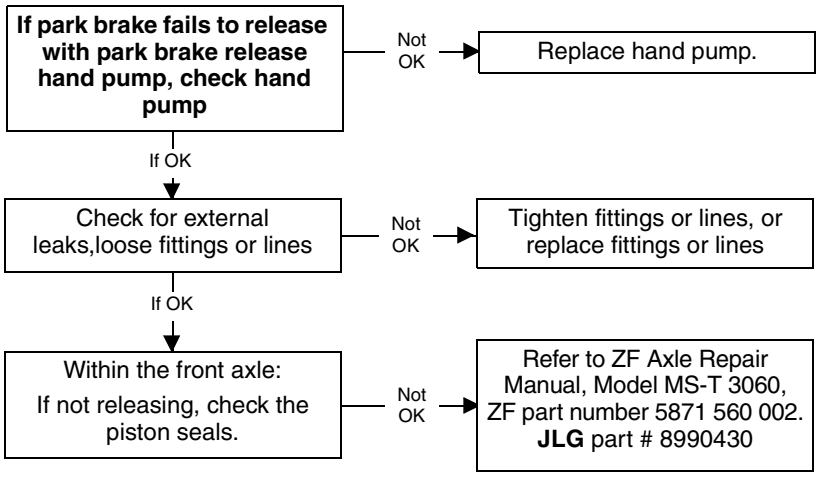
MM5030

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

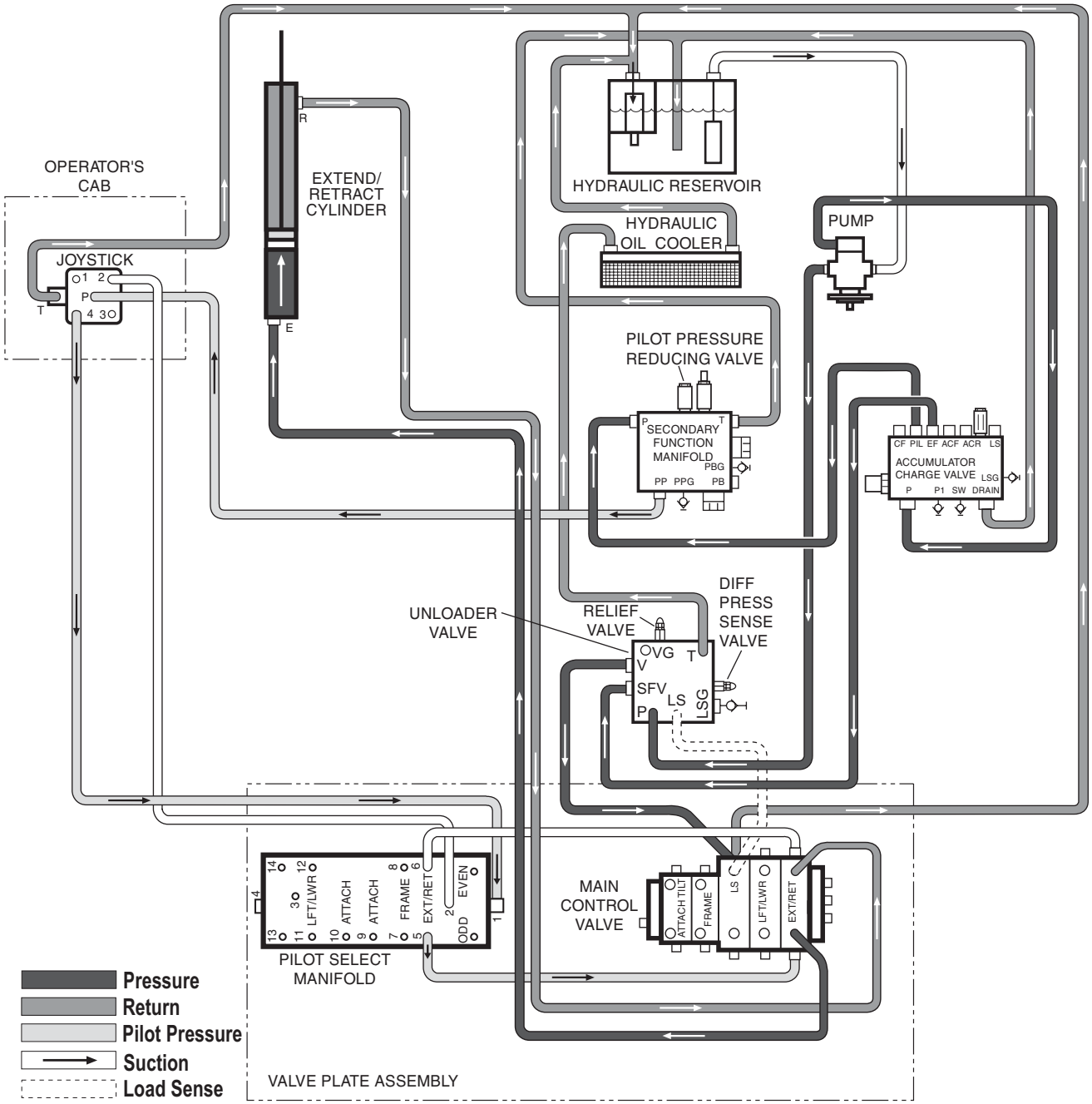
NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



9.8.4 Boom Extend Circuit and Troubleshooting

(Refer to *Section 9.8.25, Boom Extend/Retract Circuit Description* for a more detailed explanation of this circuit.)



MM3261

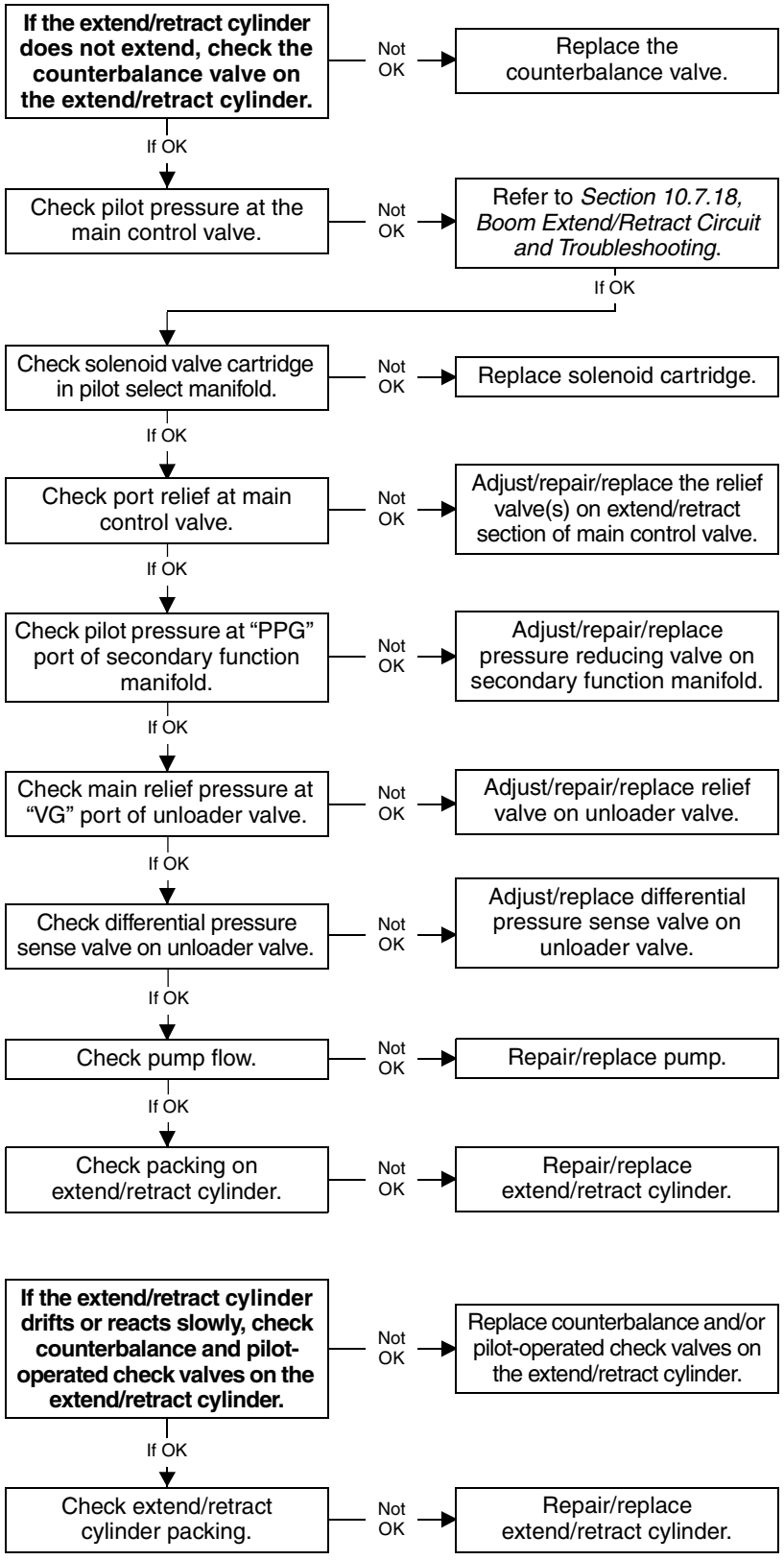


Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

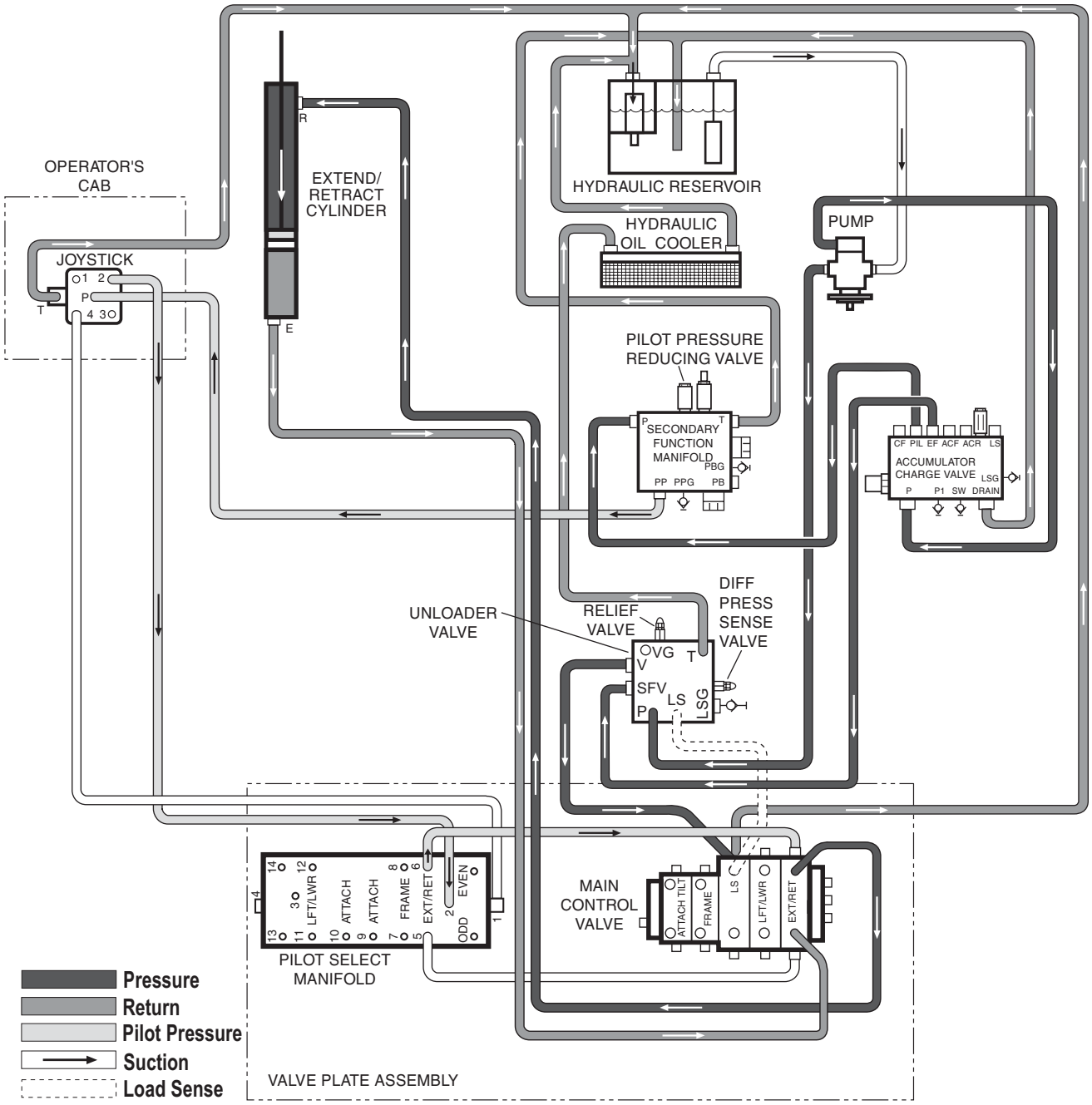
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.





9.8.5 Boom Retract Circuit and Troubleshooting

(Refer to *Section 9.8.25, Boom Extend/Retract Circuit Description* for a more detailed explanation of this circuit.)



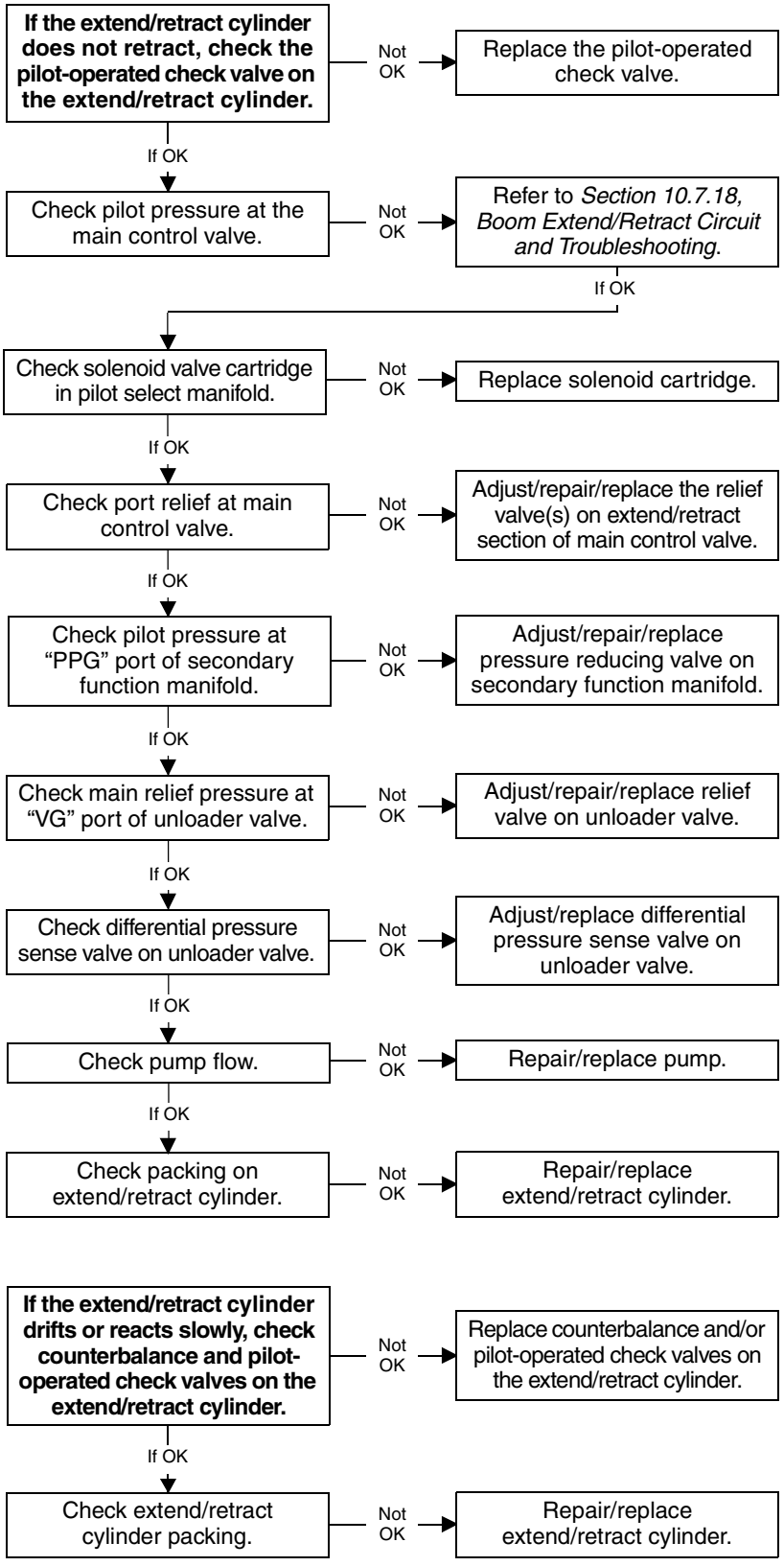
MM3271

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

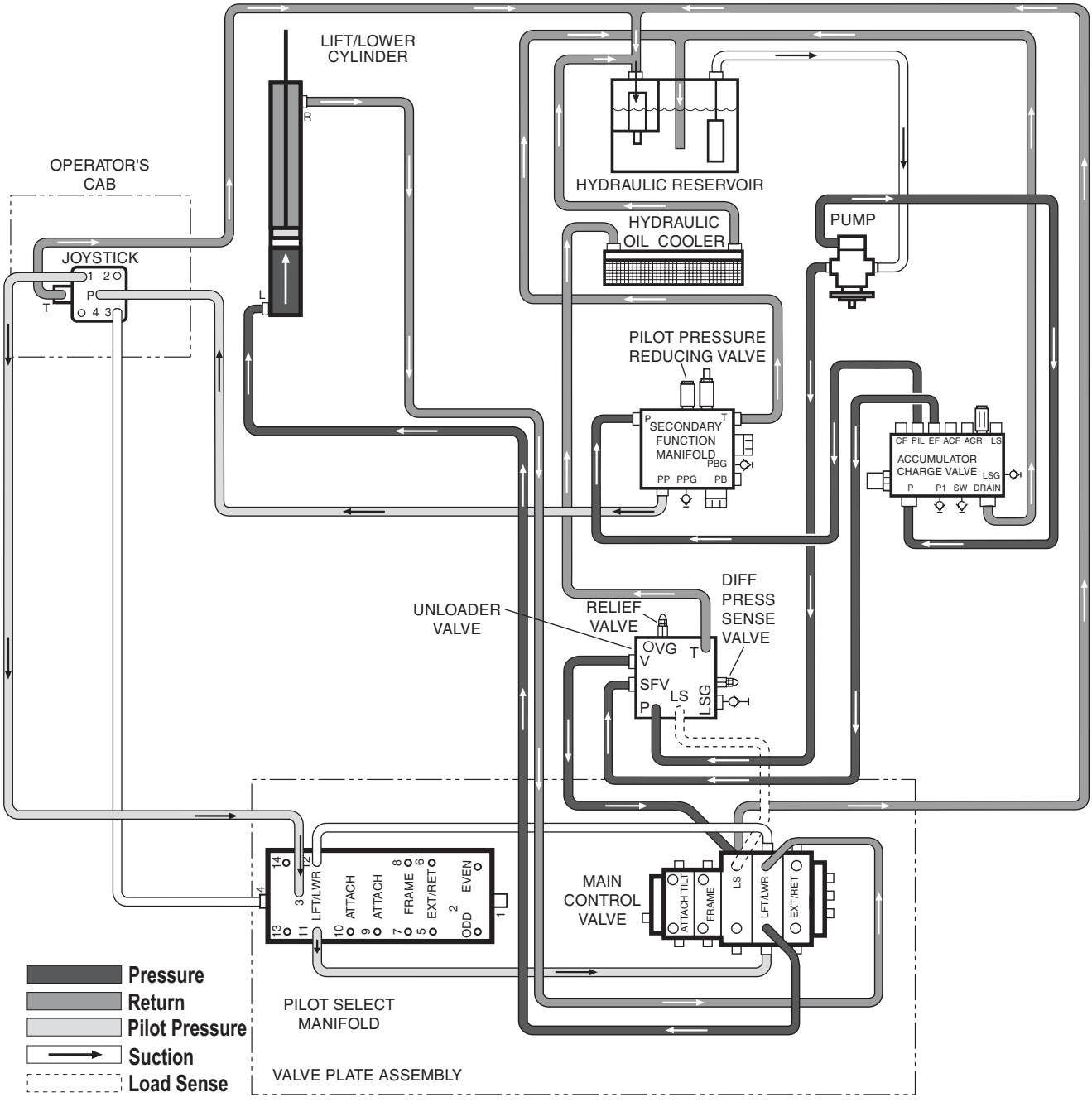
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.





9.8.6 Boom Lift Circuit and Troubleshooting

(Refer to *Section 9.8.26, Boom Lift/Lower Circuit Description* for a more detailed explanation of this circuit.)



MM3281

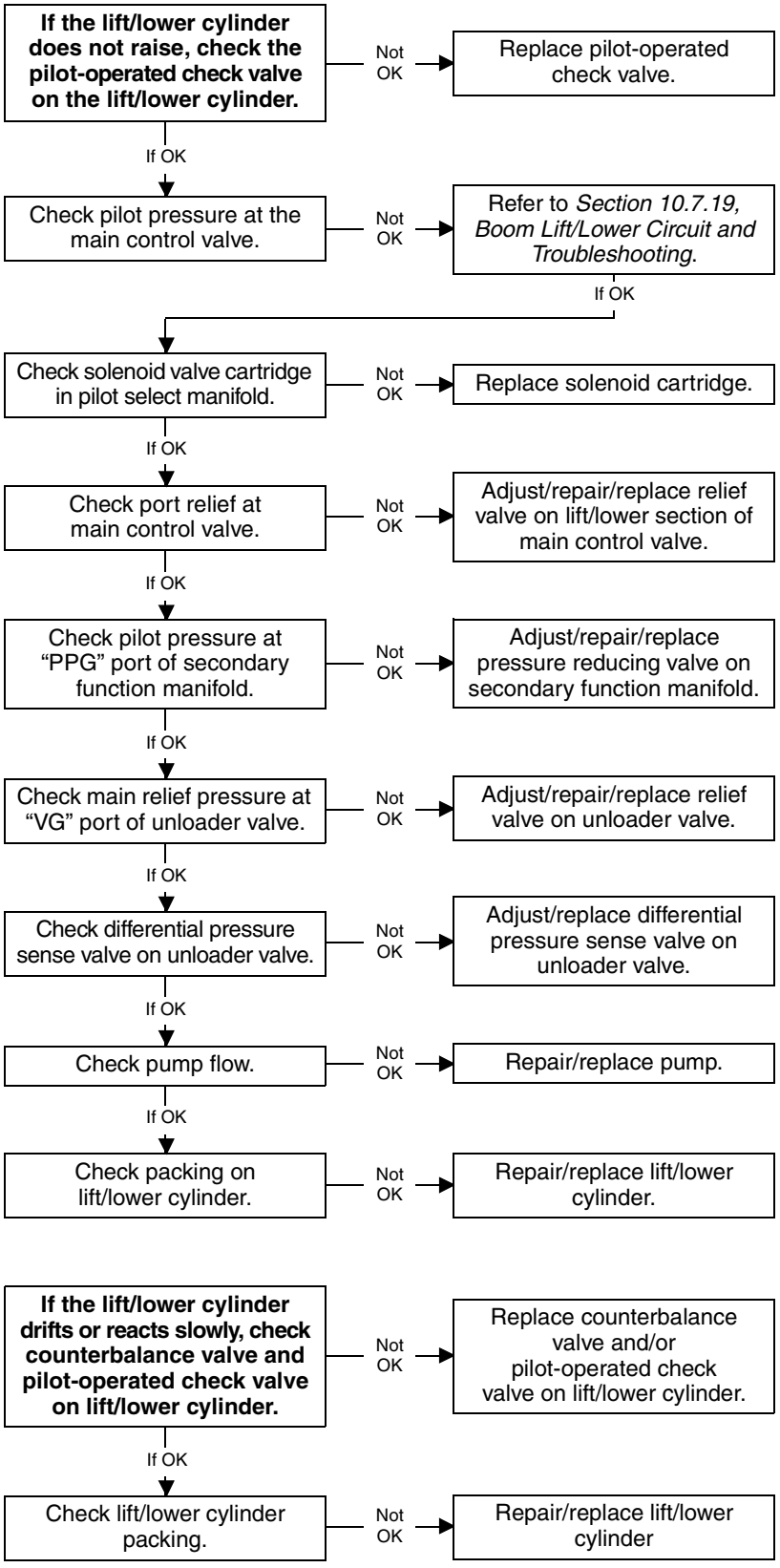


Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

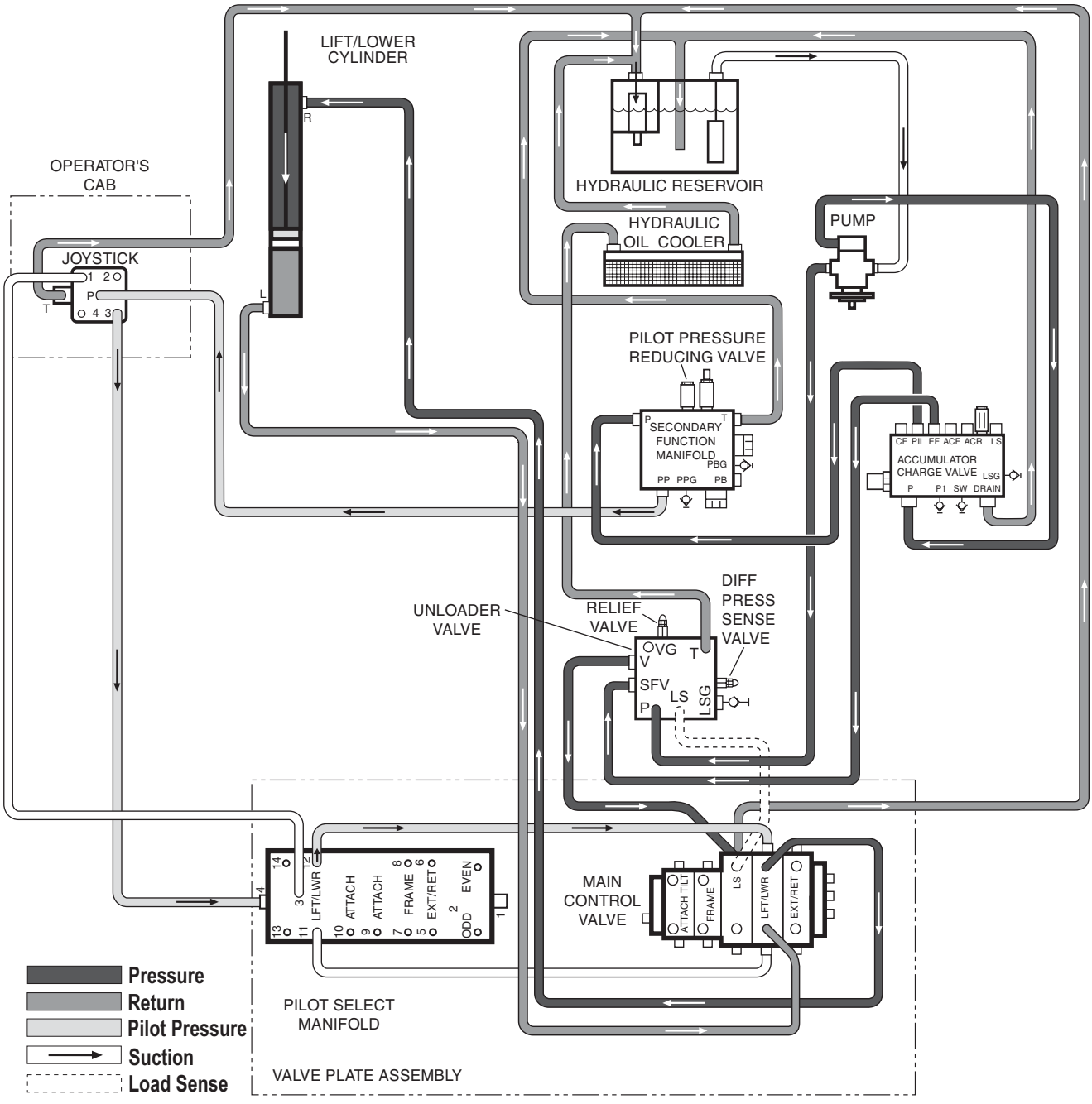
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.





9.8.7 Boom Lower Circuit and Troubleshooting

(Refer to *Section 9.8.26, Boom Lift/Lower Circuit Description* for a more detailed explanation of this circuit.)



MM3291

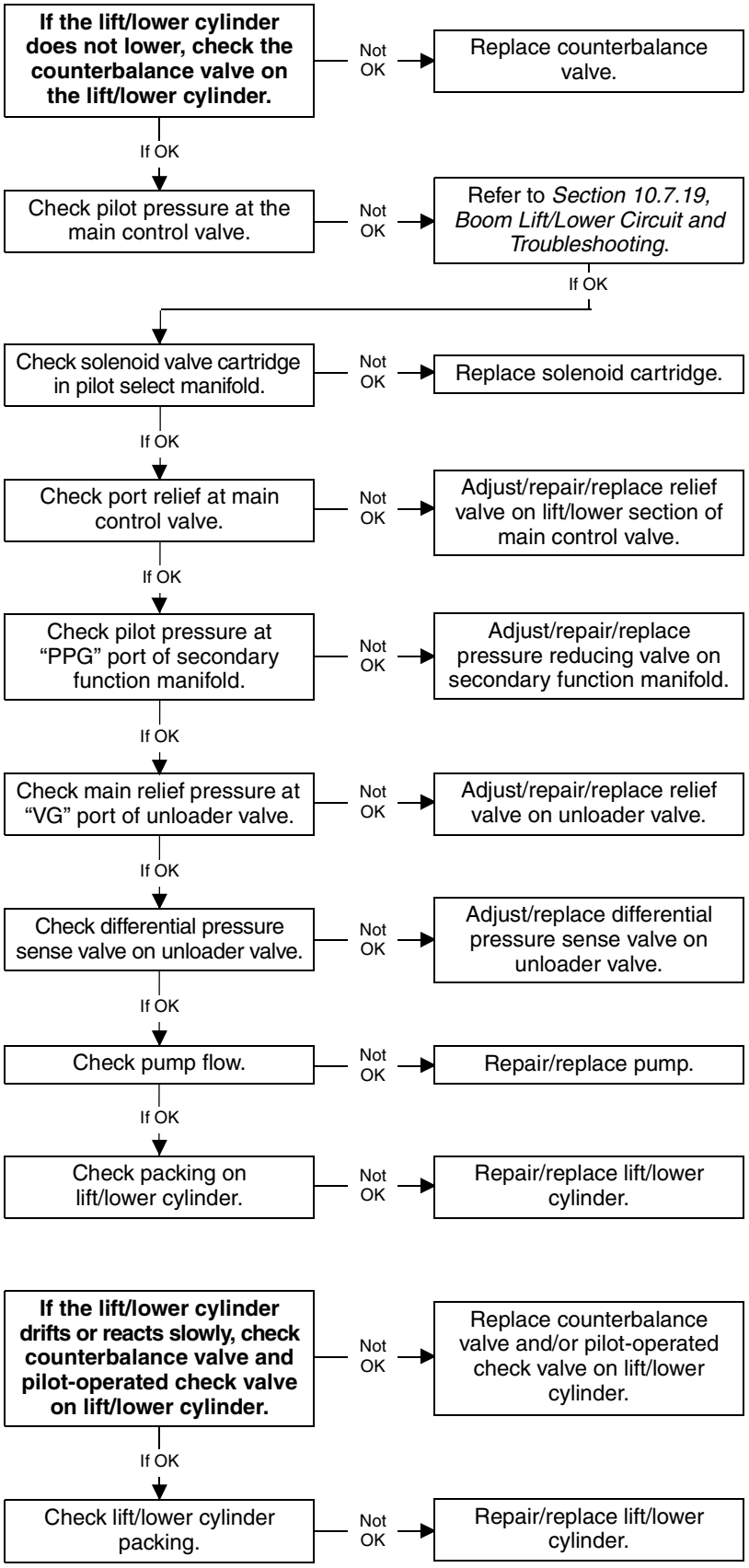


Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

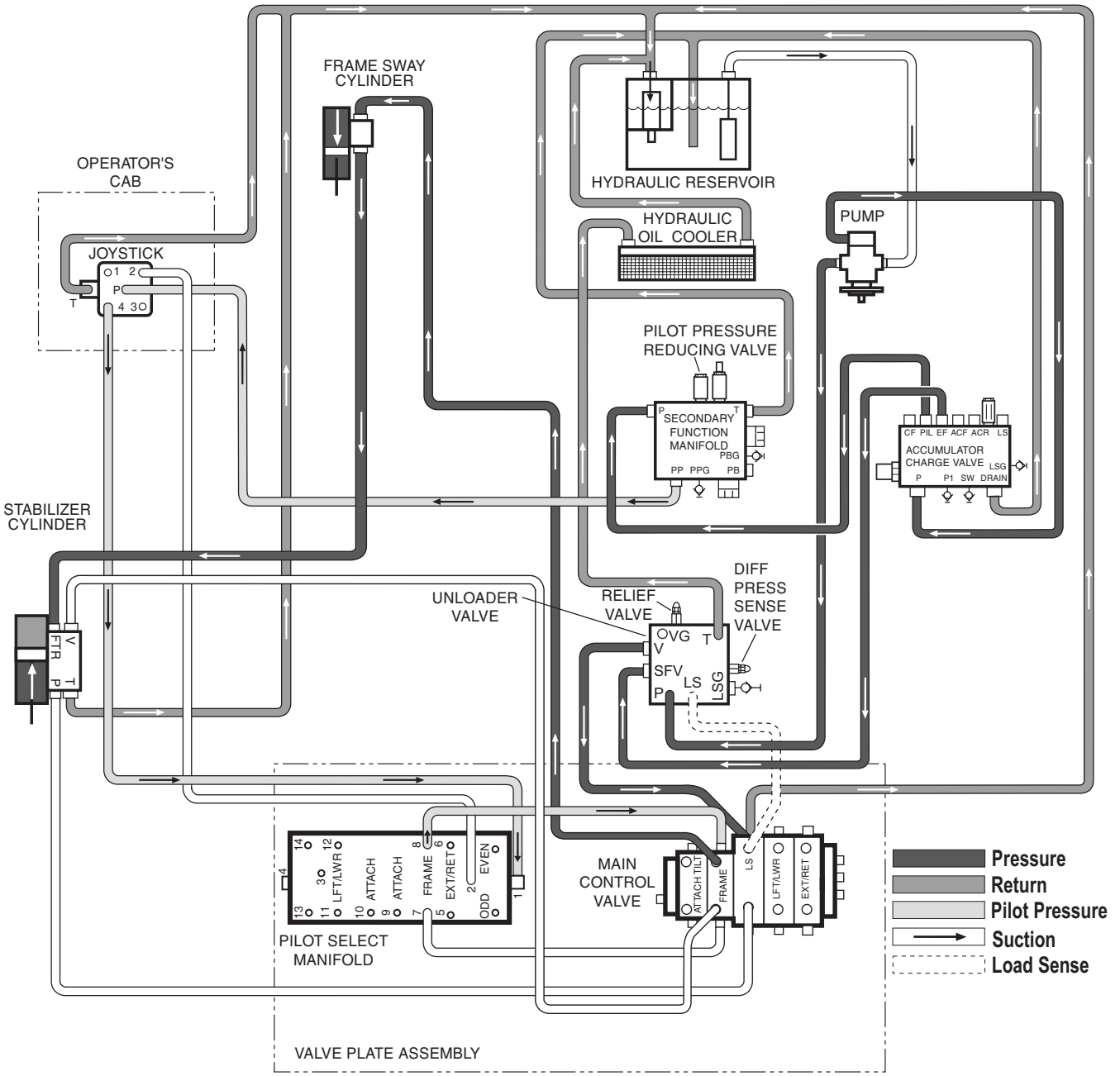
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.





9.8.8 Frame Sway (Left) and Stabilizer Circuit and Troubleshooting

(Refer to *Section 9.8.27, Frame Sway Circuit Description* for a more detailed explanation of this circuit.)



MM3301



Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

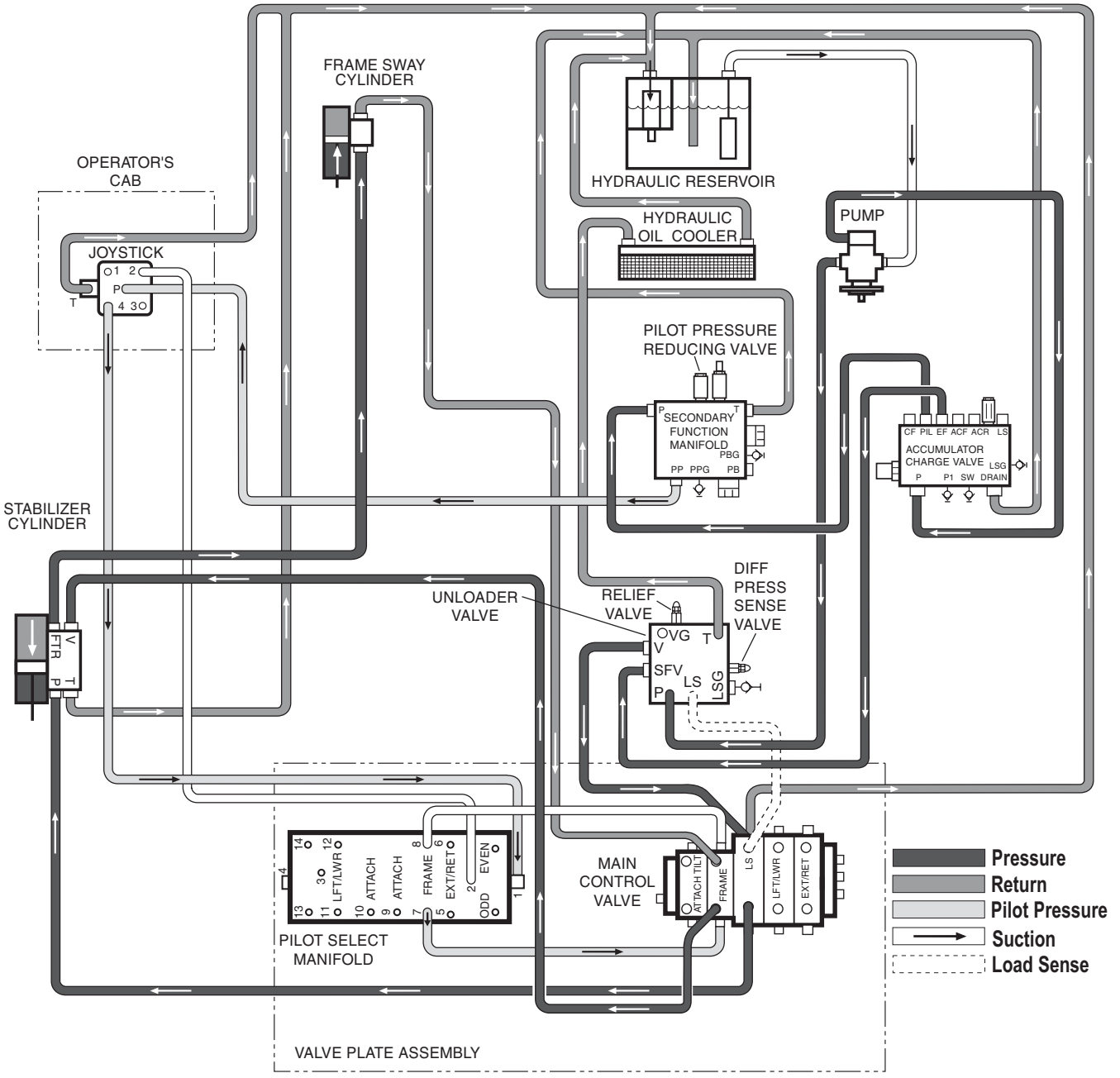
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

Refer to *Section 11.4, Stabil-TRAK™ Circuit Operation and Troubleshooting* for information on troubleshooting the frame sway and stabilizer circuits.



9.8.9 Frame Sway (Right) and Stabilizer Circuit and Troubleshooting

(Refer to *Section 9.8.27, Frame Sway Circuit Description* for a more detailed explanation of this circuit.)



MM3311



Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

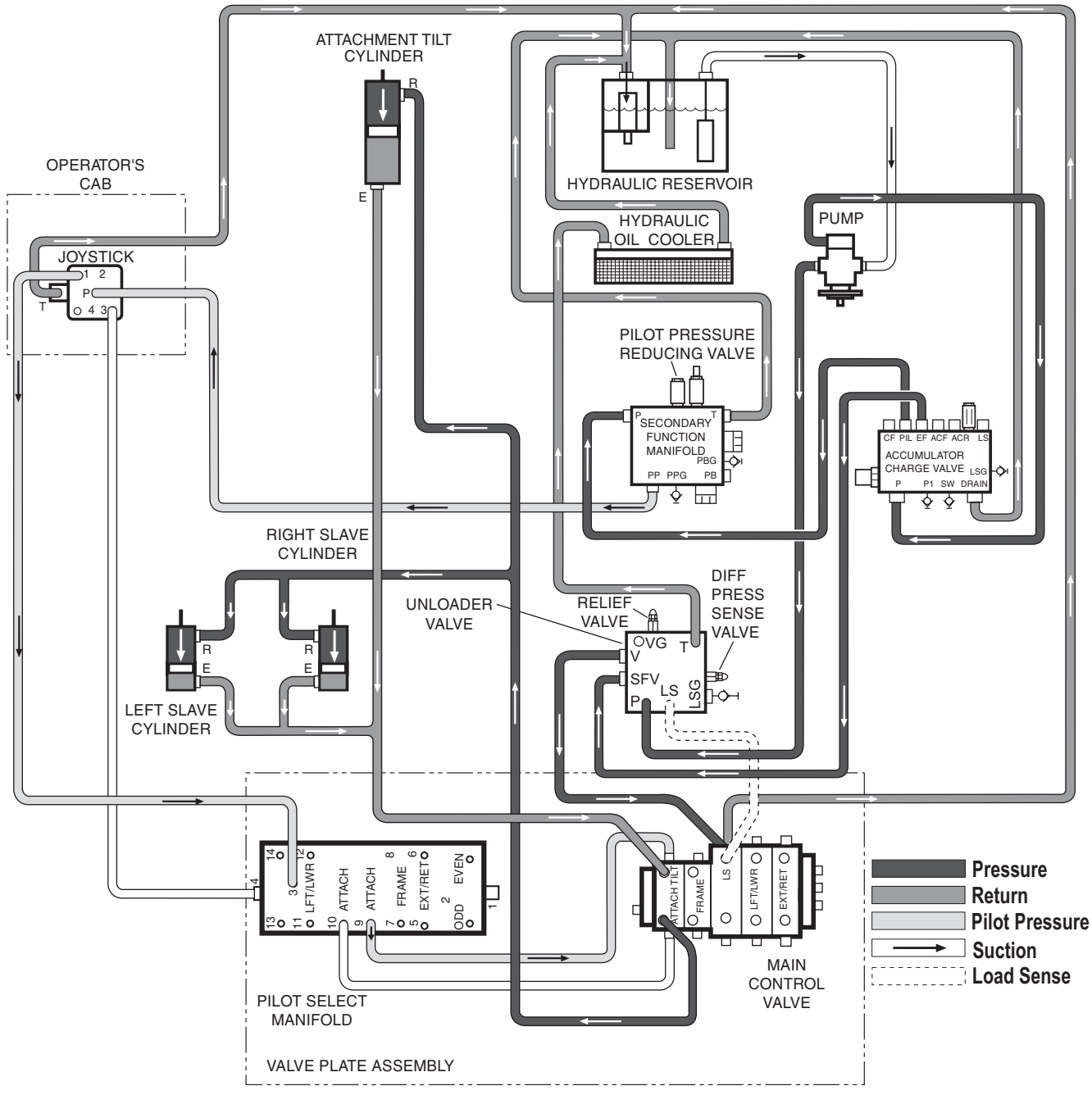
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

Refer to *Section 11.4, Stabil-TRAK™ Circuit Operation and Troubleshooting* for information on troubleshooting the frame sway and stabilizer circuits.



9.8.10 Attachment Tilt (Down) and Slave Cylinder Circuit and Troubleshooting

(Refer to *Section 9.8.28, Attachment Tilt and Slave Circuit Description* for a more detailed explanation of this circuit.)



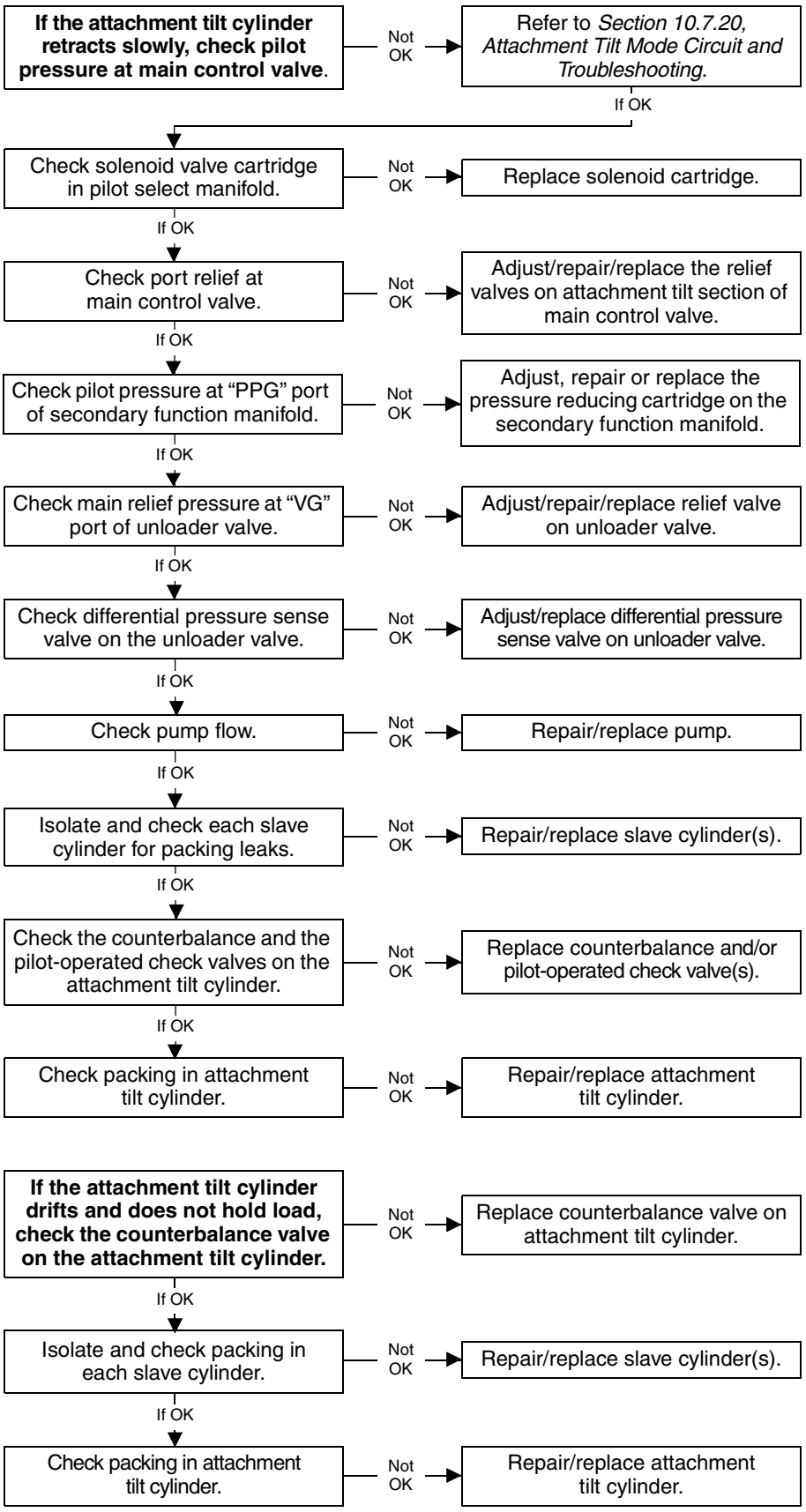
MM3321

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

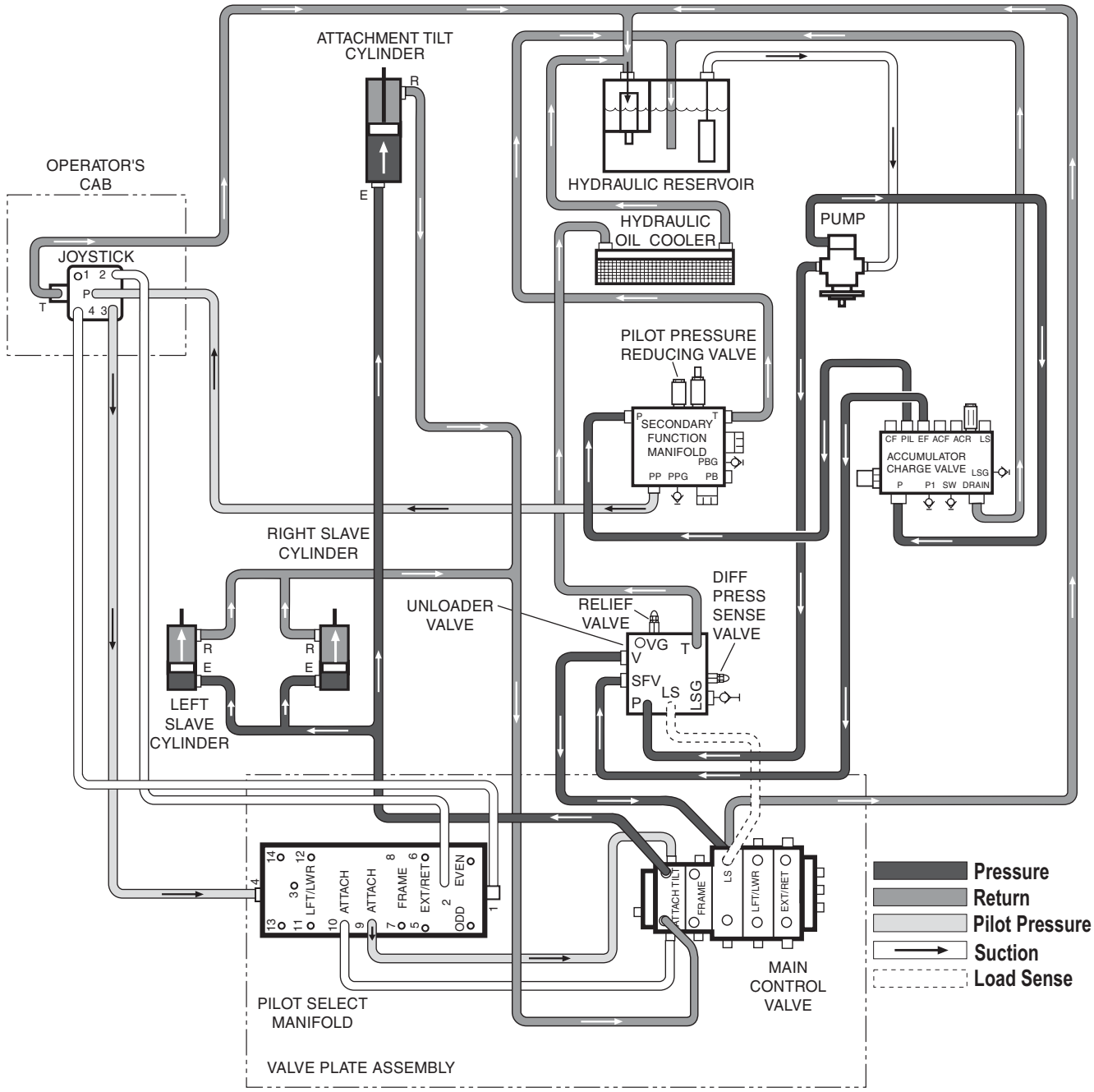
NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



9.8.11 Attachment Tilt (Up) and Slave Cylinder Circuit and Troubleshooting

(Refer to *Section 9.8.28, Attachment Tilt and Slave Circuit Description* for a more detailed explanation of this circuit.)



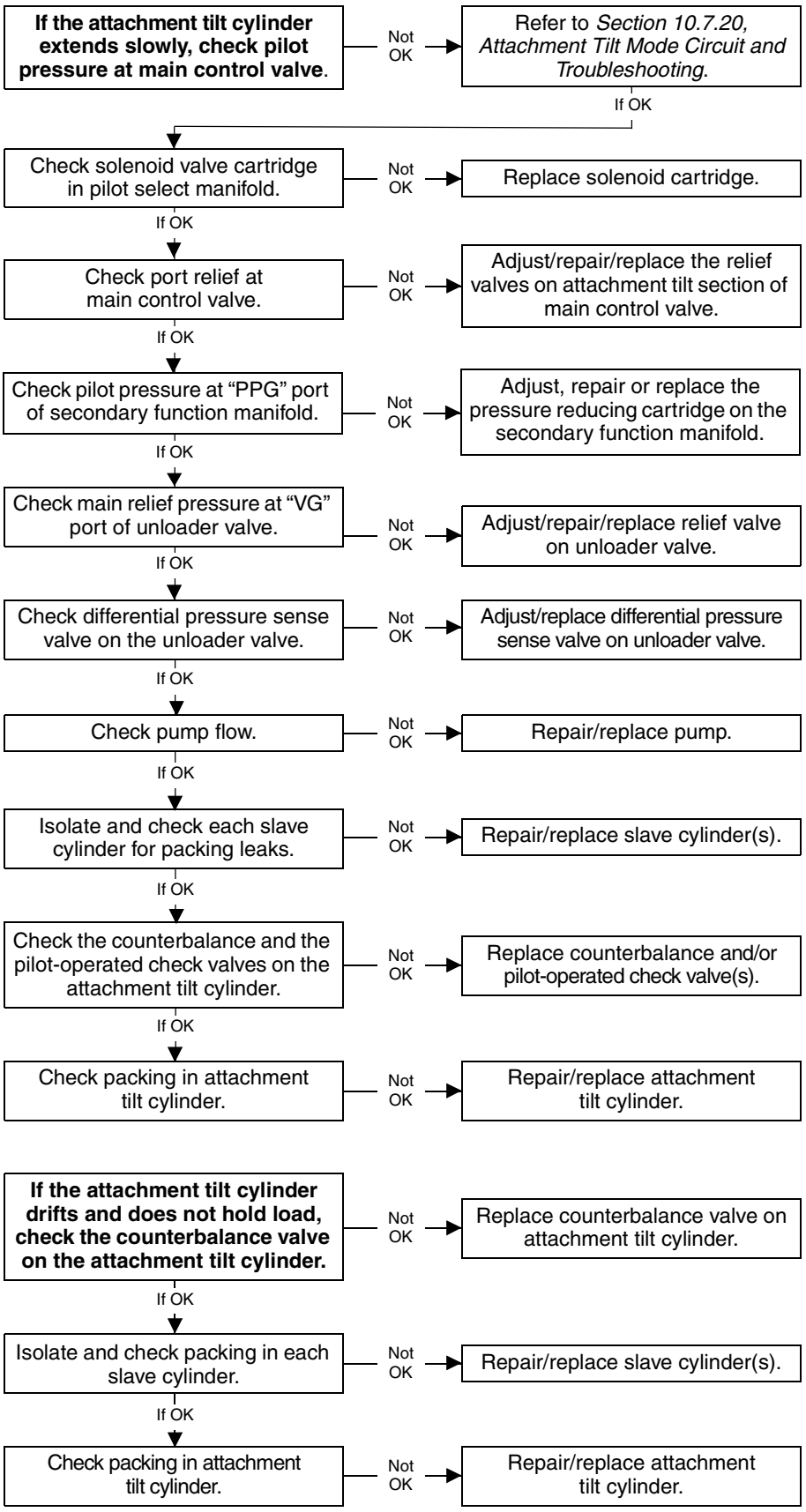
MM3331

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

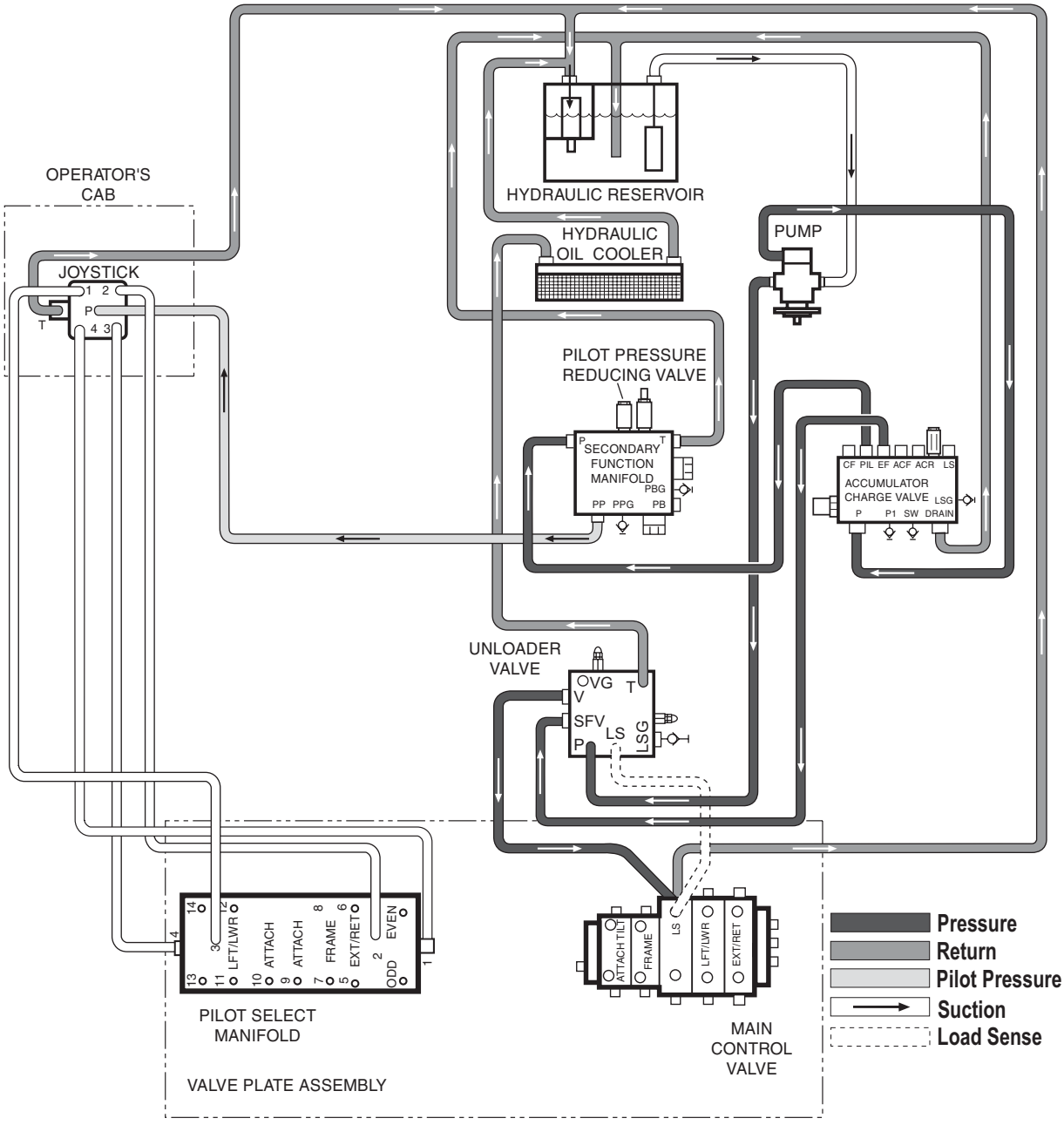
NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



9.8.12 Joystick Circuit and Troubleshooting

(Refer to *Section 9.8.29, Joystick Circuit Description* for a more detailed explanation of this circuit.)



MM3341

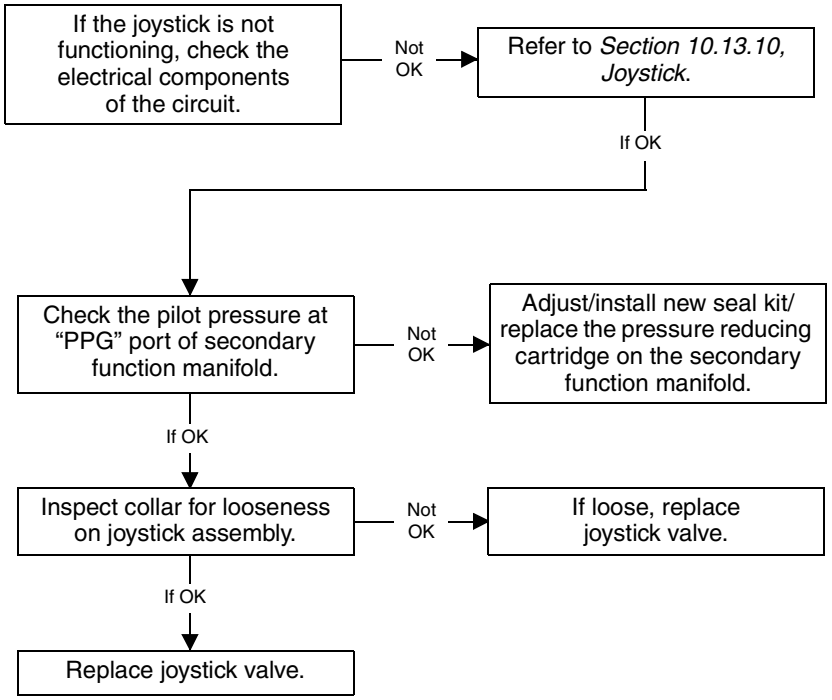


Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

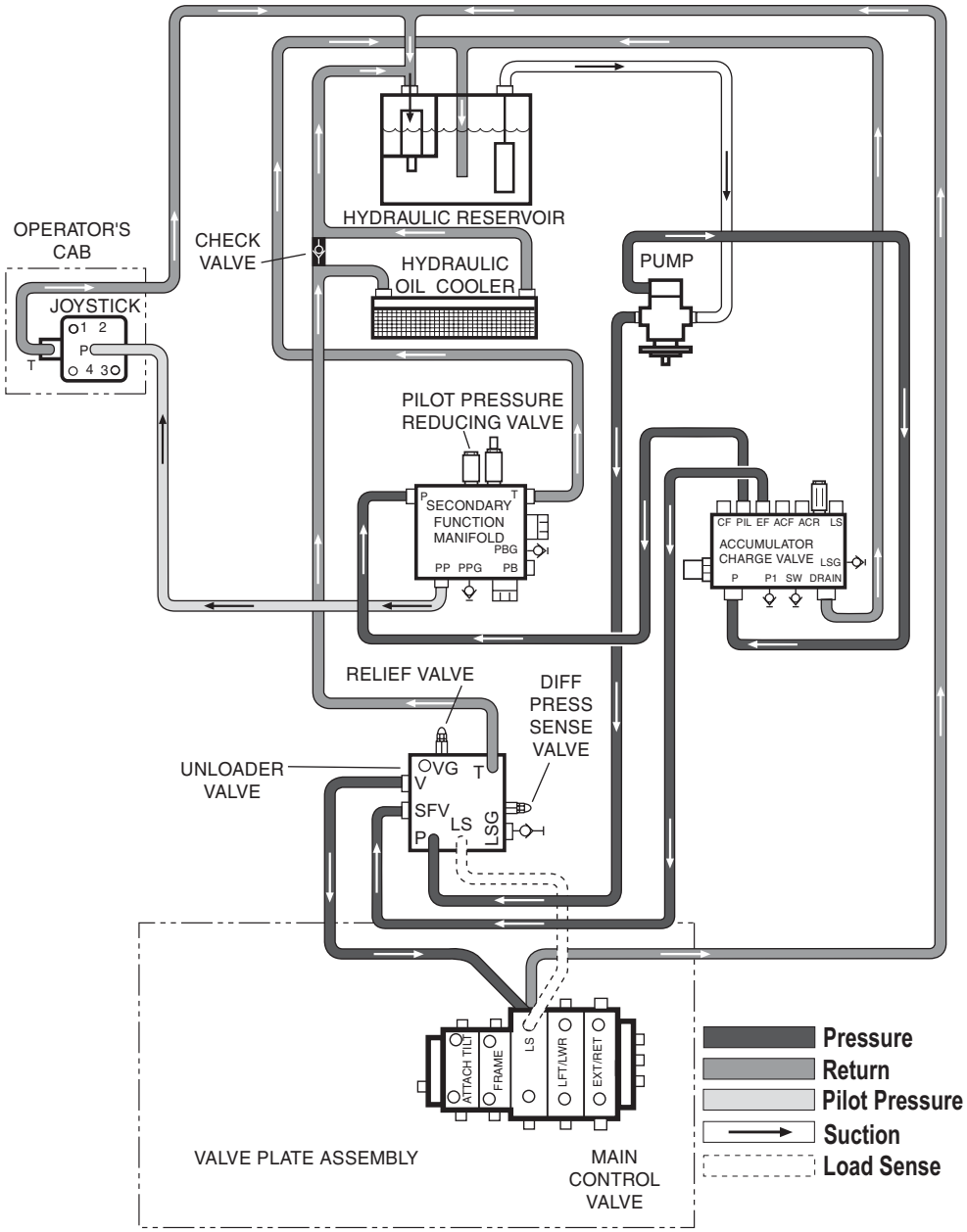
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.





9.8.13 Pump, Unloader Valve and Cooling Circuit and Troubleshooting

(Refer to *Section 9.8.30, Pump, Unloader Valve and Cooling Circuit Description* for a more detailed explanation of this circuit.)



MM3351



Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

If the pump is not functioning properly, check the suction line from the reservoir.

Not OK → Repair/replace suction line.

If OK ↓

Check the oil flow to the pump.

Not OK → Repair/replace pump.

If the cooler is not cooling the oil, check that the radiator and cooler are not clogged or obstructed.

Not OK → Clean radiator and cooler.

If OK ↓

Inspect the check valve in the cooler hydraulic line.

Not OK → Replace check valve.

If OK ↓

Refer to *Section 10.13.4, Hydraulic Oil Temperature Switch*.

If the unloader valve is not functioning properly, check the pressure and flow to the valve.

If OK ↓

Check the main system pressure at the “VG” port of unloader valve.

Not OK → Adjust/repair/replace the relief valve on the unloader valve.

If OK ↓

Check the differential pressure sense valve on the unloader valve.

Not OK → Repair/replace the differential pressure sense valve on the unloader valve.

If OK ↓

Check pump flow.

Not OK → Repair/replace pump.

If OK ↓

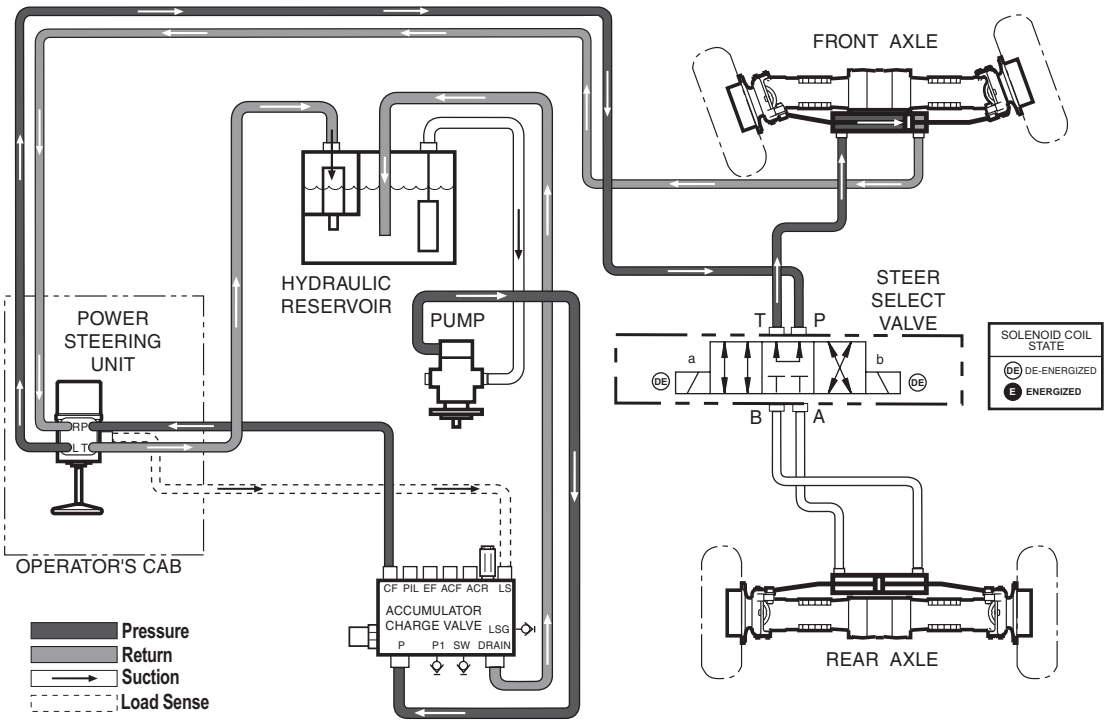
Check the suction line from the reservoir.

Not OK → Repair/replace suction line.



9.8.14 Front-Wheel Steering Circuit (Left Turn) and Troubleshooting

(Refer to *Section 9.8.31, Three-Mode Steering Circuit Descriptions* for a more detailed explanation of this circuit.)



MM3361

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

If the steering is slow or difficult, check the pressure at the "P1" port of the accumulator charge valve.
Not OK → Adjust/repair/replace pressure relief valve on accumulator charge valve

If OK

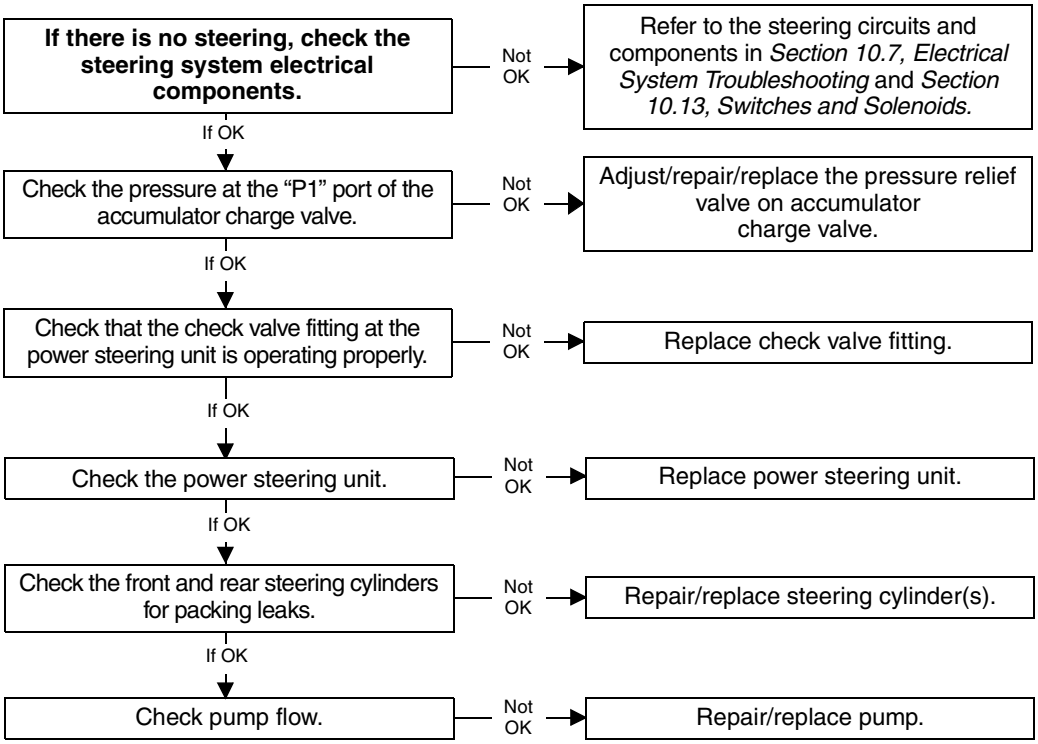
Check that the check valve fitting at the power steering unit is operating properly.
Not OK → Replace check valve fitting.

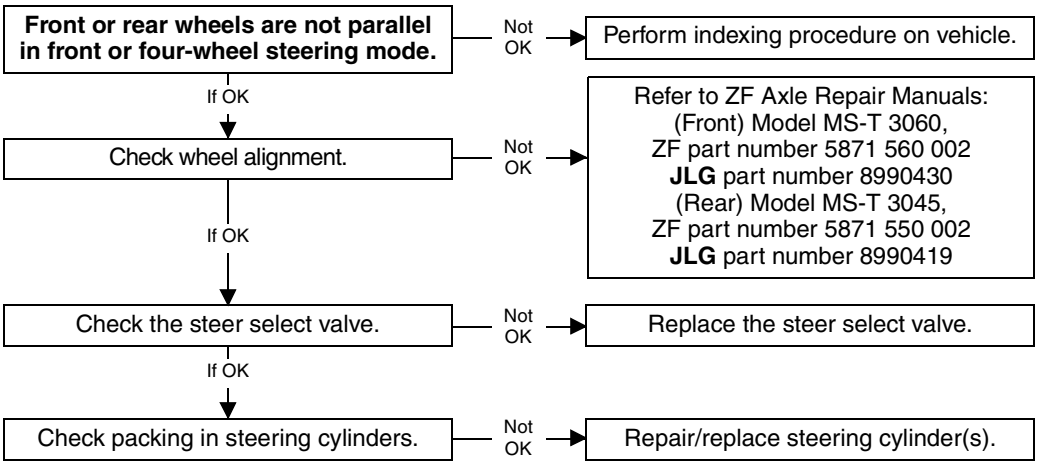
If OK

Check the power steering unit.
Not OK → Replace power steering unit.

If OK

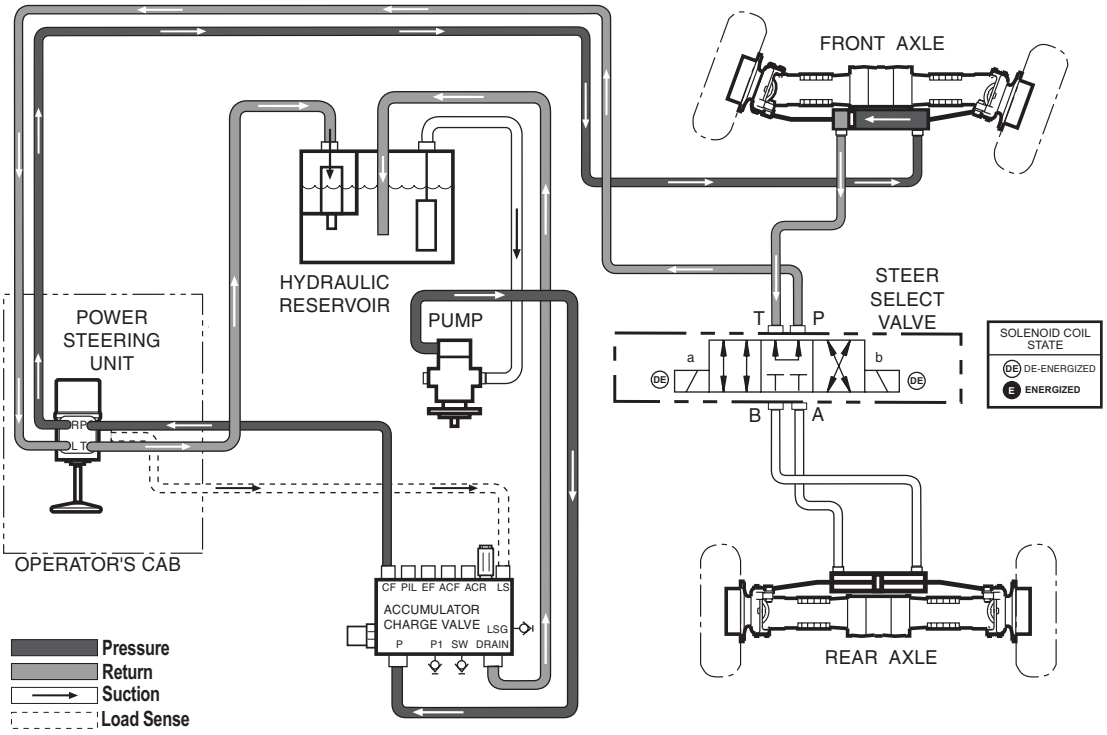
Check packing in steering cylinders.
Not OK → Repair/replace steering cylinder(s).


If there is no steering, check the steering system electrical components.
Not OK
Refer to the steering circuits and components in *Section 10.7, Electrical System Troubleshooting* and *Section 10.13, Switches and Solenoids.*
If OK
Check the pressure at the "P1" port of the accumulator charge valve.
Not OK
Adjust/repair/replace the pressure relief valve on accumulator charge valve.
If OK
Check that the check valve fitting at the power steering unit is operating properly.
Not OK
Replace check valve fitting.
If OK
Check the power steering unit.
Not OK
Replace power steering unit.
If OK
Check the front and rear steering cylinders for packing leaks.
Not OK
Repair/replace steering cylinder(s).
If OK
Check pump flow.
Not OK
Repair/replace pump.


Front or rear wheels are not parallel in front or four-wheel steering mode.
Not OK
Perform indexing procedure on vehicle.
If OK
Check wheel alignment.
Not OK
Refer to ZF Axle Repair Manuals:
(Front) Model MS-T 3060,
ZF part number 5871 560 002
JLG part number 8990430
(Rear) Model MS-T 3045,
ZF part number 5871 550 002
JLG part number 8990419
If OK
Check the steer select valve.
Not OK
Replace the steer select valve.
If OK
Check packing in steering cylinders.
Not OK
Repair/replace steering cylinder(s).

9.8.15 Front-Wheel Steering Circuit (Right Turn) and Troubleshooting

(Refer to *Section 9.8.31, Three-Mode Steering Circuit Descriptions* for a more detailed explanation of this circuit.)



MM3371

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

If the steering is slow or difficult, check the pressure at the "P1" port of the accumulator charge valve.
Not OK → Adjust/repair/replace pressure relief valve on accumulator charge valve.

If OK ↓

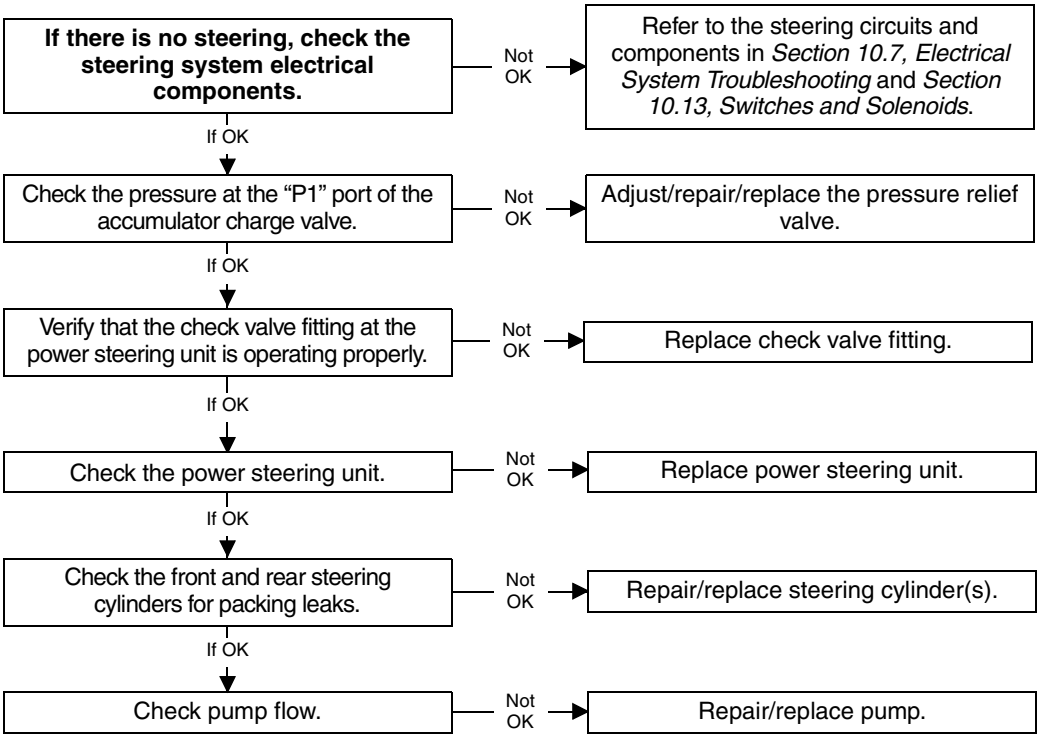
Check that the check valve fitting at the power steering unit is operating properly.
Not OK → Replace check valve fitting.

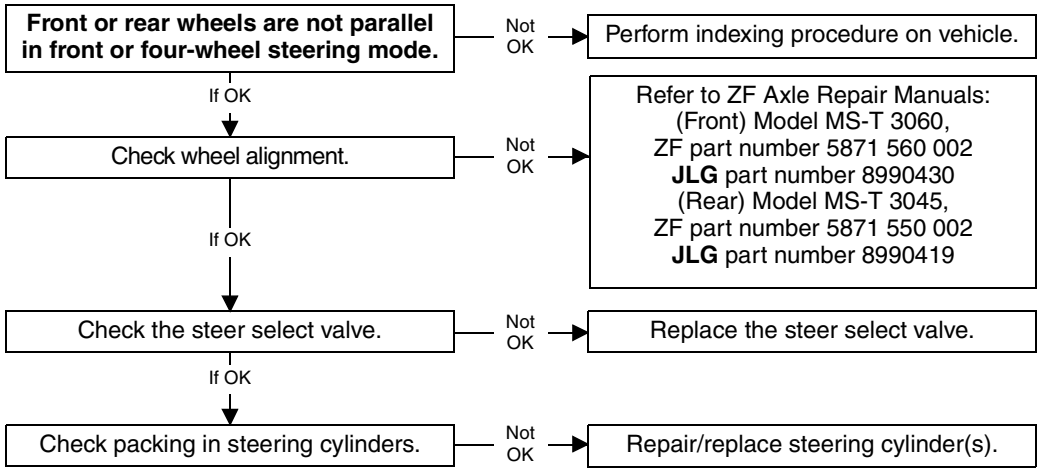
If OK ↓

Check the power steering unit.
Not OK → Replace power steering unit.

If OK ↓

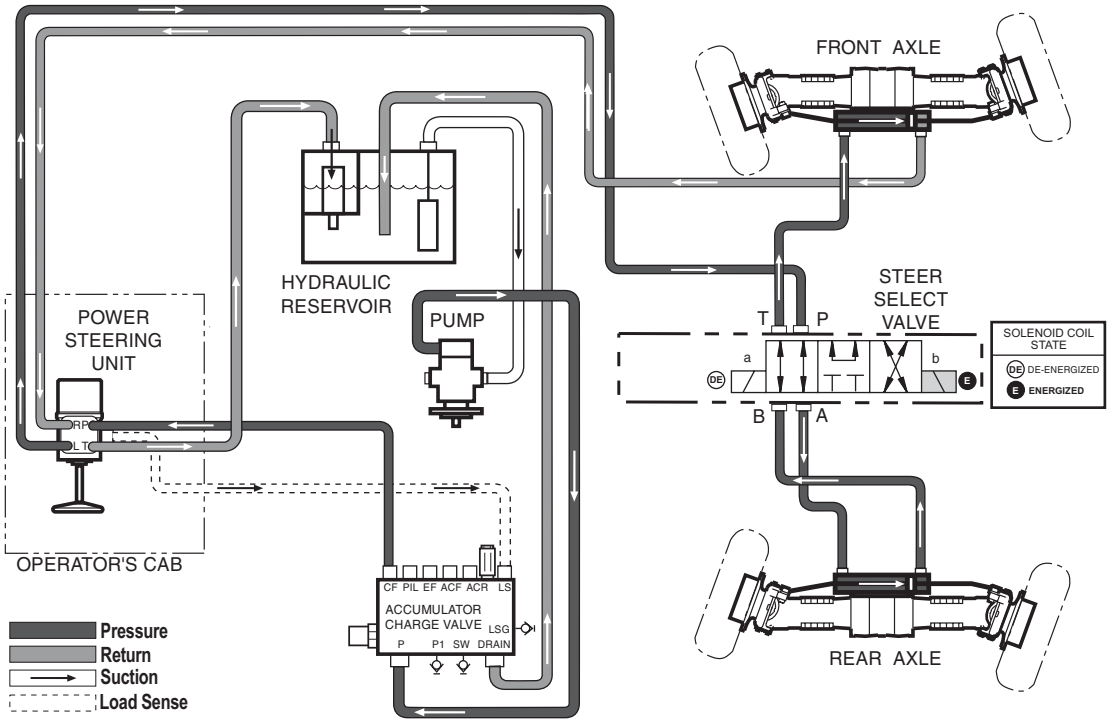
Check packing in steering cylinders.
Not OK → Repair/replace cylinder(s).


If there is no steering, check the steering system electrical components.
Not OK
Refer to the steering circuits and components in *Section 10.7, Electrical System Troubleshooting* and *Section 10.13, Switches and Solenoids*.
If OK
Check the pressure at the "P1" port of the accumulator charge valve.
Not OK
Adjust/repair/replace the pressure relief valve.
If OK
Verify that the check valve fitting at the power steering unit is operating properly.
Not OK
Replace check valve fitting.
If OK
Check the power steering unit.
Not OK
Replace power steering unit.
If OK
Check the front and rear steering cylinders for packing leaks.
Not OK
Repair/replace steering cylinder(s).
If OK
Check pump flow.
Not OK
Repair/replace pump.


Front or rear wheels are not parallel in front or four-wheel steering mode.
Not OK
Perform indexing procedure on vehicle.
If OK
Check wheel alignment.
Not OK
Refer to ZF Axle Repair Manuals:
(Front) Model MS-T 3060,
ZF part number 5871 560 002
JLG part number 8990430
(Rear) Model MS-T 3045,
ZF part number 5871 550 002
JLG part number 8990419
If OK
Check the steer select valve.
Not OK
Replace the steer select valve.
If OK
Check packing in steering cylinders.
Not OK
Repair/replace steering cylinder(s).

9.8.16 Four-Wheel Steering Circuit (Left Turn) and Troubleshooting

(Refer to *Section 9.8.31, Three-Mode Steering Circuit Descriptions* for a more detailed explanation of this circuit.)



MM3381

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

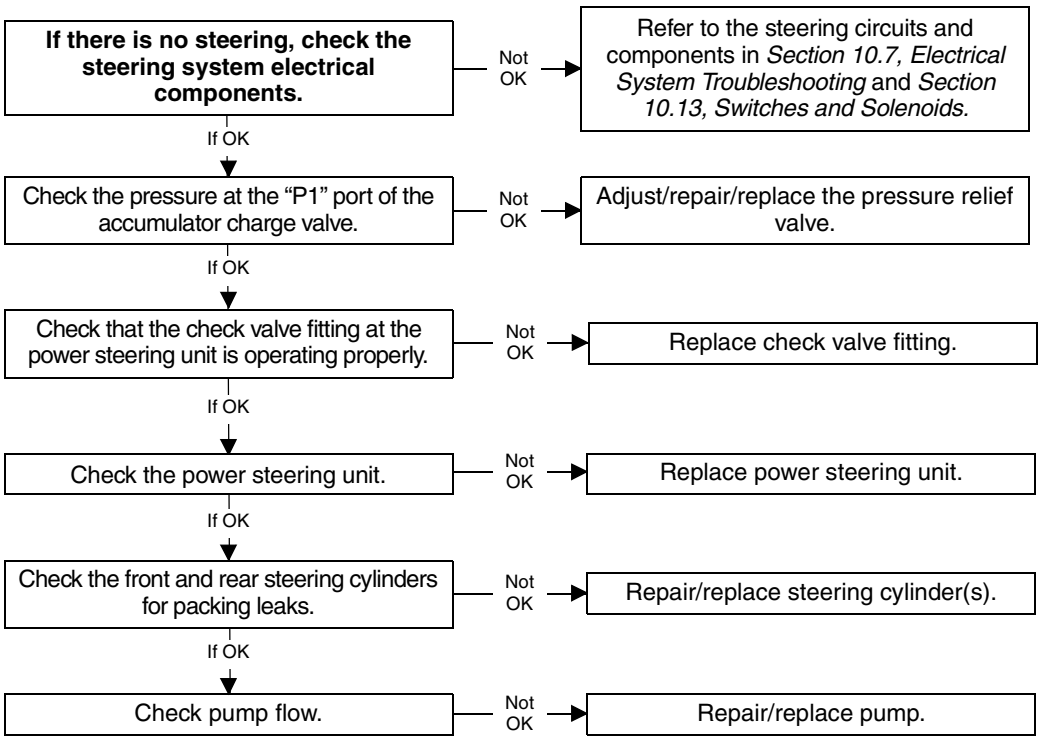
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

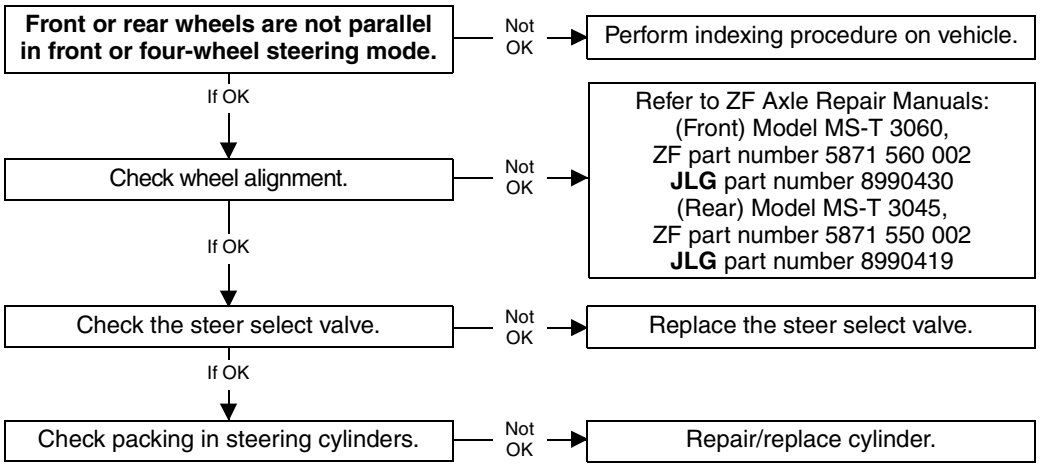
If the steering is slow or difficult, check the pressure at the "P1" port of the accumulator charge valve.
- Not OK → Adjust/repair/replace pressure relief valve on accumulator charge valve.
- If OK ↓

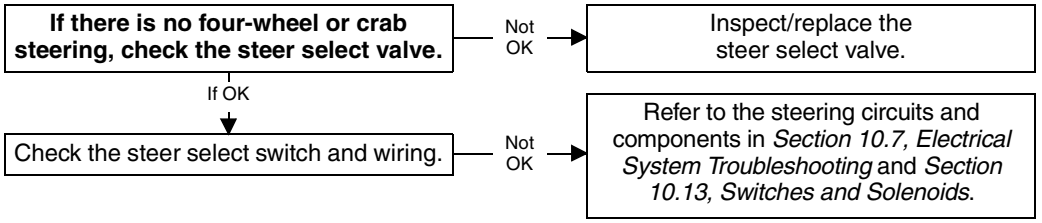
Verify that the check valve fitting at the power steering unit is operating properly.
- Not OK → Replace check valve fitting.
- If OK ↓

Check the power steering unit.
- Not OK → Replace power steering unit.
- If OK ↓

Check packing in steering cylinders.
- Not OK → Repair/replace cylinder(s).

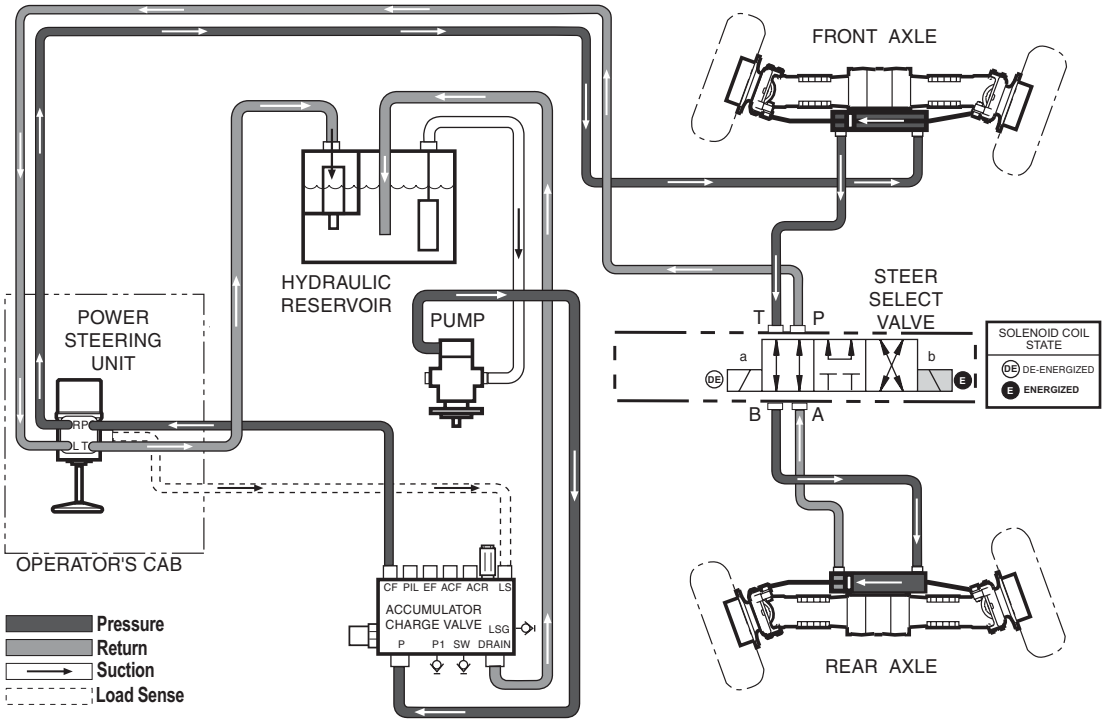

If there is no steering, check the steering system electrical components.
Not OK
Refer to the steering circuits and components in Section 10.7, Electrical System Troubleshooting and Section 10.13, Switches and Solenoids.
If OK
Check the pressure at the "P1" port of the accumulator charge valve.
Not OK
Adjust/repair/replace the pressure relief valve.
If OK
Check that the check valve fitting at the power steering unit is operating properly.
Not OK
Replace check valve fitting.
If OK
Check the power steering unit.
Not OK
Replace power steering unit.
If OK
Check the front and rear steering cylinders for packing leaks.
Not OK
Repair/replace steering cylinder(s).
If OK
Check pump flow.
Not OK
Repair/replace pump.


Front or rear wheels are not parallel in front or four-wheel steering mode.
Not OK
Perform indexing procedure on vehicle.
If OK
Check wheel alignment.
Not OK
Refer to ZF Axle Repair Manuals:
(Front) Model MS-T 3060,
ZF part number 5871 560 002
JLG part number 8990430
(Rear) Model MS-T 3045,
ZF part number 5871 550 002
JLG part number 8990419
If OK
Check the steer select valve.
Not OK
Replace the steer select valve.
If OK
Check packing in steering cylinders.
Not OK
Repair/replace cylinder.


If there is no four-wheel or crab steering, check the steer select valve.
Not OK
Inspect/replace the steer select valve.
If OK
Check the steer select switch and wiring.
Not OK
Refer to the steering circuits and components in Section 10.7, Electrical System Troubleshooting and Section 10.13, Switches and Solenoids.

9.8.17 Four-Wheel Steering Circuit (Right Turn) and Troubleshooting

(Refer to *Section 9.8.31, Three-Mode Steering Circuit Descriptions* for a more detailed explanation of this circuit.)



MM3391

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

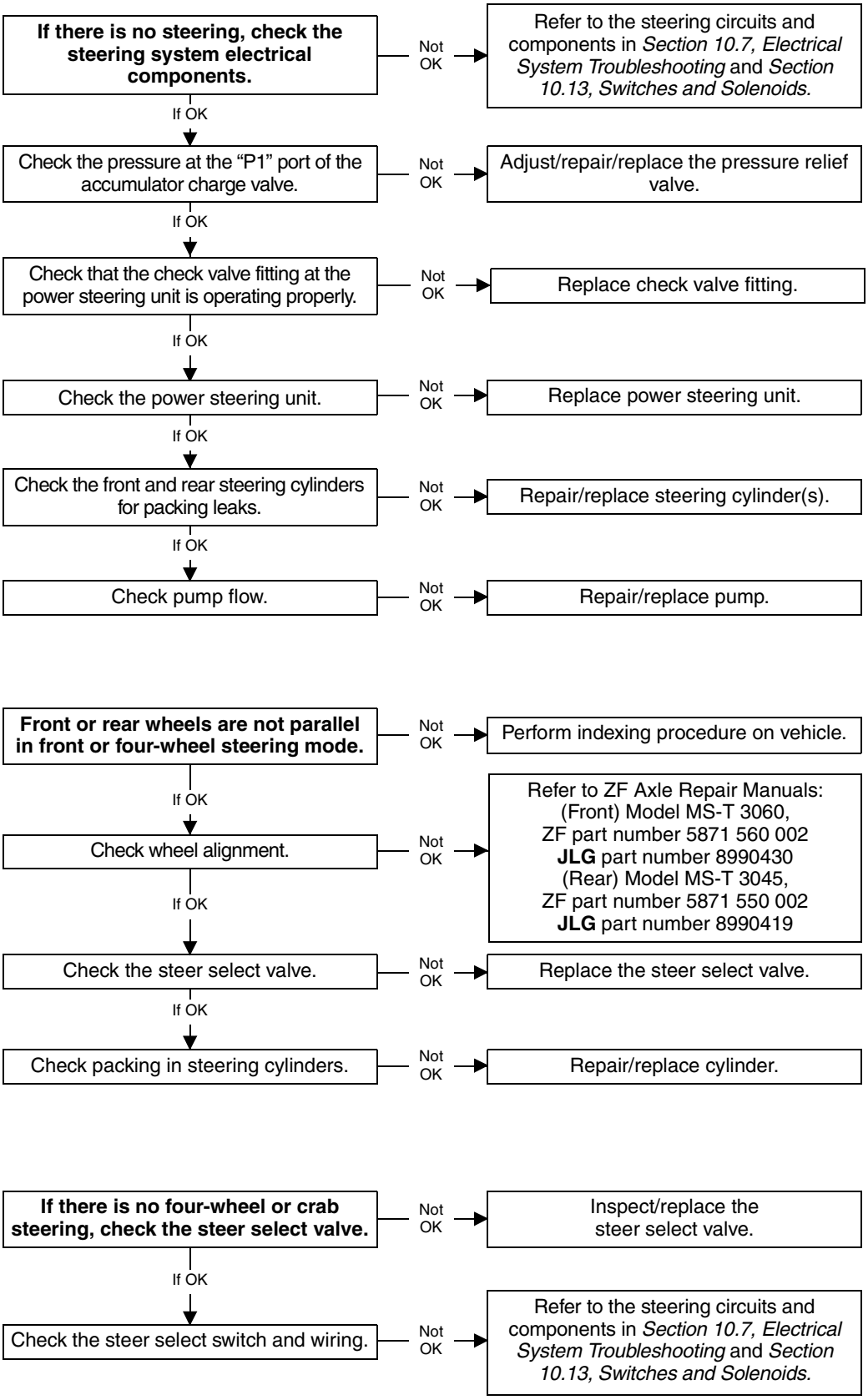
When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

If the steering is slow or difficult, check the pressure at the "P1" port of the accumulator charge valve.
- Not OK → Adjust/repair/replace pressure relief valve on accumulator charge valve.
- If OK ↓

Verify that the check valve fitting at the power steering unit is operating properly.
- Not OK → Replace check valve fitting.
- If OK ↓

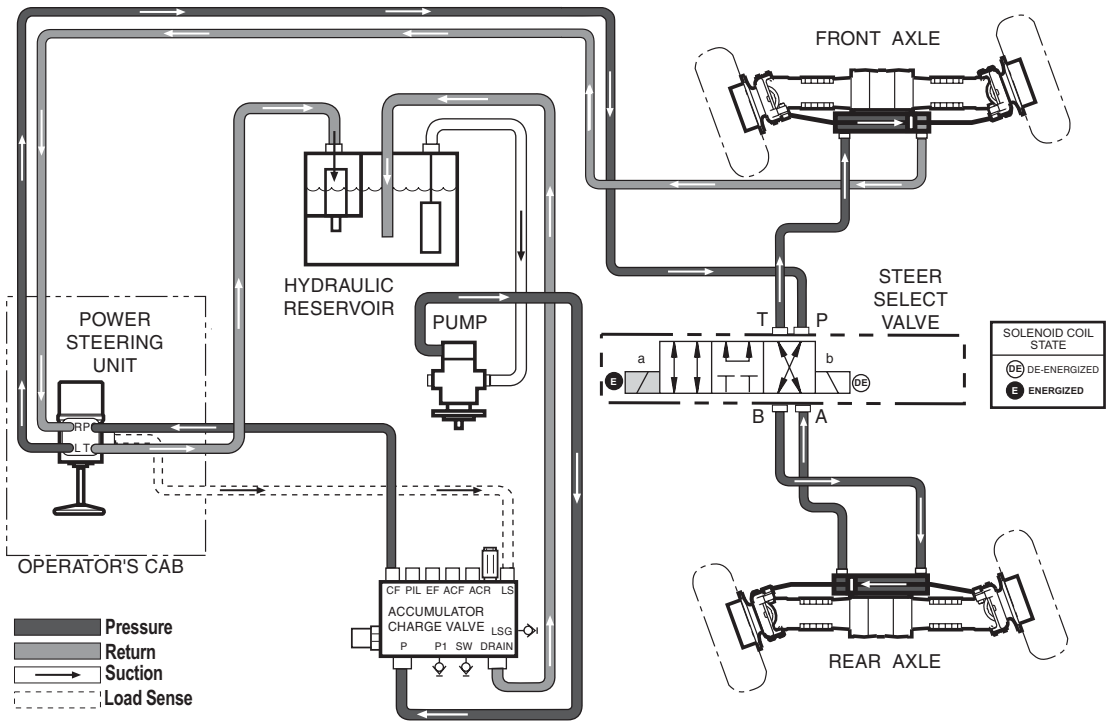
Check the power steering unit.
- Not OK → Replace power steering unit.
- If OK ↓

Check packing in steering cylinders.
- Not OK → Repair/replace cylinder(s).


If there is no steering, check the steering system electrical components.
Not OK
Refer to the steering circuits and components in Section 10.7, Electrical System Troubleshooting and Section 10.13, Switches and Solenoids.
If OK
Check the pressure at the "P1" port of the accumulator charge valve.
Not OK
Adjust/repair/replace the pressure relief valve.
If OK
Check that the check valve fitting at the power steering unit is operating properly.
Not OK
Replace check valve fitting.
If OK
Check the power steering unit.
Not OK
Replace power steering unit.
If OK
Check the front and rear steering cylinders for packing leaks.
Not OK
Repair/replace steering cylinder(s).
If OK
Check pump flow.
Not OK
Repair/replace pump.
Front or rear wheels are not parallel in front or four-wheel steering mode.
Not OK
Perform indexing procedure on vehicle.
If OK
Check wheel alignment.
Not OK
Refer to ZF Axle Repair Manuals:
(Front) Model MS-T 3060,
ZF part number 5871 560 002
JLG part number 8990430
(Rear) Model MS-T 3045,
ZF part number 5871 550 002
JLG part number 8990419
If OK
Check the steer select valve.
Not OK
Replace the steer select valve.
If OK
Check packing in steering cylinders.
Not OK
Repair/replace cylinder.
If there is no four-wheel or crab steering, check the steer select valve.
Not OK
Inspect/replace the steer select valve.
If OK
Check the steer select switch and wiring.
Not OK
Refer to the steering circuits and components in Section 10.7, Electrical System Troubleshooting and Section 10.13, Switches and Solenoids.

9.8.18 Crab Steering Circuit (Left) and Troubleshooting

(Refer to *Section 9.8.31, Three-Mode Steering Circuit Descriptions* for a more detailed explanation of this circuit.)



MM3401

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

If the steering is slow or difficult, check the pressure at the "P1" port of the accumulator charge valve.

Not OK → Adjust/repair/replace pressure relief valve on accumulator charge valve.

If OK ↓

Verify that the check valve fitting at the power steering unit is operating properly.

Not OK → Replace check valve fitting.

If OK ↓

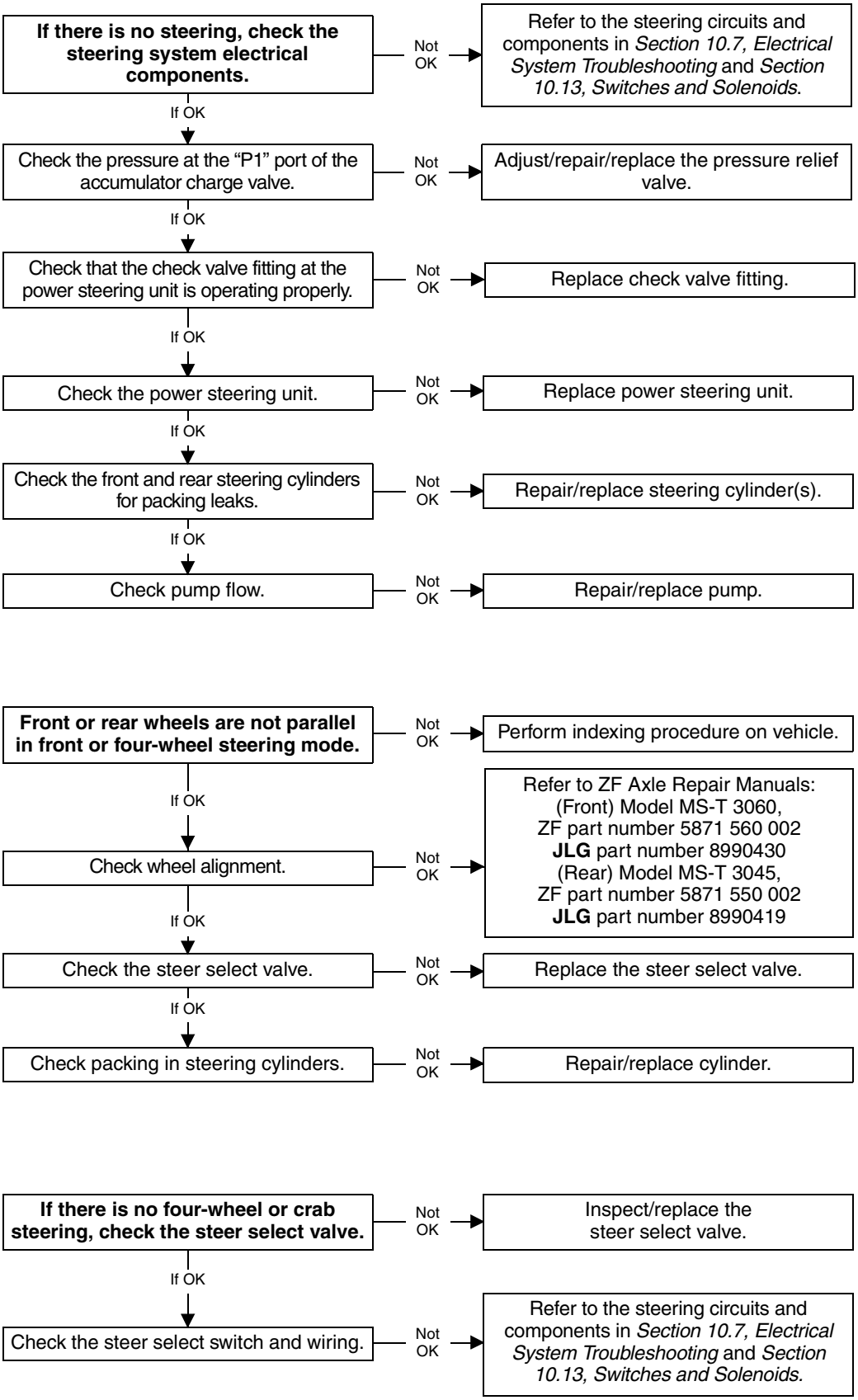
Check the power steering unit.

Not OK → Replace power steering unit.

If OK ↓

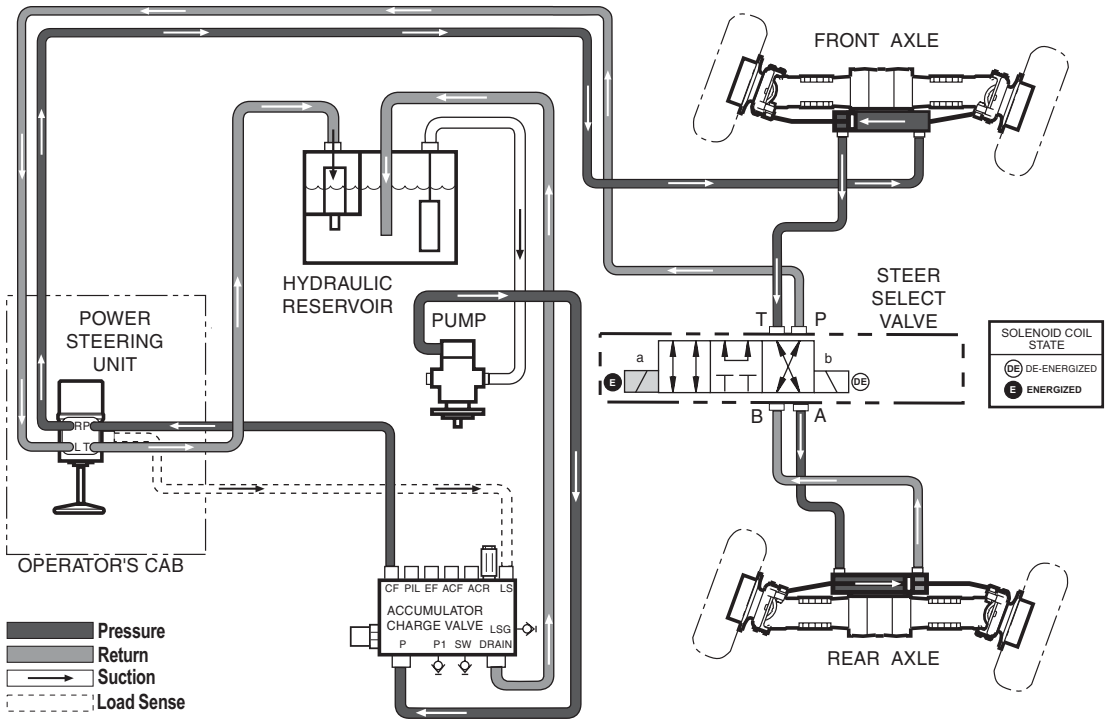
Check packing in steering cylinders.

Not OK → Repair/replace cylinder(s).


If there is no steering, check the steering system electrical components.
Not OK
Refer to the steering circuits and components in Section 10.7, Electrical System Troubleshooting and Section 10.13, Switches and Solenoids.
If OK
Check the pressure at the "P1" port of the accumulator charge valve.
Not OK
Adjust/repair/replace the pressure relief valve.
If OK
Check that the check valve fitting at the power steering unit is operating properly.
Not OK
Replace check valve fitting.
If OK
Check the power steering unit.
Not OK
Replace power steering unit.
If OK
Check the front and rear steering cylinders for packing leaks.
Not OK
Repair/replace steering cylinder(s).
If OK
Check pump flow.
Not OK
Repair/replace pump.
Front or rear wheels are not parallel in front or four-wheel steering mode.
Not OK
Perform indexing procedure on vehicle.
If OK
Check wheel alignment.
Not OK
Refer to ZF Axle Repair Manuals:
(Front) Model MS-T 3060,
ZF part number 5871 560 002
JLG part number 8990430
(Rear) Model MS-T 3045,
ZF part number 5871 550 002
JLG part number 8990419
If OK
Check the steer select valve.
Not OK
Replace the steer select valve.
If OK
Check packing in steering cylinders.
Not OK
Repair/replace cylinder.
If there is no four-wheel or crab steering, check the steer select valve.
Not OK
Inspect/replace the steer select valve.
If OK
Check the steer select switch and wiring.
Not OK
Refer to the steering circuits and components in Section 10.7, Electrical System Troubleshooting and Section 10.13, Switches and Solenoids.

9.8.19 Crab Steering Circuit (Right) and Troubleshooting

(Refer to *Section 9.8.31, Three-Mode Steering Circuit Descriptions* for a more detailed explanation of this circuit.)



MM3411

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.

If the steering is slow or difficult, check the pressure at the "P1" port of the accumulator charge valve.

Not OK → Adjust/repair/replace pressure relief valve on accumulator charge valve.

If OK ↓

Verify that the check valve fitting at the power steering unit is operating properly.

Not OK → Replace check valve fitting.

If OK ↓

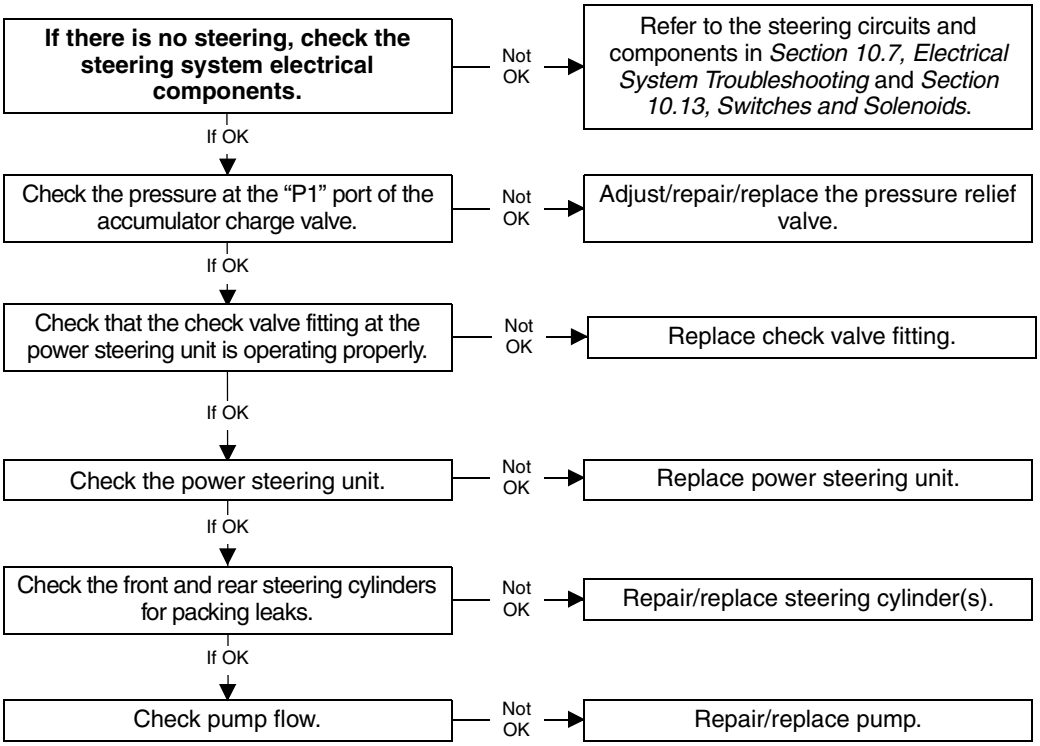
Check the power steering unit.

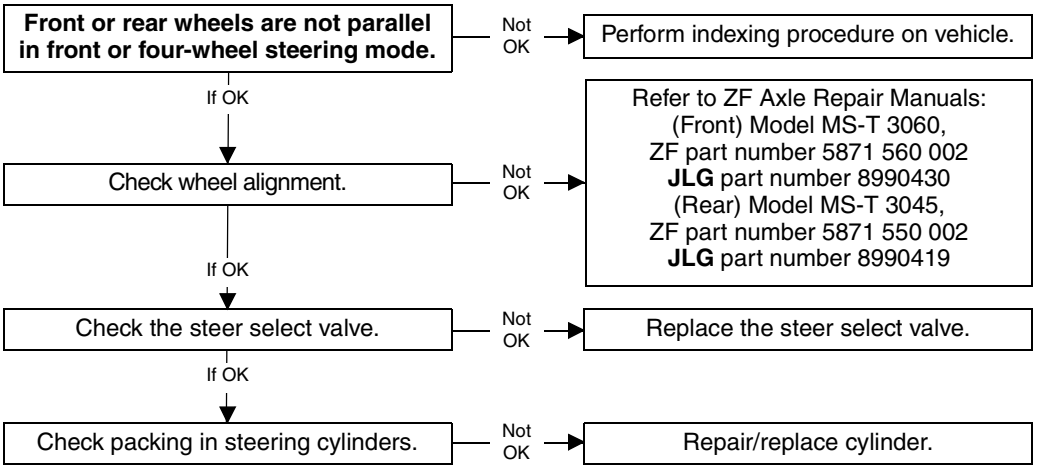
Not OK → Replace power steering unit.

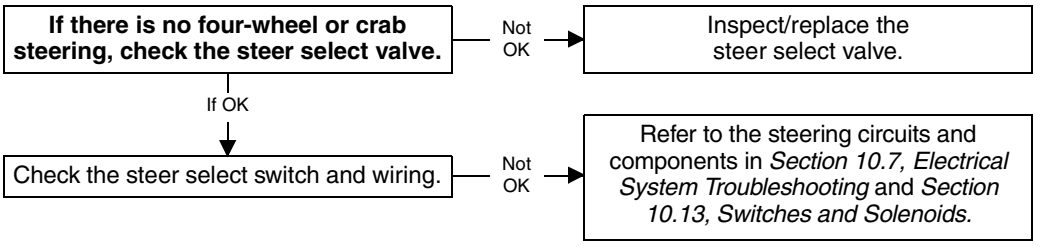
If OK ↓

Check packing in steering cylinders.

Not OK → Repair/replace cylinder(s).

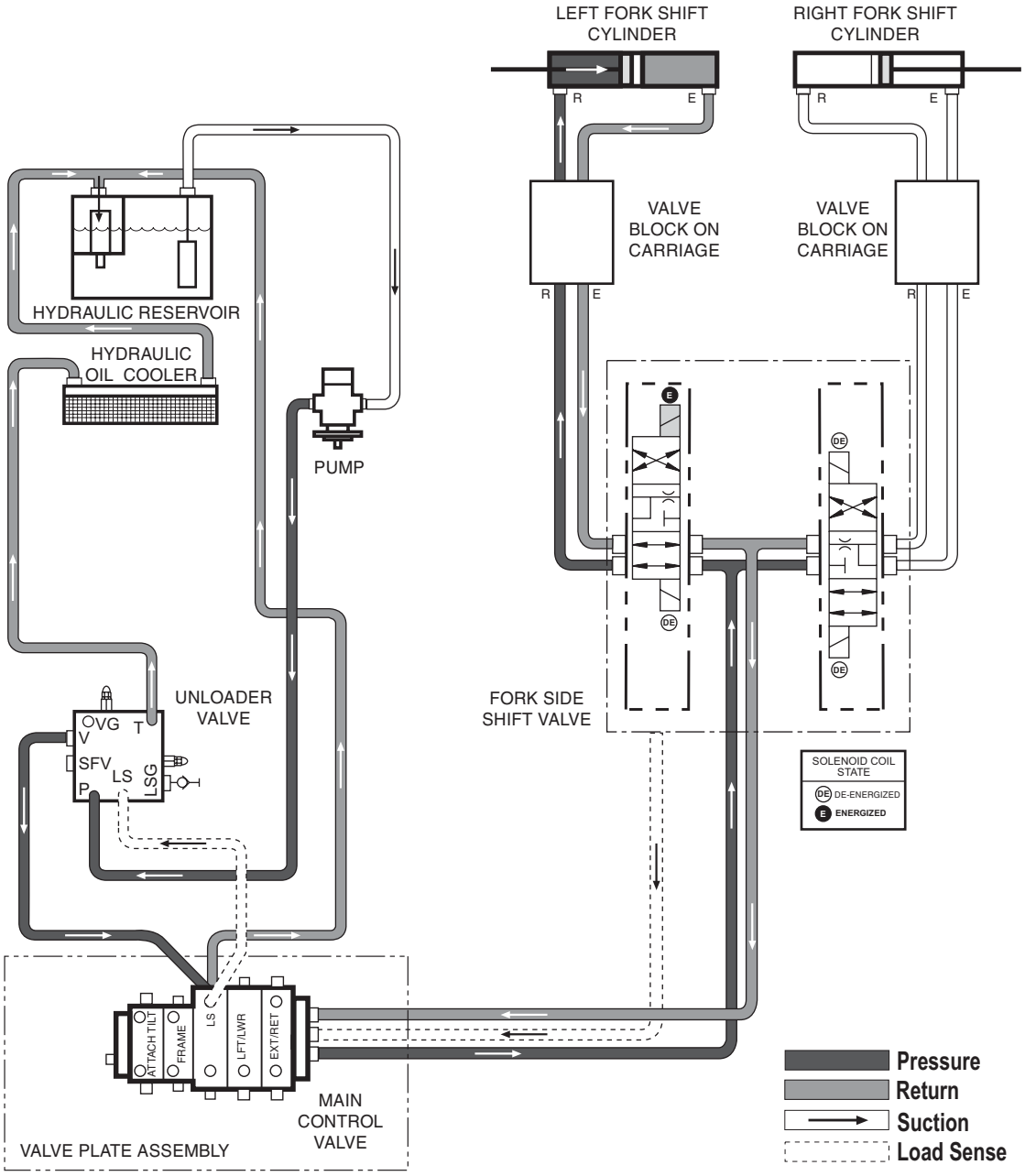

If there is no steering, check the steering system electrical components.
Not OK
Refer to the steering circuits and components in Section 10.7, Electrical System Troubleshooting and Section 10.13, Switches and Solenoids.
If OK
Check the pressure at the "P1" port of the accumulator charge valve.
Not OK
Adjust/repair/replace the pressure relief valve.
If OK
Check that the check valve fitting at the power steering unit is operating properly.
Not OK
Replace check valve fitting.
If OK
Check the power steering unit.
Not OK
Replace power steering unit.
If OK
Check the front and rear steering cylinders for packing leaks.
Not OK
Repair/replace steering cylinder(s).
If OK
Check pump flow.
Not OK
Repair/replace pump.


Front or rear wheels are not parallel in front or four-wheel steering mode.
Not OK
Perform indexing procedure on vehicle.
If OK
Check wheel alignment.
Not OK
Refer to ZF Axle Repair Manuals:
(Front) Model MS-T 3060,
ZF part number 5871 560 002
JLG part number 8990430
(Rear) Model MS-T 3045,
ZF part number 5871 550 002
JLG part number 8990419
If OK
Check the steer select valve.
Not OK
Replace the steer select valve.
If OK
Check packing in steering cylinders.
Not OK
Repair/replace cylinder.


If there is no four-wheel or crab steering, check the steer select valve.
Not OK
Inspect/replace the steer select valve.
If OK
Check the steer select switch and wiring.
Not OK
Refer to the steering circuits and components in Section 10.7, Electrical System Troubleshooting and Section 10.13, Switches and Solenoids.

9.8.20 Left Fork Shift Circuit (Shift Right) and Troubleshooting

(Refer to *Section 9.8.32, Fork Side Shift Circuit Description* for a more detailed explanation of this circuit.)



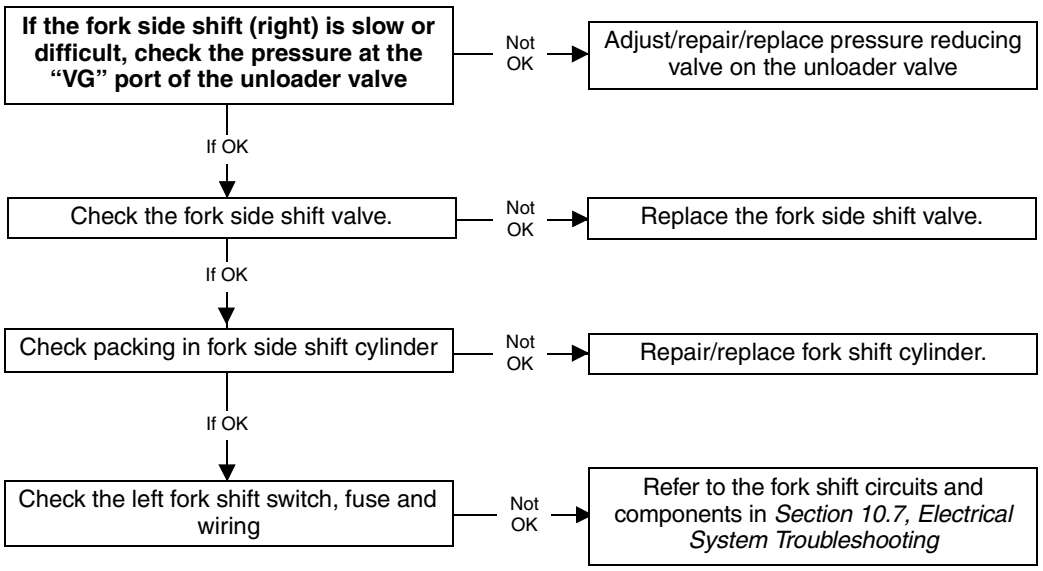
MM3461

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

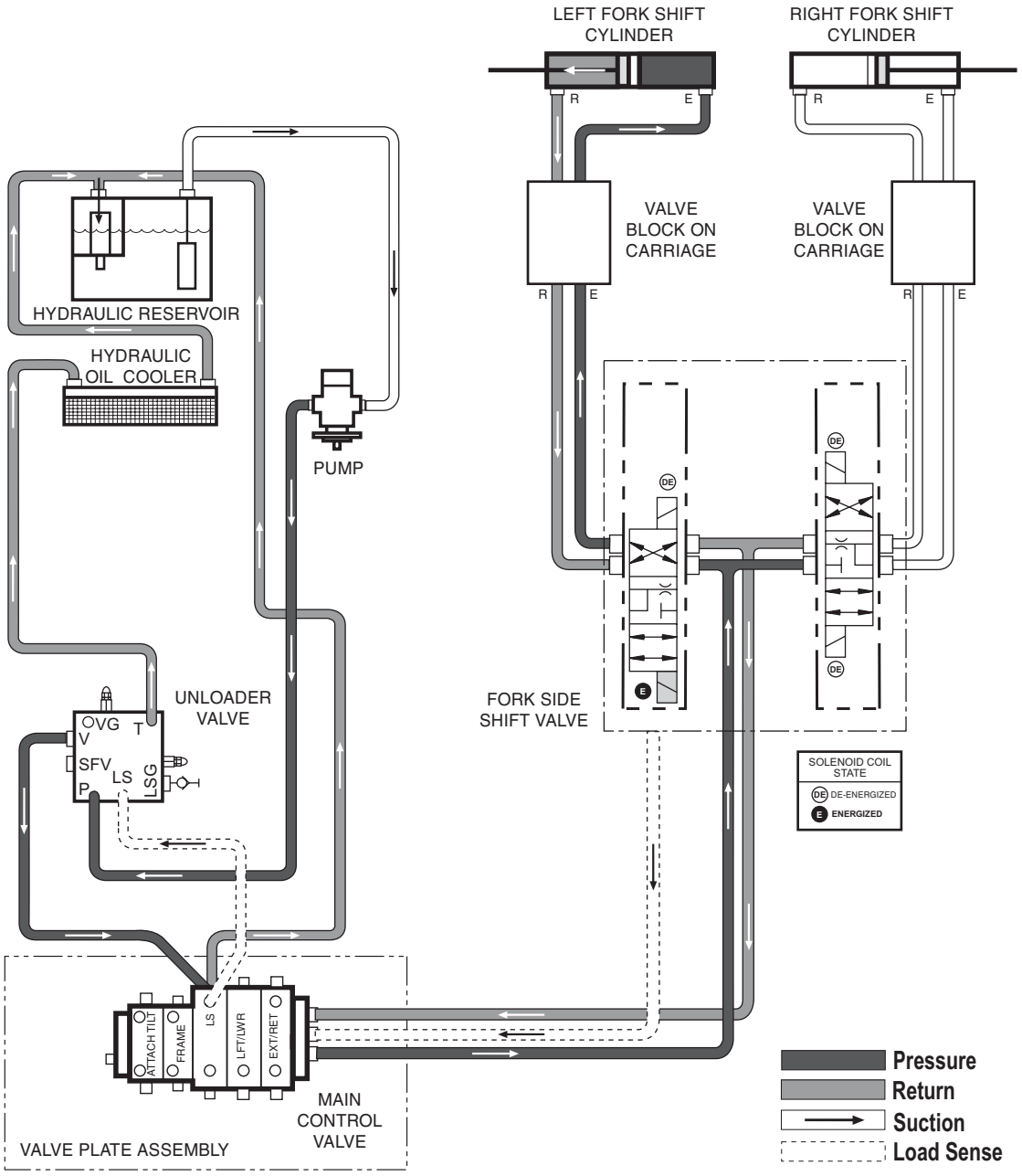
NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



9.8.21 Left Fork Shift Circuit (Shift Left) and Troubleshooting

(Refer to *Section 9.8.32, Fork Side Shift Circuit Description* for a more detailed explanation of this circuit.)



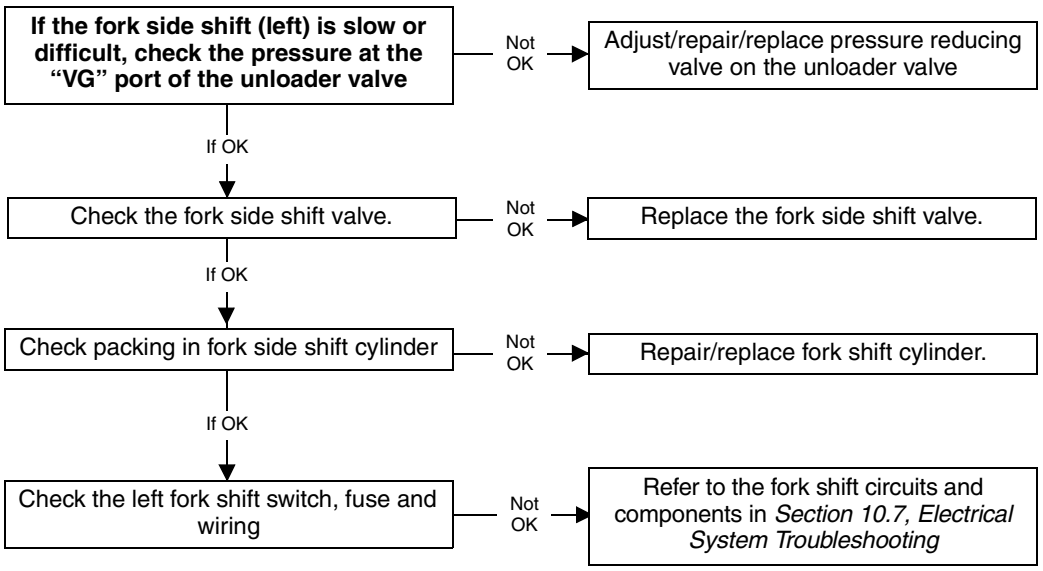
MM3471

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

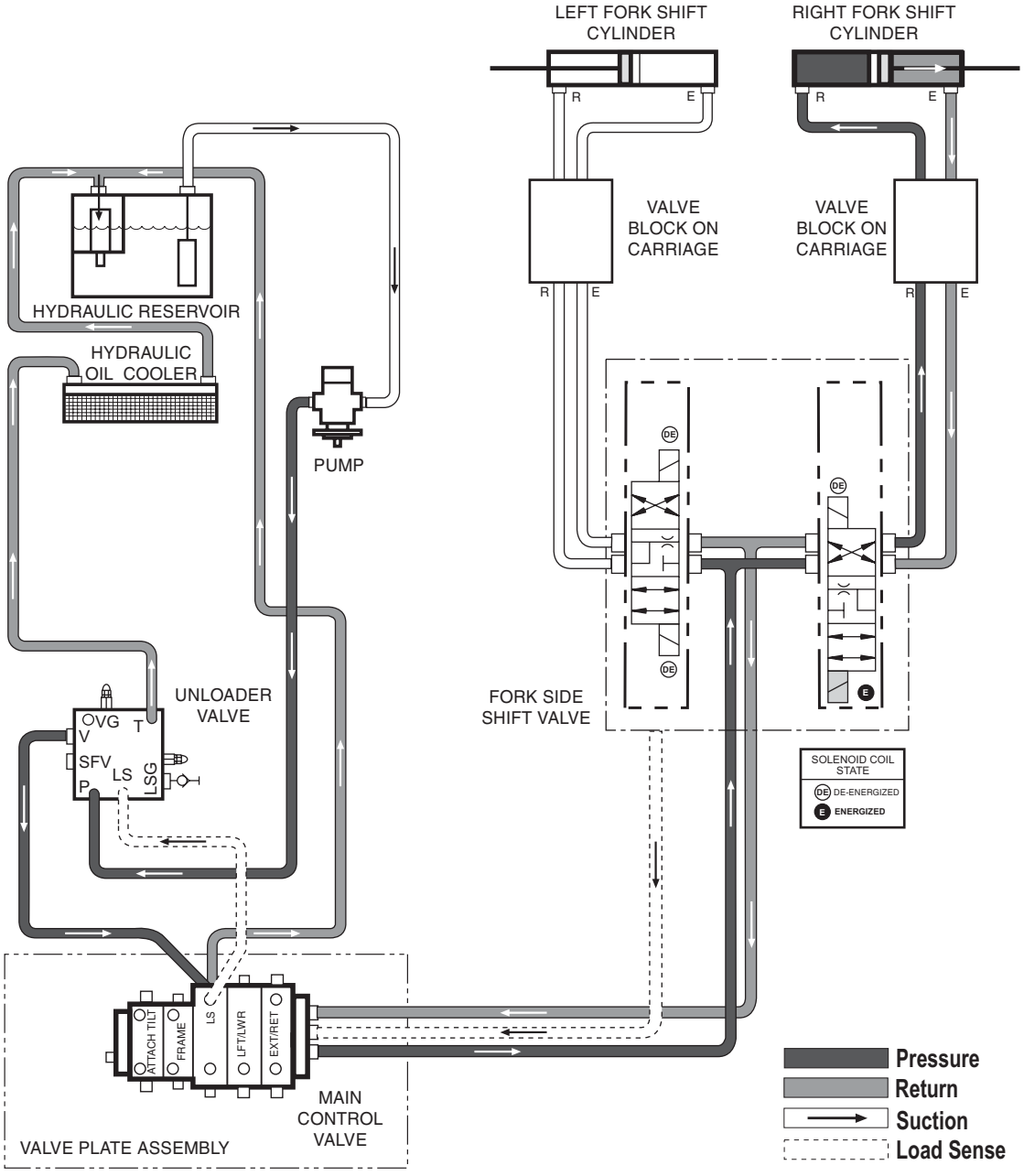
NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



9.8.22 Right Fork Shift Circuit (Shift Right) and Troubleshooting

(Refer to *Section 9.8.32, Fork Side Shift Circuit Description* for a more detailed explanation of this circuit.)



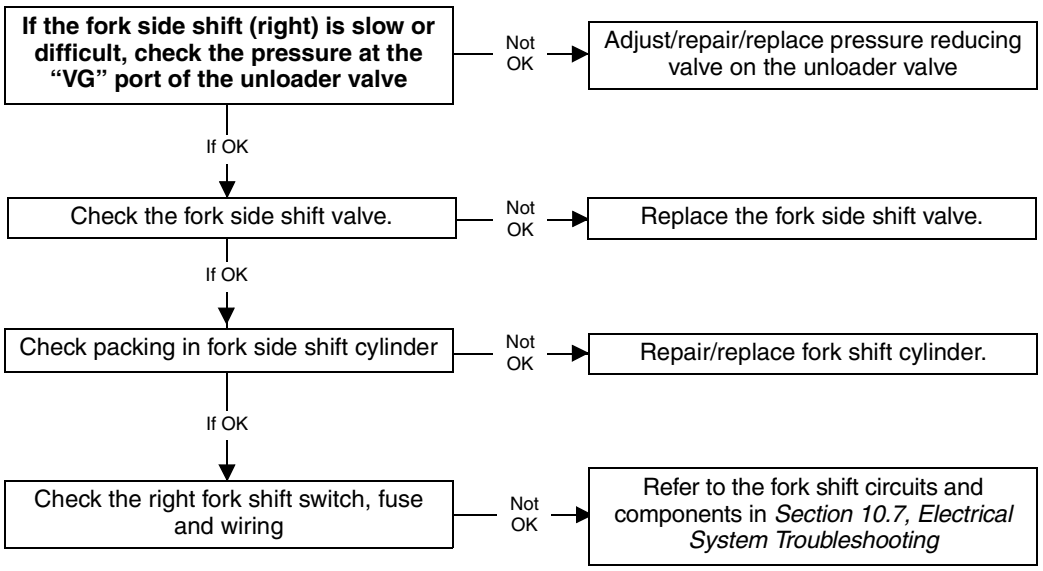
MM3481

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

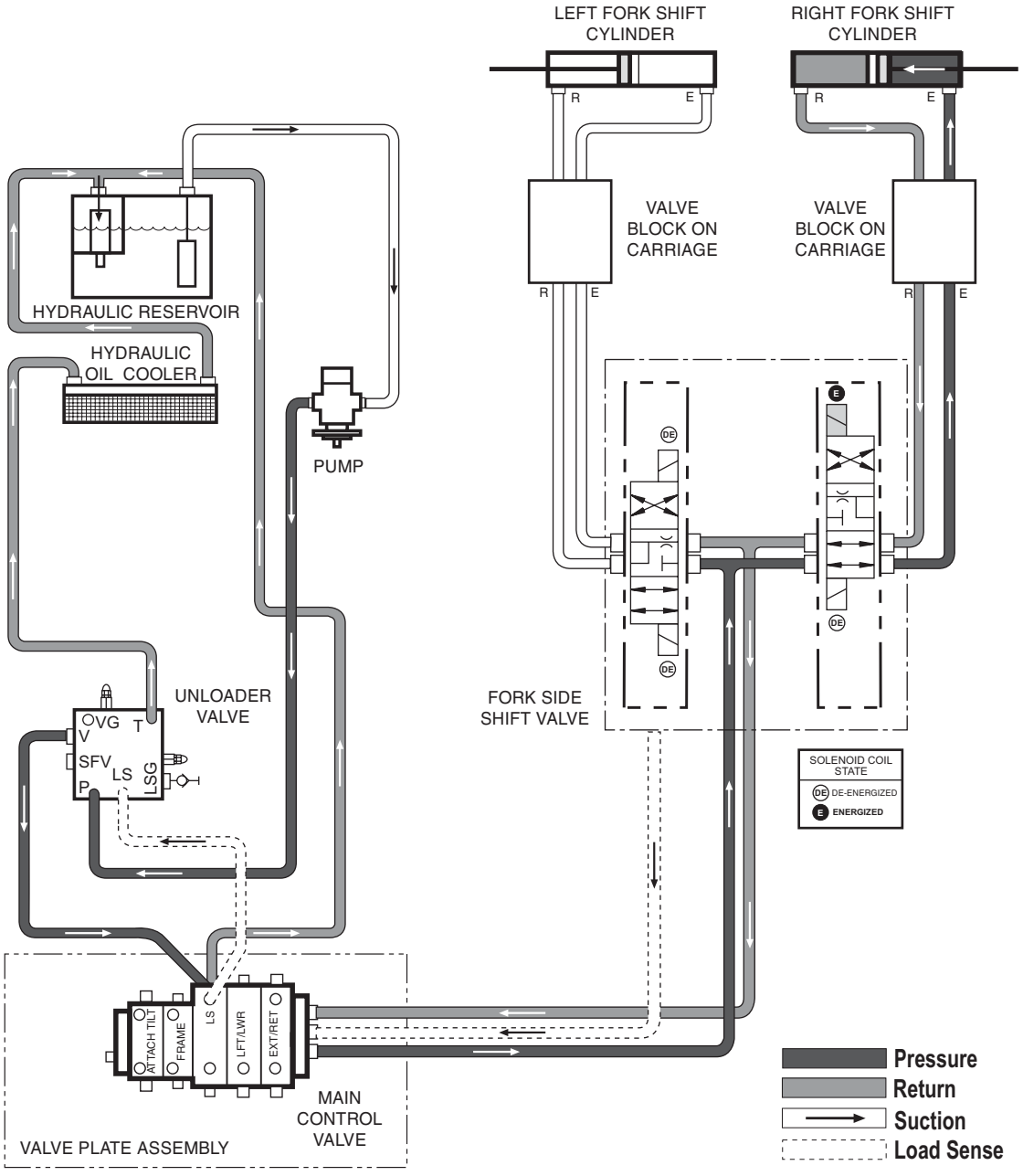
NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



9.8.23 Right Fork Shift Circuit (Shift Left) and Troubleshooting

(Refer to *Section 9.8.32, Fork Side Shift Circuit Description* for a more detailed explanation of this circuit.)



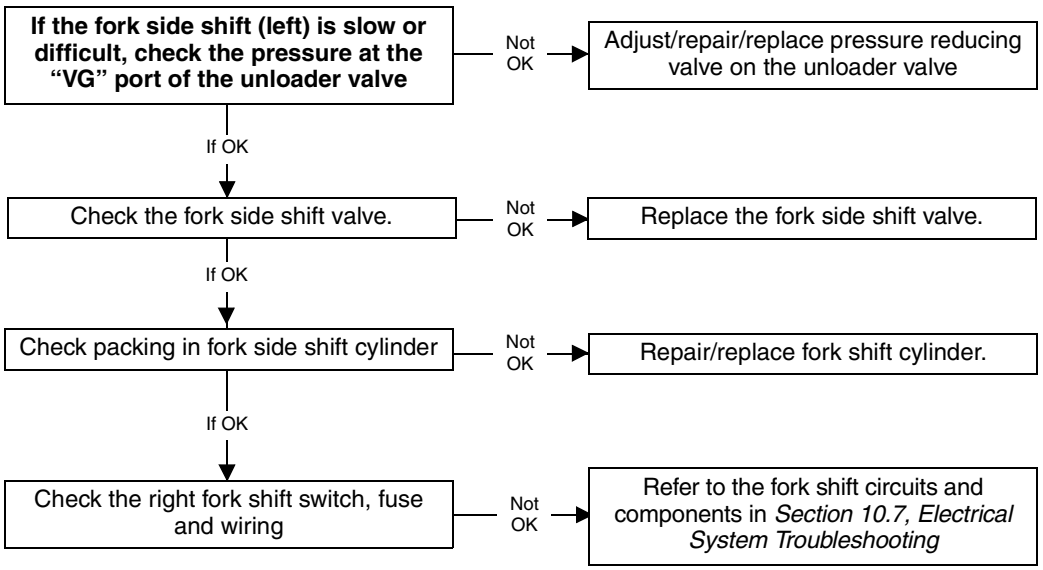
MM3491

Before troubleshooting any hydraulic circuit, ALWAYS begin by checking the following:

1. **Hydraulic oil level in the reservoir**
2. **All hoses, tubes, fittings for leaks, kinks, interference, etc.**
3. **Air in the lines**

NOTE:

When checking pressures in circuits, refer to *Section 9.7, Hydraulic System Testing* for correct pressure readings.



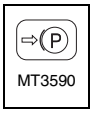
9.8.24 Brake Circuit Description

The brake system circuit (see page 9.14 thru page 9.18) includes the park brake and the service brake, along with the secondary function manifold, main control valve, accumulator charge valve, accumulators and various hoses, fittings and other components.

When the engine is OFF and the ignition switch is in the OFF position, the park brake is ON. The park brake is part of the front axle ONLY.

The vehicle is designed so that the service brake can be used to stop the vehicle with the engine OFF. The service brakes are contained within both the front and rear axles. Refer to *Section 5, Axles, Wheels and Tires* for further information.

a. Park Brake Circuit (See page 9.14)



Only the front axle is equipped with a spring-applied, pressure-released park brake. The park brake operates via two solenoids at the secondary function manifold. With the engine running and the park brake switch ON, one of the solenoids is normally open and the other is normally closed. This prevents fluid flow in one direction but allows it in another. Spring pressure within the front axle engages the park brake. Oil is prevented from flowing to the front axle and releasing the park brake.

With the engine running and the park brake switch OFF, fluid flows from the hydraulic pump, to the accumulator charge valve, to the secondary function valve, through the park brake solenoid valve, out the park brake “PB” port and to the park brake section of the front axle. Oil pressure overcomes the spring pressure within the front axle, and the park brake is released. Oil is prevented from flowing back to the reservoir because of the closed solenoid valve at the secondary function manifold.

With the engine OFF and the park brake switch OFF, spring pressure at the front axle engages the park brake.

b. Service Brake Circuit (See page 9.16)

With the engine, running fluid flows from the hydraulic pump to the accumulator charge valve. Two hydraulic lines from the accumulator charge valve “ACR” and “ACF” charge the two accumulators which provide fluid flow to the service brake valve when the engine is running. A line returns oil back to the reservoir from the “T” port on the service brake valve. From the brake valve there are lines going to the front axle and rear axles, providing pressure to the service brakes. Pressure can be checked at the brake valve for each brake line.

This system utilizes two accumulators to hold pressure in the service brake system in the event of loss of engine power. The accumulators hold a sufficient charge to stop the vehicle without engine power.

c. Emergency Towing Park Brake Release Circuit (See page 9.18)

With the engine OFF, ignition switch ON and the park brake switch OFF, the park brake can be released manually using the park brake release hand pump. This pump is used for emergency towing of the vehicle only.

Note: *With the ignition switch in the ON position, the low brake pressure buzzer will sound continuously until the towing operation is complete and ignition switch turned to the OFF position.*

	CAUTION: **DO NOT** exceed 650 psi (45 bar) when pressurizing the system. Applying to much pressure may damage the brake seals

Use the park brake release pump to pump hydraulic pressure into the park brake system. Watch the pressure gauge next to the hand pump. **DO NOT** exceed 650 psi (45 bar) when pressurizing the system.

When releasing the park brake with the park brake release hand pump, oil is sucked out of the hydraulic oil reservoir through the return line and is pressurized into the park brake lines by the hand pump. The hand pump has internal check valves to prevent oil from flowing back to the tank when using the hand pump to release the brakes or when the system is under normal operating pressure.

9.8.25 Boom Extend/Retract Circuit Description

Hydraulic flow is applied in the boom extend/retract circuit (see page 9.20 and page 9.24) by the front section of the hydraulic gear pump through the unloader valve. The rear section of the pump provides hydraulic flow through the accumulator charge valve to the unloader valve. System pressure is directed to either side of the extend/retract cylinder by the shifting of the spool valve in the main control valve. The spool valve is shifted by pilot pressure provided from the pilot select manifold, regulated by the position of the joystick.

a. Boom Extend Position (See page 9.20)



When the joystick is in the boom EXTEND position, the spool valve is shifted by pilot pressure in the pilot select manifold so flow is directed through extend/retract spool valve ports, through the counterbalance valve to the base end of the extend/retract cylinder. Return oil from the rod end of the cylinder exits through the check valve. The oil will pass from the cylinder to the spool valve, to the return filter and then to the reservoir.

If system pressure exceeds 3000 psi (207 bar), the extend port relief will open and allow hydraulic oil to return to the reservoir. If the return filter is plugged, the oil returning to the reservoir bypasses the filter when the internal pressure of the filter reaches 25 psi (1,7 bar).

b. Boom Retract Position (See page 9.24)



When the joystick is in the boom RETRACT position, the extend/retract spool valve is shifted by pilot pressure in the pilot select manifold so that system pressure is directed through the spool valve, to the rod end of the extend/retract cylinder. The counterbalance valve is piloted open by high pressure, allowing return oil from the base end of the cylinder to flow through the spool valve to the return filter and then to the reservoir.

If system pressure reaches 3500 psi (241 bar), the main relief valve opens, allowing hydraulic oil to return to the reservoir. If the return filter becomes plugged, return hydraulic oil will bypass the filter when pressure reaches 25 psi (1,7 bar) and return to the reservoir unfiltered.

The extend/retract cylinder includes a counterbalance valve and a pilot-operated check valve. The valves serve two main functions. One of the functions is to help prevent component damage.

The other valve functions can be described as follows:

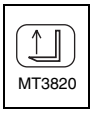
- If the vehicle is travelling and the boom runs into a solid object, pressure will build up on the base end of the of the cylinder. Without a counterbalance valve, the cylinder rod would bend, damaging the cylinder. With the counterbalance valve installed, the pressure will build up until it reaches 4000 psi (276 bar) and then the counterbalance valve will be internally piloted open, allowing the pressure to return to the reservoir. This condition will only exist if the cylinder has been extended. If the cylinder is fully retracted, the counterbalance valve will have no effect and damage can result.
- Should any of the hydraulic lines going to the extend/retract cylinder fail, there will be a loss of hydraulic system pressure to the cylinder. For example, if there was a hydraulic line failure in the pressurized retract line during retracting, the counterbalance valve would lose pilot pressure, closing off flow returning to the reservoir. The oil in the base end of the cylinder would then be trapped, which would immediately stop boom retraction, preventing an elevated load from uncontrolled retraction. The load can be lowered safely to the ground by following the procedures in *Section 4.3.10, Emergency Boom Lowering and Retracting* of this manual.

***IMPORTANT: DO NOT** attempt to reset a counterbalance valve cartridge. In the event that a counterbalance valve cartridge was disabled for emergency boom lowering or any unauthorized adjustments are ever made to this cartridge, remove and replace the cartridge with a new part. Failure to replace this cartridge with a new part may alter the holding characteristics of the counterbalance valve, creating an unsafe condition for vehicle operation.*

9.8.26 Boom Lift/Lower Circuit Description

Hydraulic flow is applied in the lift/lower circuit (see page 9.28 and page 9.32) by the front section of the hydraulic gear pump through the unloader valve. The rear section of the pump provides hydraulic flow through the accumulator charge valve to the unloader valve. System pressure is directed to either side of the lift/lower cylinder by the shifting of the spool valve in the main control valve. The spool valve is shifted by pilot pressure provided from the pilot select manifold, regulated by the position of the joystick.

a. Boom Lift Circuit (See page 9.28)

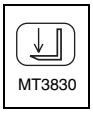


With the joystick in the boom lift position, pilot pressure provided from the pilot select manifold shifts the lift/lower spool valve in the main control valve to direct system pressure through the counterbalance valve to the base end of the lift/lower cylinder.

Return oil from the rod end of the cylinder flows through the pilot-operated check valve to the spool valve, to the return filter and then to the hydraulic fluid reservoir.

If system pressure exceeds 3500 psi (241 bar), the main relief will open, allowing oil to return to the reservoir. If the return filter becomes plugged, return hydraulic oil will bypass the filter when pressure reaches 25 psi (1,7 bar) and return to the reservoir unfiltered.

b. Boom Lower Circuit (See page 9.32)



When the joystick is in the boom lowering position, pilot pressure provided from the pilot select manifold shifts the lift/lower spool valve in the main control valve. Oil is then directed to the pilot-operated check valve to the rod end of the lift/lower cylinder. System pressure also pilots open the counterbalance valve in the base end of the lift/lower cylinder.

The open counterbalance valve allows oil from the base of the cylinder to flow to the main control valve, to the return filter and then to the hydraulic fluid reservoir.

If system pressure exceeds 3500 psi (241 bar), the main relief will open allowing oil to return to the reservoir. If the return filter becomes plugged, return hydraulic oil will bypass the filter when pressure reaches 25 psi (1,7 bar) and return to the reservoir unfiltered.

The counterbalance and pilot-operated check valves serve another main function for safety purposes. This function can be described as follows:

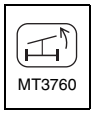
Should any of the hydraulic lines routed to the lift/lower cylinder fail, there will be a loss of hydraulic system pressure to the cylinder. For example, if a hydraulic line failure occurred in the pressurized lowering line during lowering, the counterbalance valve would lose pilot pressure, closing off flow returning to the reservoir. The oil in the base end of the cylinder would then be trapped, which would immediately stop boom lowering and prevent an elevated load from falling to the ground uncontrolled. The load can be lowered safely to the ground by following the procedures in *Section 4.3.10, Emergency Boom Lowering and Retracting* of this manual.

***IMPORTANT: DO NOT** attempt to reset the counterbalance valve cartridge. In the event that the counterbalance valve cartridge was disabled for emergency boom lowering, or if any unauthorized adjustments are ever made to the cartridge, remove and replace the cartridge with a new part. Failure to replace the cartridge with a new part may alter the holding characteristics of the counterbalance valve, creating an unsafe condition for vehicle operation.*

9.8.27 Frame Sway Circuit Description

Hydraulic flow is applied in the frame sway circuit (see page 9.36 and page 9.40) by the front section of the hydraulic gear pump through the unloader valve. The rear section of the pump provides hydraulic flow through the accumulator charge valve to the unloader valve. System pressure is directed to either side of the frame sway cylinder by the shifting of the spool valve in the main control valve. The spool valve is shifted by pilot pressure from the secondary function manifold, regulated by the position of the joystick.

a. Frame Sway LEFT (See page 9.36)



With the two frame sway select buttons (front and left) depressed and held, and the joystick moved to the left, the spool valve in the frame sway section of the main control valve assembly is shifted by pilot pressure provided from the pilot select manifold. System pressure is directed to the spool valve (in the main control valve), and from there to the base end of the frame sway cylinder. Oil from the rod end of the frame sway cylinder flows through a check valve, unseated by system pressure, to the stabilizer cylinder, through the solenoid valve, and returned to the return filter and the reservoir via the tank port on the stabilizer cylinder.

b. Frame Sway RIGHT (See page 9.40)



With the two frame sway select buttons (front and left) depressed and held, and the joystick moved to the right, the spool valve in the frame sway section of the main control valve assembly is shifted by pilot pressure provided from the pilot select manifold.

System pressure is directed to the spool valve, then to the stabilizer cylinder, through the solenoid valve, back to the frame sway cylinder, where it flows to the rod end of the cylinder. Oil from the base end of the cylinder flows through the check valve, which was unseated by system pressure, then to the spool valve, and returned to the return filter and the reservoir via the tank port on the stabilizer cylinder.

9.8.28 Attachment Tilt and Slave Circuit Description

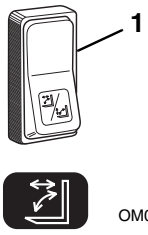
System pressure is applied in the attachment tilt and slave cylinder circuit (see page 9.44 and page 9.46) from the attachment tilt section of the main control valve.

Fluid flow is directed to either side of the attachment tilt and slave cylinder pistons by shifting of the spool valve in the attachment tilt section of the main control valve assembly. The spool valve is shifted by pilot pressure provided from the pilot select manifold, actuated by joystick control and electrical solenoids.

The attachment tilt joystick functions are dependent on the position of the attachment tilt mode switch in either Mode 2A or Mode 2B.

a. Mode 2A

When the top of the attachment tilt mode switch is depressed (Mode 2A) (**1**), press and hold the top right button (**2**) on the joystick (**3**). As the mode is activated the corresponding lights will illuminate on the logic panel (**4**).



OM0670

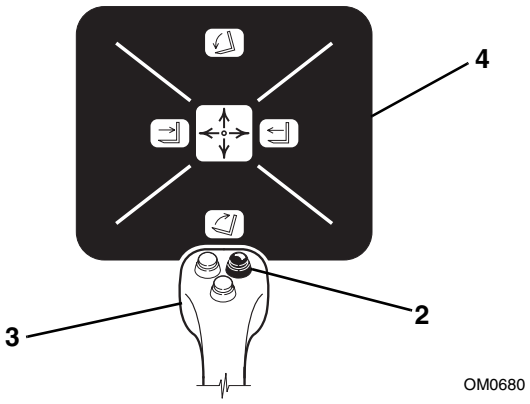
Attachment Tilt Up..... move handle BACKWARD

Attachment Tilt Down .. move handle FORWARD

Boom Extend..... move handle to the right

Boom Retract ..... move handle to the left

OS0671



OM0680

1. DOWN Position (Mode 2A) (See page 9.44)

MT3780

With the attachment tilt switch in Mode 2A (top depressed) (**1**), the right button on the joystick pressed and held and the joystick moved FORWARD, the attachment tilts DOWN. The spool valve in the main control valve is shifted so system pressure is directed to the rod end of the attachment tilt cylinder and the slave cylinders.

The extension of the slave cylinders is fixed by the position of the boom so that only the attachment tilt cylinder is retracted to tilt the attachment downward. The pilot pressure opens the counterbalance valve. The open counterbalance valve allows return oil from the base of the attachment tilt cylinder to flow to ports of the attachment tilt section of the main control valve, to the return filter and ultimately to the reservoir.

If system pressure reaches 3500 ±100 psi (241 ±7 bar) the main relief will open and allow hydraulic oil to return to the return filter and to the reservoir. In any case, if the return filter becomes restricted, hydraulic oil will bypass the filter when the pressure reaches 25 psi (1,7 bar).

2. UP Position (Mode 2A) (See page 9.46)

MT3790

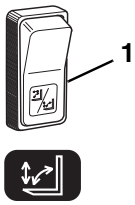
With the attachment tilt switch in Mode 2A (top depressed) (**1**), the right button on the joystick pressed and held and the joystick moved BACKWARD, the attachment tilts UP. The spool valve in the main control valve is shifted so system pressure is directed to the base end of the attachment tilt cylinder and the slave cylinders.

If system pressure reaches 3500 ±100 psi (241 ±7 bar) the main relief will open, allowing hydraulic oil to flow to the return filter and to the reservoir. If the return filter becomes restricted, hydraulic oil will bypass the filter when the pressure reaches 25 psi (1,7 bar).

Return oil from the rod side of the attachment tilt cylinder is directed back to the attachment tilt section of the main control valve through the spool valve, to the return filter and to the reservoir. If the return filter becomes restricted, hydraulic oil will bypass the filter when the pressure reaches 25 psi (1,7 bar).

b. Mode 2B

When the bottom of the attachment tilt mode switch is depressed (Mode 2B) (**1**), press and hold the right button (**2**) on the joystick (**3**). As the mode is activated the corresponding lights will illuminate on the logic panel (**4**).



OM0690

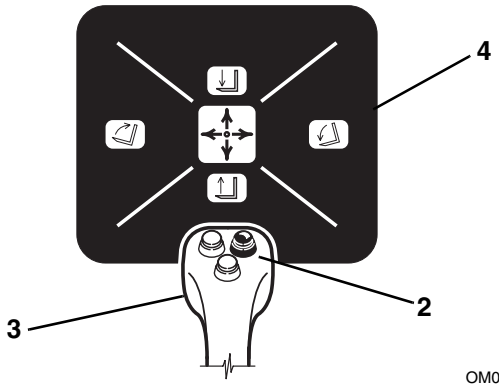
Boom Lift ..... move handle BACKWARD

Boom Lower ..... move handle FORWARD

Attachment Tilt Down .... move handle to the right

Attachment Tilt Up..... move handle to the left

OS0610



OM0700

1. DOWN Position (Mode 2B) (See page 9.44)

MT3780

With the attachment tilt switch in Mode 2B (bottom depressed) (**1**), the right button (**2**) on the joystick (**3**) pressed and held and the joystick moved RIGHT, the attachment tilts DOWN. The spool valve in the main control valve is shifted so system pressure is directed to the rod end of the attachment tilt cylinder and the slave cylinders.

The extension of the slave cylinders is fixed by the position of the boom so that only the attachment tilt cylinder is retracted to tilt the attachment downward. The pilot pressure opens the counterbalance valve. The open counterbalance valve allows return oil from the base of the attachment tilt cylinder to flow to ports of the attachment tilt section of the main control valve, to the return filter and ultimately to the reservoir.

If system pressure reaches 3500 ±100 psi (241 ±7 bar) the main relief will open and allow hydraulic oil to return to the return filter and to the reservoir. In any case, if the return filter becomes restricted, hydraulic oil will bypass the filter when the pressure reaches 25 psi (1,7 bar).

2. UP Position (Mode 2B) (See page 9.46)

MT3790

With the attachment tilt switch in Mode 2B (bottom depressed) (**1**), the right button on the joystick pressed and held and the joystick moved LEFT, the attachment tilts UP. The spool valve in the main control valve is shifted so system pressure is directed to the base end of the attachment tilt cylinder and the slave cylinders.

If system pressure reaches 3500 ±100 psi (241 ±7 bar) the main relief will open, allowing hydraulic oil to flow to the return filter and to the reservoir. If the return filter becomes restricted, hydraulic oil will bypass the filter when the pressure reaches 25 psi (1,7 bar).

Return oil from the rod side of the attachment tilt cylinder is directed back to the attachment tilt section of the main control valve through the spool valve, to the return filter and to the reservoir. If the return filter becomes restricted, hydraulic oil will bypass the filter when the pressure reaches 25 psi (1,7 bar).

9.8.29 Joystick Circuit Description

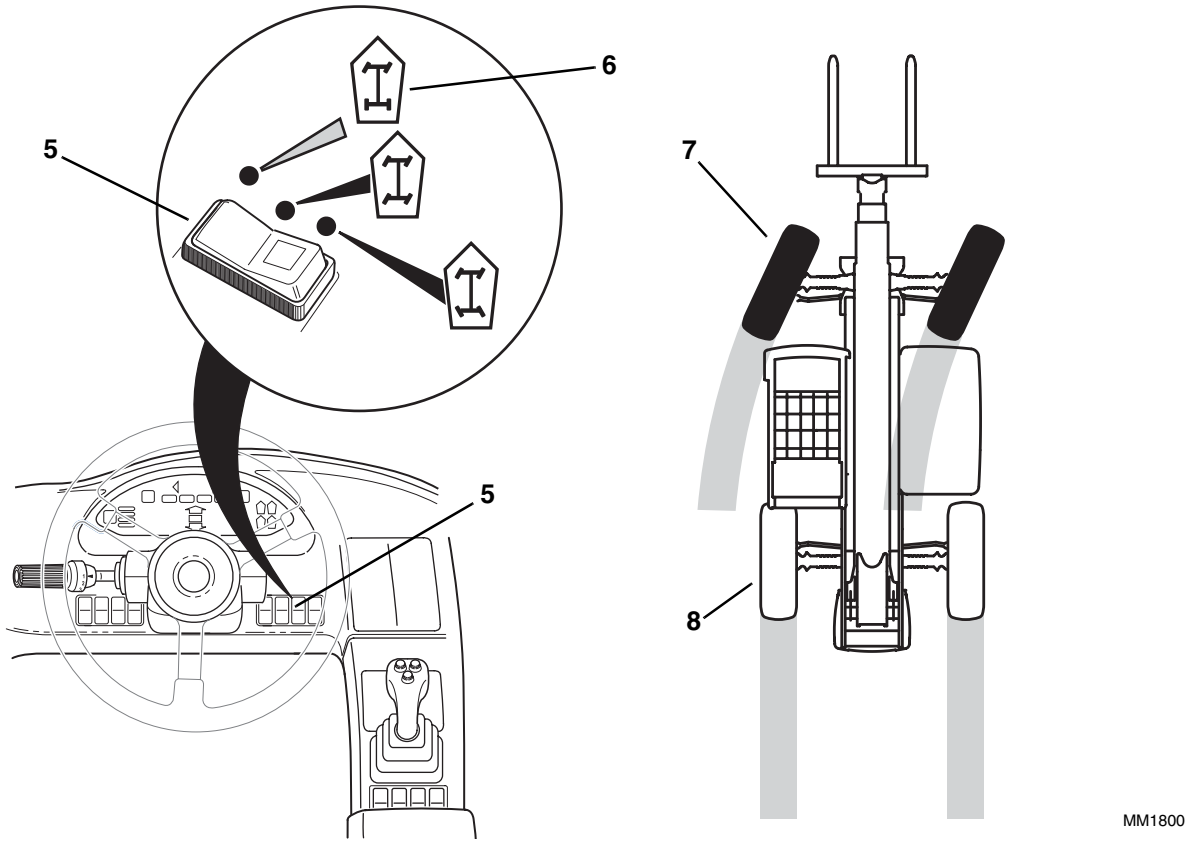
Joystick hydraulic circuit (see page 9.48) commands are achieved through electric and hydraulic signals via a set of cartridge-type, solenoid-operated control valves mounted in an array at the pilot select manifold.

The cartridge valves shift to allow hydraulic oil to flow to the proper circuit as commanded by joystick position. Hydraulic fluid flows from the joystick valve to the pilot select manifold, then to the appropriate working section of the main control valve.

9.8.30 Pump, Unloader Valve and Cooling Circuit Description

In the pump/unloader valve/cooling circuit (see page 9.52), the pump draws oil from the hydraulic reservoir and sends pressurized oil from the front section to the unloader valve. The rear section of the pump sends pressurized oil to the accumulator charge valve which provides pressure to the secondary function manifold which provides pilot pressure to the joystick. Excess accumulator charge valve flow is routed to the unloader valve.

The unloader valve regulates maximum system operating pressure for various vehicle functions and sends oil to the main control valve. When oil from the unloader valve is returned to the reservoir, it is sent through the hydraulic oil cooler first. A check valve located in the line will allow oil to bypass the cooler and return to the reservoir uncooled if pressure on the check valve exceeds 85 psi (5,9 bar).



9.8.31 Three-Mode Steering Circuit Descriptions

Vehicle three-mode steering includes front-wheel steering (see page 9.56 and page 9.58), four-wheel steering (see page 9.60 and page 9.62) and crab steering (see page 9.64 and page 9.66).

a. Front-Wheel Steering



When the steer select switch (**5**) is in the front-wheel steer (forward) position (**6**), the front wheels (**7**) will steer in the direction the steering wheel is turned and the rear wheels (**8**) will remain fixed.

1. Front-Wheel Steering Left Turn (See page 9.56)

In the front-wheel steering mode, when a left turn is made, system pressure from the accumulator charge valve is applied through the intake side of the metering section of the power steering unit.

A specific amount of hydraulic oil is exhausted from the metering section and routed to the power steering control valve, internal to the power steering unit, where it is channeled through the steer select valve to the left rod end of the front steering cylinder. Both solenoids in the steer select valve are de-energized.

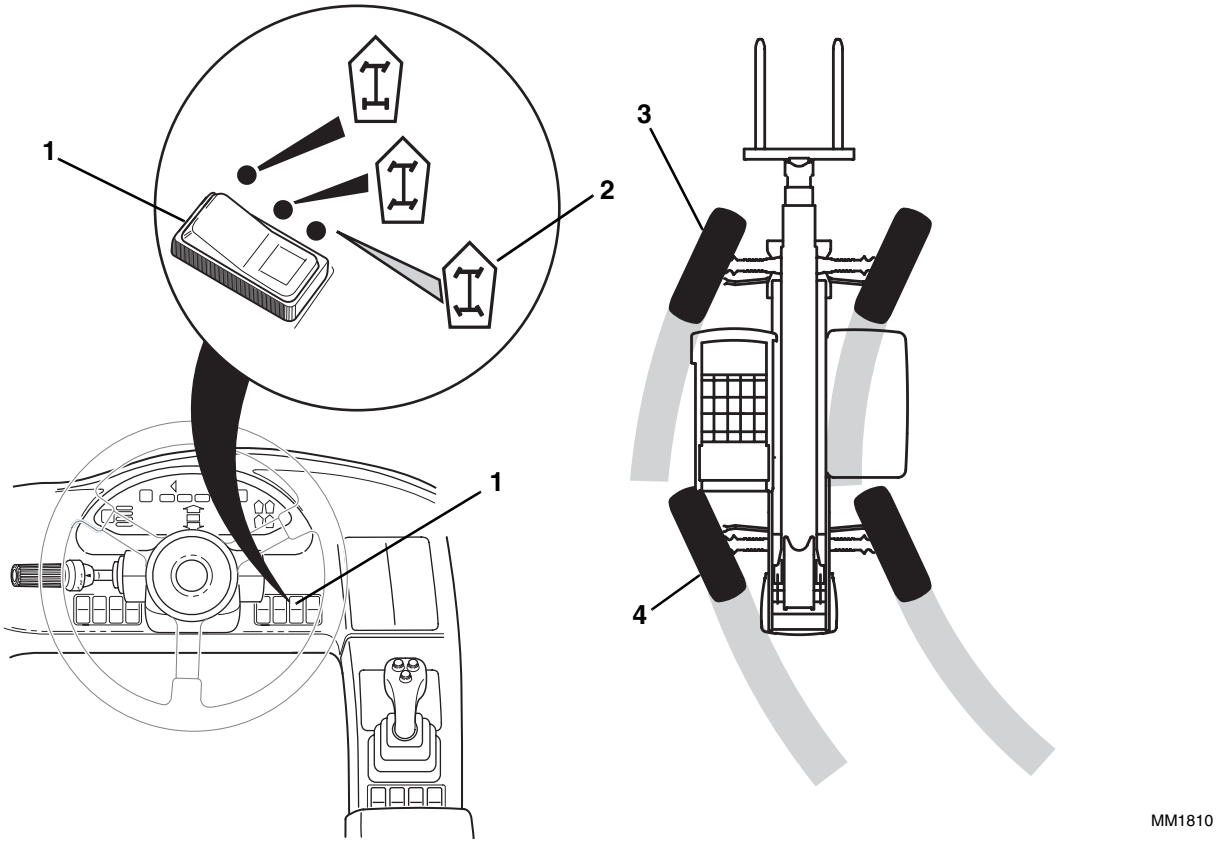
Oil from the right rod end of the front steering cylinder flows to the power steering unit, then to the return filter in the reservoir.

2. Front-Wheel Steering Right Turn (See page 9.58)

When a right turn is made, the steering unit spool is shifted so that system pressure from the accumulator charge valve is applied to the intake side of the metering section of the power steering unit.

A specific amount of hydraulic oil is exhausted from the metering section and routed to the power steering control valve, internal to the power steering unit, where it is channeled to the right rod end of the front steering cylinder.

Oil from the left rod end of the front steering cylinder flows through the steer select valve to the power steering control valve, then to the return filter in the reservoir. Both solenoids in the steer select valve are de-energized.



b. Four-Wheel Steering

MT3880

When the steer select switch (**1**) is in the four-wheel steer (down) position (**2**), the front wheels (**3**) will steer in the direction the steering wheel is turned and the rear wheels (**4**) will steer in the opposite direction.

1. Four-Wheel Steering Left Turn (See page 9.60)

With the steer select switch (**1**) in the four-wheel steer (down) position (**2**), one of the steer select valve solenoids is energized. The power steering unit control valve spool is shifted so that the system pressure from the accumulator charge valve is applied to the intake side of the power steering unit metering section.

A specific amount of hydraulic oil is exhausted from the metering section and routed back to the power steering control valve section, internal to the power steering unit, where it is channeled to the left rod end of the rear steering cylinder.

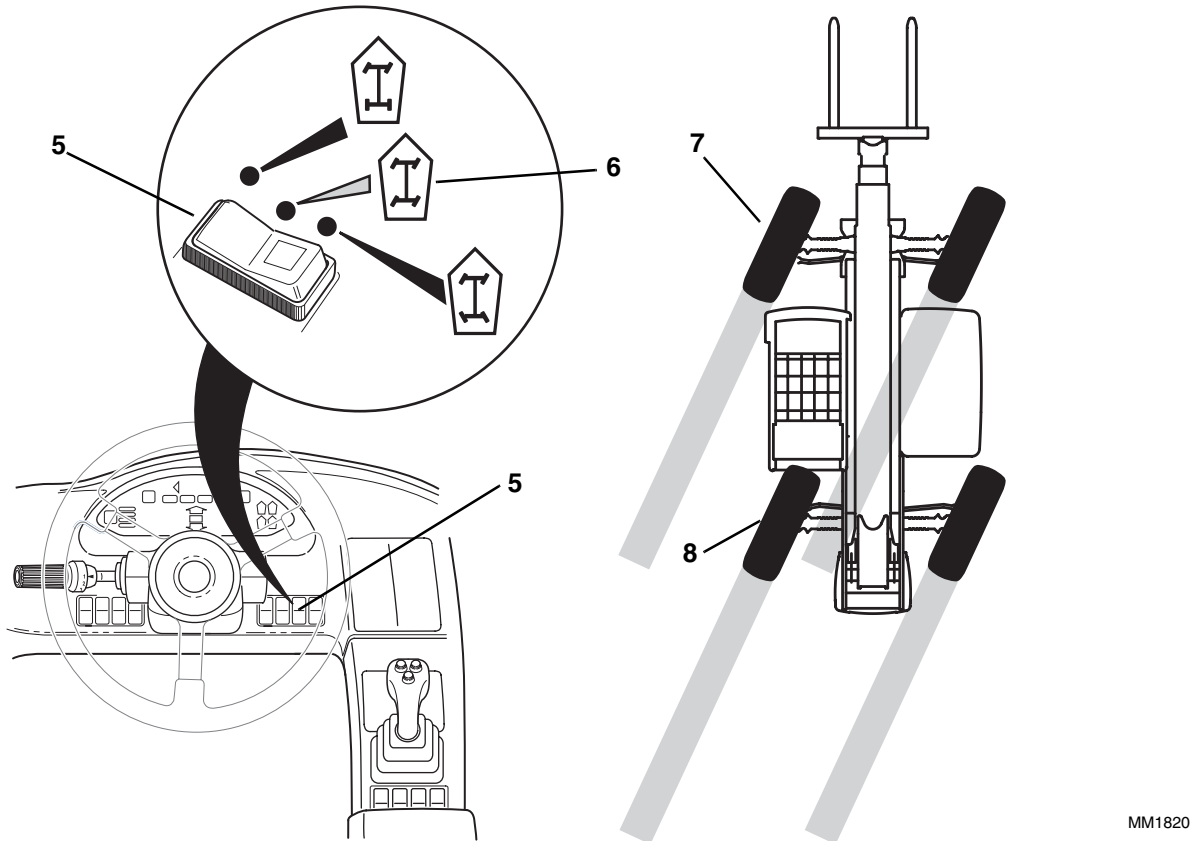
Oil from the right rod end of the rear steering cylinder flows through the steer select valve to the left rod end of the front steering cylinder. Oil from the right rod end of the front steering cylinder flows to the power steering control valve, then to the return filter in the reservoir.

2. Four-Wheel Steering Right Turn (See page 9.62)

With the steer select switch (**1**) in the four-wheel steer (down) position (**2**), one of the steer select valve solenoids is energized. The power steering unit control valve spool is shifted so that the system pressure from the accumulator charge valve is applied to the intake side of the power steering unit metering section.

A specific amount of hydraulic oil is exhausted from the metering section and routed back to the power steering control valve, internal to the power steering unit, where it is channeled to the right rod end of the front steering cylinder.

Oil from the left rod end of the front steering cylinder flows through the steer select valve to the right rod end of the rear steering cylinder. Oil from the left rod end of the rear steering cylinder flows through the steer select valve and back to the power steering control valve, then to the return filter in the reservoir.



c. Crab Steering Mode



When the steer select switch (**5**) is in the crab steer (center) position (**6**), the front wheels (**7**) will steer in the direction the steering wheel is turned and the rear wheels (**8**) will steer in the same direction.

1. Crab Steering Left Turn (See page 9.64)

With the steer select switch (**5**) in the crab steer (center) position (**6**), one of the steer select valve solenoids is energized. The power steering control valve is shifted so that system pressure from the accumulator charge valve is applied through the intake side of the power steering unit metering section.

A specific amount of hydraulic oil is exhausted from the metering section and routed back to the power steering control valve, internal to the power steering unit, where it is channeled through the steer select valve to the right rod end of the rear steering cylinder.

Oil from the left rod end of the rear steering cylinder flows through the steer select valve to the left rod end of the front steering cylinder. Oil from the right rod end of the front steering cylinder flows to the power steering control valve, then to the return filter in the reservoir.

2. Crab Steering Right Turn (See page 9.66)

With the steer select switch (**5**) in the crab steer (center) position (**6**), one of the steer select valve solenoids is energized. The power steering control valve is shifted so that system pressure from the accumulator charge valve is applied through the intake side of the power steering unit metering section.

A specific amount of hydraulic oil is exhausted from the metering section and routed back to the power steering control valve, internal to the power steering unit, where it is channeled to the right rod end of the front steering cylinder.

Oil from the left rod end of the front steering cylinder flows through the steer select valve to the left rod end of the rear steering cylinder. Oil from the right rod end of the rear steering cylinder flows through the steer select valve to the power steering control valve, then to the return filter in the reservoir.

9.8.32 Fork Side Shift Circuit Description

The fork side shift circuits are controlled by individual rocker switches located on the right side console to the rear of the joystick. The right side switch (**1**) controls the right side fork and the left side switch (**2**) controls the left side fork.

a. Left Fork - Shift Right (page 9.68)



Press the bottom of the left fork shift switch to shift the left fork to the right. The switch is spring loaded to return to the center OFF position when released.

When the bottom of the switch is pushed, one of the solenoids on the fork side shift valve is energized allowing hydraulic oil at system pressure to pass thru the valve block mounted on the left side of the carriage. The hydraulic oil is then directed into the rod end of the left fork cylinder, shifting the fork to the right.

Oil from the base end of the left fork cylinder is returned through the valve block, through the fork side shift valve and back to the hydraulic oil reservoir by going through the main control valve to the return filter in the reservoir.

b. Left Fork - Shift Left (page 9.70)



Press the top of the left fork shift switch to shift the left fork to the left. The switch is spring loaded to return to the center OFF position when released.

When the top of the switch is pushed, one of the solenoids on the fork side shift valve is energized allowing hydraulic oil at system pressure to pass thru the valve block mounted on the left side of the carriage. The hydraulic oil is then directed into the base end of the left fork cylinder, shifting the fork to the left.

Oil from the rod end of the left fork cylinder is returned through the valve block, through the fork side shift valve and back to the hydraulic oil reservoir by going through the main control valve to the return filter in the reservoir.

c. Right Fork - Shift Right (page 9.72)



Press the bottom of the right fork shift switch to shift the right fork to the right. The switch is spring loaded to return to the center OFF position when released.

When the bottom of the switch is pushed, one of the solenoids on the fork side shift valve is energized allowing hydraulic oil at system pressure to pass thru the valve block mounted on the right side of the carriage. The hydraulic oil is then directed into the base end of the right fork cylinder, shifting the fork to the right.

Oil from the rod end of the right fork cylinder is returned through the valve block, through the fork side shift valve and back to the hydraulic oil reservoir by going through the main control valve to the return filter in the reservoir.

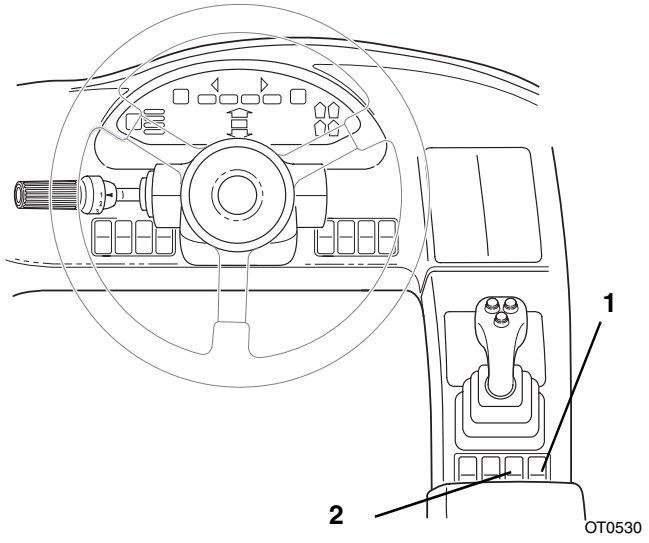
d. Right Fork - Shift Left (page 9.74)



Press the top of the right fork shift switch to shift the right fork to the left. The switch is spring loaded to return to the center OFF position when released.

When the top of the switch is pushed, one of the solenoids on the fork side shift valve is energized allowing hydraulic oil at system pressure to pass thru the valve block mounted on the right side of the carriage. The hydraulic oil is then directed into the rod end of the right fork cylinder, shifting the fork to the left.

Oil from the base end of the right fork cylinder is returned through the valve block, through the fork side shift valve and back to the hydraulic oil reservoir by going through the main control valve to the return filter in the reservoir.



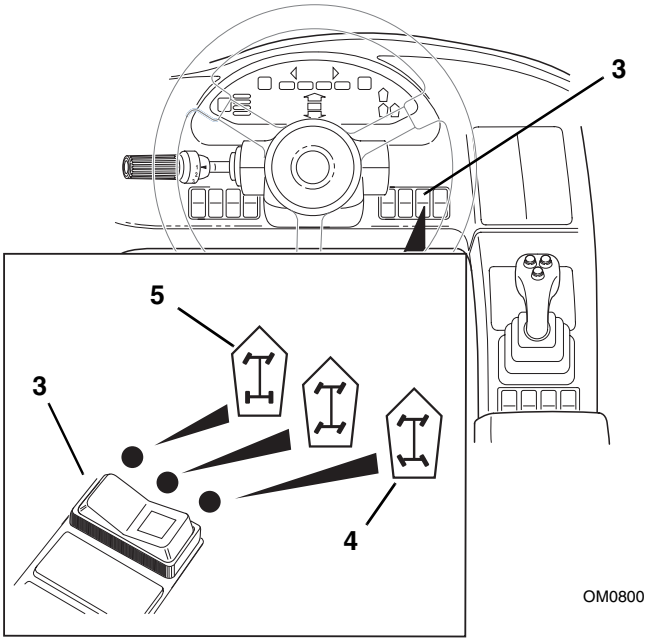
9.9 STEER INDEXING PROCEDURES

a. Four-Wheel Steer Indexing Procedure

If the vehicle does not drive “straight,” the steering could be out-of-phase. Perform the following Four Wheel Steer Indexing Procedure to synchronize the front and rear steering.

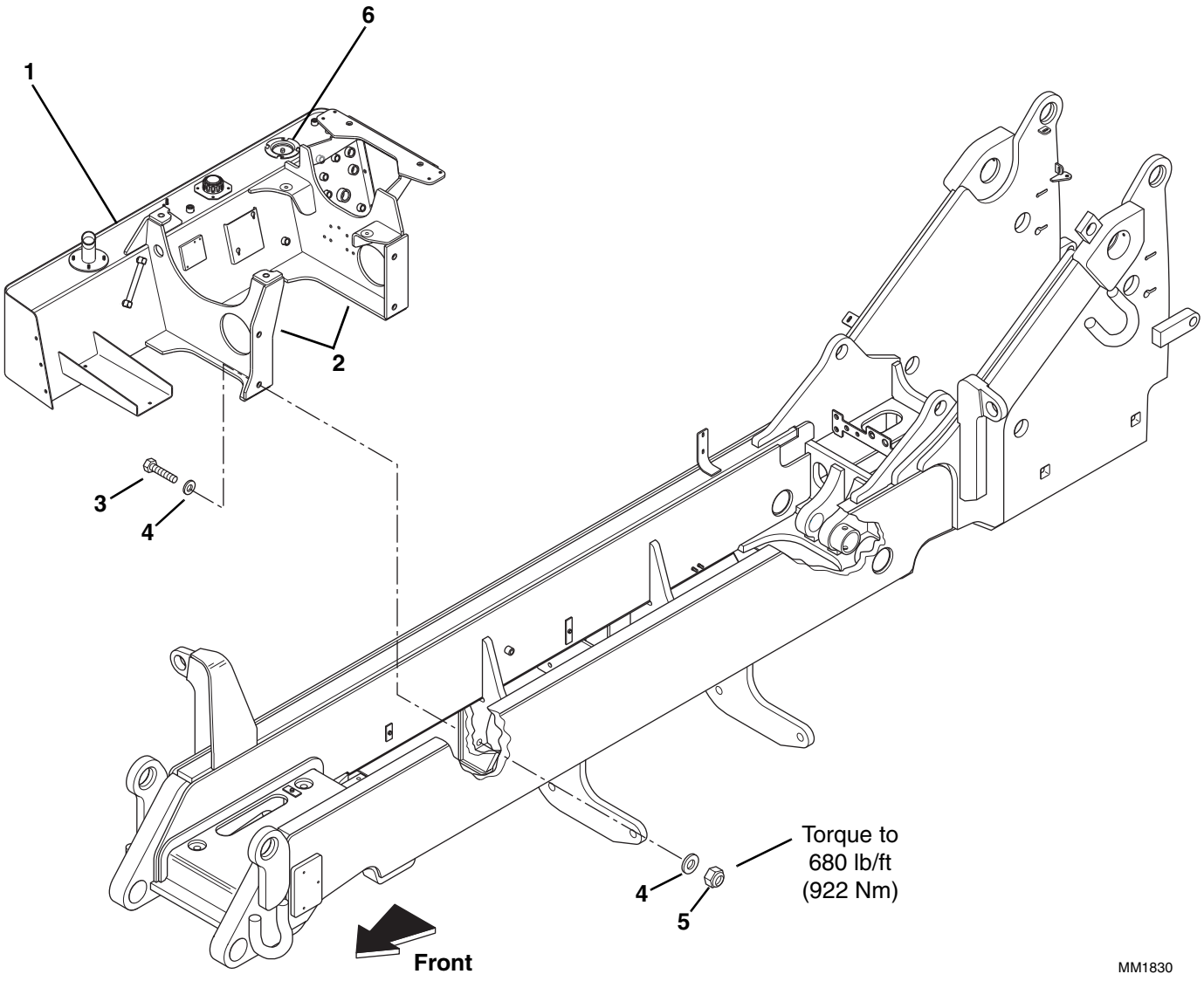
1. With the steering select switch (**3**) in the Four Wheel Steer position (**4**), turn the steering wheel full left.
2. While holding the steering wheel full left, toggle the steer select switch to the Front Wheel Steer position (**5**) and steer the front wheels back to center.
3. Toggle the steer select switch back to Four Wheel Steer position (**4**) and turn the steering wheel full left.
4. Toggle the steer select switch back to Front Wheel Steer position (**5**) and steer the front wheels full left.
5. Toggle the switch to the Four Wheel Steer position (**4**) and return to center.

The vehicle should now be properly indexed in Four Wheel Steering. If the wheels are still out-of-phase, repeat the above procedure. If, after repeating the above procedure, the wheels are still out-of-phase, refer to *Section 9.8.16, Four-Wheel Steering Circuit (Left Turn) and Troubleshooting*, and *Section 9.8.17, Four-Wheel Steering Circuit (Right Turn) and Troubleshooting*.



9.10 HYDRAULIC RESERVOIR

The hydraulic reservoir (**1**) is located on the right side of the vehicle and includes the engine mounting crossmembers (**2**). The reservoir is secured to the right side of the vehicle frame with capscrews (**3**), hardened washers (**4**) and locknuts (**5**).



Occasionally, fluid may seep, leak or be more forcefully expelled from the filter head (**6**) when system pressure exceeds the rating of the filter head or breather. If the return filter becomes plugged, return hydraulic oil will bypass the filter when pressure reaches 25 psi (1,7 bar) and return to the reservoir unfiltered.

Carefully examine fluid seepage or leaks from the hydraulic reservoir to determine the exact cause. Clean the reservoir and note where any seepage occurs.

DANGER: **NEVER** weld in, on, near or around the hydraulic reservoir. Hydraulic fluid and fumes can cause the reservoir to explode. This can result in death or serious personal injury.

Leaks from a cracked or damaged reservoir require that the reservoir be removed from the vehicle, flushed completely with water and repaired by a certified welder using approved techniques. If these conditions cannot be met, the reservoir must be replaced in its entirety. Contact **JLG** or the nearest **JLG** Authorized Service Center (ASC) should reservoir welding or replacement be required.

9.10.1 Hydraulic Reservoir Replacement

To remove the hydraulic reservoir, first remove the engine and transmission assemblies, along with all brackets, hoses, wiring, etc. Refer to *Section 8.10, Engine Replacement* and *Section 7.7.1, Transmission Removal*.

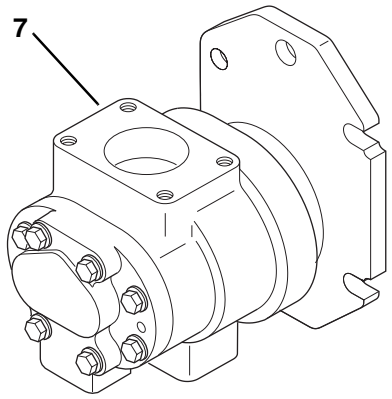
After the engine and transmission assemblies and all related brackets, hoses, wiring, etc. are removed, the hydraulic reservoir must be supported with a suitable device and unbolted from the vehicle frame.

Install the replacement reservoir (**1**) and secure it to the vehicle with four 1-8 X 3" Grade 8 capscrews (**3**), 1" hardened washers (**4**) and 1-8 locknuts (**5**). Torque the nuts to 680 lb/ft (922 Nm).

9.11 HYDRAULIC SYSTEM PUMP

The gear pump (**7**) is attached at the rear of the transmission and driven by the pump main shaft via meshing with an internal transmission gear.

The pump draws fluid through a 2" inside diameter hose via negative displacement.



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Fluid is forced from the front section of the pump through a 3/4" inside diameter hose to the unloader valve. The rear section of the pump forces fluid through a 3/4" inside diameter hose to the accumulator charge valve. Hydraulic system pressure begins at the pump. Various factors are involved in creating the relatively high pressure used in the hydraulic system. Pump rpm, controlled via a transmission input shaft (and dependent on engine rpm), the internal pump gears and passageways and the differential between pump inlet (2" I.D.) and outlets (3/4" I.D.) openings, all contribute to pressure supplied to the unloader valve and accumulator charge valve which supplies pressure to the system. The unloader valve ultimately regulates maximum system-operating pressure of 3500 psi (241 bar) for various vehicle functions. The accumulator charge valve regulates the steering pressure at 2500 ±100 psi (172,3 ±7 bar) and maintains service brake accumulator pressure. The accumulator charge valve also supplies pressure to the secondary function manifold.

9.11.1 Pump Failure Analysis

The pump is the “heart” of the hydraulic system, and whenever there is a problem in the system, the pump often is blamed. Yet, pump failure is seldom due to failure of pump components. Pump failure usually indicates another problem in the hydraulic system.

According to pump manufacturer statistics, 90-95 percent of pump failures are due to one or more of the following causes:

- Aeration
- Cavitation
- Contamination
- Excessive Heat
- Over-Pressurization
- Improper Fluid

In the event of pump failure, investigate further to determine the cause of the problem.

9.11.2 Pump Replacement

a. Pump Removal

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

> **WARNING:** Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

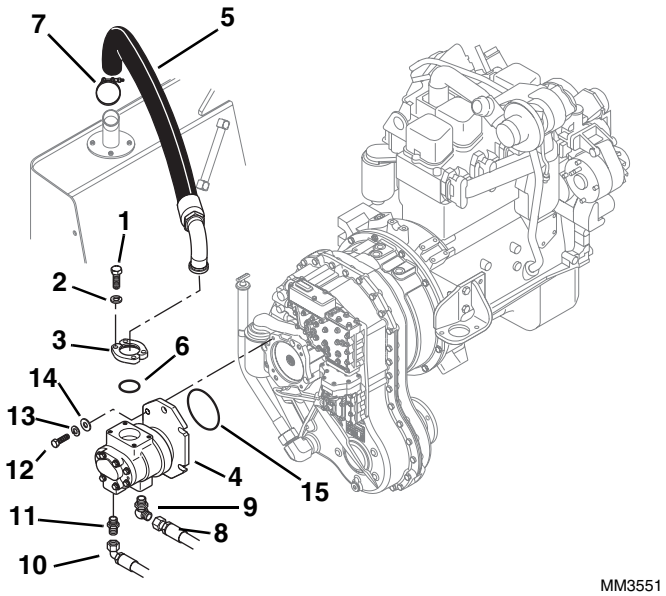
3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

> **WARNING:** Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Remove the four capscrews (**1**) and lockwashers (**2**) securing the flange halves (**3**) to the pump (**4**). Remove the inlet hose (**5**) and o-ring (**6**).

Note: *It is not necessary to remove the T-bolt band clamp (**7**) and inlet hose (**5**) from the inlet tube assembly.*

5. Disconnect the front outlet hose (**8**) from the connector (**9**). Cap the outlet hose to prevent unnecessary fluid spillage.
6. Disconnect the rear outlet hose (**10**) from the connector (**11**). Cap the outlet hose to prevent unnecessary fluid spillage.
7. Remove the four capscrews (**12**), lockwashers (**13**) and plain washers (**14**) securing the pump (**4**) and accumulator charge valve mount bracket to the transmission. Remove the pump and o-ring (**15**) from the vehicle. Wipe up any hydraulic oil spillage.

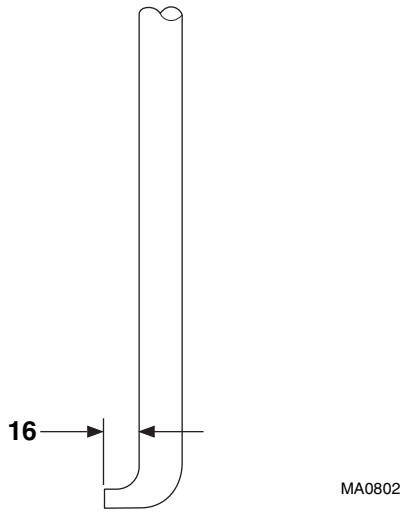


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b. Tools Required for Pump Repair

The following tools are required for servicing the pump:

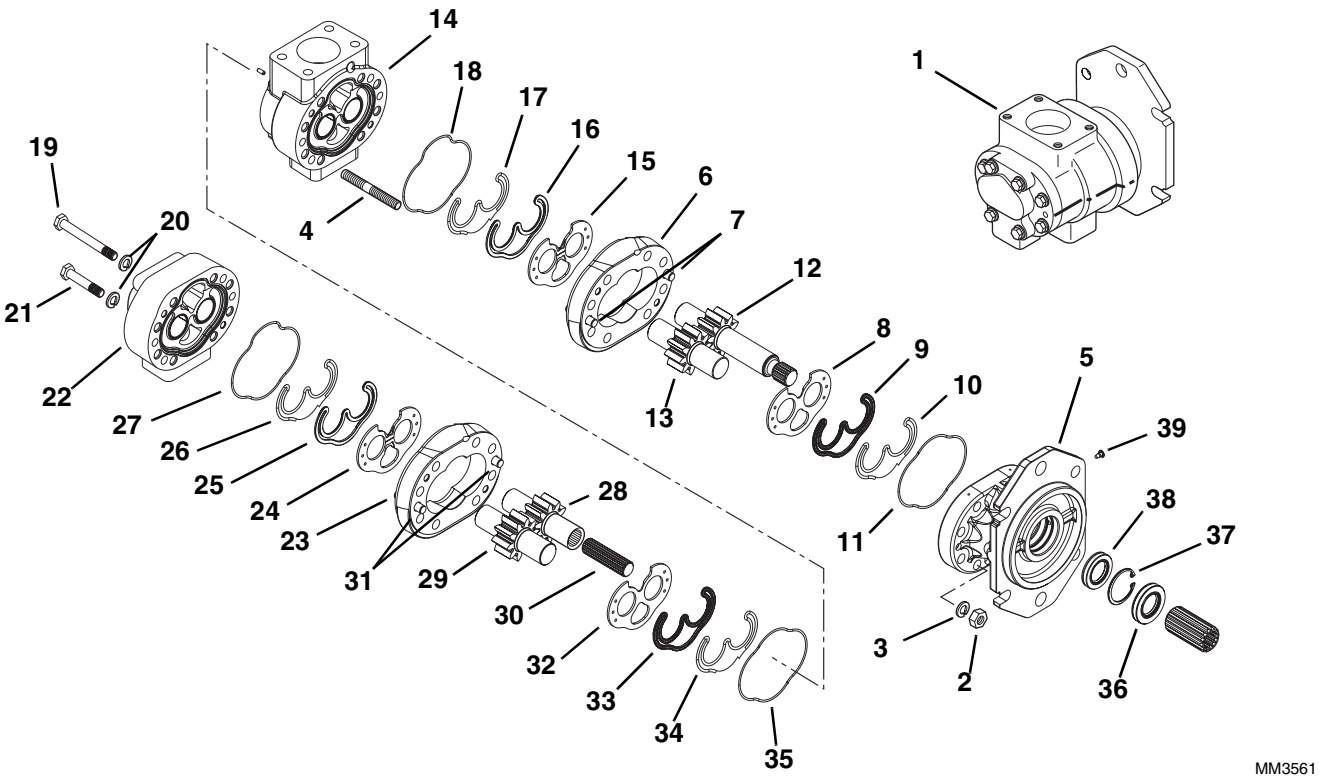
1. A seal removal tool made by heating the tip of a quality forged screwdriver and bending it. Grind off the tip to fit the notch behind the pump shaft seal. After bending and grinding the screwdriver, the measurement between the tip and the shaft (**16**) should be 1/4".



2. A lip seal installation bar made from 1-3/4" (44,5 mm) diameter round steel bar stock, 2" (50,8 mm) long. Grind the edges slightly to form the tool.
3. The following tools will also be required:
   - Arbor Press
   - Clean, Lintless Cloths
   - Soft Hammer
   - Medium-Grit Carborundum Stone
   - Oil and Graphite Grease
   - Internal Snap-Ring Pliers
   - Small Screwdriver
   - Torque Wrench
   - Vise with 8" Minimum Open Spread

c. General Repair Precautions

1. To facilitate repair of the pump and before any work is done, read and understand all of the steps used in the disassembly and assembly instructions.
2. Perform procedures in a clean area. It is important to service hydraulic equipment in as clean an environment as possible.
3. If it becomes necessary to separate the sections, use a plastic mallet to separate the sections. **NEVER** pry the sections apart with a pry tool or screwdriver.
4. The front and rear covers, center sections and ported section all have notches cast into the edges for alignment when reassembling the sections. By lining up the notches of these parts the pump will be properly assembled and proper rotation of the pump will be assured. It is still recommended that the parts be marked on the side to ensure proper reassembly.
5. Gears are closely matched sets that wear in together. Keep gears together as sets when removing them from a unit. Handle gears with care to avoid damaging the journals or teeth. Avoid touching gear journals. Always replace matched parts as a set.
6. To help prevent damage, **DO NOT** grip machined surfaces in a vise.
7. If parts are difficult to fit together during assembly, tap gently with a soft hammer. **NEVER** use an iron or steel hammer to tap parts.
8. **NEVER** hammer bushings into bores. Use an arbor press and bushing drivers of appropriate sizes to install bushings.



d. Pump Disassembly

1. Plug all ports and thoroughly clean the outside of the pump (**1**) before starting to disassemble the pump.
2. Remove the port plugs and drain all the oil from the pump into a suitable container.
3. Place the pump in a vise with the shaft end up. Tighten the jaws of the vise securely on the pump.
4. Loosen and remove the eight nuts (**2**) and lockwashers (**3**) from the stud bolts (**4**). Save the lockwashers and nuts for reassembly.
5. Use a plastic mallet to separate the mounting flange housing (**5**) from the front center section (**6**). The two dowel pins (**7**) which align the front center section (**6**) and the mounting flange housing (**5**) are a tight fit and will require the use of the plastic mallet to separate. **DO NOT** use a screwdriver or other pry tool to separate these parts as damage will result. Remove the mounting flange housing from the pump.
6. Remove the wear plate (**8**) from the mounting flange housing (**5**). Place the wear plate on a clean surface.
7. Remove the plastic seal retainer (**9**) with the seal gland (**10**) from the mounting flange housing (**5**). Discard the seal retainer with seal gland.
8. Remove the square cross section o-ring (**11**) from the mounting flange housing (**5**). Discard the o-ring.
9. Use marking fluid to identify the intersecting teeth of the drive gear (**12**) and the driven gear (**13**). Carefully remove the driven gear and then the drive gear from the pump and place on a clean surface.
10. Use a plastic mallet to separate the center section (**6**) from the ported section (**14**) of the pump. The two dowel pins (**7**) which align the front center section (**6**) and ported section (**14**) are a tight fit and will require the use of the plastic mallet to separate. **DO NOT** use a screwdriver or other pry tool to separate these parts as damage will result.
11. Remove the center section from the pump.
12. Remove the wear plate (**15**) and the plastic seal retainer (**16**) with the seal gland (**17**) from the ported section (**14**). Discard the seal retainer with seal gland. Place the wear plate on a clean surface.

13. Remove the square cross section o-ring (**18**) from the ported section (**14**). Discard the o-ring.
14. Remove the eight stud bolts (**4**) from the ported section (**14**). Save the stud bolts for reassembly.
15. Remove the four long bolts (**19**), lockwashers (**20**), four short bolts (**21**) and lockwashers (**20**) holding the rear section cover (**22**) and rear center section (**23**) to the ported section (**14**) of the pump. Carefully remove the front cover from the front center section housing. The two locating dowel pins (**31**) will remain in place on the center section.
16. Remove the wear plate (**24**) and the plastic seal retainer (**25**) with the seal gland (**26**) from the rear section cover (**22**). Discard the seal retainer with seal gland. Place the wear plate on a clean surface.
17. Remove the square cross section o-ring (**27**) from the rear section cover (**22**). Discard the o-ring.
18. Use marking fluid to identify the intersecting teeth of the drive gear (**28**) and the driven gear (**29**). Carefully remove the driven gear and then the drive gear from the lower gear bearing block.
19. Remove the splined adapter shaft (**30**) from the drive gear (**28**).
20. Use a plastic mallet to separate the rear center section (**23**) from the ported section (**14**) of the pump. The two dowel pins (**31**) which align the rear center section (**23**) and ported section (**14**) are a tight fit and will require the use of the plastic mallet to separate. **DO NOT** use a screwdriver or other pry tool to separate these parts as damage will result.
21. Remove the front center section from the ported section.
22. Remove the wear plate (**32**) and the plastic seal retainer (**33**) with the seal gland (**34**) from the ported section (**14**). Discard the seal retainer with seal gland. Place the wear plate on a clean surface.
23. Remove the square cross section o-ring (**35**) from the ported section (**14**). Discard the o-ring.
24. Remove the outer shaft seal (**36**) from the mounting face of the mounting flange housing (**5**). Use a internal snap ring pliers to remove the snap ring (**37**) holding the inner shaft seal (**38**) in the mounting flange housing. Discard the snap ring, outer seal and inner shaft seal.
25. Remove the weep hole plug (**39**) from the side of the pump mounting flange. Discard the plug.

e. Pump Cleaning

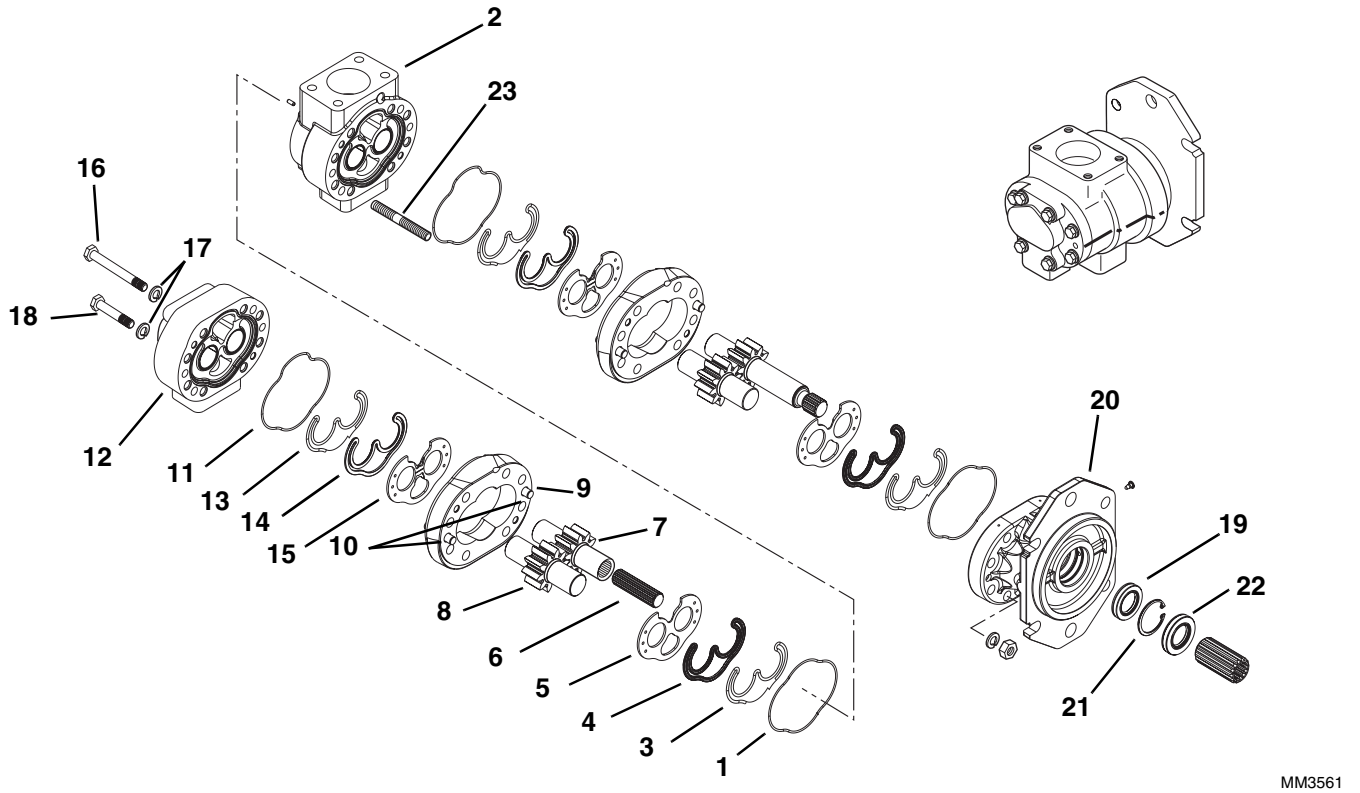
Clean all pump components with a suitable cleaner such as trichlorethylene. Dry all parts thoroughly with a clean, lintless cloth.

f. Pump Inspection

1. Check the splines on the drive gears (**12** and **28**) for twisted or broken teeth, nicks or excessive wear. Inspect the gear journals for scratches or discoloration. Any discoloration of shaft requires replacement of the gear sets. Replace drive gears and driven gears as matched sets only.
2. Inspect the splined adapter shaft (**30**) for twisted or broken teeth, nicks or excessive wear.
3. Inspect the drive and driven gear teeth for scratches or excessive wear. Light stoning of the teeth to remove sharp edges is permissible.
4. Inspect the gear face of both drive gears (**12** and **28**) and both driven gears (**13** and **29**). If the face edge of the gear teeth are sharp, they will mill into the wear plates. If wear on the face of the gears has occurred, the gears need to be replaced.
5. Inspect the bearings in the mounting flange housing (**5**) for excessive wear, scoring, flaking or movement of the bearings.
6. Inspect the bearings in the ported section (**14**) for excessive wear, scoring, flaking or movement of the bearings.
7. Inspect the bearings in the rear section cover (**22**) for excessive wear, scoring, flaking or movement of the bearings.
8. Inspect the gear pockets inside the front center section (**6**) and the rear center section (**23**). It is normal for the surface inside the gear housing to show a clean “wipe” on the inside gear pocket wall on the intake side. There should not be excessive wear or deep scratches or gouges.
9. Inspect the bronze side of the wear plates (**8**, **15**, **24** and **32**) for erosion, pitting, scratches or scoring. Replace if damaged.

Note: *Refer to the parts manual when ordering kits to repair or replace sections of this pump. Not all parts of this pump are serviced separately.*

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.*



g. Pump Assembly

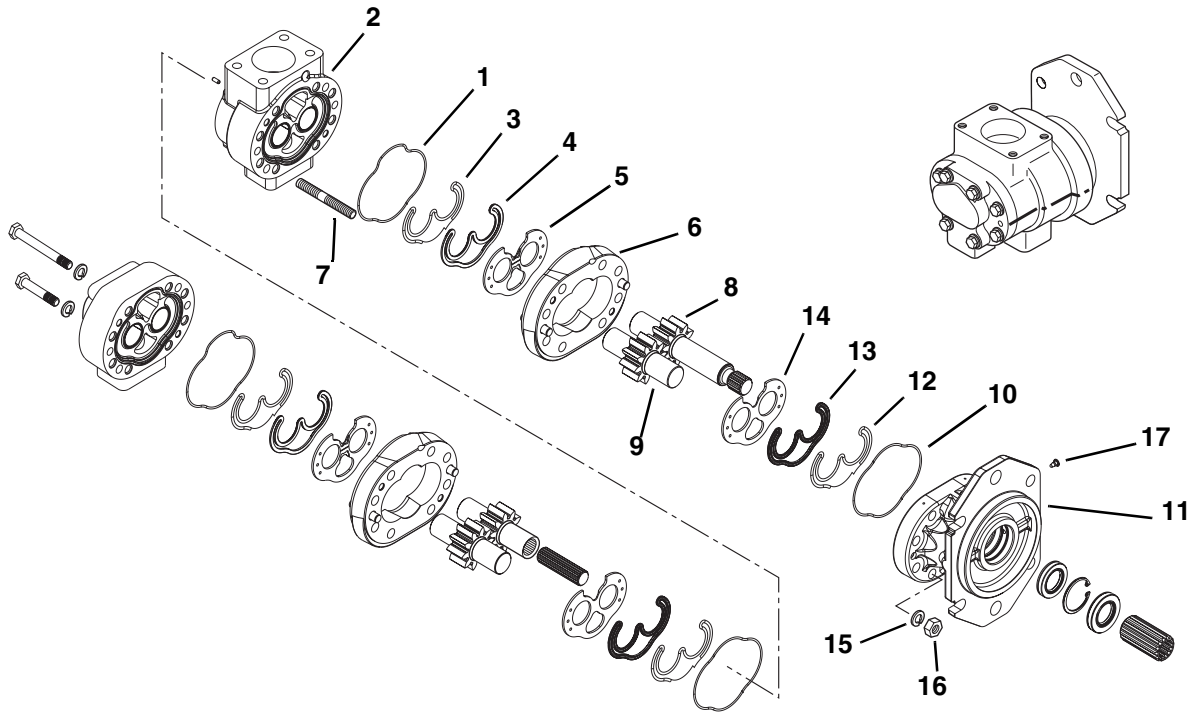
IMPORTANT: *It is important that the relationship of the front cover, front center section, ported section and center section is correct. Notches cast into the outside surfaces of these three parts must be aligned for proper reassembly of this pump. Also, use the alignment marks put on the side of the housing sections for reassembly. Failure to properly assemble this pump will result in low flow, low pressure and possible damage to the pump.*

1. Rinse all parts in an approved solvent. Blow dry and wipe the parts with a clean, lintless cloth before beginning assembly.

Note: *Upon reassembly of the pump, all parts should be lightly oiled with clean hydraulic oil. Use small amounts of graphite grease to hold seals and seal retainers in place during assembly.*

2. Apply a light coating of graphite grease to the new square cross section o-ring (**1**) and carefully install into the groove in the front side of the ported section (**2**). Be careful that the o-ring does not twist in the groove. The o-ring must be flat in the groove for proper sealing of the pump when assembled.
3. Coat both the new seal gland (**3**) and new plastic seal retainer (**4**) with graphite grease. Carefully install the seal gland in the groove in the seal retainer, make sure the seal gland is seated completely in the seal retainer.
4. Coat the seal cavity area in the ported section with graphite grease to hold the new seals in place during assembly.
5. Install the assembled seal gland and seal retainer in the cavity in the ported section (**2**). Be sure the plastic seal retainer (**4**) is facing away from the ported section. Very carefully press this assembly in place until it is firmly seated in the machined recess. This assembly must be seated completely in the recess to allow proper installation of the bronze wear plate (**5**).
6. Lubricate the steel side of the bronze wear plate (**5**) with graphite grease and install over the seal retainer and seal gland assembly. When properly installed the bronze face will be next to the gears and flush with the surface of the ported section.
7. Insert the splined adapter shaft (**6**) into the splined end of the drive gear (**7**).

8. Lubricate the drive gear (**7**) with clean hydraulic oil. Very carefully insert the shaft through the wear plate (**5**).
9. Lubricate the driven gear (**8**) with clean hydraulic oil and install the gear through the wear plate (**5**) and into the ported section (**2**). Align the marks on the gear teeth and push all the way into the ported section.
10. Line up the alignment notches or the alignment marks and install the rear center section (**9**) onto the ported section (**2**). It may be necessary to use a plastic mallet to seat the front center section on to the ported section because of the tight fit of the dowel pins (**10**). Hold the bronze wear plate (**5**) in position while tapping the front center section. Seat the front center section tightly against the ported section.
11. Apply a light coating of graphite grease to the new square cross section o-ring (**11**) and carefully install into the groove in the rear section cover (**12**). Be careful that the o-ring does not twist in the groove. The o-ring must be flat in the groove for proper sealing of the pump when assembled.
12. Coat both the new seal gland (**13**) and new plastic seal retainer (**14**) with graphite grease. Carefully install the seal gland in the groove in the seal retainer, make sure the seal gland is seated completely in the seal retainer.
13. Coat the seal cavity area in the front section cover with graphite grease to hold the new seals in place during assembly.
14. Install the assembled seal gland and seal retainer in the cavity in the rear section cover (**12**). Be sure the plastic seal retainer (**14**) is facing away from the front section cover. Very carefully press this assembly in place until it is firmly seated in the machined recess. This assembly must be seated completely in the recess to allow proper installation of the bronze wear plate (**15**).
15. Lubricate the steel side of the bronze wear plate (**15**) with graphite grease and install over the seal retainer and seal gland assembly. When properly installed the bronze face will be next to the gears and flush with the surface of the front section cover.
16. Line up the alignment notches or the alignment marks and install the rear section cover (**12**) onto the rear center section (**9**). It may be necessary to use a plastic mallet to seat the rear section cover on to the rear center section because of the tight fit of the dowel pins (**10**). Hold the bronze wear plate (**15**) in position while tapping the front section cover. Seat the front section cover tightly against the front center section.
17. Secure the rear section cover (**12**) and rear center section (**9**) to the ported section (**2**). Insert the four long bolts (**16**) with lockwashers (**17**) into the four holes in the raised part of the cover. Insert the four short bolts (**18**) with lockwashers (**17**) into the four holes in the lower part of the cover. Torque all eight bolts to 65-75 lb/ft (88-101 Nm).
18. Install the new inner shaft seal (**19**) into the mounting flange housing (**20**), make sure the spring loaded member of the shaft seal is toward the inside of the pump. Press the seal into the bore seal bore until the seal reaches the bottom of the bore. Uniform pressure must be used to prevent misalignment or damage to the seal.
19. Retain the inner shaft seal (**19**) in place with the new internal retaining ring (**21**). Be sure the retaining ring is seated completely in the groove.
20. Install the new outer shaft seal (**22**) which has a larger outside diameter into the seal cavity in the mounting flange housing (**20**). Make sure the spring loaded member of the outer shaft seal is toward the inside of the pump. Uniform pressure must be used to prevent misalignment or damage to the seal. Press the seal into the cavity until the seal is seated properly.
21. Install the eight threaded studs (**23**) into the ported section (**2**). The course thread end of the studs goes into the ported section. Torque the studs to 25-35 lb/ft (34-47 Nm).



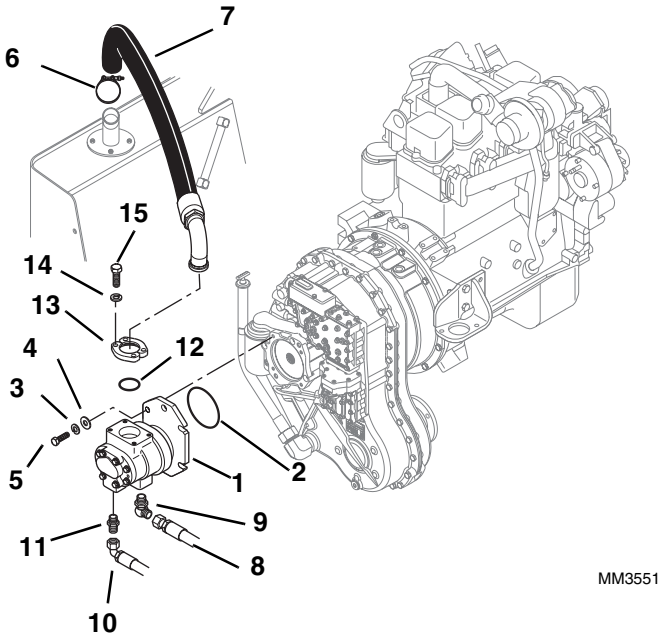
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22. Apply a light coating of graphite grease to the new square cross section o-ring (**1**) and carefully install into the groove in the ported section (**2**). Be careful that the o-ring does not twist in the groove. The o-ring must be flat in the groove for proper sealing of the pump when assembled.
23. Coat both the new seal gland (**3**) and new plastic seal retainer (**4**) with graphite grease. Carefully install the seal gland in the groove in the seal retainer, make sure the seal gland is seated completely in the seal retainer.
24. Coat the seal cavity area in the ported section (**2**) with graphite grease to hold the new seals in place during assembly.
25. Install the assembled seal gland and seal retainer in the cavity in the ported section (**2**). Be sure the plastic seal retainer (**4**) is facing away from the ported section. Very carefully press this assembly in place until it is firmly seated in the machined recess. This assembly must be seated completely in the recess to allow proper installation of the bronze wear plate (**5**).
26. Lubricate the steel side of the bronze wear plate (**5**) with graphite grease and install over the seal retainer and seal gland assembly. When properly installed the bronze face will be next to the gears and flush with the surface of the ported section. Lightly oil the bronze side of the wear plate with clean hydraulic oil.
27. Line up the alignment notches or the alignment marks on the ported section and the front center section. Slide the front center section (**6**) onto the studs (**7**). Make sure all the seals and wear plates have stayed in their proper position. It may be necessary to use a plastic mallet to seat the front center section onto the ported section.
28. Lubricate the drive gear (**8**) with clean hydraulic oil. Very carefully insert the shaft through the wear plate (**5**).
29. Lubricate the driven gear (**9**) with clean hydraulic oil and install the gear through the wear plate (**5**) and into the ported section (**2**). Align the marks on the gear teeth and push all the way into the ported section.

30. Apply a light coating of graphite grease to the new square cross section o-ring (**10**) and carefully install into the groove in the mounting flange housing (**11**). Be careful that the o-ring does not twist in the groove. The o-ring must be flat in the groove for proper sealing of the pump when assembled.
31. Coat both the new seal gland (**12**) and new plastic seal retainer (**13**) with graphite grease. Carefully install the seal gland in the groove in the seal retainer, make sure the seal gland is seated completely in the seal retainer.
32. Coat the seal cavity area in the mounting flange housing (**11**) with graphite grease to hold the new seals in place during assembly.
33. Install the assembled seal gland and seal retainer in the cavity in the mounting flange housing (**11**). Be sure the plastic seal retainer (**13**) is facing away from the mounting flange housing. Very carefully press this assembly in place until it is firmly seated in the machined recess. This assembly must be seated completely in the recess to allow proper installation of the bronze wear plate (**14**).
34. Lubricate the steel side of the bronze wear plate (**14**) with graphite grease and install over the seal retainer and seal gland assembly. When properly installed the bronze face will be next to the gears and flush with the surface of the mounting flange housing. Lightly oil the bronze side of the wear plate with clean hydraulic oil.
35. Install the mounting flange housing (**11**) onto the studs (**7**). Be careful not to damage the seals inside the mounting flange housing with the splined end of the drive gear (**8**). Make sure all the seals and wear plates have stayed in their proper position. It may be necessary to use a plastic mallet to seat the mounting flange housing onto the center section.
36. Install the eight lockwashers (**15**) and hex nuts (**16**) onto the threaded studs. Torque the hex nuts to 65-75 lb/ft (88-101 Nm).
37. Install the new weep hole plug (**17**) in the side of the mounting flange. Push the weep hole plug all the way in.
38. Place a small amount of clean hydraulic oil in the inlet of the pump and rotate the drive shaft one revolution. No binding should be evident.

h. Pump Installation

1. Place the pump (**1**) and a new oiled o-ring (**2**) into position on the transmission. Align the pump gear shaft coupling with the internal transmission gear so that the machined teeth mesh together.
2. Align the bolt holes with the pump mount holes. Line up the holes in the accumulator charge valve mounting bracket with the pump flange. Secure the pump and mounting bracket to the transmission with four plain washers (**4**), lockwashers (**3**) and capscrews (**5**). Torque the capscrews to 75 lb/ft (102 Nm).
3. If necessary, slide the T-bolt band clamp (**6**) onto the pump inlet hose (**7**). Secure the hose to the inlet tube assembly with the T-bolt band clamp.
4. Thread the front outlet hose (**8**) onto the connector (**9**).
5. Thread the rear outlet hose (**10**) onto the connector (**11**).
6. Prime the pump by filling the pump inlet opening with fresh, filtered hydraulic oil from a clean container before attaching the inlet hose (**7**).
7. Place a new oiled o-ring (**12**) into position over the opening and secure the inlet hose (**7**) with two flange halves (**13**), four lockwashers (**14**) and four capscrews (**15**). Torque the capscrews to 31 lb/ft (42 Nm).



8. Check all routing of hoses, wiring and tubing for sharp bends or interference with any rotating members. All tube and hose clamps must be tight.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

9. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

10. Inspect for leaks and check all fluid levels. The hydraulic reservoir oil level must be to the middle of the sight gauge.

Note: *Check for leaks and repair as required before continuing.*

i. Pump Test

Refer to *Section 9.7, Hydraulic System Testing*.

1. Perform a flow meter test on both pumps.
2. Check the load sense at the unloader valve.
3. Check the load sense at the accumulator charge valve.
4. Check the system functions.



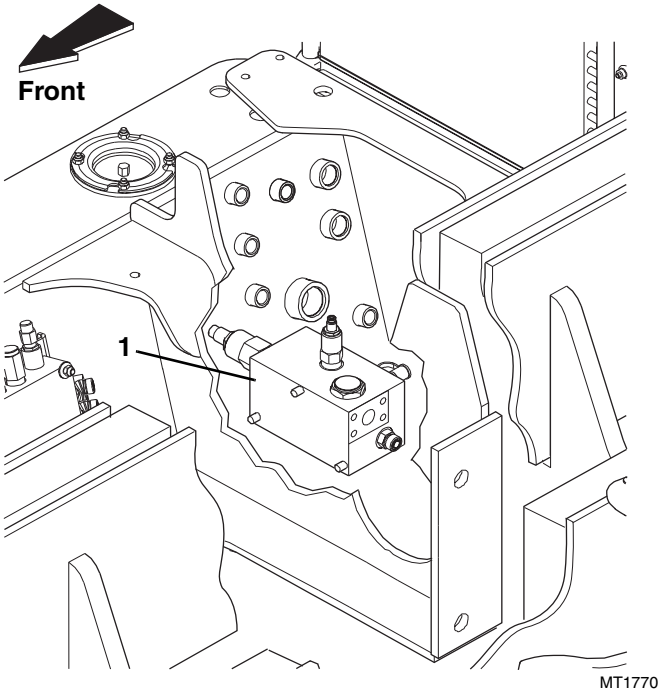
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9.12 VALVES AND MANIFOLDS

Valves are devices that open or close passageways. Manifolds contain circuit passageways involved in the distribution of hydraulic fluid flowing under pressure. There are various valves and manifolds in use on this vehicle. As valves open and close, hydraulic fluid is directed to flow through various passageways to the prescribed circuit, causing vehicle functions to occur.

9.12.1 Unloader Valve

The unloader valve (**1**) creates system pressure and distributes the hydraulic fluid for various vehicle functions via its load sense, bypass to tank (via the oil cooler), and primary and secondary valve ports. The unloader valve is secured to the underside of the frame near the rear of the hydraulic reservoir.



DO NOT loosen, disassemble or attempt to adjust any cartridges unless specifically instructed by **JLG** to do so! Tampering with the cartridges will irrevocably alter pressure in the affected circuits.

a. Unloader Valve Removal

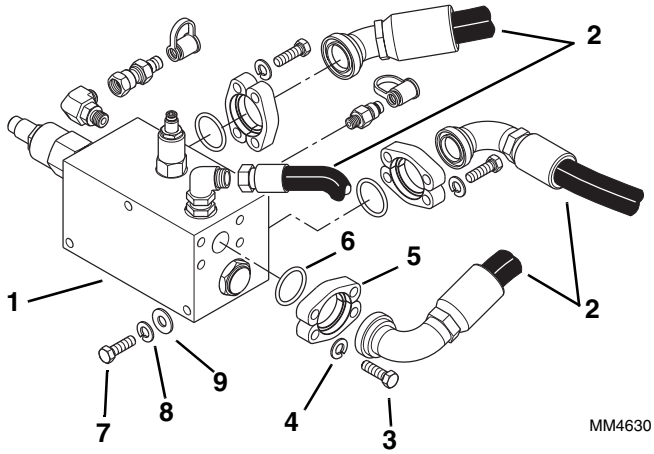
1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. At the unloader valve (**1**), label, disconnect and cap the hydraulic lines (**2**). Remove the twelve capscrews (**3**), twelve lockwashers (**4**), six flange halves (**5**) and three o-rings (**6**).
5. Remove the three capscrews (**7**), lockwashers (**8**) and washers (**9**) securing the unloader valve (**1**) to the vehicle frame. Remove the valve from the vehicle. Wipe up any hydraulic fluid spillage.

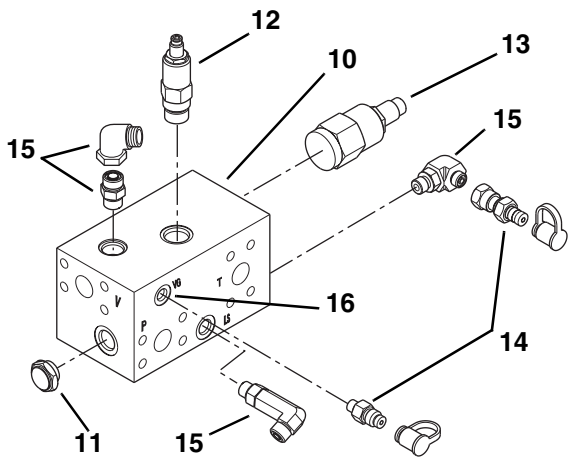


b. Unloader Valve Disassembly, Inspection and Assembly

1. Safely secure the unloader valve (**10**) in a bench vise or by other suitable means.

> **WARNING:** Significant pressure may be trapped inside the valve. Exercise caution when removing a valve. Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

2. Remove the o-ring boss plug (**11**).
3. Remove the relief valve (**12**).
4. Remove the differential pressure sense valve (**13**).
5. Remove the diagnostic test nipples (**14**) and remaining fittings (**15**).



6. Clean metal parts in an approved solvent such as triclorethylene and blow dry.
7. Inspect all sealing surfaces. They must be clean, smooth and free of damage, and have no indication of wear. Replace parts if damaged or worn.

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.*

8. Install the o-ring boss plug (**11**).
9. Install the relief valve assembly (**12**) and torque to 35-40 lb/ft (47-54 Nm).
10. Install the differential pressure sense valve assembly (**13**) and torque to 80-90 lb/ft (108-122 Nm).
11. Install diagnostic nipples (**14**) and fittings (**15**).

c. Unloader Valve Installation

1. Secure the unloader valve (**1**) to the vehicle frame near the engine with the three capscrews (**7**), lockwashers (**8**) and washers (**9**). Torque the capscrews to 31 lb/ft (42 Nm).

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.*

2. Connect the hydraulic lines to their appropriate ports on the unloader valve.
3. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members. All tube and hose clamps must be tight.

> **WARNING:** Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

4. Start the engine and run at approximately one-third to one-half throttle for approximately one minute without moving the vehicle or operating any hydraulic functions.

> **WARNING:** Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

5. Inspect for leaks and check all fluid levels. The hydraulic reservoir oil level must be to the middle of the sight gauge.

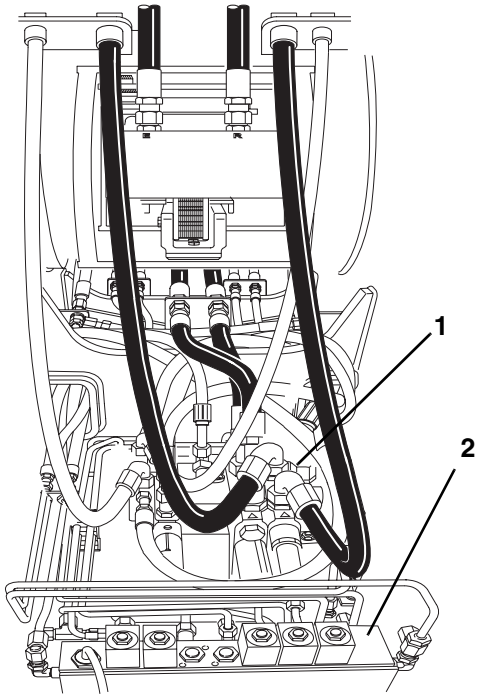
Note: *Check for leaks and tighten fittings or repair as required before continuing. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.*

d. Unloader Valve Pressure Check Test

1. Monitor the valve pressure at the VG test port (**16**) on the unloader valve. It should be at 200 ±50 psi (13,8 ±3,4 bar) within moments after starting the engine. Adjust the differential pressure sense valve as required.
2. Check the pressure at the VG test port (**16**) on the unloader valve while performing the boom lower function. It should be 3500 ±100 psi (241 ±6,9 bar). Adjust the relief valve as required.

9.12.2 Valve Plate Assembly

The main control valve (**1**) and the pilot select manifold (**2**) are mounted on a valve plate located at the back of the vehicle inside the rear door.

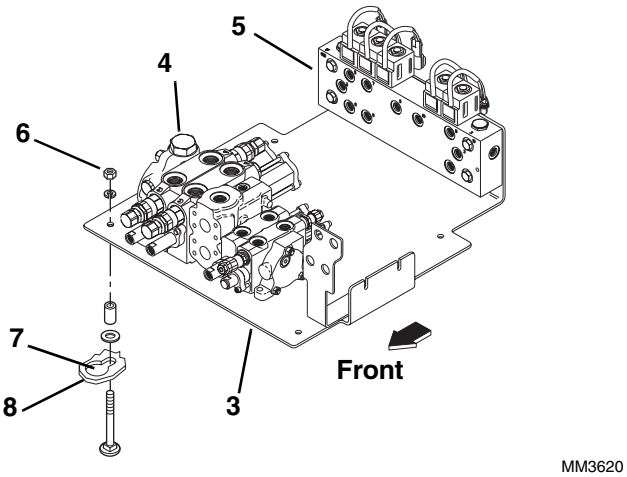


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Follow the procedure in this section to remove the valve plate assembly (**3**) from the vehicle in order to service the main control valve (**4**) or the pilot select manifold (**5**). If only the pilot select manifold needs servicing, it is not necessary to remove the entire valve plate assembly from the vehicle.

a. Valve Plate Removal

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, raise the boom, place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.



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> **WARNING:** **DO NOT** get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing that requires the boom to be up. Unexpected lowering of the boom may cause death or serious injury.

3. Temporarily block up or support the raised boom.

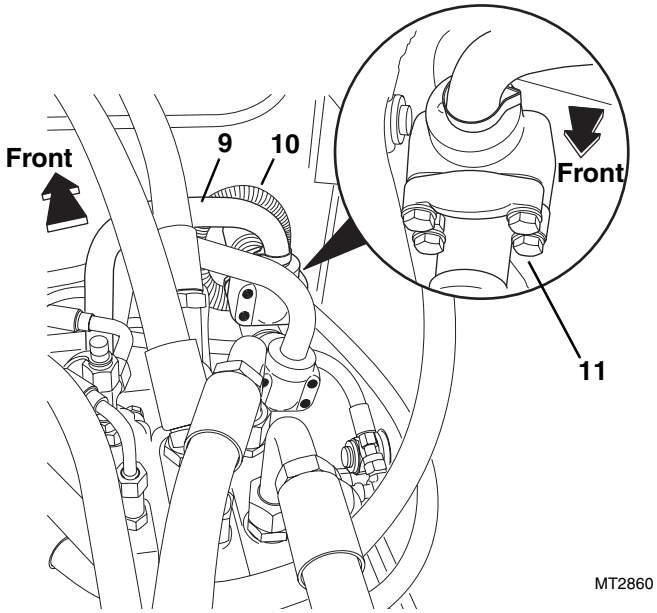
> **WARNING:** Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

4. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

> **WARNING:** Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

5. Thoroughly clean the pilot select manifold, main control valve and surrounding area, including all hoses and fittings, before proceeding.
6. Label or otherwise mark the hydraulic hoses and tubes at the main control valve and pilot select manifold. Place a suitable container to catch hydraulic fluid drainage beneath the rear counterweight.

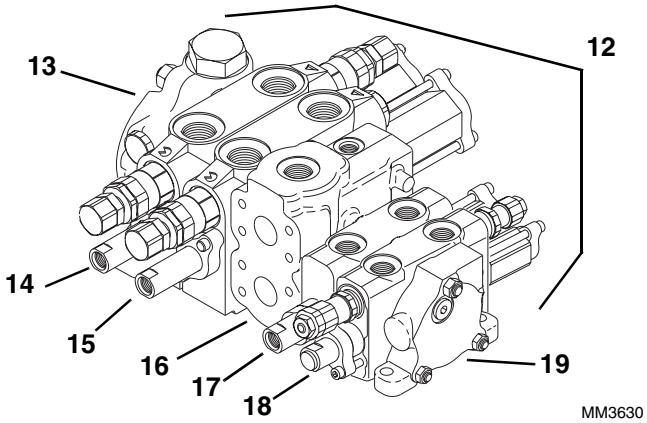
Note: *Before disconnecting the unloader valve tube (**9**), remove the tie wrap on the hoses (underneath the vehicle) coming through the conduit (**10**). This will provide enough play to slide the valve plate assembly forward during the removal process. Disconnect the unloader valve tube by removing the four bolts on the flange (**11**).*



7. Loosen, but **DO NOT** remove, the four nuts (**6**) securing the valve plate to the frame. The carriage bolt assembly should remain connected to the valve plate. Once the bolts are loose, the valve plate assembly can be slid forward and lifted out. There are slots (**7**) in the frame (**8**) so that the carriage bolt head can slip through.
8. Remove the entire valve plate assembly from the vehicle.
9. Secure the valve plate assembly to a work bench or a vise, or stabilize by other suitable means.
10. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle and the work area.

9.12.3 Main Control Valve

The main control valve assembly (**12**) consists of various working sections with their own valve assemblies, each providing a specific hydraulic function. The section assemblies are the outlet (**13**), extend/retract (**14**), lift/lower (**15**), mid-inlet (**16**), frame sway (**17**), attachment tilt (**18**) and end cap (**19**) sections.

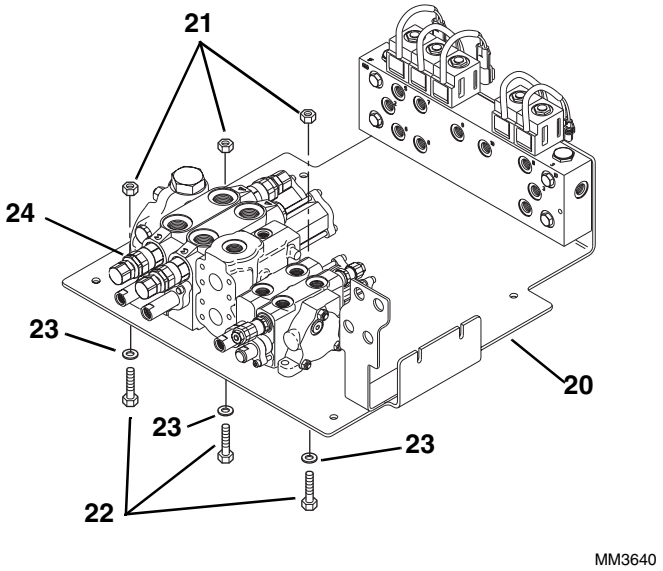


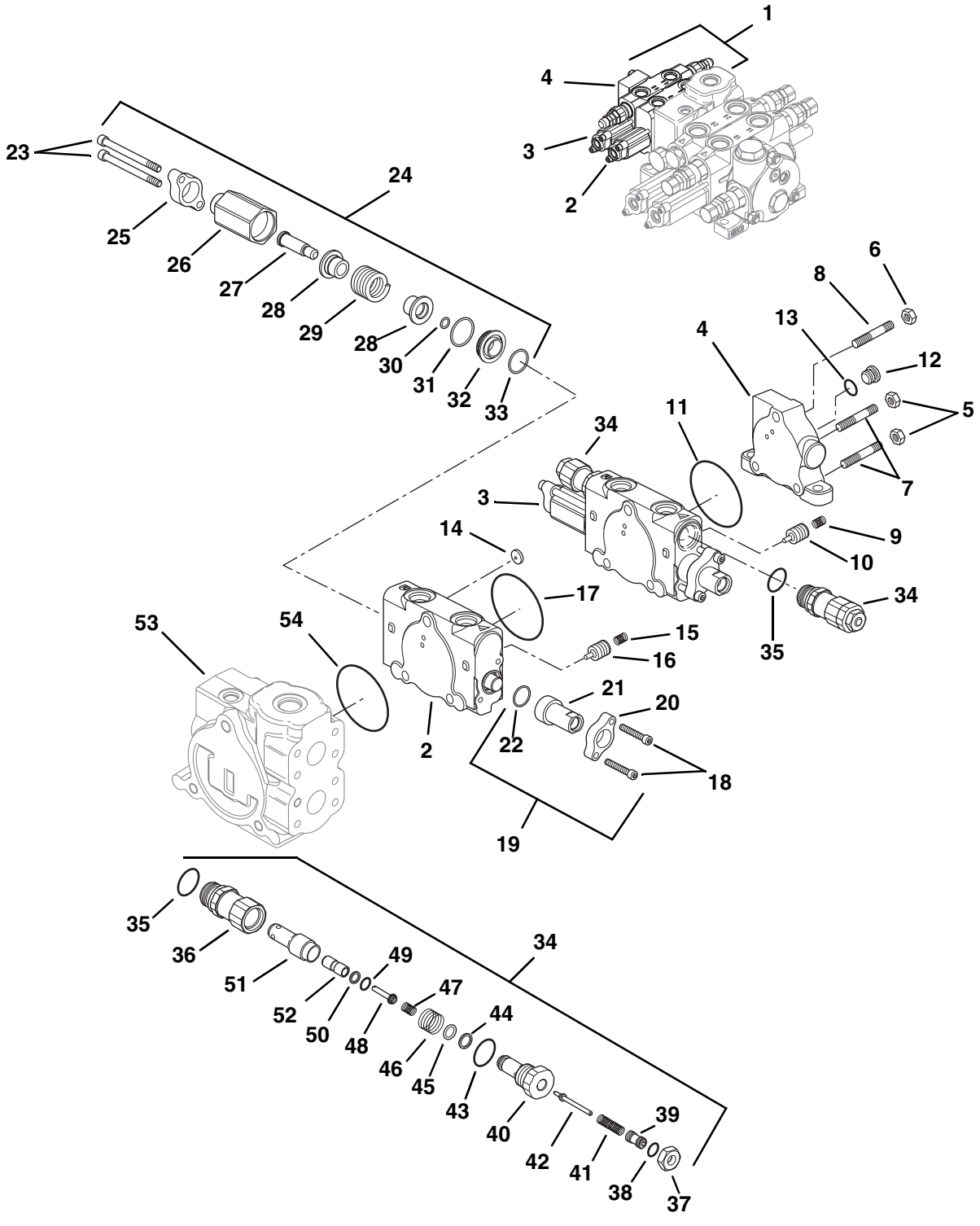
If service to the main control valve assembly is required, remove the valve plate assembly from the vehicle. Refer to *Section 9.12.2, Valve Plate Assembly*.

a. Main Control Valve Removal from Valve Plate

Before disassembling the main control valve, remove it from the valve plate assembly.

1. Working from beneath the valve plate assembly (**20**), remove the three locknuts (**21**), capscrews (**22**) and plain washers (**23**) securing the main control valve (**24**) to the plate (**20**).
2. Remove the main control valve from the plate.




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b. Main Control Valve Disassembly

This section covers disassembly of one half (**1**) of the main control valve, including the frame sway (**2**), attachment tilt (**3**) and end cap (**4**) sections of the main control valve.

1. To disassemble the frame sway, attachment tilt and end cap sections of the main control valve (**1**), remove the nuts (**5** and **6**) from the end of the tie rods (**7** and **8**). The tie rods can remain in place in the sections.
2. Disassemble each section assembly as required.

Some sections include a pre-adjusted relief valve that regulates pressure in a specific circuit.

***IMPORTANT: DO NOT** adjust any of the relief valve assemblies! Tampering with a relief valve will irrevocably alter pressure in the affected circuit, requiring re-calibration or a new relief valve.*

Disassemble the End Cap Section

1. Carefully separate the end cap section (**4**) from the attachment tilt section (**3**). Avoid dislodging or losing the spring (**9**) and poppet (**10**).
2. Remove the o-ring (**11**) from between the two sections.
3. Remove the shut-off plug (**12**) and o-ring (**13**) from the end cap section (**4**).

Disassemble the Attachment Tilt Section

1. Carefully separate the attachment tilt section (**3**) from the frame sway section (**2**). Avoid dislodging or losing the shuttle (**14**), spring (**15**) and poppet (**16**).
2. Remove the o-ring (**17**) from between the two sections.
3. Remove the spring (**9**) and poppet (**10**) from the attachment tilt section (**3**).
4. Remove both socket head capscrews (**18**) securing the end mechanism (**19**) to the attachment tilt section (**3**).
5. Remove the retainer (**20**), spool cap (**21**) and o-ring (**22**) from the end mechanism (**19**).
6. Remove both socket head capscrews (**23**) securing the other end mechanism (**24**) to the attachment tilt section (**3**).
7. Remove the retainer (**25**) and spool cap (**26**).
8. Hold the spool from turning while removing the spool end (**27**) from the spool.
9. Remove the spring seat (**28**), spring (**29**), another spring seat (**28**), small o-ring (**30**), large o-ring (**31**), spool cap retainer (**32**) and o-ring (**33**) from this end mechanism (**24**).

Disassemble the Relief Valve

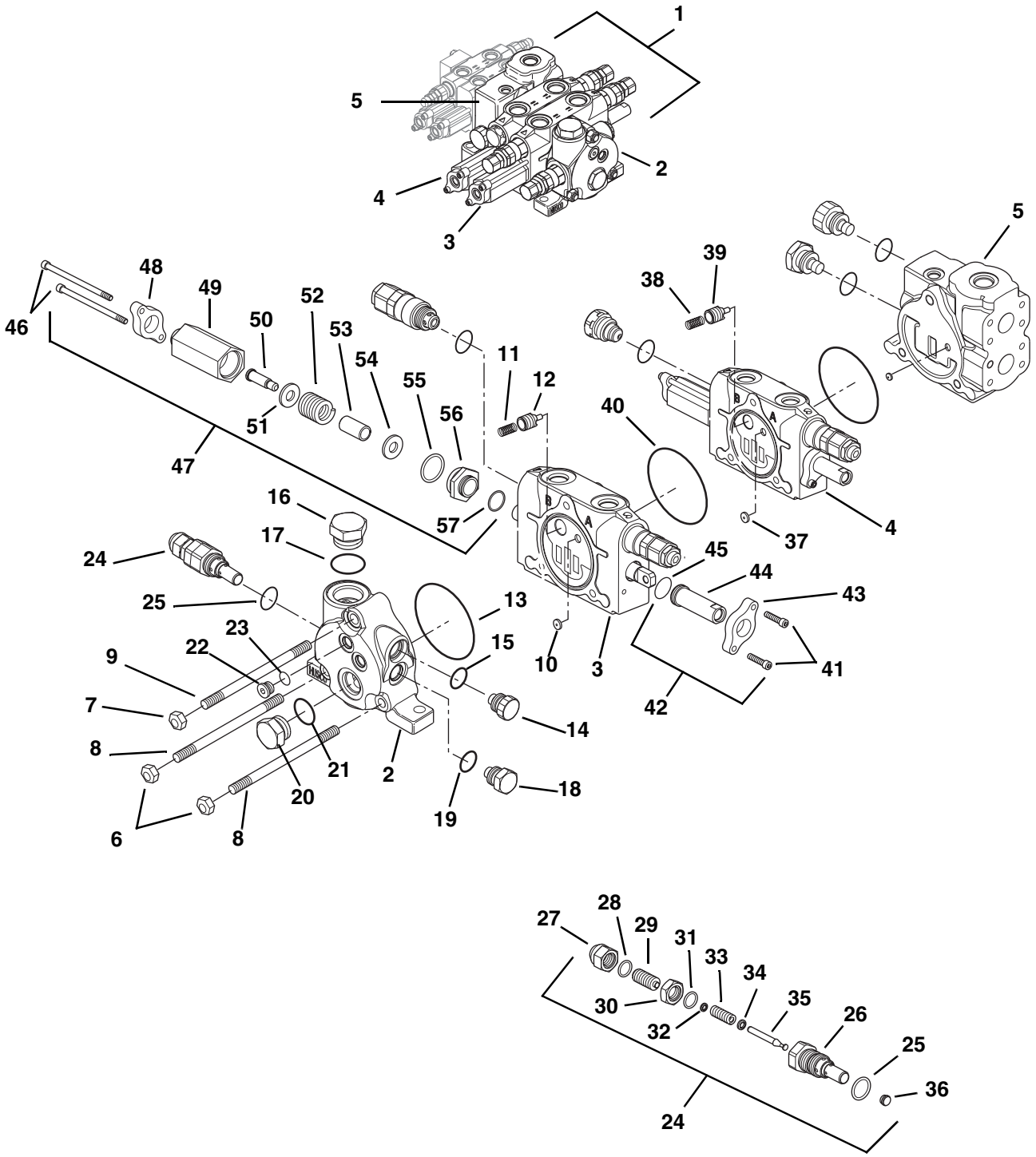
The relief valve assemblies (**34**) are part of the attachment tilt section. The valves are preset at 4000 ±50 psi (276 ±3,5 bar).

***Note:** The internal parts of the relief valve can be disassembled without removing the relief valve body (**36**) from the valve section. Skip to step 2 to start disassembly of the relief valve.*

1. Remove the relief valve (**34**) and o-ring (**35**) from the attachment tilt section assembly (**3**).
2. Grip the relief valve body (**36**) with a suitable tool and use another tool to remove the nut (**37**), revealing an o-ring (**38**) and the adjustment screw (**39**).
3. Carefully remove the plug (**40**), spring (**41**) and pilot poppet (**42**).
4. Remove the large o-ring (**43**), back-up ring (**44**), small o-ring (**45**), large spring (**46**), small spring (**47**), piston (**48**), o-ring (**49**), back-up ring (**50**) and relief valve poppets (**51** and **52**).

Disassemble the Frame Sway Section

1. Carefully separate the frame sway section (2) from the mid-inlet section (**53**). Remove the o-ring (**54**) from between the two sections. Remove the shuttle (**14**), spring (**15**) and poppet (**16**) from the frame sway section (**2**).
2. Remove both socket head capscrews (**18**) securing the end mechanism (**19**) to the frame sway section (**2**).
3. Remove the retainer (**20**), spool cap (**21**) and o-ring (**22**) from the end mechanism (**19**).
4. Remove both socket head capscrews (**23**) securing the other end mechanism (**24**) to the frame sway section (**2**).
5. Remove the retainer (**25**) and spool cap (**26**)
6. Hold the spool from turning while removing the spool end (**27**) from the spool.
7. Remove the spring seat (**28**), spring (**29**), another spring seat (**28**), small o-ring (**30**), large o-ring (**31**), spool cap retainer (**32**) and o-ring (**33**) from this end mechanism (**24**).


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c. Main Control Valve Disassembly

This section covers the disassembly of the other half (**1**) of the main control valve, including the outlet (**2**), extend/retract (**3**), lift/lower (**4**) and mid-inlet (**5**) sections of the main control valve.

1. To disassemble the outlet, extend/retract, lift/lower and mid-inlet sections of the main control valve (**1**), remove the three nuts (**6** and **7**) from the end of the tie rods (**8** and **9**). The tie rods can remain in place in the sections.
2. Disassemble each section as required.

Some sections include a pre-adjusted relief valve that regulates pressure in a specific circuit.

IMPORTANT: DO NOT *adjust any of the relief valve assemblies! Tampering with a relief valve will irrevocably alter pressure in the affected circuit, requiring re-calibration or a new relief valve assembly.*

Disassemble the Extend/Retract and Lift/Lower Outlet Section

1. Carefully separate the outlet section (**2**) from the extend/retract section (**3**). Avoid dislodging or losing the shuttle (**10**), spring (**11**) and poppet (**12**).
2. Remove the o-ring (**13**) from between the two sections.
3. Remove the shut-off plug (**14**) and o-ring (**15**) from the outlet section (**2**).
4. Remove the plug (**16**), o-ring (**17**), plug (**18**), o-ring (**19**), plug (**20**), o-ring (**21**), plug (**22**) and o-ring (**23**) from the outlet section (**2**).

Disassemble the Main Relief Valve (Outlet Section)

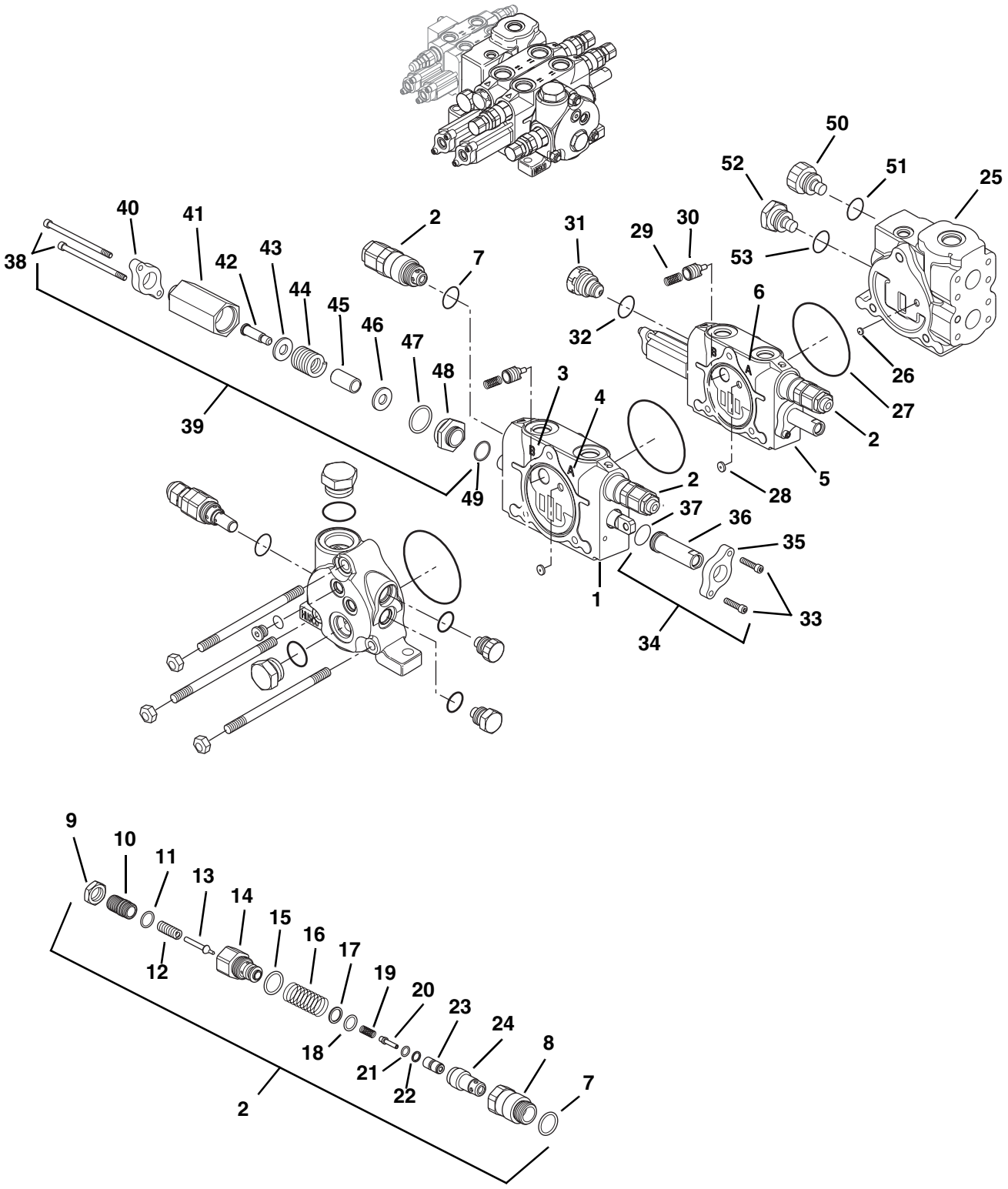
Note: *The internal parts of the relief valve can be disassembled without removing the relief valve body (***24***) from the outlet section. Skip to step 2 to start disassembly of the relief valve.*

The main relief valve (**24**) is part of the outlet section (**2**). The valve is preset at 3000 ±100 psi (207 ±6,9 bar).

1. Remove the relief valve (**24**) and the seal (**25**) from the outlet section (**2**).
2. Grip the relief valve body (**26**) with a suitable tool and use another tool to remove the nut (**27**), revealing an o-ring (**28**) and the adjustment screw (**29**).
3. Remove the nut (**30**), o-ring (**31**), shim (**32**), spring (**33**), spring retainer (**34**), and poppet (**35**).
4. Remove the plug (**36**) from the body (**26**).

Disassemble the Extend/Retract Section

1. Carefully separate the extend/retract section (**3**) from the lift/lower section (**4**). Avoid dislodging or losing the shuttle (**37**), spring (**38**) and poppet (**39**).
2. Remove the o-ring (**40**) from between the two sections.
3. Remove the shuttle (**10**), spring (**11**) and poppet (**12**) from the extend/retract section (**3**).
4. Remove the two socket head capscrews (**41**) securing the end mechanism (**42**) to the extend/retract section (**3**).
5. Remove the retainer (**43**), spool cap (**44**) and o-ring (**45**) from the end mechanism (**42**).
6. Remove both socket head capscrews (**46**) securing the other end mechanism (**47**) to the extend/retract section (**3**).
7. Remove the retainer (**48**). Remove the spool cap (**49**) by unthreading it from the spool cap retainer (**56**).
8. Hold the spool from turning while removing the spool end (**50**) from the spool.
9. Remove the flat washer (**51**), spring (**52**), spacer (**53**), another flat washer (**54**), o-ring (**55**), spool cap retainer (**56**) and o-ring (**57**) from this end mechanism (**47**).


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Disassemble the Relief Valve (Extend/Retract and Lift/Lower Sections)

On the extend/retract section (**1**), one relief valve (**2**) is on the "B" side (**3**) and is preset at 3750 ±50 psi (258 ±3,5 bar); the other relief valve (**2**) is on the "A" side (**4**) and is preset at 3000 ±50 psi (207 ±3,5 bar). On the lift/lower section (**5**), the relief valve (**2**) is on the "A" side (**6**) and is preset at 3000 ±50 psi (207 ±3,5 bar).

Note: *The internal parts of the relief valves can be disassembled without removing the relief valve body from the valve section. Skip to step 2 to start disassembly of the relief valve.*

1. Remove the relief valve (**2**) and o-ring (**7**) from the appropriate section.
2. Grip the relief valve body (**8**) with a suitable tool and use another tool to remove the nut (**9**), revealing an adjustment screw (**10**) and an o-ring (**11**).
3. Remove the spring (**12**) and poppet (**13**) from the plug (**14**).
4. Remove the o-ring (**15**), large spring (**16**), back-up ring (**17**), o-ring (**18**), small spring (**19**), poppet (**20**), o-ring (**21**), back-up ring (**22**), small poppet (**23**) and large poppet (**24**) from the body (**8**).

Disassemble the Lift/Lower Section

1. Carefully separate the lift/lower section (**5**) from the mid-inlet section (**25**). Avoid dislodging or losing the shuttle (**26**) between the lift/lower (**5**) and mid-inlet (**25**) sections.
2. Remove the o-ring (**27**) from between the two sections. Remove the shuttle (**28**), spring (**29**) and poppet (**30**) from the lift/lower section (**5**).
3. Remove the anti-void assembly (**31**) and o-ring (**32**) from the lift/lower section (**5**).
4. Remove the relief valve (**2**) following the Relief Valve (Extend/Retract and Lift/Lower Sections) procedure.
5. Remove both socket head capscrews (**33**) securing the end mechanism (**34**) to the lift/lower section (**5**).
6. Remove the retainer (**35**), spool cap (**36**) and o-ring (**37**) from the end mechanism (**34**).
7. Remove both socket head capscrews (**38**) securing the other end mechanism (**39**) to the lift/lower section (**5**).
8. Remove the retainer (**40**).
9. Remove the spool cap (**41**) by unthreading it from the spool cap retainer (**48**).
10. Hold the spool from turning while removing the spool end (**42**).
11. Remove the flat washer (**43**), spring (**44**), spacer (**45**), another flat washer (**46**), o-ring (**47**), spool cap retainer (**48**) and o-ring (**49**) from this end mechanism (**39**).

Disassemble the Mid-Inlet Section

1. Remove the shuttle (**26**) from the mid-inlet section (**25**).
2. Remove the shut-off plug (**50**) and o-ring (**51**).
3. Remove the plug (**52**) and o-ring (**53**).

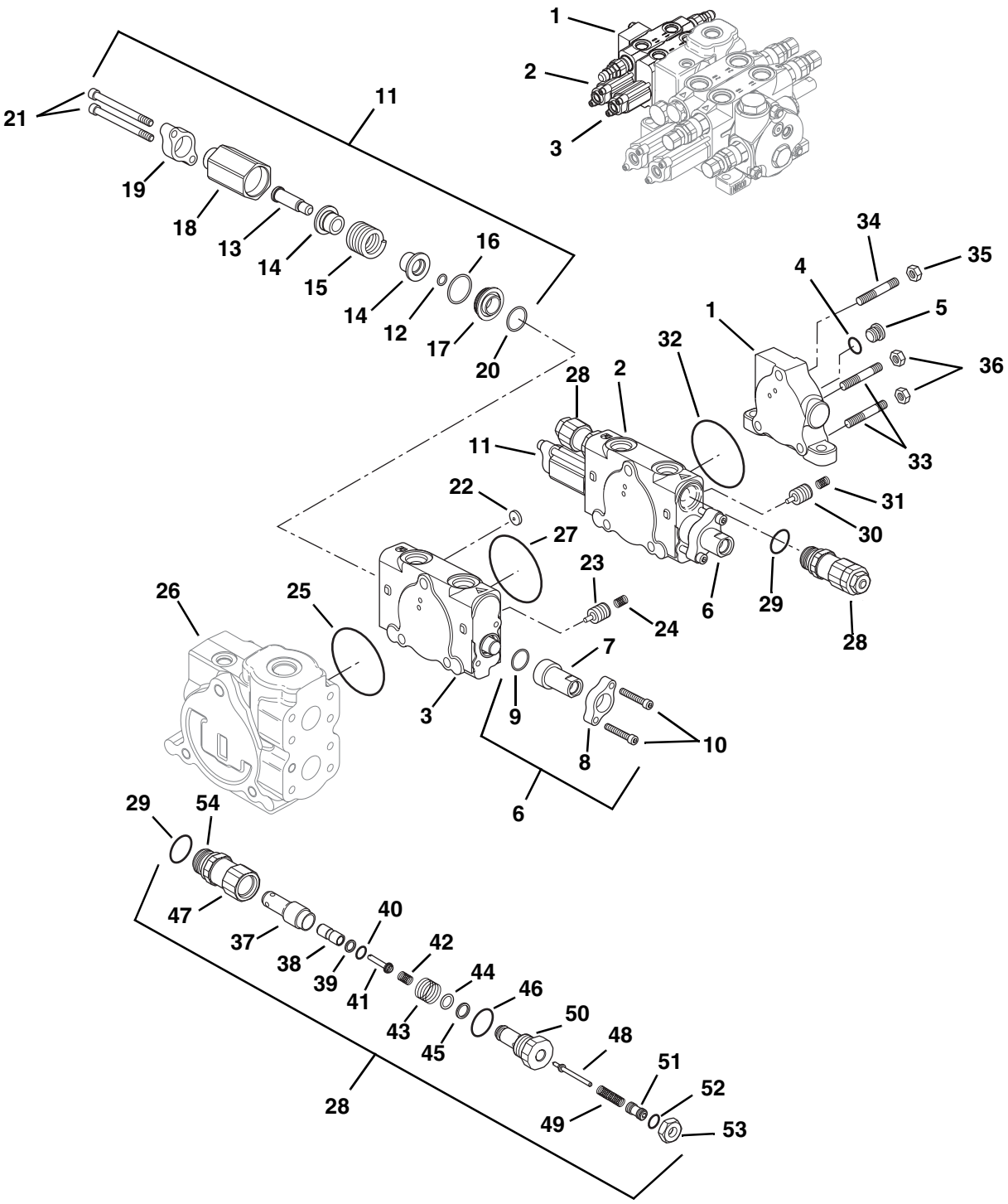
d. Main Control Valve Parts Cleaning

Clean all components with a suitable cleaner, such as trichlorethylene, before continuing. Blow dry.

e. 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.

Carefully remove the spools from each section and inspect for contamination, scratches, scoring or discoloration. If any damage is noted the sections with spools must be replaced as a complete assembly. The spools are not serviced separately.


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MM3650

f. Main Control Valve Assembly

This section covers the assembly of the end cap (**1**), attachment tilt (**2**) and frame sway (**3**) sections of the main control valve.

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 the End Cap Section

1. Install a new oiled o-ring (**4**) and the plug (**5**) into the end cap section (**1**).

Assemble the Frame Sway Section

1. Assemble the end mechanism (**11**) by inserting a new small oiled o-ring (**12**) onto the spool end (**13**). Insert the spool end, the spring seat (**14**), the spring (**15**), the other spring seat (**14**), a new large oiled o-ring (**16**) and the spool cap retainer (**17**) into the spool cap (**18**) and then into the retainer (**19**).
2. Insert a new oiled o-ring (**20**) into the section and attach this end mechanism (**11**) with the capscrews (**21**).
3. Assemble the other end mechanism (**6**) by inserting the spool cap (**7**) into the retainer (**8**).
4. Insert a new oiled o-ring (**9**) onto the section and attach the end mechanism (**6**) with the capscrews (**10**).
5. Insert the shuttle (**22**), poppet (**23**) and spring (**24**) into the section (**3**).
6. Place a new oiled o-ring (**25**) between the mid inlet section (**26**) and the frame sway section (**3**) and slide the frame sway section onto the tie rods.

Place a new oiled o-ring (**27**) on the frame sway section (**3**).

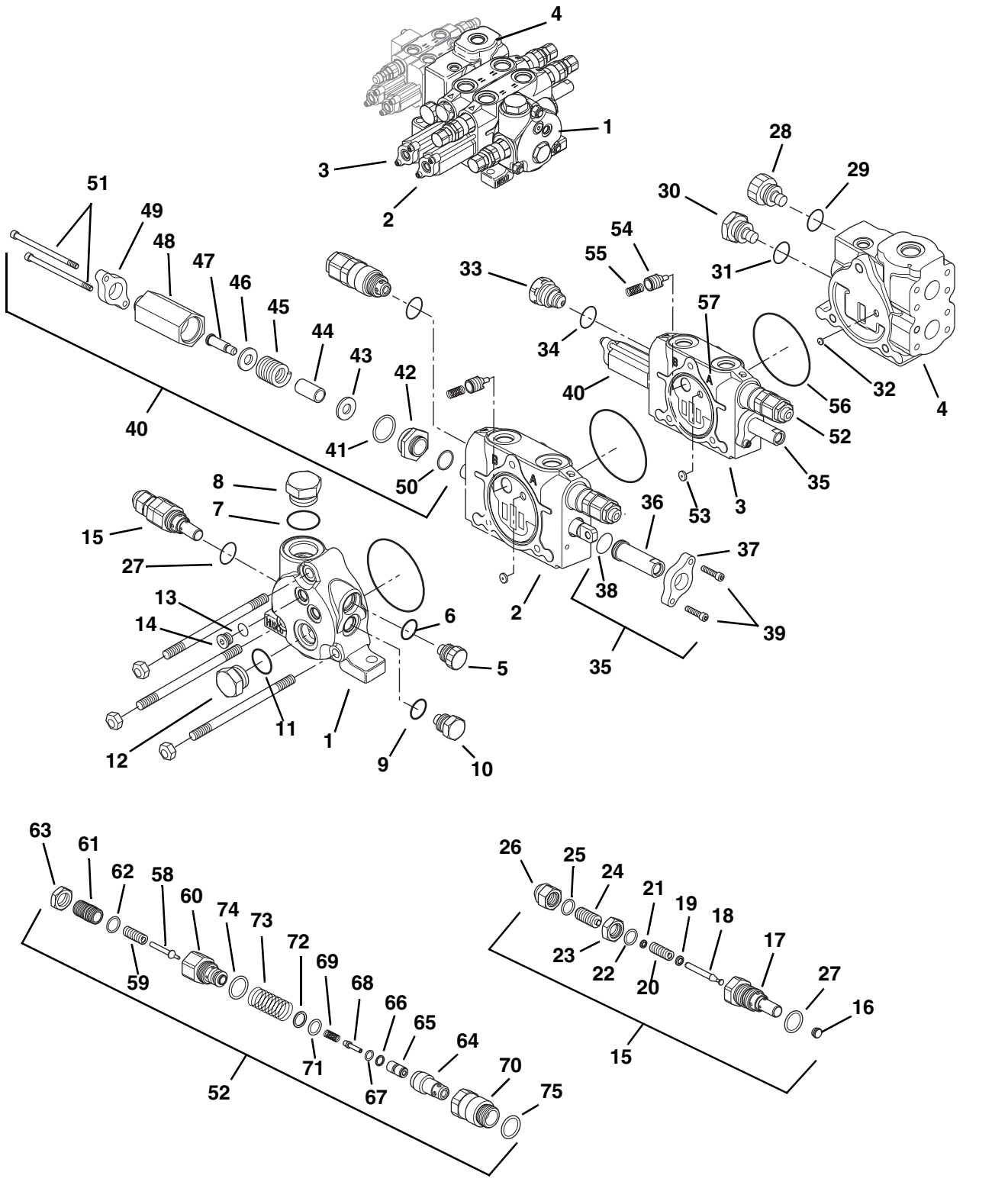
Assemble the Attachment Tilt Section

1. Assemble the end mechanism (**11**) by inserting a new small oiled o-ring (**12**) onto the spool end (**13**). Insert the spool end, the spring seat (**14**), the spring (**15**), the other spring seat (**14**), a new large oiled o-ring (**16**) and the spool cap retainer (**17**) into the spool cap (**18**) and then into the retainer (**19**).
2. Insert a new oiled o-ring (**20**) into the section and attach this end mechanism (**11**) with the capscrews (**21**).
3. Assemble the other end mechanism (**6**) by inserting the spool cap (**7**) into the retainer (**8**).
4. Insert a new oiled o-ring (**9**) onto the section and attach the end mechanism (**6**) with the capscrews (**10**).
5. Install the relief valves (**28**) and new oiled o-ring (**29**) after assembling them using the procedure that follows.
6. Insert the poppet (**30**) and spring (**31**) into the section (**2**).
7. Place a new oiled o-ring (**32**) between the attachment tilt section (**2**) and the end cap (**1**) section.
8. Slide the attachment tilt section (**2**) onto the tie rods (**33** & **34**).
9. Slide the end cap (**1**) onto the tie rods (**33** & **34**).
10. Assemble the upper tie rod nut (**35**) and the two lower tie rod nuts (**36**). Torque two lower tie rod nuts (**36**) to 13-15 (18-20 Nm) and the third upper tie rod nut (**35**) to 30-36 lb/ft (41-49 Nm).

Assemble the Relief Valves (Attachment Tilt Section).

Note: *There is a seal and spring kit package for assembling the relief valves.*

1. Install the relief valve poppets (**37** and **38**), new back-up ring (**39**), new oiled o-ring (**40**), piston (**41**), new small spring (**42**), new large spring (**43**), new oiled o-ring (**44**), new back-up ring (**45**) and new large oiled o-ring (**46**) into the relief valve body (**47**).
2. Install the pilot poppet (**48**) and new spring (**49**) into the plug (**50**).
3. Install the plug (**50**) onto the body (**47**).
4. Install the adjustment screw (**51**) and new oiled o-ring (**52**).
5. Tighten the nut (**53**) onto the body (**47**).
6. Check that the piston (**41**) moves freely inside the relief valve assembly by pushing the piston in from the threaded end (**54**) of the relief valve.
7. Install a new oiled o-ring (**29**) into the section.
8. Using a wrench on the body (**47**), install the relief valve (**28**) onto the section.


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g. Main Control Valve Assembly

This section covers assembly of the outlet (**1**), extend/retract (**2**), lift/lower (**3**) and mid-inlet (**4**) sections.

Note: *ALWAYS replace o-rings with new o-rings lubricated with clean hydraulic oil to help ensure a leak-proof seal and proper vehicle performance.*

Assemble the Outlet Section

1. Install the shut-off plug (**5**) and new oiled o-ring (**6**) into the outlet section (**1**).
2. Install new oiled o-ring (**7**), plug (**8**), new oiled o-ring (**9**), plug (**10**), new oiled o-ring (**11**), plug (**12**), new oiled o-ring (**13**) and plug (**14**) into the outlet section (**1**).
3. Install the main relief valve (**15**) after assembling it using the procedure that follows.

Assemble the Main Relief Valve (Outlet Section)

Note: *There is a seal and spring kit for assembling the relief valve.*

1. Install the plug (**16**) into the body (**17**).
2. Install the poppet (**18**), spring retainer (**19**), new spring (**20**), shim (**21**) and new oiled o-ring (**22**) into the body (**17**). Install the nut (**23**).
3. Install the adjustment screw (**24**) and new oiled o-ring (**25**). Install the nut (**26**).
4. Install a new seal (**27**) and the relief valve (**15**) onto the outlet section (**1**).

Assemble the Mid-Inlet Section

1. Install the shut-off plug (**28**) and new oiled o-ring (**29**) into the mid-inlet section (**4**).
2. Install the plug (**30**) and new oiled o-ring (**31**) into the mid-inlet section (**4**).
3. Install the shuttle (**32**) into the mid-inlet section (**4**).

Assemble the Lift/Lower Section

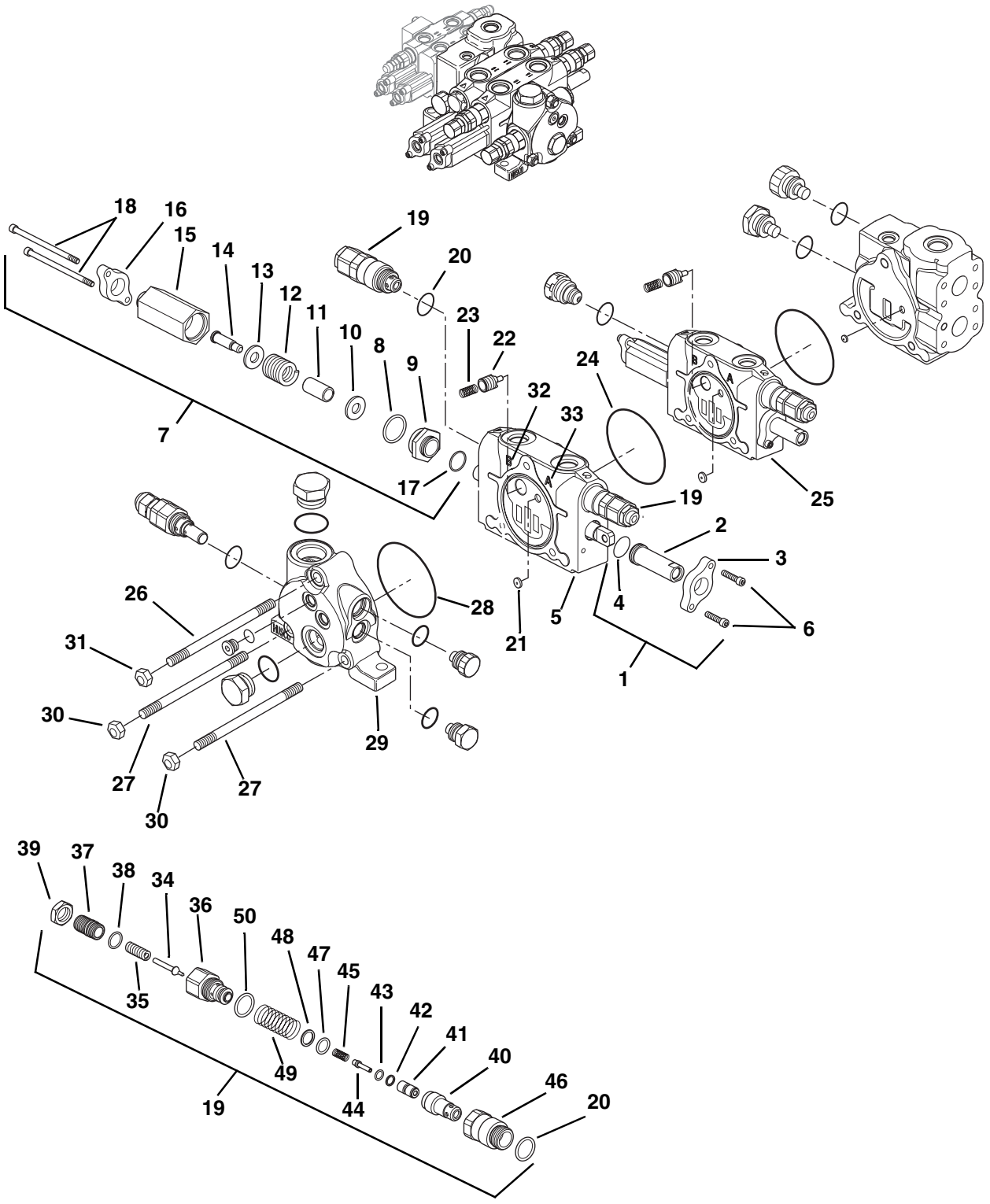
1. Install the anti-void assembly (**33**) with a new oiled o-ring (**34**) into the lift/lower section (**3**).
2. Assemble the end mechanism (**40**) by inserting a new oiled o-ring (**41**) in the spool cap retainer (**42**). Install the flat washer (**43**), spacer (**44**), spring (**45**), another flat washer (**46**) and spool end (**47**) into the spool cap (**48**). Install the spool cap retainer (**42**) onto the spool cap (**48**). Place the retainer (**49**) on the other end.
3. Insert a new oiled o-ring (**50**) into the section and attach this end mechanism (**40**) with the capscrews (**51**).
4. Assemble the other end mechanism (**35**) by inserting the spool cap (**36**) into the retainer (**37**).
5. Insert a new oiled o-ring (38) onto the section and attach the end mechanism (**35**) with the capscrews (**39**).
6. Install the relief valve (**52**), after assembling it, using the procedures that follow.
7. Insert the shuttle (**53**), poppet (**54**) and spring (**55**) into the section.
8. Place a new oiled o-ring (**56**) between the lift/lower section (**3**) and the mid-inlet section (**4**) and slide the lift/lower section onto the tie rods.

Assemble Relief Valve (Lift/Lower Sections)

On the lift/lower section (**3**), the relief valve is on the “A” side (**57**) and is preset at 3000 ±50 psi (207 ±3,5 bar).

Note: *There is a seal and spring kit* for assembling the relief valve.

1. Install the poppet (**58**) and new spring (**59**) into the plug (**60**). Install the adjustment screw (**61**) and new oiled o-ring (**62**) with the nut (**63**) onto the plug (**60**).
2. Install the larger poppet (**64**), smaller poppet (**65**), new back-up ring (**66**), new oiled o-ring (**67**), poppet (**68**) and new small spring (**69**) into the body (**70**). Install the new oiled o-ring (**71**), new back-up ring (**72**) and new large spring (**73**) into the body (**70**).
3. Install the new oiled o-ring (**74**) and plug (**60**) onto the body (**70**).
4. Using a wrench on the body (**70**), install the relief valve (**52**) and new oiled o-ring (**75**) into the lift/lower section (**3**) assembly


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Assemble the Extend/Retract Section

1. Assemble the end mechanism (**7**) by inserting a new oiled o-ring (**8**) in the spool cap retainer (**9**). Install the flat washer (**10**), spacer (**11**), spring (**12**), another flat washer (**13**) and spool end (**14**) into the spool cap (**15**). Install the spool cap retainer (**9**) onto the spool cap (**15**). Place the retainer (**16**) on the other end of the spool cap.
2. Insert a new oiled o-ring (**17**) into the section and attach the end mechanism (**7**) with the capscrews (**18**).
3. Assemble the other end mechanism (**1**) by inserting the spool cap (**2**) into the retainer (**3**).
4. Insert a new oiled o-ring (**4**) onto the extend/retract section (**5**) and attach the end mechanism (**1**) with the capscrews (**6**).
5. Install the relief valves (**19**) with new oiled o-rings (**20**) after assembling them using the procedures that follow.
6. Insert the shuttle (**21**), poppet (**22**) and spring (**23**) into the section.
7. Place a new oiled o-ring (**24**) between the extend/retract section (**5**) and the lift/lower section (**25**) and slide the extend/retract section onto the tie rods (**26** & **27**).
8. Place a new oiled o-ring (**28**) between the extend/retract section (**5**) and the outlet section (**29**) and slide the outlet section onto the tie rods (**26** & **27**).
9. Torque the two tie rod nuts (**30**) to 43-53 lb/ft (58-72 Nm) and the third tie rod nut (**31**) to 66-82 lb/ft (89-111 Nm) holding all sections together.

Assemble Relief Valves (Extend/Retract Section)

On the extend/retract section (**5**), one relief valve (**19**) is on the “B” side (**32**) and is preset at 3750 ±50 psi (258 ±3,5 bar); the other relief valve is on the “A” side (**33**) and is preset at 3000 ±50 psi (207 ±3,5 bar).

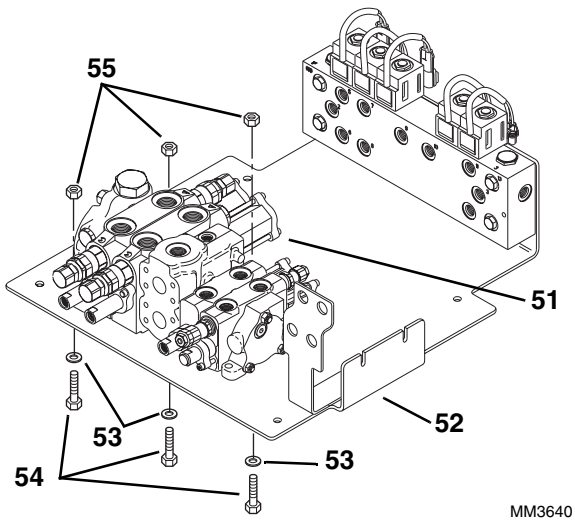
Note: *There is a seal and spring kit* for assembling the relief valves.

For each relief valve (**19**):

1. Install the poppet (**34**) and new spring (**35**) into the plug (**36**). Install the adjustment screw (**37**) and new oiled o-ring (**38**) with the nut (**39**) onto the plug (**36**).
2. Install the larger poppet (**40**), smaller poppet (**41**), new back-up ring (**42**), new oiled o-ring (**43**), poppet (**44**) and new small spring (**45**) into the body (**46**). Install the new oiled o-ring (**47**), new back-up ring (**48**) and new large spring (**49**) into the body (**46**).
3. Install the new oiled o-ring (**50**) and plug (**36**) onto the body (**46**).
4. Using a wrench on the body (**46**), install the relief valve (**19**) and new oiled o-ring (**20**) into the extend/retract section assembly (**5**).

h. Main Control Valve Installation

1. Place the assembled main control valve (**51**) into position on the valve plate assembly (**52**) aligning the three bolt holes with the main control valve holes.

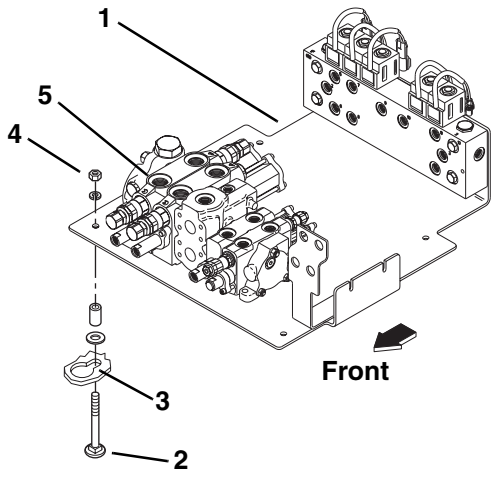


2. Place the plain washers (**53**) on the capscrews (**54**). Insert from the bottom of the valve plate (**52**).

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

3. Tighten the new elastic locknuts (**55**) onto the capscrews (**54**).

4. Install the assembled valve plate (**1**) into the vehicle aligning the carriage bolt heads (**2**) with the slots (**3**) in the frame. Slide the valve plate assembly into position and tighten the nuts (**4**).



5. Prime the main control valve by filling the inlet openings (**5**) with fresh, filtered hydraulic oil from a clean container before attaching the hoses.
6. Use new oiled o-rings as required. Reattach and secure all hoses, clamps, etc. to the main control valve (**6**).
7. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

8. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

9. 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.*

10. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

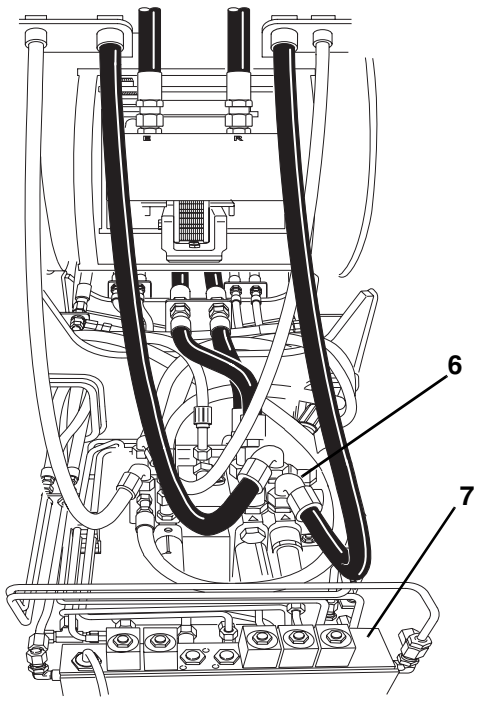
i. Main Control Valve Test

Conduct a pressure check of the hydraulic system in its entirety. Adjust pressure(s) as required. Refer to *Section 9.7, Hydraulic System Testing*.

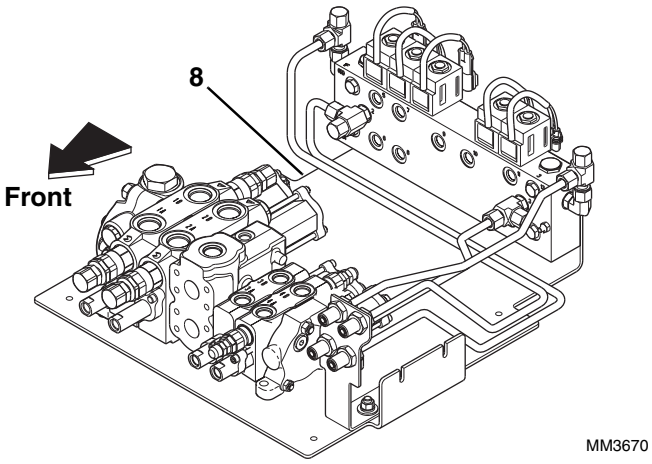
9.12.4 Pilot Select Manifold

The pilot select manifold (**7**) is a precisely machined block located inside the rear door, secured by capscrews and lockwashers to the main control valve plate assembly (**8**). The pilot select manifold contains ports for solenoid cartridge valves and tube fittings.

Verify the correct operation of the pilot select solenoids before considering replacement of the manifold. Refer to *Section 10.13.10, Joystick.*



DO NOT loosen, disassemble or attempt to adjust any of the cartridges unless specifically instructed by **JLG** to do so!



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a. Pilot Select Manifold Removal

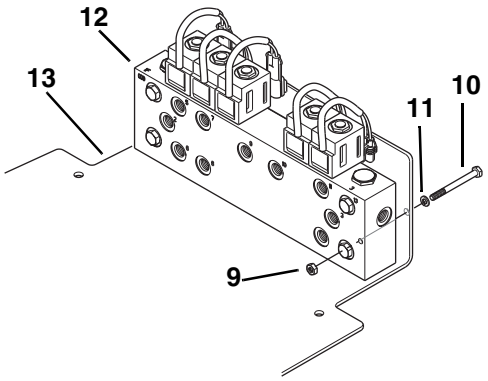
1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] neutral, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

> **WARNING:** Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

> **WARNING:** Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark all of the hydraulic hoses and solenoid wire terminal leads in relation to the pilot select manifold. Disconnect the wiring, and cap all hoses, fittings, etc.
5. Remove the two hex nuts (**9**), two capscrews (**10**), and lockwashers (**11**) securing the manifold (**12**) to the main control valve plate bracket (**13**).

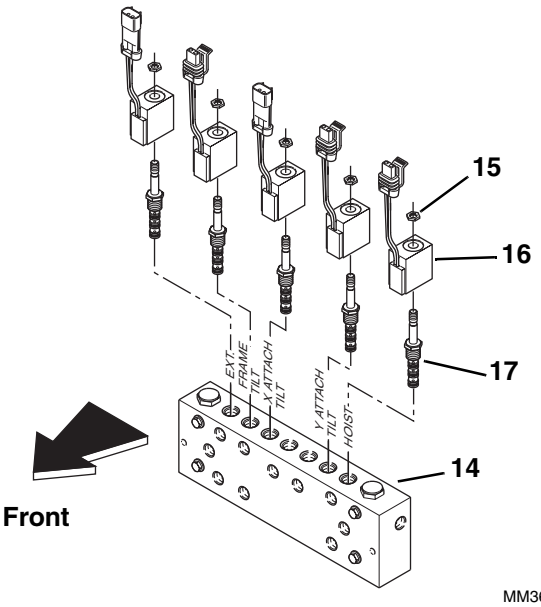


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6. Remove the pilot select manifold (**12**) from the vehicle. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle.

b. Pilot Select Manifold Disassembly, Cleaning, Inspection and Assembly

1. Secure the pilot select manifold (**14**) in a suitable bench vise if possible. **DO NOT** overtighten the vise. Individually label or otherwise mark and remove the solenoid nuts (**15**), the coils (**16**) and cartridge valves (**17**) from the manifold.



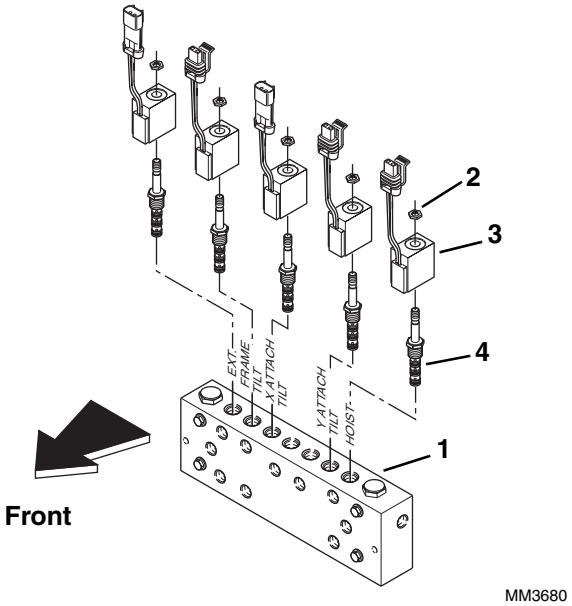
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2. Clean all components with a suitable cleaner before inspection.

3. Inspect internal passageways and parts for wear, damage, etc. If inner surfaces of the pilot select manifold **DO NOT** display an ultra-smooth, polished finish, or are damaged in any way, replace the manifold in its entirety. Often, dirty hydraulic fluid causes failure of internal seals and damage to the polished surfaces within the component.

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.*

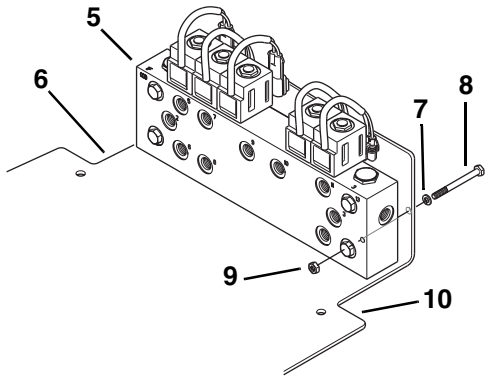
4. Inspect the solenoid cartridges for proper operation. Check by shifting the spool to ensure that it is functioning properly. Check that the spring is intact. Inspect the cartridge interior for contamination.
5. Install the cartridges (**4**). Torque to 35-40 lb/ft (47-54 Nm) Install the coils (**3**) and solenoid nuts (**2**). Torque the nuts to 4-6 lb/ft (5-8 Nm). **DO NOT** overtighten.



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c. Pilot Select Manifold Installation

1. Place the pilot select manifold (**5**) into position on the valve plate (**6**) in the rear of the vehicle.
2. Install the two lockwashers (**7**), capscrews (**8**) and nuts (**9**) securing the manifold (**5**) to the main control valve plate bracket (**10**).



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3. Prime the pilot select manifold by adding a small quantity of fresh, filtered hydraulic oil, from a clean container, in the port holes before attaching the tubes.
4. Use new oiled o-rings as required. Reattach and secure all tubes, clamps, wire terminals, etc.
5. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube clamps.

> **WARNING:** Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

6. Start the engine and run at approximately 1/3-1/2 throttle for about one minute without moving the vehicle or operating any hydraulic functions.

> **WARNING:** Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

7. 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.*

8. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

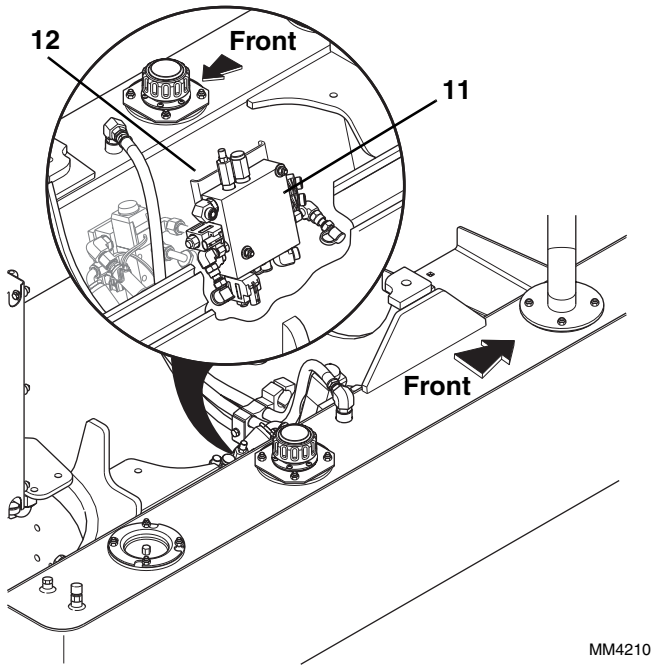
d. Pilot Select Manifold Test

Conduct a function test of the boom operation.

9.12.5 Secondary Function Manifold

The secondary function manifold (**11**) is a directional control valve. Hydraulic oil from the main pump flows into the accumulator charge valve where the pressure is directed to the secondary function manifold which directs pressure to the park brake or pilot pressure to the joystick.

The secondary function manifold is a machined block with ports for a pressure reducing valve, a pressure relief valve, two park brake solenoid valves (one normally open and one normally closed), a check valve and diagnostic test nipples. The secondary function manifold is secured to a bracket (**12**) at the hydraulic fluid reservoir/engine mount with capscrews, lockwashers and nuts.



Verify the correct operation of the solenoids before considering replacement of the secondary function manifold. Refer to *Section 10, Electrical System.* The manifold itself is not serviceable and must be replaced if defective.

DO NOT loosen, disassemble or attempt to adjust any of the pressure valves unless specifically instructed by **JLG** to do so! Tampering with a pressure valve will irrevocably alter pressure in the affected circuits.

a. Secondary Function Manifold Replacement

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

> **WARNING:** Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

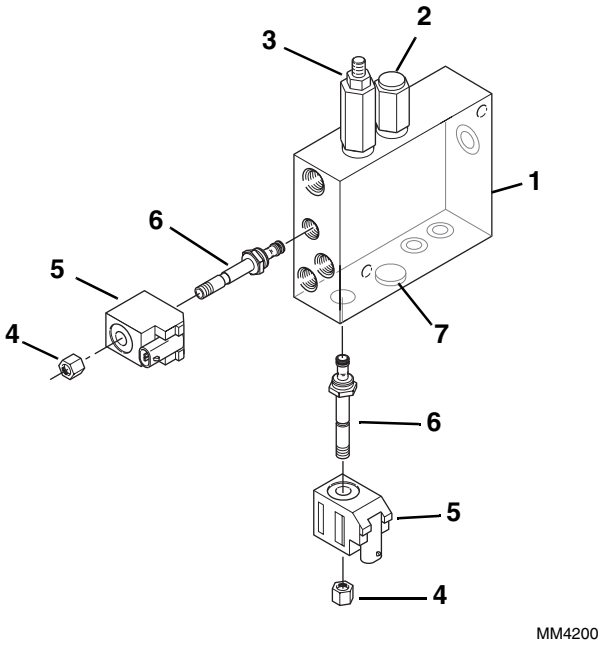
3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

> **WARNING:** Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the hydraulic hoses in relation to the secondary function manifold. Disconnect and cap all hoses, fittings, solenoid wire terminal leads, etc.
5. Remove the secondary function manifold from the vehicle. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle.

b. Secondary Function Manifold Disassembly, Cleaning, Inspection and Assembly

1. Secure the secondary function manifold (**1**) in a suitable bench vise if possible.



MM4200

2. Remove the 550 psi (38 bar) pressure-reducing valve (**2**).
3. Remove the 650 psi (45 bar) pressure-relief valve (**3**).
4. Remove the solenoid nuts (**4**), coils (**5**) and cartridges (**6**).
5. Remove the check valve (**7**).
6. Clean all components with a suitable cleaner before inspection.
7. Inspect the solenoid cartridges for proper operation. Check by shifting the spool to ensure that it is functioning properly. Check that the spring is intact. Inspect the cartridge interior for contamination.
8. Inspect internal passageways of the secondary function manifold and its component parts for wear, damage, etc. If inner surfaces of the secondary function manifold **DO NOT** display an ultra-smooth, polished finish, or components are damaged in any way, replace the secondary function manifold or appropriate part. Often, dirty hydraulic fluid causes failure of internal seals and damage to the polished surfaces within the secondary function manifold.

Note: *ALWAYS replace seals, o-rings, gaskets, etc., with new parts to help ensure proper sealing and operation. Lubricate seals and o-rings with clean hydraulic oil.*

9. Secure the secondary function manifold (**1**) in a bench vise or by other suitable means.
10. Install the pressure reducing valve assembly (**2**) and torque to 35-40 lb/ft (47-54 Nm).
11. Install the relief valve assembly (**3**) and torque to 25-30 lb/ft (34-41 Nm).
12. Install the check valve (**7**) and torque to 25-30 lb/ft (34-41 Nm).
13. Install the solenoid cartridges (**6**) and torque to 25-30 lb/ft (34-41 Nm). Install the solenoid coils (**5**) and nuts (**4**). Torque the nuts to 4-6 lb/ft (5-8 Nm).

c. Secondary Function Manifold Installation

1. Align the secondary function manifold with its mount holes on the hydraulic reservoir/engine mount.
2. Align gaskets, bolt holes, etc., with component mount holes. Secure the secondary function manifold with the necessary fasteners. Torque fasteners to specification. Refer to the fastener torque chart in *Section 2.3, Torques*.
3. Before attaching the hoses, prime the secondary function manifold by filling the hydraulic hose ports with fresh, filtered hydraulic fluid from a clean container.
4. Use new oiled o-rings as required. Reattach and secure all diagnostic test nipples, hoses, clamps, wiring, etc.
5. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

6. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

7. Inspect the secondary function manifold 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.*

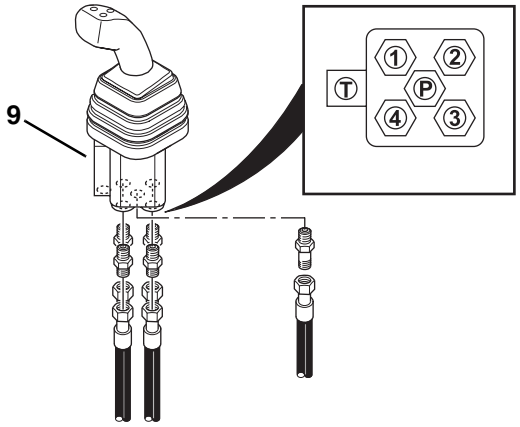
8. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

d. Secondary Function Manifold Test

Conduct a pressure check of the park brake circuit. Refer to *Section 9.7, Hydraulic System Testing*.

9.12.6 Joystick Valve

The joystick valve (**9**) is part of the joystick assembly. Joystick commands are actuated both electrically and hydraulically via a set of solenoid-operated control valves mounted in an array at the pilot select manifold.



MT2190

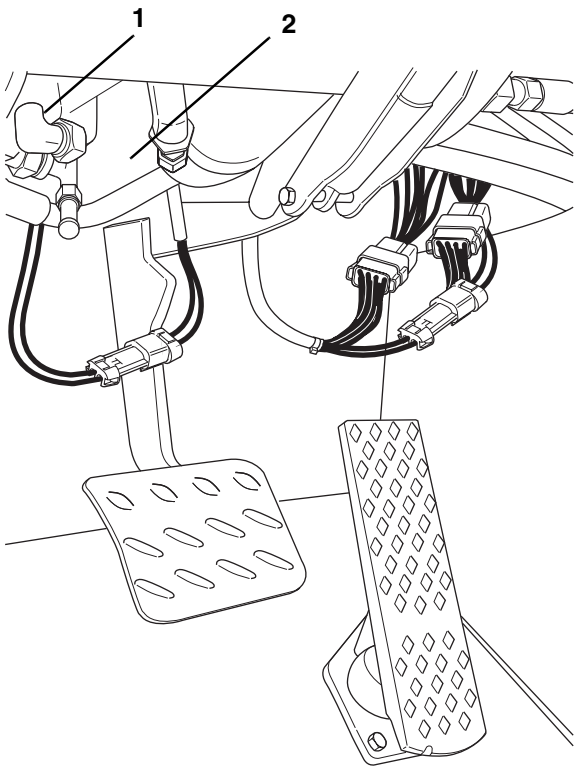
Verify the correct operation of the joystick switches and circuit solenoids before considering replacement of the joystick valve. Refer to *Section 10.13.10, Joystick.* The valve itself is not serviceable and must be replaced in its entirety if replacement of electrical parts does not solve the problem. Refer to *Section 3.5.2, Joystick Replacement.*

After replacing the joystick valve assembly, check for the proper functioning of all joystick functions.

9.12.7 Service Brake Valve

The service brake valve (**1**) is secured with two capscrews and lockwashers at the base of the steering column support (**2**), concealed by the lower dash cover.

The service brakes themselves are part of the axles (the park brake is part of the front axle only). Refer to *Section 5, Axles, Wheels and Tires,* for further information.



MM4600

a. Service Brake Valve Removal

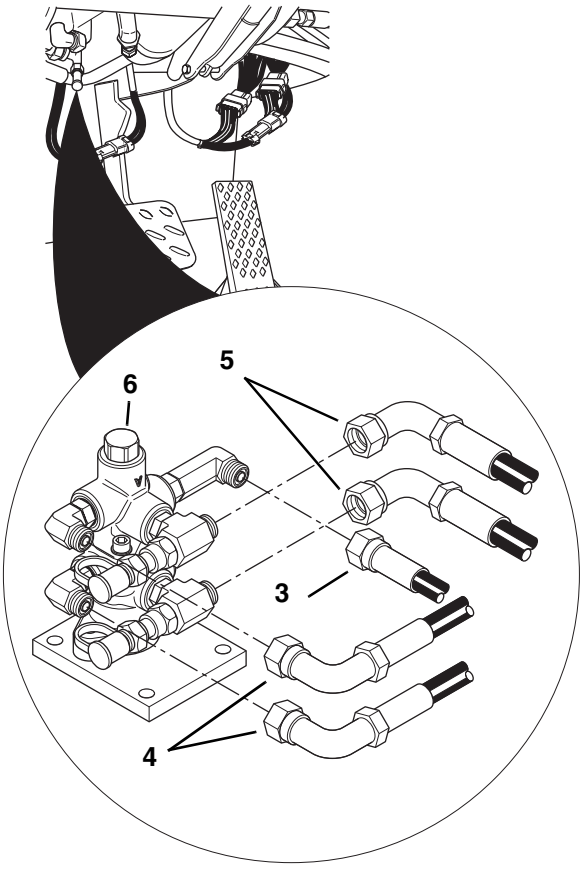
1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

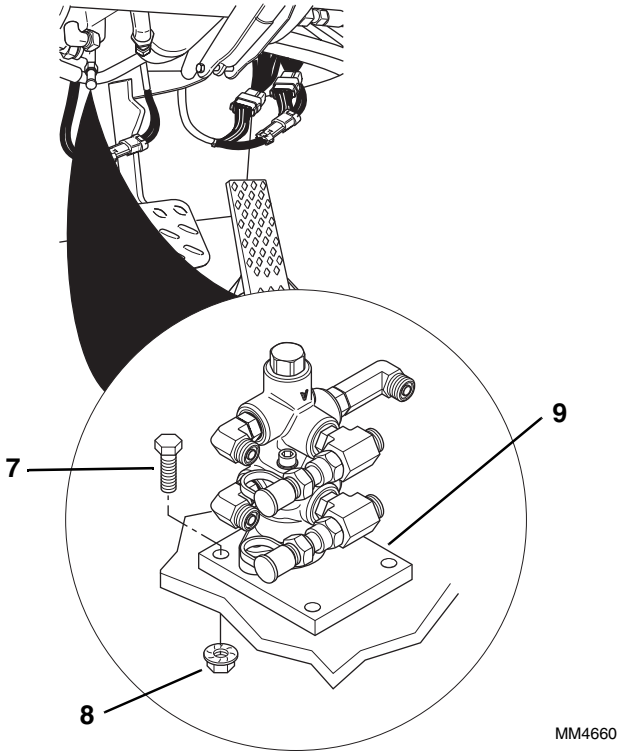
4. To remove the service brake valve, both the lower dash panel and the front dash panel must be removed. Refer to *Section 3.2.3, Cab Maintenance.*
5. Pump the brake pedal several times to relieve all the stored pressure in the accumulator system.
6. Label or otherwise mark the hydraulic hoses on the top (**3**), bottom (**4**) and side (**5**) of the service brake valve (**6**). Disconnect and cap all hoses, fittings, wire terminal leads, etc.



MM4620

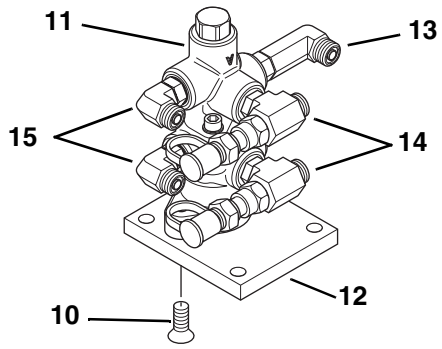
7. Remove the four capscrews (**7**) and flange head nuts (**8**) mounting the service brake valve mounting plate (**9**) to the steering column support. Bring the service brake valve with mounting plate out through the top of the dash.

DO NOT disassemble the service brake valve. The service brake valve is not serviceable and must be replaced in its entirety, if defective, as no replacement parts are available for internal components.



MM4660

8. Remove the two countersunk screws (**10**) holding the brake valve (**11**) to the mounting plate (**12**). Save the mounting plate and screws for assembling the new brake valve.



MM4670

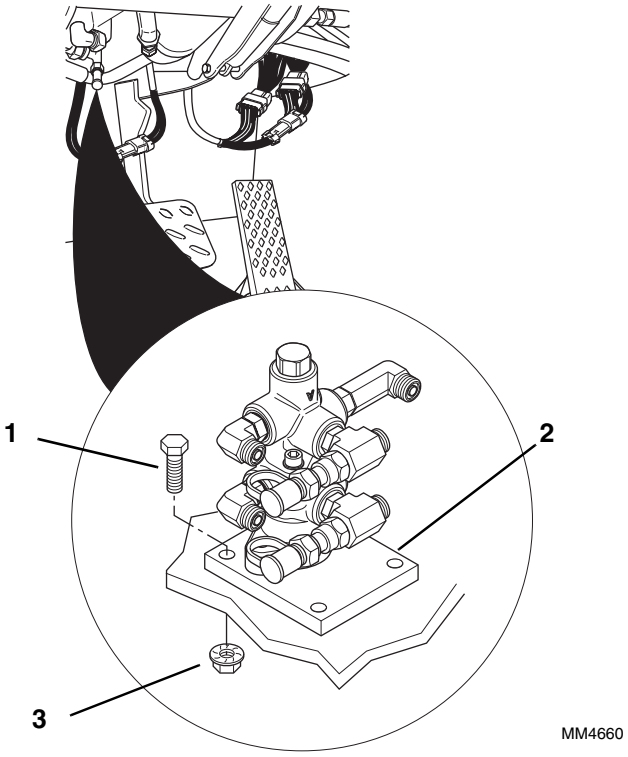
b. Service Brake Valve Reassembly

Note: *Use new oiled o-rings as required. 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. Transfer the fittings to the new brake valve. Note the orientation of each fitting before removing them.
2. Transfer the elbow (**13**) to the tank port on the top of the new brake valve. Tighten securely.
3. Transfer the two tee fittings with diagnostic nipples (**14**) to the “A” ports on the side of the new brake valve. Tighten securely.
4. Transfer the two elbows (**15**) to the two pressure ports on the bottom side of the new brake valve. Tighten securely.
5. Place the new brake valve with fittings (**11**) on the mounting plate (**12**) with the diagnostic nipples toward the long side of the mounting plate.
6. Line up the holes in the mounting plate (**12**) with the threaded holes in the mounting flange of the brake valve (**11**).
7. Apply Loctite® threadlocker 242 (blue) to the threads of each countersunk screw (**10**). Insert the screws through the plate and thread into the brake valve. Torque both screws to 18 lb/ft (24 Nm).

c. Service Brake Valve Installation

1. Insert the service brake valve with mounting plate attached in through the top of the dash. Position onto the steering column support with the tank return elbow on the topside of the brake valve.
2. Install the four capscrews (**1**) from the top down through the brake valve mounting plate (**2**) and secure to the steering column support with flange head nuts (**3**). Tighten securely.



3. Use new oiled o-rings as required. Reattach and secure all hoses, clamps, wiring, etc.
4. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.

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.*

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

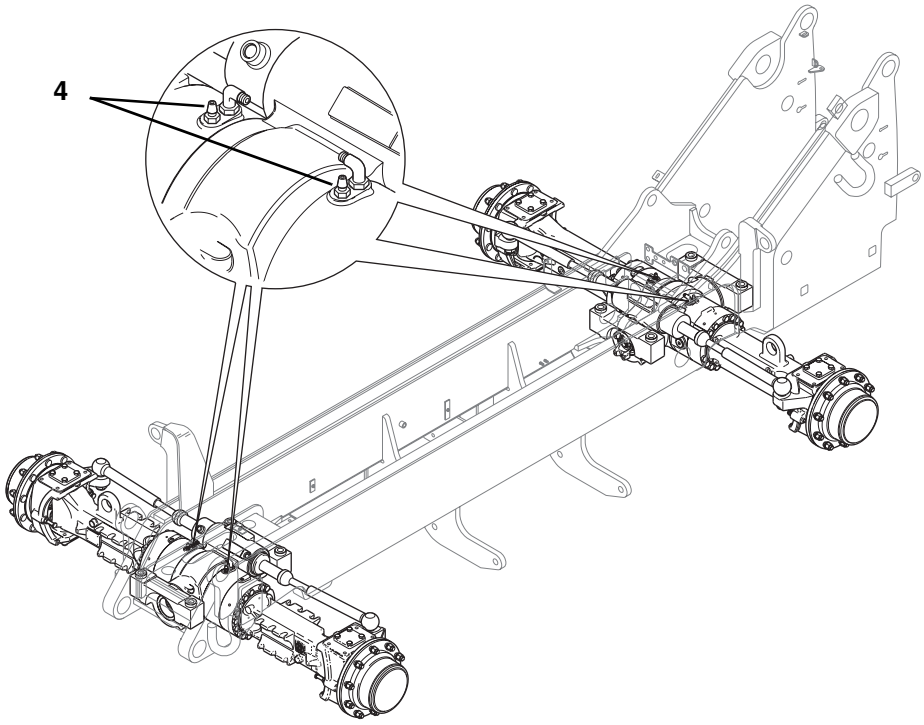
5. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

6. 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 the reservoir as needed.*

7. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.



MM3700

d. Brake Test

Carefully bleed the brake lines as soon as the brake valve is installed in the vehicle. Air in the system will not allow the brakes to apply properly. There are four brake bleeder locations (**4**) on the axles. Work with an assistant to perform this procedure.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

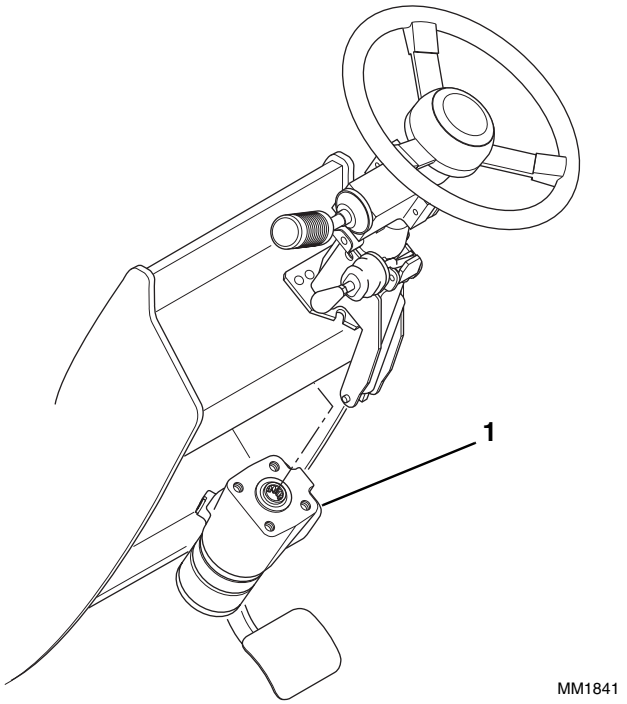
1. Place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and start the engine.
2. Have the assistant frame sway the vehicle full left to expose the brake bleeders on the right front and right rear axles.
3. Remove the plastic cap from the front brake bleeder (**4**). Attach one end of a length of transparent tubing over the brake bleeder. Place the other end of this tubing in a suitable transparent container that is partially filled with hydraulic oil. The end of the tubing must be below the oil level in the container.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

4. **DO NOT** open the brake bleeder without holding the tubing firmly on the bleeder. There is pressure at the brakes. Carefully open the bleeder with a 12 mm wrench. Have the assistant depress the brake pedal. Close the brake bleeder when air bubbles no longer appear in the oil. Release the brake pedal. Remove the tubing from the brake bleeder.
5. Repeat Steps 3-4 for the right rear brake.
6. Frame sway the vehicle full right, exposing the brake bleeders on the left front and rear axles.
7. Repeat Steps 3-4 for the left front and left rear brakes.
8. Conduct a pressure and function check of the service brake and the accumulator system. Refer to *Section 9.7, Hydraulic System Testing*.

9.12.8 Power Steering Valve

The power steering valve (**1**) is located at the base of the steering wheel shaft, concealed by the lower dash cover. The valve is not serviceable and must be replaced in its entirety if defective.



a. Power Steering Valve Removal

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

> **WARNING:** Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

> **WARNING:** Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

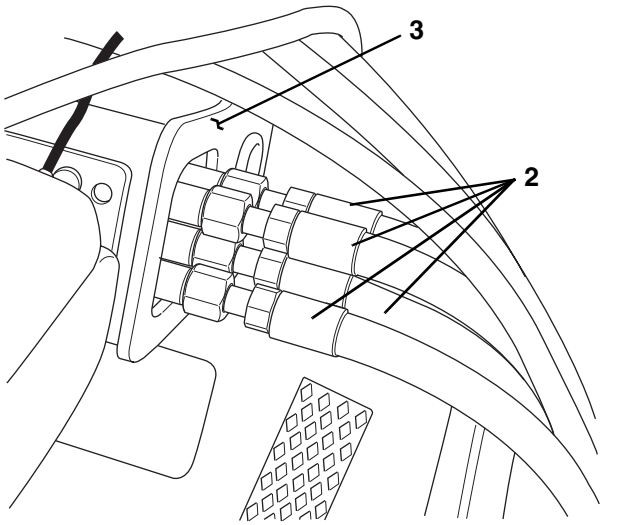
4. To remove the power steering valve, remove both the lower and front dash panels. Refer to *Section 3.2.3, Cab Maintenance.*

5. Label or otherwise mark the hydraulic hoses (**2**) connected to the power steering valve (**3**). Disconnect the hoses and cap all hoses, fittings, etc. Wipe up any hydraulic fluid spillage.
6. Refer to *Section 3.5.1, Steering Wheel, Column and Shifter,* for information on removing the steering column. The steering column and power steering valve are mounted together. **DO NOT** attempt to disassemble the steering valve.

b. Power Steering 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. Install the steering column, connecting it to the power steering valve.
2. Connect all the hydraulic hoses (**2**) to the power steering valve.
3. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all hose clamps.



MM4680

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

4. Start the engine and run at approximately 1/3-1/2 throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

5. 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.*

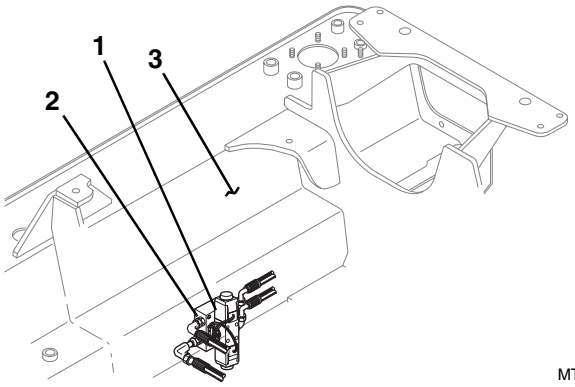
6. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

c. Power Steering Test

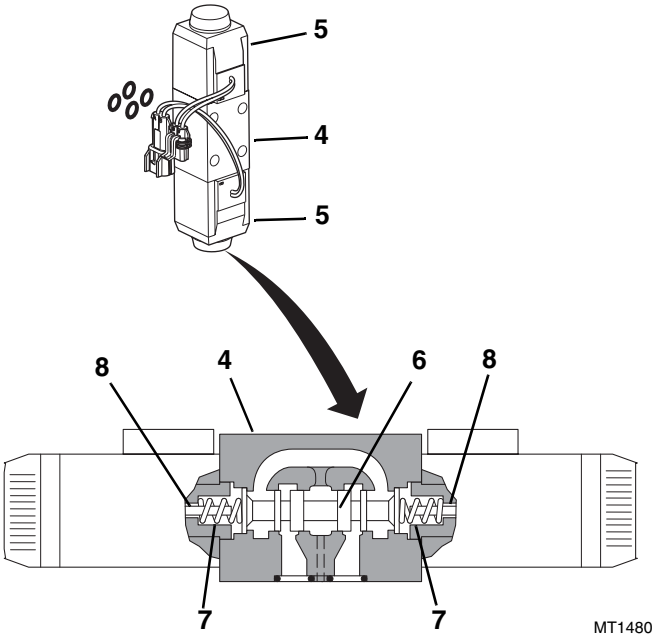
Conduct a pressure check of the steering hydraulic circuits at the accumulator charge valve. Refer to *Section 9.7, Hydraulic System Testing*.

9.12.9 Steer Select Valve (Three-Mode Steer)

With the three-mode steer, the vehicle can be used in the front-wheel, four-wheel or crab steering mode. The steer select valve (**1**) controls the direction of hydraulic fluid flow to the steering cylinders mounted on each axle. The steer select valve (**1**) is attached to a manifold (**2**) mounted on the hydraulic reservoir/engine mount (**3**).



MT3420



MT1480

The steer select valve (**4**) contains two solenoids (**5**) that direct the flow of hydraulic fluid according to steering input. The valve is a direct dual-solenoid operated, spool-type main control valve.

The valve consists of a housing (**4**), two solenoids (**5**), a control spool (**6**) and two return springs (**7**). In the de-energized state, the spool (**6**) is held by the return springs (**7**) in the center position.

The spool is shifted via the action of the two wet-pin type solenoids (**5**). The force of an acting solenoid pushes against the push pin (**8**) on the end of the spool (**6**). The spool is shifted from its normal position to the end position for selected flow.

When the solenoid is de-energized, the control spool (**6**) is returned to its normal condition by the centering springs (**7**).

Verify the correct operation of the steer select valve solenoids before considering replacement of the valve. Refer to *Section 10.7, Electrical System Troubleshooting* and *Section 10.13.14, Steer Select Valve*. The housing (**4**) of the steer select valve is not serviceable and must be replaced if defective.

a. Steer Select Manifold and Valve Removal

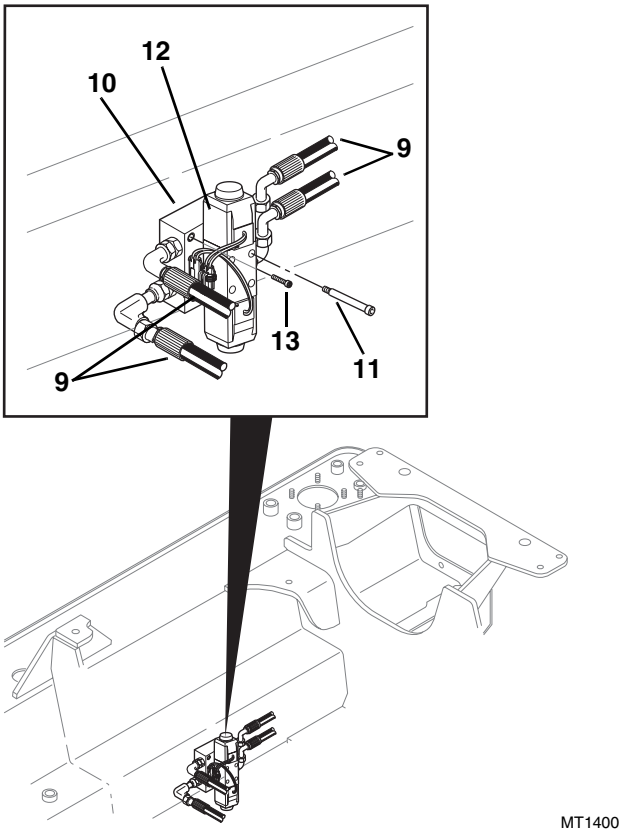
1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the hydraulic hoses (**9**) in relation to the steer select manifold (**10**). Disconnect and cap all hoses, fittings, solenoid wire terminal leads, etc.

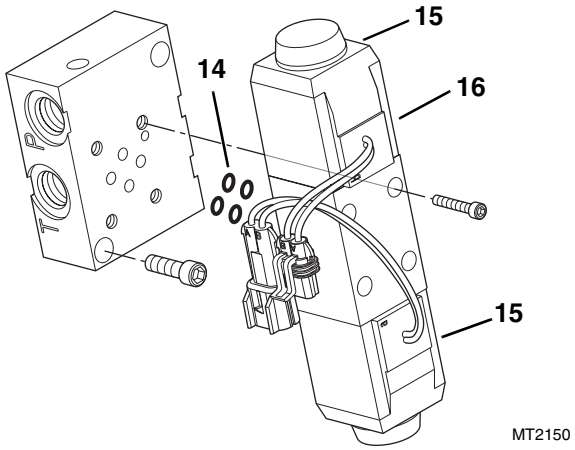


MT1400

5. Remove the four socket head capscrews (**11**) securing the steer select valve (**12**) to the steer select manifold (**10**) Remove the steer selct valve.
6. Remove the two socket head capscrews (**13**) holding the steer select manifold (**10**) to the vehicle. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle.

b. Steer Select Valve and Manifold Disassembly, Cleaning, Inspection and Assembly

1. Place the steer select manifold and steer select valve assembly on a suitable work surface.
2. Discard the four o-rings (**14**).



MT2150

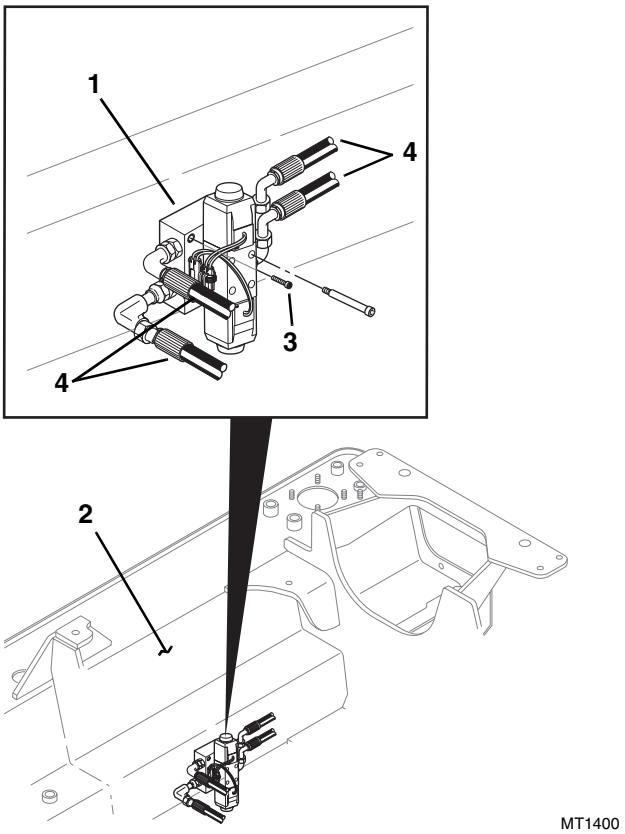
3. Remove the solenoid valves and cartridges (**15**) from the steer select valve (**16**).
4. Clean all components with a suitable cleaner before inspection.
5. Inspect the solenoid cartridges for proper operation. Check by shifting the spool to ensure that it is functioning properly. Check that the spring is intact. Inspect the cartridge interior for contamination.
6. Inspect internal passageways of the steer select manifold and valve for wear, damage, etc. If inner surfaces of the manifold **DO NOT** display an ultra-smooth, polished finish, or components are damaged in any way, replace the manifold or appropriate part. Often, dirty hydraulic fluid causes failure of internal seals and damage to the polished surfaces within the steer select 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.*

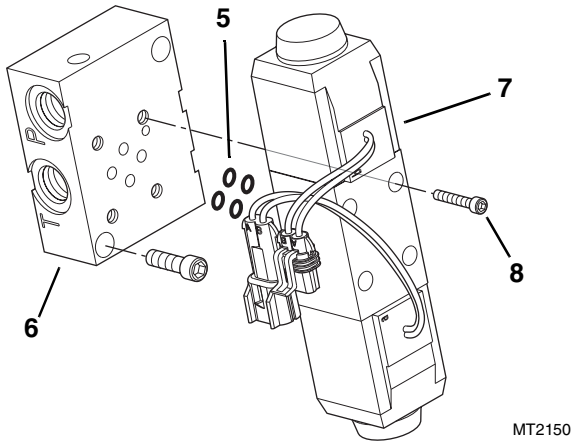
7. Install the solenoid cartridges and coils (**15**) in the steer select valve (**16**).

c. Steer Select Manifold and Valve Installation

1. Attach the steer select manifold (**1**) to the hydraulic fluid reservoir/engine mount (**2**) using the two socket head capscrews (**3**).



2. Connect the hydraulic hoses (**4**) and fittings to the steer select manifold (**1**).
3. Place four new oiled o-rings (**5**) between the steer select manifold (**6**) and the steer select valve (**7**).
4. Secure the steer select valve to the steer select manifold with the four socket head capscrews (**8**).
5. Reattach any wire connectors to the steer select valve terminals.



6. Check the routing of all hoses, wiring and tubing for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all tube and hose clamps.

> **WARNING:** Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

7. Start the engine and run at approximately 1/3-1/2 throttle for about one minute without moving the vehicle or operating any hydraulic functions.

> **WARNING:** Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

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 vehicle, work area and tools.

d. Three-Mode Steering Test

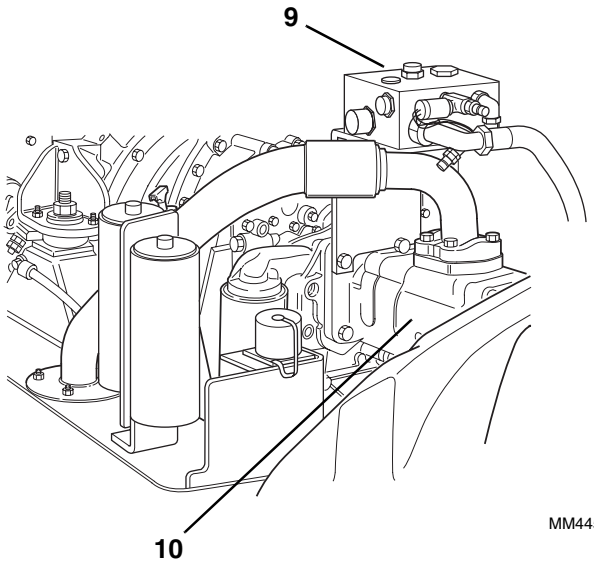
Refer to *Section 9.7, Hydraulic System Testing*.

1. Conduct a pressure check of the steering hydraulic circuit at the accumulator charge valve.
2. Check each steering mode for proper function.

9.12.10 Accumulator Charge Valve

Hydraulic oil from the rear pump flows into the accumulator charge valve and then is directed to the power steering unit, the two accumulators which direct pressure to the service brakes. Oil also flows from the accumulator charge valve to the unloader valve and the secondary function manifold.

The accumulator charge valve (**9**) is a machined block with ports for various valves, cartridges and other fittings. The accumulator charge valve is located under the engine hood and mounted to a bracket behind and above the main pump (**10**).



DO NOT loosen, disassemble or attempt to adjust any of the pressure valves unless specifically instructed by **JLG** to do so! Tampering with a pressure valve will irrevocably alter pressure in the affected circuits.

a. Accumulator Charge Valve Replacement

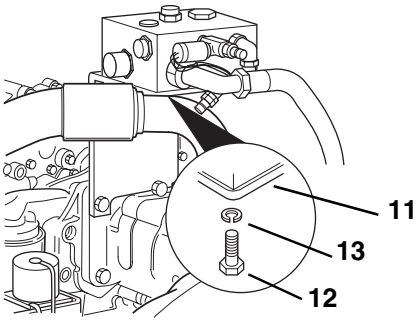
1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

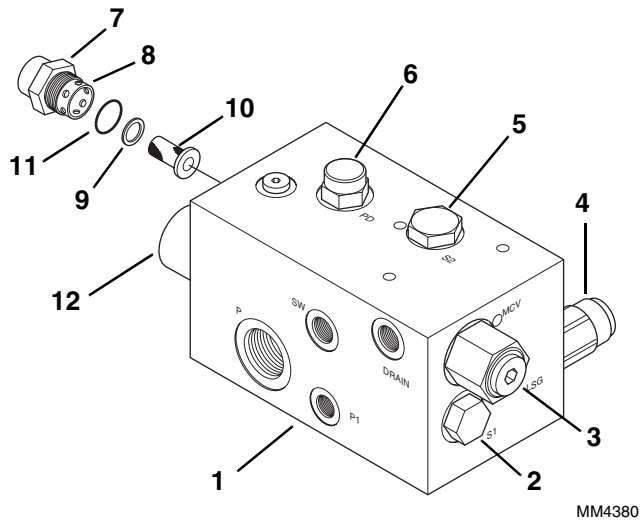
WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. With the engine OFF, relieve the hydraulic pressure from the accumulators. Apply the service brake pedal and then release. Do this several times until all hydraulic pressure has been relieved from the accumulators.
5. Label or otherwise mark the hydraulic hoses in relation to the accumulator charge valve. Disconnect and cap all hoses and fittings. Label or mark any wire harness connectors as they relate to the accumulator charge valve.
6. Remove the accumulator charge valve from the vehicle. The accumulator charge valve (**9**) is held to the mounting bracket (**11**) with four capscrews(**12**) and four lockwashers(**13**) from the underside. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle.



b. Accumulator Charge Valve Disassembly, Cleaning, Inspection and Assembly

1. Secure the accumulator charge valve (**1**) in a suitable bench vise if possible.
2. Tag and remove all hydraulic fittings and diagnostic test nipples from the accumulator charge valve.
3. Remove the load shuttle valve (**2**).
4. Remove the accumulator charge cartridge (**3**). This cartridge has two settings: Low Setting 1050 psi (72 bar) and High Setting 1950 psi (134 bar).
5. Remove the 2500 psi (172 bar) relief valve (**4**).
6. Remove the inverted shuttle (**5**).
7. Remove the pilot directional valve (**6**).
8. Loosen the filter nut (**7**), remove the adjusting screw assembly (**8**), washer (**9**) and sintered filter (**10**) from the port. Remove the o-ring (**11**) from the adjustment screw and discard the o-ring.
9. Remove the compensator (**12**).



10. Clean all components with a suitable cleaner before inspection.
11. Inspect internal passageways of the accumulator charge valve and its component parts for wear, damage, etc. If inner surfaces of the accumulator charge valve **DO NOT** display an ultra-smooth, polished finish, or components are damaged in any way, replace the accumulator charge valve or appropriate part. Often, dirty hydraulic fluid causes failure of internal seals and damage to the polished surfaces within the accumulator charge valve.

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.*

12. Secure the accumulator charge valve (**1**) in a bench vise or by other suitable means.
13. Install the load shuttle valve (**2**) and torque to 20 lb/ft (27 Nm).
14. Install the accumulator charge cartridge (**3**) and torque to 35 - 40 lb/ft (47 - 54 Nm).
15. Install the relief valve (**4**) and torque to 20 lb/ft (27 Nm).
16. Install the inverted shuttle (**5**) and torque to 35 - 40 lb/ft (47 - 54 Nm).
17. Install the pilot directional valve (**6**) and torque to 20 lb/ft (27 Nm).
18. Install the new sintered filter (**10**) followed by the washer (**9**) into the port. Secure in place with the adjusting screw assembly (**8**). Torque the adjusting screw assembly to 18 - 22 lb/ft (24 - 30 Nm). Tighten the filter nut (**7**) and torque to 32 - 38 lb/ft (43 - 51 Nm).
19. Install the compensator (**12**) and torque to 50 lb/ft (68 Nm).

c. Accumulator Charge Valve Installation

1. Align the accumulator charge valve with its mount holes on the bracket mounted behind and above the main pump..
2. Align gaskets, bolt holes, etc., with component mount holes. Secure the accumulator charge valve with the necessary fasteners. Torque fasteners to specification. Refer to the fastener torque chart in *Section 2.3, Torques*.
3. Use new oiled o-rings as required. Reattach and secure all hoses and fittings.
4. Reconnect any wire harness connectors.
5. Check the routing of all hoses for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all hose fittings.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

6. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

7. Inspect the accumulator charge valve 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.*

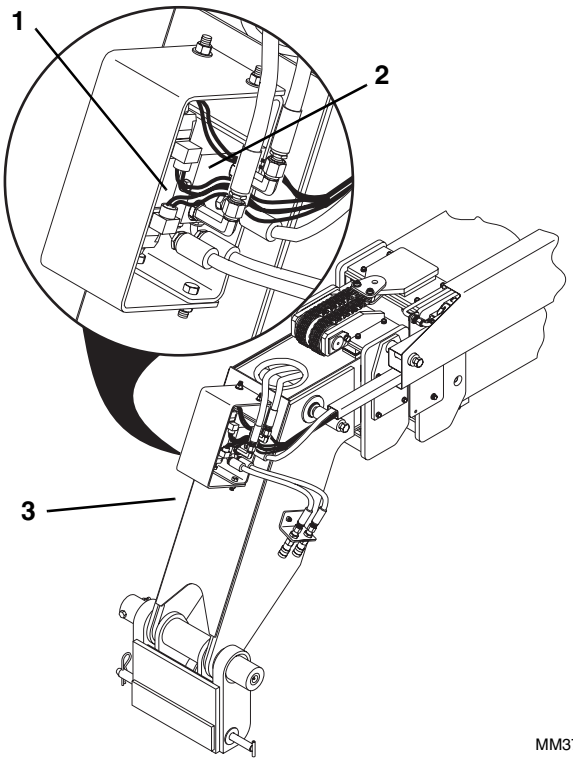
8. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

d. Accumulator Charge Valve Test

Conduct a pressure check of the accumulator circuit. Refer to *Section 9.7, Hydraulic System Testing*.

9.12.11 Fork Side Shift Valve

The fork side shift valves (**1**) control the direction of hydraulic fluid flow to the base or rod end of the left and right fork shift cylinders mounted on the carriage. The fork side shift valves (**1**) are attached to a manifold (**2**) mounted on the front of the inner boom gooseneck (**3**).



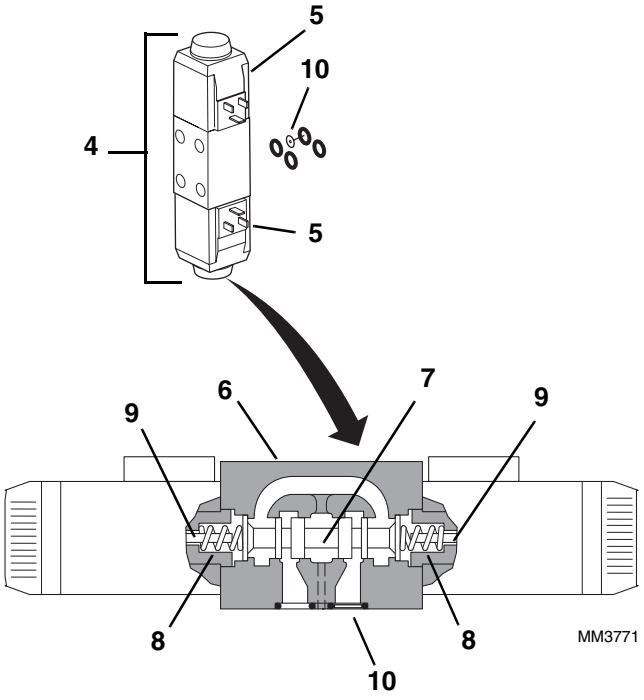
Each fork side shift valve (**4**) contains two solenoids (**5**) that direct the flow of hydraulic fluid according to side shift input. The valve is a direct dual-solenoid operated, spool-type valve.

Each valve consists of a housing (**6**), two solenoids (**5**), a control spool (**7**) and two return springs (**8**). In the de-energized state, the spool (**7**) is held by the return springs (**8**) in the center position.

The spool is shifted via the action of the two wet-pin type solenoids (**5**). The force of an acting solenoid pushes against the push pin (**9**) on the end of the spool (**7**). The spool is shifted from its normal position to the end position for selected flow.

When the solenoid is de-energized, the control spool (**7**) is returned to its normal condition by the centering springs (**8**).

There is an orifice disk (**10**) in each valve. The disks are used to control the flow out of each valve. These disks fit inside the o-ring in each “P” port.



Verify the correct operation of the fork side shift valve solenoids before considering replacement of the valve. Refer to *Section 10.7, Electrical System Troubleshooting*. The housing (**6**) of the fork side shift valve is not serviceable and must be replaced if defective.

a. Fork Side Shift Manifold and Valve Removal

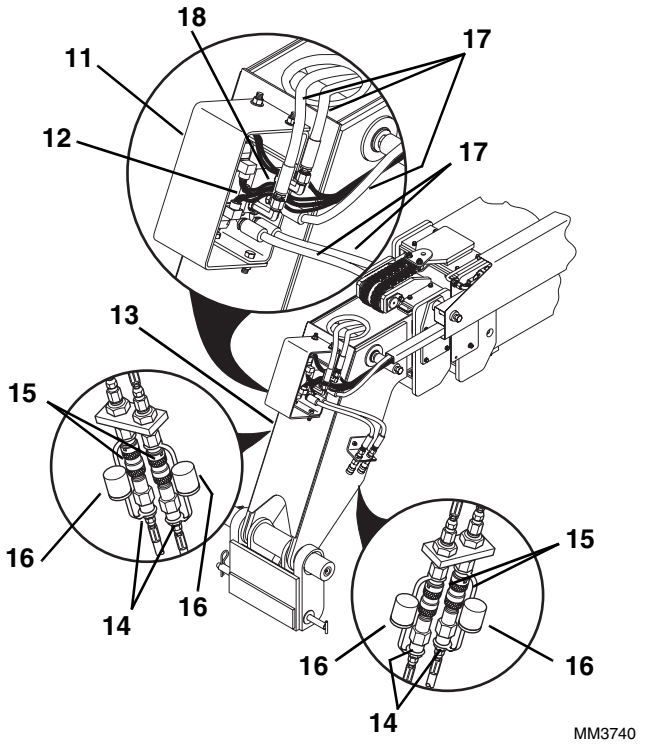
1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Allow the hydraulic fluid to cool.

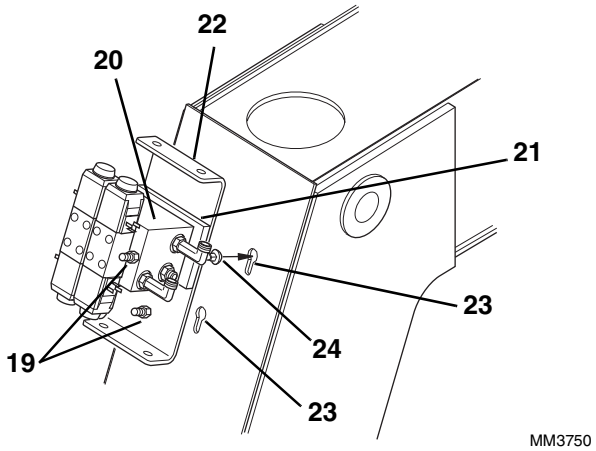
WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Remove the protective cover (**11**) around the fork side shift valve (**12**) on the front of the gooseneck (**13**).
5. Disconnect the fork side shift quick couplers (**14**) on the carriage from the quick couplers (**15**) on each side of the gooseneck (**13**). Install the protective caps (**16**) on all the quick couplers.



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6. Label or otherwise mark the hydraulic hoses (**17**) in relation to the fork side shift manifold (**18**). Disconnect and cap all hoses, fittings, solenoid wire terminal leads, etc. It is not necessary to remove the quick couplers from the mounts on each side of the gooseneck.
7. Loosen the hex nuts (**19**) holding the fork side shift valve manifold (**20**), manifold spacer (**21**) and the mounting plate (**22**) to the gooseneck. Slide the valve and plates up in the key hole mounting slots (**23**) and remove from the gooseneck.

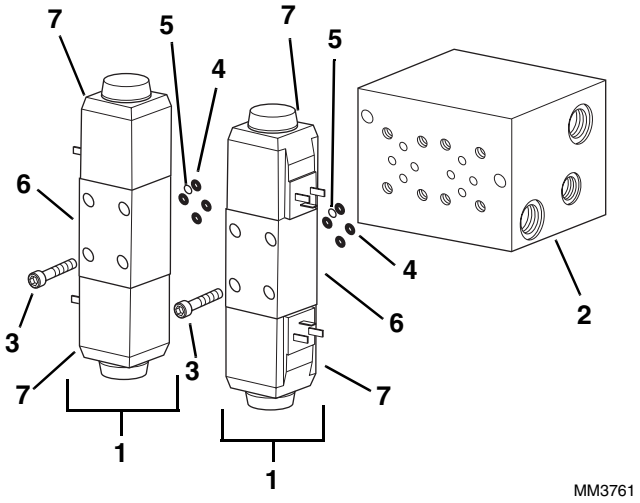


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8. The manifold spacer (**21**) and the mounting plate (**22**) can now be removed from the side shift valve manifold if needed by removing the hex nuts (**19**) from the carriage bolts (**24**).

b. Fork Side Shift Valve and Manifold Disassembly, Cleaning, Inspection and Assembly

1. Place the fork side shift valve and manifold assembly on a suitable work surface.
2. Remove the fork side shift valve assemblies (**1**) from the manifold (**2**) by removing the four socket head capscrews (**3**) from each valve. Discard the four o-rings (**4**) under each valve. Retain the “P” port orifice disks (**5**) from the underside of each shift valve housing (**6**).
3. Remove the solenoid coils and cartridges (**7**) from each end of the fork side shift valves (**1**).
4. Clean all components with a suitable cleaner before inspection.
5. Inspect the solenoid cartridges for proper operation. Check by shifting the spool to ensure that it is functioning properly. Check that the spring is intact. Inspect the cartridge interior for contamination.



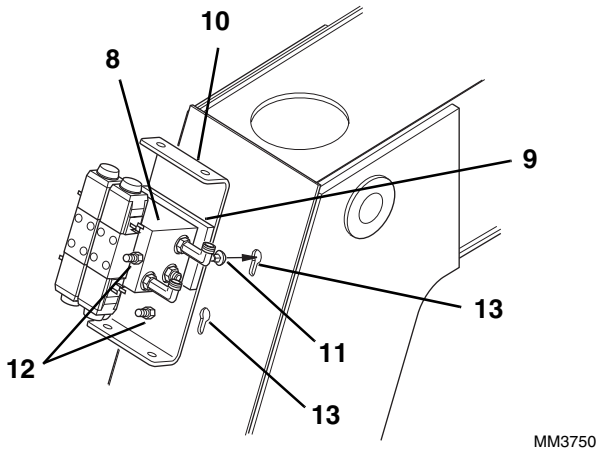
6. Inspect internal passageways of the fork side shift manifold and valve for wear, damage, etc. If inner surfaces of the manifold **DO NOT** display an ultra-smooth, polished finish, or components are damaged in any way, replace the manifold or appropriate part. Often, dirty hydraulic fluid causes failure of internal seals and damage to the polished surfaces within the side shift 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 valve cartridges and coils (**7**) in the fork side shift valve housing (**6**).
8. Attach each fork side shift valve assembly (**1**) to the manifold (**2**) using four new oiled o-rings (**4**) under each valve. Be sure the orifice disks (**5**) are in place under each side shift valve assembly. Secure in place using four socket head capscrews (**3**) for each valve.

c. Fork Side Shift Manifold And Valve Installation

1. Assemble the fork side shift manifold (**8**), manifold spacer (**9**) and mounting plate (**10**) together using the carriage bolts (**11**) and hex nuts (**12**). DO NOT fully tighten the hex nuts at this time.
2. Place the carriage bolts into the key hole mounting slots (**13**) on the front of the gooseneck and position the carriage bolts in the bottom of the slots. Tighten the three hex nuts (**12**) securely.
3. Connect the hydraulic hoses, fittings and solenoid wire connectors to the manifold and fork side shift valves.



4. Reassemble the protective cover around the front of the fork side shift valve and manifold assembly. Tighten the hardware securely.
5. Check the routing of all hoses for sharp bends or interference with any rotating members, and install tie wraps and/or protective conduit as required. Tighten all hose fittings.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

6. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Hydraulic oil leaking under pressure can penetrate the skin and cause severe personal injury. **DO NOT** use your hand or any part of your body to check for hydraulic leaks. When checking for hydraulic leaks, wear safety glasses and gloves to help provide protection from spraying hydraulic oil. Use a piece of cardboard or paper to search for leaks.

7. Inspect the fork side shift valve 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.*

8. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

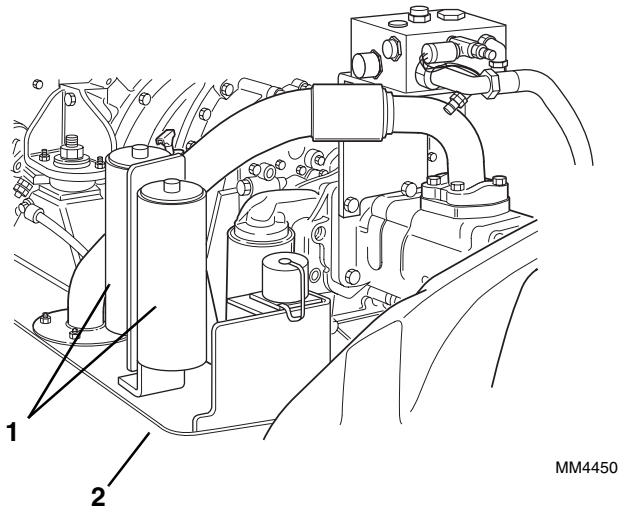
d. Fork Side Shift Valve Test

1. Remove the protective caps from the quick couplers on the each side of the gooseneck and from the quick couplers attached to the carriage.
2. Connect the quick couplers in the following order: Connect the YELLOW couplers then the GREEN couplers on the right side. Connect the BLACK couplers on the left side and then the RED couplers.
3. Conduct a check of the right and left side fork side shift valves.
4. Check each valve separately. Activate the right side fork switch inside the operators cab in both directions. Activate left side switch inside the operators cab in both directions.

9.13 ACCUMULATORS

This section covers the testing and charging of the accumulator system.

The accumulators (**1**) are located under the engine cover and are mounted to the top of the hydraulic oil reservoir (**2**). The internal parts of these accumulators are not serviceable. If the internal seals on the “free floating” piston are leaking or the seals on the top or bottom cap are leaking the accumulator requires replacement.



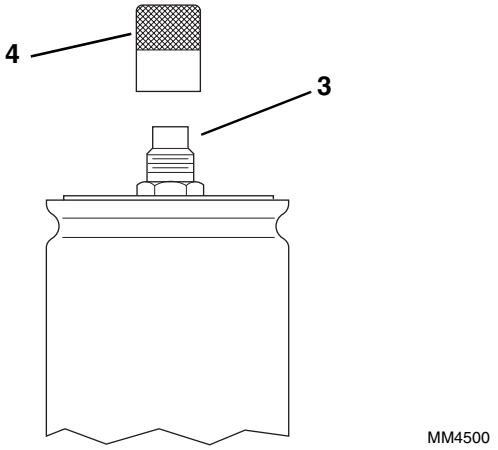
9.13.1 General Information

Each accumulator is a 4000 psi (276 bar) piston type accumulator. Each accumulator has an oil volume of 53 cubic inches and a gas volume of 58 cubic inches, with a bore size of three inches.

The pneumatic accumulator is operated by compressed gas. Gas and hydraulic oil occupy the same container. When oil pressure rises, incoming oil compresses the gas. When oil pressure drops, the gas expands, forcing the oil out into the service brake system.

The gas is separated from the oil by a “free floating” piston. This piston prevents the mixing of gas and oil and keeps the gas out of the hydraulic system. The piston fits into a smooth bore and uses seals to separate the gas from the oil. O-rings on both end caps prevent leakage of the gas or oil.

The accumulator must be “pre-charged” with gas before use in the service brake system. This is done by filling the gas chamber with dry nitrogen to a pressure of 700 +50/-0 psi (4826 +345/-0 kPa). The gas valve (**3**) located under the protective cap (**4**) at the top of the accumulator. The gas valve is used for pre-charging and testing the accumulator.



9.13.2 Pre-Charging Accumulator

Note: *Replacement accumulators are not pre-charged when shipped.*

> **WARNING:** **NEVER fill an accumulator with oxygen!** An explosion could result if oil and oxygen mix under pressure. This can result in death or serious personal injury. Only fill accumulator with dry nitrogen.

Pre-charge accumulators with nitrogen gas only. Nitrogen gas is free of water vapor and oxygen which makes it harmless to internal parts and will not react if mixed with oil under pressure.

> **CAUTION:** Never fill an accumulator with air. When air is compressed, water vapor condenses and can cause corrosion. This corrosion may damage seals and ruin the accumulator.

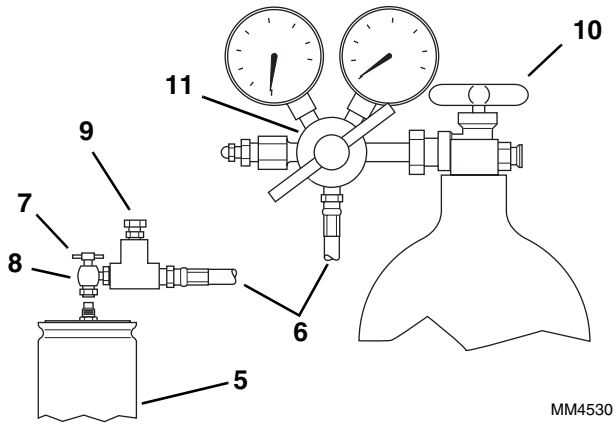
NEVER charge an accumulator to a pressure more than specified. The proper pressure for these accumulators is 700 +50/-0 psi (4826 +345/-0 kPa).

IMPORTANT: *Make sure the nitrogen bottle, as well as the charging and gauging assembly used is compatible with the gas valve assembly on the accumulator. The nitrogen source and all components must be rated for a pressure at least as high as the nitrogen source. It is strongly recommended that the nitrogen bottle has a high pressure regulator. Nitrogen gas bottles for water-pumped nitrogen have right-hand valve threads and are used with accumulators up to 3000 psi (207 bar).*

You will require an accumulator fill kit to properly charge the accumulators. Contact JLG Inc. at (717) 485-5161 domestically or (877) 554-5438 internationally for ordering information.

Use the following steps to properly pre-charge each accumulator:

1. Thoroughly clean the top of each accumulator (**5**).
2. Make sure the nitrogen supply is shut off.
3. Attach the accumulator fill kit (**6**) to the nitrogen bottle.
4. Remove the protective cap (**4**) from the gas valve (**3**) on the accumulator.
5. Back the “T” handle (**7**) on the accumulator fill kit all the way out (counter-clockwise). Attach the schrader adapter (**8**) to the gas valve on the accumulator. Tighten securely.
6. Turn the gas valve/bleed valve (**9**) on the accumulator fill kit all the way in.
7. Turn the “T” handle (**7**) all the way in to open the valve core on the accumulator.
8. Open the valve (**10**) on the nitrogen bottle.
9. Slowly adjust the regulator (**11**) on the nitrogen bottle to read 700 +50/-0 psi (4826 +345/-0 kPa).
10. Close the main valve (10) on the nitrogen bottle.
11. Back the “T” handle (**7**) on the accumulator fill kit all the way out (counter-clockwise).
12. Let the pre-charge on the accumulator set for 10-15 minutes. This will allow the gas temperature to stabilize. If the desired pre-charge range is exceeded, turn the “T” handle (**7**) all the way in. With the main valve (**10**) closed on the nitrogen bottle, turn the gas valve/bleed valve (**9**) out to bleed pressure off the accumulator. Turn the valve all the way in and check the pressure reading on the regulator gauge.
13. When the correct pressure is reached, back the “T” handle (**7**) on the accumulator fill kit all the way out (counter-clockwise). Bleed the pressure from the hose by turning the gas valve/bleed valve out to relieve the pressure.
14. Turn the gas valve/bleed valve all the way in and remove the schrader adapter (**8**) from the valve on the accumulator.
15. Reassemble the protective cap on to the gas valve on the accumulator.



9.13.3 Checking Pre-Charge

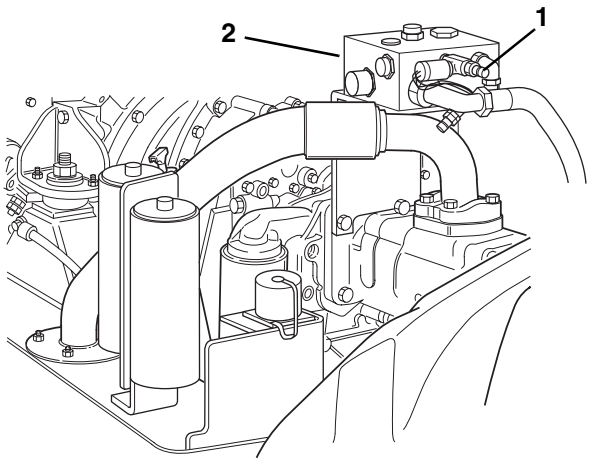
Gas Leaks

1. If an external leak is suspected, apply soapy water to the gas valve and the seams of the gas end cap. If bubbles form, the accumulator has to be replaced.
2. If an internal leak is suspected, check for foaming oil in the hydraulic oil reservoir and/or no accumulator action. If any of these signs are evident, the accumulator has to be replaced.

Checking Accumulator Recharge Pressure and Nitrogen Pre-Charge

Note: *This procedure will require the assistance of a second person to read the pressure gauge on the engine side of the vehicle.*

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. With the engine OFF, pump the brake pedal repeatedly until the accumulators are completely discharged. This will allow the free floating piston to bottom against the hydraulic end cap in each accumulator. ALL stored pressure should now be removed from the brake accumulator system.
3. Unlatch and open the engine cover.
4. Locate the diagnostic test nipple (**1**) on the accumulator charge valve (**2**) in the “SW” port. Attach a 5000 psi (348 bar) pressure gauge to the test nipple.
5. Start the engine and allow the accumulators to fully charge. Slowly pump the service brake pedal, while closely watching the test gauge.
6. Record the lowest pressure observed before the accumulator recharges. The pressure should be 950 - 1200 psi (65 - 83 bar). This reading is the accumulator recharge pressure.
7. Shut the engine OFF.
8. Slowly pump the service brake pedal while closely watching the pressure gauge.
9. Record the lowest pressure observed before the pressure drops to nearly zero. This reading is the nitrogen pre-charge of the accumulators. This pressure should be 700 psi (48 bar).
10. If either of these readings are outside the recommended ranges, the accumulator charge valve may need repair or replacement. *Section 9.12.10, Accumulator Charge Valve*.
11. If the nitrogen charge pressure is not correct *Section 9.13.2, Pre-Charging Accumulator*.



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12. Remove the pressure gauge from the test nipple and reinstall the protective rubber cap.
13. Close and latch the engine cover.

9.13.4 Accumulator Charge Troubleshooting

Problem	Cause	Remedy
1. Accumulator charging cycle repeats frequently when accumulator is not normally being discharged	1. Leaking accumulator lines or fittings.	1. Check lines and fittings for leaks and correct.
	2. Incorrect settings of accumulator gas charge.	2. Check accumulator gas charge. Refer to *Section 9.13.2, Pre-Charging Accumulator*.
	3. Line to accumulator plugged.	3. Replace line.
	4. Inoperative accumulator charging valve.	4. Replace accumulator charging valve.
2. Accumulator starts to charge but does not reach high limit	1. No oil or low oil level in hydraulic reservoir.	1. Check oil level and add oil as needed.
	2. Pump worn or inoperative and not delivering full flow or pressure.	2. Check pump flow and pressure. Refer to *Section 9.7, Hydraulic System Testing*.
	3. Inoperative relief valve in accumulator charge valve. Valve leaking or has low setting so full flow and pressure are not available.	3. Check relief valve and/or replace. Refer to *Section 9.12.10, Accumulator Charge Valve*.
	4. Inoperative accumulator charging valve.	4. Replace accumulator charging valve.
3. Accumulator charging time too long	1. No oil or low oil level in hydraulic reservoir.	1. Check oil level and add oil as needed.
	2. Relief valve setting to low.	2. Check relief valve setting. Refer to *Section 9.7, Hydraulic System Testing*.
	3. Pump worn or inoperative and not delivering full flow or pressure.	3. Check pump flow and pressure. Refer to *Section 9.7, Hydraulic System Testing*.
	4. Inoperative accumulator charging valve.	4. Replace accumulator charging valve.

Accumulator Charge Troubleshooting (cont'd)

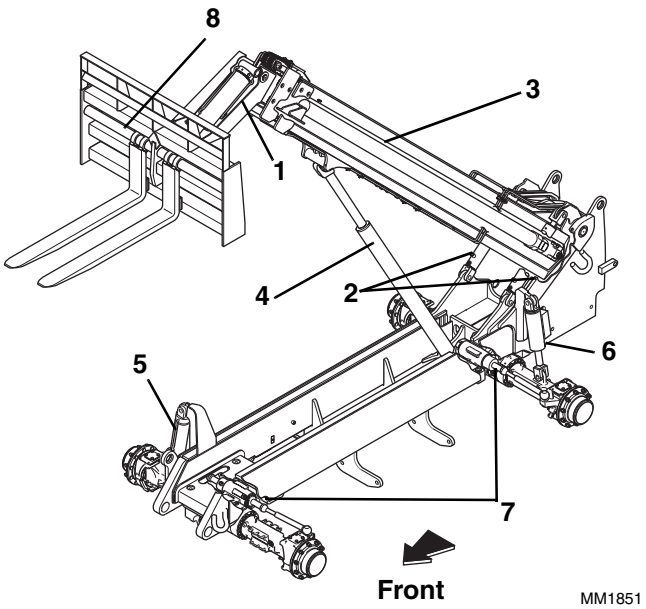
Problem	Cause	Remedy
4. Accumulator fails to start charging	1. No oil or low oil level in hydraulic reservoir. 2. Pump worn or inoperative and not delivering full flow or pressure. 3. Air in accumulator line. 4. Inoperative accumulator charging valve.	1. Check oil level and add oil as needed. 2. Check pump flow and pressure. Refer to *Section 9.7, Hydraulic System Testing*. 3. Bleed accumulator line. 4. Replace accumulator charging valve.
5. Very rapid cycling of accumulator charging valve	1. Incorrect settings of accumulator gas charge. 2. Inoperative accumulator charging valve.	1. Check accumulator gas charge. Refer to *Section 9.13.2, Pre-Charging Accumulator*. 2. Replace accumulator charging valve.
6. Lack of adequate flow through accumulator charge valve	1. Pump worn or inoperative and not delivering full flow or pressure. 2. Inoperative relief valve in accumulator charge valve. 3. Inoperative accumulator charging valve.	1. Check pump flow and pressure. Refer to *Section 9.7, Hydraulic System Testing*. 2. Check relief valve setting. Refer to *Section 9.7, Hydraulic System Testing*. 3. Replace accumulator charging valve.



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9.14 HYDRAULIC CYLINDERS

This section covers servicing the attachment tilt (**1**), slave (**2**), extend/retract (**3**), lift/lower (**4**), frame sway (**5**), stabilizer (**6**), steering (**7**) and fork side shift (**8**) cylinders on the vehicle.



There are many factors involved with the proper disassembly, cleaning, inspection, repair and reassembly of hydraulic cylinders; therefore, only qualified professionals with proper training, supervision, tools and equipment should rebuild the cylinders used on this vehicle.

For example, special pin spanner wrenches of the correct size are needed to disassemble the cylinders. Also, the lift/lower cylinder rod locknut must be torqued to 2200-2600 lb/ft (2034-3525 Nm); this requires a special torque wrench and/or torque multiplier. If the proper knowledge and equipment are not available, the cylinders must be sent out for rebuilding by a competent professional at a company that specializes in rebuilding agricultural and commercial heavy-equipment hydraulic cylinders.

Rebuild cylinders only in a clean, well-lighted area where all components can be carefully and thoroughly inspected. If leaving a cylinder dismantled for any length of time longer than the immediate rebuilding period, and especially in high-humidity environments, coat the metal parts with a suitable preservative and place them in protective storage.

Refer to the specific instructions for removal, rebuilding and installation of each cylinder.

9.14.1 General Cylinder Disassembly Instructions

WARNING: To help prevent severe burns, proceed with caution when applying heat to parts.

IMPORTANT: *Avoid the use of excessive heat, which will damage parts and make them unusable.*

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.

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. Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

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.

Note: *An additional o-ring may be included at the base of the cylinder rod. This additional o-ring may be discarded, as it served only in a temporarily protective role.*

9.14.2 General Cylinder Cleaning Instructions

Clean all reusable metal parts thoroughly after disassembly and prior to inspection. Use an approved solvent such as trichlorethylene.

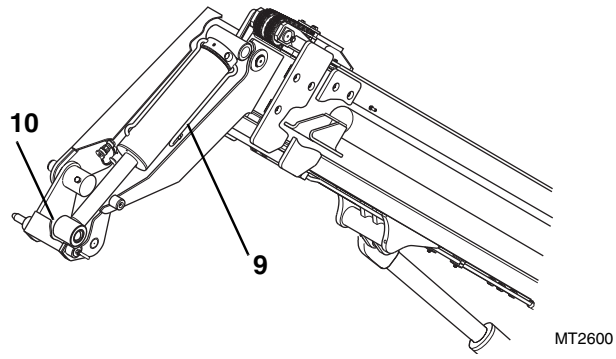
9.14.3 General Cylinder Assembly Instructions

1. Before reassembly, ensure that parts are clean and free from foreign matter. Use an approved solvent for cleaning, such as trichlorethylene.
2. Use the proper tools for specific installation tasks. Clean tools are required for installation.
3. Protect the finish on the rod at all times. Damage to the rod can cause premature seal failure.

4. ALWAYS use new oiled o-rings, seals, gaskets, etc. **DO NOT** over-stretch seals, wipers and o-rings. After installing such parts, verify that they are not twisted in their grooves.
5. To aid in installation, lubricate piston seals and the seal installation path with clean, filtered hydraulic oil.
6. Lubricate the outer surfaces of the seals and o-rings and the inside of the tube, piston and head gland with clean, filtered hydraulic oil. Use a suitable installation or compression tool when installing the piston and head gland into the cylinder to help prevent twisting or damaging the seals and o-rings. When sliding the rod and piston assembly in the tube, **DO NOT** damage the piston by scraping it against the threads in the tube. Keep the rod in line with the tube to prevent binding.
7. Follow the manufacturer's instructions when applying primer, locking or retaining compounds that are specified in the cylinder assembly procedures. The use of primer is recommended in some cases to decrease cure time. Allow sealant to cure fully before proceeding with the assembly procedure. The curing process may be hastened by the use of a heat gun to blow warm, dry air on the parts.
8. After assembling a cylinder, test the cylinder at low operating pressures. Verify that the piston and rod move freely in both directions.
9. Increase the operating pressure to the maximum pressure recommended for the cylinder. Check for external leakage and for free movement in both directions.
10. Retract the piston fully. Cap the hydraulic fittings.

9.14.4 Attachment Tilt Cylinder

The attachment tilt cylinder (**9**) is attached at the front of the inner boom inside the gooseneck.



a. Attachment Tilt Cylinder Removal

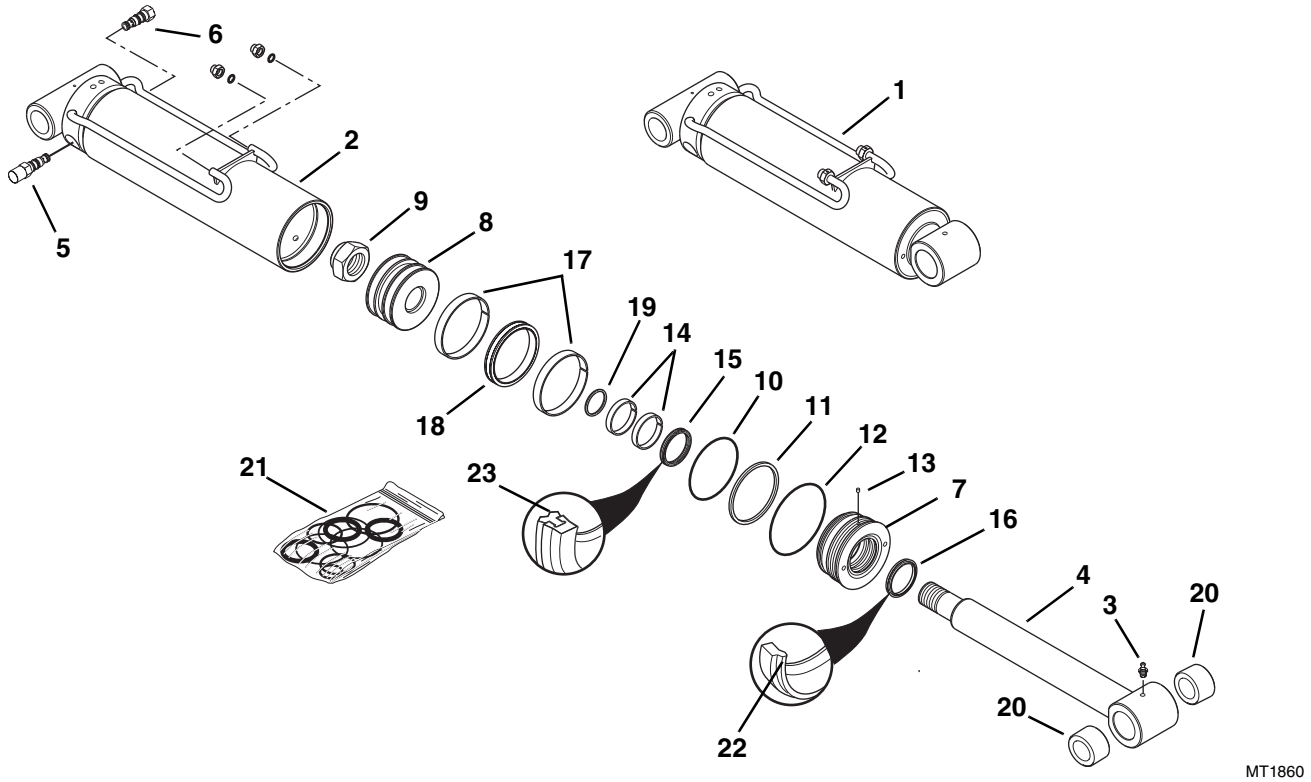
1. Remove any attachment from the vehicle. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders. Allow sufficient work space at the front of the boom. Raise the boom enough to allow the quick attach or the bottom of the gooseneck to clear the ground. Place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

> **WARNING:** Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

> **WARNING:** Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the hydraulic hoses in relation to the attachment tilt cylinder. Disconnect and cap both hoses and attachment tilt cylinder fittings. Refer to *Section 4.3, Boom Assembly Maintenance*.
5. Remove the retaining bolt (**10**) at the rod end of the attachment tilt cylinder. Remove the lower pivot pin.
6. Screw an eyelet, hook or other suitable fastener into the nut welded to the top of the attachment tilt cylinder. Make sure the device used can actually support the cylinder. Attach a suitable sling to an appropriate lifting device and to the attachment tilt cylinder at the eyelet or hook.
7. Remove the two 2" external retaining rings securing the attachment tilt cylinder base pin to the boom.
8. Remove the lower attachment tilt cylinder pin by tapping it out through the bottom of the quick attach (if installed).
9. Remove the attachment tilt cylinder base pin by tapping it out through the top of the gooseneck.
10. Remove the attachment tilt cylinder from the vehicle. Wipe up any hydraulic fluid spillage in, on, near or around the vehicle.



b. Attachment Tilt Cylinder Disassembly

Note: *An additional o-ring may be included at the base of the cylinder rod. This additional o-ring may be discarded, as it served only in a temporarily protective role.*

1. Clean the attachment tilt cylinder (**1**) with a suitable cleaner before inspection. Remove all dirt, debris and grease from the cylinder.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**2**).*

2. If necessary, remove the grease fitting (**3**) from the end of the rod (**4**).
3. Clamp the trunnion end of the attachment tilt 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. Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

4. Slowly remove the 4000 psi (276 bar) counterbalance valve (**5**) and the pilot-operated check valve (**6**) from the attachment tilt cylinder.
5. Extend the rod (**4**) to allow access to the base of the cylinder.

IMPORTANT: *Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

6. Using a pin spanner wrench, unscrew the head gland (**7**) from the tube (***2***). The head gland was originally torqued to 300-400 lb/ft (407-542 Nm), so a considerable amount of force is required to remove it. Carefully slide the head gland down along the rod toward the eyelet end, away from the cylinder tube.

IMPORTANT: *When sliding the rod and piston assembly in the tube, prevent the threaded end of the tube from damaging the piston (**8**). Keep the rod centered within the tube to help prevent binding.*

7. Carefully pull the rod (**4**) along with the head gland (**7**) and all attachments straight out of the tube (***2***).
8. Fasten the rod end in a soft-jawed vise and put a padded support below and near the threaded end of the rod to help prevent damage to the rod.

9. Remove the locknut (**9**) from the rod (**4**). The locknut is a deformed-thread type nut torqued at 2600-2900 lb/ft (3526-3932 Nm).

Note: *It may be necessary to apply heat to break the bond of the sealant between the locknut (**9**) and the rod (**4**) before the piston (**8**) can be removed. Some parts of cylinders 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 joint. Wipe off any hydraulic oil and heat the joint 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 or pressure for removal while the parts are still hot.

Breakdown of sealant will leave a white, powdery residue on threads and parts. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.

10. Remove the piston (**8**) and head gland (**7**) from the rod (**4**).
11. Remove the o-ring (**10**), back-up ring (**11**), and o-ring (**12**) from the head gland (**7**).
12. Remove the locking insert (**13**) from its hole in the head gland threads. Pry or drill out the insert as required. **DO NOT** damage the head gland threads. A new locking insert will be required for reassembly.
13. Remove the precision wearbands (**14**) and the deep Z-seal with rod back-up (**15**) from the front of the head gland (**7**). Remove the sealed outside diameter heavy-duty rod wiper (**16**) from the rear of the head gland.
14. Remove both precision wearbands (**17**) and the capped T-seal (**18**) from the piston (**8**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" itself.*

15. Remove the small o-ring (**19**) from within the piston (**8**).
16. If the bushings (**20**) need replacement, support the rod (**4**) in a soft-jawed vise or other suitable holding device. Carefully press the bushings from the rod.

c. Attachment Tilt Cylinder Cleaning

1. Thoroughly clean the inner surface of the attachment tilt cylinder with trichlorethylene or another approved cleaner.
2. Discard all seals, back-up rings and o-rings. Replace with new items from a complete seal kit (**21**) to help ensure proper cylinder function.
3. 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 and parts, it can be removed. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.*

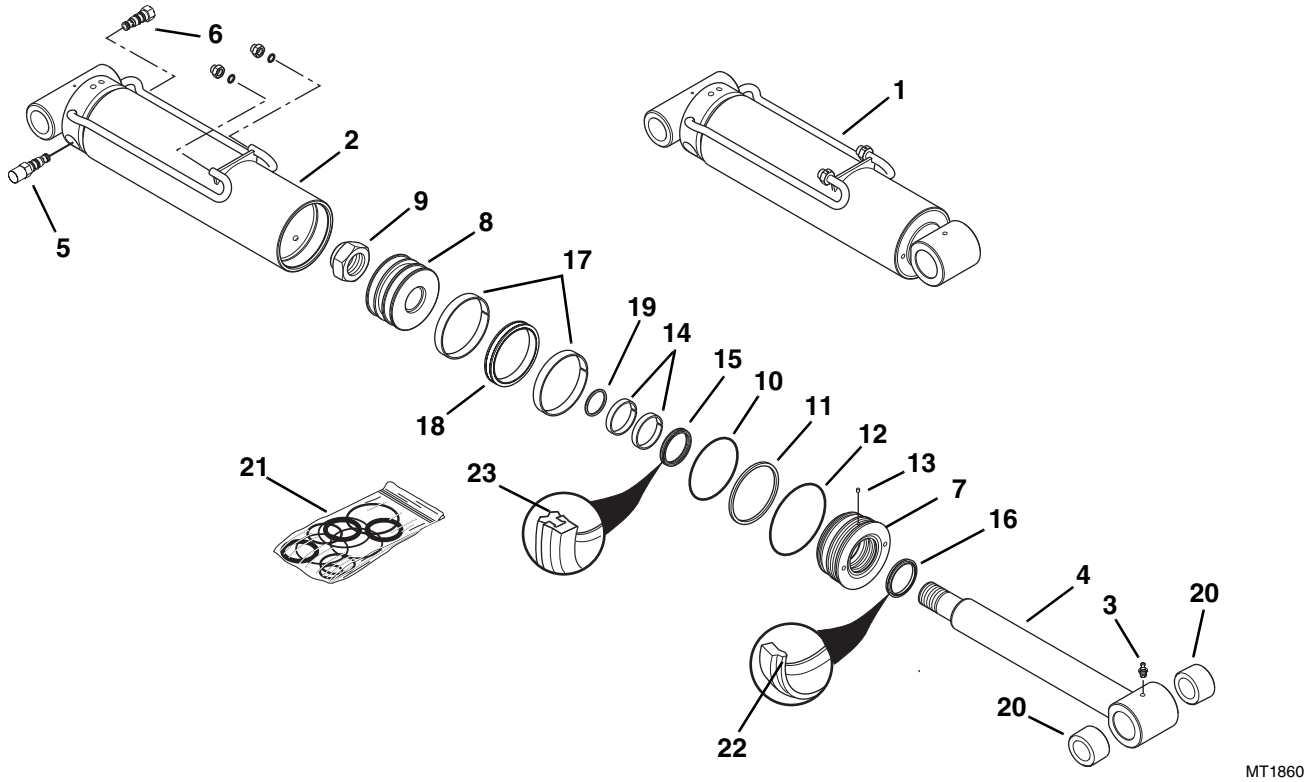
d. Attachment Tilt Cylinder Inspection

1. Inspect internal surfaces and all parts for wear, damage, etc. If the inner surface of the tube (***2***) does not display a smooth finish, or is scored or damaged in any way, replace the tube. Often, dirty hydraulic fluid causes failure of internal seals and damage to the smooth surface within the tube.
2. Remove slight scratches on the piston, rod, or inner surface of the tube with very fine grit emery cloth. Use the emery cloth in a rotary motion to polish out and blend the scratch(es) into the surrounding surface.
3. Inspect all other components for wear, damage, etc. Clean parts with trichlorethylene.
4. Check that the rod (**4**) is straight. If it is bent, a new rod must be installed.

e. Attachment Tilt Cylinder Assembly

Note: *Follow Section 9.14.3, General Cylinder Assembly Instructions.*

1. Install the sealed outside diameter heavy-duty rod wiper (**16**) into the outer end of the head gland (**7**). The wiper lip (**22**) should be toward the outer end of the head gland and the seal lips toward the inner end of the head gland. Use tools that will not damage the seals.
2. Install new oiled o-ring (**10**), back-up ring (**11**), oiled o-ring (**12**), precision wearbands (**14**) and deep Z-seal with rod back-up (**15**) onto the head gland (**7**) orienting the edge (**23**).
3. Install the small new oiled o-ring (**19**) into the rod-end of the piston (**8**).



4. Install both precision wearbands (**17**) and the capped T-seal (**18**) onto the piston (**8**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" itself.*

5. Install the head gland (**7**) and piston (**8**) onto the rod (**4**).

IMPORTANT: *Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

6. Fasten the rod end in a soft-jawed vise and put a padded support below and near the threaded end of the rod to help prevent damage to the rod. Apply Loctite #271 (red) and install the locknut (**9**) onto the rod (**4**). Torque the nut to 2600-2900 lb/ft (3526-3932 Nm). The threads will deform upon tightening, locking the nut in place.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder.*

7. Place the attachment tilt cylinder tube (**2**) in a soft-jawed vise or other acceptable holding equipment if possible.

IMPORTANT: *When sliding the rod and piston assembly in the tube, prevent the threaded end of the tube from damaging the piston (**8**). Keep the rod centered within the tube to help prevent binding.*

8. Carefully insert the rod (**4**) with all attachments straight into the tube (**2**).
9. Using a pin spanner wrench, thread the head gland (**7**) almost completely into the tube (**2**), leaving just enough room to install a new locking insert (**13**) into its hole in the head gland threads.
10. Install a new locking insert (**13**). Thread the head gland (**7**) tightly into the tube and torque to 300-400 lb/ft (407-542 Nm).
11. Using new oiled o-rings, thread the 4000 psi (276 bar) counterbalance valve (**5**) and the pilot-operated check valve (**6**) into the attachment tilt cylinder. Torque to 30-35 lb/ft (41-47 Nm).
12. If necessary, install a grease fitting (**3**) into the tapped hole in the end of the rod (**4**). Lubricate the bushings in the rod end through the grease fitting with multi-purpose grease before the vehicle is operated.

f. Attachment Tilt Cylinder Installation

1. Attach a suitable sling to an overhead crane or other suitable device and to the attachment tilt cylinder at the eyelet or hook. Make sure the device used can actually support the cylinder. Place the attachment tilt cylinder in position within the gooseneck. Refer to *Section 4.3, Boom Assembly Maintenance*.
2. Install the lower attachment tilt cylinder pin by tapping it out through the bottom of the quick attach (if installed). Install the retaining bolt.
3. Coat the attachment tilt cylinder base pin with anti-seize compound and install the pin by tapping it in through the top of the gooseneck.
4. Secure the attachment tilt cylinder base pin to the boom with two 2" external retaining rings.
5. Install the lower pivot pin and quick attach as required.
6. Connect the attachment tilt cylinder hydraulic hoses in relation to the labels or markings made during removal.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

7. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

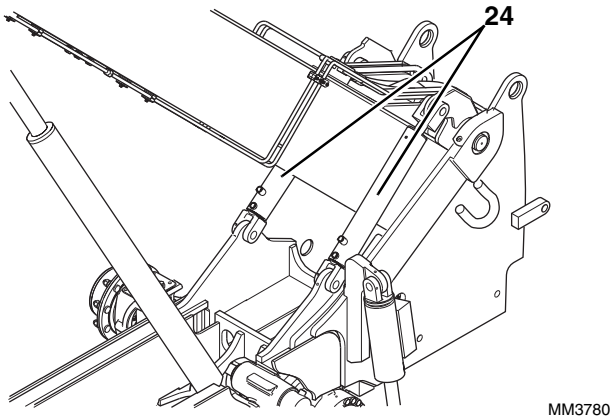
8. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Add hydraulic fluid to the reservoir as needed. Shut the engine OFF.
9. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.
10. Conduct a pressure check of the attachment tilt cylinder hydraulic circuit and bleed the circuit as outlined in the procedure that follows.

g. Attachment Tilt Cylinder Pressure Checking and Circuit Bleeding

1. Attach a 5000 psi (345 bar) gauge to the main control valve at the extend/retract base port relief to test the attachment tilt cylinder hydraulic system circuit pressure. The unit is equipped with test fittings from the factory. Pressure readings should be 4000 psi ±50 psi (276 ±3,4 bar). Refer to *Section 9.7, Hydraulic System Testing*.
2. With no accessory installed on the quick attach, start with the lift/lower and attachment tilt cylinders fully retracted.
3. Fully extend the attachment tilt cylinder. Hold the attachment tilt joystick at full extend while fully raising the lift/lower cylinder.
4. Fully retract the attachment tilt cylinder. Hold the attachment tilt joystick at full retract while fully retracting the lift/lower cylinder.
5. Repeat Steps 3-4 five times.

9.14.5 Slave Cylinders

Each slave cylinder (**24**) is secured to the vehicle frame and outer boom with cylinder mount pins, capscrews and nuts.

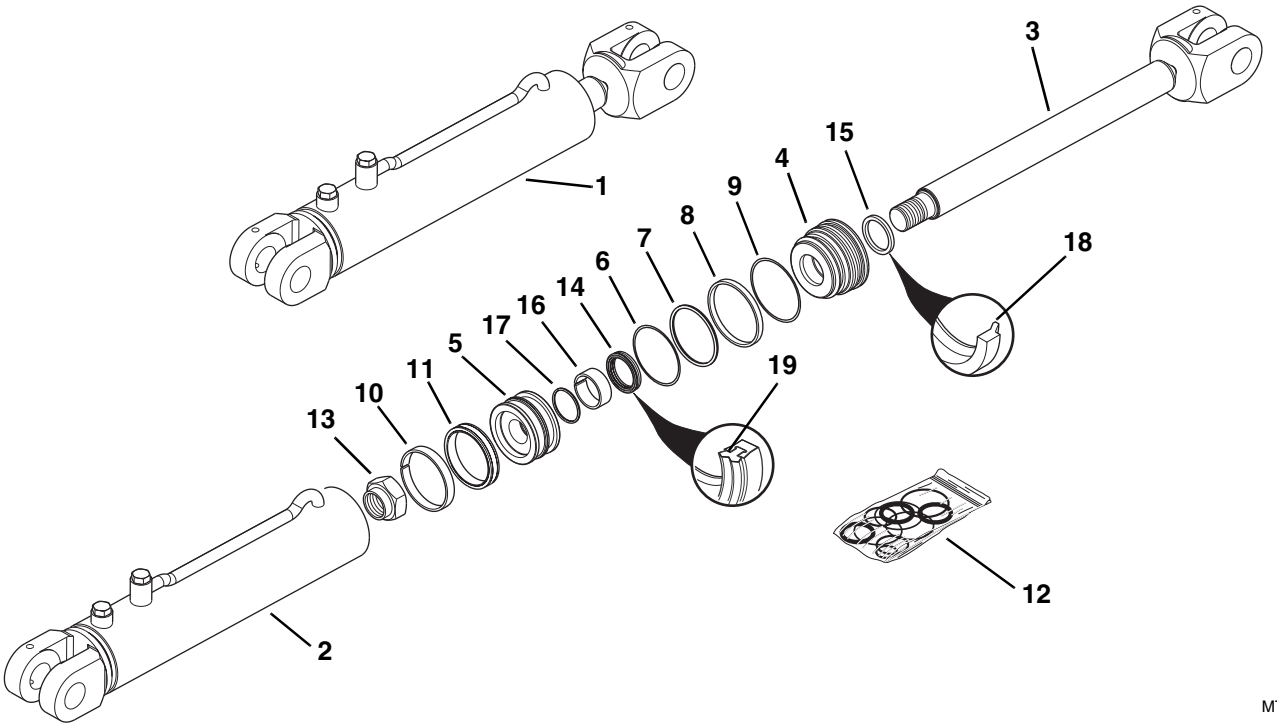


a. Slave Cylinder Removal

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, then raise the boom to approximately a 30-degree angle. Support the boom. Place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.



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WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the hydraulic hoses (right side) or tubes (left side) in relation to the slave cylinder being removed. Disconnect and cap the hydraulic hoses and slave cylinder fittings.
5. Securely support the slave cylinder. Remove the nuts, capscrews and cylinder pins securing the slave cylinder to the vehicle frame and outer boom.
6. With the help of at least one assistant, remove the slave cylinder from the vehicle. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle.

b. Slave Cylinder Disassembly

Note: *An additional o-ring may be included at the base of the cylinder rod. This additional o-ring may be discarded, as it served only in a temporarily protective role.*

1. Clean the slave cylinder (**1**) with a suitable cleaner before inspection. Remove all dirt, debris and grease from the cylinder.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**2**).*

2. Place the slave cylinder in a soft-jawed vise or other acceptable holding equipment if possible.
3. Extend the rod (**3**) to allow access to the base of the cylinder.

IMPORTANT: *Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

4. Using a pin spanner wrench, unscrew the head gland (**4**) from the tube (**2**). The head gland was originally torqued at 250-300 lb/ft (339-407 Nm), so a considerable amount of force is required to remove it. Carefully slide the head gland down along the rod toward the eyelet end, away from the cylinder tube (**2**).

IMPORTANT: *When sliding the rod and piston assembly in the tube, prevent the threaded end of the tube from damaging the piston (**5**). Keep the rod centered within the tube to help prevent binding.*

5. Carefully pull the rod (**3**) with all attachments straight out of the tube (**2**).
6. Fasten the rod end in a soft-jawed vise and put a padded support below and near the threaded end of the rod to help prevent damage to the rod.
7. Remove the o-ring (**6**), back-up ring (**7**), locking insert (**8**) and o-ring (**9**) from the head gland.

8. Remove the precision wearband (**10**) and the capped T-seal (**11**) from the piston (**5**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" itself.*

9. Remove the locknut (**13**) from the rod (**3**). The deforming-thread type nut was coated with Loctite #271 (red) and torqued to 750-800 lb/ft (1017-1085 Nm). Discard the nut.

Note: *It may be necessary to apply heat to break the bond of the sealant between the locknut (**13**) and the rod (**3**) before the piston (**5**) can be removed. Some parts of cylinders 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 joint. Wipe off any hydraulic oil and heat the joint 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 or pressure for removal while the parts are still hot.

Breakdown of sealant will leave a white, powdery residue on threads and parts. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.

10. Remove the piston (**5**) and head gland (**4**) from the rod (**3**).
11. From within the head gland (**4**), remove the deep Z-seal with rod back-up (**14**) and the sealed outside diameter heavy-duty rod wiper (**15**).
12. From within the piston (**5**), remove the precision wearband (**16**) and the small o-ring (**17**).

c. Slave Cylinder Cleaning

1. Remove all hydraulic fluid, dirt and debris from the inner surface of the cylinder.
2. Discard all seals, back-up rings and o-rings. Replace with new items from a complete seal kit (**12**) to help ensure proper cylinder function.
3. 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 and parts, it can be removed. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.*

d. Slave Cylinder Inspection

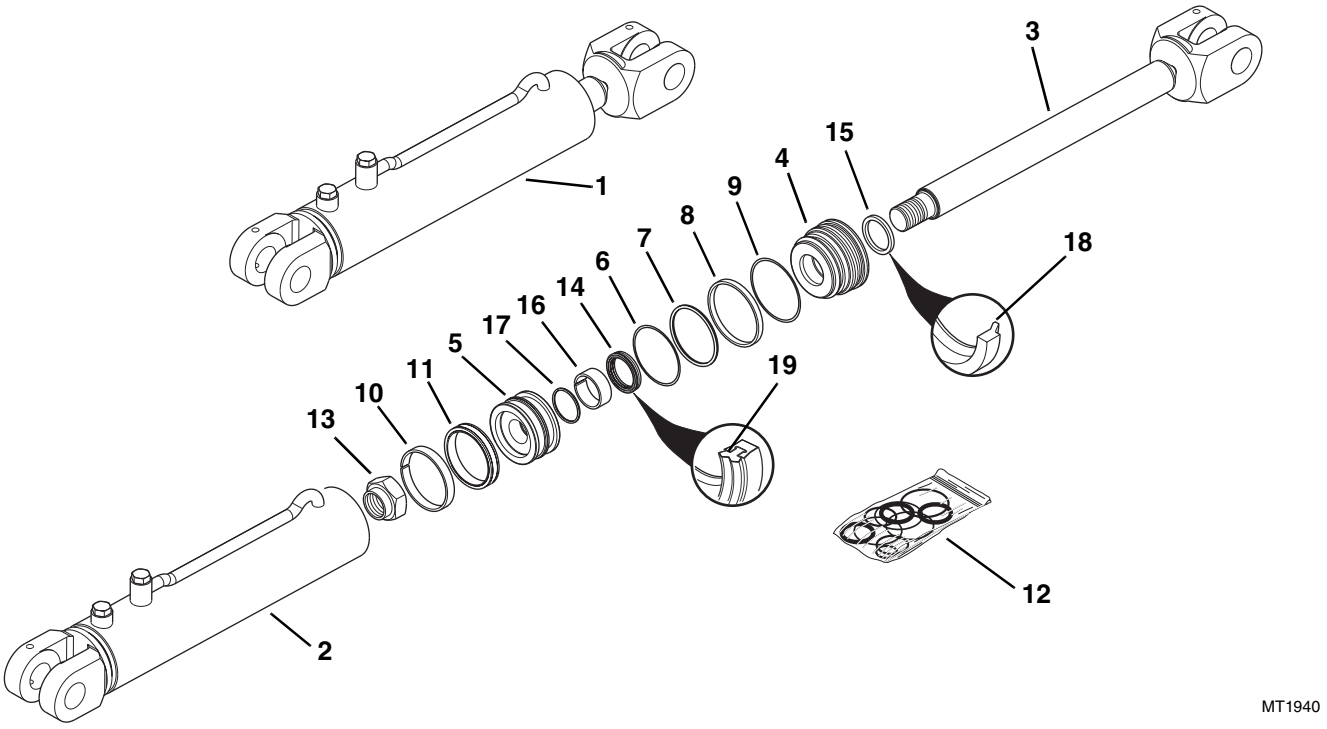
1. Inspect internal surfaces and all parts for wear, damage, etc. If the inner surface of the tube (**2**) does not display a smooth finish, or is scored or damaged in any way, replace the tube. Often, dirty hydraulic fluid causes failure of internal seals and damage to the smooth surface within the tube.
2. Remove slight scratches on the piston, rod, or inner surface of the tube with very fine grit emery cloth. Use the emery cloth in a rotary motion to polish out and blend the scratch(es) into the surrounding surface.
3. Clean parts with trichlorethylene.
4. Check that the rod (**3**) is straight. If it is bent, install a new rod.

e. Slave Cylinder Assembly

Note: *Follow Section 9.14.3, General Cylinder Assembly Instructions.*

IMPORTANT: *Use a suitable installation tool or compression sleeve to help prevent twisting or damaging the seals and o-rings when installing the piston and head gland into the cylinder. When sliding the rod and piston assembly in the tube, **DO NOT** damage the piston by scraping it against the threads in the tube. Keep the rod in line with the tube to prevent binding.*

1. Fasten the rod end in a soft-jawed vise and put a padded support below and near the threaded end of the rod to help prevent damage to the rod.
2. Install the small o-ring (**17**) and the precision wearband (**16**) in the piston (**5**).
3. Install the sealed outside diameter heavy-duty rod wiper (**15**). The wiper lip (**18**) should be toward the outer end of the head gland and the seal lips toward the inner end of the head gland. Use tools that will not damage the seals.
4. Install the deep Z-seal with rod back-up (**14**) in the head gland (**4**) orienting the edge (**19**).
5. Carefully install the head gland (**4**) onto the rod (**3**).
6. Carefully install the piston (**5**) onto the rod (**3**).



Note: *If a white, powdery residue remains on the threads and parts, clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before proceeding.*

7. Apply Loctite Threadlocker #271 (red) to the locknut (**13**). Thread the locknut onto the rod (**3**) and torque to 750-800 lb/ft (1017-1085 Nm). The threads will deform upon tightening, locking the nut in place.
8. Install the capped T-seal (**11**) and precision wearband (**10**) onto the piston (**5**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" itself.*

9. Install new oiled o-ring (**6**), back-up ring (**7**), locking insert (**8**) and oiled o-ring (**9**) onto the head gland (**4**).

IMPORTANT: *When sliding the rod and piston assembly in the tube, prevent the threaded end of the tube from damaging the piston (**5**). Keep the rod centered within the tube to help prevent binding. Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

10. Carefully insert the rod (**3**) with all attachments straight into the tube (**2**).
11. Using a pin spanner wrench, thread the head gland (**4**) into the tube (**2**). Torque the head gland to 250-300 lb/ft (339-407 Nm).

f. Slave Cylinder Installation

1. Align the slave cylinder with its mounting bosses within the rear frame uprights.
2. Align the mount pin bolt holes with the slave cylinder mount holes. Align the self-aligning bearing. Secure the slave cylinder with the cylinder pins, capscrews and nuts. Torque the capscrews and nuts to specification. Refer to the fastener torque chart in *Section 2.3, Torques*.

3. Use new oiled o-rings and reattach and secure the hydraulic hoses (right side) or tubes (left side) to the slave cylinder fittings.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

4. Start and run the engine at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

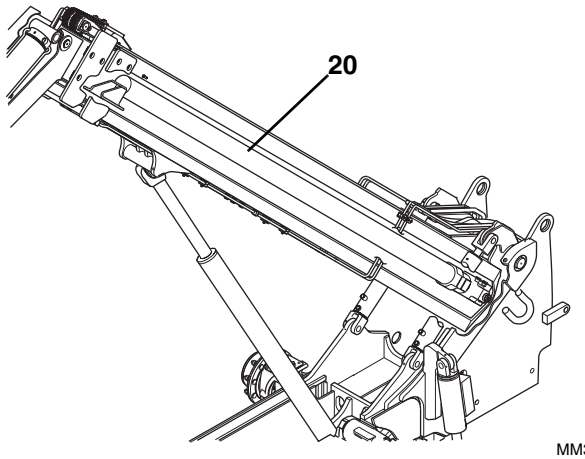
5. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF. Add hydraulic fluid if required.
6. Conduct a pressure check of the attachment tilt/ slave cylinder hydraulic circuit and bleed the circuit as outlined in the procedure that follows.
7. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

g. Slave Cylinder Pressure Checking and Circuit Bleeding

1. Attach a 5000 psi (345 bar) gauge to the main control valve at the attachment tilt port to test the attachment tilt and slave cylinder hydraulic system circuit pressure. The unit is equipped with test fittings from the factory. Pressure readings should be 3500 psi ±100 psi (241,3 ±7 bar). Refer to *Section 9.7, Hydraulic System Testing*.
2. With no accessory installed on the quick attach, start with the lift/lower and attachment tilt cylinders fully retracted.
3. Fully extend the attachment tilt cylinder. Monitor pressure while fully raising the lift/lower cylinder.
4. Fully retract the attachment tilt cylinder. Monitor pressure while fully retracting the lift/lower cylinder.
5. Repeat Steps 3-4 five times.

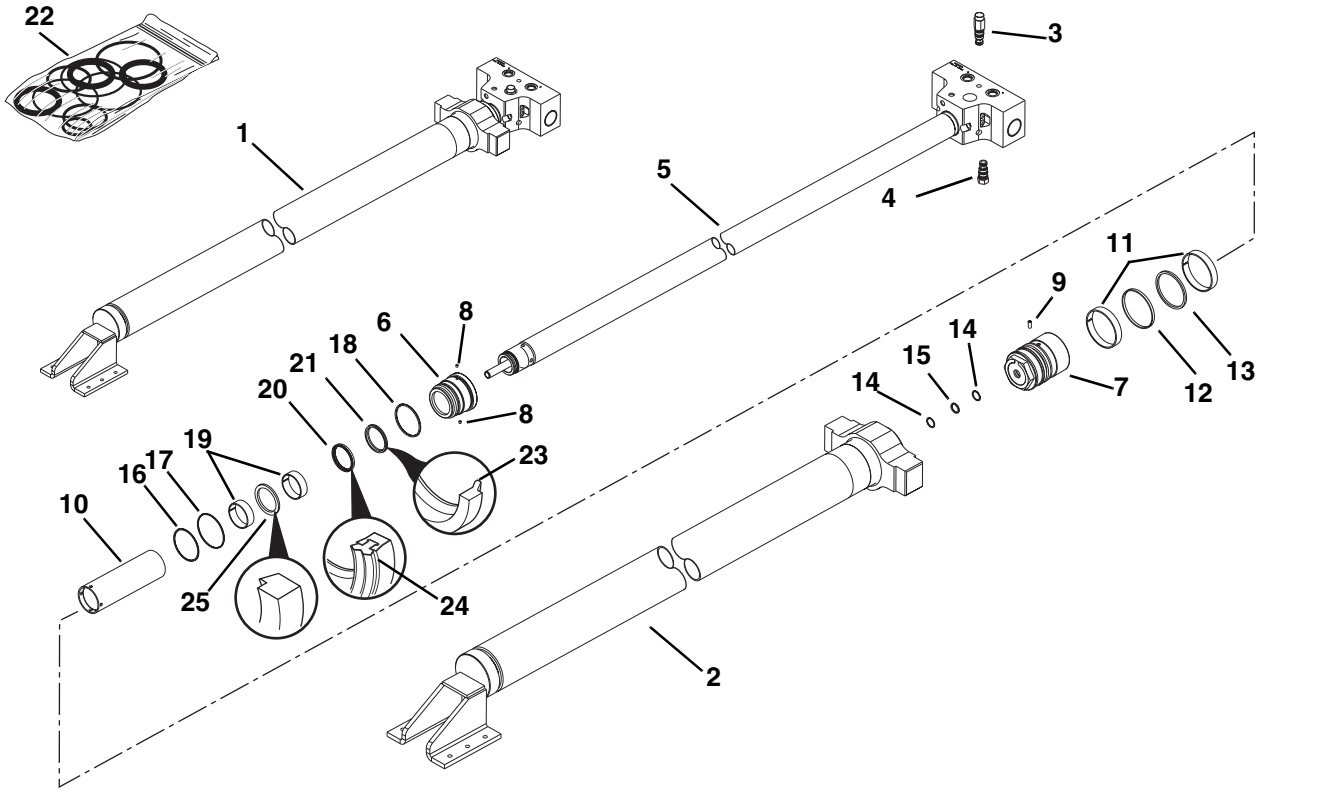
9.14.6 Extend/Retract Cylinder

The extend/retract cylinder (**20**) is located within the inner boom.



a. Extend/Retract Cylinder Removal

Procedures for removing the extend/retract cylinder appear in *Section 4.3.2, Inner Boom Replacement*.



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b. Extend/Retract Cylinder Disassembly

Note: *An additional o-ring may be included at the base of the cylinder rod. This additional o-ring may be discarded, as it served only in a temporarily protective role.*

1. Clean the extend/retract cylinder (**1**) with a suitable cleaner. Remove all dirt, debris and grease from the cylinder.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**2**).*

2. Secure the extend/retract 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. Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

3. Slowly remove the counterbalance valve (**3**) and the pilot-operated check valve (**4**).

IMPORTANT: ***DO NOT*** *tamper with or attempt to reset the counterbalance valve cartridge. If adjustment or replacement is necessary, replace a counterbalance valve with a new part.*

4. Extend the rod (**5**) as required to allow access to the base of the cylinder.

IMPORTANT: *Protect the finish on 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 (**6**) from the tube (**2**). The head gland was originally torqued to 300-400 lb/ft (407-542 Nm), so a considerable amount of force is required. Carefully slide the head gland down along the rod toward the trunnion end, away from the cylinder tube (**2**).

IMPORTANT: *When sliding the rod and piston assembly in the tube, prevent the threaded end of the tube from damaging the piston (**7**). Keep the rod centered within the tube to help prevent binding.*

6. Carefully pull the rod (**5**) with all attachments straight out of the tube (**2**).

7. Fasten the trunnion end of the rod in a soft-jawed vise and put a padded support below and near the threaded end of the rod to help prevent damage to the rod.
8. Remove the locking inserts (**8**) from the head gland threads. Pry or drill out the insert as required. **DO NOT** damage the head gland threads. A new locking insert will be required for reassembly.
9. Remove the setscrew (**9**) from the piston (**7**). The setscrew is used to provide a secondary lock on the piston.
10. Remove the piston (**7**) from the rod spacer (**10**) and rod (**5**). The piston was installed with Loctite #243 and torqued to 350-450 lb/ft (475-610 Nm).

Note: *It may be necessary to apply heat to break the bond of the sealant between piston (**7**) and the rod (**5**) before the piston can be removed. Some parts of cylinders 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 joint. Wipe off any hydraulic oil and heat the joint 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 or pressure for removal while the parts are still hot.

Breakdown of sealant will leave a white, powdery residue on threads and parts. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.

11. Remove the rod spacer (**10**).
12. Remove both precision wearbands (**11**), piston seal (**12**) and square ring (**13**) from the piston (**7**).
13. From within the piston (**7**), remove the back-up rings (**14**) and the small o-ring (**15**).
14. Remove the o-ring (**16**), back-up ring (**17**) and o-ring (**18**) from the head gland (**6**). Remove them from the rod (**5**).
15. Remove the head gland (**6**) from the rod.
16. From within the head gland (**6**), remove one of the precision wearbands (**19**), the buffer seal (**25**), another precision wear band (**19**), the deep Z-seal with back-up (**20**) and the sealed outside diameter heavy-duty rod wiper (**21**).

c. Extend/Retract Cylinder Cleaning

1. Remove all hydraulic fluid, dirt and debris from the inner surface of the cylinder tube (**2**).
2. Discard all seals, back-up rings, o-rings, etc. Replace with new items from a complete seal kit (**22**) to help ensure proper cylinder function.
3. 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 and parts, it can be removed. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.*

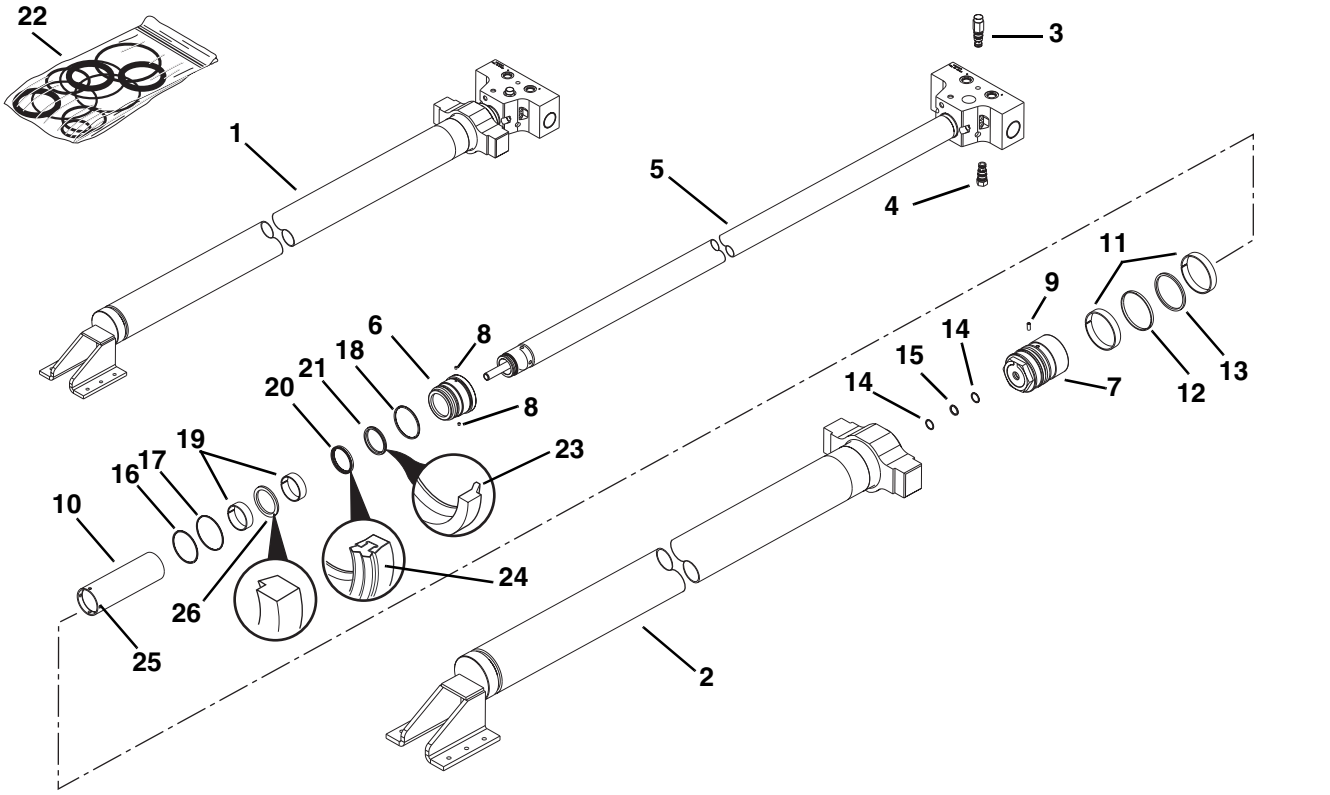
d. Extend/Retract Cylinder Inspection

1. Inspect internal surfaces and all parts for wear, damage, etc. If the inner surface of the tube (**2**) does not display a smooth finish, or is scored or damaged in any way, replace the tube. Often, dirty hydraulic fluid causes failure of internal seals and damage to the smooth surface within the tube.
2. Remove slight scratches on the piston, rod, or inner surface of the tube with very fine grit emery cloth. Use the emery cloth in a rotary motion to polish out and blend the scratch(es) into the surrounding surface.
3. Clean parts with trichlorethylene.
4. Check that the rod (**5**) is straight. If it is bent, install a new rod.

e. Extend/Retract Cylinder Assembly

Note: *Follow Section 9.14.3, General Cylinder Assembly Instructions.*

1. Install a new back-up ring (**14**), small o-ring (**15**) and another back-up ring (**14**) into the forward end of the piston (**7**).
2. Install the square ring (**13**), piston seal (**12**) and both precision wearbands (**11**) onto the piston (**7**).



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3. Install one of the precision wearbands (**19**), the buffer seal (**26**) with the angled edge toward the outside of the cylinder, another precision wearband (**19**), the deep Z-seal with rod back-up (**20**) and the sealed outside diameter heavy-duty rod wiper (**21**) into the head gland (**6**). Orient the Z-seal edge (**24**). The rod wiper lip (**23**) should be toward the outer end of the head gland and the seal lips toward the inner end of the head gland. Use tools that will not damage the seals.
4. Install new oiled o-ring (**18**), back-up ring (**17**) and oiled o-ring (**16**) onto the head gland (**6**).
5. Fasten the trunnion end of the rod in a soft-jawed vise and put a padded support below and near the threaded end of the rod to help prevent damage to the rod.
6. Carefully slide the head gland (**6**), then the rod spacer (**10**) onto the rod (**5**).

Note: *The holes (**25**) in the rod spacer (**10**) must be near the piston (**7**).*

7. Carefully slide the piston (**7**) onto the rod spacer (**10**) and rod (**5**). Apply Loctite Threadlocker #243 to the piston and torque the piston to 350-450 lb/ft (475-610 Nm).
8. Turn the rod spacer (**10**) as required to align the piston setscrew hole. The setscrew is used to provide a secondary lock on the piston. Apply Loctite Threadlocker #243 to the setscrew (**9**) and thread it into the piston (**7**). Torque the setscrew to 13-15 lb/ft (155-175 lb/in) (18-20 Nm).
9. Install new locking inserts (**8**) into the holes in the head gland threads.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder.*

10. Secure the extend/retract cylinder tube (**2**) in a soft-jawed vise or other acceptable holding equipment if possible.
11. Lubricate the inside of the tube (**2**) and outside of the piston (**7**) and head gland (**6**) with clean, filtered hydraulic oil.
12. Apply a compression sleeve or other suitable tool to the head gland (**6**) and piston (**7**) in order to compress the o-rings, back-up rings and seals while inserting the assembled piston, rod and head into the tube (**2**).

IMPORTANT: *When sliding the rod (**5**) and piston assembly in the tube, prevent the threaded end of the tube from damaging the piston (**7**). Keep the rod centered within the tube to help prevent binding. Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

13. Carefully insert the rod (**5**) with all attachments straight into the tube (**2**).
14. Using a pin spanner wrench, thread the head gland (**6**) into the tube (**2**). Torque the head gland to 300-400 lb/ft (407-542 Nm).
15. Lubricate the counterbalance valve (**3**) and the pilot-operated check valve (**4**) with clean, filtered hydraulic oil. Using new oiled o-rings, thread the counterbalance valve and the pilot-operated check valve into the trunnion end of the cylinder. Torque the valves to 45-50 lb/ft (61-68 Nm).

IMPORTANT: ***DO NOT*** *tamper with or attempt to reset the counterbalance valve cartridge. If adjustment or replacement is necessary, replace a counterbalance valve with a new part.*

16. Test the cylinder at low operating pressure (100 psi or 7 bar). Verify that the piston and the rod move freely in both directions.
17. Increase the operating pressure to the maximum amount for the cylinder (4000 psi or 275 bar) and again check for free movement in both directions.
18. Retract the rod fully into the tube and cap and plug the hydraulic hose ports.

f. Extend/Retract Cylinder Installation

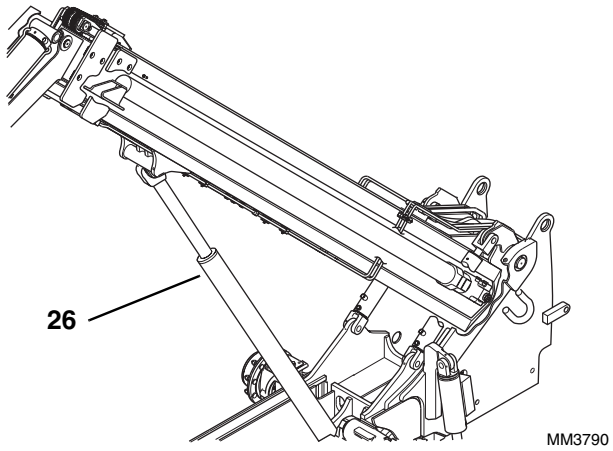
Installation procedures are covered in *Section 4.3.2, Inner Boom Replacement*.

g. Extend/Retract Cylinder Pressure Checking and Circuit Bleeding

1. Attach a 5000 psi (345 bar) gauge to the main control valve at the extend/retract base port relief to test the extend/retract cylinder hydraulic system circuit pressure. The unit is equipped with test fittings from the factory. Pressure readings should be 3000 ±100 psi (206,8 ±7 bar) on the extend and 3750 psi (259 bar) on the retract. Refer to *Section 9.7, Hydraulic System Testing*.
2. With no accessory installed on the quick attach, start with the lift/lower and attachment tilt cylinders fully retracted.
3. Fully extend the extend/retract cylinder. Hold the joystick at full extend while fully raising the lift/lower cylinder.
4. Fully retract the attachment tilt cylinder. Hold the attachment tilt joystick at full retract while fully retracting the lift/lower cylinder.
5. Repeat Steps 3-4 five times.

9.14.7 Lift/Lower Cylinder

The lift/lower cylinder (**26**) is anchored to the underside of the outer boom and to the vehicle frame.



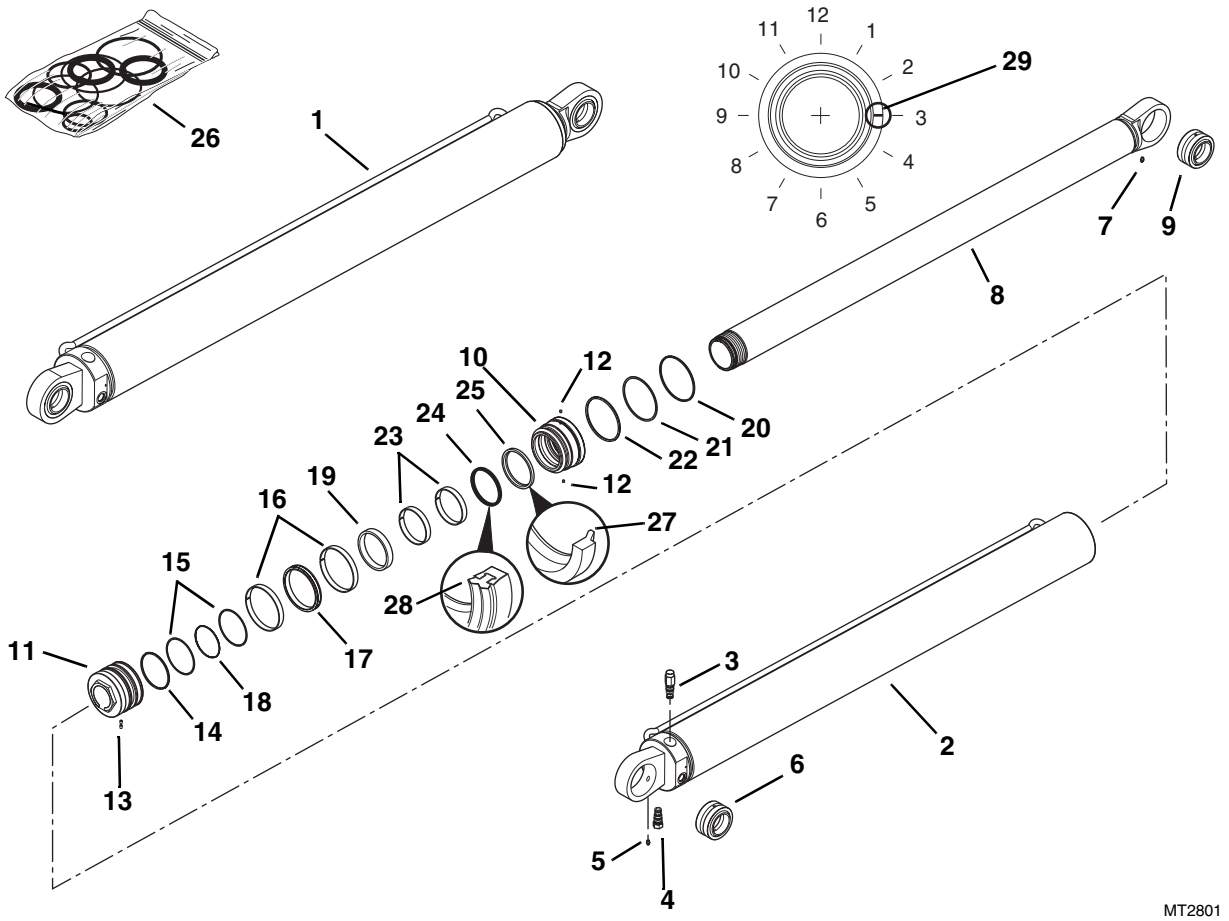
a. Lift/Lower Cylinder Removal

> **WARNING:** **DO NOT** get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing that requires the boom to be up. Unexpected lowering of the boom may cause death or serious injury.

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch, raise and support the boom to allow removal of the lift/lower cylinder and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

> **WARNING:** Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.



WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the lift/lower cylinder hydraulic hoses. Disconnect and cap all hoses and fittings.
5. Attach a sling to the lift/lower cylinder and to a hoist or an overhead crane. Support the lift/lower cylinder in the sling, and remove the nuts, capscrews and cylinder mount pins from the cylinder. The lower cylinder mounting pin is held in place with a retainer clevis pin and hair pin.
6. Safely and carefully, remove the lift/lower cylinder from the vehicle. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle.

b. Lift/Lower Cylinder Disassembly

Note: *An additional o-ring may be included at the base of the cylinder rod. This additional o-ring may be discarded, as it served only in a temporarily protective role.*

1. Clean the lift/lower cylinder (**1**) with a suitable cleaner. Remove all dirt, debris and grease from the cylinder.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**2**).*

2. Secure the lift/lower 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. Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

3. Slowly remove the counterbalance valve (**3**) and pilot-operated check valve (**4**) from the eyelet end of the tube (**2**). If necessary, remove the grease fitting (**5**) from the tapped hole in the eyelet end of the tube.

IMPORTANT: ***DO NOT*** *tamper with or attempt to reset the counterbalance valve cartridge. If adjustment or replacement is necessary, replace the counterbalance valve with a new part.*

4. If the self-aligning bearing (**6**) requires replacement, carefully press the bearing out of the tube eyelet.
5. If necessary, remove the grease fitting (**7**) from the tapped hole in the eyelet end of the rod (**8**).
6. If the self-aligning bearing (**9**) requires replacement, support the rod (**8**) in a soft-jawed vise or other suitable holding device. Carefully press the bearing out of the rod eyelet.
7. Extend the rod (**8**) as required to allow access to the base of the cylinder.

IMPORTANT: *Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

8. Using a pin spanner wrench, unscrew the head gland (**10**) from the tube (**2**). The head gland was originally torqued to 500-600 lb/ft (678-814 Nm), so a considerable amount of force is required. Carefully slide the head gland down along the rod toward the eyelet end, away from the cylinder tube (**2**).

IMPORTANT: *When sliding the rod and piston assembly in the tube, prevent the threaded end of the tube from damaging the piston (**11**). Keep the rod centered within the tube to help prevent binding.*

9. Carefully pull the rod (**8**) with all attachments straight out of the tube (**2**).
10. Fasten the eyelet end of the rod in a soft-jawed vise and put a padded support below and near the threaded end of the rod to help prevent damage to the rod.
11. Remove both locking inserts (**12**) from their installation holes in the head gland threads. Pry or drill out the inserts as required. **DO NOT** damage the head gland threads. New locking inserts will be required for reassembly.
12. Remove the two setscrews (**13**) from the piston (**11**). New setscrews will be required for reassembly.
13. Remove the piston (**11**) from the rod (**8**). The piston was installed with Loctite #271 (red) and torqued to 500-600 lb/ft (678-814 Nm).

Note: *It may be necessary to apply heat to break the bond of the sealant between piston (**11**) and the rod (**8**) before the piston can be removed. Some parts of cylinders 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 joint. Wipe off any hydraulic oil and heat the joint 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 or pressure for removal while the parts are still hot.

Breakdown of sealant will leave a white, powdery residue on threads and parts. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.

14. Remove the o-ring (**14**) and back-up rings (**15**) from the piston (**11**).
15. Remove both precision wearbands (**16**) and the capped T-seal (**17**) from the piston (**11**).

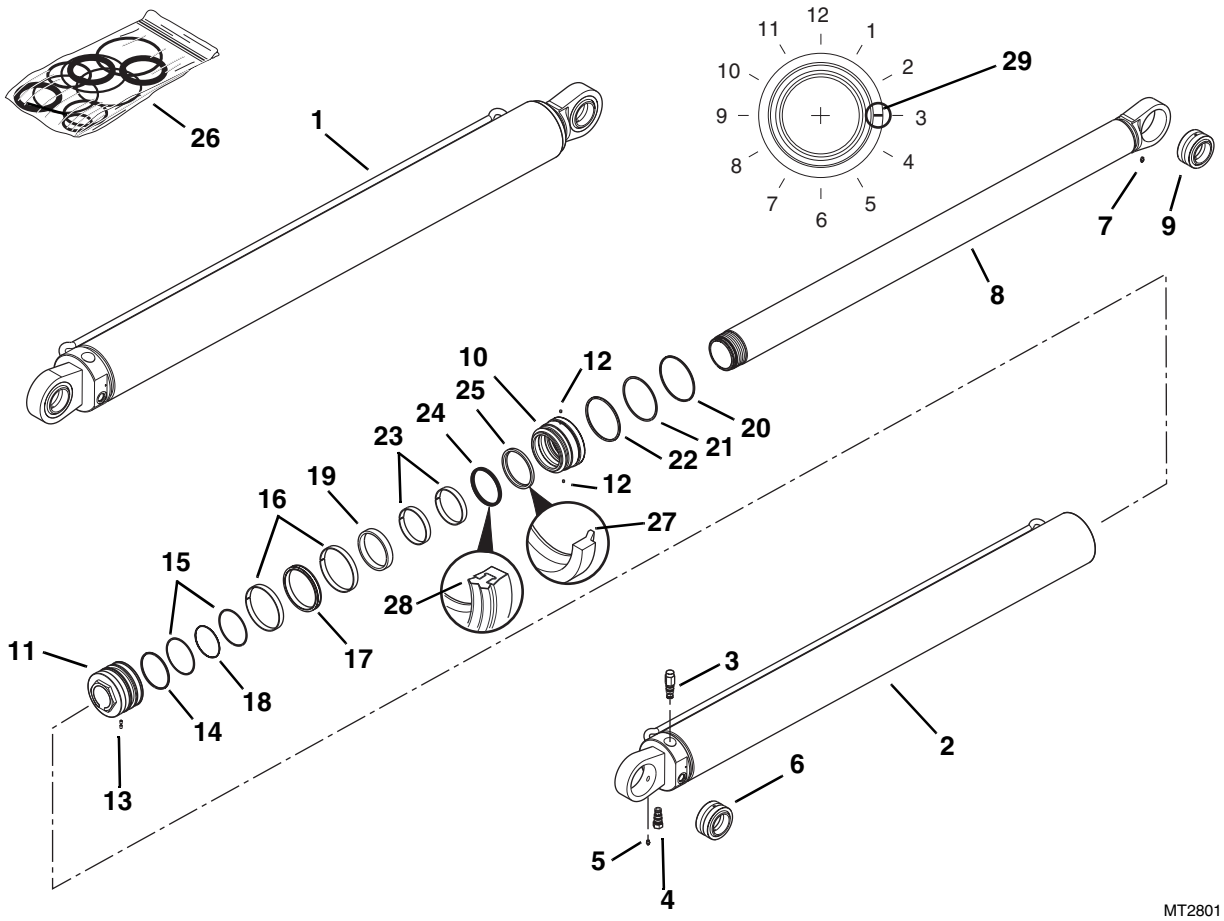
Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" itself.*

16. Remove the small o-ring (**18**) from within the piston (**11**).
17. Remove the rod spacer (**19**) from the rod (**8**).
18. Remove the o-ring (**20**), back-up ring (**21**) and o-ring (**22**) from the head gland (**10**). Slide the rings off the rod (**8**).
19. Remove the precision wearbands (**23**), deep Z-seal with back-up (**24**) and sealed outside diameter heavy-duty rod wiper (**25**) from the head gland (**10**).

c. Lift/Lower Cylinder Cleaning

1. Remove all hydraulic fluid, dirt and debris from the inner surface of the cylinder tube (**2**).
2. Discard all seals, back-up rings, o-rings, etc. Replace with new items from a complete seal kit (**26**) to help ensure proper cylinder function.
3. 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 and parts, it can be removed. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.*



d. Lift/Lower Cylinder Inspection

1. Inspect internal surfaces and all parts for wear, damage, etc. If inner surface of the tube (**2**) does not display a smooth finish, or is scored or damaged in any way, replace the tube. Often, dirty hydraulic fluid causes failure of internal seals and damage to the smooth surface within the tube.
2. Remove slight scratches on the piston, rod, or inner surface of the tube with very fine grit emery cloth. Use the emery cloth in a rotary motion to polish out and blend the scratch(es) into the surrounding surface.
3. Clean parts with trichlorethylene.
4. Check that the rod (**8**) is straight. If it is bent, install a new rod.

e. Lift/Lower Cylinder Assembly

Note: *Follow Section 9.14.3, General Cylinder Assembly Instructions.*

1. Install a new oiled o-ring (**22**), back-up ring (**21**) and o-ring (**20**) on the head gland (**10**).
2. Install the sealed outside diameter heavy-duty rod wiper (**25**). The wiper lip (**27**) should be toward the head gland. Install the deep Z-seal with back-up (**24**), orienting the edge (**28**). Install the precision wearbands (**23**) in the head gland. Use tools that will not damage the seals.
3. Install the capped T-seal (**17**) and both precision wearbands (**16**) on the piston (**11**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" itself.*

4. Install a new oiled o-ring (**14**) and back-up rings (**15**) on the piston.
5. Install a new small oiled o-ring (**18**) into the piston (**11**).
6. Fasten the rear of the rod in a soft-jawed vise and put a padded support below and near the threaded end of the rod to help prevent damage to the rod.
7. Carefully slide the head gland (**10**) onto the rod (**8**).

8. Install the rod spacer (**19**) on the rod (**8**).
9. Apply Loctite Threadlocker #271 (red) to the threads of the piston (**11**). Thread it onto the rod (**8**). Torque to 500-600 lb/ft (678-814 Nm).
10. Install two new setscrews (**13**) into the piston. Apply Loctite #243 to the threads and torque to 12-13 lb/ft (16-18 Nm).
11. Install two new locking inserts (**12**) into the holes in the head gland threads.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**2**).*

12. Secure the lift/lower cylinder in a soft-jawed vise or other acceptable holding equipment if possible.
13. Lubricate the inside of the tube (**2**) and outside of the piston (**11**) and head gland (**10**) with clean, filtered hydraulic oil.
14. Apply a compression sleeve or other suitable tool to the head gland (**10**) and piston (**11**) in order to compress the o-rings, back-up rings and seals while inserting the assembled piston, rod and head into the tube (**2**).

IMPORTANT: *When sliding the rod (**8**) and piston assembly in the tube, prevent the threaded end of the tube from damaging the piston (**11**). Keep the rod centered within the tube to help prevent binding. Protect the finish on the rod at all times. Damage to the surface of the rod can cause seal failure.*

15. Carefully insert the rod (**8**) with all attachments straight into the tube (**2**).
16. Using a pin spanner wrench, thread the head gland (**10**) into the tube (**2**). Torque the head gland to 500-600 lb/ft (678-814 Nm).

IMPORTANT: ***DO NOT*** *tamper with or attempt to reset the counterbalance valve cartridge (**3**). If adjustment or replacement is necessary, replace a counterbalance valve with a new part.*

17. Lubricate the counterbalance valve (**3**) and the pilot-operated check valve (**4**) with clean, filtered hydraulic oil. Using new oiled o-rings, thread the valves into tube (**2**). Torque to 45-50 lb/ft (61-68 Nm).

Note: *If new lift/lower cylinder bearings (**6** or **9**) are being installed, the fracture (**29**) in the bearing race must be positioned at the clock position shown in the illustration.*

18. If the self-aligning bearings (**6** and **9**) require replacement, support the rod (**8**) in a soft-jawed vise or other suitable holding device. Carefully press new bearings into the tube or rod eyelet.
19. If necessary, install grease fittings (**5** and **7**) into the tapped holes in the end of the tube and rod eyelets. Lubricate the self-aligning bearing (**9**) in the rod end through the grease fitting (**7**) with multi-purpose grease before the boom is operated. Lubricate the self-aligning bearing (**6**) in the tube end through the grease fitting (**5**) with multi-purpose grease before the boom is operated.
20. Test the cylinder at low operating pressure (100 psi or 6,9 bar). Verify that the piston and the rod move freely in both directions.
21. Increase the operating pressure to the maximum amount for the cylinder (4000 psi or 276 bar) and again check for free movement in both directions.
22. Retract the rod fully into the tube and cap and plug the hydraulic hose ports.

f. Lift/Lower Cylinder Installation



WARNING: **DO NOT** get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing that requires the boom to be up. Unexpected lowering of the boom may cause death or serious injury.

1. Raise and support the boom to allow installation of the lift/lower cylinder (**1**).
2. Attach a sling to the lift/lower cylinder and to a hoist or an overhead crane. Safely and carefully, position the lift/lower cylinder between the frame rails, aligning the rod and base eyelets with mounting bosses of the frame and boom.
3. Secure the cylinder with cylinder mount pins, capscrew, nut, retaining pin and hair pin.
4. Connect all hoses according to the labels or other marks used to identify their location during removal.



WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

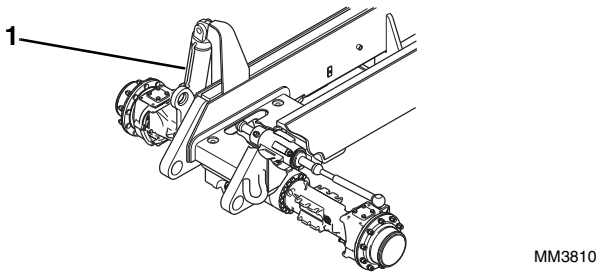
5. Operate the vehicle to check all boom functions and for hydraulic system leaks.
6. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle. Perform the pressure check and circuit bleeding procedure on the next page.

g. Lift/Lower Cylinder Pressure Checking and Circuit Bleeding

1. Attach a 5000 psi (345 bar) gauge to the main control valve at the extend/retract base port relief to test the lift/lower cylinder hydraulic system circuit pressure. The unit is equipped with test fittings from the factory. Pressure readings should be 3750 ±100 psi (259 ±7 bar). Refer to *Section 9.7, Hydraulic System Testing*.
2. With no accessory installed on the quick attach, start with the lift/lower and attachment tilt cylinders fully retracted.
3. Fully raise and fully extend the boom. Hold the joystick at full extend while fully raising the lift/lower cylinder.
4. Fully retract the attachment tilt cylinder. Hold the joystick at full retract while fully lowering the boom.
5. Repeat Steps 3-4 five times.

9.14.8 Frame Sway Cylinder

The frame sway cylinder (**1**) is attached to the right side of the frame at the front axle and to the cast loop on the axle.



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a. Frame Sway Cylinder Removal

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the hydraulic hoses in relation to the cylinder being removed. Safely position suitable supports between the frame and axle to prevent the frame from leaning to one side.
5. Disconnect and cap all hoses and fittings, etc.
6. Use a sling and hoist or other suitable lifting device to support the cylinder. Remove the nuts, capscrews, and cylinder mount pins securing the cylinder to the frame and anchor plate.
7. Remove the cylinder from the vehicle. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle.

b. Frame Sway Cylinder Disassembly

Note: *An additional o-ring may be included at the base of the cylinder rod. This additional o-ring may be discarded, as it served only in a temporarily protective role.*

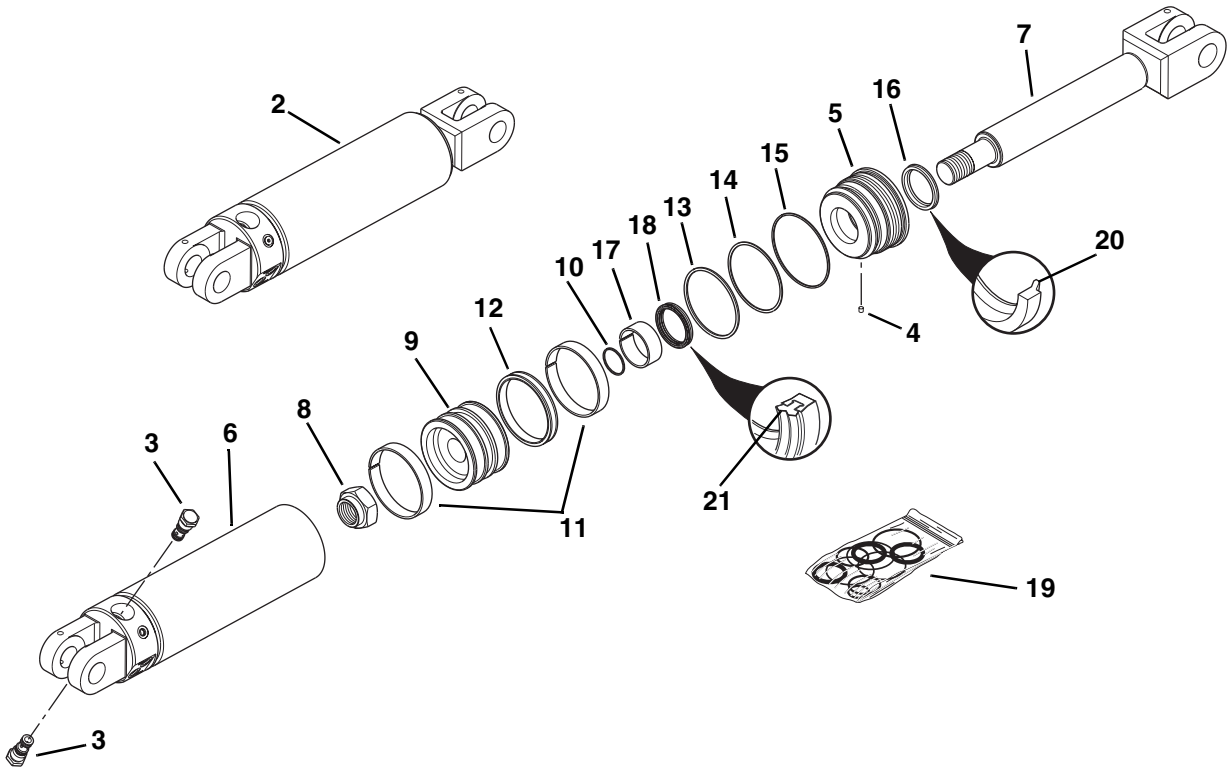
1. Clean the frame sway cylinder (**2**) with a suitable cleaner. Remove all dirt, debris and grease from the cylinder.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder.*

2. Secure the frame sway cylinder (**2**) in a soft-jawed vise or other holding device, and place a suitable container beneath the cylinder to catch hydraulic fluid run-off.

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. Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

3. Slowly remove the pilot-operated check valves (**3**) from the frame sway cylinder.



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IMPORTANT: *Protect the finish on the rod at all times. Damage to the rod can cause premature seal failure.*

4. Use a pin spanner wrench to unthread the head gland (**5**) from the tube (**6**). The head gland is installed at a torque of 300-400 lb/ft (407-542 Nm), so a considerable amount of force is required to remove it. Carefully slide the head gland down along the rod toward the eyelet end, away from the cylinder tube.
5. Remove the locking insert (**4**) from its hole in the head gland threads. Pry or drill out the insert as required. **DO NOT** damage the head gland threads. A new locking insert will be required for reassembly.

IMPORTANT: *When sliding the rod and piston assembly in the tube, **DO NOT** damage the piston by scraping it against the threads in the tube. Keep the rod in line with the tube to prevent binding.*

6. Carefully withdraw the rod (**7**) straight out of the tube (**6**). Keep the rod straight during withdrawal to help avoid scratching, nicking or damaging the tube (**6**).
7. Secure the rod eyelet and remove the locknut (**8**) from the threaded end of the rod. Discard the nut; a new nut will be required for reassembly.

Note: *Heating the nut (**8**) to approximately 300° F (150° C) may also be required to break the seal formed by the Loctite Threadlocker #271 (red) applied to the nut when installed. The application of significant force is required to overcome the 1100-1250 lb/ft (1492-1695 Nm) of torque the nut was tightened to when originally installed.*

8. Remove the piston (**9**) from the rod (**7**).
9. Remove the small o-ring (**10**) from the piston.
10. Remove the head gland (**5**) from the rod (**7**).
11. Remove both precision wearbands (**11**) from the piston (**9**).
12. Remove the capped T-seal (**12**) from the piston (**9**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" seal band.*

13. Remove the o-ring (**13**), the back-up ring (**14**) and the o-ring (**15**) from the head gland (**5**).
14. Remove the heavy-duty rod wiper (**16**) from the head gland (**5**).
15. Remove the precision wearband (**17**) and deep Z-seal with rod back-up (**18**) from inside the head gland (**5**).

c. Frame Sway Cylinder Internal Cleaning

1. Remove all hydraulic fluid, dirt and debris from the inner surface of the cylinder.
2. Discard all seals, back-up rings and o-rings. Replace with new items from a complete seal kit (**18**) to help ensure proper cylinder function.
3. Clean all metal parts with an approved cleaning solvent such as trichlorethylene. Carefully clean cavities, grooves, threads, etc.

d. Frame Sway Cylinder Inspection and Repair

1. Inspect all parts for wear, damage, etc. If inner surfaces of the cylinder (**1**) 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 and damage to the polished surfaces within the component.
2. Inspect the inside of the tube (**5**) for scoring and other damage. If the tube is damaged, replace it with a new tube.
3. Remove small scratches on the rod or inside of the tube with very fine grit emery cloth. Use the emery cloth in a rotary motion to polish out and blend scratch(es) into the surrounding surface.
4. Clean the parts with trichlorethylene after repair.
5. Check that the rod (**6**) is straight. If the rod is bent, install a new rod.

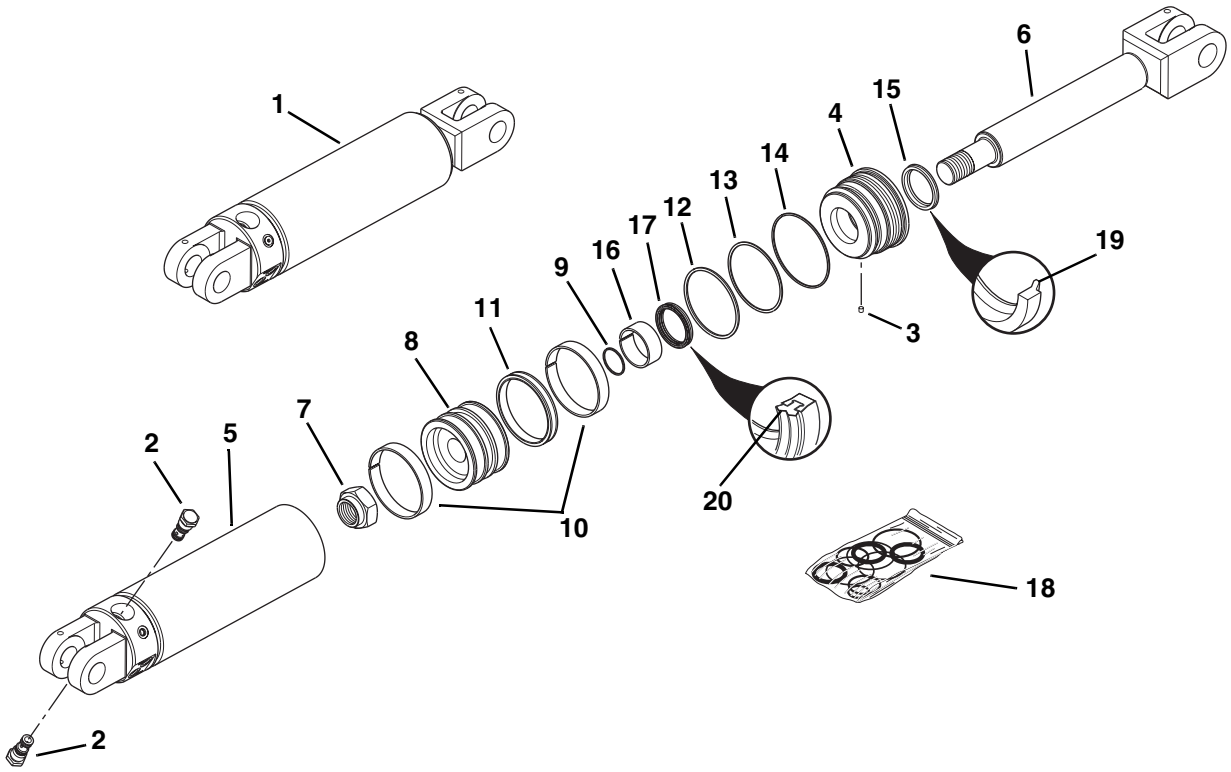
e. Frame Sway Cylinder Assembly

Note: *Follow Section 9.14.3, General Cylinder Assembly Instructions.*

1. Install the deep Z-seal with rod back-up (**17**) into the head gland, orienting the edge (**20**).
2. Install the precision wearband (**16**) into the head gland.
3. Install the heavy-duty rod wiper (**15**) with the raised portion of the lip seal (**19**) oriented toward the rod eyelet. The wiper lip (**19**) should be toward the outer end of the head gland and the seal lips toward the inner end of the head gland. Use tools that will not damage the seals.
4. Install new oiled o-ring (**14**), back-up ring (**13**) and oiled o-ring (**12**) onto the head gland (**4**). If the back-up ring is not flat on both sides, the side with the arc must be toward the o-ring.
5. Install the head gland (**4**) onto the rod (**6**). If necessary, use a soft hammer to drive the head gland onto the rod.
6. Install the new small oiled o-ring (**9**) into the piston (**8**).
7. Install the capped T-seal (**11**) onto the piston (**8**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" seal band.*

8. Install the two precision wearbands (**10**) onto the piston (**8**).
9. Install the piston (**8**) onto the rod (**6**).
10. Secure the rod eyelet in a soft-jawed vise or other suitable holding device. Place a padded support below the threaded end of the rod to help prevent damaging the rod.



11. Apply Loctite Primer “T” and Threadlocker #271 (red), to a new locknut (**7**) in accordance with Loctite instructions. Install the nut onto the threaded end of the rod (**6**). Torque the nut to 1100-1250 lb/ft (1492-1695 Nm).

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**5**).*

12. Fasten the tube (**5**) in a soft-jawed vise or other suitable holding device.
13. To aid in installation, lubricate the o-rings and the inside of the tube, piston and head gland with clean, filtered hydraulic oil.

IMPORTANT: *Use a suitable installation tool or compression sleeve to help prevent twisting or damaging the seals and o-rings when installing the piston (**8**) and head gland (**4**) into the cylinder. When sliding the rod and piston assembly in the tube, **DO NOT** damage the piston by scraping it against the threads in the tube. Keep the rod in line with the tube to prevent binding.*

14. Keep the rod (**6**) straight and carefully insert the rod into the tube (**5**). Avoid scratching, nicking or damaging the tube while installing the rod.
15. Begin threading the head gland (**4**) into the tube (**5**). Place the locking insert (**3**) in its hole in the head gland threads just before the hole is threaded into the tube. Use a suitable pin spanner wrench to thread the head gland (**4**) completely into the tube (**5**). Torque the head gland to 300-400 lb/ft (407-542 Nm).
16. Lubricate the pilot-operated check valves (**2**) with clean, filtered hydraulic oil. Using new oiled o-rings, thread the pilot-operated check valves into tube (**5**). Torque valves to 35-40 lb/ft (47,2-54,2 Nm).
17. Test the cylinder at low operating pressure (100 psi or 6,9 bar) to verify that the piston and rod move freely in both directions.
18. Increase the operating pressure to the maximum for the cylinder (4000 psi or 275 bar) and check for external leakage and for free movement in both directions.
19. Retract the piston fully.

f. Frame Sway Cylinder Installation

1. Lubricate the cylinder pins with multi-purpose lithium-based grease.
2. Use a sling and hoist or other suitable lifting device to help install the cylinder. Orient the cylinder with the cylinder eyelet on top and the rod eyelet on the bottom.
3. Install the upper cylinder pin. Drive the lubricated cylinder pin through the cylinder eyelet, frame mount and self-aligning bearing. Secure the pin with a capscrew and hex locknut. Torque to 18 lb/ft (24 Nm).
4. Use new flat-faced oiled o-rings when installing the upper and lower hydraulic hoses. Install and tighten the hoses onto the appropriate fittings.

> **WARNING:** Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

5. With the help of an assistant, start the engine. Carefully and slowly, operate the joystick frame sway function to properly align the rod with the anchor plate as required. Turn the engine OFF.
6. Install the lower cylinder pin. Drive the lubricated cylinder pin through the rod eyelet, anchor plate and self-aligning bearing. Secure the pin with a capscrew and hex locknut. Torque nut to 18 lb/ft (24 Nm).
7. Remove all tools, etc. from the vehicle. Carefully remove the blocking supporting the vehicle frame at the front and rear axles.
8. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions. Operate the joystick to fully sway the frame left and right at least five times each.

> **WARNING:** Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

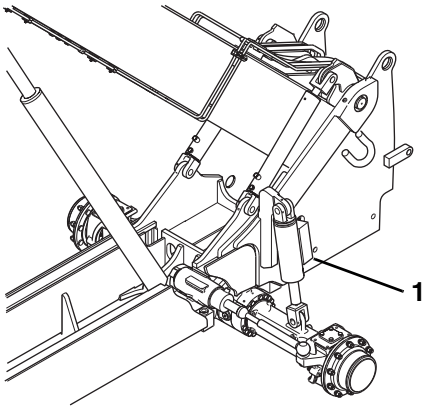
9. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF. Add hydraulic fluid if required.
10. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

g. Frame Sway Cylinder Pressure Checking and Circuit Bleeding

1. Attach a 5000 psi (345 bar) gauge to the main control valve at the extend/retract base port relief to test the frame sway/stabilizer cylinder hydraulic system circuit pressure. The unit is equipped with test fittings from the factory. Pressure readings should be 3500 psi ±100 psi (241,3 ±7 bar). Refer to *Section 9.7, Hydraulic System Testing*.
2. Start with the frame sway and stabilizer cylinders balanced; that is, with the frame level.
3. Sway the vehicle fully left. Hold the joystick at full sway left for several seconds, then sway the vehicle fully right and hold the joystick at full sway right for several seconds. Observe the readings on the gauge during the frame sway operations.
4. Level the frame. While leveling the frame, check the pressure reading on the gauge.
5. Repeat Steps 3-4 five times.

9.14.9 Stabilizer Cylinder

The stabilizer cylinder (**1**) is attached to the left side of the frame at the rear axle and to the cast loop on the axle.



MM3820

The Stabil-TRAK manifold attached to the stabilizer cylinder at the left rear of the vehicle provides the operating characteristics for the patented Stabil-TRAK system.

a. Stabilizer Cylinder Removal

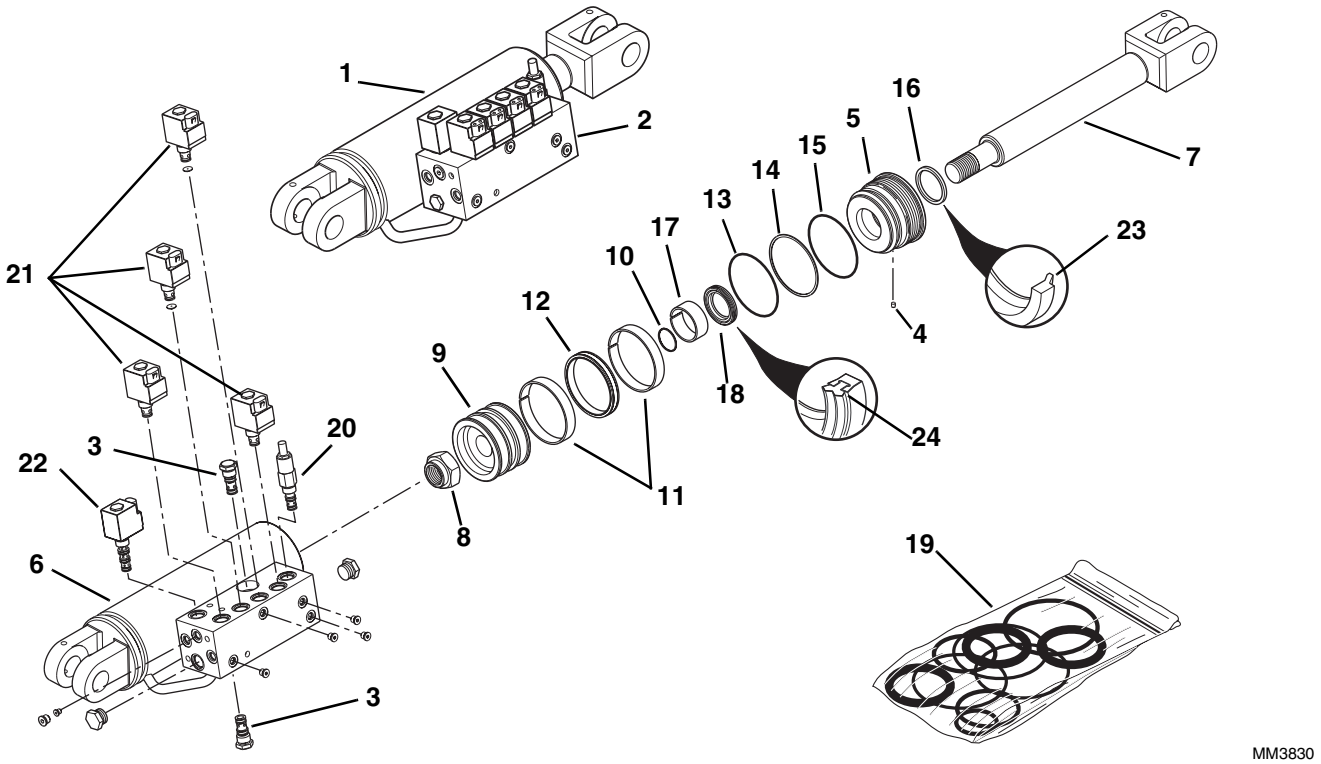
1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the hydraulic hoses in relation to the cylinder being removed. Safely position suitable supports between the frame and axle to prevent the frame from leaning to one side.
5. Disconnect and cap all hoses and fittings, etc.
6. Tag and remove all the wire harness connectors from the stabilizer cylinder manifold.
7. Use a sling and hoist or other suitable lifting device to support the cylinder. Remove the nuts, capscrews, and cylinder mount pins securing the cylinder to the frame and anchor plate.
8. Remove the cylinder from the vehicle. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle.



b. Stabilizer Cylinder Disassembly

Note: *An additional o-ring may be included at the base of the cylinder rod. This additional o-ring may be discarded, as it served only in a temporarily protective role.*

1. Clean the stabilizer cylinder (**1**) with a suitable cleaner. Remove all dirt, debris and grease from the cylinder.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**6**).*

2. Secure the stabilizer cylinder (**1**) in a soft-jawed vise or other holding device, and place a suitable container beneath the cylinder to catch hydraulic fluid run-off.

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. Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

3. Slowly remove the two pilot-operated check valves (**3**), the pressure reducing valve (**20**) and the five solenoid valves (**21** and **22**) on the manifold block (**2**) if replacement of any of these components is required. Label the solenoid valves with the locations stamped on the manifold. Remove the solenoid cartridges from the manifold.

Note: *The head gland (**5**) is installed at a torque of 300-400 lb/ft (407-542 Nm). Use suitable tools to remove the head gland.*

4. Use a pin spanner wrench to unthread the head gland (**5**) from the tube (**6**). The head gland is installed at a torque of 300-400 lb/ft (407-542 Nm), so a considerable amount of force is required to remove it. Carefully slide the head gland down along the rod toward the eyelet end, away from the cylinder tube.

IMPORTANT: *Protect the finish on the rod at all times. Damage to the rod can cause premature seal failure.*

5. Remove the locking insert (**4**) from its hole in the head gland threads. Pry or drill out the insert as required. **DO NOT** damage the head gland threads. A new locking insert will be required for reassembly.

IMPORTANT: *When sliding the rod and piston assembly in the tube,* ***DO NOT*** *damage the piston (**9**) by scraping it against the threads in the tube. Keep the rod in line with the tube to prevent binding.*

6. Carefully withdraw the rod (**7**) straight out of the tube (**6**). Keep the rod straight during withdrawal to help avoid scratching, nicking or damaging the tube.
7. Secure the rod eyelet and remove the locknut (**8**) from the threaded end of the rod. Discard the nut; a new nut will be required for reassembly.

Note: *Heating the nut to approximately 300° F (150° C) may also be required to break the seal formed by the Loctite Threadlocker #271 (red) applied to the nut when installed. The application of significant force is required to overcome the 1100-1250 lb/ft (1492-1695 Nm) of torque the nut was tightened to when originally installed.*

8. Remove the piston (**9**) from the rod (**7**).
9. Remove the small o-ring (**10**) from the piston. Remove both precision wearbands (**11**) from the piston (**9**). Remove the capped T-seal (**12**) from the piston (**9**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" seal band.*

10. Remove the head gland (**5**) from the rod (**7**).
11. Remove the o-ring (**13**), the back-up ring (**14**) and the o-ring (**15**) from the head gland (**7**).
12. Remove the heavy-duty rod wiper (**16**). Remove the precision wearband (**17**) and deep Z-seal with rod back-up (**18**) from inside the head gland (**5**).

Note: *Discard all seals and o-rings. ALWAYS replace seals, o-rings, gaskets, etc. with new parts to help ensure proper sealing and operation.*

c. Stabilizer Cylinder Internal Cleaning

1. Remove all hydraulic fluid, dirt and debris from the inner surface of the cylinder.
2. Discard all seals, back-up rings and o-rings. Replace with new items from a complete seal kit (**19**) to help ensure proper cylinder function.
3. Clean all metal parts with an approved cleaning solvent such as trichlorethylene. Carefully clean cavities, grooves, threads, etc.

d. Stabilizer Cylinder Inspection and Repair

1. Inspect all parts for wear and damage. If inner surfaces of the cylinder (**1**) 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 and damage to the polished surfaces within the component.
2. Inspect the inside of the tube (**6**) for scoring and other damage. If the tube is damaged, replace it with a new tube.
3. Remove small scratches on the rod or inside of the tube with very fine grit emery cloth. Use the emery cloth in a rotary motion to polish out small imperfections in the metal and blend scratch(es) into the surrounding surface.
4. Clean the parts with trichlorethylene after repair.
5. Check that the rod (**7**) is straight. If the rod is bent, install a new rod.

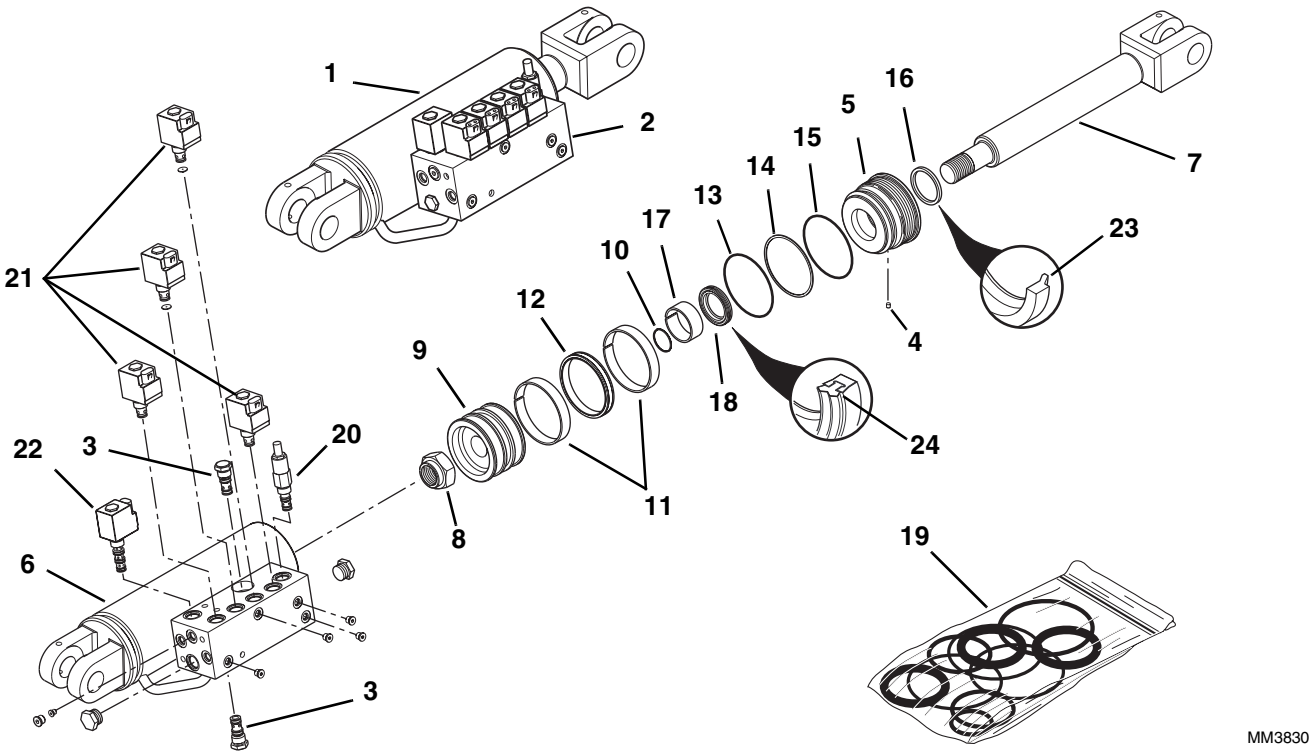
e. Stabilizer Cylinder Assembly

Note: *Follow Section 9.14.3, General Cylinder Assembly Instructions.*

1. Install the deep Z-seal with rod back-up (**18**) into the head gland (**5**), orienting the edge (**24**).
2. Install the precision wearband (**17**) into the head gland (**5**).
3. Install the heavy-duty rod wiper (**16**) with the raised portion of the lip seal (**23**) oriented toward the rod eyelet. The wiper lip (**23**) should be toward the outer end of the head gland and the seal lips toward the inner end of the head gland. Use tools that will not damage the seals.
4. Install new oiled o-ring (**15**), back-up ring (**14**) and oiled o-ring (**13**) onto the head gland (**5**). If the back-up ring is not flat on both sides, the side with the arc must be toward the o-ring.
5. Install the head gland (**5**) onto the rod (**7**). If necessary, use a soft hammer to drive the head gland onto the rod.
6. Install the new small oiled o-ring (**10**) into the piston (**9**).
7. Install the capped T-seal (**12**) onto the piston (**9**).

Note: *The T-seal actually consists of four components; a wide, flexible inner band, the flexible T-seal band itself, and two supportive split caps that mount on either side of the "T" seal band.*

8. Install the two precision wearbands (**11**) onto the piston (**9**).
9. Install the piston (**9**) onto the rod (**7**).



10. Secure the rod eyelet in a soft-jawed vise or other suitable holding device. Place a padded support below the threaded end of the rod to help prevent damaging the rod.
11. Apply Loctite Primer “T” and Threadlocker #271 (red) to a new locknut (**8**) in accordance with Loctite instructions. Install the nut onto the threaded end of the rod. Torque the nut to 1100-1250 lb/ft (1492-1695 Nm).

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**6**).*

12. Fasten the tube (**6**) in a soft-jawed vise or other suitable holding device.
13. Lubricate the o-rings and the inside of the tube, piston and head gland with clean, filtered hydraulic oil. This will aid in installation.

IMPORTANT: *Use a suitable installation tool or compression sleeve to help prevent twisting or damaging the seals and o-rings when installing the piston (**9**) and head gland (**5**) into the cylinder. When sliding the rod and piston assembly in the tube, **DO NOT** damage the piston by scraping it against the threads in the tube. Keep the rod in line with the tube to prevent binding.*

14. Keep the rod (**7**) straight and carefully insert the rod into the tube (**6**). Avoid scratching, nicking or damaging the tube while installing the rod.
15. Begin threading the head gland (**5**) into the tube (**6**). Place the locking insert (**4**) in its hole in the head gland threads just before the hole is threaded into the tube. Use a suitable pin spanner wrench to thread the head gland (**5**) completely into the tube (**6**). Torque the head gland to 300-400 lb/ft (407-542 Nm).
16. Using new oiled o-rings, thread the two pilot-operated check valves (**3**), the pressure reducing valve (**20**) and the five solenoid valves (**21** and **22**) into the manifold block. Torque the four solenoid cartridges (**21**) to 25-30 lb/ft (34-41 Nm). Torque the check valves, the pressure reducing valve, and the fifth solenoid cartridge (**22**) to 35-40 lb/ft (47-54 Nm). Place the solenoid coils on the cartridges and torque the solenoid nuts to 4-6 lb/ft (48-72 lb/in) (5-8 Nm).
17. Test the cylinder at low operating pressure (100 psi or 6,9 bar) to verify that the piston and rod move freely in both directions.
18. Increase the operating pressure to the maximum for the cylinder (4000 psi or 275 bar) and check for external leakage and for free movement in both directions.
19. Retract the piston fully.

f. Stabilizer Cylinder Installation

1. Lubricate the cylinder pins with multi-purpose lithium-based grease.
2. Use a sling and hoist or other suitable lifting device to help install the cylinder. Orient the cylinder with the cylinder eyelet on top and the rod eyelet on the bottom.
3. Install the upper cylinder pin. Drive the lubricated cylinder pin through the cylinder eyelet, frame mount and self-aligning bearing. Secure the pin with a capscrew and hex locknut. Torque to 18 lb/ft (24 Nm).
4. Use new flat-faced oiled o-rings when installing the upper and lower hydraulic hoses. Install and tighten the hoses onto the appropriate fittings on the manifold.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

5. Connect all the wire harness connectors to the proper solenoids and snap into place.
6. With the help of an assistant, start the engine. Carefully and slowly, operate the joystick frame sway function to properly align the rod with the anchor plate as required. Turn the engine OFF.
7. Install the lower cylinder pin. Drive the lubricated cylinder pin through the rod eyelet, anchor plate and self-aligning bearing. Secure the pin with a capscrew and hex locknut. Torque to 18 lb/ft (24 Nm).
8. Remove all tools, etc. from the vehicle. Carefully remove the blocking supporting the vehicle frame at the front and rear axles.
9. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions. Operate the joystick to fully sway the frame left and right at least five times each.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

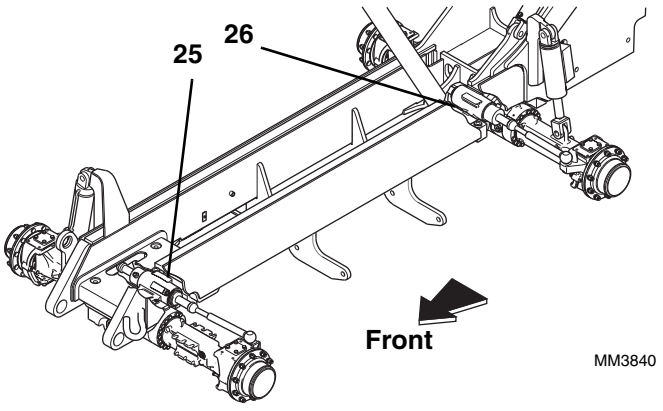
10. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF. Add hydraulic fluid to the reservoir as required.
11. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

g. Stabilizer Cylinder Pressure Checking and Circuit Bleeding

1. Attach a 5000 psi (345 bar) gauge to the main control valve at the extend/retract base port relief to test the frame sway/stabilizer cylinder hydraulic system circuit pressure. The unit is equipped with test fittings from the factory. Pressure readings should be 3500 psi ±100 psi (241,3 ±7 bar). Refer to *Section 9.7, Hydraulic System Testing*.
2. Level the frame.
3. Sway the vehicle fully left. Hold the joystick at full sway left for several seconds, then sway the vehicle fully right and hold the joystick at full sway right for several seconds. Observe the readings on the gauge during the frame sway operations.
4. Level the frame. While leveling the frame, check the pressure reading on the gauge.
5. Repeat Steps 3-4 five times.

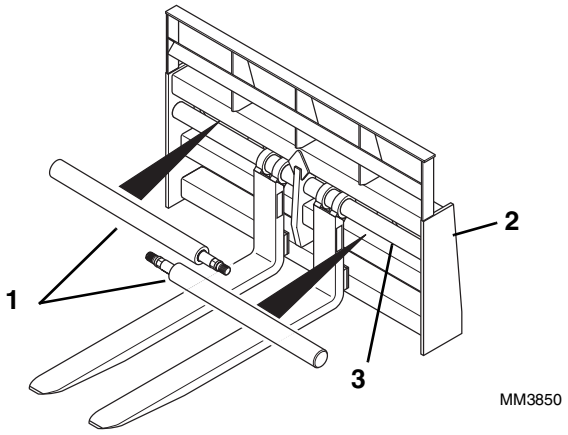
9.14.10 Steering Cylinders

The steering cylinders (**25** and **26**) are secured to the axle assemblies. Steer cylinders are covered in the appropriate manufacturer's axle literature. For the front steering cylinder (**25**), refer to the ZF Axle Repair Manual, Model MS-T 3060 (ZF part number 5871 560 002, **JLG** part # 8990430). For the rear steering cylinder (**26**), refer to the ZF Axle Repair Manual, Model MS-T 3045 (ZF part number 5871 550 002, **JLG** part # 8990419).



9.14.11 Side Shift Cylinders (7K Carriage)

The right fork and left fork side shift cylinders (**1**) are mounted to the back of the carriage (**2**). The cylinder on the left side of the carriage is mounted below the fork shaft (**3**) and controls the right side fork. The cylinder on the right side of the carriage is mounted above the fork shaft and controls the left side fork.



a. Side Shift Cylinder Removal

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

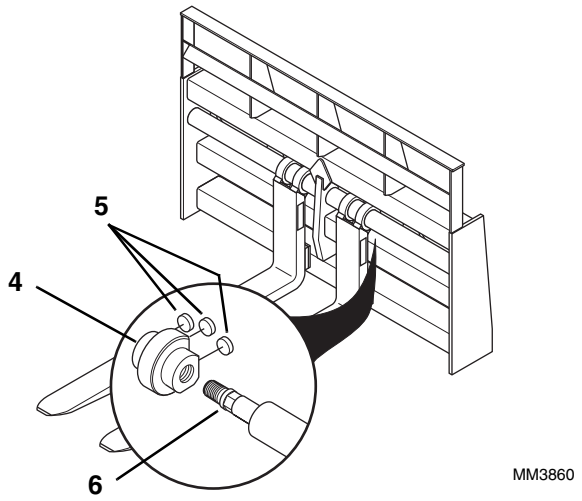
WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the hydraulic hoses in relation to the cylinder being removed. Cap or plug all hose ends and fittings.
5. Remove the cylinder rod end pawl (**4**) from the rod of the cylinder being removed. The cylinder rod end pawl has Loctite applied to the threads. Heat the pawl to remove it.

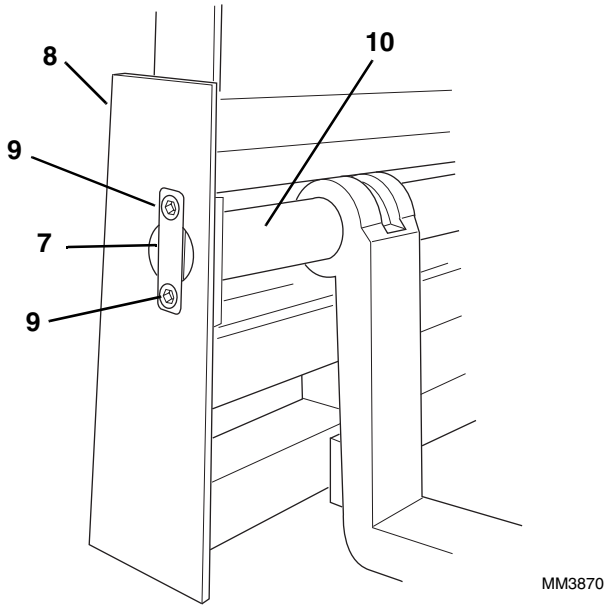
Note: *Heating the cylinder rod end pawl to approximately 300° F (150° C) will be required to break the seal formed by the Loctite Threadlocker #277 (red) applied to the threads of the cylinder rod. Avoid overheating or the parts may become distorted or damaged. Apply sufficient torque or pressure for removal while the parts are still hot.*

Breakdown of sealant will leave a white, powdery residue on threads and parts. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.

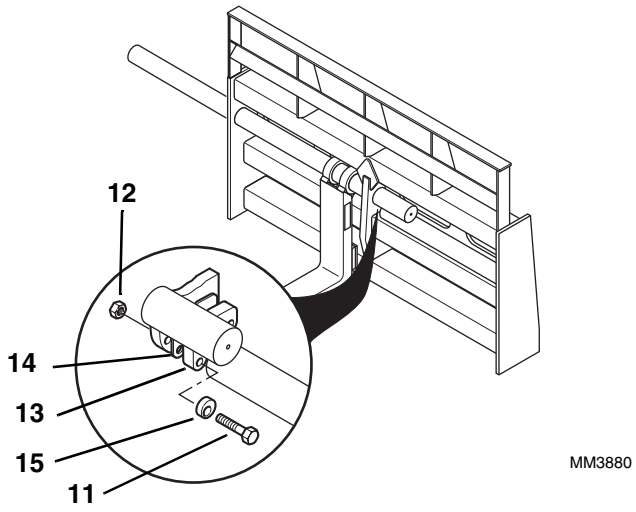
6. When the pawl is being heated the pawl pads (**5**) will be loosened by the heat and will fall out of the pockets in the pawl. New pawl pads will be required for reassembly.
7. Turn the hex on the cylinder rod (**6**) with a open end wrench to remove the cylinder rod end pawl (**4**). Thread the pawl all the way off the cylinder rod. The pawl is flat on the backside, this flat side will hold the pawl from turning while turning the rod.



8. Remove the fork shaft retainer (**7**) from the right side of the carriage (**8**). The two mounting screws (**9**) have Loctite (blue) 242 threadlocker applied to the threads. Thoroughly clean the threads of each screw.
9. From the left side of the carriage, push the fork shaft (**10**) out the right side of the carriage. The fork shaft is heavy, use a suitable hoist and slings to hold the shaft during removal. Push the fork shaft out far enough to remove both forks.

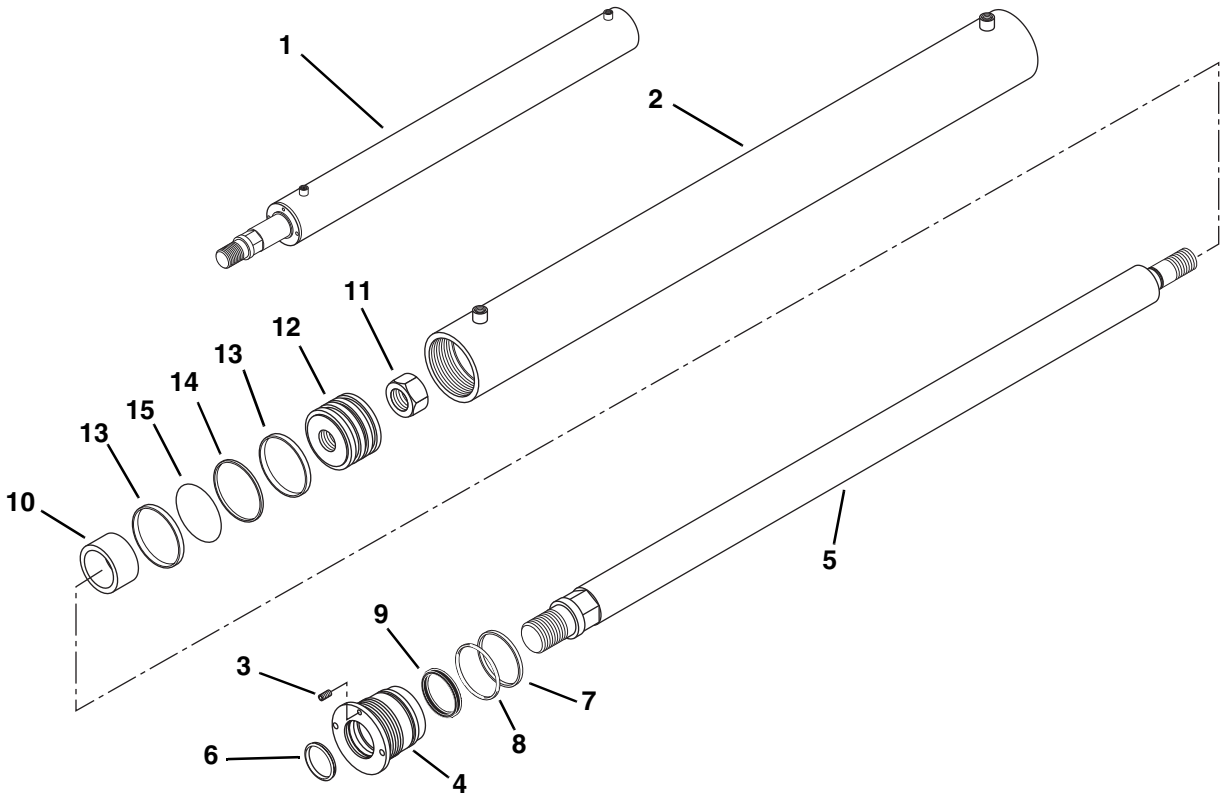


10. The fork side shift cylinders are heavy. The assistance of another person will be required to remove the cylinder from the carriage.
11. Remove the capscrews (**11**) and hex nuts (**12**) holding the cylinder retainer plate (**13**), cylinder retainer shims (**14**) and cylinder retainer bolt cams (**15**) to the carriage.



12. After the retainer plate and shims are removed, slide the cylinder toward the center of the carriage. Remove the base end of the cylinder from behind the retaining plate on the outer edge of the carriage. Remove the cylinder from the carriage.

.



b. Fork Side Shift Cylinder Disassembly

Note: *An additional o-ring may be included at the base of the cylinder rod. This additional o-ring may be discarded, as it served only in a temporarily protective role.*

1. Clean the fork side shift cylinder (**1**) with a suitable cleaner. Remove all dirt, debris and grease from the cylinder.

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**2**).*

2. Secure the fork side shift cylinder (**1**) in a soft-jawed vise or other holding device, and place a suitable container beneath the cylinder to catch hydraulic fluid run-off.
3. Remove the setscrew (**3**) from the flange of the guide (**4**).
4. Use a pin spanner wrench to unthread the guide (**4**) from the tube (**2**). Carefully slide the guide off the end of the rod (**5**).

IMPORTANT: *Protect the finish on the rod at all times. Damage to the rod can cause premature seal failure.*

5. Remove the HD rod wiper (**6**) from the front inner edge of the guide (**4**).
6. Remove the o-ring (**7**) and back-up ring (**8**) from the guide (**4**).
7. Remove the U cup seal (**9**) from the rear inside edge of the guide (**4**).

IMPORTANT: *When sliding the rod and piston assembly in the tube, **DO NOT** damage the piston (**12**) by scraping it against the threads in the tube. Keep the rod in line with the tube to prevent binding.*

8. Carefully withdraw the rod (**5**) straight out of the tube (**2**). Keep the rod straight during withdrawal to help avoid scratching, nicking or damaging the tube.
9. Carefully slide the rod spacer (**10**) off the rod (**5**).
10. Secure the hex portion of the rod and remove the locknut (**11**) from the threaded end of the rod. Discard the nut, a new nut will be required for reassembly.

11. Remove the piston (**12**) from the end of the rod (**5**).
12. Remove the two wear rings (**13**), the piston seal (**14**) and the o-ring (**15**) from the piston.

c. Fork Side Shift Cylinder Internal Cleaning

1. Remove all hydraulic fluid, dirt and debris from the inner surface of the cylinder.
2. Discard all seals, back-up rings and o-rings. Replace with new items from a complete seal kit to help ensure proper cylinder function.
3. Clean all metal parts with an approved cleaning solvent such as trichlorethylene. Carefully clean cavities, grooves, threads, etc.

d. Fork Side Shift Cylinder Inspection and Repair

1. Inspect all parts for wear and damage. If inner surfaces of the cylinder (**1**) 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 and damage to the polished surfaces within the component.
2. Inspect the inside of the tube (**2**) for scoring and other damage. If the tube is damaged, replace it with a new tube.
3. Remove small scratches on the rod or inside of the tube with very fine grit emery cloth. Use the emery cloth in a rotary motion to polish out small imperfections in the metal and blend scratch(es) into the surrounding surface.
4. Clean the parts with trichlorethylene after repair.
5. Check that the rod (**5**) is straight. If the rod is bent, install a new rod.

e. Fork Side Shift Cylinder Assembly

Note: *Follow Section 9.14.3, General Cylinder Assembly Instructions.*

1. Install a new oiled wear ring (**13**), new o-ring (**15**), new piston seal (**14**) and another wear ring (**13**) onto the piston (**12**).
2. Place the piston onto the threaded end of the rod (**5**) and secure inplace with a new nut (**11**). Torque the nut to 275-330 lb/ft (373-447 Nm).
3. Place the rod spacer (**10**) onto the rod (**5**) and slide down against the piston (**12**).

IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**2**).*

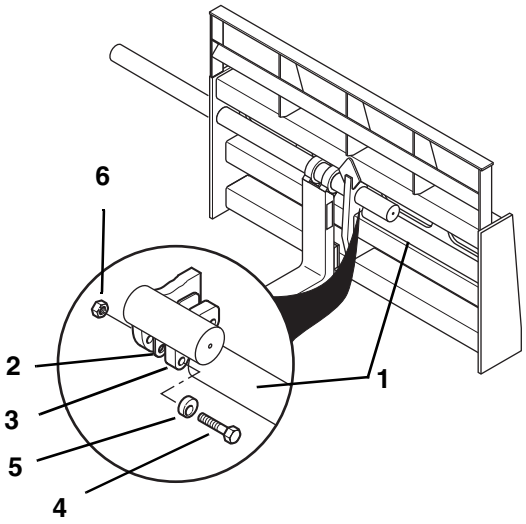
4. Fasten the tube (**2**) in a soft-jawed vise or other suitable holding device.
5. Lubricate the o-rings on the piston and the inside of the tube with clean, filtered hydraulic oil. This will aid in installation.

IMPORTANT: *Use a suitable installation tool or compression sleeve to help prevent twisting or damaging the seals and o-rings when installing the piston (**12**) into the cylinder. When sliding the rod and piston assembly in the tube, **DO NOT** damage the piston by scraping it against the threads in the tube. Keep the rod in line with the tube to prevent binding.*

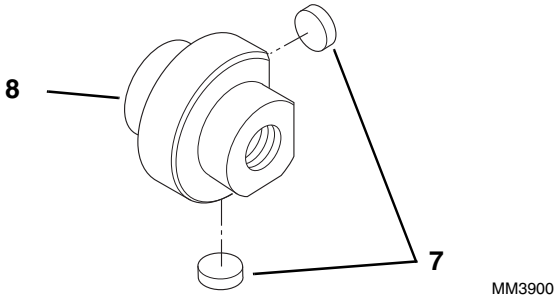
6. Keep the rod (**5**) straight and carefully insert the rod into the tube (**2**). Avoid scratching, nicking or damaging the tube while installing the rod.
7. Install a new oiled U-cup seal (**9**) into the rear end of the guide (**4**). Use tools that will not damage the seals.
8. Install a new oiled HD rod wiper seal (**6**) into the flange side of the guide (**4**). The angled edge of the seal must point toward the flange edge of the guide away from the cylinder tube (**2**).
9. Install a new oiled back-up ring (**8**) and o-ring (**7**) to the outside of the guide (**4**). Carefully install the guide onto the rod. Use seal protectors or place tape on the threads of the rod to protect the seals during installation.
10. Apply a drop of Loctite 242 (blue) removable threadlocker to the first two threads of the guide (**4**) 180° apart. Install the guide into the tube (**2**) and tighten securely.
11. Apply Loctite 242 (blue) removable threadlocker to the threads of the setscrew (**3**) and thread into the flange of the guide. Tighten the setscrew securely.
12. Test the cylinder at low operating pressure (100 psi or 6,9 bar) to verify that the piston and rod move freely in both directions.
13. Increase the operating pressure to the maximum for the cylinder (4000 psi or 275 bar) and check for external leakage and for free movement in both directions.
14. Retract the piston fully.

f. Fork Side Shift Cylinder Installation

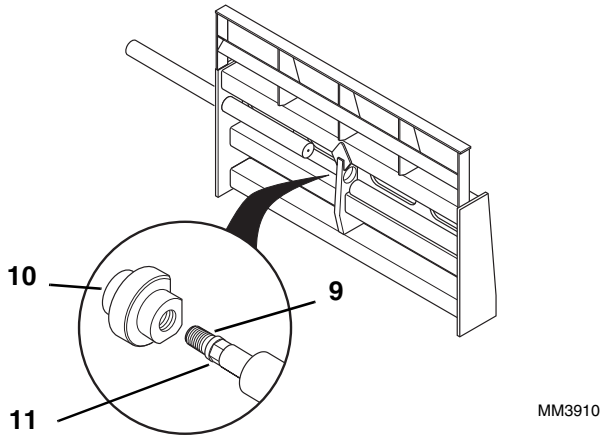
1. Place the rod end of the fork side shift cylinder (**1**) through the opening in the center support of the carriage. Pull the cylinder base end toward the outside edge of the carriage and position behind the retaining plate.
2. Secure the fork side shift cylinder (**1**) in place using the cylinder retainer shims (**2**), cylinder retainer plate (**3**), capscrews (**4**), cylinder bolt retainer cams (**5**) and hex nuts (**6**).
3. Position the retainer shims (**2**) and retainer plate (**3**) against the center support of the carriage, line up the holes and insert a capscrew (**4**) with bolt cam (**5**) through the retainer plate and shims from the cylinder side through each hole. Rotate the bolt cams against the cylinder (**1**) and tighten securely with the hex nuts (**6**). Be sure the bolt cams remain tight against the cylinder during tightening of the hex nuts.



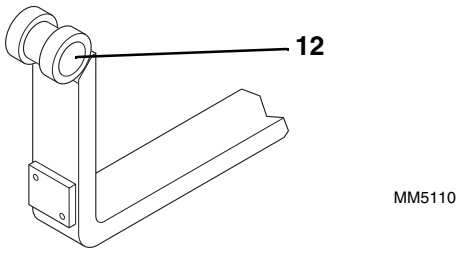
4. Assemble the new pawl pads (**7**) into the cavities of the rod end pawl (**8**). Spray each pad with 3M #90 High Strength Spray and insert into each cavity.



5. Apply Loctite Threadlocker 277 (red) High Strength to the threads of the cylinder rod (**9**). Be sure the flats on the rod end pawl are against the carriage. Line up the rod end pawl (**10**) with the cylinder rod. Using the hex part (**11**) of the cylinder rod, turn the rod until the rod end pawl bottoms on the threads of the cylinder rod. The flats on the pawl will keep the pawl from rotating while turning the cylinder rod.

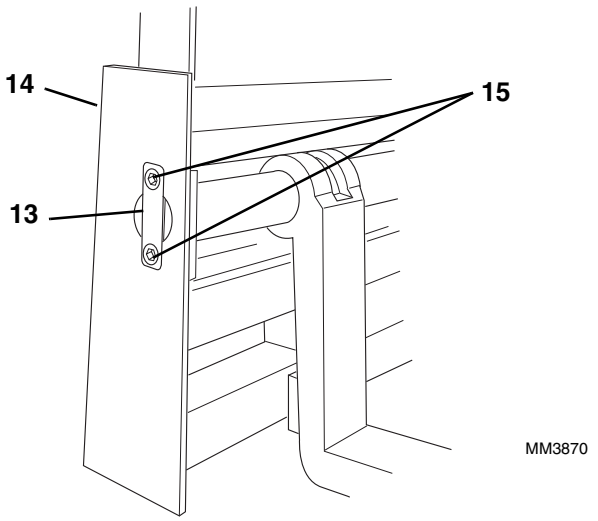


6. Check the bushings inside each fork. If the bushings are worn or torn, replace with new bushings. Be sure to thoroughly clean the fork “eye” (**12**) in each fork of all old bushing residue and debris. Use a lapping tool or a hard wire rotary brush to remove the bushing residue, debris, rust or uneven metal in each fork.



Note: *Be careful not to tear the bushings when inserting the fork shaft through the forks.*

7. Reassemble the fork shaft and forks to the carriage. Push the fork shaft in from the right side of the carriage, placing the forks over the rod end pawls and then inserting the fork shaft through the fork.
8. Place the fork shaft retainer (**13**) in place on the right side of the carriage (**14**). Apply Loctite 242 (blue) removable threadlocker to the threads of the two screws (**15**) and secure the retainer plate to the carriage. Torque both screws to 120-125 lb/ft (163-169 Nm).



9. Reassemble the hydraulic hoses to the appropriate ports on the cylinder.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

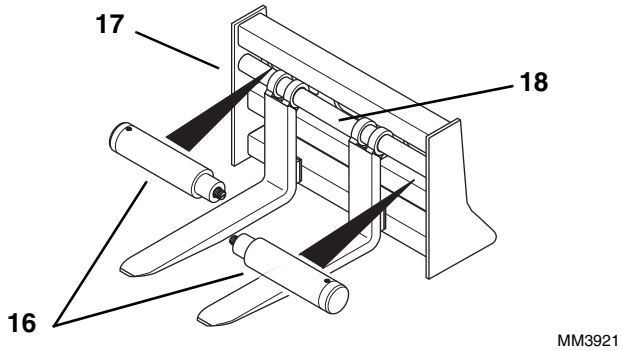
10. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

11. Activate the fork side shift switches to shift the forks to the right and left. Repeat shifting the forks fully from one side to the other side 3-5 times.
12. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF. Add hydraulic fluid to the reservoir as required.
13. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

9.14.12 Side Shift Cylinders (11K Carriage)

The right fork and left fork side shift cylinders (**16**) are mounted to the back of the carriage (**17**). The cylinder on the left side of the carriage is mounted below the fork shaft (**18**) and controls the right side fork. The cylinder on the right side of the carriage is mounted above the fork shaft and controls the left side fork.



a. Side shift Cylinder Removal

1. Park the vehicle on a firm, level surface, fully retract all hydraulic cylinders, ground the attachment (if any), place the travel select lever in [N] NEUTRAL, place the neutral lock lever in the [N] NEUTRAL LOCK position, engage the park brake switch and shut the engine OFF.
2. Place an Accident Prevention Tag on both the ignition switch and the steering wheel, stating that the vehicle should not be operated. Refer to *Section 1.5, Accident Prevention Tag Usage*.

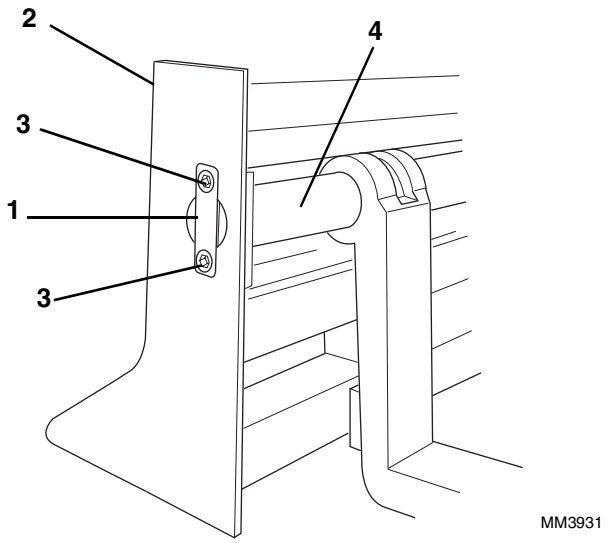
WARNING: Hot hydraulic fluid can cause severe burns. Wait for hydraulic fluid to cool before servicing any hydraulic component.

3. Unlatch and open the engine cover. Allow the hydraulic fluid to cool.

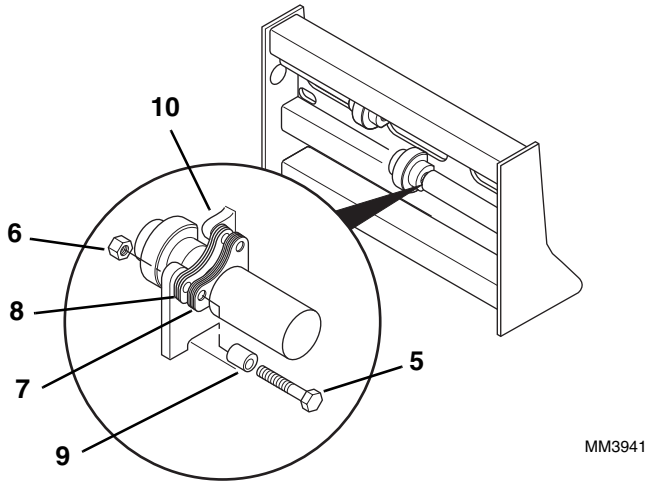
WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury. Relieve hydraulic pressure before servicing any hydraulic component.

4. Label or otherwise mark the hydraulic hoses in relation to the cylinder being removed. Cap or plug all hose ends and fittings.

5. Note the orientation of each fitting. Remove the fittings from the cylinder being removed. Plug the ports on the cylinder.
6. Remove the fork shaft retainer (**1**) from the right side of the carriage (**2**). The two mounting screws (**3**) have Loctite (blue) 242 threadlocker applied to the threads. Thoroughly clean the threads of each screw.
7. From the left side of the carriage, push the fork shaft (**4**) out the right side of the carriage. The fork shaft is heavy, use a suitable hoist and slings to hold the shaft during removal. Push the fork shaft out and remove both forks and the fork shaft from the carriage.



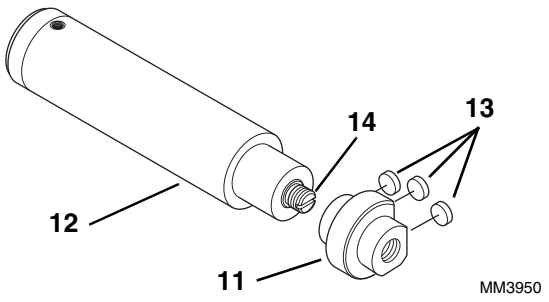
8. For the cylinder being repaired, locate and remove the capscrews (**5**) and hex nuts (**6**) holding the cylinder retainer plates (**7**), cylinder retainer shims (**8**) and cylinder retainer spacer cams (**9**) to the mounting plate on the carriage (**10**). Note the number of shims and plates as you remove them.
9. After the retainer plates and shims are removed, slide the cylinder toward the center of the carriage. Remove the base end of the cylinder from behind the retaining plate on the outer edge of the carriage. Remove the cylinder from the carriage.
10. Remove the cylinder rod end pawl (**11**) from the cylinder (**12**). The cylinder rod end pawl has Loctite applied to the threads. Heat the pawl to remove it.

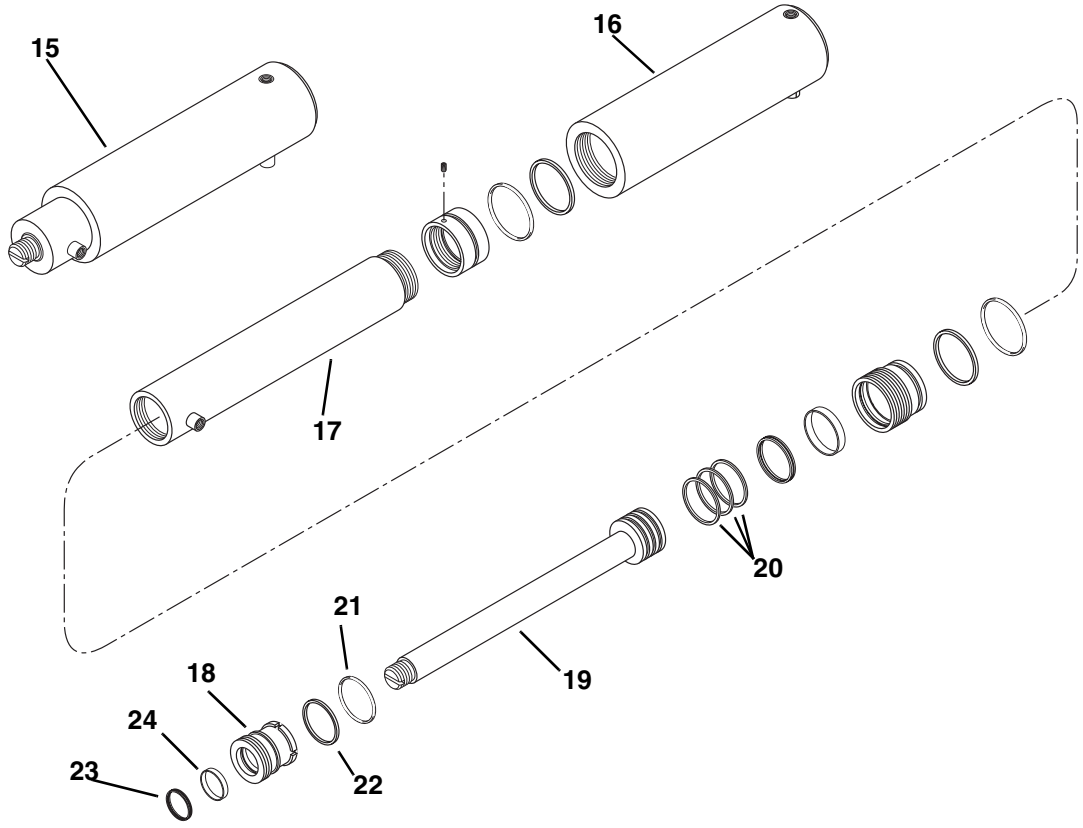


Note: *Heating the cylinder rod end pawl to approximately 300° F (150° C) will be required to break the seal formed by the Loctite Threadlocker #277 (red) applied to the threads of the cylinder rod. Avoid overheating or the parts may become distorted or damaged. Apply sufficient torque or pressure for removal while the parts are still hot.*

Breakdown of sealant will leave a white, powdery residue on threads and parts. Clean the residue away with a soft brass wire brush prior to reassembly, and wipe with Loctite "T" cleaner before reinstallation.

11. When the pawl is being heated the pawl pads (**13**) will be loosened by the heat and will fall out of the pockets in the pawl. New pawl pads will be required for reassembly.
12. Clamp the pawl in a vise, while supporting the cylinder use a large flat blade screwdriver to turn the cylinder rod. Insert the screwdriver in the hole in the end of the pawl and into the slot (**14**) in the end of the cylinder rod. Remove the pawl from the rod.





b. Fork side Shift Cylinder Disassembly

1. Clean the fork side shift cylinder (**15**) with a suitable cleaner. Remove all dirt, debris and grease from the cylinder.

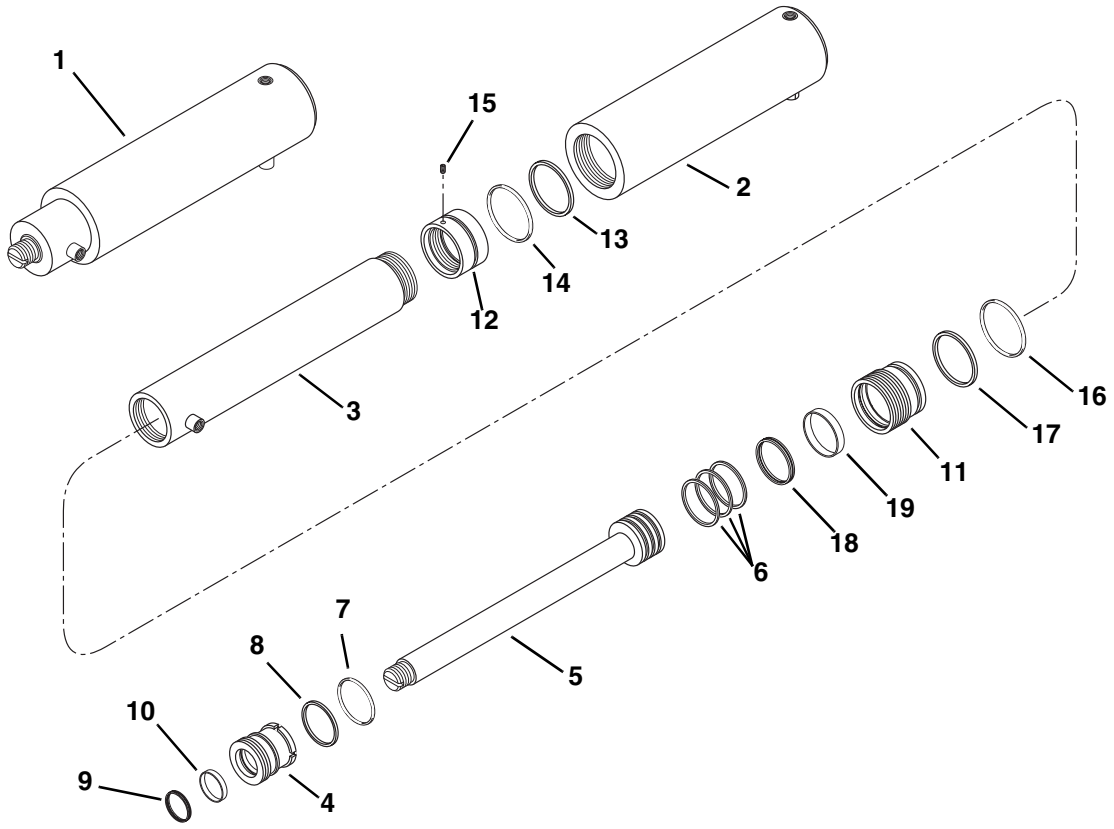
IMPORTANT: *Avoid using excess force when clamping the cylinder in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**16**).*

2. Secure the fork side shift cylinder (**15**) in a soft-jawed vise or other holding device, and place a suitable container beneath the cylinder to catch hydraulic fluid run-off.
3. Extend the cylinder rod by hand to expose part of the tube rod (**17**). While holding the tube rod securely, use a pin spanner wrench to remove the guide (**18**) from the end of the tube rod. Unthread the guide from the tube rod. Carefully slide the guide off the end of the rod (**19**).

IMPORTANT: *Protect the finish on the rod at all times. Damage to the rod can cause premature seal failure.*

IMPORTANT: *When sliding the rod assembly in the tube rod, **DO NOT** damage the piston end of the rod assembly (**19**) by scraping it against the threads in the tube rod. Keep the rod assembly in line with the tube rod to prevent binding.*

4. Carefully withdraw the rod assembly (**19**) straight out of the tube rod (**17**). Keep the rod assembly straight during withdrawal to help avoid scratching, nicking or damaging the tube rod.
5. Remove the three cast iron piston rings (**20**) from the piston end of the rod assembly (**19**).
6. Remove the o-ring (**21**) and back-up ring (**22**) from the guide (**18**).
7. Remove the AN series wiper ring (**23**) from the inside front edge of the guide (**18**).
8. Remove the poly seal (**24**) from inside the front of the guide (**18**).



9. Use a pin spanner wrench to remove the guide (**11**) from the end of the cylinder tube (**2**). Unthread the guide from the cylinder tube. Carefully slide the guide down the tube rod (**3**).

IMPORTANT: *Protect the finish on the tube rod at all times. Damage to the tube rod can cause premature seal failure.*

10. Carefully withdraw the tube rod assembly (**3**) with guide (**11**) and piston (**12**) straight out of the cylinder tube (**2**). Keep the tube rod assembly straight during withdrawal to help avoid scratching, nicking or damaging the cylinder tube.

IMPORTANT: *When sliding the tube rod assembly in the cylinder tube,* ***DO NOT*** *damage the piston end of the tube rod assembly (**3**) by scraping it against the threads in the cylinder tube. Keep the tube rod assembly in line with the cylinder tube to prevent binding.*

11. Remove the piston seal (**13**) and o-ring (**14**) from the piston (**12**).
12. Remove the setscrew (**15**) from the piston (**12**). The setscrew has Loctite 242 (blue) removable threadlocker applied to it. Clean all residue from the threads.
13. Remove the piston (**12**) from the end of the tube rod (**3**).
14. Remove the guide (**11**) from the tube rod (**3**) by carefully sliding the guide off the threaded end.
15. Remove the o-ring (**16**) and back-up ring (**17**) from the guide (**11**).
16. Remove the AN series wiper ring (**18**) from the guide (**11**).
17. Remove the poly seal (**19**) from inside the guide (**11**).

c. Fork Side Shift Cylinder Internal Cleaning

1. Remove all hydraulic fluid, dirt and debris from the inner surface of the cylinder.
2. Discard all seals, back-up rings and o-rings. Replace with new items from a complete seal kit to help ensure proper cylinder function.
3. Clean all metal parts with an approved cleaning solvent such as trichlorethylene. Carefully clean cavities, grooves, threads, etc.

d. Fork Side Shift Cylinder Inspection and Repair

1. Inspect all parts for wear and damage. If inner surfaces of the cylinder (**1**) 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 and damage to the polished surfaces within the component.
2. Inspect the inside of the tube (**2**) and tube rod (**3**) for scoring and other damage. If the tube or tube rod are damaged, replace it with new parts.
3. Remove small scratches on the rod or inside of the tube or tube rod with very fine grit emery cloth. Use the emery cloth in a rotary motion to polish out small imperfections in the metal and blend scratch(es) into the surrounding surface.
4. Clean the parts with trichlorethylene after repair.
5. Check that the rod assembly (**5**) is straight. If the rod assembly is bent, install a new rod assembly.
6. Check that the tube rod (**3**) is straight. If the tube rod is bent, install an new tube rod.

e. Fork Side Shift Cylinder Assembly

Note: *Follow Section 9.14.3, General Cylinder Assembly Instructions.*

1. Install a new oiled back-up ring (**17**) and o-ring (**16**) into the groove on the outside of the guide (**11**).
2. Install a new oiled poly seal (**19**) into the inside of the guide (**11**). Use tools that will not damage the seals.
3. Install a new oiled AN series wiper ring (**18**) into the guide (**11**). The angled edge of the wiper must point toward the outside edge of the guide.
4. Lubricate the seals on the inside of the guide (**11**) and carefully slide the guide onto the tube rod (**3**).
5. Apply a drop of Loctite 242 (blue) removable threadlocker to the first two threads of the tube rod (**3**) 180° apart. Install the piston (**12**) onto the tube rod (**3**) and tighten securely.
6. Apply Loctite 242 (blue) removable threadlocker to the threads of the setscrew (**15**) and thread into the piston (**12**). Tighten the setscrew securely.
7. Install a new oiled o-ring (**14**) and piston seal (**13**) onto the piston (**12**).

IMPORTANT: *Avoid using excess force when clamping the cylinder tube in a vise. Apply only enough force to hold the cylinder securely. Excessive force can damage the cylinder tube (**2**).*

8. Fasten the tube (**2**) in a soft-jawed vise or other suitable holding device.
9. Lubricate the o-ring and seal on the piston and the inside of the tube (**2**) with clean, filtered hydraulic oil. This will aid in installation.

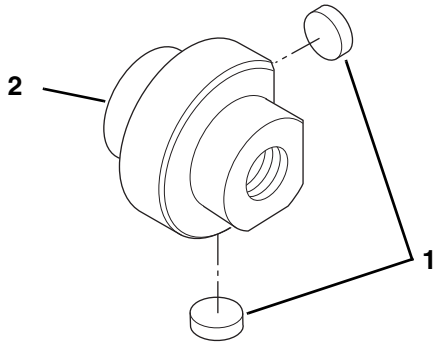
IMPORTANT: *Use a suitable installation tool or compression sleeve to help prevent twisting or damaging the seals and o-rings when installing the piston (**12**) into the cylinder tube (**2**). When sliding the tube rod and piston assembly in the tube, **DO NOT** damage the piston by scraping it against the threads in the tube. Keep the tube rod in line with the tube to prevent binding.*

10. Keep the tube rod (**3**) straight and carefully insert the rod into the tube (**2**). Avoid scratching, nicking or damaging the tube while installing the rod.
11. Apply a drop of Loctite 242 (blue) removable threadlocker to the first two threads of the guide (**11**) 180° apart. Slide the guide down the tube rod and thread into the cylinder tube (**2**) and tighten securely.
12. Install the three new oiled cast iron piston rings (**6**) onto the piston end of the rod assembly (**5**). Carefully slide the rod assembly into the tube rod (**3**).
13. Install a new oiled back-up ring (**8**) and o-ring (**7**) onto the guide (**4**).
14. Install a new oiled poly seal (**10**) into the inside of the guide (**4**).
15. Install a new oiled AN series wiper ring (**9**) into the guide (**4**). The angled edge of the wiper must point toward the outside edge of the guide.
16. Lubricate the seal and wiper inside the guide with clean filtered hydraulic oil. This will aid in assembly of the guide onto the rod assembly.
17. Apply a drop of Loctite 242 (blue) removable threadlocker to the first two threads of the guide (**4**) 180° apart. Slide the guide onto the rod assembly (**5**) and thread into the tube rod (**3**) and tighten securely.

18. Test the cylinder at low operating pressure (100 psi or 6,9 bar) to verify that the piston and rod move freely in both directions.
19. Increase the operating pressure to the maximum for the cylinder (4500 psi or 310 bar) and check for external leakage and for free movement in both directions.
20. Retract the piston fully.

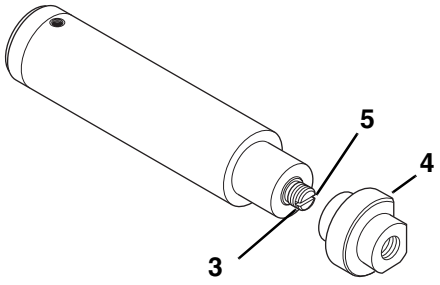
f. Fork Side Shift Cylinder Installation

1. Assemble the new pawl pads (**1**) into the cavities of the rod end pawl (**2**). Spray each pad with 3M #90 High Strength Spray and insert into each cavity.



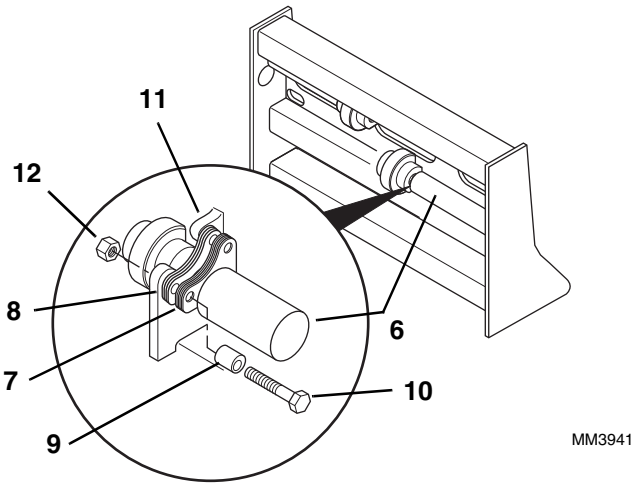
MM3900

2. Clamp the rod end pawl in a vise.
3. Apply Loctite Threadlocker 277 (red) High Strength to the threads of the cylinder rod (**3**). Line up the rod end pawl (**4**) with the cylinder rod (**3**). Turn the rod until the rod end pawl bottoms on the threads of the cylinder rod. Use a large flat blade screwdriver to turn the cylinder rod inside the rod end pawl. Insert the screwdriver in through the opening in the rod end pawl and into the slot (**5**) in the end of the cylinder rod.



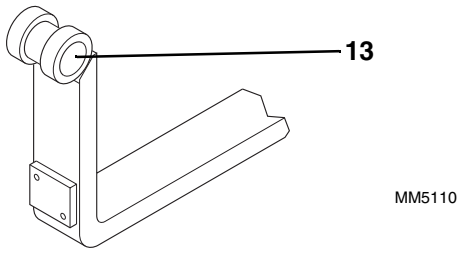
MM3970

4. Place the base end of the cylinder in place behind the retaining plate on the outer edge of the carriage. Turn the rod end pawl till the wear pads sit squarely against the surfaces of the carriage.
5. Position the cylinder (**6**) in place and reassemble the cylinder retainer plates (**7**), retainer plate shims (**8**) and the cylinder retainer spacer cams (**9**). Insert the capscrews (**10**) through the cams, plates, shims and mounting plate (**11**) on the carriage. Secure in place with the hex nut (**12**). Turn the spacer cams to securely hold the cylinder in place and tighten both hex nuts securely.



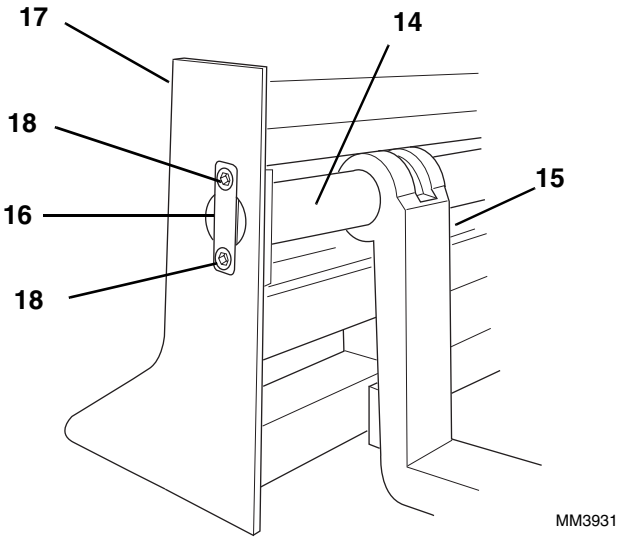
MM3941

6. Check the bushings inside each fork. If the bushings are worn or torn, replace with new bushings. Be sure to thoroughly clean the fork “eye” (**13**) of all old bushing residue and debris. Use a lapping tool or a hard wire rotary brush to remove the bushing residue, debris, rust or uneven metal in each fork.



Note: *Be careful not to tear the bushings when inserting the fork shaft through the forks.*

7. Reassemble the fork shaft (**14**) and forks (**15**) to the carriage. Push the fork shaft in from the right side of the carriage, placing the forks over the rod end pawls and then inserting the fork shaft through the fork.
8. Place the fork shaft retainer (**16**) in place on the right side of the carriage (**17**). Apply Loctite 242 (blue) removable threadlocker to the threads of the two screws (**18**) and secure the retainer plate to the carriage. Torque both screws to 120-125 lb/ft (163-169 Nm).



9. Reassemble the fittings into the ports on the cylinder.
10. Reassemble the hydraulic hoses to the appropriate ports on the cylinder.

WARNING: Avoid prolonged engine operation in closed areas with inadequate ventilation. Failure to properly ventilate exhaust fumes can result in death or serious injury.

11. Start the engine and run at approximately one-third to one-half throttle for about one minute without moving the vehicle or operating any hydraulic functions.

WARNING: Escaping hydraulic fluid under pressure can penetrate the skin, causing death or serious injury.

12. Activate the fork side shift switches to shift the forks to the right and left. Repeat shifting the forks fully from one side to the other side 3-5 times.
13. Inspect for leaks and check the level of the hydraulic fluid in the reservoir. Shut the engine OFF. Add hydraulic fluid to the reservoir as required.
14. Wipe up any hydraulic fluid spillage in, on, near and around the vehicle, work area and tools.

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Section 10
Electrical System

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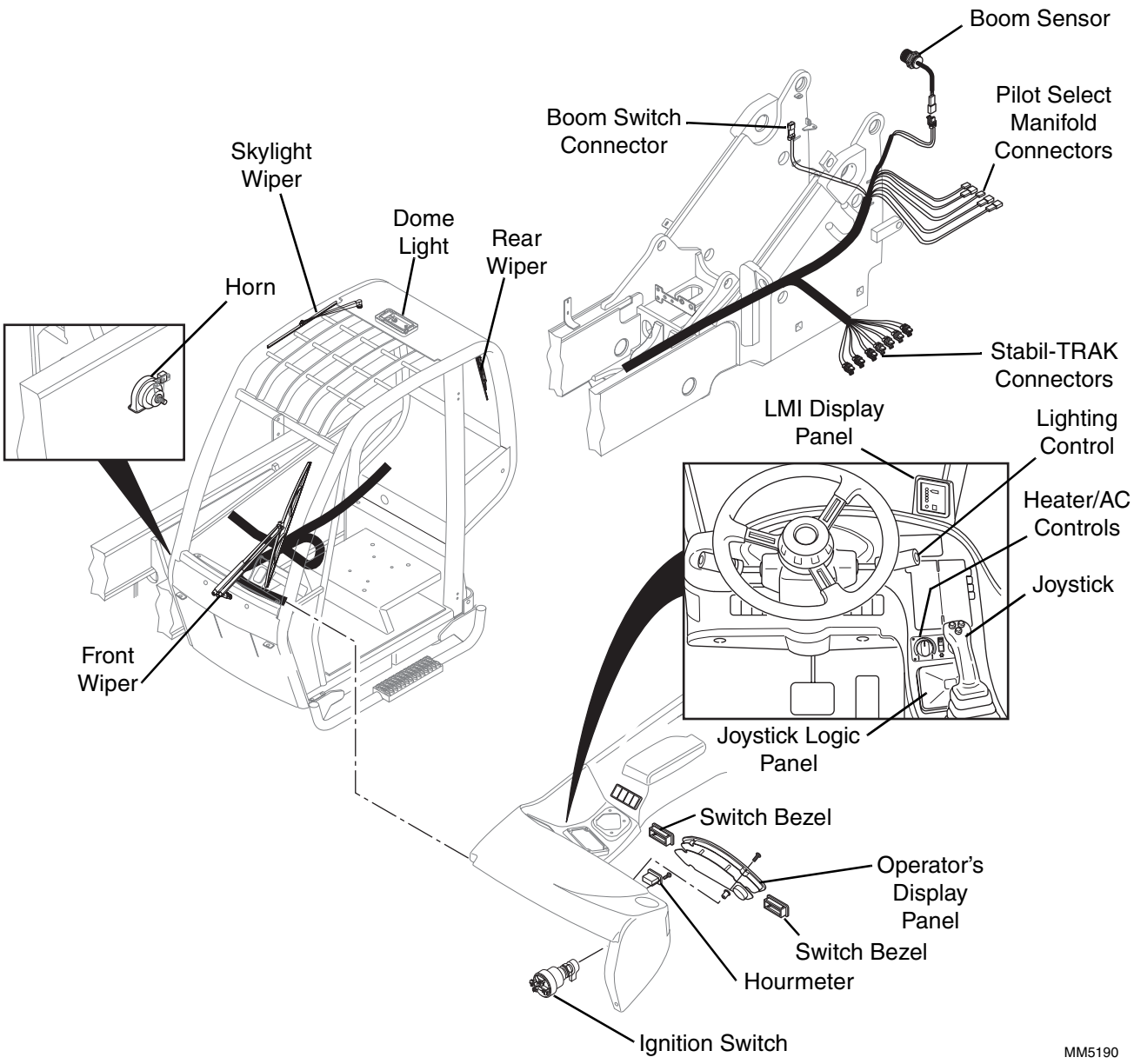
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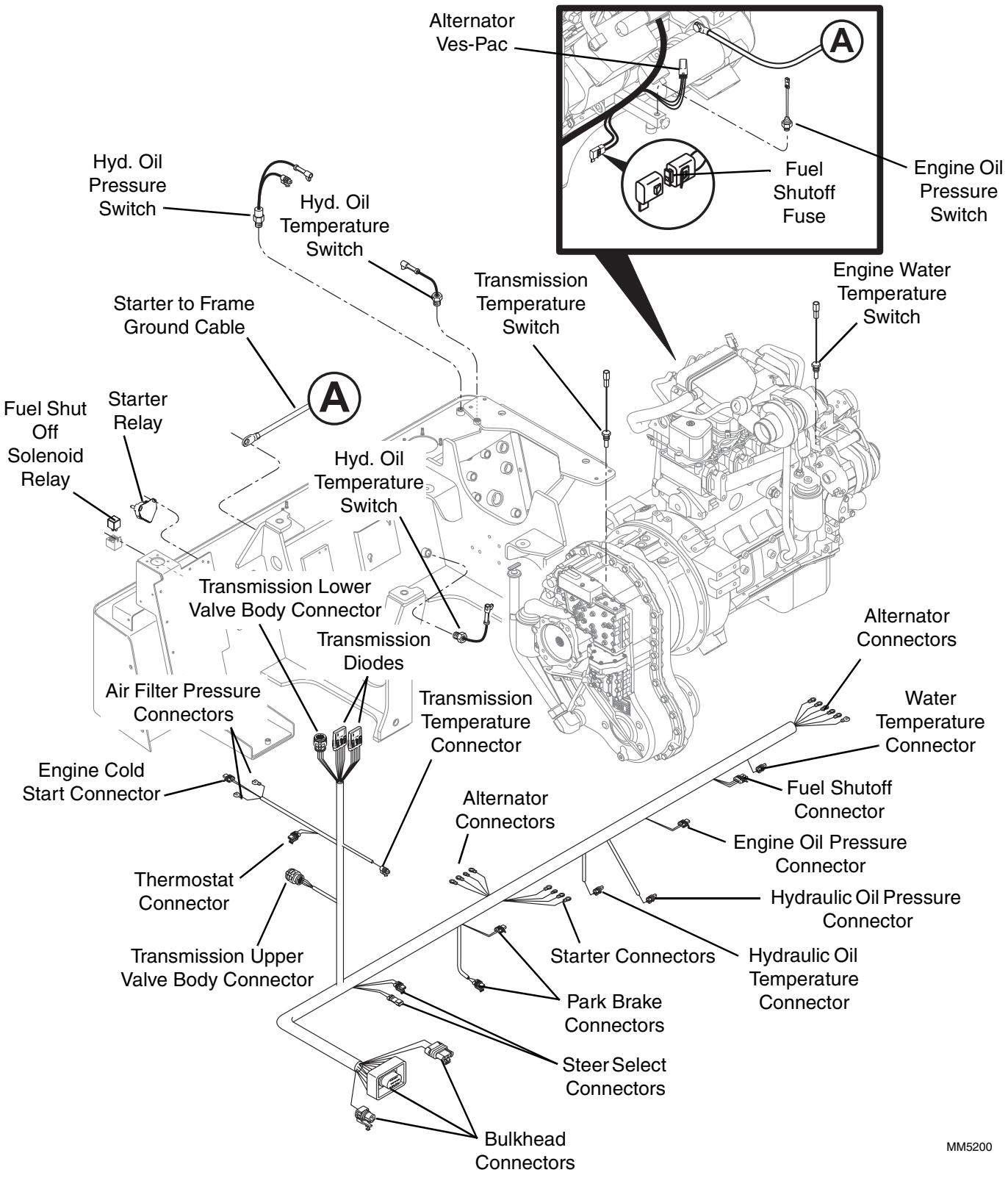
10.1 ELECTRICAL COMPONENT TERMINOLOGY

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 vehicle. The following illustration identifies the components that are referred to throughout this section.

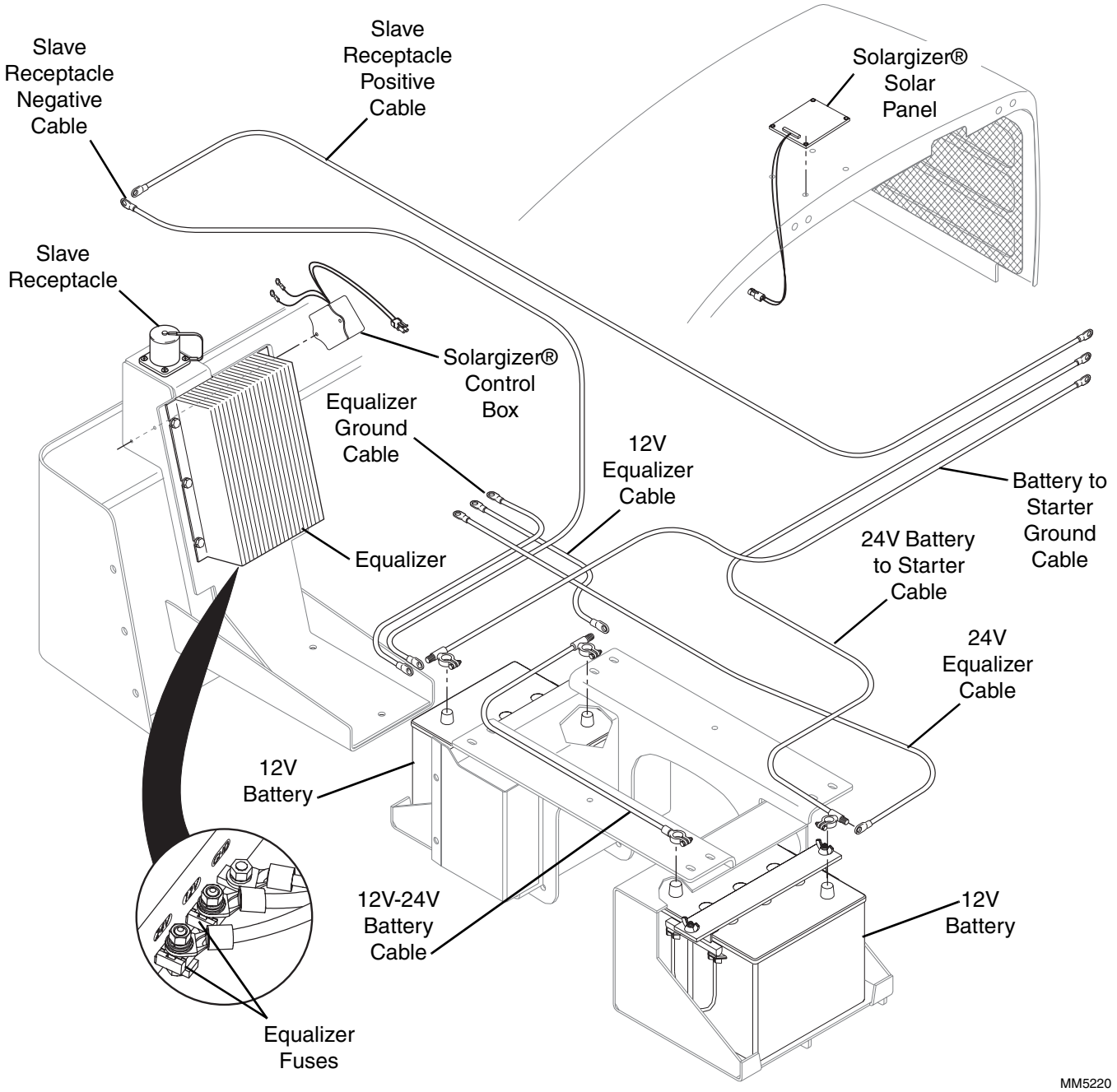
10.1.1 General Overview (Cab Harness)



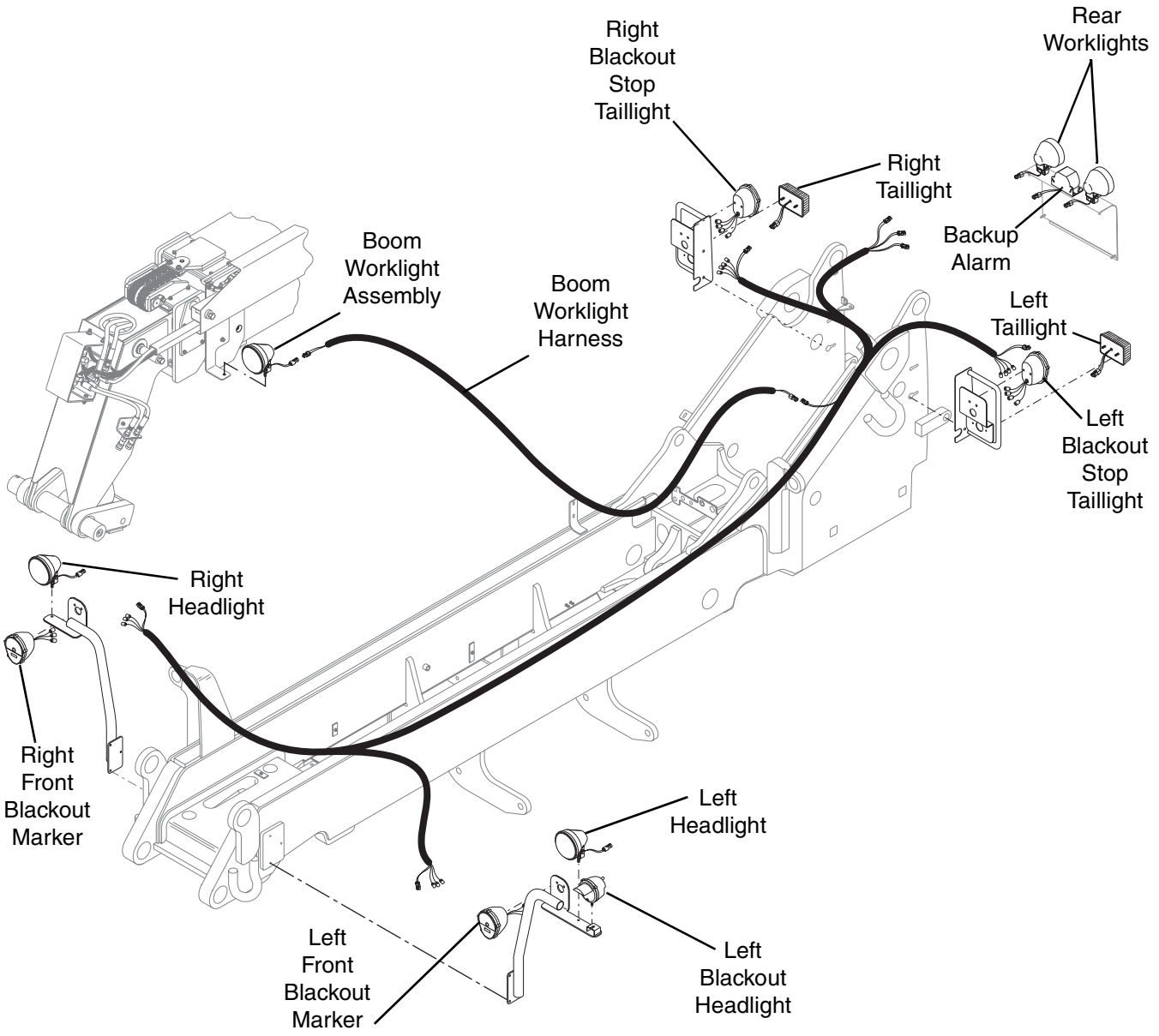
10.1.2 General Overview (Engine Harness)



10.1.3 General Overview (Battery, Equalizer Harness)



10.1.4 General Overview (Lighting Harness)



10.2 SERVICE WARNINGS

10.2.1 General

CAUTION: **DO NOT** disconnect any wiring without first stopping the engine, turning all electrical switches to the OFF position and disconnecting the battery ground (-) cable from the battery. Failure to remove the negative (-) battery cable will result in damage to vehicle electronic systems.

CAUTION: **DO NOT** cause a short circuit by connecting leads to incorrect terminals. Always identify a lead and its correct terminal. A short circuit or wrong connection creating reverse polarity will immediately and permanently ruin internal components within the electrical system.

CAUTION: **DO NOT** momentarily or "flash" connect a terminal to check for current flow. No matter how brief the contact, internal components may be ruined.

10.2.2 Battery

WARNING: All lead acid batteries generate hydrogen gas, which is highly flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery, and possible severe personal injuries, particularly to the eyes. Wear safety glasses when working near the battery.

WARNING: Avoid battery acid. Battery acid can cause chemical burns or other serious injury. In case of contact with battery acid, flush immediately with water.

WARNING: Charge the battery in a well-ventilated area only. Always turn battery chargers OFF before connecting to or disconnecting from a battery.

CAUTION: **DO NOT** disconnect the battery while the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin internal components.

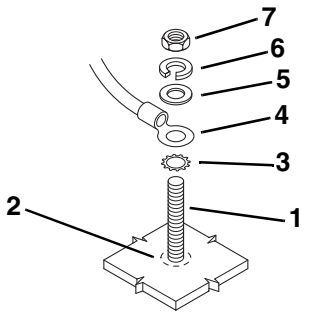
CAUTION: **DO NOT** connect a battery into the system without checking for correct polarity and voltage.

10.3 SPECIFICATIONS

Electrical system specifications are listed in *Section 2, General Information, Specifications and Maintenance* Instructions.

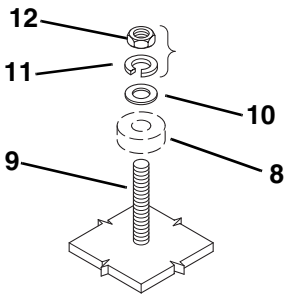
10.4 EFFECTIVE GROUND CONNECTIONS

1. Effective ground connections are essential to the efficient operation of electrical components. If an inadequate ground is suspected or determined, establishing another ground may be desired. Also, in the event a factory-authorized accessory is being installed, it is necessary to follow the proper sequence for providing an electrical ground. The sequence for installing or attaching a component to an electrical ground to a stud, bolt or capscrew (**1**) is to provide a clean surface by eliminating paint and rust from the area around the base of the stud (**2**). Install a tooth type lockwasher (**3**), electrical wire connector (**4**), flat washer (**5**), tooth or slot-type lockwasher (**6**) and nut or locknut (**7**).



MA0871

2. When an electrical component (**8**) is to be grounded, eliminate paint and rust from around the stud, bolt or capscrew (**9**), install a flat washer (**10**), tooth type or slot-type lockwasher, or locking nut with slotted type lockwasher (**11**) and nut or locknut (**12**).



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10.5 WIRING HARNESSES

Wiring on the vehicle is contained within five separate wiring harnesses, the engine harness, cab harness, lighting harness, boom worklight harness and load moment indicator harness. A harness consists of black-nylon woven braiding, providing a protective cover to bundle numerous wiring groups, splices, terminals, connectors, and, where applicable, diodes. Each harness is identified with a **JLG** part number when the vehicle leaves the factory.

Each wire is identified by a wire number on each end of the individual wire, and by the color and gauge size of the wire. The wire numbers are also identified on the appropriate electrical schematic. All circuits have been electrically tested for continuity, and all diodes have been tested for correct biasing. Where several individual connectors appear, the wiring leading to a particular connector can help identify the specific circuit. For some circuits, a colored band (tie wrap) is present, affixed to the connector wiring and used as a color-code indicator. If wiring ever needs to be replaced, use the correct gauge size wiring. **NEVER** replace a wire with a smaller gauge wire.

10.5.1 Removal and Replacement

Remove a wiring harness only if damaged or unusable. Install a new harness one terminal at a time as the old harness is removed. Label or tag the terminal locations of all wires, harness clips, tie wraps and conduit as the old harness is removed to allow correct installation of the new harness.

10.5.2 Disassembly

Disassembly of the wiring harness is not recommended due to the precise arrangement of wires and splice requirements. If it becomes necessary to replace wires, use the correct gauge size wiring, and **NEVER** replace a wire with a smaller gauge wire.

10.5.3 Cleaning and Drying

Clean a wire harness with a natural bristle brush and the same detergent used to clean the vehicle. Allow the harness to air dry. **DO NOT** allow surface temperatures to exceed 300° F (149° C).

10.5.4 Inspection and Repair

Replace a harness only if it is damaged or unusable. If a splice or repair must be made to a wire, always use rosin core solder to bond wires together. Use heat-shrink tubing or insulating electrical tape to cover all splices or bare wires.

10.5.5 Installation

The wiring harnesses are held securely in place by wire tie wraps, clips or other devices to help prevent chafing or wearing of the insulation and entanglement with moving parts. Sections of ribbed plastic conduit have been installed where wiring or harnesses pass through openings in the vehicle frame. Always install tie wraps, clips, conduit, etc., in their original locations to help prevent damage to the wiring or harnesses.

10.5.6 Wire Code and Color

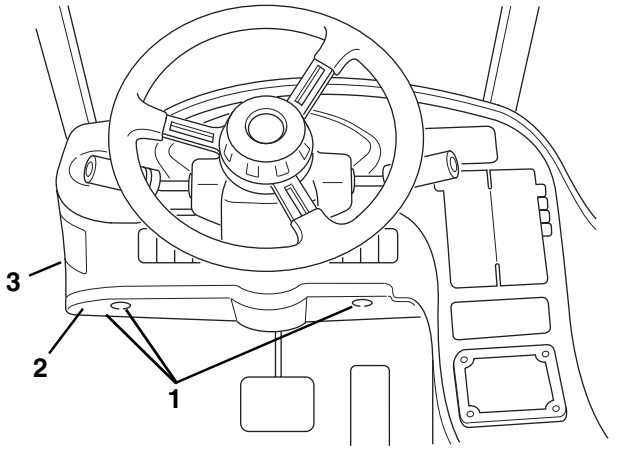
The chart below indicates the wire code abbreviation and color as used on the electrical schematics.

Wire Code	Color
BLK	Black
BLU	Blue
BRN	Brown
DK BLU	Dark Blue
DK GRN	Dark Green
GRN	Green
GRY	Grey
LT BLU	Light Blue
LT GRN	Light Green
ORN	Orange
PNK	Pink
PUR	Purple
RED	Red
TAN	Tan
YEL	Yellow
WHT	White

10.6 FUSES AND RELAYS

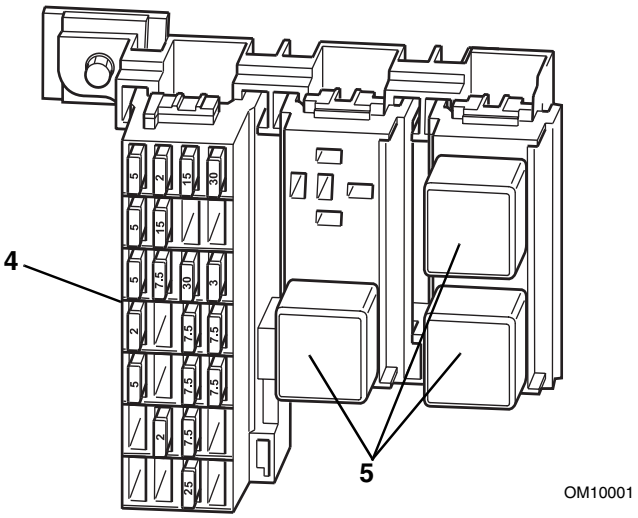
Fuses and relays help to protect the electrical system. In general, a blown fuse is a symptom of another electrical problem. Address the true problem, not just the symptom. Simply replacing the fuse often will not solve the problem. Blown fuses are usually due to simple causes, including loose or corroded connections, or a defective relay. There are two main causes of blown fuses; a shorted or grounded wire in the applicable circuit, or a defective electrical component. Visually check the condition of the fuse, wires, connections and components in the involved circuit before replacing a fuse. Check the circuit for shorts, grounding, or defective electrical components. Keep in mind that many parts in the electrical system work with components of the hydraulic system; a careful inspection of the related hydraulic components may help in solving problems.

For access to the fuse and relay panel, remove the three self-drilling screws (**1**) (one screw is not visible in figure) securing the lower dash cover (**2**) to the front dash (**3**). Remove the lower dash cover (**2**).



MT2050

The fuses (**4**) and sealed 12 volt relays (**5**) are mounted under the lower left side of the operator's console. The fuse and relay panels are part of the cab harness.

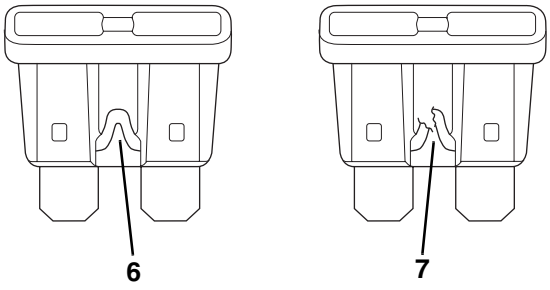


OM10001

10.6.1 Circuit Protection - Fuses

a. Auto Type Fuses

The fuse is the most common method used for protecting wiring circuits. A good fuse (**6**) will have the center element connected to both sides of the fuse. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt (**7**) and create an open or incomplete circuit.



MT0420

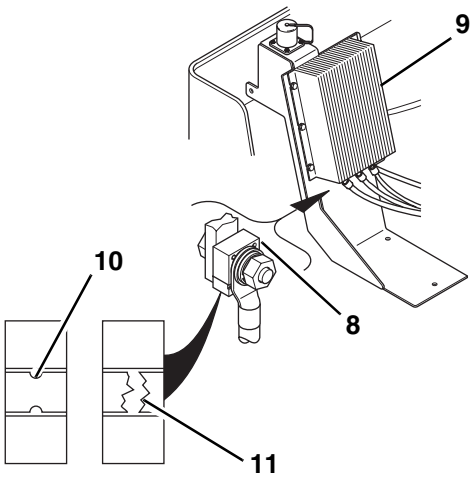
Fuses are a one time protection device and must be replaced each time the circuit is overloaded. To determine if a fuse is open (**7**), remove the suspected fuse and examine the element in the fuse for an open (break). If not broken, also check for continuity using a DMM or a continuity tester. If the element is open or continuity is suspect, replace the fuse with one of equal current rating.

Fuse Types	
Current Rating Amperes	**Color**
Auto Fuses, Mini Fuses	
1	Black
2	Gray
3	Violet
5	Tan
7.5	Brown
10	Red
15	Blue
20	Yellow
25	White
30	Green
Maxi Fuses	
20	Yellow
30	Light Green
40	Orange or Amber
50	Red
60	Blue

b. Battery Equalizer Fuses

There are two fuses (**8**) located on the bottom side of the equalizer (**9**). These two fuses are 125 amp fuses and are located on the 12V and 24V positive terminals of the equalizer. These fuses protect the battery cables connected to the equalizer in case of an internal short or failure. You will require a small telescoping mirror to check these two fuses.

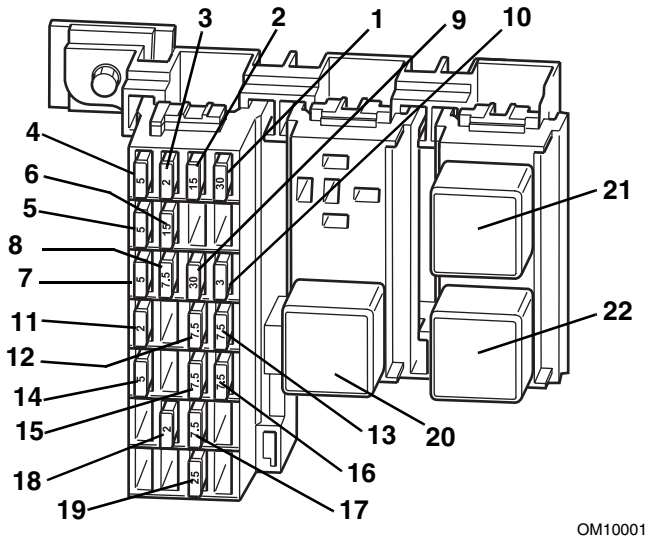
As with the auto type fuses, a good fuse (**10**) will have the center element connected to both sides of the fuse. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt (**11**) and create an open or incomplete circuit.



MM4290

10.6.2 Fuse and Relay Locations

a. Fuses & Relays (Left Side Dash)



OM10001

No.	Amp/Volt	Circuit Protected
1	30 Amp	Main
2	15 Amp	Ignition - Preheat
3	2 Amp	Hourmeter
4	5 Amp	Transmission Gear
5	5 Amp	Transmission Direction
6	15 Amp	Front Dash Display Panel
7	5 Amp	Parking Brake
8	7.5 Amp	Joystick Logic Panel
9	30 Amp	Power Window
10	3 Amp	LMI (Load Moment Indicator)
11	2 Amp	Service Brake
12	7.5 Amp	Front Wiper/Washer
13	7.5 Amp	Left Fork Shift
14	5 Amp	Steer Mode
15	7.5 Amp	Skylight Wiper/Washer
16	7.5 Amp	Right Fork Shift
17	7.5 Amp	Rear Wiper
18	2 Amp	Switch Lamps
19	25 Amp	Heater
20	12 Volt	Neutral Engage Relay
21	12 Volt	Door Window Relay
22	12 Volt	Closed Cab Accessory Power Relay

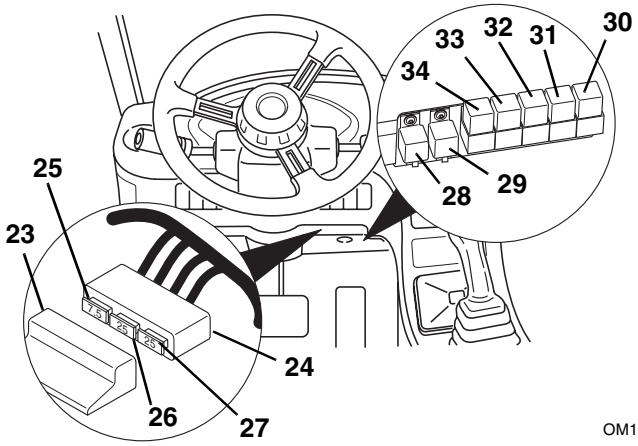
b. Fuses & Relays (Right Side Dash)

There is a separate fuse holder under the right side of the dash containing three fuses. This fuse holder is located in the cab wire harness. To gain access, remove the three screws that secure the lower dash panel in place.

To gain access to the fuses remove the cover (**23**) from the fuse holder (**24**).

Refer to the following chart for the size of fuse and circuit protected.

There are seven relays mounted to the front of the cab. Refer to the following chart for the voltage rating of each relay and circuit that they control.



OM1011

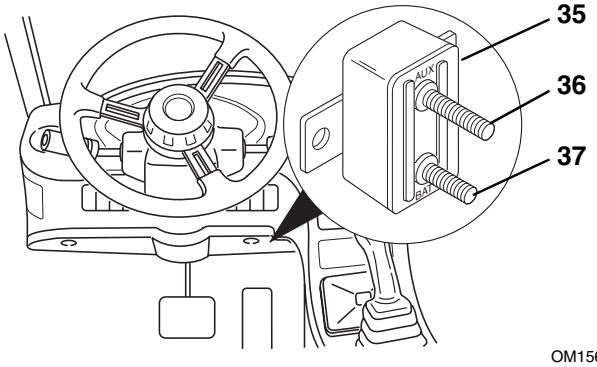
No.	Amp/Volt	Circuit Protected
25	7.5 Amp	Fuse - Horn
26	25 Amp	Fuse - Normal Lights
27	25 Amp	Fuse - Blackout Lights
28	24 Volt	Relay - Worklight Power
29	24 Volt	Relay - High Beam Power
30	12 Volt	Relay - Brake Light
31	12 Volt	Relay - Light Power
32	12 Volt	Relay - Blackout Ignition
33	12 Volt	Relay - Normal Lights Ignition
34	12 Volt	Relay - Reverse Signal

There is one circuit breaker (**35**) located under the right side of the dash. The circuit breaker protects the keyless ignition circuit. It is mounted to the side of the steering column mount just below the flasher.

This circuit breaker will trip if there is a short or grounded wire in the applicable circuit. The circuit breaker will automatically reset once it cools. If the circuit breaker continually trips, check the system for shorts, grounds or defective electrical components.

Under normal operating conditions the circuit breaker should never need replacement. however, if a circuit breaker does not automatically reset, the breaker is defective and replacement is required.

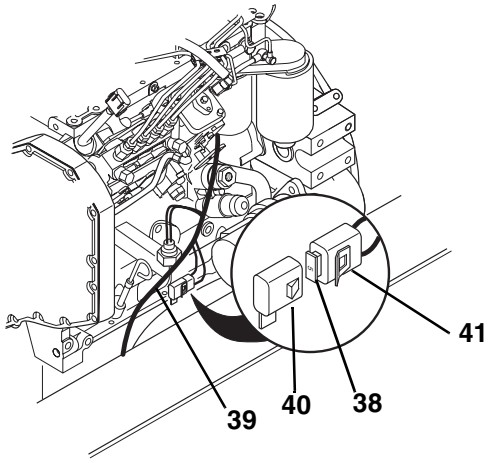
IMPORTANT: *The circuit breaker has a long terminal (**36**) and a short terminal (**37**). The short terminal is labeled "BAT" and the long terminal is labeled "AUX". Connect the wires from the battery to the "BAT" terminal and connect the other wires to the "AUX" terminal. If the wires are connected to the wrong terminals and the circuit breaker trips because of a short or grounded wire in the circuit, the contacts in the circuit breaker will melt together and the circuit breaker will not protect the circuit because it cannot open.*



OM1560

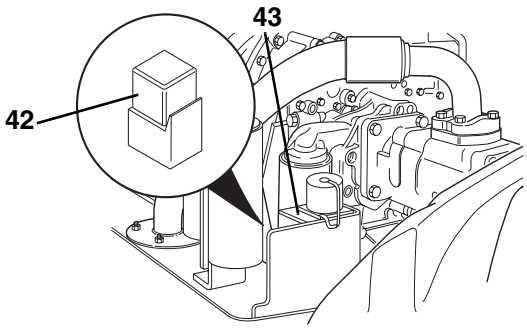
c. Fuse and Relay (Under Engine Cover)

There is one fuse (**38**) located under the engine cover. Open the engine cover to gain access to this fuse.



OM1170

The fuse is a 5 amp fuse which protects the fuel shut off solenoid, located in the engine harness (**39**). To gain access to the fuse, remove the protective cover (**40**) from the fuse holder (**41**).



OM1351

There is one relay (**42**) located behind the battery equalizer mounting bracket (**43**). This relay is a 12 volt relay that controls the fuel shut off solenoid.

There are two fuses (**12**) located on the bottom side of the equalizer (**13**). These two fuses are 125 amp fuses and are located on the 12V and 24V positive terminals of the equalizer. These fuses protect the 12V and 24V circuits of the equalizer. You will require a small telescoping mirror to check these two fuses.

If a 125 amp fuse blows, the fuse, along with the mounting hardware will have to be replaced as a kit. Refer to *Section 10.6.3, Fuse and Relay Replacement*.

d. Relay and Fuse (Inside Rear Door)

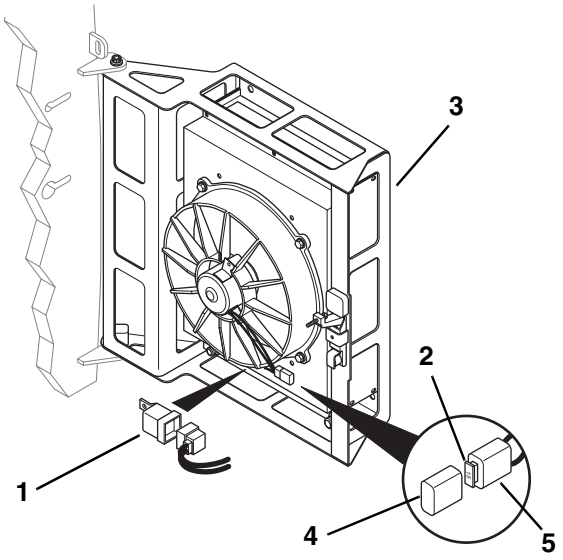
There is one relay (**1**) and one fuse (**2**) located inside the rear door (**3**). The relay is a 12 volt relay that controls the fan on the air conditioner condenser.

The fuse is a 15 amp fuse that protects the fan motor on the air conditioner condenser.

WARNING: **DO NOT** open the rear door with the ignition switch in the RUN position. Contact with moving parts can cause death or serious personal injury.

Unlatch and open the rear door. The relay is mounted to the fan shroud.

Remove the protective cover (**4**) from the fuse holder (**5**) to gain access to the 15 amp fuse.

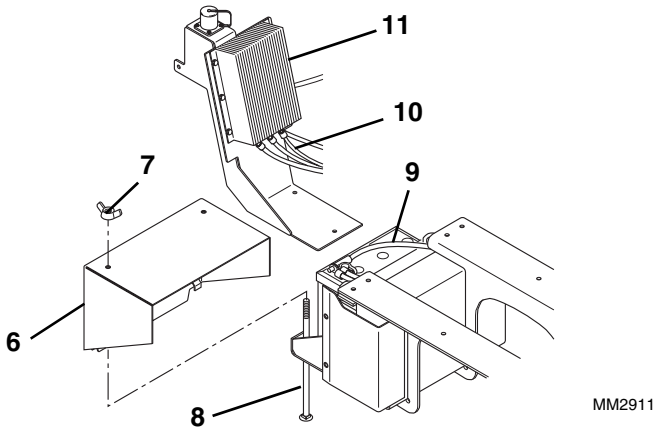


OM1660

10.6.3 Fuse and Relay Replacement

Shut off the engine and disconnect the batteries before checking the electrical system fuses or relays.

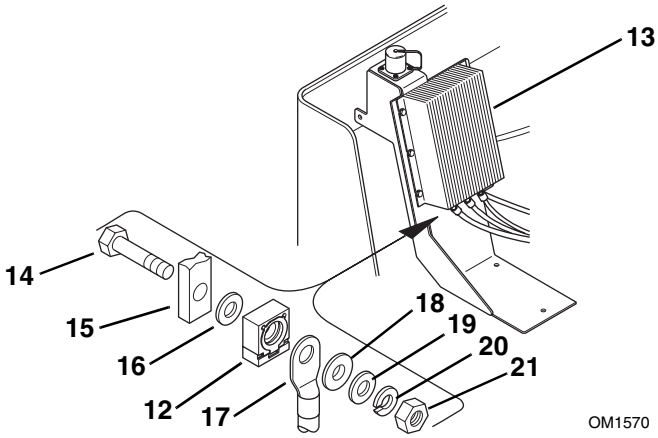
1. Remove engine side battery box cover (**6**). Remove wing nuts (**7**) and carriage bolts (**8**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**9**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**10**) at the bottom of the battery equalizer (**11**).



4. Remove a suspect fuse (Refer to *Section 10.6.2, Fuse and Relay Locations* for locations of fuses and relays) from the fuse and relay panel by pulling the fuse or relay straight out and away. ALWAYS install the correct amp rated fuse or relay.

Replace a 125 amp equalizer fuses as follows:

5. Remove the blown fuse and associated hardware. Discard all items.
6. Insert the new capscrew (**14**) through the tab (**15**) on the equalizer (**13**).
7. Place a flat washer (**16**) and new fuse (**12**) onto the capscrew. Position fuse as required to best see the clear window.
8. Place the positive cable (**17**) onto the capscrew.
9. Place the nylon shoulder washer (**18**) onto the capscrew and place against the positive cable with the hub toward the cable.
10. Secure in place with a flat washer (**19**), lockwasher (**20**) and hex nut (**21**). Torque the hex nut to a maximum of 100 lbs/in (11 Nm).



11. Connect the negative (-) battery cable (**9**) at the battery negative (-) terminal on the battery in the engine side battery box.
12. Connect the negative (-) battery equalizer cable (**10**) at the bottom of the battery equalizer (**11**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
13. Replace battery box cover (**6**). Use the wing nuts (**7**) and carriage bolts (**8**) to secure the cover in place.

10.7 ELECTRICAL SYSTEM TROUBLESHOOTING

10.7.1 Introduction

The electrical system produces, stores and distributes electricity in the operation of the vehicle.

An engine-driven, 24 volt, 70-amp alternator equipped with an internal, solid-state voltage regulator produces electricity. Current from the alternator charges the battery and powers electrical system components.

The battery provides power for starting the engine and supplements the output of the alternator during periods of peak demand.

The vehicle is equipped with two separate, but connected wiring harnesses, an engine harness and a cab harness. A multiple or "bulkhead" connector at the end of each harness joins the two together.

Each wire within a harness has color-coded insulation and is marked with a number to aid in identifying and tracing each circuit and in making proper connections. Fuses and relays are included with the cab harness to help protect the electrical system and its components.

The main wiring diagrams in this section indicate electrical circuits and components respective of their approximate location on the vehicle.

The information in this section has been developed from the perspective that all wires are connected and routed as they were when the vehicle left the factory. Take into account any disconnected or re-routed wires before beginning to diagnose a circuit. Refer to the wiring diagrams to test circuits for continuity or for shorts using a digital multimeter, analog multimeter, test light, ohmmeter, or low-reading voltmeter.

The text discusses each circuit and component, as well as component function and replacement. Many of the circuits have a separate diagram specific to that circuit's function which can be used for troubleshooting purposes. Those same circuits also have their own troubleshooting flow chart. Keep in mind that the various systems on the vehicle include both electrical and hydraulic components. What at first may appear to be an electrical problem may turn out to be a hydraulic problem.

Note: *All of the main electrical schematics in this section are shown in the OFF position. The individual circuit diagrams are shown in the ON position.*

10.7.2 Troubleshooting with a Digital Multimeter (DMM)

IMPORTANT: *Circuits which include any solid-state control modules should only be tested with a ten megohm or higher impedance digital multimeter, or damage could occur to the module.*

A DMM should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present, a DMM indicates how much voltage is present.

The ohmmeter function on a DMM shows how much resistance exists between two points along a circuit. Low resistance in a circuit means good continuity.

IMPORTANT: *Disconnect the power feed from the suspect circuit when measuring resistance with a DMM. This prevents incorrect readings. DMM's apply such a small voltage to measure resistance that the presence of voltages can upset a resistance reading.*

Diodes and solid-state components in a circuit can cause a DMM to display a false reading. To find out if a component is affecting a measurement take a reading once, then reverse the leads and take a second reading. If the readings differ, the solid-state component is affecting the measurement.

Following are examples of the various methods of connecting the DMM to the circuit to be tested:

- Backprobe both ends of the connector and either hold the leads in place while manipulating the connector or tape the leads to the harness for continuous monitoring while you perform other operations or test driving.
- Disconnect the harness at both ends of the suspected circuit where it connects either to a component or to other harnesses.

10.7.3 Probing Electrical Connectors

a. Front Probe

Disconnect the connector and probe the terminals from the mating side (front) of the connector.

***Note: DO NOT** insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use a connector test adapter kit or a flat wire probe adapter kit (usually supplied with a DMM) when front probing terminals. **DO NOT** use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.*

b. Back Probe

DO NOT disconnect the connector and probe the terminals from the harness side (back) of the connector.

- Back probe connector terminals only when specifically required in diagnostic procedures.
- **DO NOT** back probe a sealed connector or a flat wire connector.
- Back probing can be a source of damage to connector terminals. Use care in order to avoid deforming the terminal, either by forcing the test probe too far into the cavity or by using too large of a test probe.
- After back probing any connector, inspect for terminal damage. If terminal damage is suspected, test for proper terminal contact.

c. Measuring Voltage

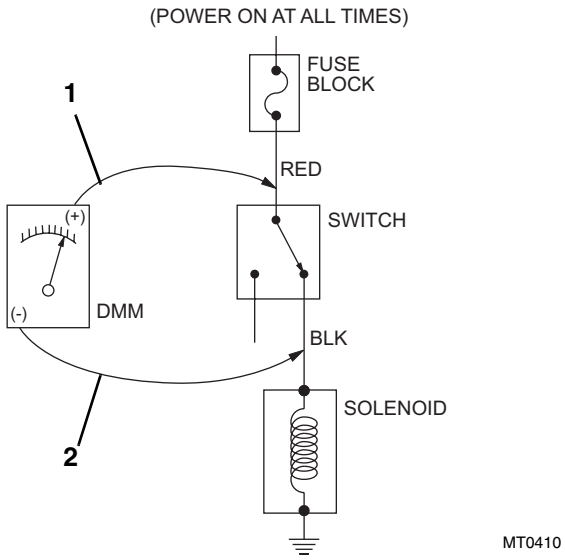
Testing for Voltage Drop

This test checks for voltage being lost along a wire, or through a connection or switch.

1. Connect the positive lead of a DMM to the end of the wire (or to one side of the connection or switch) which is closer to the battery.
2. Connect the negative lead to the other end of the wire (or the other side of the connection or switch).
3. Operate the circuit.
4. Voltage at the wire should be displayed.

Measuring Voltage Drop

The following test determines the difference in voltage potential between two points.



1. Set the rotary dial of the DMM to the V (DC) position.
2. Connect the (+) positive lead (**1**) of the DMM to one point of the circuit to be tested.
3. Connect the (-) negative lead (**2**) of the DMM to the other point of the circuit.
4. Operate the circuit.
5. The DMM displays the difference in voltage between the two points.

Testing for Continuity

The following procedures verify good continuity in a circuit.

With a DMM

1. Set the rotary dial of the DMM to the Ohm position.
2. Disconnect the power feed (i.e. fuse, control module) from the suspect circuit.
3. Disconnect the load.
4. Press the MIN MAX button on the DMM.
5. Connect one lead of the DMM to one end of the circuit to be tested.
6. Connect the other lead of the DMM to the other end of the circuit.
7. If the DMM displays low or no resistance and a tone is heard, the circuit has good continuity.

With a Test Lamp

IMPORTANT: *Only use the test lamp procedure on low impedance power and ground circuits.*

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to one end of the circuit to be tested.
4. Connect the other lead of the test lamp to battery positive voltage.
5. Connect the other end of the circuit to ground.
6. If the test lamp illuminates (full intensity), then the circuit has good continuity.

Testing for Short to Ground

The following procedures test for a short to ground in a circuit.

With a DMM

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Set the rotary dial of the DMM to the Ohm position.
4. Connect one lead of the DMM to one end of the circuit to be tested.
5. Connect the other lead of the DMM to a good ground.
6. If the DMM does NOT display infinite resistance (OL), there is a short to ground in the circuit.

With a Test Lamp

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to one end of the circuit to be tested.
4. Connect the other lead of the test lamp to battery positive voltage.
5. Connect the other end of the circuit to ground.
6. If the lamp illuminates (full intensity), then the circuit has good continuity.

Testing a Fuse Powering Several Loads

1. Review the system schematic and locate the fuse that is open.
2. Open the first connector or switch leading from the fuse to each load.
3. Connect a DMM across the fuse terminals (be sure that the fuse is powered).
   - When the DMM displays voltage the short is in the wiring leading to the first connector or switch.
   - If the DMM does not display voltage, refer to next step.
4. Close each connector or switch until the DMM or analog tester displays voltage in order to find which circuit is shorted.

Testing for Electrical Intermittence

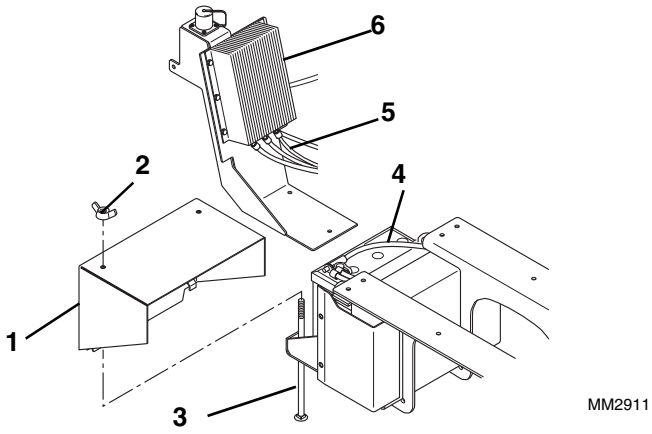
Perform the following procedure while wiggling the harness from side to side. If possible, continue this at 6-inch intervals while watching the test equipment.

- Testing for Short to Ground
- Testing for Continuity

Testing Relays

Relays are used to control a large amount of current by using a small amount of control current flowing through the relay coil.

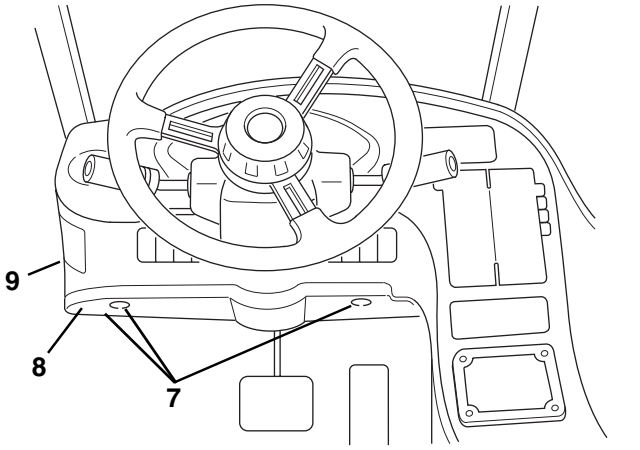
1. Be sure the vehicle is on a level surface, the implement grounded, parking brake engaged, ignition switch is in the OFF position
2. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
3. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



MM2911

5. To gain access to the ten relays located under the operator's dash panel, remove the three self-drilling screws (**7**) (one screw is not visible in figure) securing the lower dash cover (**8**) to the front dash (**9**). Remove the lower dash cover .

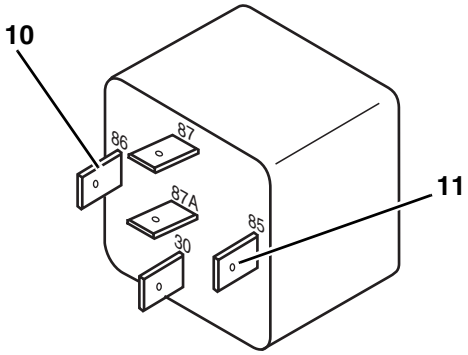
   To gain access to the relay located under the engine cover, open the engine cover.



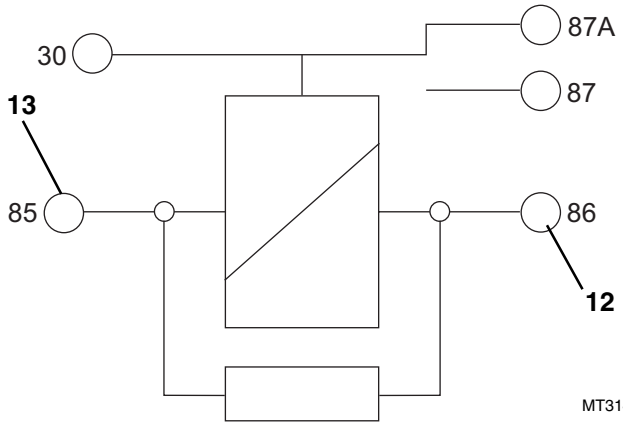
MT2050

6. Remove the suspect relay from the vehicle.

7. Apply the proper voltage to the relay coil, either 12V or 24V depending on the relay coil voltage, at terminal 86 (**10** and **12**) and attach the ground (-) probe to terminal 85 (**11** and **13**), ground. An audible click should be heard indicating that the relay is functioning properly.



MN1820



MT3140

Testing Diodes

To test diodes in the electrical system, set your DMM dial on R x1 setting and connect one lead to each side of the diode. Note the reading on the DMM. Reverse the leads and note reading. Your DMM should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected to the other. If both readings are high or infinite, the diode is open. If both readings are low, the diode is shorted. Repeat test on remaining diodes. If any diodes are shorted or open, replace the diode.

Note: *To test diodes in the alternator connect one lead to the common side of the diode. Connect the other lead to the other side of any of the remaining diodes. Take note of the reading on the DMM. Reverse the leads and note the reading. Repeat test on all diodes in the alternator. If any diodes are shorted or open, replace or repair the alternator.*

10.7.4 Electrical Schematic Legend

Wire No.	Gauge	Color	Pin	From Function To	Pin
1	10	LT GRN	B	Alternator Assembly to 24V Starter Motor	1
1A	10	LT GRN	1	24V Starter Motor to Alternator Assembly	1
2	16	BLK	B	“Four Wheel” Steer Select Solenoid Connector to Splice 100	SPL
2A	16	BLK	SPL	Splice 500 to Splice 130	SPL
2AA	16	BLK	1	Front Wiper Motor Ground to Splice 145	SPL
2AB	16	BLK	B	Attachment “Y” Solenoid Connector to Splice 80	SPL
2AC	16	BLK	B	Attachment “X” Solenoid Connector to Splice 80	SPL
2AD	16	BLK	B	Hoist Solenoid Connector to Splice 80	SPL
2AE	16	BLK	B	Extend Solenoid Connector to Splice 80	SPL
2AF	16	BLK	B	Frame Sway Solenoid to Splice 80	SPL
2AH	16	BLK	86	Fuel Shut Off Relay to Splice 130	SPL
2AJ	14	BLK	86	Engine Start Relay to Splice 130	SPL
2AM	12	BLK	1	Alternator Ground to Engine Ground “A”	1
2AN	12	BLK	1	Alternator Ground to Splice 100	SPL
2AP	16	BLK	1	Skylight Wiper Ground to Splice 155	SPL
2AQ	16	BLK	7	Front Wiper / Washer Switch to Splice 145	SPL
2AR	16	BLK	7	Skylight Wiper / Washer Switch to Splice 145	SPL
2AS	16	BLK	3	Air Conditioning Switch to Splice 145	SPL
2AT	16	BLK	B	Heat Valve Connector to Splice 155	SPL
2AU	16	BLK	86	Cab Power Relay “86” to Splice 145	SPL
2AV	16	BLK	86	Lights Power Relay to Splice 70	SPL
2AW	16	BLK	10	Hazard Switch to Splice 70	SPL
2AX	16	BLK	1	Blackout Headlight Ground to Splice 240	SPL
2AY	14	BLK	1	Front Left Composite Light Ground to Splice 240	SPL
2AZ	14	BLK	C	Left Headlight Ground to Splice 240	SPL
2A_B	16	BLK	SPL	Splice 500 to “Y4” Solenoid	G
2B	16	BLK	SPL	Splice 700 to Splice 130	SPL
2BA	14	BLK	SPL	Splice 240 to Right Headlight Ground	C
2BB	16	BLK	B	Cold Start Thermostat to Splice 130	SPL
2BC	14	BLK	1	Front Right Composite Light Ground to Splice 240	SPL
2BD	14	BLK	1	Left Blackout Light Ground to Splice 245	SPL
2BE	10	BLK	SPL	Splice 240 to Frame Ground “A”	1
2BF	14	BLK	D	Rear Left Composite Light Ground to Splice 245	SPL
2BG	10	BLK	SPL	Splice 245 to Cab Ground “B”	1
2BH	14	BLK	D	Right Rear Composite Light Ground to Splice 245	SPL
2BJ	16	BLK	B	Rear Left Worklight to Splice 245	SPL
2BK	16	BLK	B	Rear Right Worklight to Splice 245	SPL
2BL	14	BLK	B	Boom Worklight to Splice 245	SPL
2BM	14	BLK	1	Right Blackout Light to Splice 245	SPL
2BN	16	BLK	B	Dome Light to Splice 240	SPL
2BP	16	BLK	1	Cab Ground “A” to Low Brake Pressure Light	2
2B_A	16	ANY	G	“Y1” Solenoid to Splice 700	SPL
2D	16	BLK	B	Fuel Gauge Dash Panel Logic Connector to Splice 105	SPL
2DD	10	BLK	SPL	Splice 100 to Engine Ground “B”	1

Wire No.	Gauge	Color	Pin	From Function To	Pin
2E	14	BLK	B	Over Current Monitor Dash Panel Logic Connector to Engine Ground “F”	1
2EE	16	BLK	B	Stabil-TRAK “3” Solenoid Connector to Splice 85	SPL
2F	16	BLK	7	Steer Select Switch to Splice 90	SPL
2FF	16	BLK	B	Stabil-TRAK “4A” Solenoid Connector to Splice 85	SPL
2G	12	BLK	B	Dash Panel Ground Connector to Engine Ground “E”	1
2GG	16	BLK	B	Stabil-TRAK “4B” Solenoid Connector to Splice 85	SPL
2H	16	BLK	B	Fuel Level Sender Connector to Splice 90	SPL
2HH	16	BLK	B	Stabil-TRAK “2A” Solenoid Connector to Splice 85	SPL
2J	16	BLK	1	Load Moment Indicator Display to Splice 105	SPL
2JJ	16	BLK	B	Stabil-TRAK “2B” Solenoid Connector to Splice 85	SPL
2KK	16	BLK	C	Boom Proximity Switch Connector to Splice 85	SPL
2L	14	BLK	C	Fuel Shutoff Solenoid Connector to Alternator Ground “3”	1
2LL	16	BLK	86	Neutral Engage Relay to Splice 105	SPL
2M	16	BLK	B	Parking Brake “A” Solenoid Connector to Splice 100	SPL
2MM	14	BLK	SPL	Splice 145 to Ground Rail “C”	1
2N	16	BLK	B	Parking Brake “B” Solenoid Connector to Splice 100	SPL
2NN	16	BLK	SPL	Splice 130 to Splice 100	SPL
2P	16	BLK	1	Air Filter Negative to Splice 130	SPL
2PP	16	BLK	7	Attachment Tilt Mode Switch to Splice 105	SPL
2QQ	12	BLK	D	Heater A/C Blower Motor to Splice 155	SPL
2R	16	BLK	B	“Crab” Steer Select Solenoid Connector to Splice 100	SPL
2RR	10	BLK	B	Door Window Switch to Splice 155	SPL
2S	16	BLK	K	Operator Reminders Dash Panel Logic Connector to Splice 105	SPL
2SS	16	BLK	1	Front Washer Pump Ground to Splice 150	SPL
2T	16	BLK	SPL	Splice 245 to Back-Up Alarm	1
2TT	16	BLK	SPL	Splice 150 to Ground Rail “B”	1
2U	16	BLK	7	Parking Brake Switch to Splice 105	SPL
2UU	16	BLK	1	Skylight Washer Pump Motor to Splice 150	SPL
2V	10	BLK	SPL	Splice 80 to Splice 85	SPL
2X	16	BLK	SPL	Splice 90 to Splice 105	SPL
2XX	16	BLK	1	Rear Wiper Motor Ground to Splice 155	SPL
2Y	10	BLK	SPL	Splice 85 to Frame Ground “B”	1
2YY	16	BLK	7	Worklight Switch to Splice 70	SPL
2YYA	16	BLK	1	Cab Ground “D” to Splice 70	SPL
2Z	16	BLK	SPL	Splice 105 to Engine Ground “G”	1
2ZZ	10	BLK	SPL	Splice 155 to Ground Rail “A”	1
3	8	RED	1	12V Battery Positive to FP A Connector	1
3A	8	RED	A	E 800 Connector to Ignition Circuit Breaker	1
4	16	GRN	6	Transmission Switch Connector to Splice 15	SPL
4A	16	GRN	SPL	Splice 15 to Transmission Control Logic Connector	C
4AC	16	GRN	F	“Y4” Solenoid to Splice 350	SPL
4B	16	GRN	SPL	Splice 15 to Bulkhead “A1” Connector	A1
4C	16	GRN	A1	Bulkhead “A1” Connector to Splice 350	SPL
5	10	YEL	SPL	Splice 115 to Splice 110	SPL
5A	16	YEL	SPL	Splice 115 to Accessory Power Connector	1
5B	10	YEL	SPL	Splice 110 to Accessory Power	M1
6	16	PNK	3	Transmission Switch Connector to Splice 25	SPL

Wire No.	Gauge	Color	Pin	From Function To	Pin
6A	16	PNK	SPL	Splice 25 to Transmission Control Dash Panel Logic Connector	E
6B	16	DK GRN/WHT	1	Reverse Signal Relay Connector to Splice 25	SPL
6C	16	DK GRN/WHT	85	Reverse Signal Relay to Reverse Signal Relay Connector	3
7	16	ORN	A4	Bulkhead “A4” Connector to Splice 600	SPL
7A	16	ORN	F	Trans. Control Reverse Dash Panel Logic Connector to Bulkhead “A4” Connector	A4
7AA	16	ORN	E	“Y2” Solenoid to Splice 600	SPL
8	16	LT BLU/DK BLU	A5	Bulkhead “A5” Connector to Splice 650	SPL
8A	16	LT BLU/DK BLU	E	Trans. Control Forward Dash Panel Logic Connector to Bulkhead “A5” Connector	A5
8AA	16	LT BLU/DK BLU	SPL	Splice 650 to “Y1” Solenoid	D
9	14	YEL	6	Parking Brake Switch to Neutral Engage Relay Block	30
10	16	PNK/GRN	SPL	Splice 175 to 6 Amp 600V Diode/Board	A
11	16	PUR/WHT	A	Oil Pressure Switch Connector to “11A” Connector	C
11A	16	PUR/WHT	C	Oil Pressure Switch Connector to Oil Pressure Dash Panel Logic Connector	C
12	16	RED/BLU	A	Water Temp. Logic Connector to Water Temp. Switch Connector	A
12A	16	RED/BLU	D	Water Temp. Dash Panel Logic Connector to Water Temp. Switch Connector	A
14	16	WHT/RED	C4	Bulkhead “C4” Connector to Hydraulic Oil Temp. Switch Connector	A
14A	16	WHT/RED	A	Hyd. Oil Temp. Logic Dash Panel Connector to Bulkhead “C4” Connector	C4
15	14	DK GRN	SPL	Splice 120 to Parking Brake Switch Connector	5
16	16	WHT/ORN	E1	5 Amp Parking Brake Fuse to Parking Brake Switch Connector	2
17	16	PNK/WHT	5	Steer Select Switch to 5 Amp Steer Select Fuse	J1
18	16	GRY/GRN	3	Steer Select Switch to Splice 50	SPL
18A	16	GRY/GRN	SPL	Splice 50 to Steer Select Dash Panel Logic Connector	G
18B	16	GRY/GRN	B1	Bulkhead “B1” Connector to Splice 50	SPL
18C	16	GRY/GRN	B1	Bulkhead “B1” Connector to “Crab” Steer Select Solenoid Connector	A
19	16	YEL/BLK	6	Steer Select Switch to Splice 55	SPL
19A	16	YEL/BLK	SPL	Splice 55 to Steer Select Dash Panel Logic Connector	F
19B	16	YEL/BLK	B2	Bulkhead “B2” Male Connector to Splice 55	SPL
19C	16	YEL/BLK	A	“Four Wheel” Steer Select Solenoid Connector to Bulkhead “B2” Connector	B2
20	14	WHT	A1	5 Amp Transmission Gear Select Fuse to Transmission Switch Connector	9
23	16	DK GRN/WHT	D	10V 1 Watt Diode/Board to Alternator “R” Terminal	R
23A	16	DK GRN/WHT	G	Alternator Indicator Logic Connector to Connector	D
24	16	BRN/WHT	1	Cab Power Connector to Cab Power Relay Block “85”	85
24A	16	BLK	85	Cab Power Relay Block “85” to Window Power Relay Block “85”	85
25	16	WHT/ORN	85	Lights Power Relay “85” to Lights Power Connector	1
26	14	ORN/RED	1	24V Battery Positive to 25 Amp Lights Fuse “A”	D
27	16	BRN/GRN	A	Fuel Level Sender Connector to Fuel Gauge Dash Panel Logic Connector	A
28	16	YEL/GRN	1	Hourmeter Positive to 2 Amp Hourmeter Fuse	A2
29	16	DK BLU/ORN	1	Parking Brake Switch to Parking Brake Dash Panel Logic Connector	H
30	16	GRY/ORN	B	Oil Pressure Switch Connector to “30A” Wire Connector	B
30A	16	GRY/ORN	B	“30A” Wire Connector to Hourmeter Negative Connector	1
31	16	YEL/ORN	C3	Bulkhead “C3” Connector to Air Filter Pressure Switch Positive Connector	1
31A	16	YEL/ORN	C	Air Filter Pressure Dash Panel Logic Connector to Bulkhead “C3” Connector	C3
32	16	TAN	A	Transmission Temperature Switch Connector to Bulkhead “C5” Connector	C5
32A	16	TAN	C5	Bulkhead “C5” Connector to Transmission Temp. Dash Panel Logic Connector	E
33	14	WHT	B	Fuel Shutoff Solenoid Connector to Fuel Shutoff Signal	1
34	16	YEL/PUR	A	Hydraulic Oil Pressure Switch Connector to Bulkhead “C2” Connector	C2
34A	16	YEL/PUR	C2	Bulkhead “C2” Connector to Hyd. Oil Filter Dash Panel Logic Connector	B

Wire No.	Gauge	Color	Pin	From Function To	Pin
35	16	RED/GRN	SPL	Splice 175 to Fuel Shutoff Relay	30
35A	16	RED/GRN	A	Fuel Shutoff Solenoid Connector to Splice 175	SPL
36	16	ORN/GRN	A	Hoist Solenoid Conn. to Hydraulic Joystick “Lift” Dash Panel Logic Connector	E
37	16	WHT/RED	A	Extend Solenoid Conn. to Hydraulic Joystick “Extend” Dash Panel Logic Connector	G
38	16	LT BLU/WHT	A	Frame Sway Solenoid Connector to Splice 95	SPL
38A	16	LT BLU/WHT	SPL	Splice 95 to Hydraulic Joystick Frame Sway Dash Panel Logic Connector	C
38B	16	LT BLU/WHT	SPL	Splice 95 to Frame Sway Dash Panel Logic Connector	E
39	16	DK GRN/RED	A	Attachment Tilt “X” Solenoid Connector to Hydraulic Joystick Attachment Tilt “Up” Dash Panel Logic Connector	F
40	16	RED/YEL	A	Attachment Tilt “Y” Solenoid Connector to Hydraulic Joystick Attachment Tilt “Down” Dash Panel Logic Connector	D
42	16	BRN/GRN	B3	Bulkhead “B3” Connector to Parking Brake Dash Panel Logic Connector	F
42A	16	BRN/GRN	SPL	Splice 40 to Bulkhead “B3” Connector	B3
42B	16	BRN/GRN	SPL	Splice 40 to Parking Brake “A” Solenoid Connector	A
42C	16	BRN/GRN	SPL	Splice 40 to Parking Brake “B” Solenoid Connector	A
43	14	GRY/BRN	A	Dash Panel Logic “Power” Connector to 7.5 Amp Logic Panel Fuse	E2
44	14	BRN	1	24V Battery Positive to 25 Amp Lights Fuse “B”	B
46	14	PNK/BLU	SPL	Splice 120 to Engine Preheat Switch Positive	1
46B	14	PNK/BLU	E	Wire Connector to Engine Preheat Switch Negative	1
46C	14	PNK/BLU	A	Ether Injector Connector to Wire Connector	E
46D	14	PNK/BLU	A	Thermostat Connector to Ether Injector Connector	B
47	16	YEL	2	Trans. Switch Connector to Trans. Control Dash Panel Logic Connector	G
48	16	TAN/PUR	87	Light Power Relay to Splice 180	SPL
48A	16	PUR/WHT	1	Hazard Switch to Splice 285	SPL
48B	16	RED/PNK	30	Hi-Beam Power Relay to Splice 165	SPL
48C	16	LT BLU/ORN	30	Worklight Power Relay to Splice 165	SPL
48D	16	LT BLU/PUR	30	Brake Light Relay to Splice 180	SPL
48E	16	BRN/YEL	SPL	Splice 185 to Blackout Light Switch	2
49	16	LT GRN/WHT	1	Horn Connector to 7.5 Amp Horn Fuse	F
50	16	RED/BLU	1	Horn Power to Audible Horn Switch	1
51	12	DK BLU/WHT	A	Dash Panel Power Connector to 15 Amp Dash Panel Fuse	C2
52	10	YEL	SPL	Splice 115 to 30 Amp Main Fuse	A4
53	10	DK GRN	SPL	Splice 120 to 15 Amp Ignition Preheat Fuse	A3
54	14	BLU	85	Engine Start Relay to Bulkhead “B4” Connector	B4
54A	14	BLU	B4	Bulkhead “B4” Connector to Neutral Engage Relay	87
55	8	RED	B	Keyless Ignition Switch to Ignition Circuit Breaker	2
56	16	TAN/GRN	A	Service Brake Switch Connector to 2 Amp Service Brake Fuse	G1
57	16	PUR/RED	SPL	Splice 140 to Service Brake Switch Connector	B
57A	16	PUR/RED	F	Service Brake Logic Connector to Splice 140	SPL
57B	16	PUR/RED	SPL	Splice 140 to Stop Connector	A
57C	16	PUR/RED	85	Brake Light Relay to Stop Connector	A
58	10	BLU	B3	15 Amp Ignition Preheat Fuse to Keyless Ignition Switch	S
59	16	GRY	4	Transmission Switch Neutral Connector to Splice 45	SPL
59A	16	GRY	F	Operator Reminders Dash Panel Logic Connector to Splice 45	SPL
59B	16	GRY	85	Neutral Engage Relay Block “85” to Splice 45	SPL
60	16	LT BLU/YEL	C	Dome Light to Hazard Switch	3
62	16	ORN/PUR	A	Stabil-TRAK “3” Solenoid Connector to Stabil-TRAK Dash Panel Logic Connector	D

Wire No.	Gauge	Color	Pin	From Function To	Pin
63	16	LT GRN/WHT	SPL	Splice 30 to Stabil-TRAK “4B” Solenoid Connector	A
63A	16	LT GRN/WHT	E	Float Mode Output Dash Panel Logic Connector to Splice 30	SPL
63B	16	LT GRN/WHT	SPL	Splice 30 to Stabil-TRAK “4A” Solenoid Connector	A
64	16	DK BLU/WHT	B	Boom Switch Connector to Boom Angle Dash Panel Logic Connector	B
65	16	ORN/BLU	A	Boom Angle Dash Panel Logic Connector to Boom Switch Connector	A
66	16	GRY/PUR	SPL	Splice 35 to Stabil-TRAK “2B” Solenoid Connector	A
66A	16	GRY/PUR	C	Free Pivot Output Dash Panel Logic Connector to Splice 35	SPL
66B	16	GRY/PUR	SPL	Splice 35 to Stabil-TRAK “2A” Solenoid Connector	A
67	2	RED	A	24V Battery Equalizer to 24V Battery Positive	1
68	16	WHT	A	Low Brake Pressure Switch Connector to Low Brake Pressure Light	1
68A	10	BLU	30	Lights Power Relay to Splice 185	SPL
68B	16	LT BLU/YEL	3	Hazard Switch to Splice 170	SPL
68C	14	DK GRN/WHT	SPL	Splice 165 to 25 Amp Lights Fuse “B”	A
68D	14	GRY	SPL	Splice 185 to 25 Amp Lights Fuse “A”	C
69	16	RED	C4	2 Amp Low Brake Pressure Fuse to Low Brake Pressure Switch Connector	B
70	16	BLK	2	Low Brake Pressure Buzzer to Low Brake Pressure Light	2
71	16	YEL	1	Low Brake Pressure Buzzer to Low Brake Pressure Light	1
72	16	GRN/WHT	2	Hazard Switch to Flasher Module	A
73	16	PUR	8	Transmission Switch Connector to Splice 5	SPL
73A	16	PUR	SPL	Splice 5 to Transmission Control Dash Panel Logic Connector	D
73B	16	PUR	SPL	Splice 5 to Bulkhead “A3” Connector	A3
73C	16	PUR	A3	Bulkhead “A3” Connector to Splice 450	SPL
73CA	16	PUR	SPL	Splice 450 to “Y6” Solenoid	D
74	16	BLU	7	Transmission Switch Connector to Splice 10	SPL
74A	16	BLU	SPL	Splice 10 to Transmission Control Dash Panel Logic Connector	B
74B	16	BLU	SPL	Splice 10 to Bulkhead “C1” Connector	C1
74C	16	BLU	C1	Bulkhead “C1” Connector to Splice 550	SPL
74CA	16	BLU	F	“Y3” Solenoid to Splice 550	SPL
75	16	BRN	5	Transmission Switch Connector to Splice 20	SPL
75A	16	BRN	SPL	Splice 20 to Transmission Control Dash Panel Logic Connector	A
75B	16	BRN	SPL	Splice 20 to Bulkhead “A2” Connector	A2
75C	16	BRN	A2	Bulkhead “A2” Connector to Splice 400	SPL
75CA	16	BRN	E	“Y5” Solenoid to Splice 400	SPL
76	16	YEL/BLU	B	Flasher Module Connector to Splice 190	SPL
76A	16	YEL	F	Lights Power Switch to Splice 190	SPL
76B	16	YEL/RED	5	Hazard Switch to Splice 190	SPL
77	4	RED	1	12V Battery Positive to 12V Battery Equalizer	A
78	16	BLU/GRY	17	Hazard Switch to Splice 195	SPL
78A	16	GRN/BLK	D	Lights Power Switch to Splice 195	SPL
78B	16	GRN/ORN	B	Rear Right Composite Light to Splice 195	SPL
78C	16	ORN/PUR	1	Front Right Composite Light Turn Indicator to Splice 195	SPL
79	16	GRN/WHT	B	6 Amp Hazard Diode/Board to Splice 205	SPL
79A	16	GRY	E	Lights Power Switch to Splice 205	SPL
79B	16	GRN/YEL	B	Rear Left Composite Light to Splice 205	SPL
79C	16	ORN/RED	1	Front Left Composite Light Turn Indicator to Splice 205	SPL
81	6	BLK	1	Equalizer Ground to Battery Ground	1
82	16	RED/BLK	1	Transmission Switch Neutral Connector to 5 Amp Transmission Select Fuse	C1

Wire No.	Gauge	Color	Pin	From Function To	Pin
83	10	BLU	87	Engine Start Relay to Starter Signal	1
84	16	WHT/BRN	A	Skylight Wiper Motor to Skylight Wiper/Washer Switch	1
85	10	GRY/BRN	1	Engine Start Power to Engine Start Relay	30
86	14	WHT	3	Worklight Switch to Boom Worklight Connector	A
88	16	PUR/BLU	SPL	Splice 110 to Bulkhead “B5” Connector	B5
88A	16	PUR/BLU	85	Fuel Shut Off Relay to Bulkhead “B5” Connector	B5
89	16	TAN	1	Starter Positive to 5 Amp Fuel Shut Off Fuse	B
90	16	YEL/RED	A	5 Amp Fuel Shut Off Fuse to Fuel Shut Off Relay	87
93	10	RED	B4	30 Amp Main Fuse to Keyless Ignition Switch	R
100	16	YEL/PNK	1	Left Fork Side Shift Switch to Left Fork Left Solenoid Connector	C
100A	16	YEL/PNK	C	Left Fork Left Solenoid Connector to Left Fork Left Solenoid	2
101	16	GRN/YEL	3	Left Fork Side Shift Switch to Left Fork Right Solenoid Connector	A
101A	16	GRN/YEL	A	Left Fork Right Solenoid Connector to Left Fork Right Solenoid	2
102	16	LT GRN	5	Steering Select Switch “5” to Steering Switch Select Switch “8”	8
103	16	WHT/TAN	C	Lights Power Switch Connector to Hi-Beam Power Relay	87
104	16	BLU	B	Lights Power Switch Connector to Splice 215	SPL
104A	16	PUR/YEL	85	Hi-Beam Power Relay to Splice 215	SPL
104B	16	RED/BLU	SPL	Splice 215 to Right Headlight Connector (Low Beam)	A
104C	16	RED/GRY	SPL	Splice 215 to Left Headlight Connector (Low Beam)	A
105	16	GRN	A	Lights Power Switch Connector to Splice 220	SPL
105A	16	WHT/BLU	SPL	Splice 220 to Rear Right Composite Light Lamp	C
105B	16	WHT/GRN	SPL	Splice 220 to Rear Left Composite Light Lamp	C
105C	16	WHT/BRN	SPL	Splice 220 to Front Right Composite Light Lamp	1
105D	16	WHT/RED	SPL	Splice 220 to Front Left Composite Light Lamp	1
106	16	PUR	B	Lights Power Switch Connector to Splice 225	SPL
106A	16	BLU/BLK	SPL	Splice 225 to Right Headlight Connector (High Beam)	B
106B	16	BLU/BLK	SPL	Splice 225 to Left Headlight Connector (High Beam)	B
107	16	WHT/ORN	18	Hazard Switch to 6 Amp Hazard Diode/Board	A
108	16	WHT/BRN	1	Right Fork Side Shift Switch to Right Fork Left Solenoid Connector	C
108A	16	WHT/BRN	C	Right Fork Left Solenoid Connector to Right Fork Left Solenoid	2
110	16	LT GRN	A	Lights Power Switch Connector to Splice 225	SPL
112	16	GRY/BLU	4	Blackout Switch to Splice 230	SPL
112A	16	GRY/ORN	SPL	Splice 230 To Rear Right Composite Light Stop Lamp	A
112B	16	GRY/BRN	SPL	Splice 230 To Rear Left Composite Light Stop Lamp	A
113	16	ORN/GRY	6	Worklight Switch to Splice 235	SPL
113A	16	ORN/YEL	SPL	Splice 235 to Rear Left Worklight	A
113B	16	ORN/GRN	SPL	Splice 235 to Rear Right Worklight	A
114	16	LT BLU/BRN	B	Light Package Logic Connector to 750 Ohm 1/2 Watt Right Turn Signal Resistor/Board	D
115	16	PNK/PUR	3	Right Fork Side Shift Switch to Right Fork Right Solenoid Connector	A
115A	16	PNK/PUR	A	Right Fork Right Solenoid Connector to Right Fork Right Solenoid	2
118	16	GRY/WHT	8	Left Fork Side Shift Switch “8” to Left Fork Side Shift Switch “2”	2
120	16	TAN/PUR	J4	7.5 Amp Right Fork Switch Fuse to Right Fork Side Shift Switch	2
121	16	YEL/BRN	B	750 Ohm 1/2 Watt Left Turn Signal Resistor/Board to Light Package Logic Connector	A
122	16	PNK/ORN	F	750 Ohm 1/2 Watt Hazard Resistor/Board to Lights Package Logic Connector	C
124	10	DK BLU/GRY	1	12V Battery Positive to 30 Amp Power Window Fuse	E3

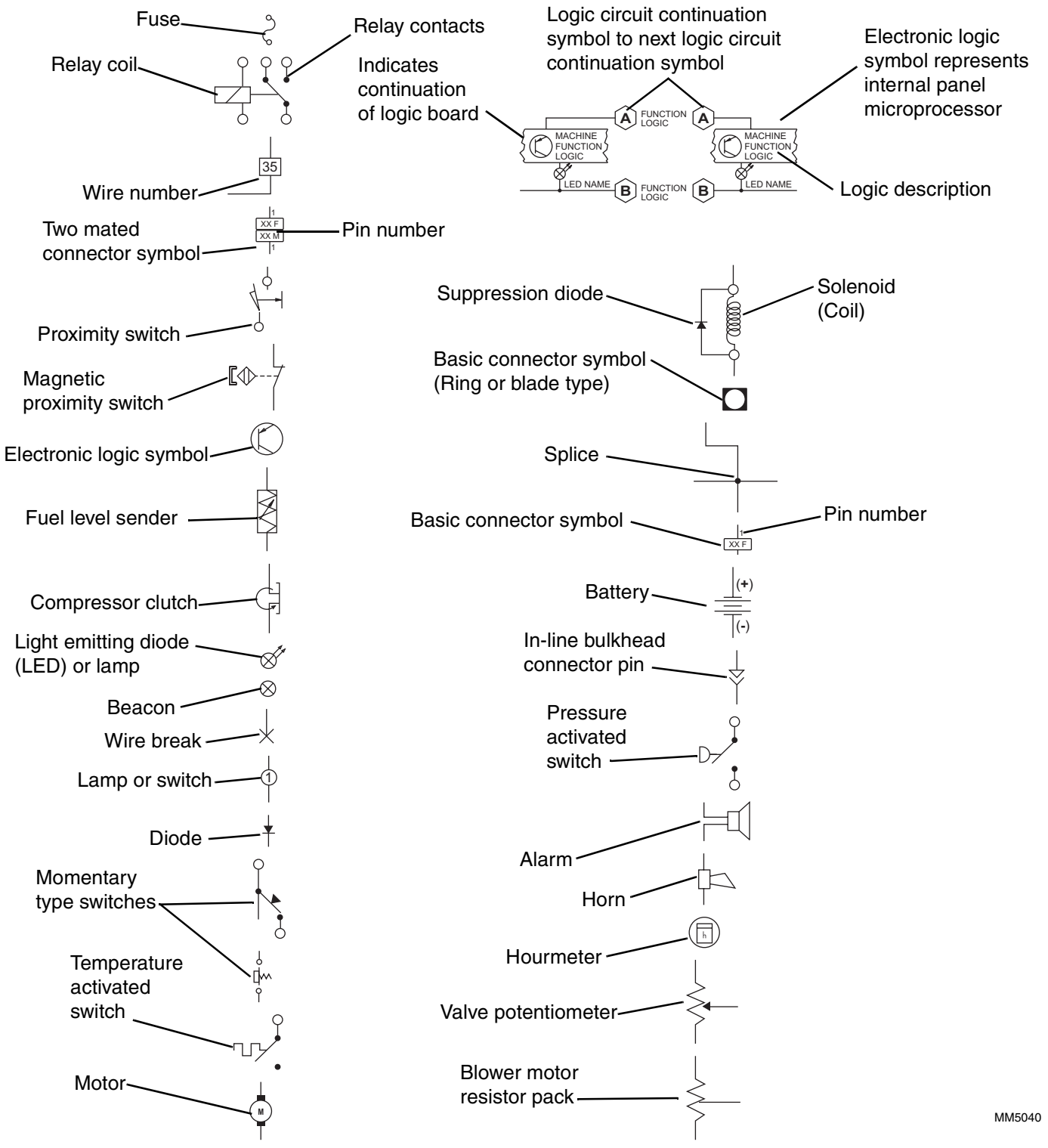
Wire No.	Gauge	Color	Pin	From Function To	Pin
132	16	RED/PNK	G4	7.5 Amp Left Fork Switch Fuse to Left Fork Side Shift Switch	2
133	16	ORN/GRN	D	Light Package Logic Connector to 820 Ohm 1/2 Watt Hi-Beam Resistor/Board	D
134	16	RED/GRY	E4	3 Amp Load Moment Indicator Fuse to Load Moment Indicator Display	3
136	10	LT GRN/RED	30	Cab Power Relay to 12V Battery Positive	1
137	16	LT BLU/ORN	A	Hydraulic Joystick Dash Panel Logic Connector to Attachment Tilt Mode Switch	2
138	16	GRN/BLU	3	Attachment Tilt Mode Switch to Splice 60	SPL
138A	16	GRN/BLU	SPL	Splice 60 to Hydraulic Joystick Dash Panel Logic Connector	B
138B	16	LT GRN/YEL	SPL	Splice 60 to Attachment Tilt Dash Panel Logic Connector	H
139	16	ORN/GRY	8	Attachment Tilt Mode Switch “8” to Attachment Tilt Mode Switch “2”	2
140	16	RED/WHT	C	Lights Power Switch Connector to Splice 280	SPL
141	10	RED/BLU	87	Cab Power Relay to Fuse Bar Power	4
142	12	YEL/GRN	N3	25 Amp Cab Heater Fuse to Splice 125	SPL
142A	12	YEL/GRN	SPL	Splice 125 to Cab Heater Blower Switch	B
142B	16	YEL/GRN	SPL	Splice 125 to Cab Heater Valve Connector	A
143	16	ORN/YEL	5	Front Wiper/Washer Switch to 7.5 Amp Front Wiper/Washer Fuse	G3
144	16	PNK	8	Front Wiper/Washer Switch “8” to Splice 210	SPL
145	16	LT BLU/WHT	P	Front Wiper Motor to Front Wiper/Washer Switch	1
146	16	TAN/RED	L	Front Wiper Motor to Front Wiper/Washer Switch	3
147	16	ANY	2	Skylight Wiper/Washer Switch “2” to Skylight Wiper/Washer Switch “5”	5
148	16	PNK/PUR	8	Skylight Wiper/Washer Switch “8” to Splice 210	SPL
149	16	YEL/ORN	5	Skylight Wiper/Washer Switch to 7.5 Amp Skylight Wiper/Washer Switch Fuse	J3
150	16	ORN/YEL	SPL	Splice 210 to Switch Light Fuse Connector	1
150A	14	PNK	1	Switch Lamp Connector to 2 Amp Fuse	L2
150B	16	ANY	2	Front Wiper Washer Switch to Front Wiper Washer Switch	5
151	16	PUR/YEL	C	Skylight Wiper Motor to Skylight Wiper/Washer Switch	3
152	16	DK BLU/WHT	6	Skylight Wiper/Washer Switch to Skylight Washer Pump Motor	1
153	16	GRN/YEL	A	Rear Wiper Motor to 7.5 Amp Rear Wiper Fuse	L3
154	16	LT GRN/BLU	6	Front Wiper/Washer Switch to Front Washer Pump Motor	1
156	14	YEL	L	Cab Heater Blower Switch to Cab Heater Blower Resistor Connector	C
157	14	RED	M	Cab Heater Blower Switch to Cab Heater Blower Resistor Connector	B
158	14	ORN	H	Cab Heater Blower Switch to Cab Heater Blower Resistor Connector	A
159	16	BLU	2	Air Conditioning Switch to Thermostat Connector	F
160	16	WHT	1	High/Low Pressure Switch “IN” to Thermostat Connector	E
161	16	BLU	A	Cab Heater Valve Potentiometer Connector to Cab Heater Module Connector	A
162	16	WHT	B	Cab Heater Valve Potentiometer Connector to Cab Heater Module Connector	B
163	16	BRN	C	Cab Heater Valve Potentiometer Connector to Cab Heater Module Connector	C
164	10	LT GRN/PUR	87	Window Power Relay to Door Window Switch Connector	A
165	16	LT GRN/ORN	2	High/Low Pressure Switch “OUT” to Compressor Clutch Connector	1
166	16	YEL/BLK	4	Load Moment Indicator Display to Axle Strain Transducer Connector	2
167	16	GRN/PNK	1	Blackout Switch to Splice 170	SPL
168	16	GRN/ORN	1	Axle Strain Transducer Connector to Load Moment Indicator Display	2
169	16	ORN/WHT	85	Worklight Power Relay to Splice 280	SPL
171	16	ORN/BRN	87A	Brake Light Relay to Blackout Switch	5
172	14	PNK	87	Worklight Power Relay to Splice 285	SPL
172A	16	LT GRN/ORN	2	Worklight Switch to Splice 285	SPL
172B	16	BLU/WHT	5	Worklight Switch to Splice 285	SPL
172C	16	TAN/PUR	E	7.5 Amp Horn Fuse to Splice 285	SPL

Wire No.	Gauge	Color	Pin	From Function To	Pin
172D	16	BRN/RED	30	Reverse Signal Relay to Splice 285	SPL
177	16	GRN/PNK	87	Normal Lights Ignition Relay to Splice 280	SPL
178	16	GRN/PNK	SPL	Splice 170 to Normal Light Ignition Relay	30
179	16	WHT/BLK	2	Blackout Marker Drive Switch to Blackout Ignition Relay	87
180	16	YEL/WHT	87	Reverse Signal Relay to Back-Up Alarm Connector	1
181	16	TAN/YEL	8	Hazard Switch to Splice 180	SPL
182	10	ORN	F3	30 Amp Window Motor Fuse to Window Power Relay	30
184	16	YEL/BRN	SPL	Splice 205 to 750 Ohm 1/2 Watt Left Turn Signal Resistor/Board	A
185	16	YEL/PNK	8	Worklight Switch to Splice 180	SPL
186	16	PNK/GRN	8	Blackout Switch to Splice 180	SPL
187	16	BRN/GRN	8	Blackout Marker Drive Switch to Splice 180	SPL
188	16	WHT/BLK	3	Blackout Switch to Blackout Ignition Relay	30
189	16	LT BLU/BRN	C	750 Ohm 1/2 Watt Right Turn Signal Resistor/Board to Splice 195	SPL
190	16	PNK/ORN	18	Hazard Switch to 750 Ohm 1/2 Watt Hazard Resistor/Board	E
191	16	LT GRN/PNK	3	Blackout Marker Drive Switch to Blackout Headlight	1
192	16	RED/GRN	4	Blackout Marker Drive Switch to Splice 295	SPL
193	16	ORN/GRN	C	850 Ohm 1/2 Watt Hi-Beam Resistor/Board to Splice 225	SPL
194	16	RED/BLK	SPL	Splice 295 to Blackout Marker Front Left Composite Light Connector	1
195	16	ANY	SPL	Splice 295 to Blackout Marker Front Right Composite Light Connector	1
196	16	ANY	SPL	Splice 295 to Rear Right Blackout Light Marker Lamp Connector	1
197	16	ANY	SPL	Splice 295 to Rear Left Blackout Light Marker Lamp Connector	1
198	16	LT BLU/TAN	6	Blackout Switch to Splice 300	SPL
199	16	LT BLU/WHT	SPL	Splice 300 to Rear Left Blackout Light Stop Lamp Connector	1
200	16	ANY	SPL	Splice 300 to Rear Right Blackout Light Stop Lamp Connector	1
204	16	PNK/GRN	B	6 Amp 600V Diode/Board to Alternator Indicator	I
208	16	ORN/GRN	C	10V 1Watt Diode/Board to Connector	D
212	16	ANY	1	Back Up Alarm Connector to Back Up Alarm	2
213	14	BLK	B	Left Fork Left Solenoid Connector to Left Fork Left Solenoid	1
214	14	BLK	D	Left Fork Right Solenoid Connector to Left Fork Right Solenoid	1
220	14	BLK	B	Right Fork Left Solenoid Connector to Right Fork Left Solenoid	1
221	14	BLK	D	Right Fork Right Solenoid Connector to Right Fork Right Solenoid	1
Battery 12V-24V	2/0	BLK	1	12V Battery Positive to 24V Battery Negative	1
Battery 24V	2/0	RED	1	Starter Positive to 24V Battery Positive	1
Battery Ground	2/0	BLK	1	12V Battery Negative to Starter Ground	1
Battery Negative Slave	1/0	BLK	1	24V Slave Receptacle Ground to Jumper Ground	1
Battery Positive Slave	1/0	RED	1	24V Slave Receptacle Power to Starter Positive	1
Battery Starter	1	BLK	1	Starter Ground to Engine Ground	1
GJ1	18	BLK	7	X1 Connector on “Y6” Solenoid to Splice 500	SPL
GJ4	18	BLK	SPL	Splice 700 to X2 Connector on “Y1” Solenoid	7
GJ10	16	ANY	2	Compressor Clutch to Ground Rail	1
GJ11	16	BLK	86	Cab Power Relay to Window Power Relay	86

Wire No.	Gauge	Color	Pin	From Function To	Pin
GJ14	16	BLK	7	Left Fork Switch to Right Fork Switch	7
GJ17	12	BLK	B	Boom Worklight Connector to Boom Ground Connector	B
GJ20	16	BLK	SPL	Splice 65 to Reverse Signal Relay	86
GJ21	14	BLK	SPL	Splice 160 to Left Fork Right Solenoid Connector	D
GJ21A	14	BLK	B	Left Fork Right Solenoid Connector to Splice 160	SPL
GJ21B	14	BLK	SPL	Splice 160 to Splice 85	SPL
GJ22	14	BLK	SPL	Splice 135 to Right Fork Left Solenoid Connector	B
GJ22A	14	BLK	D	Right Fork Right Solenoid Connector to Splice 135	SPL
GJ22B	14	BLK	SPL	Splice 135 to Splice 85	SPL
GJ25	16	BLU	7	Right Fork Side Shift Switch to Splice 90	SPL
GJ26	16	BLK	86	Blackout Ignition Relay to Lights Power Relay	86
GJ27	16	BLK	86	Hi-Beam Power Relay to Splice 65	SPL
GJ27A	16	BLK	SPL	Splice 65 to Brake Light Relay	86
GJ28	16	BLK	86	Blackout Ignition Relay to Normal Lights Ignition Relay	86
GJ29	16	BLK	86	Normal Lights Ignition Relay to Splice 65	SPL
GJ30	16	BLK	7	Blackout Switch to Blackout Switch	9
GJ31	16	BLK	9	Blackout Switch to Blackout Marker Drive Switch	7
GJ32	16	BLK	7	Blackout Marker Drive Switch to Blackout Marker Drive Switch	9
GJ33	16	BLK	9	Blackout Marker Drive Switch to Worklight Switch	7
GJ34	16	BLK	86	Brake Light Relay to Worklight Power Relay	86
GJ35	16	ANY	E	Worklight Power Diode to Worklight Power Relay	86
GJ36	16	ANY	A	Hi-Beam Power Diode to Hi-Beam Power Relay	86
J1	16	BRN	8	Right Fork Side Shift Switch to Left Fork Side Shift Switch	8
J11	16	ANY	1	Back Up Alarm Connector to Back Up Alarm	1
J19	16	ANY	8	Blackout Marker Drive Switch to Blackout Marker Drive Switch	10
J27	16	ANY	8	Park Brake Switch to Park Brake Switch	2
J60	12	LT BLU	A	Boom Worklight Power Connector to Boom Worklight Connector	A
J67	16	ANY	SPL	Splice 550 to X2 Connector on “Y3” Solenoid	3
J68	16	ANY	SPL	Splice 600 to X2 Connector “Y2” Solenoid	2
J69	16	ANY	SPL	Splice 650 to X2 Connector “Y1” Solenoid	1
J70	16	ANY	SPL	Splice 350 to X1 Connector “Y4” Solenoid	4
J71	16	ANY	SPL	Splice 400 to X1 Connector “Y5” Solenoid	5
J72	16	ANY	SPL	Splice 450 to X1 Connector “Y6” Solenoid	6
J74	16	ANY	2	Steering Select Switch to Steering Select Switch	4
J75	16	ANY	C	Rear Wiper Motor “C” to Rear Wiper Switch “BATT”	1
J76	16	ANY	1	Air Conditioning Switch to Blower Switch	C
J78	14	ORN	A	Cab Heater Blower Resistor Connector to Cab Heater Blower Motor	Power
J82	16	ANY	4	Blackout Marker Drive Switch to Blackout Marker Drive Switch	6
J83	16	ANY	2	Blackout Marker Drive Switch to Blackout Marker Drive Switch	5
J84	16	ANY	5	Blackout Marker Drive Switch to Blackout Switch	10
J85	16	ANY	85	Blackout Ignition Relay to Light Power Relay	85
J86	16	ANY	85	Blackout Ignition Relay to Normal Lights Ignition Relay	85
J87	16	ANY	F	Worklight Power Diode to Worklight Power Relay	85
J88	16	ANY	B	Hi-Beam Power Diode to Hi-Beam Power Relay	85

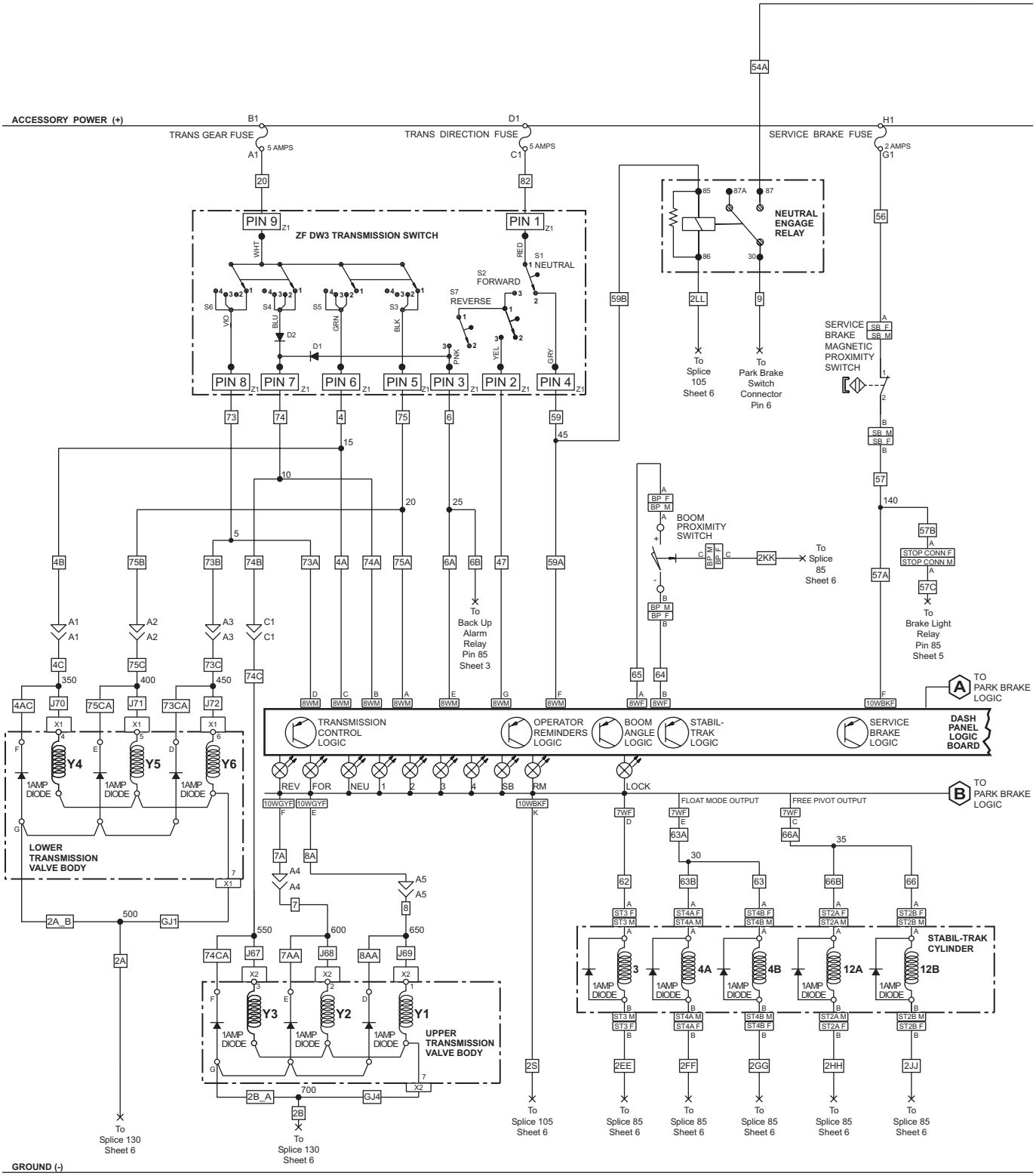
10.7.5 Electrical Symbols Directory

The following directory shows the most common electrical symbols used in the electrical schematics and circuit diagrams in this section.

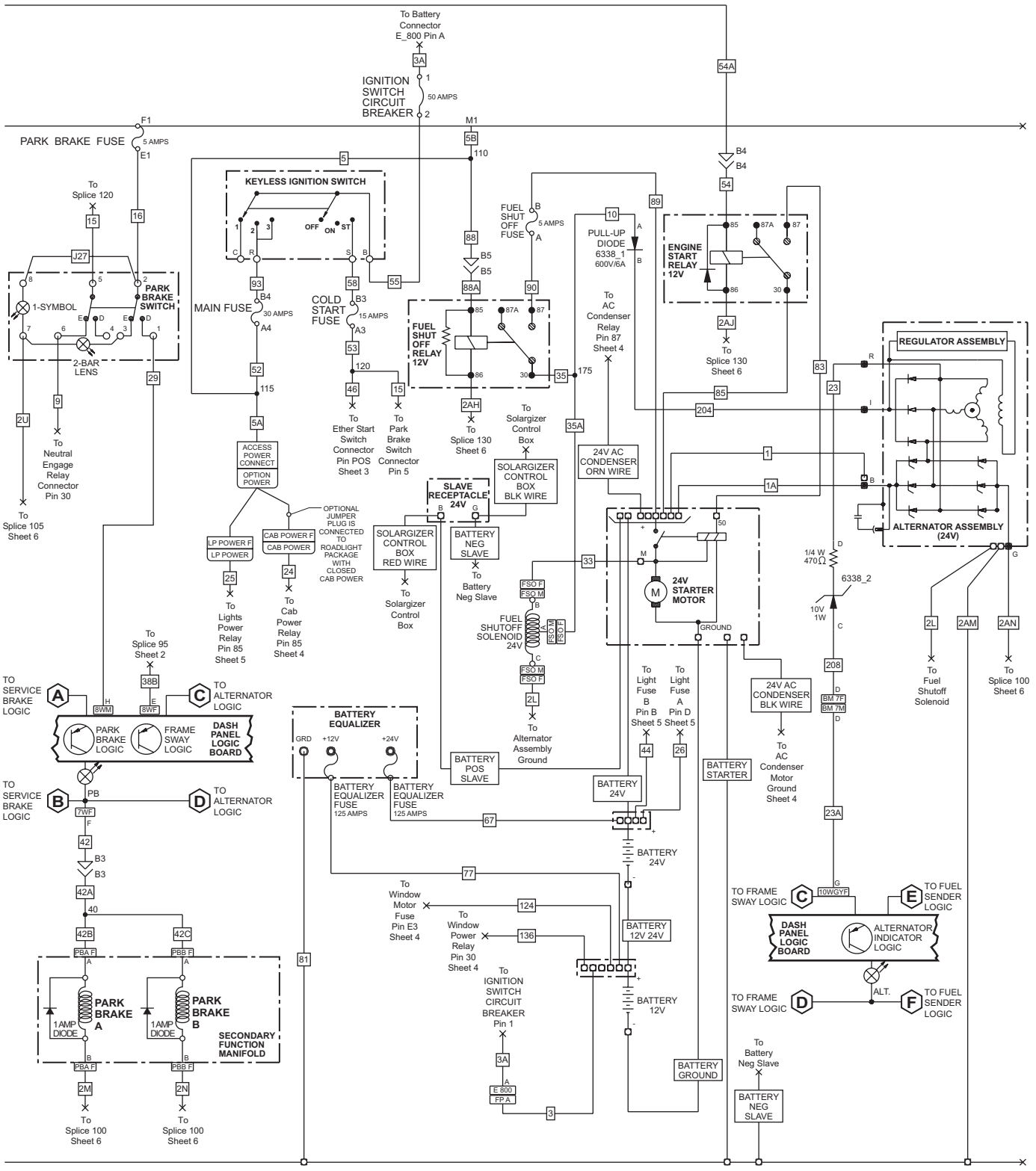


10.7.6 Main Electrical Schematic (Sheet 1 of 6)

Schematic is drawn with the ignition switch in the OFF position.



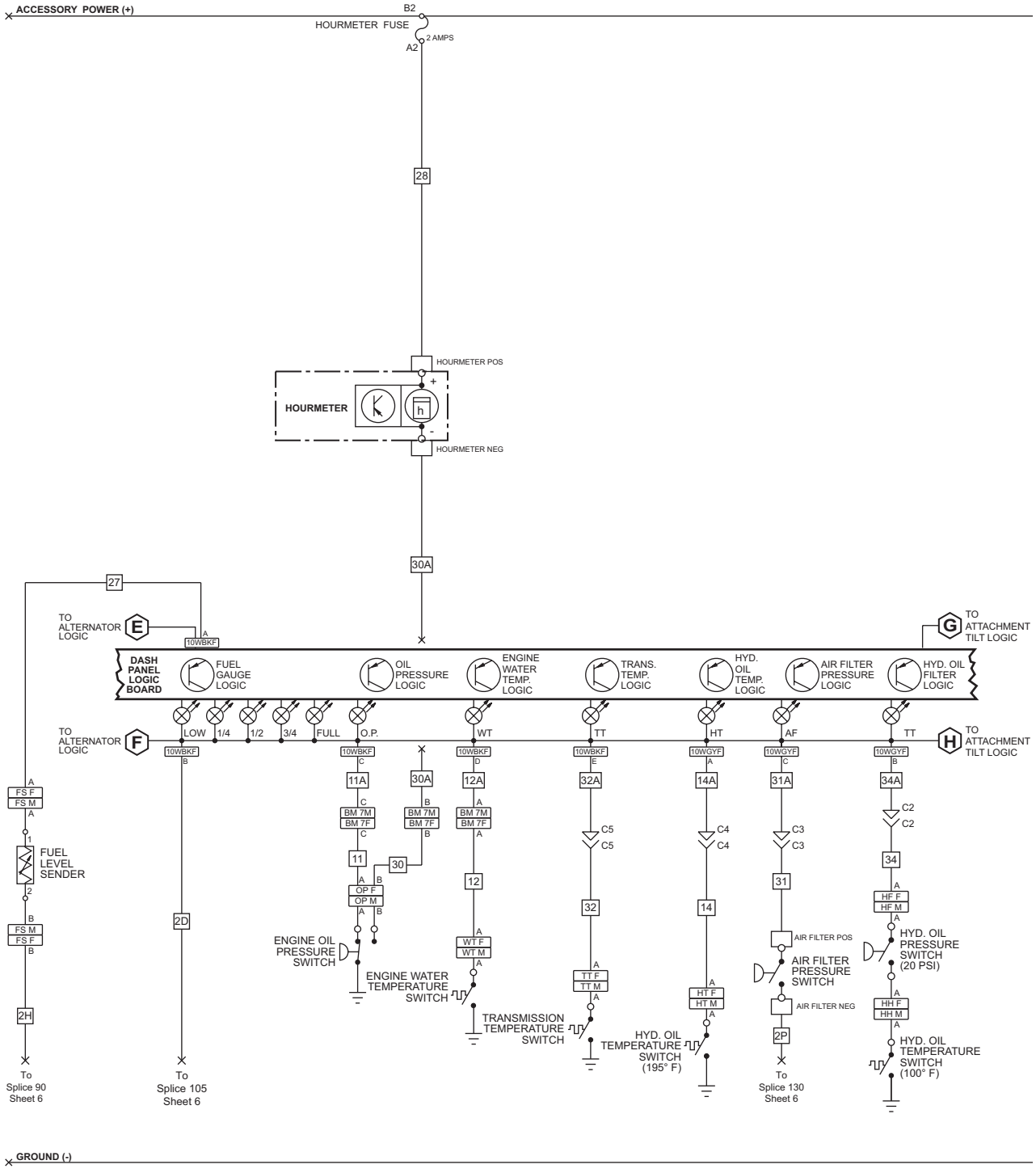
MM21411


To Battery Connector E_800 Pin A
3A
IGNITION SWITCH CIRCUIT BREAKER
50 AMPS
54A
F1
PARK BRAKE FUSE
5 AMPS
E1
M1
5B
110
5
KEYLESS IGNITION SWITCH
OFF ON ST
88
B5
88A
FUEL SHUT OFF FUSE
5 AMPS
PULL-UP DIODE 6338_1 600V/6A
89
10
90
B4
54
ENGINE START RELAY 12V
85 87A 87 86 30
2AJ
To Splice 130 Sheet 6
To Splice 120
15
16
J27
PARK BRAKE SWITCH
1-SYMBOL
2-BAR LENS
29
9
2U
To Neutral Engage Relay Connector Pin 30
To Splice 105 Sheet 6
MAIN FUSE
30 AMPS
93
B4
A4
52
115
5A
COLD START FUSE
15 AMPS
58
B3
A3
53
120
46
15
To Ether Start Switch Connector Pin POS Sheet 3
To Park Brake Switch Connector Pin 5
FUEL SHUT OFF RELAY 12V
85 87A 87 86 30
35
175
2AH
To Splice 130 Sheet 6
To Solargizer Control Box
To AC Condenser Relay Pin 87 Sheet 4
35A
24V AC CONDENSER ORN WIRE
SOLARGIZER CONTROL BOX BLK WIRE
ACCESS POWER CONNECT
OPTION POWER
OPTIONAL JUMPER PLUG IS CONNECTED TO ROADLIGHT PACKAGE WITH CLOSED CAB POWER
LP POWER F
LP POWER
CAB POWER F
CAB POWER
25
24
To Lights Power Relay Pin 85 Sheet 5
To Cab Power Relay Pin 85 Sheet 4
SLAVE RECEPTACLE 24V
B G
SOLARGIZER CONTROL BOX RED WIRE
BATTERY NEG SLAVE
To Battery Neg Slave
To Solargizer Control Box
FSO F
FSO M
FUEL SHUTOFF SOLENOID 24V
2L
To Alternator Assembly Ground
83
85
204
1
1A
23
REGULATOR ASSEMBLY
ALTERNATOR ASSEMBLY (24V)
24V STARTER MOTOR
GROUND
50
M
1/4 W 470Ω
6338_2
10V 1W
208
BM 7F
BM 7M
23A
2L
2AM
2AN
To Fuel Shutoff Solenoid
To Splice 100 Sheet 6
To Splice 95 Sheet 2
38B
TO SERVICE BRAKE LOGIC
A
C
TO ALTERNATOR LOGIC
8WM
8WF
PARK BRAKE LOGIC
FRAME SWAY LOGIC
DASH PANEL LOGIC BOARD
TO SERVICE BRAKE LOGIC
B
PB
7WF
F
D
TO ALTERNATOR LOGIC
42
B3
42A
40
42B
42C
PBA F
PBB F
PARK BRAKE A
PARK BRAKE B
1AMP DIODE
SECONDARY FUNCTION MANIFOLD
2M
2N
To Splice 100 Sheet 6
To Splice 100 Sheet 6
BATTERY EQUALIZER
GRD +12V +24V
BATTERY EQUALIZER FUSE 125 AMPS
BATTERY EQUALIZER FUSE 125 AMPS
BATTERY POS SLAVE
67
81
77
To Window Motor Fuse Pin E3 Sheet 4
124
To Window Power Relay Pin 30 Sheet 4
136
To IGNITION SWITCH CIRCUIT BREAKER Pin 1
3A
E 800 FP A
3
To Light Fuse B Pin B Sheet 5
To Light Fuse A Pin D Sheet 5
44
26
BATTERY 24V
BATTERY 12V 24V
BATTERY 12V
BATTERY GROUND
BATTERY STARTER
24V AC CONDENSER BLK WIRE
To AC Condenser Motor Ground Sheet 4
To Battery Neg Slave
BATTERY NEG SLAVE
TO FRAME SWAY LOGIC
C
10WGYF
E
TO FUEL SENDER LOGIC
DASH PANEL LOGIC BOARD
ALTERNATOR INDICATOR LOGIC
ALT.
TO FRAME SWAY LOGIC
D
F
TO FUEL SENDER LOGIC

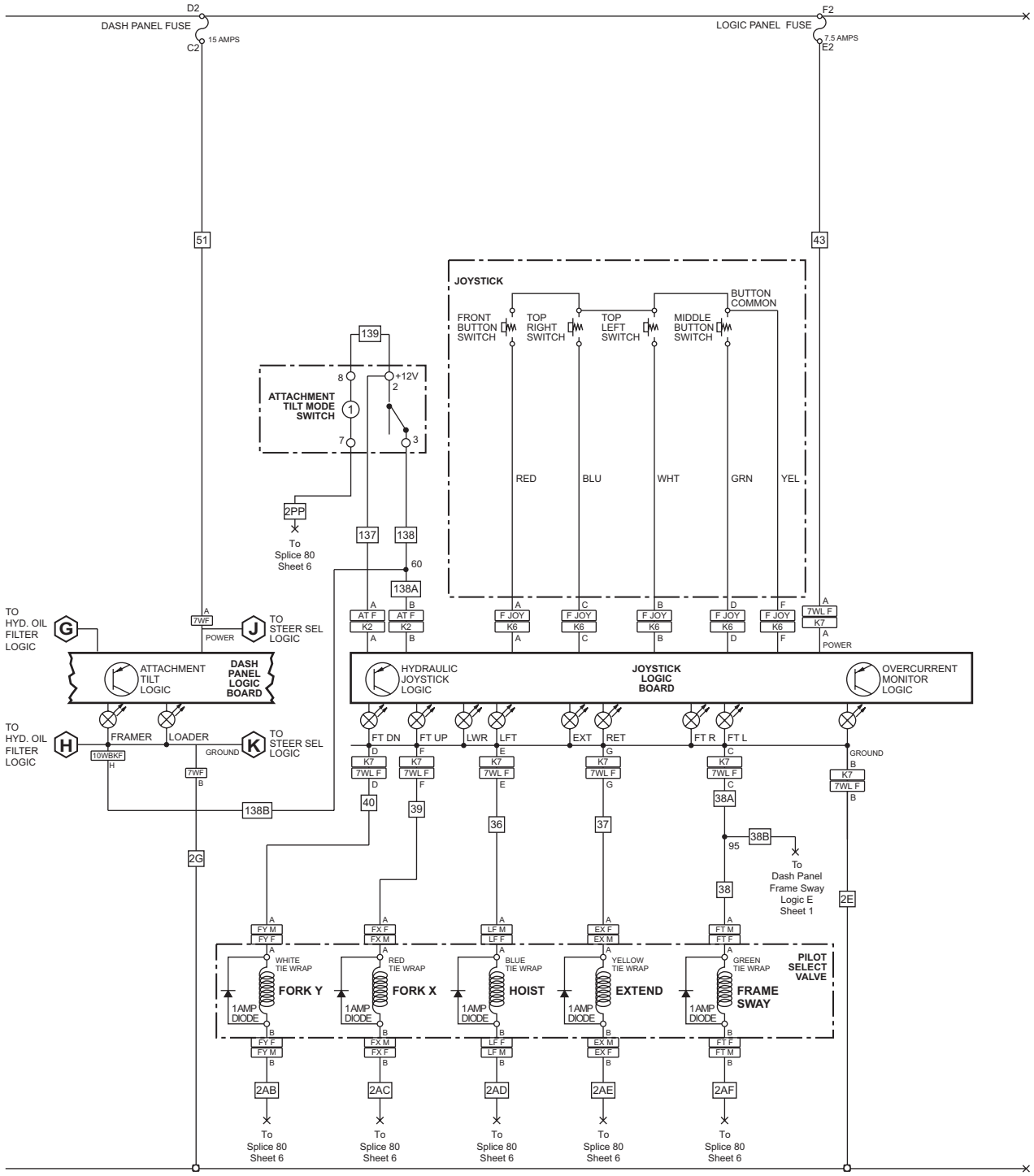
MM21412

10.7.7 Main Electrical Schematic (Sheet 2 of 6)

Schematic is drawn with the ignition switch in the OFF position.



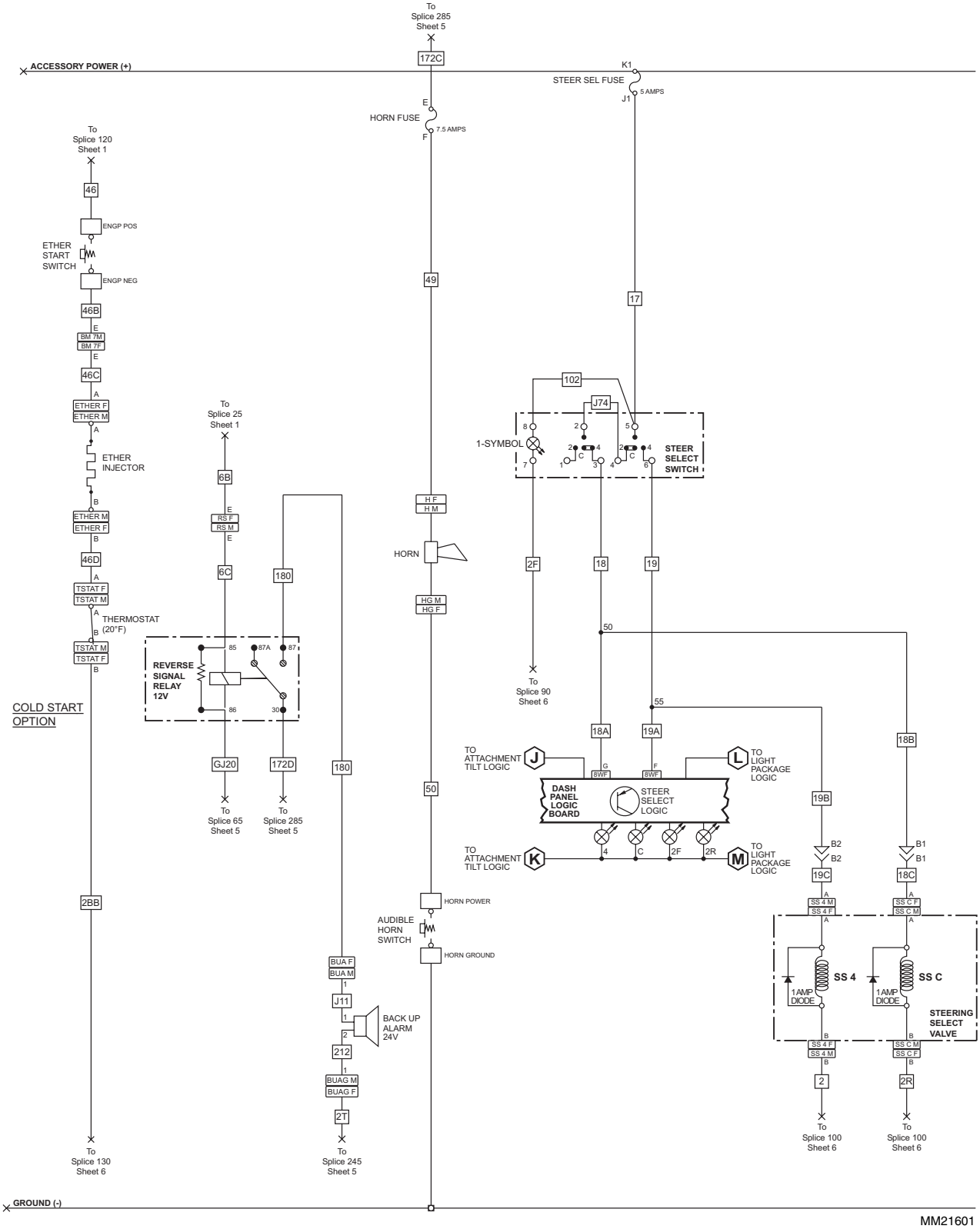
MM21501

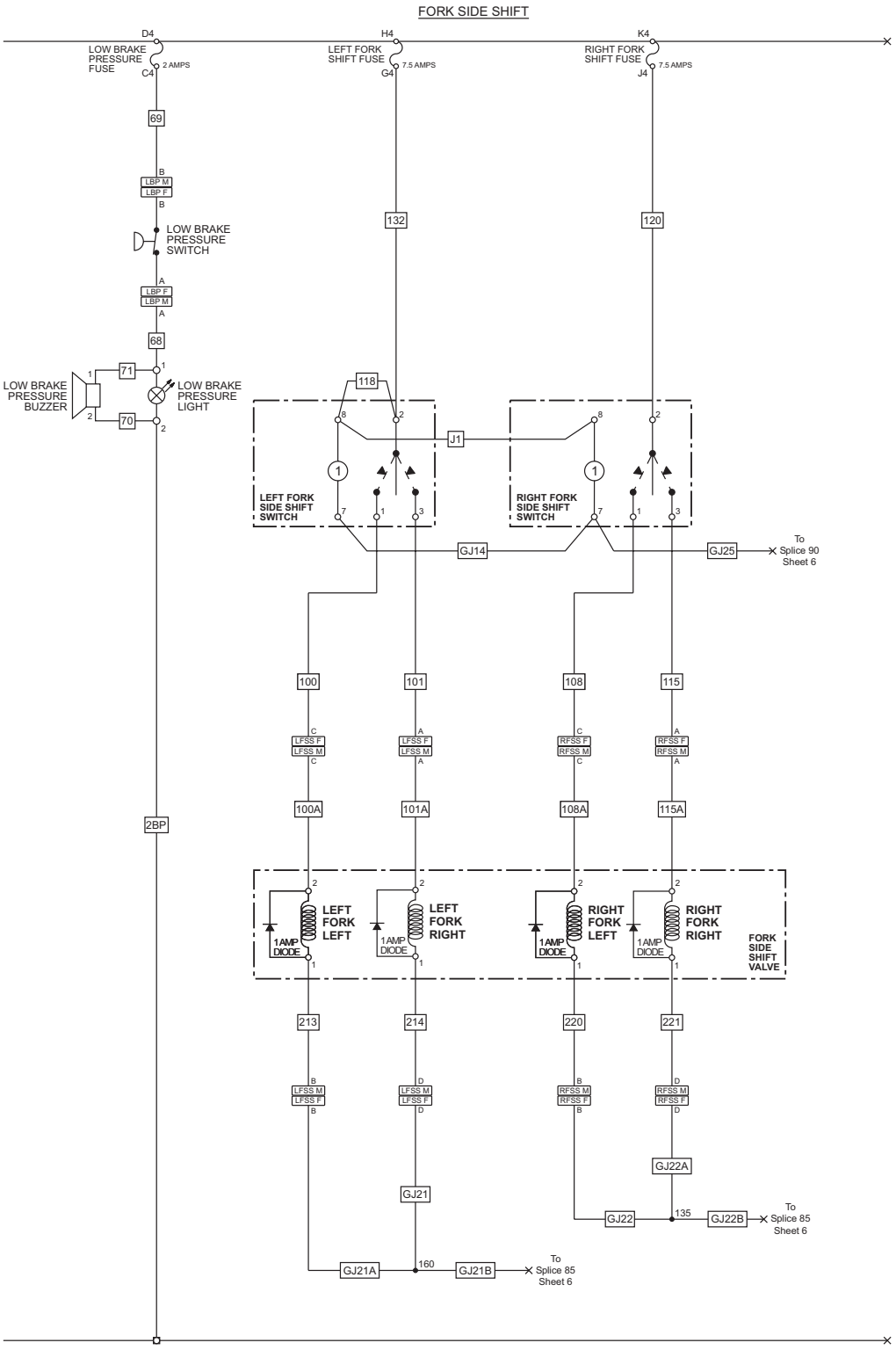

D2
DASH PANEL FUSE
C2
15 AMPS
F2
LOGIC PANEL FUSE
E2
7.5 AMPS
51
43
JOYSTICK
FRONT BUTTON SWITCH
TOP RIGHT SWITCH
TOP LEFT SWITCH
MIDDLE BUTTON SWITCH
BUTTON COMMON
RED
BLU
WHT
GRN
YEL
139
ATTACHMENT TILT MODE SWITCH
8
1
7
+12V
2
3
2PP
To Splice 80 Sheet 6
137
138
60
138A
TO HYD. OIL FILTER LOGIC
G
7WF
POWER
J
TO STEER SEL LOGIC
ATTACHMENT TILT LOGIC
DASH PANEL LOGIC BOARD
HYDRAULIC JOYSTICK LOGIC
JOYSTICK LOGIC BOARD
OVERCURRENT MONITOR LOGIC
FT DN
FT UP
LWR
LFT
EXT
RET
FT R
FT L
GROUND
TO HYD. OIL FILTER LOGIC
H
FRAMER
LOADER
10WBKF
GROUND
K
TO STEER SEL LOGIC
138B
40
39
36
37
38A
95
38B
To Dash Panel Frame Sway Logic E Sheet 1
38
2G
2E
WHITE TIE WRAP
RED TIE WRAP
BLUE TIE WRAP
YELLOW TIE WRAP
GREEN TIE WRAP
FORK Y
FORK X
HOIST
EXTEND
FRAME SWAY
PILOT SELECT VALVE
1 AMP DIODE
2AB
2AC
2AD
2AE
2AF
To Splice 80 Sheet 6

MM21502

10.7.8 Main Electrical Schematic (Sheet 3 of 6)

Schematic is drawn with the ignition switch in the OFF position.

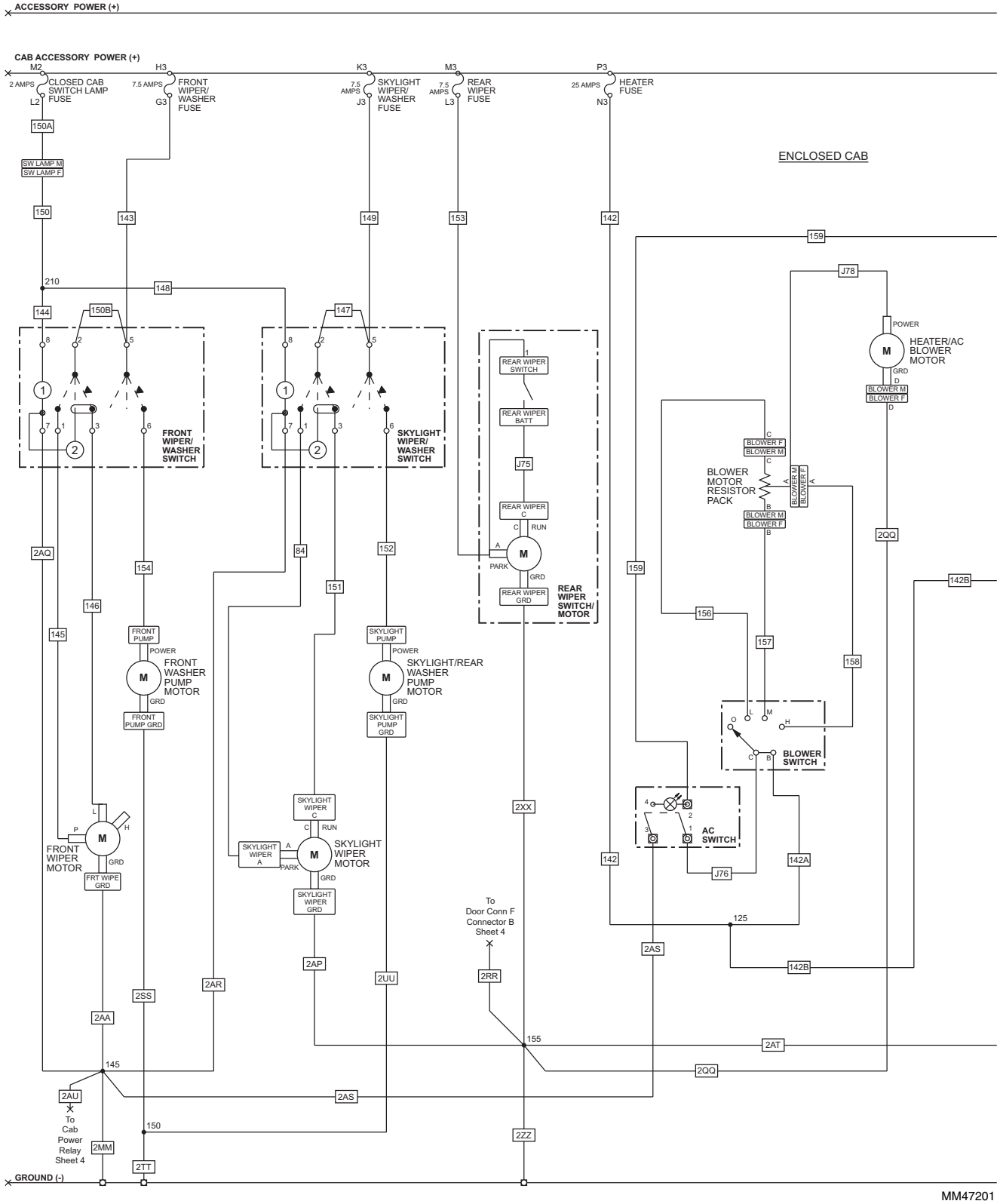


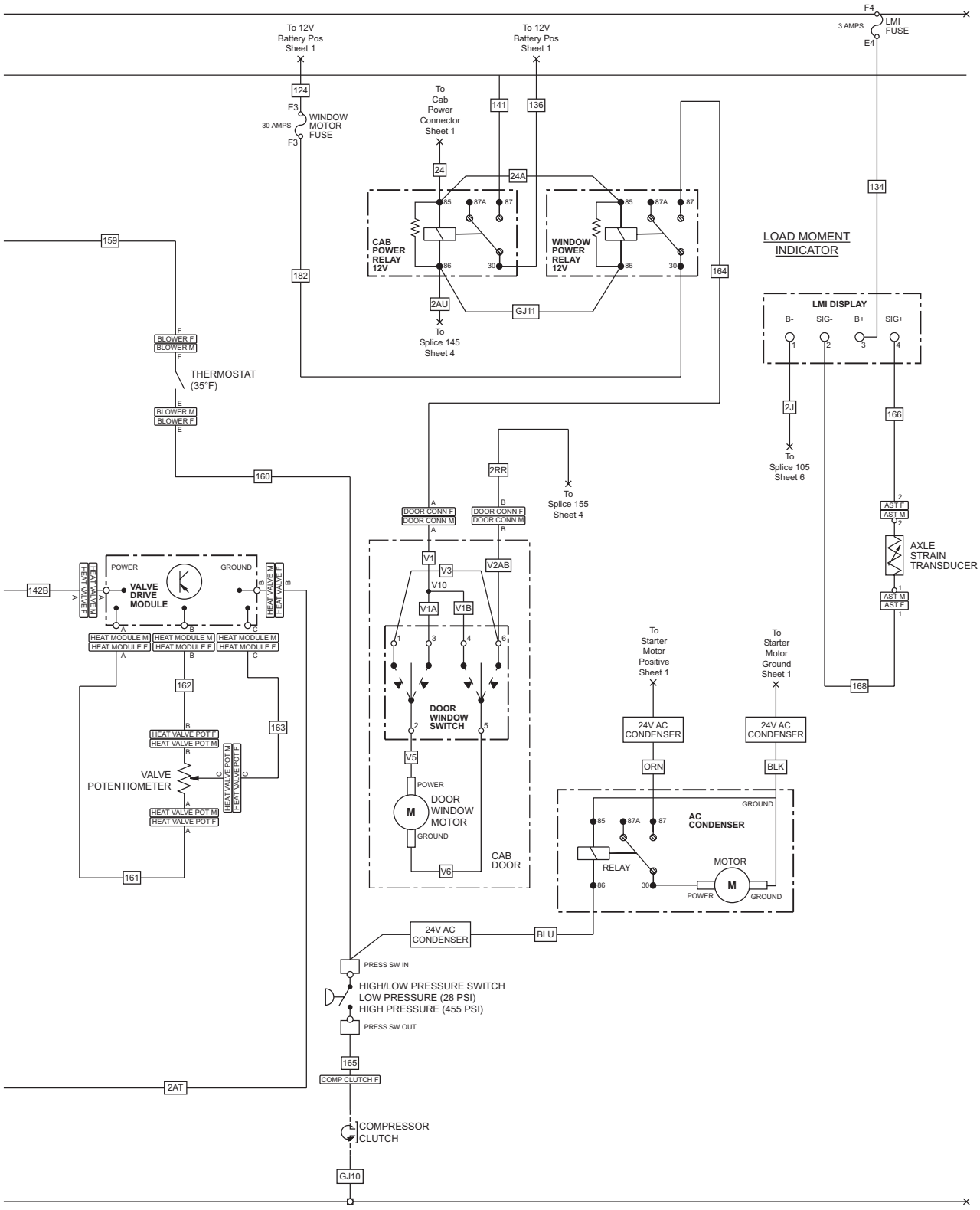

FORK SIDE SHIFT
D4
LOW BRAKE PRESSURE FUSE
2 AMPS
C4
H4
LEFT FORK SHIFT FUSE
7.5 AMPS
G4
K4
RIGHT FORK SHIFT FUSE
7.5 AMPS
J4
69
B
LBP M
LBP F
B
LOW BRAKE PRESSURE SWITCH
A
LBP F
LBP M
A
68
LOW BRAKE PRESSURE BUZZER
71
70
LOW BRAKE PRESSURE LIGHT
2BP
132
120
118
J1
LEFT FORK SIDE SHIFT SWITCH
RIGHT FORK SIDE SHIFT SWITCH
GJ14
GJ25
To Splice 90 Sheet 6
100
101
108
115
LFSS F
LFSS M
RFSS F
RFSS M
100A
101A
108A
115A
1 AMP DIODE
LEFT FORK LEFT
LEFT FORK RIGHT
RIGHT FORK LEFT
RIGHT FORK RIGHT
FORK SIDE SHIFT VALVE
213
214
220
221
GJ22A
GJ21
GJ22
135
GJ22B
To Splice 85 Sheet 6
GJ21A
160
GJ21B
To Splice 85 Sheet 6

MM21602

10.7.9 Main Electrical Schematic (Sheet 4 of 6)

Schematic is drawn with the ignition switch in the OFF position.

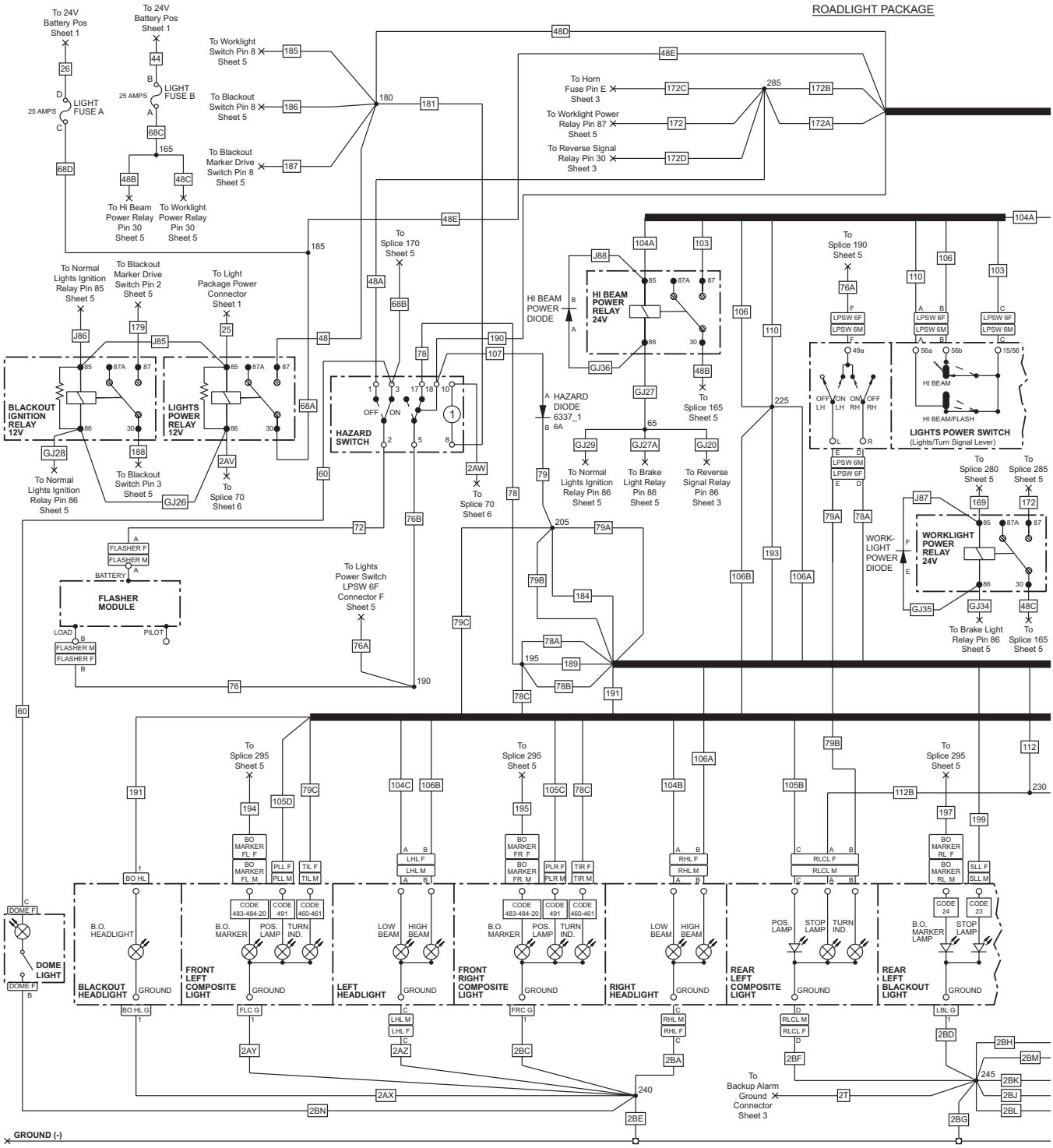



To 12V Battery Pos Sheet 1
To 12V Battery Pos Sheet 1
F4
3 AMPS
LMI FUSE
E4
124
E3
30 AMPS
WINDOW MOTOR FUSE
F3
To Cab Power Connector Sheet 1
141
136
24
24A
CAB POWER RELAY 12V
WINDOW POWER RELAY 12V
85
87A
87
86
30
2AU
To Splice 145 Sheet 4
GJ11
134
LOAD MOMENT INDICATOR
LMI DISPLAY
B-
SIG-
B+
SIG+
159
182
164
F
BLOWER F
BLOWER M
THERMOSTAT (35°F)
E
BLOWER M
BLOWER F
2J
To Splice 105 Sheet 6
166
160
2RR
To Splice 155 Sheet 4
DOOR CONN F
DOOR CONN M
AST F
AST M
AXLE STRAIN TRANSDUCER
142B
POWER
GROUND
VALVE DRIVE MODULE
HEAT VALVE F
HEAT VALVE M
HEAT MODULE M
HEAT MODULE F
V1
V3
V2AB
V10
V1A
V1B
DOOR WINDOW SWITCH
V5
V6
POWER
GROUND
DOOR WINDOW MOTOR
CAB DOOR
To Starter Motor Positive Sheet 1
To Starter Motor Ground Sheet 1
24V AC CONDENSER
ORN
BLK
AC CONDENSER
RELAY
MOTOR
162
163
HEAT VALVE POT F
HEAT VALVE POT M
VALVE POTENTIOMETER
161
168
BLU
PRESS SW IN
HIGH/LOW PRESSURE SWITCH
LOW PRESSURE (28 PSI)
HIGH PRESSURE (455 PSI)
PRESS SW OUT
165
COMP CLUTCH F
2AT
COMPRESSOR CLUTCH
GJ10

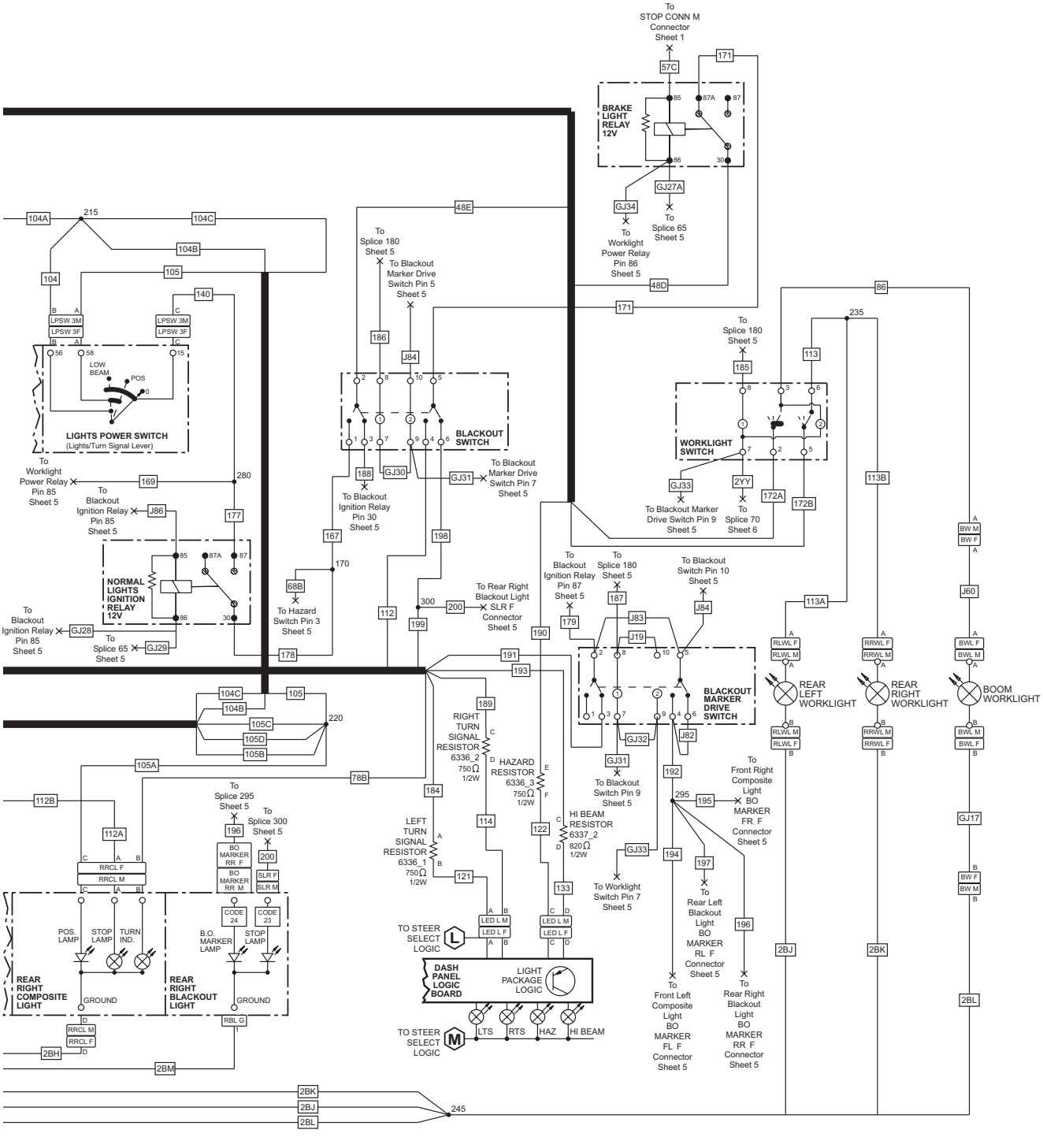
MM47202

10.7.10 Main Electrical Schematic (Sheet 5 of 6)

Schematic is drawn with the ignition switch in the OFF position.



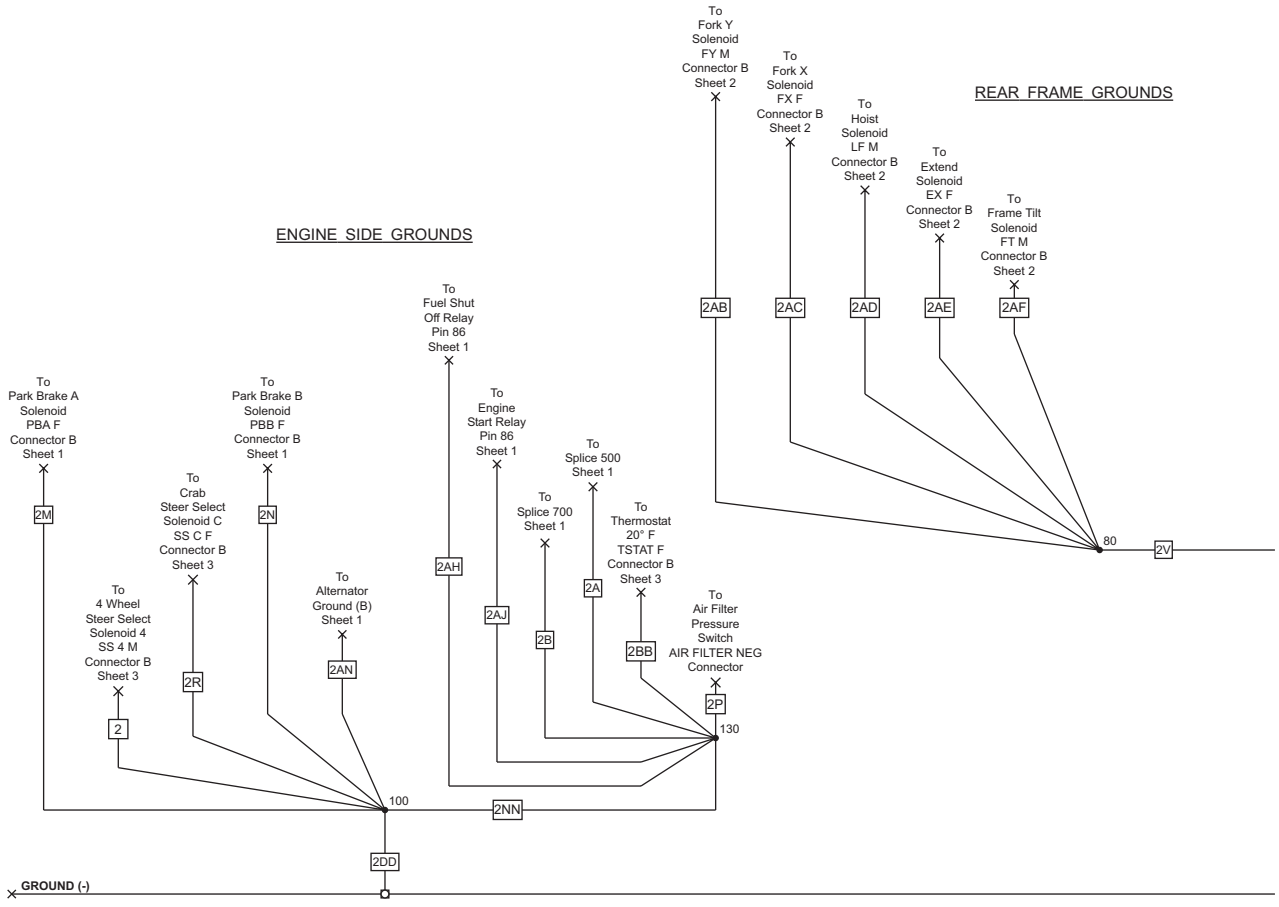
MM47301


To STOP CONN M Connector Sheet 1
57C
171
BRAKE LIGHT RELAY 12V
85
87A
87
86
30
GJ27A
GJ34
To Worklight Power Relay Pin 86 Sheet 5
To Splice 65 Sheet 5
48E
48D
To Splice 180 Sheet 5
To Blackout Marker Drive Switch Pin 5 Sheet 5
186
J84
BLACKOUT SWITCH
188
GJ30
GJ31
To Blackout Marker Drive Switch Pin 7 Sheet 5
To Blackout Ignition Relay Pin 30 Sheet 5
104A
215
104C
104B
105
104
140
LPSW 3M
LPSW 3F
56
58
15
LOW BEAM
POS
LIGHTS POWER SWITCH
(Lights/Turn Signal Lever)
To Worklight Power Relay Pin 85 Sheet 5
169
280
To Blackout Ignition Relay Pin 85 Sheet 5
J86
177
NORMAL LIGHTS IGNITION RELAY 12V
87A
To Blackout Ignition Relay Pin 85 Sheet 5
GJ28
To Splice 65 Sheet 5
GJ29
68B
To Hazard Switch Pin 3 Sheet 5
170
167
178
112
300
200
To Rear Right Blackout Light SLR F Connector Sheet 5
198
199
190
191
193
To Blackout Ignition Relay Pin 87 Sheet 5
To Splice 180 Sheet 5
To Blackout Switch Pin 10 Sheet 5
187
J83
J19
J84
179
BLACKOUT MARKER DRIVE SWITCH
GJ32
J82
GJ31
To Blackout Switch Pin 9 Sheet 5
192
To Front Right Composite Light BO MARKER FR F Connector Sheet 5
295
195
GJ33
To Worklight Switch Pin 7 Sheet 5
194
197
To Rear Left Blackout Light BO MARKER RL F Connector Sheet 5
196
To Front Left Composite Light BO MARKER FL F Connector Sheet 5
To Rear Right Blackout Light BO MARKER RR F Connector Sheet 5
2BJ
2BK
2BL
86
235
To Splice 180 Sheet 5
113
185
WORKLIGHT SWITCH
GJ33
2YY
172A
172B
To Blackout Marker Drive Switch Pin 9 Sheet 5
To Splice 70 Sheet 6
113B
113A
RLWL F
RLWL M
RRWL F
RRWL M
BWL F
BWL M
REAR LEFT WORKLIGHT
REAR RIGHT WORKLIGHT
BOOM WORKLIGHT
J60
GJ17
BW M
BW F
104C
104B
105
105C
105D
105B
220
105A
78B
189
RIGHT TURN SIGNAL RESISTOR 6336_2 750Ω 1/2W
HAZARD RESISTOR 6336_3 750Ω 1/2W
HI BEAM RESISTOR 6337_2 820Ω 1/2W
LEFT TURN SIGNAL RESISTOR 6336_1 750Ω 1/2W
184
114
122
121
133
112B
112A
To Splice 295 Sheet 5
To Splice 300 Sheet 5
196
200
RRCL F
RRCL M
BO MARKER RR F
BO MARKER RR M
SLR F
SLR M
CODE 24
CODE 23
POS. LAMP
STOP LAMP
TURN IND.
B.O. MARKER LAMP
STOP LAMP
REAR RIGHT COMPOSITE LIGHT
GROUND
REAR RIGHT BLACKOUT LIGHT
GROUND
RBL G
2BH
2BM
LED L M
LED L F
TO STEER SELECT LOGIC
L
DASH PANEL LOGIC BOARD
LIGHT PACKAGE LOGIC
TO STEER SELECT LOGIC
M
LTS
RTS
HAZ
HI BEAM
245

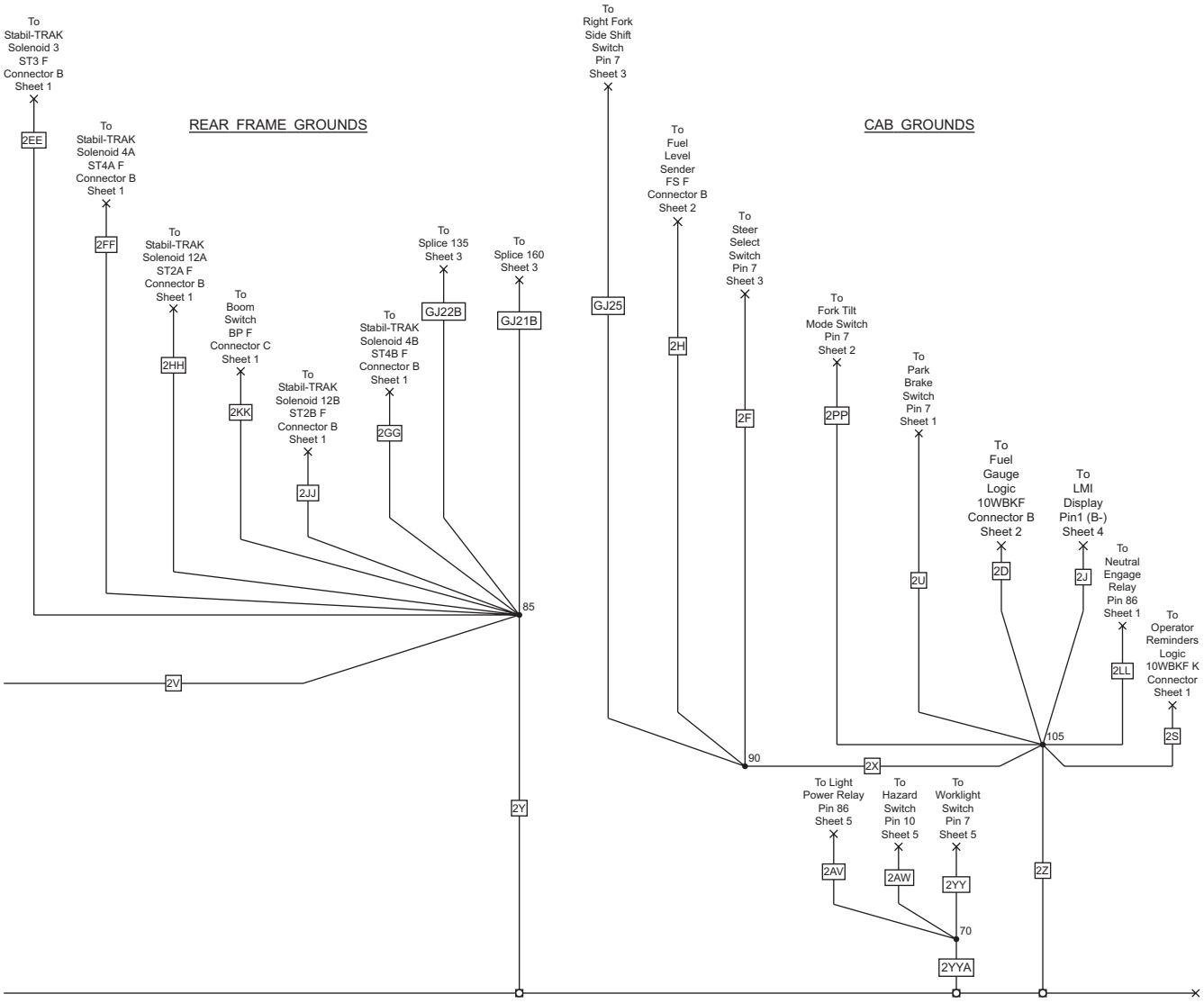
MM47302

10.7.11 Main Electrical Schematic (Sheet 6 of 6)

Schematic is drawn with the ignition switch in the OFF position.



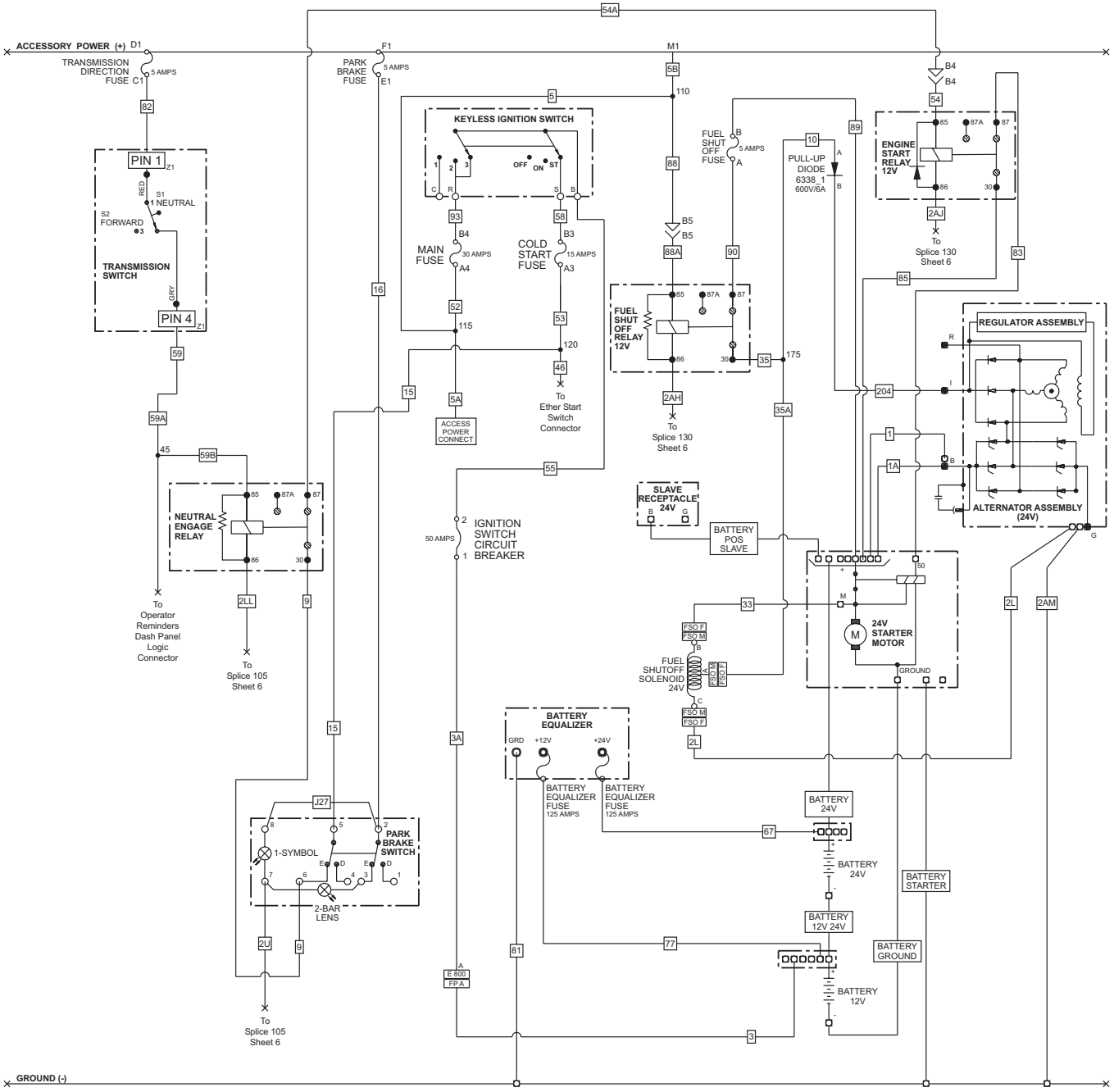
MM47501


To Stabil-TRAK Solenoid 3 ST3 F Connector B Sheet 1
2EE
To Stabil-TRAK Solenoid 4A ST4A F Connector B Sheet 1
2FF
REAR FRAME GROUNDS
To Stabil-TRAK Solenoid 12A ST2A F Connector B Sheet 1
2HH
To Boom Switch BP F Connector C Sheet 1
2KK
To Stabil-TRAK Solenoid 12B ST2B F Connector B Sheet 1
2JJ
To Stabil-TRAK Solenoid 4B ST4B F Connector B Sheet 1
2GG
To Splice 135 Sheet 3
GJ22B
To Splice 160 Sheet 3
GJ21B
85
2V
2Y
To Right Fork Side Shift Switch Pin 7 Sheet 3
GJ25
CAB GROUNDS
To Fuel Level Sender FS F Connector B Sheet 2
2H
To Steer Select Switch Pin 7 Sheet 3
2F
To Fork Tilt Mode Switch Pin 7 Sheet 2
2PP
To Park Brake Switch Pin 7 Sheet 1
2U
To Fuel Gauge Logic 10WBKF Connector B Sheet 2
2D
To LMI Display Pin1 (B-) Sheet 4
2J
To Neutral Engage Relay Pin 86 Sheet 1
2LL
To Operator Reminders Logic 10WBKF K Connector Sheet 1
2S
105
90
2X
To Light Power Relay Pin 86 Sheet 5
2AV
To Hazard Switch Pin 10 Sheet 5
2AW
To Worklight Switch Pin 7 Sheet 5
2YY
2Z
70
2YYA

MM47502

10.7.12 Engine Start Circuit and Troubleshooting

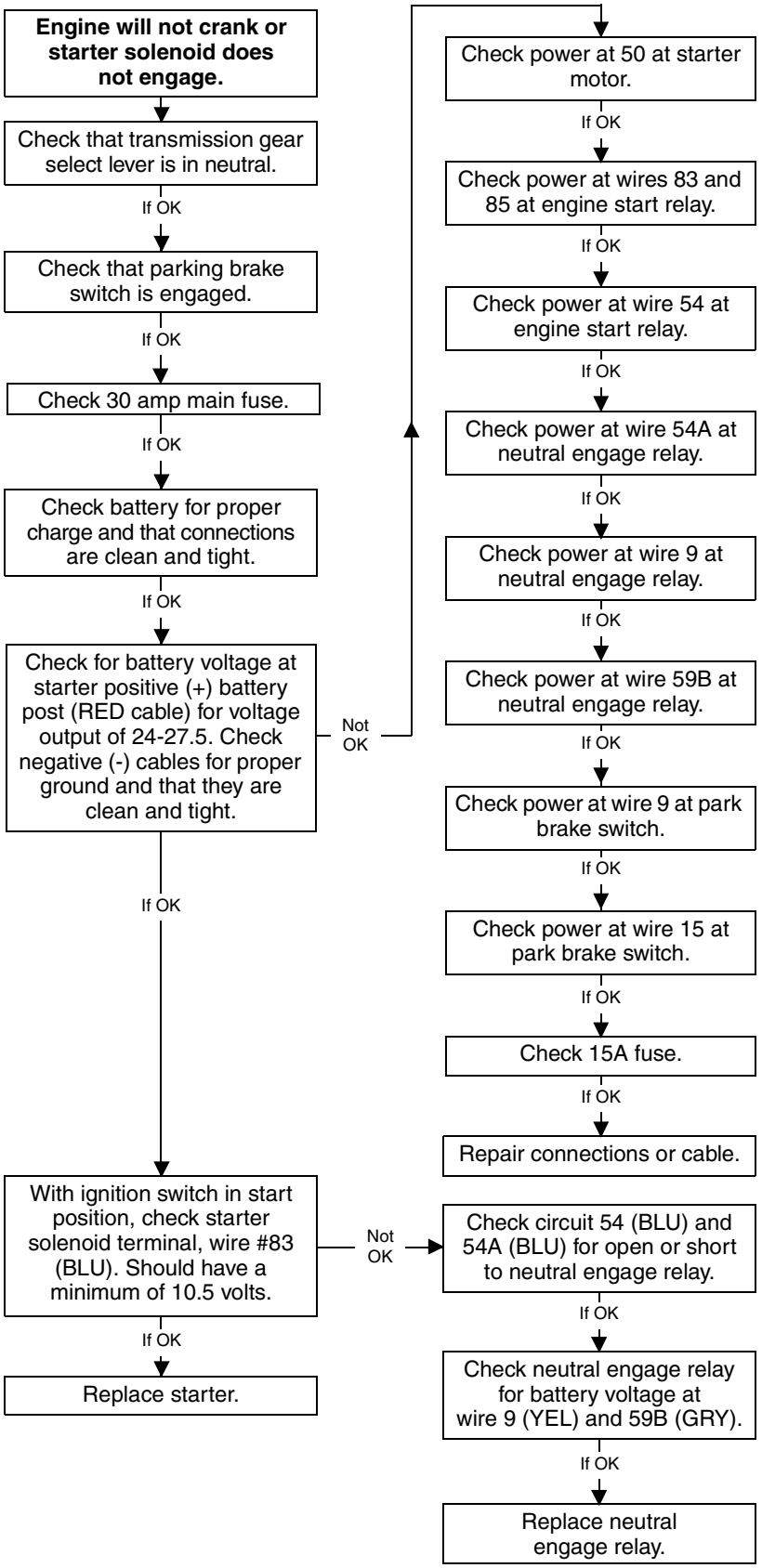
Schematic is drawn with the ignition switch in the START position.



MM4780

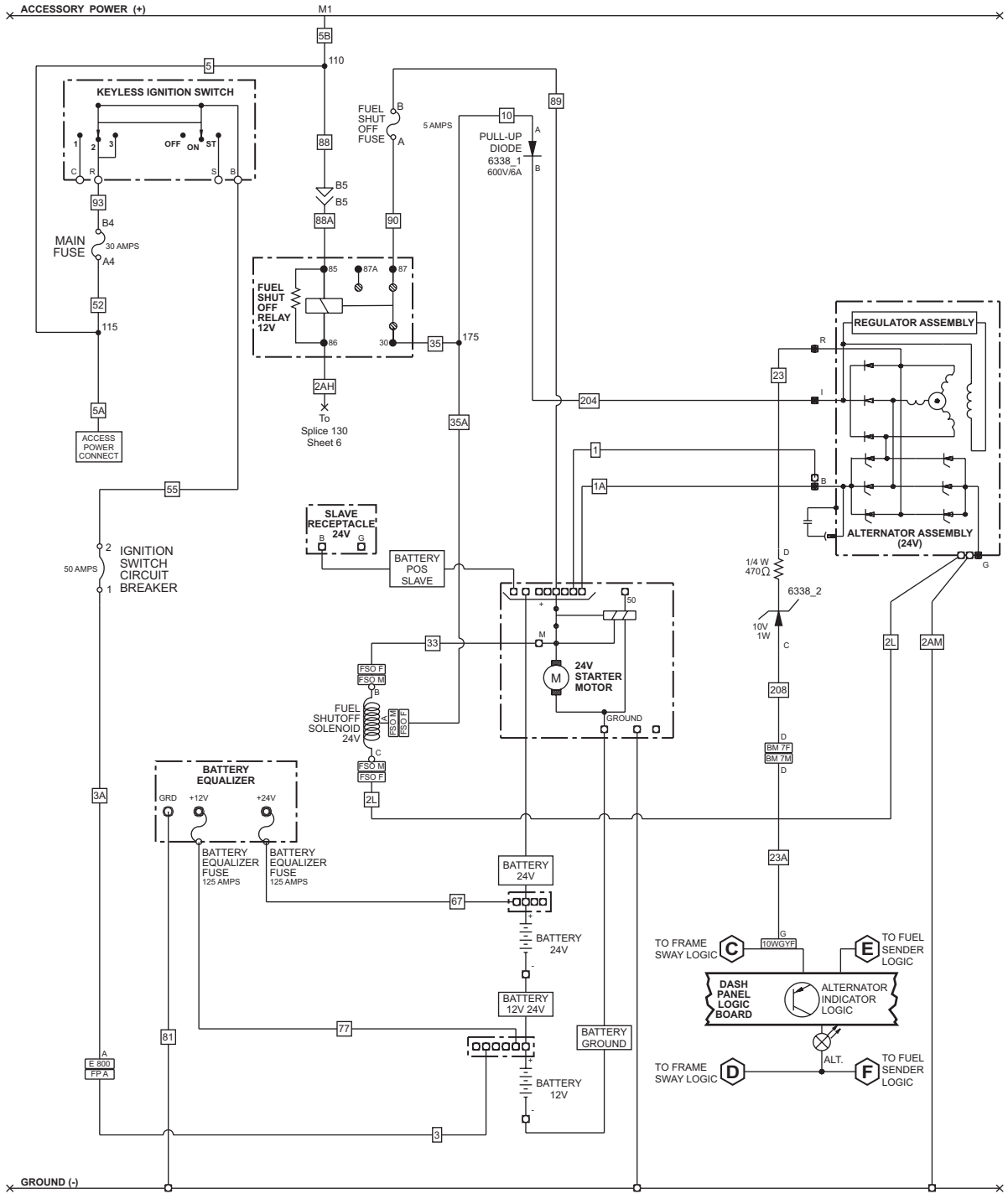
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.13 Charging Circuit and Troubleshooting

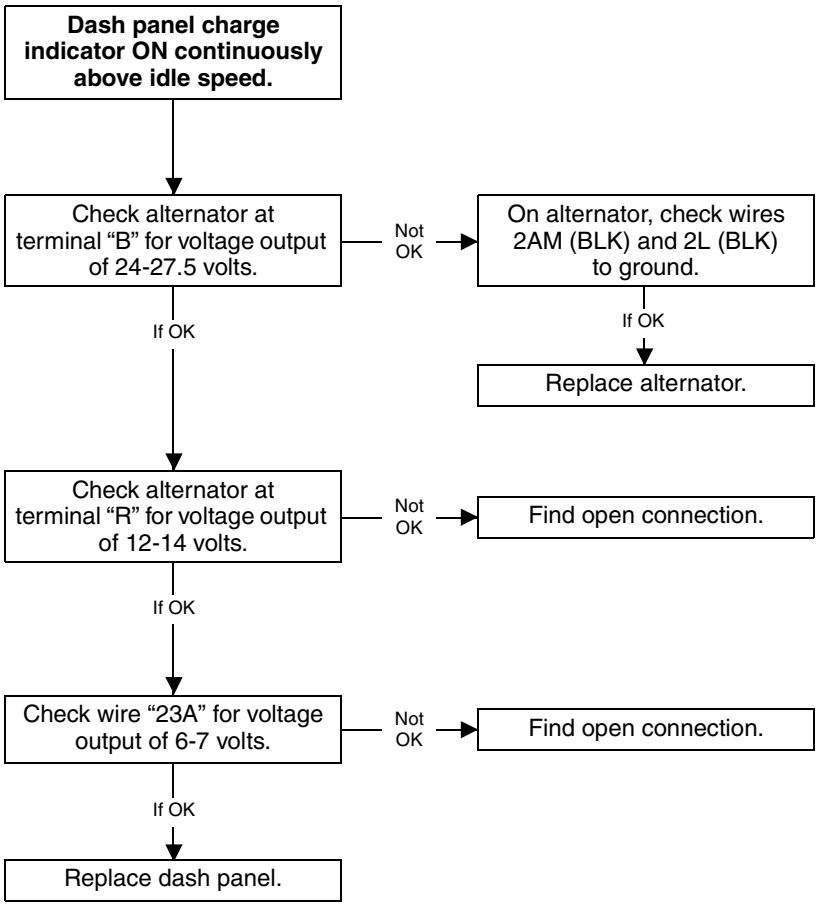
Schematic is drawn with the ignition switch in the RUN position.



MM4800

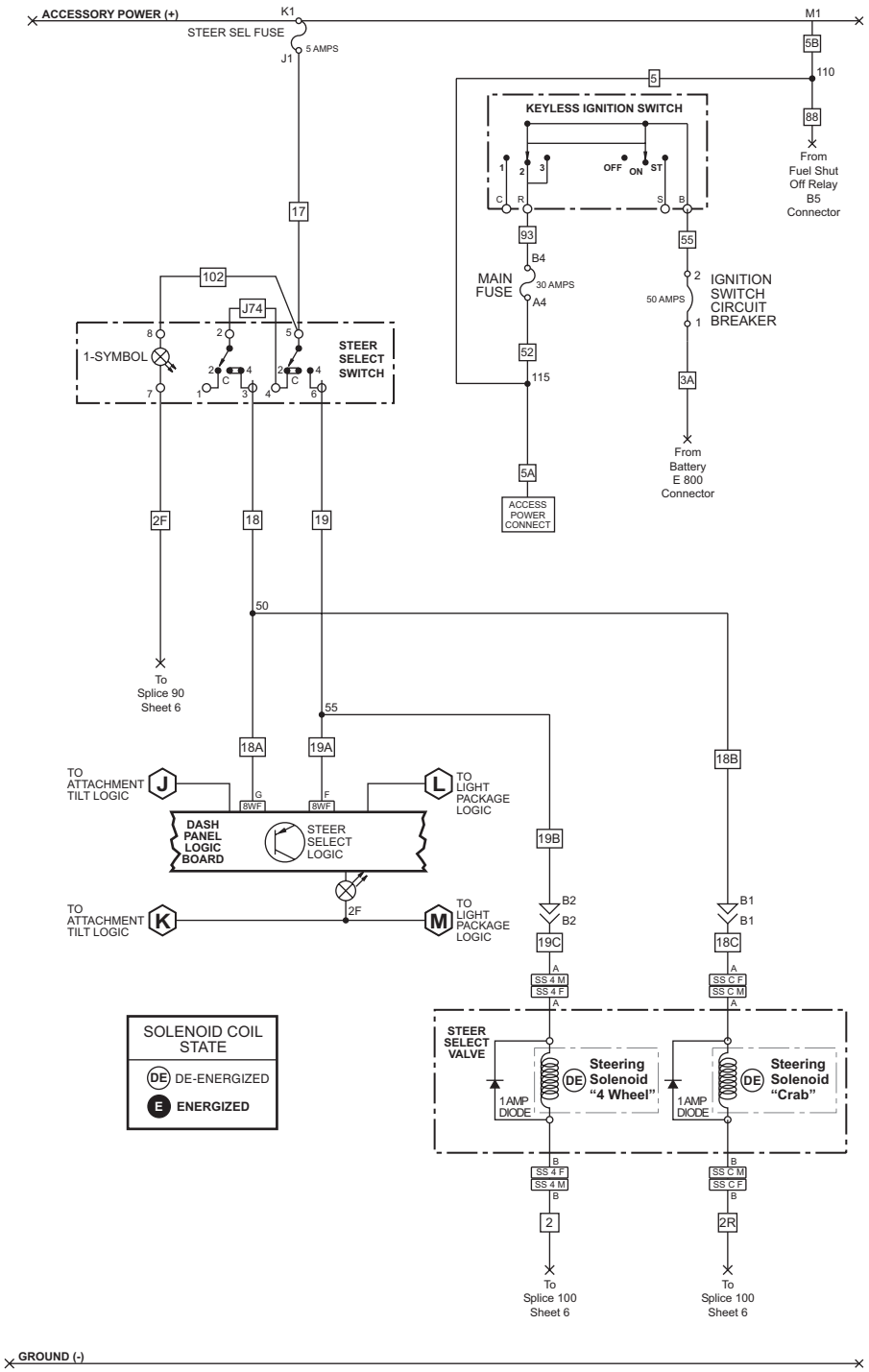
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses**
2. **All connections relating to circuit are clean and tight**



10.7.14 Front Steer Circuit and Troubleshooting

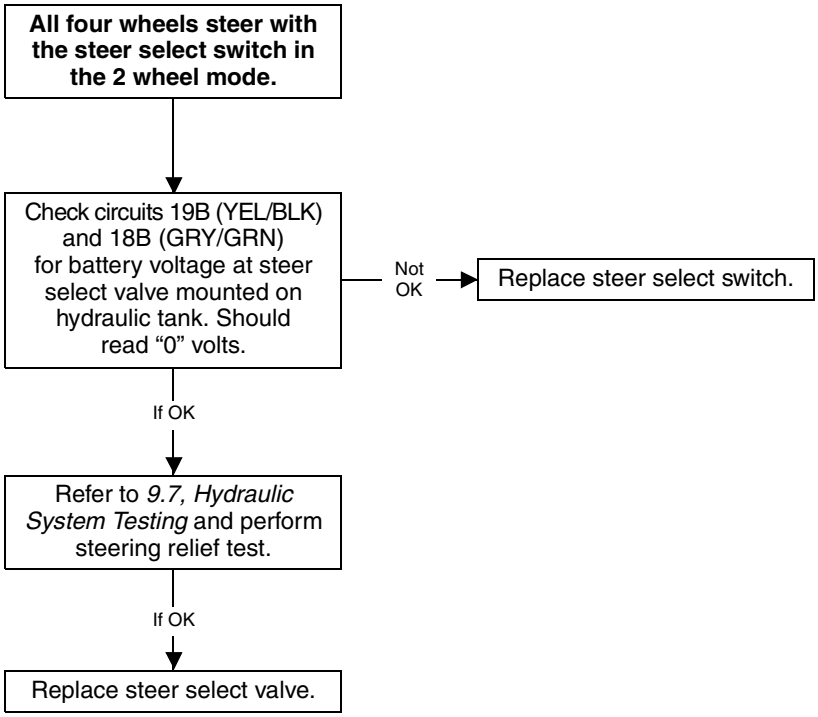
Schematic is drawn with the ignition switch in the RUN position.



MM4810

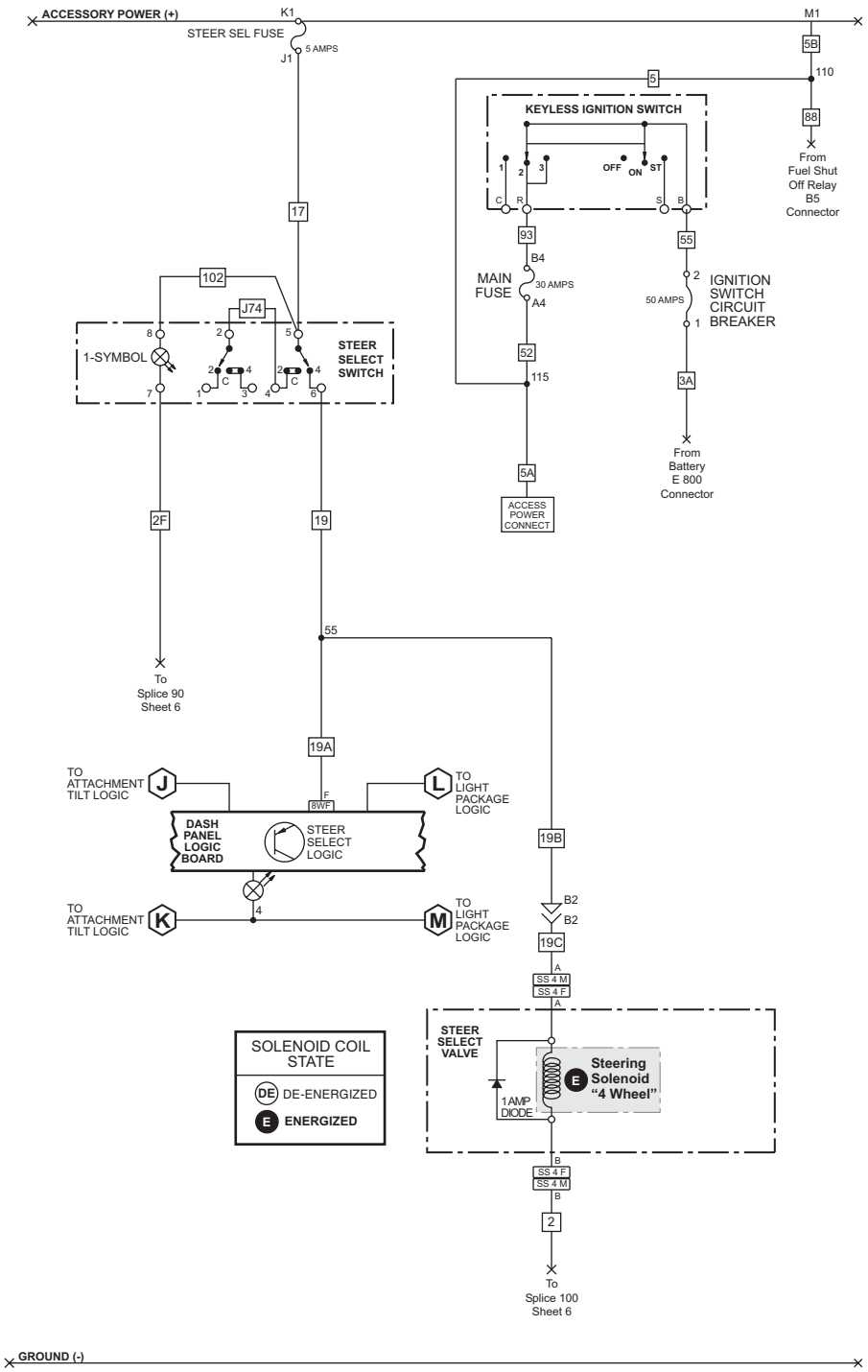
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses**
2. **All connections relating to circuit are clean and tight**



10.7.15 Four Wheel Steer Circuit and Troubleshooting

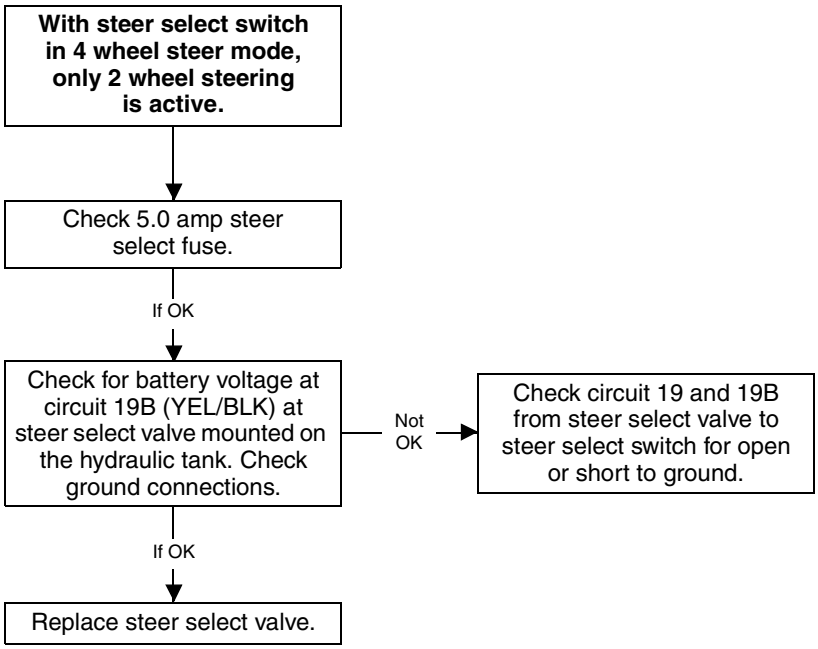
Schematic is drawn with the ignition switch in the RUN position.



MM4830

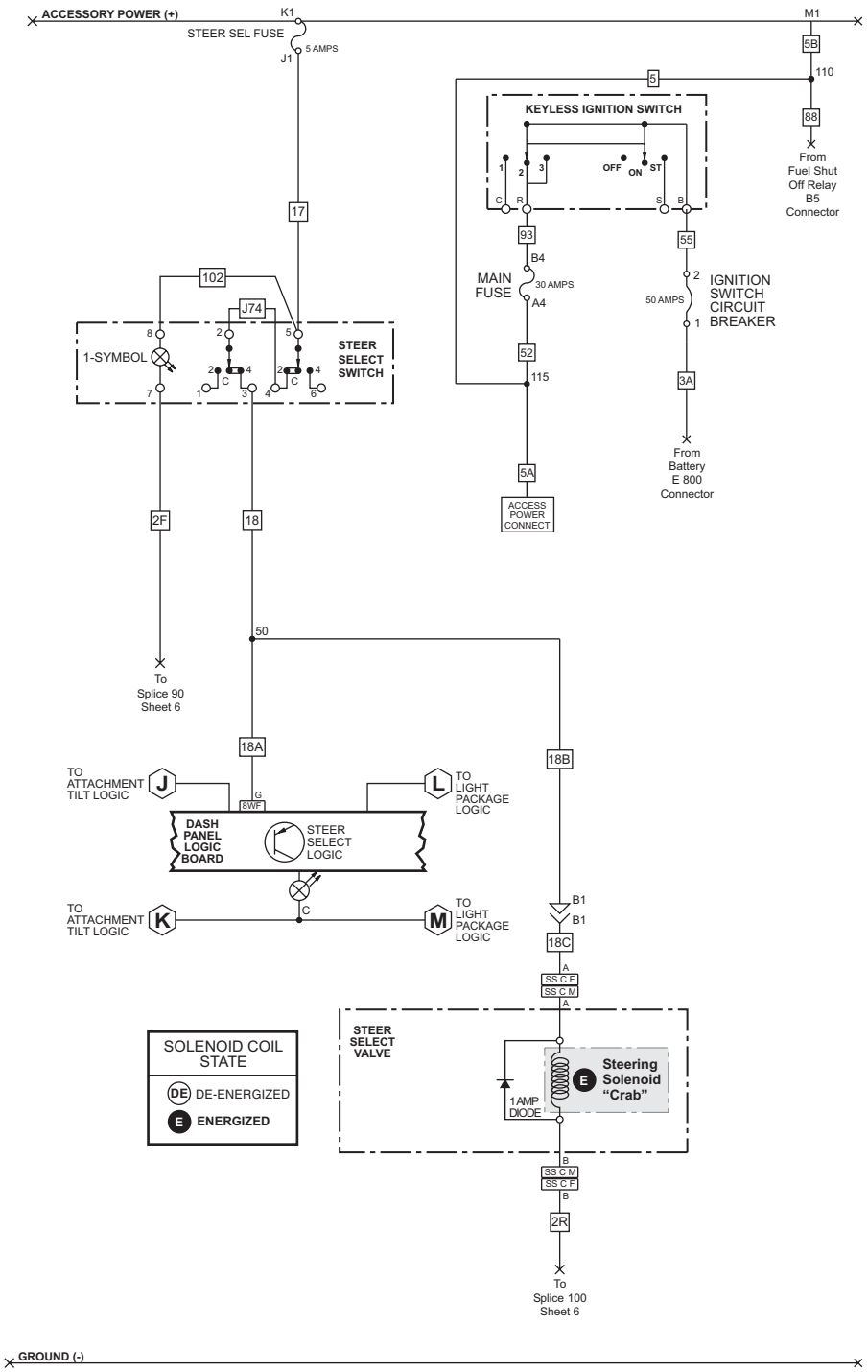
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.16 Crab Steer Circuit and Troubleshooting

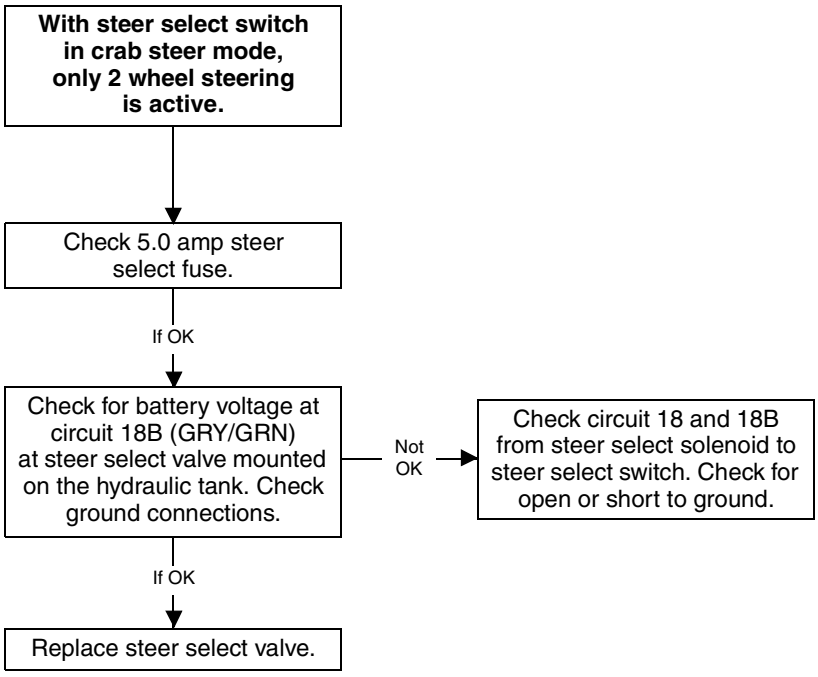
Schematic is drawn with the ignition switch in the RUN position.



MM4820

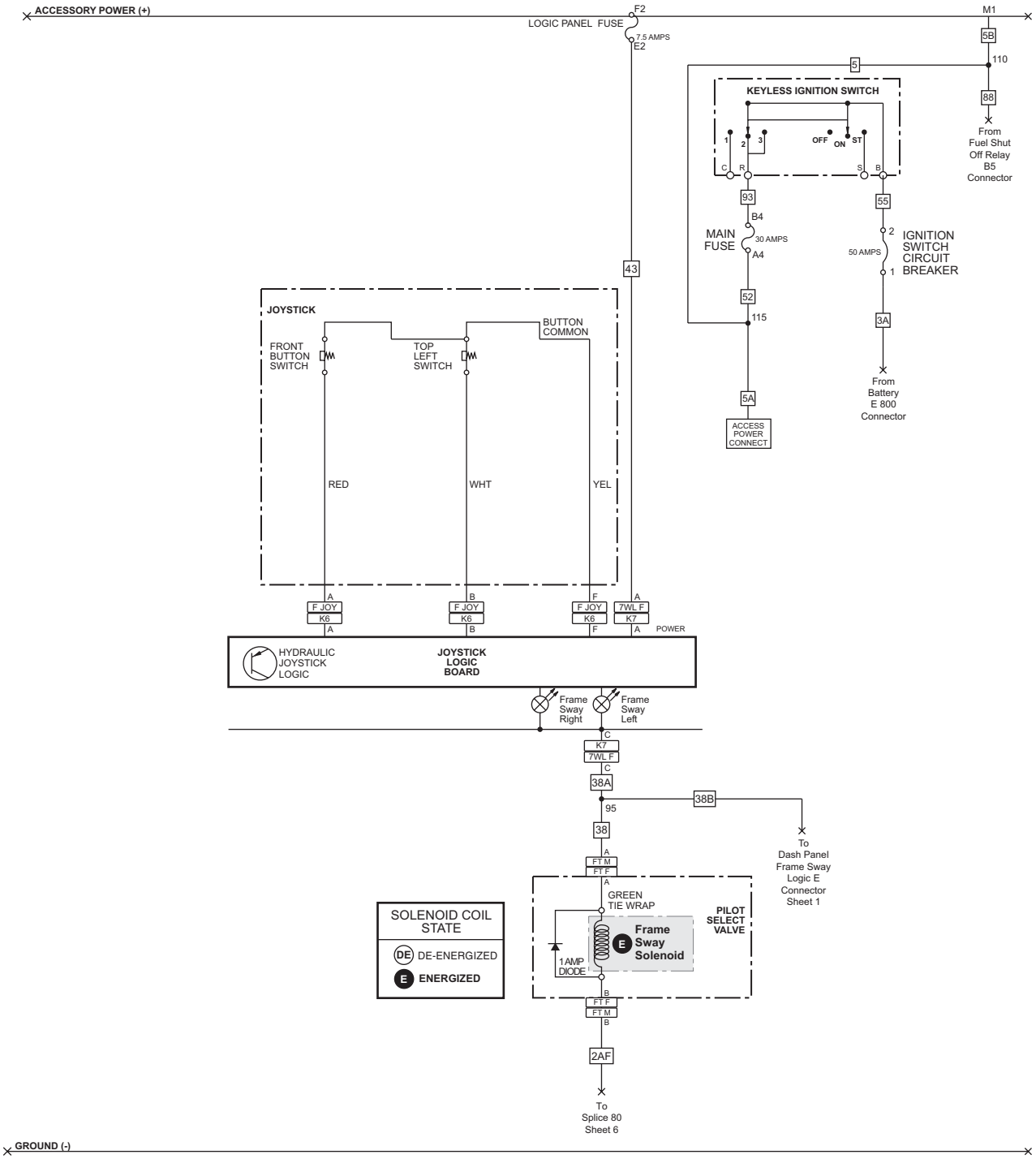
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.17 Frame Sway Circuit and Troubleshooting

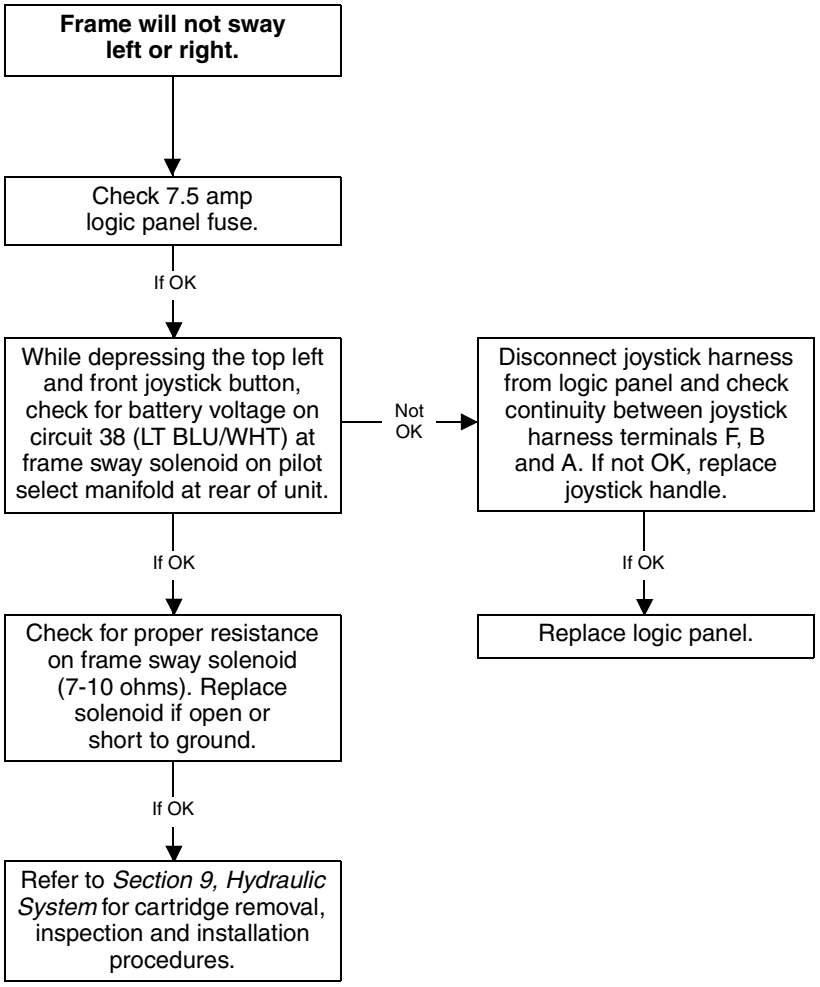
Schematic is drawn with the ignition switch in the RUN position.



MM4840

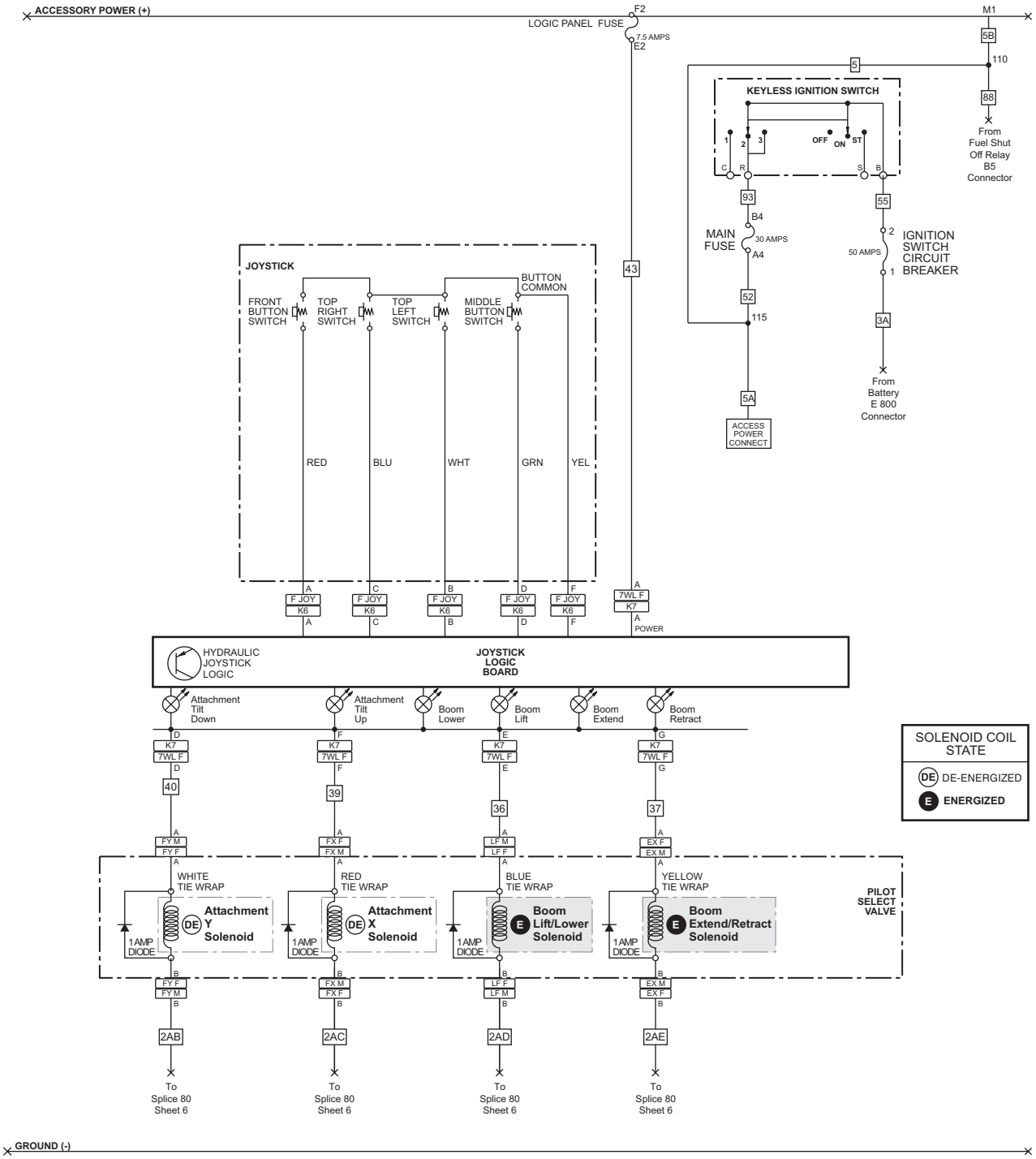
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.18 Boom Extend/Retract Circuit and Troubleshooting

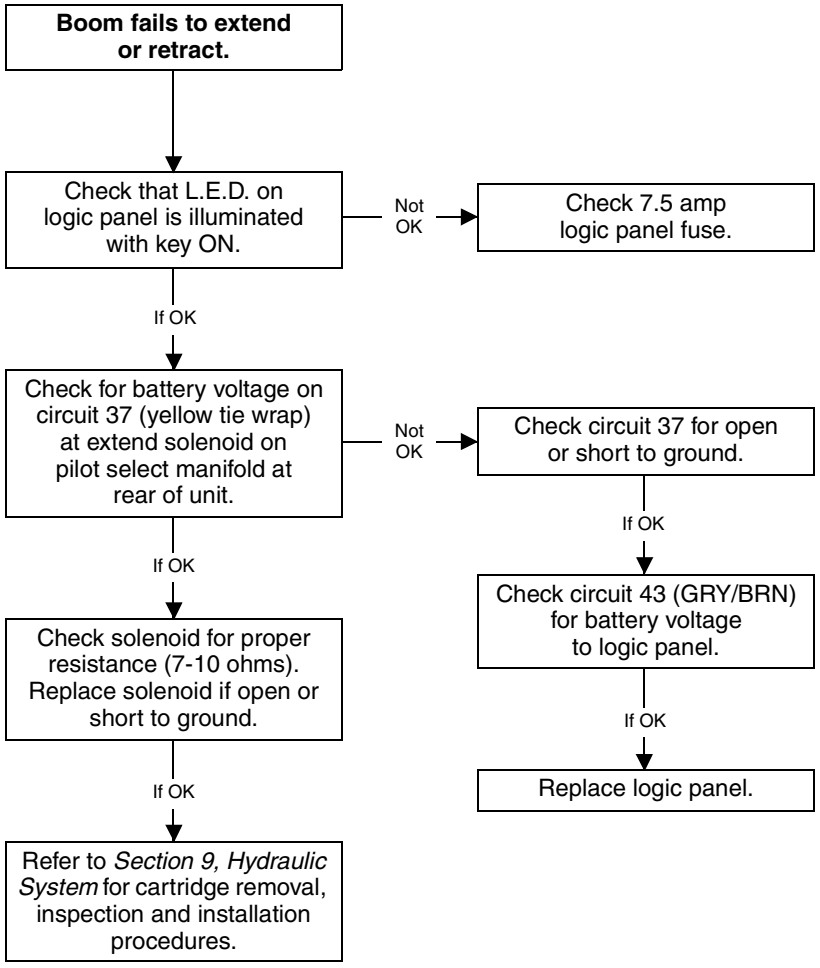
Schematic is drawn with the ignition switch in the RUN position.



MM4850

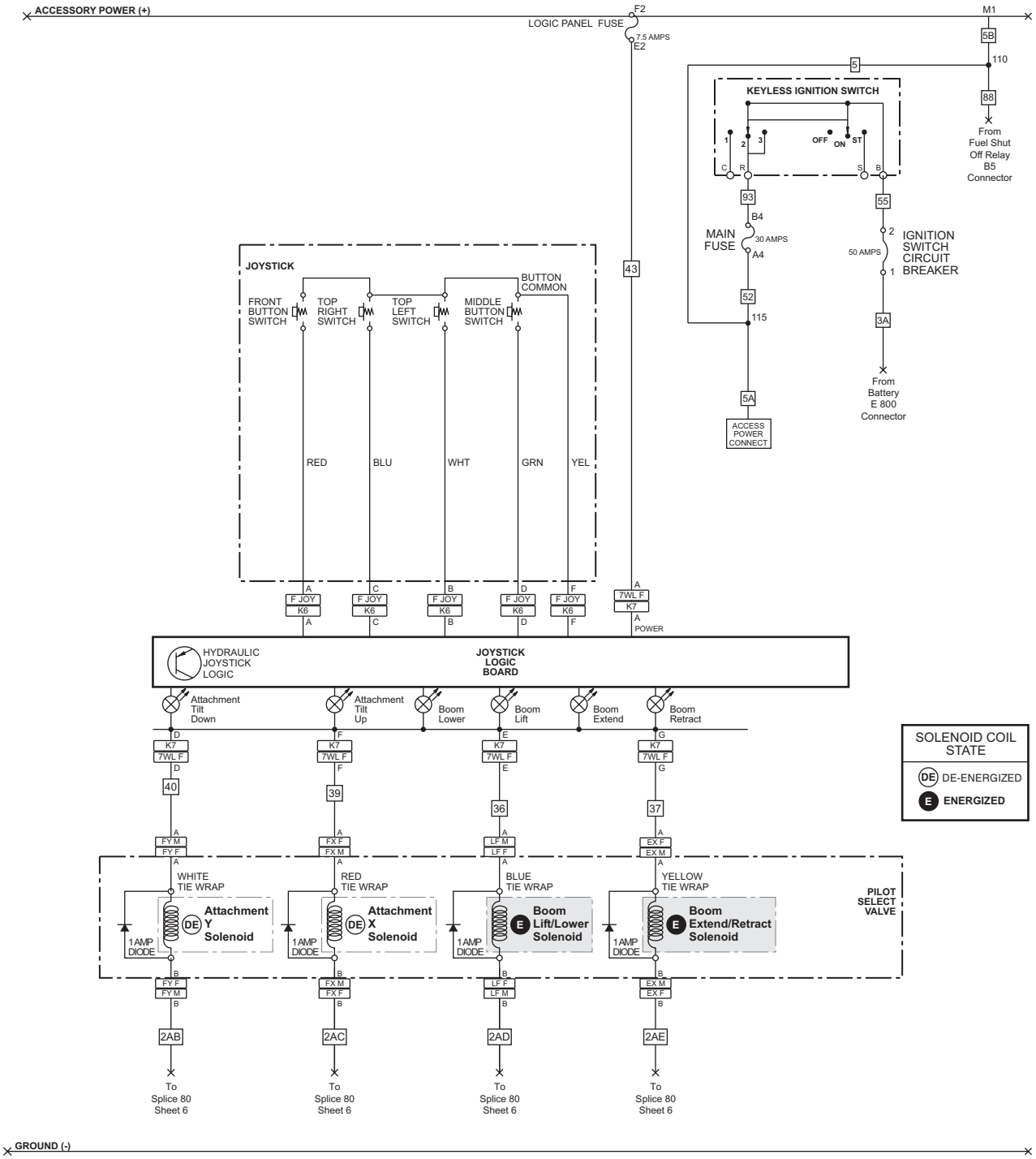
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.19 Boom Lift/Lower Circuit and Troubleshooting

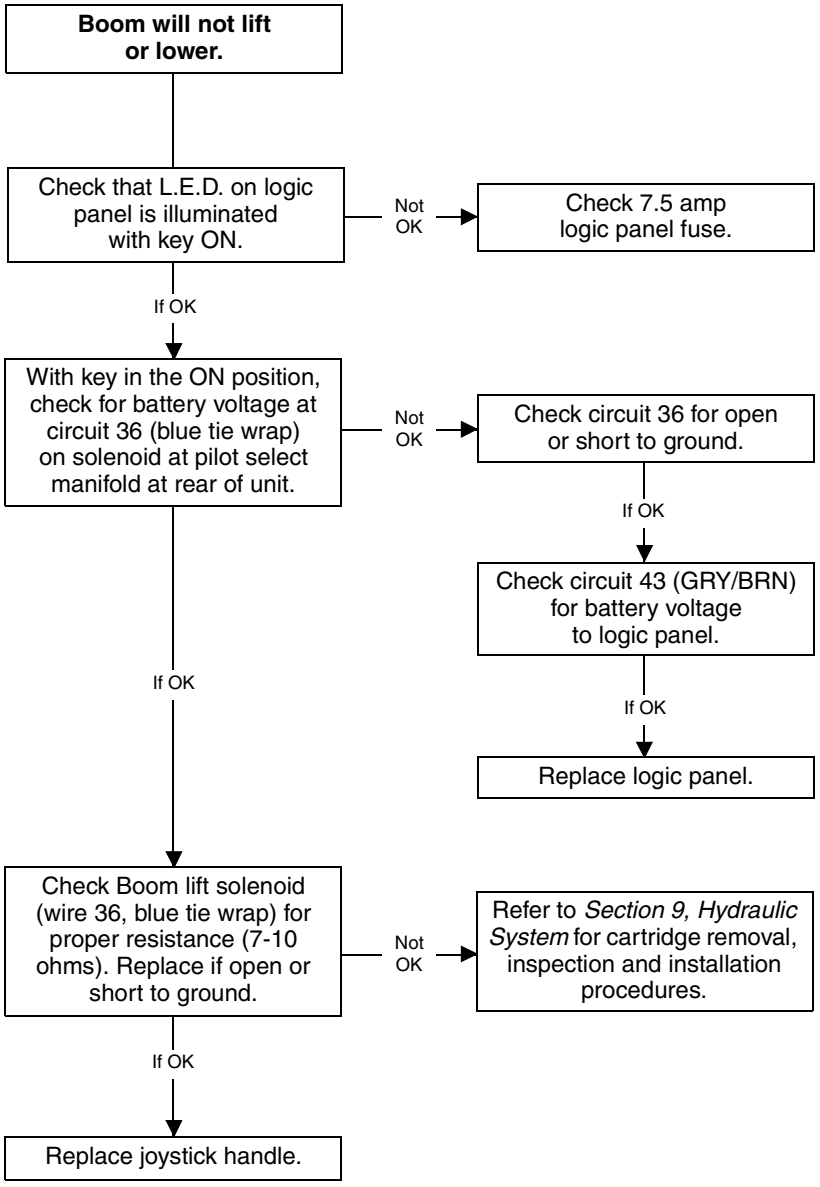
Schematic is drawn with the ignition switch in the RUN position.



MM4850

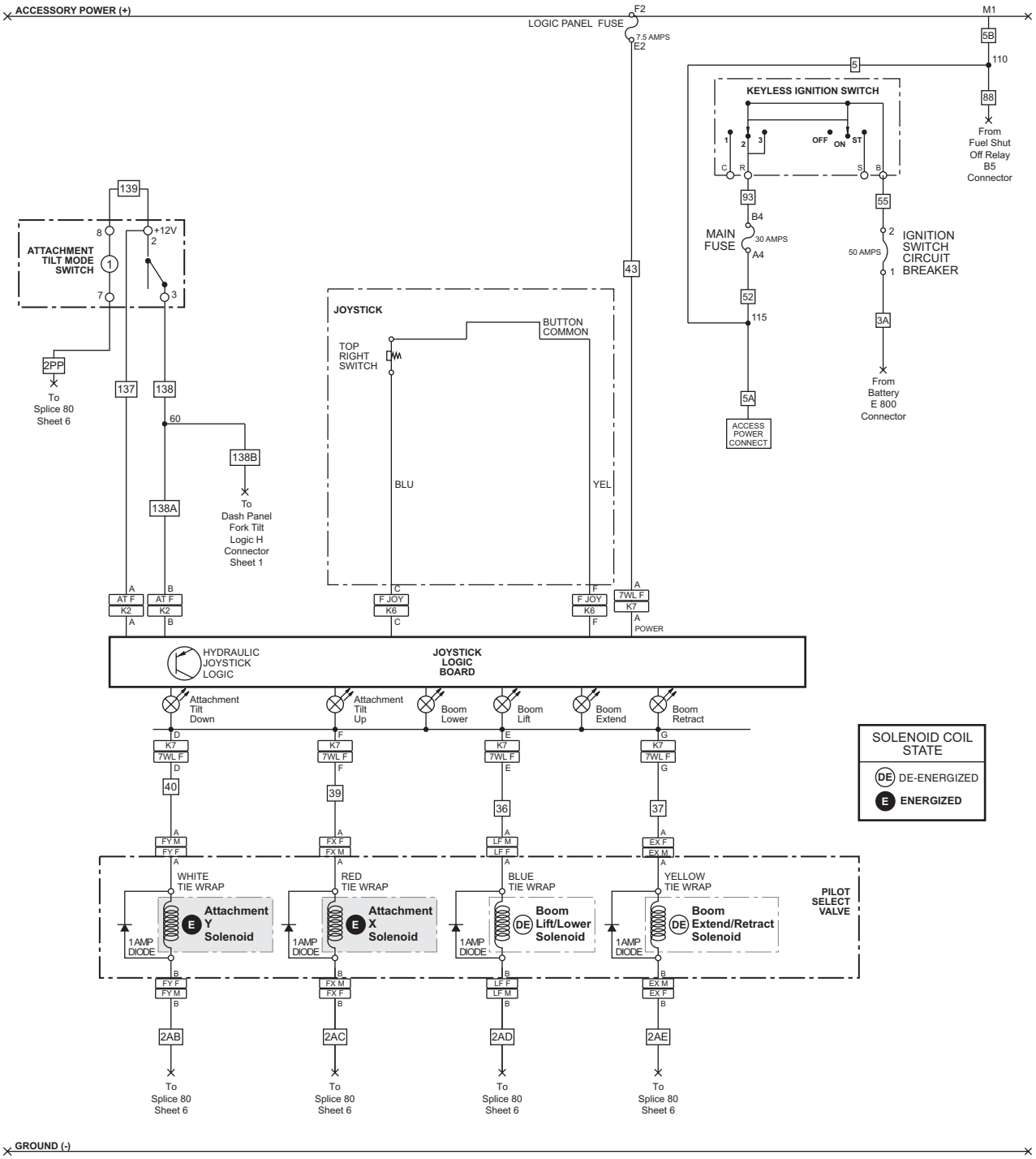
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.20 Attachment Tilt Mode Circuit and Troubleshooting

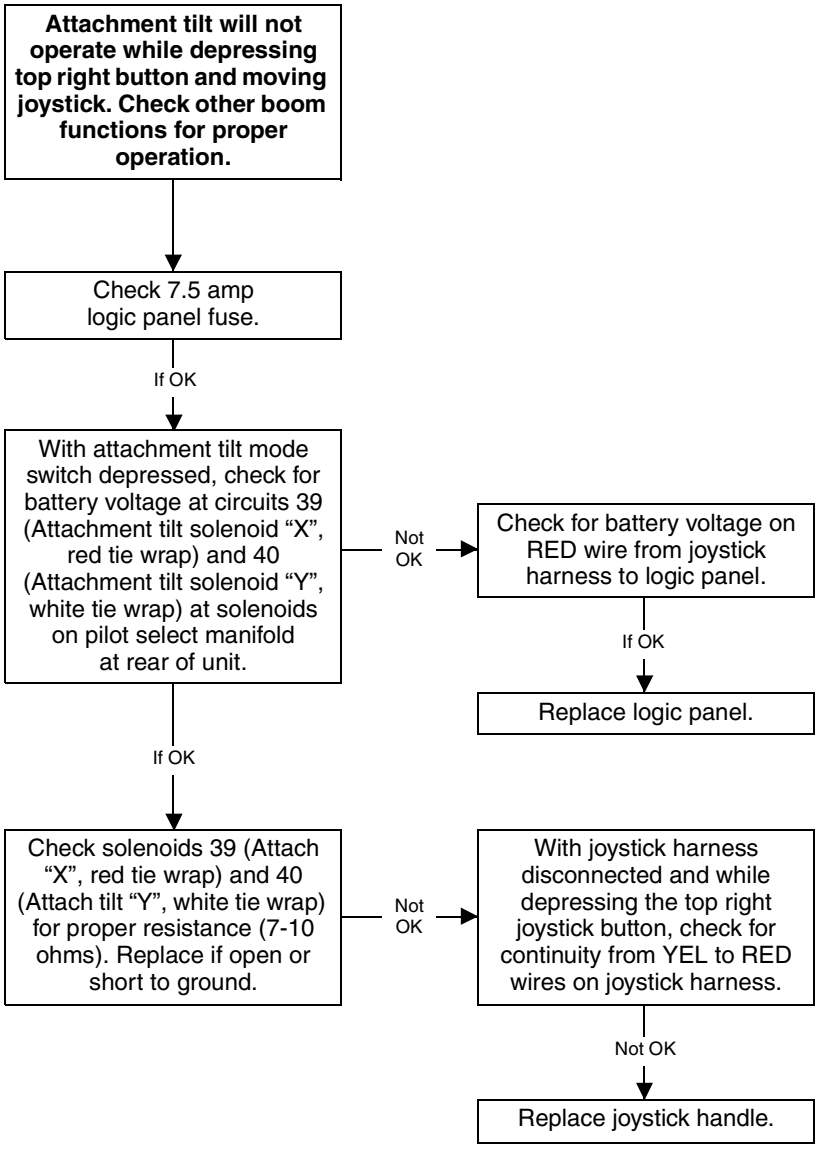
Schematic is drawn with the ignition switch in the RUN position.



MM4860

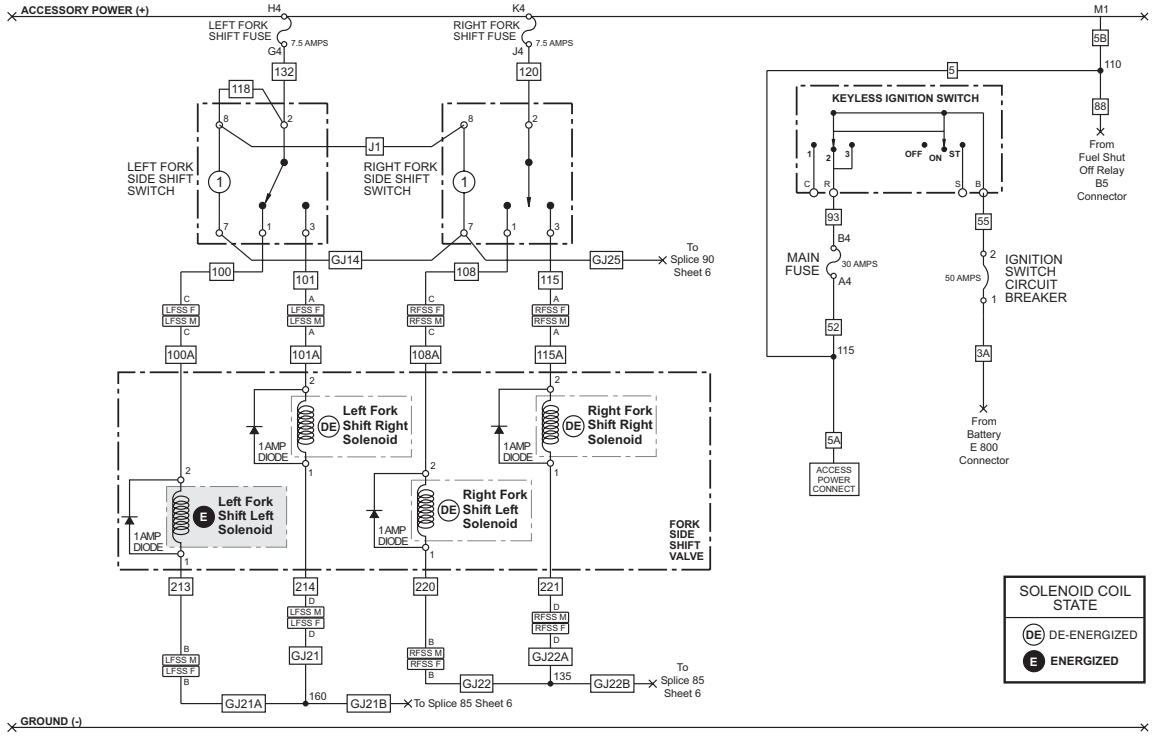
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.21 Left Fork - Side Shift Left, Circuit and Troubleshooting

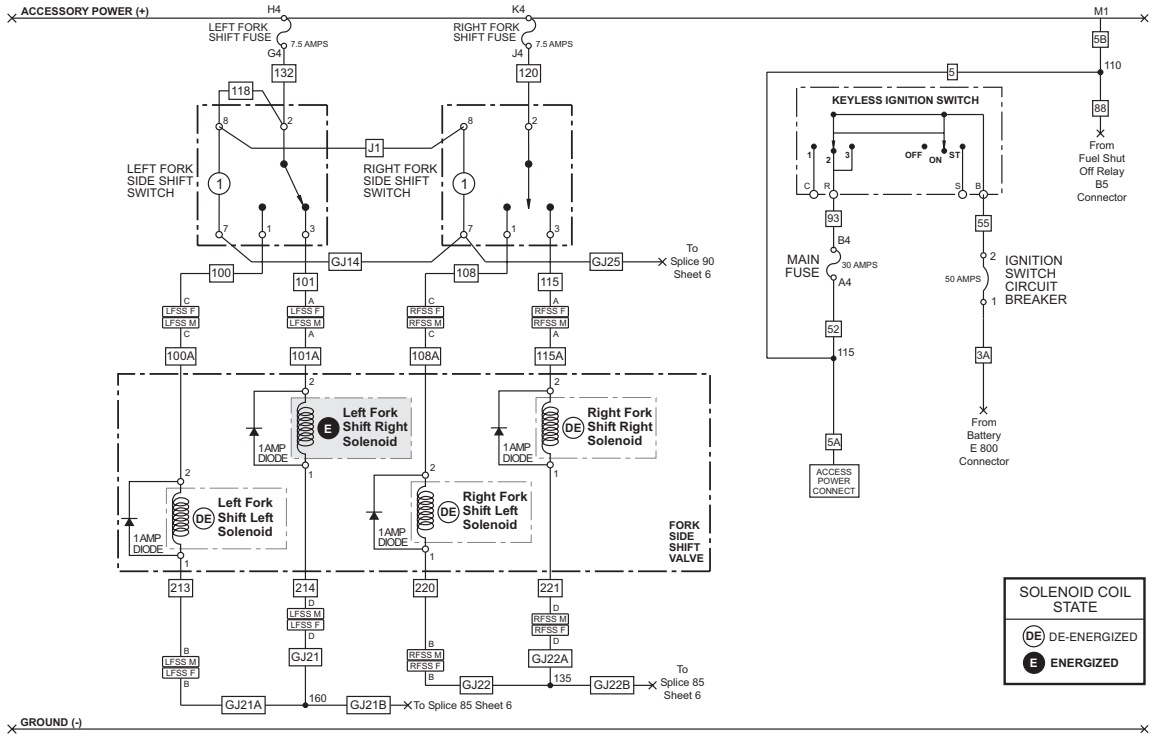
Schematic is drawn with the ignition switch in the RUN position.



MM4870

10.7.22 Left Fork - Side Shift Right, Circuit and Troubleshooting

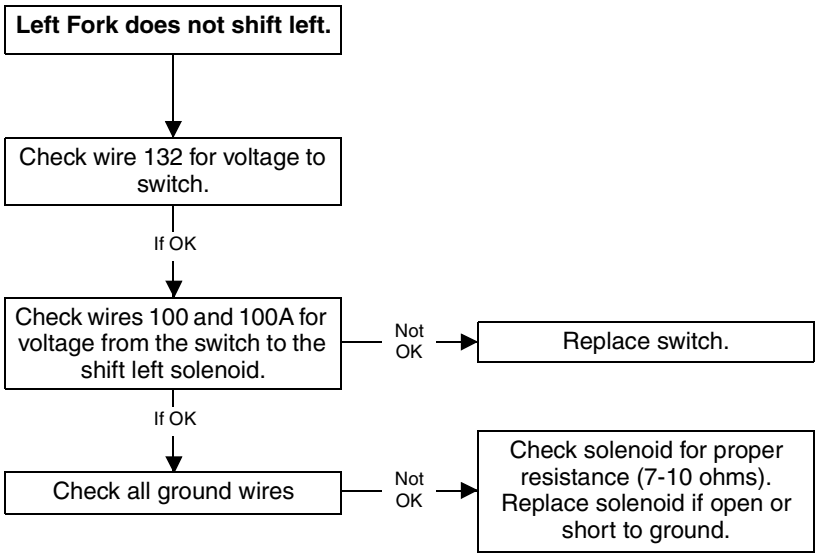
Schematic is drawn with the ignition switch in the RUN position.



MM4880

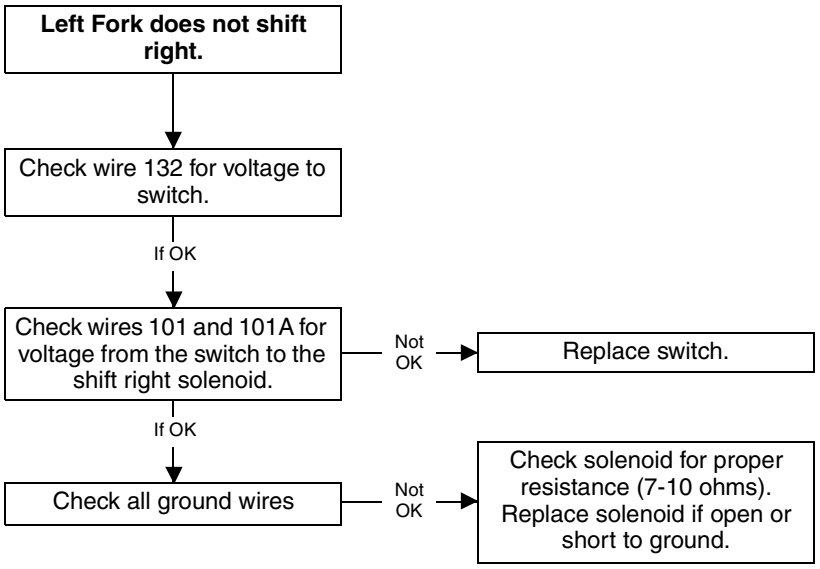
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**
2. **Fuses**



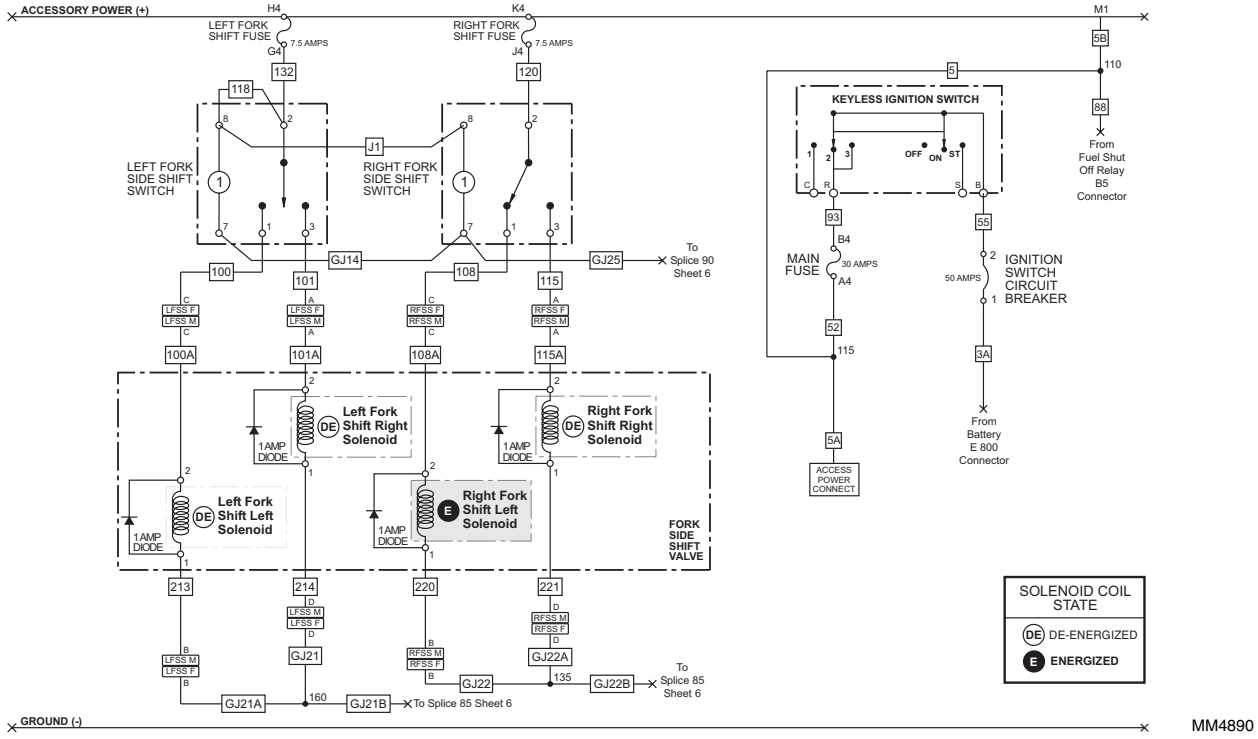
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**
2. **Fuses**



10.7.23 Right Fork - Side Shift Left, Circuit and Troubleshooting

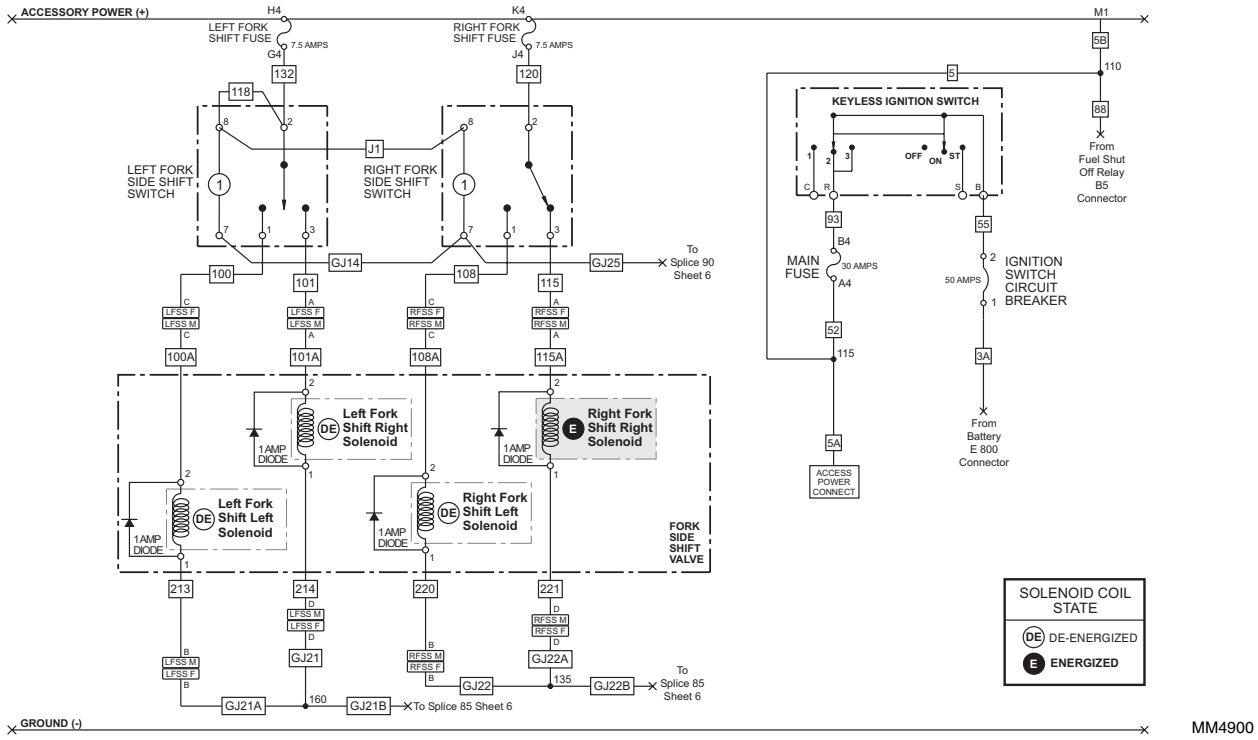
Schematic is drawn with the ignition switch in the RUN position.



MM4890

10.7.24 Right Fork - Side Shift Right, Circuit and Troubleshooting

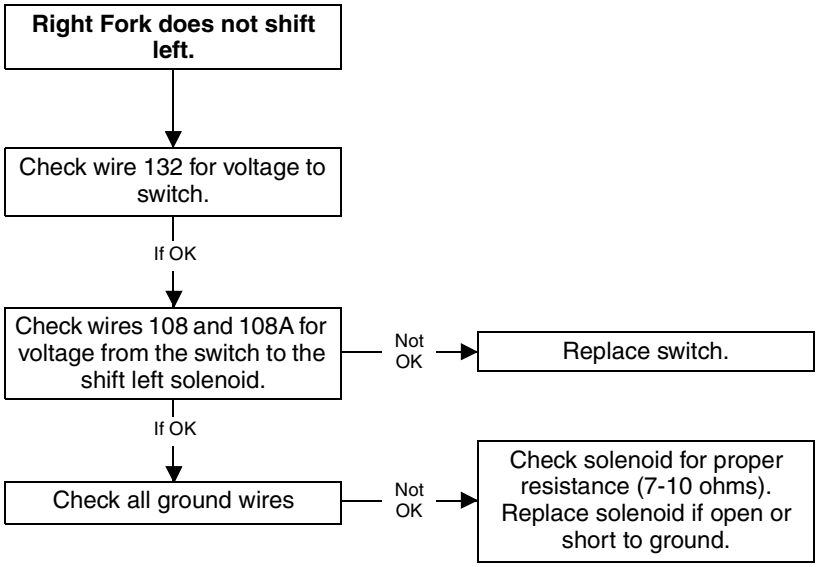
Schematic is drawn with the ignition switch in the RUN position.



MM4900

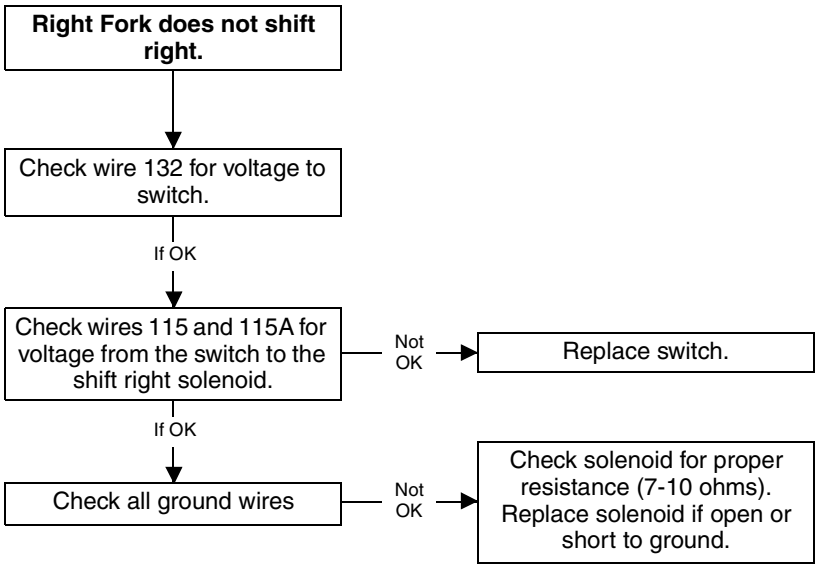
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**
2. **Fuses**



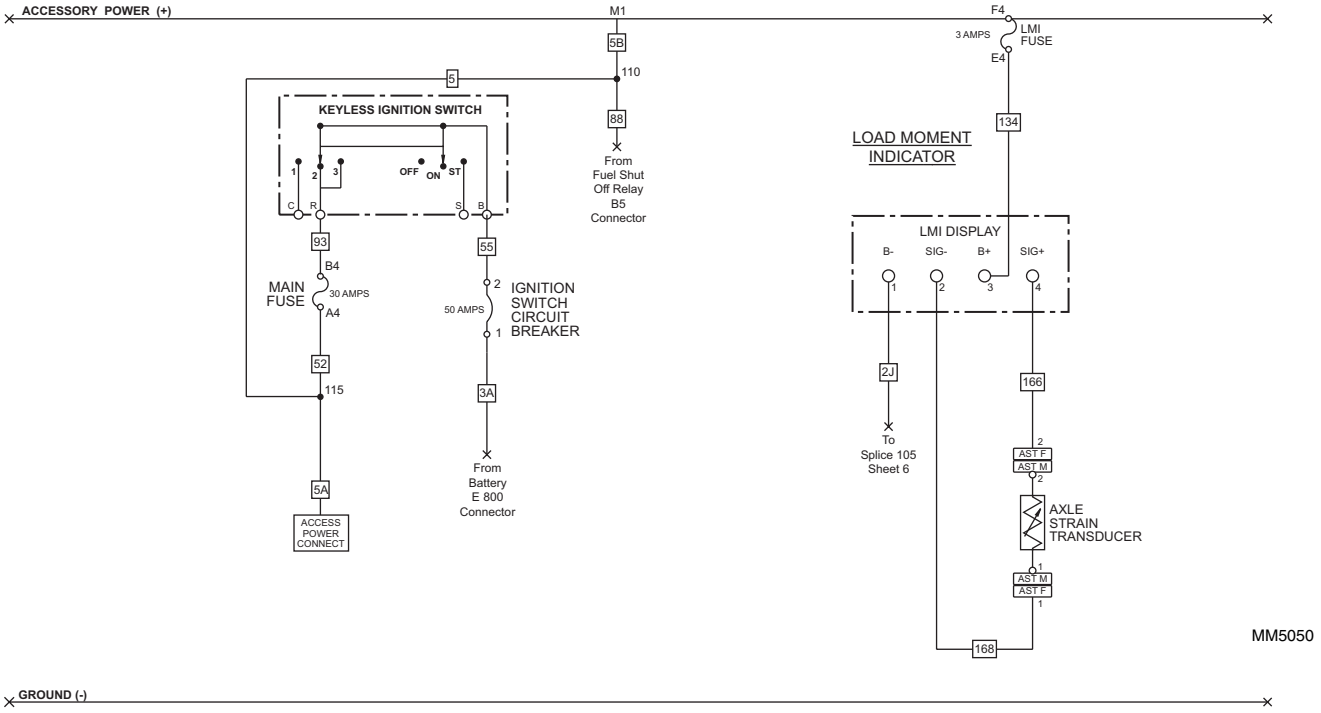
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**
2. **Fuses**



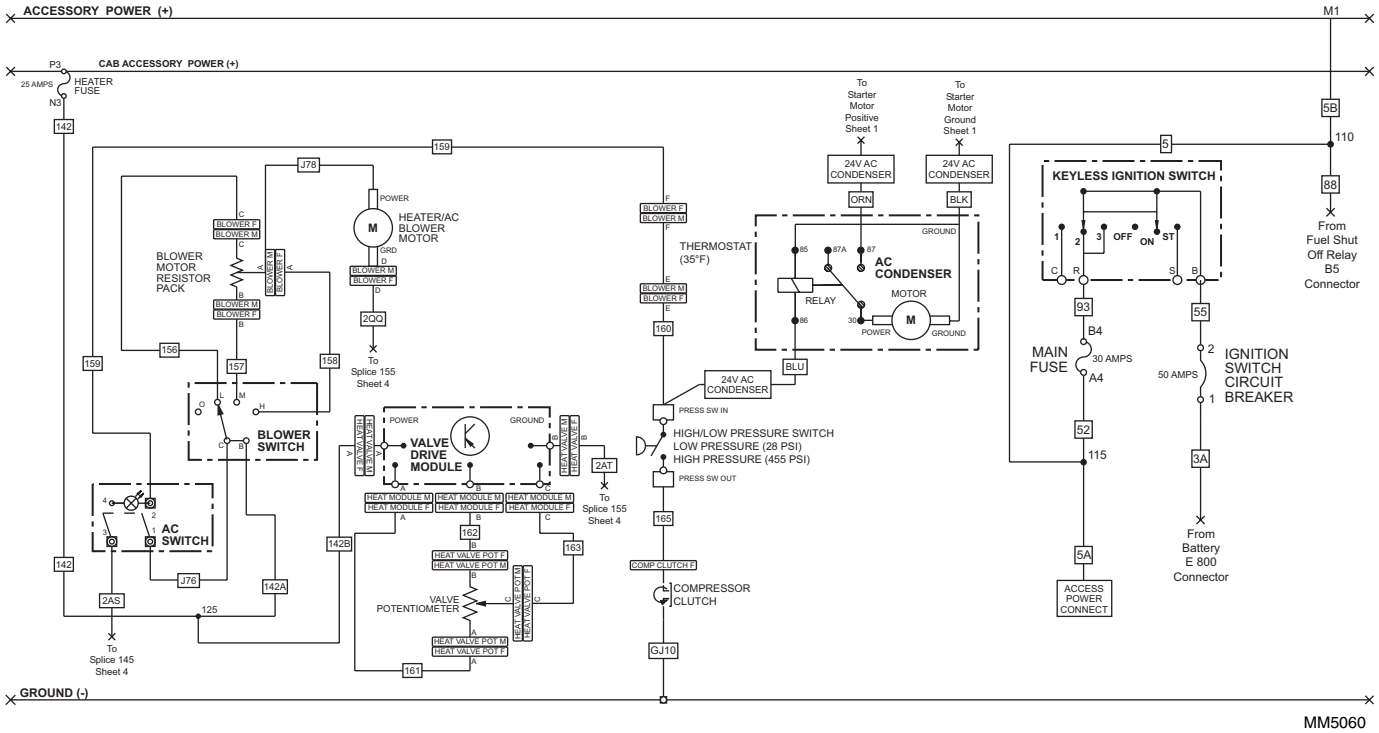
10.7.25 Load Moment Indicator Circuit and Troubleshooting

Schematic is drawn with the ignition switch in the RUN position.



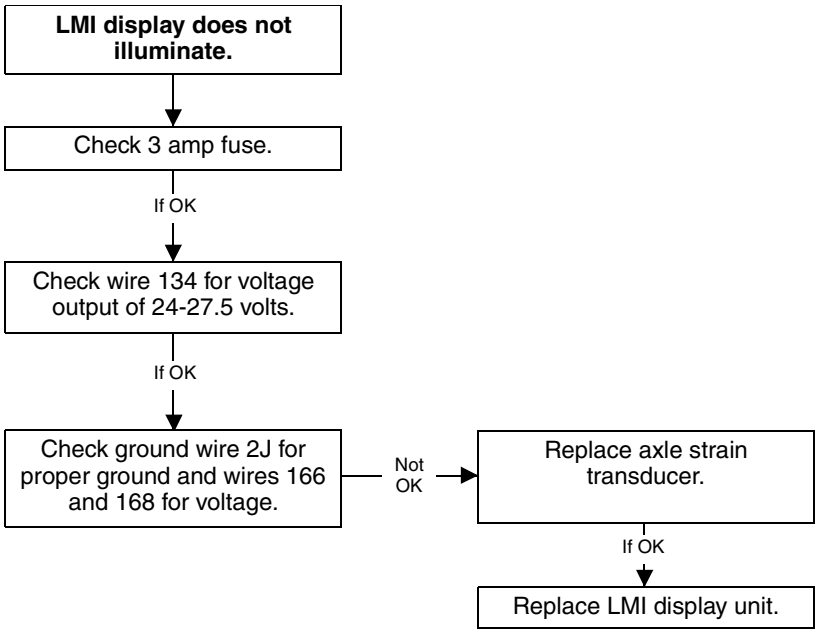
10.7.26 Cab Heater & Air Conditioning Blower Motor Circuit and Troubleshooting

Schematic is drawn with the ignition switch in the RUN position.



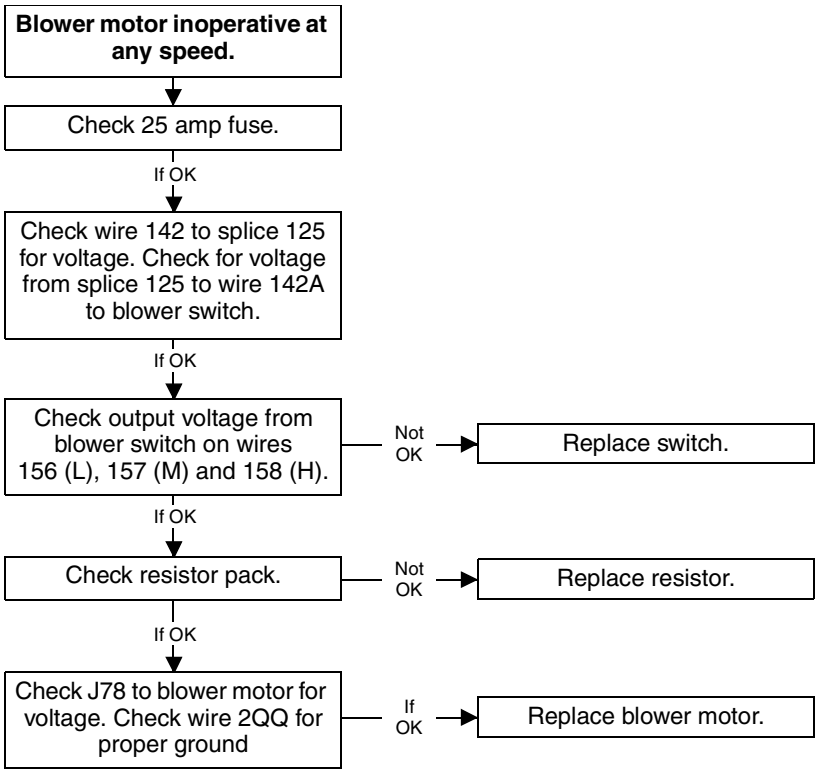
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



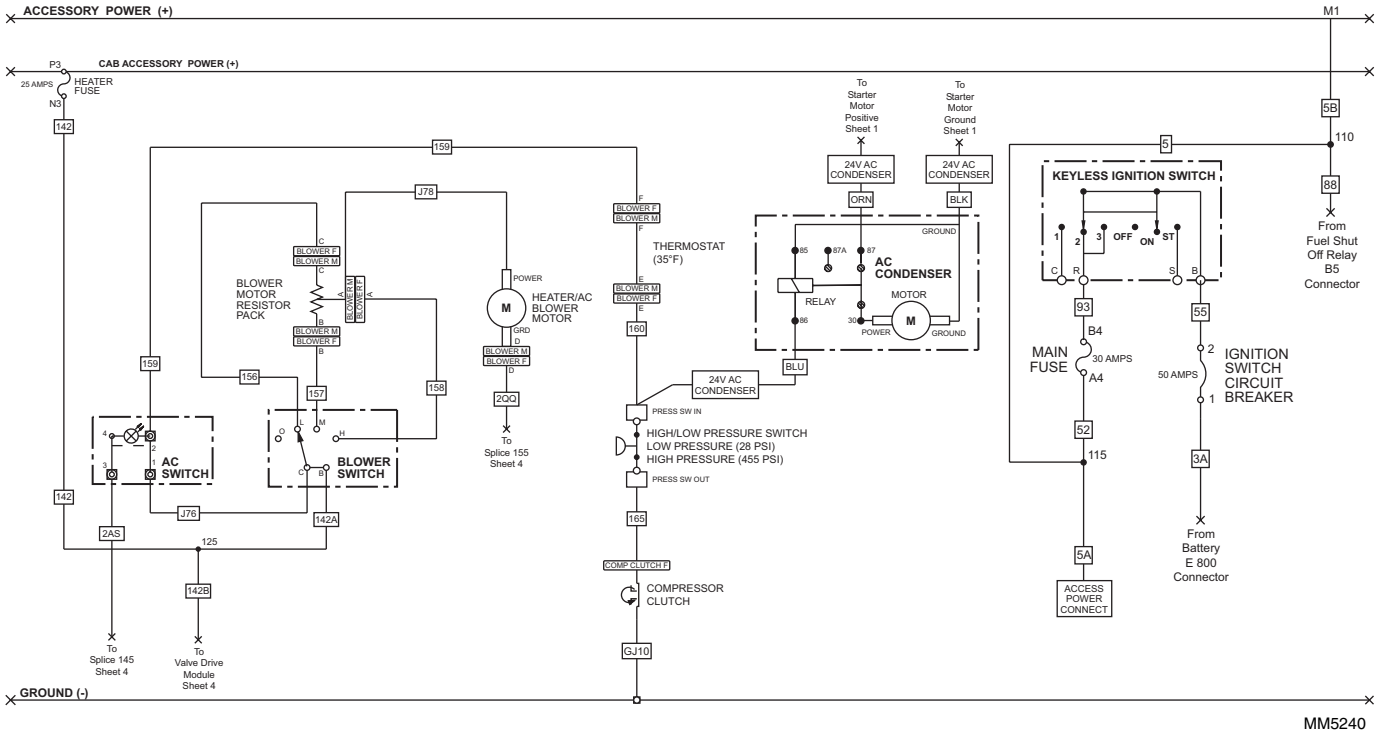
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.27 Air Conditioning Circuit and Troubleshooting

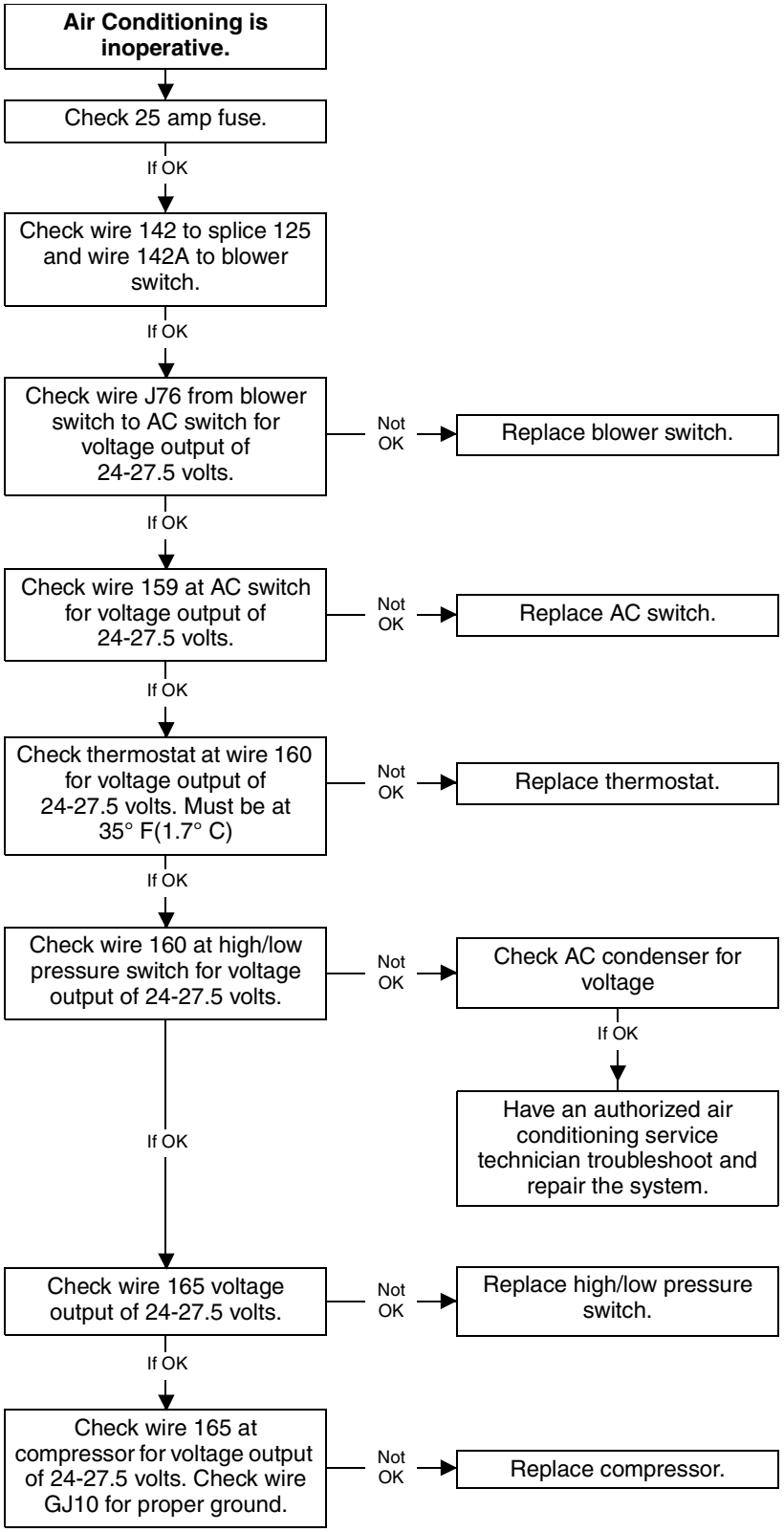
Schematic is drawn with the ignition switch in the RUN position.



MM5240

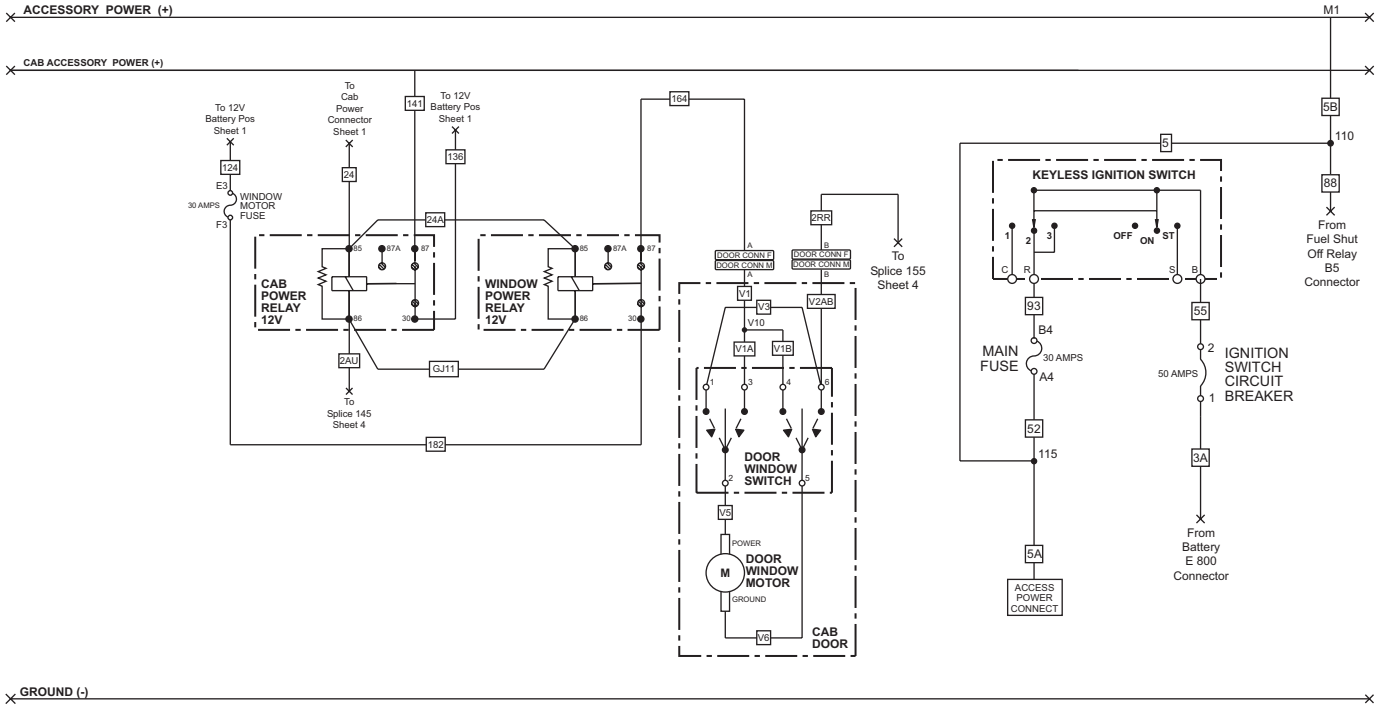
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**



10.7.28 Power Window Circuit and Troubleshooting

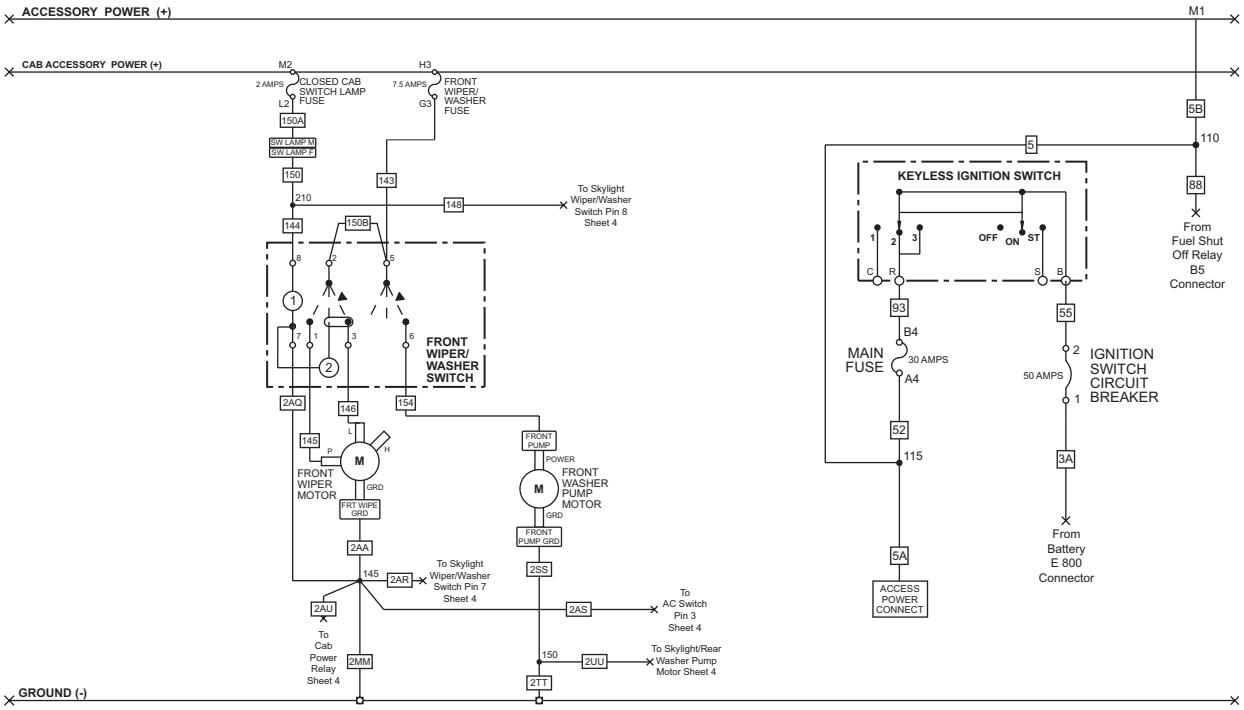
Schematic is drawn with the ignition switch in the RUN position.



MM5070

10.7.29 Front Wiper/Washer Circuit and Troubleshooting

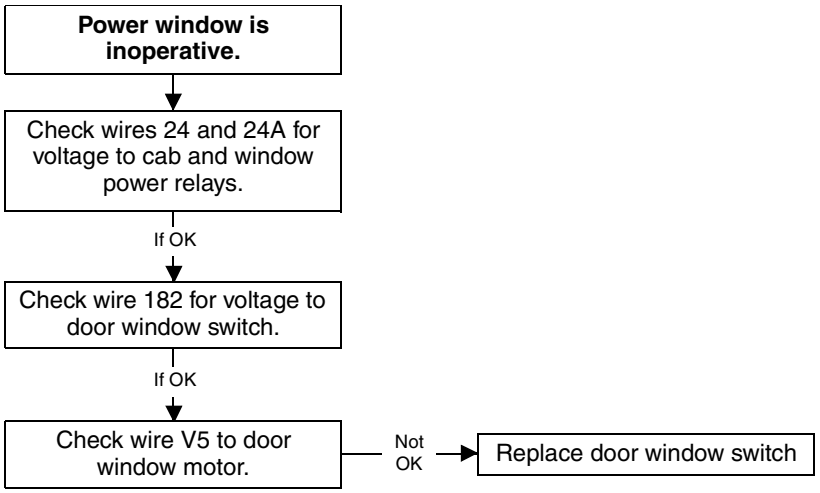
Schematic is drawn with the ignition switch in the RUN position.



MM5080

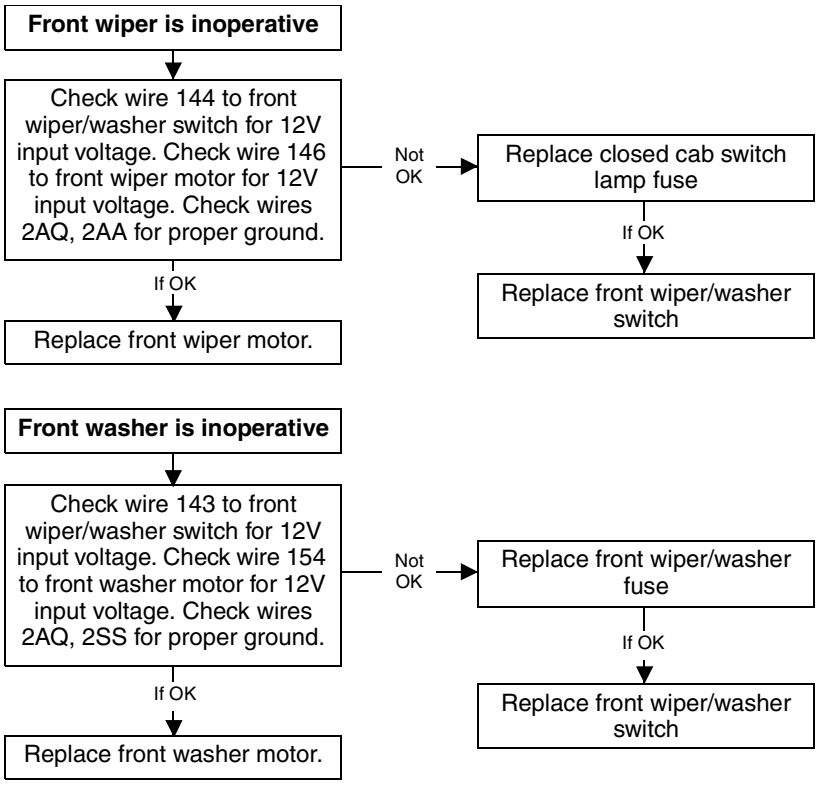
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**
2. **Fuses**



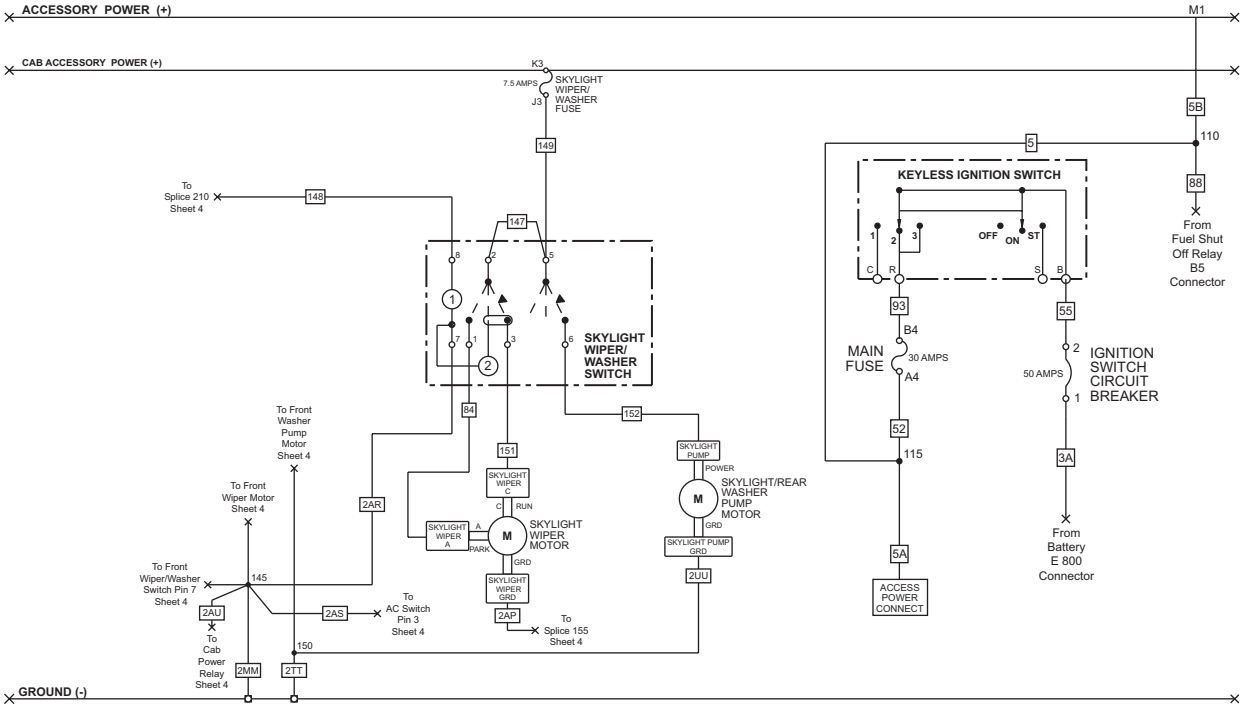
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**
2. **Fuses**



10.7.30 Skylight Wiper/Washer, Rear Washer Circuit and Troubleshooting

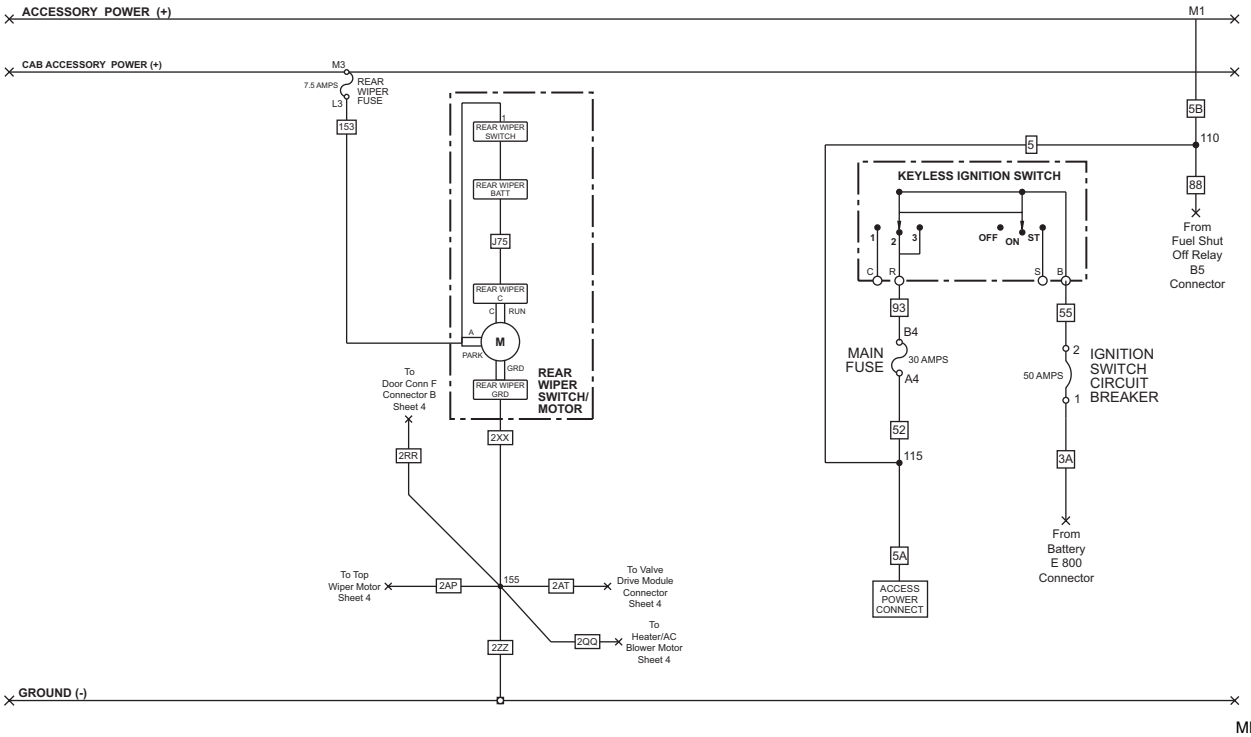
Schematic is drawn with the ignition switch in the RUN position.



MM5090

10.7.31 Rear Wiper Circuit and Troubleshooting

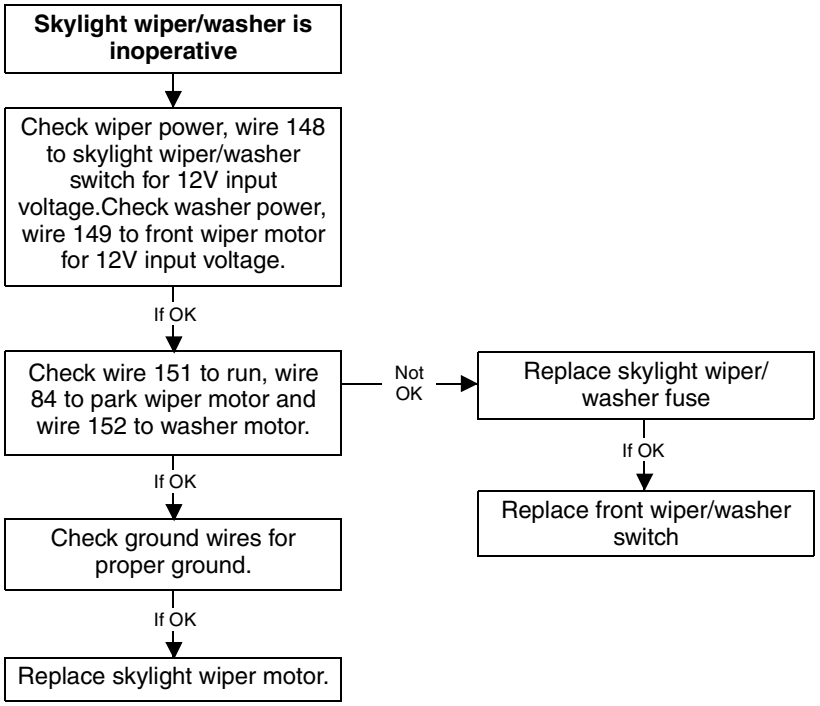
Schematic is drawn with the ignition switch in the RUN position.



MM5100

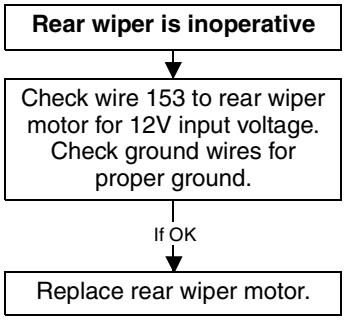
Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**
2. **Fuses**



Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **All connections relating to circuit are clean and tight**
2. **Fuses**

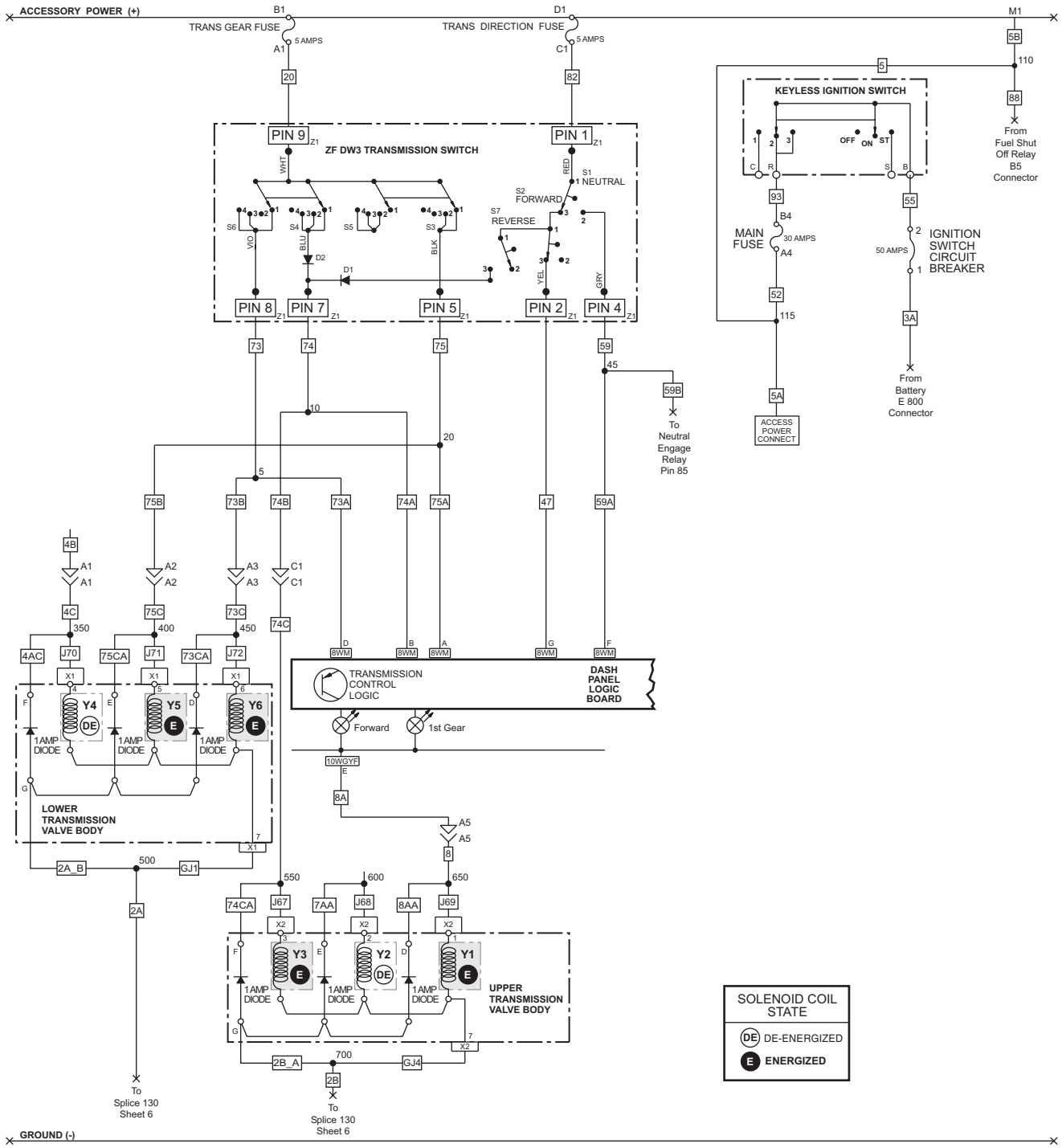


10.8 TRANSMISSION GEAR SELECTION TROUBLESHOOTING

The following seven electrical circuit schematics address each transmission position. Additional troubleshooting information can be found in *Section 10.13.7, Transmission Shift Control Switch*.

10.8.1 Transmission, Forward - First Gear Circuit

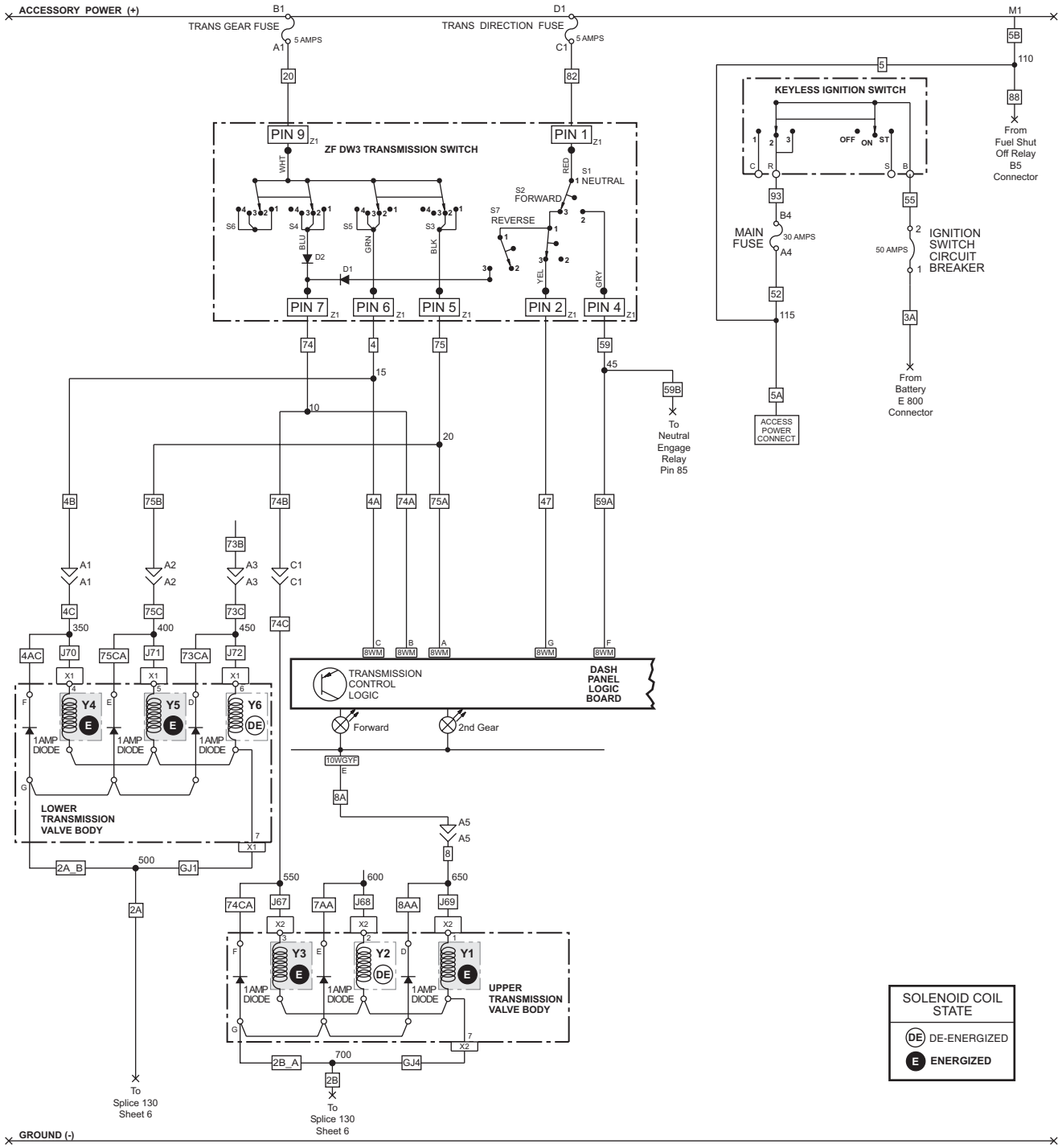
Schematic is drawn with the ignition switch in the RUN position.



MM4910

10.8.2 Transmission, Forward - Second Gear Circuit

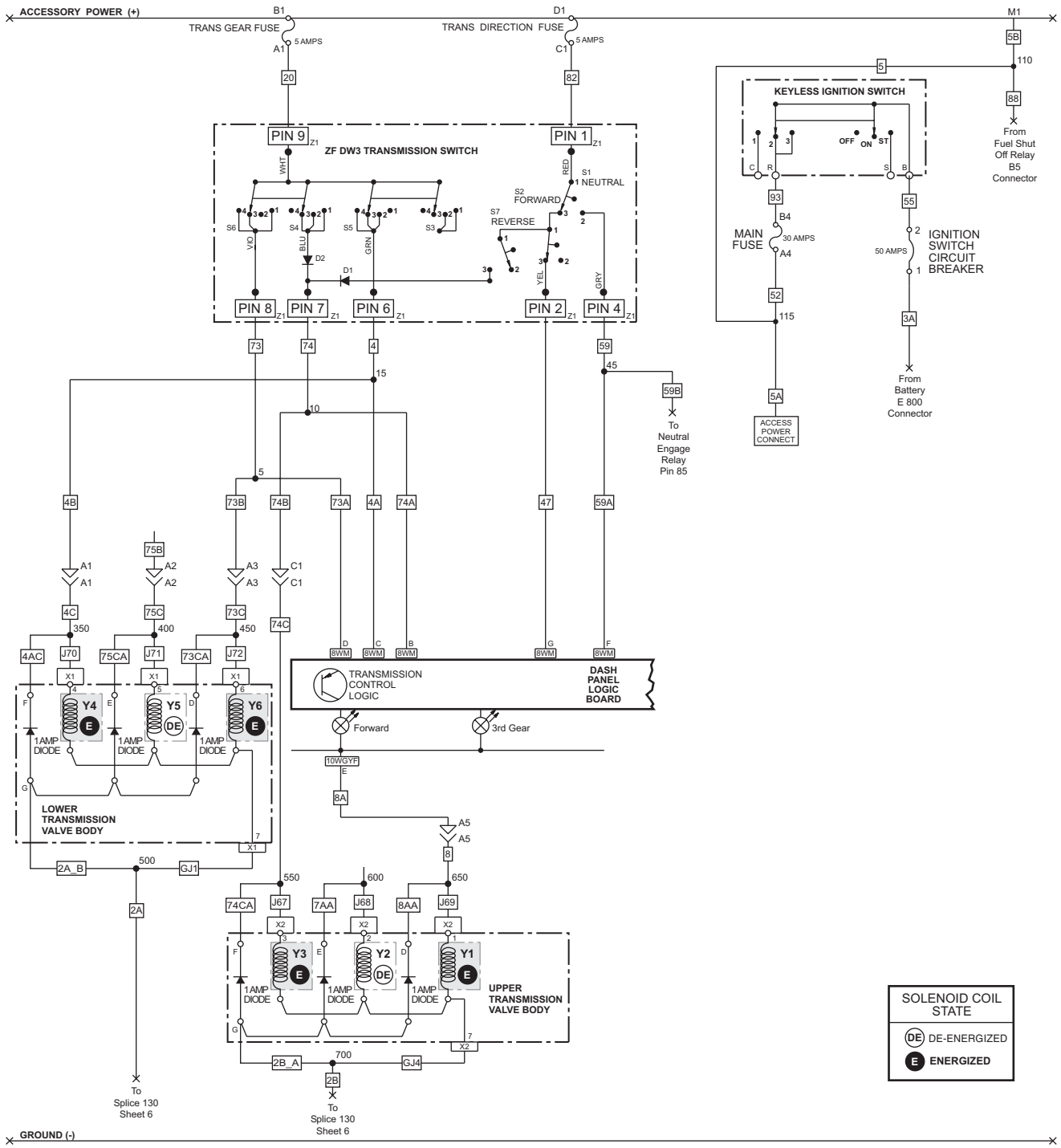
Schematic is drawn with the ignition switch in the RUN position.



MM4920

10.8.3 Transmission, Forward - Third Gear Circuit

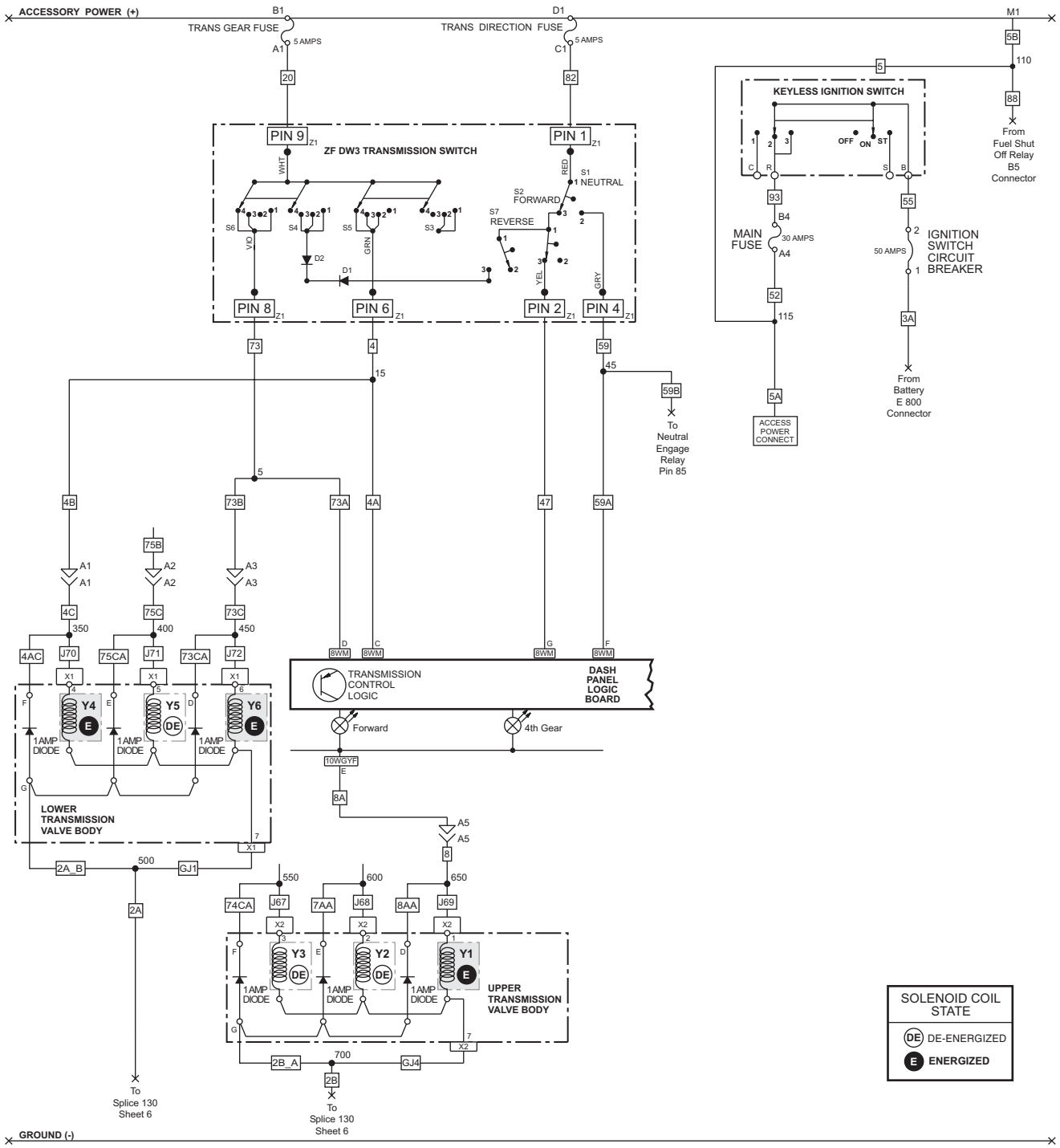
Schematic is drawn with the ignition switch in the RUN position.



MM4930

10.8.4 Transmission, Forward - Fourth Gear Circuit

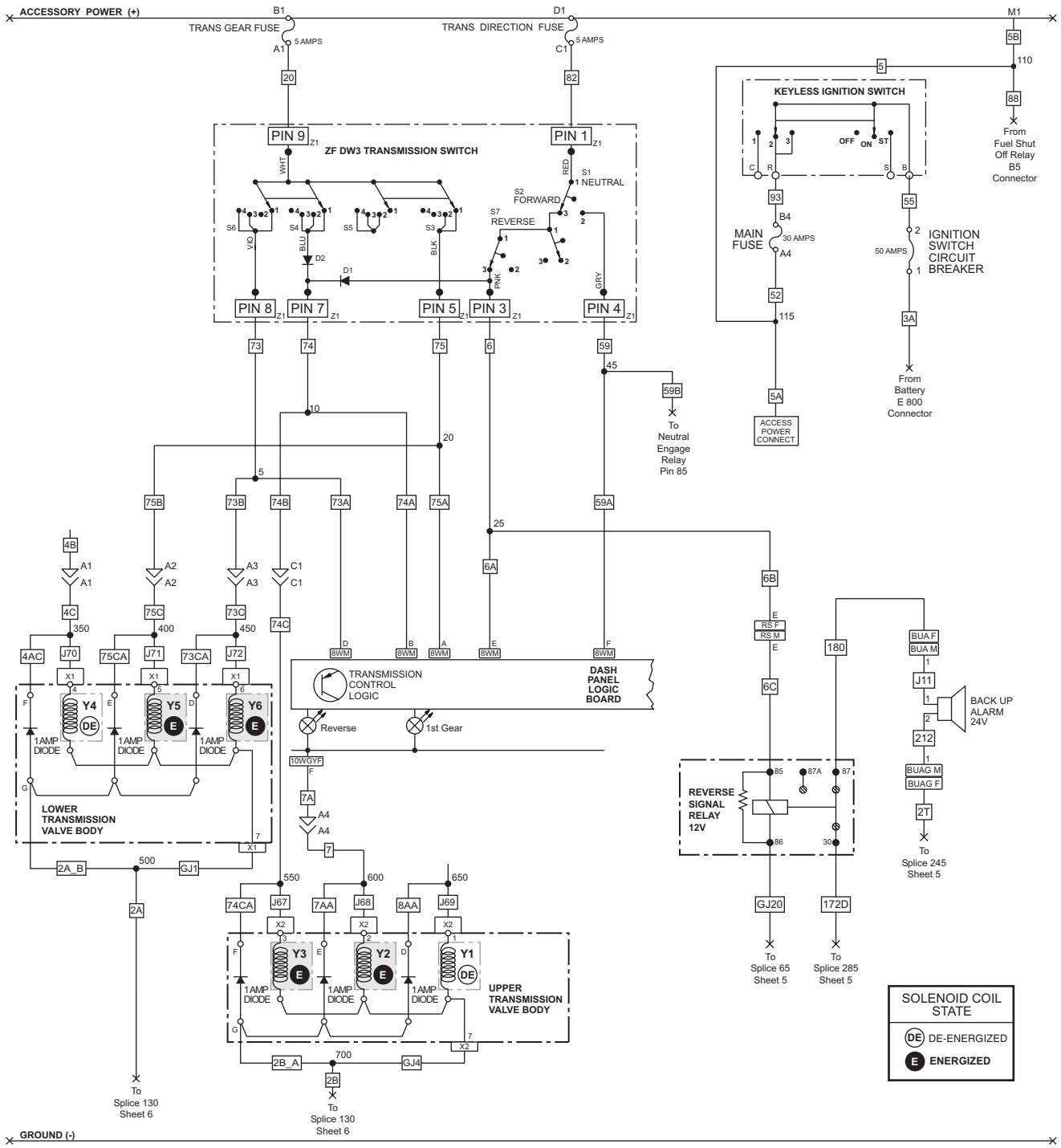
Schematic is drawn with the ignition switch in the RUN position.



MM4940

10.8.5 Transmission, Reverse - First Gear Circuit

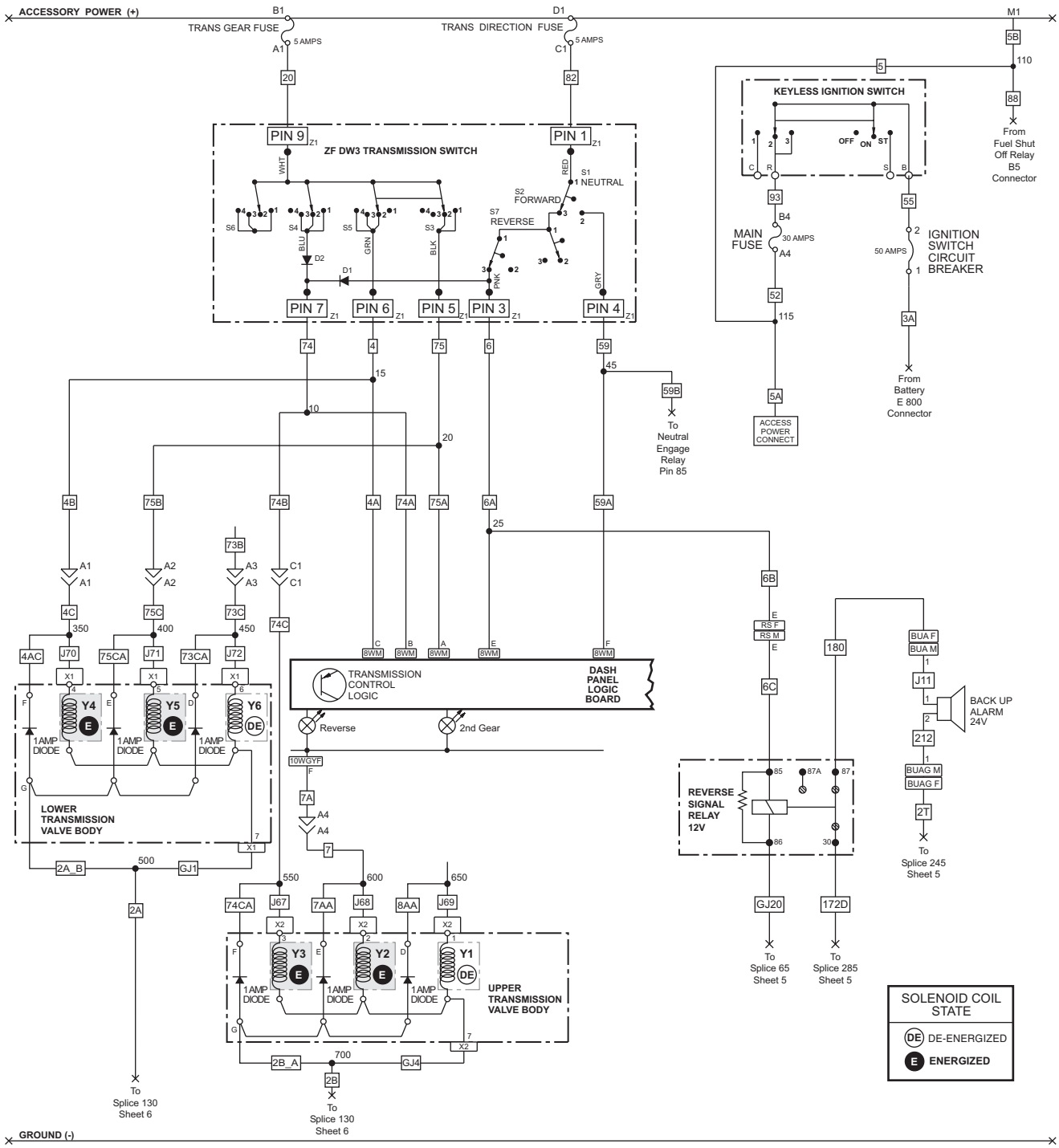
Schematic is drawn with the ignition switch in the RUN position.



MM4950

10.8.6 Transmission, Reverse - Second Gear Circuit

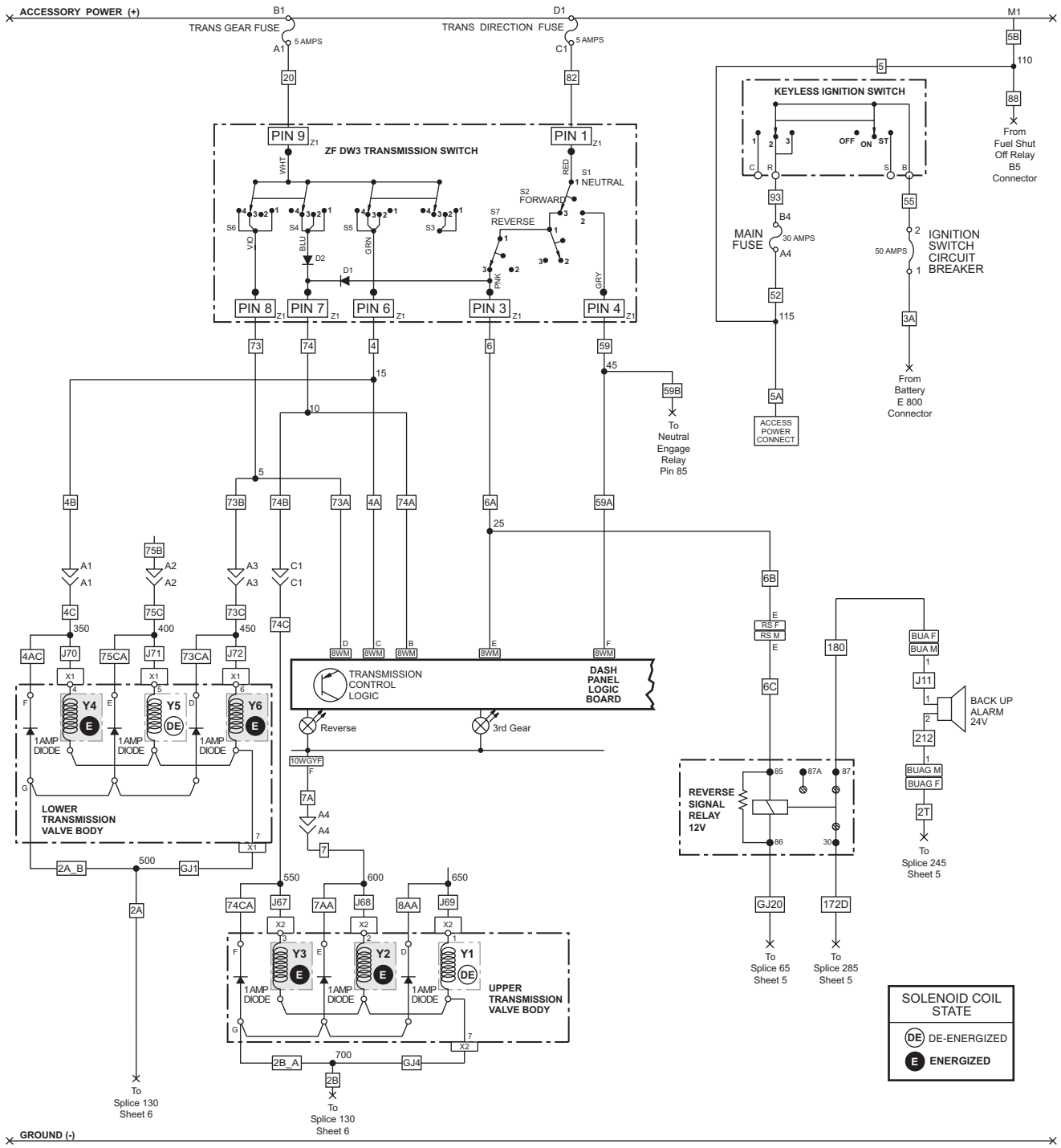
Schematic is drawn with the ignition switch in the RUN position.



MM4960

10.8.7 Transmission, Reverse - Third Gear Circuit

Schematic is drawn with the ignition switch in the RUN position.



MM4970

10.9 DASH PANEL WARNING INDICATOR TROUBLESHOOTING

The following nine troubleshooting flow charts discuss each dash panel indicator separately. Additional information for each indicator can be found by referring to *Section 10.7.7, Main Electrical Schematic (Sheet 2 of 6)*.

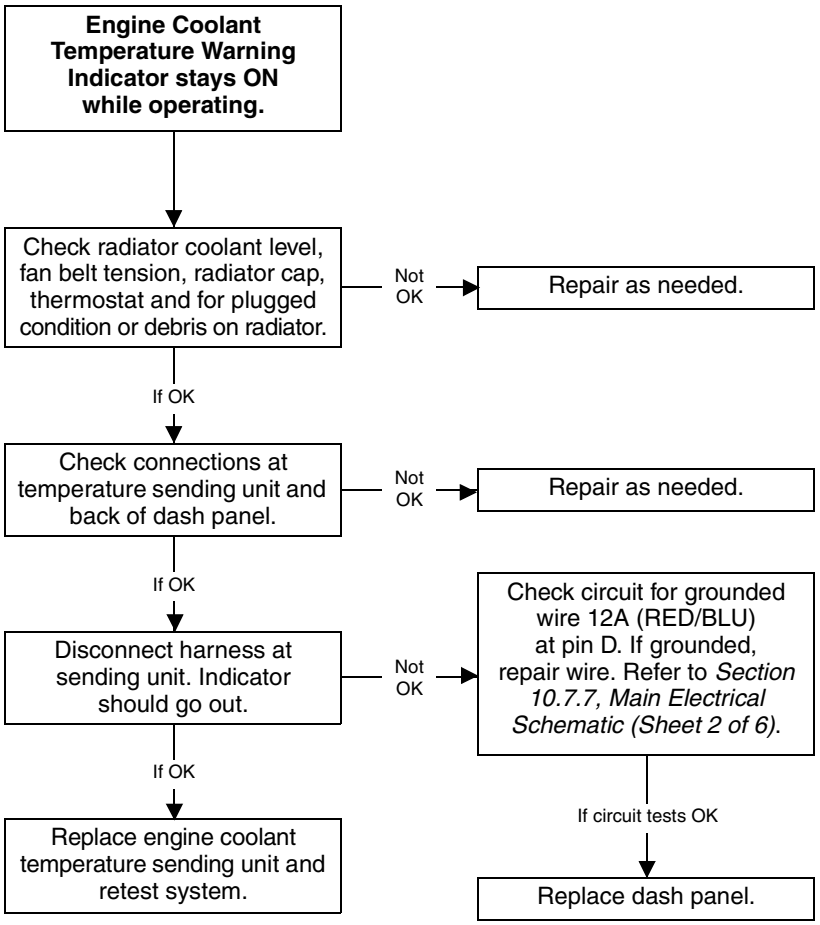
10.9.1 Engine Coolant Temperature Warning Indicator Troubleshooting



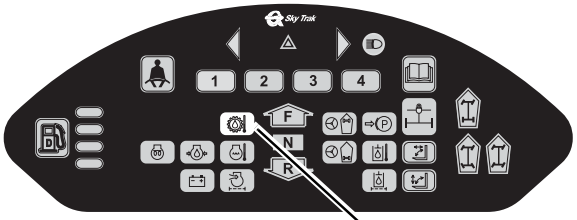
Engine Coolant Temperature Warning Indicator

Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**



10.9.2 Transmission Temperature Warning Indicator Troubleshooting



Transmission Temperature Warning Indicator

Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**

Transmission Temperature Warning Indicator stays ON while operating and alarm sounds.

↓

Stop and idle vehicle for 1 minute to allow transmission oil to cool.

↓ Not OK

Check transmission fluid level. Check radiator for plugged condition or debris.

→ Not OK → Repair as needed.

↓ If OK

Check connections and circuit at sending unit on transmission.

→ Not OK → Repair as needed.

↓ If OK

Disconnect harness at sending unit. Indicator should go out.

→ Not OK → Check circuit for grounded wire 32A (TAN) at pin E. If grounded, repair wire. Refer to *Section 10.7.7, Main Electrical Schematic (Sheet 2 of 6)*.

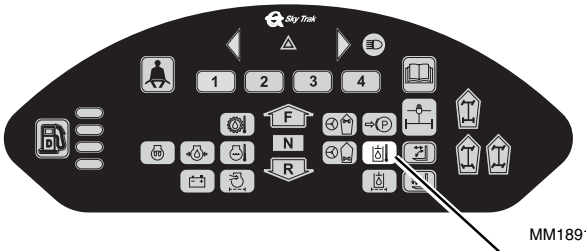
↓ If circuit tests OK

Replace dash panel.

↓ If OK

Replace transmission temperature sending unit and retest system.

10.9.3 Hydraulic Oil Temperature Warning Indicator Troubleshooting



Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**

Hydraulic Oil Temperature Warning Indicator stays ON while operating.

Stop and Idle engine for 5 minutes to allow hydraulic oil to cool.

Not OK

Check hydraulic fluid level. Check for plugged condition or debris on oil cooler.

Not OK → Repair as needed.

If OK

Check connections and circuit at sending unit.

Not OK → Repair as needed.

If OK

Disconnect harness at sending unit. Indicator should go out.

Not OK → Check circuit for grounded wire 14A (WHT/RED) at pin A. If grounded, repair wire. Refer to *Section 10.7.7, Main Electrical Schematic (Sheet 2 of 6)*.

If OK

Replace hydraulic oil temperature sending unit and retest system.

If circuit tests OK

Replace dash panel.

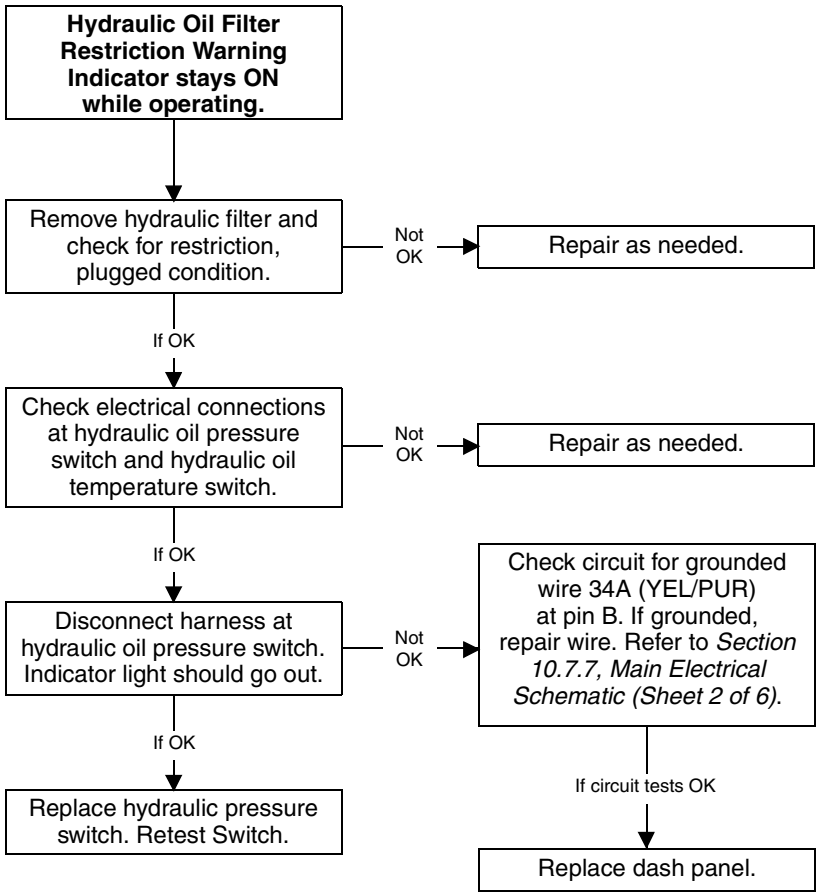
10.9.4 Hydraulic Oil Filter Restriction Warning Indicator Troubleshooting



Hydraulic Oil Filter Restriction Warning Indicator

Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**



10.9.5 Engine Air Filter Restriction Warning Indicator Troubleshooting



Engine Air Filter Restriction Warning Indicator

Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**

Engine Air Filter Restriction Warning Indicator stays ON while operating.

Check air filter element. Check for plugged or dirty condition. Check for air inlet for obstruction.

Not OK → Repair as needed.

If OK

Check connections and circuits at air filter pressure switch on air cleaner assembly.

Not OK → Repair as needed.

If OK

Disconnect harness at air filter pressure switch. Indicator should go out.

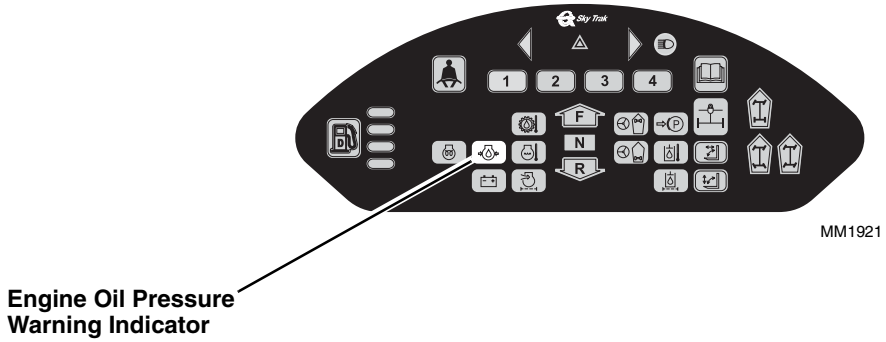
Not OK → Check circuit for grounded wire 31A (YEL/ORN) at pin C. If grounded, repair wire. Refer to *Section 10.7.7, Main Electrical Schematic (Sheet 2 of 6).*

If circuit tests OK → Replace dash panel.

If OK

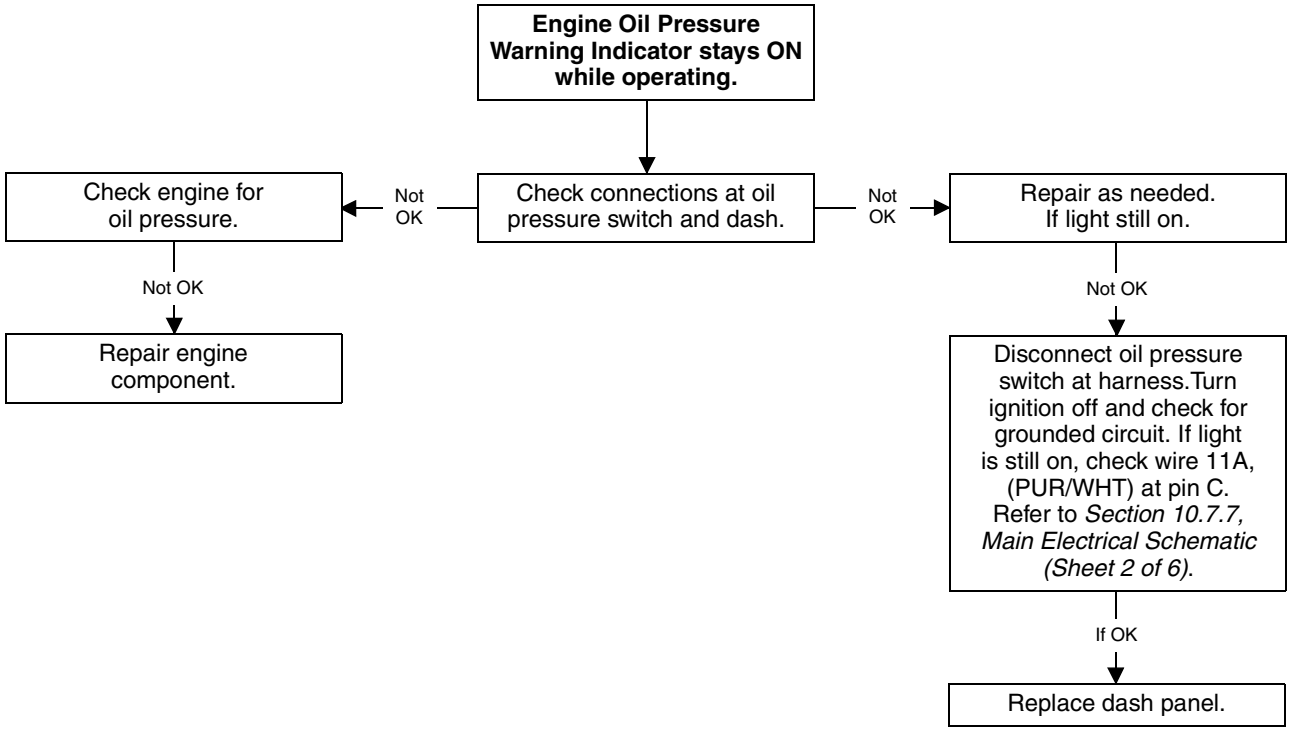
Replace air filter pressure switch. Retest system.

10.9.6 Engine Oil Pressure Warning Indicator Troubleshooting

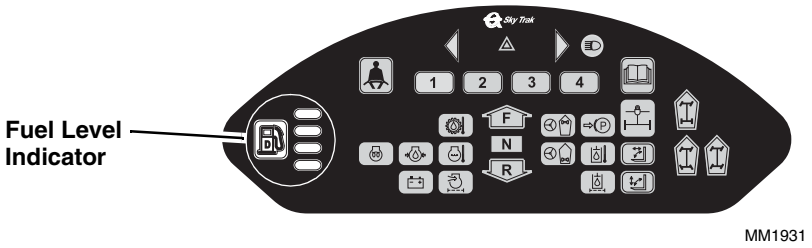


Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**

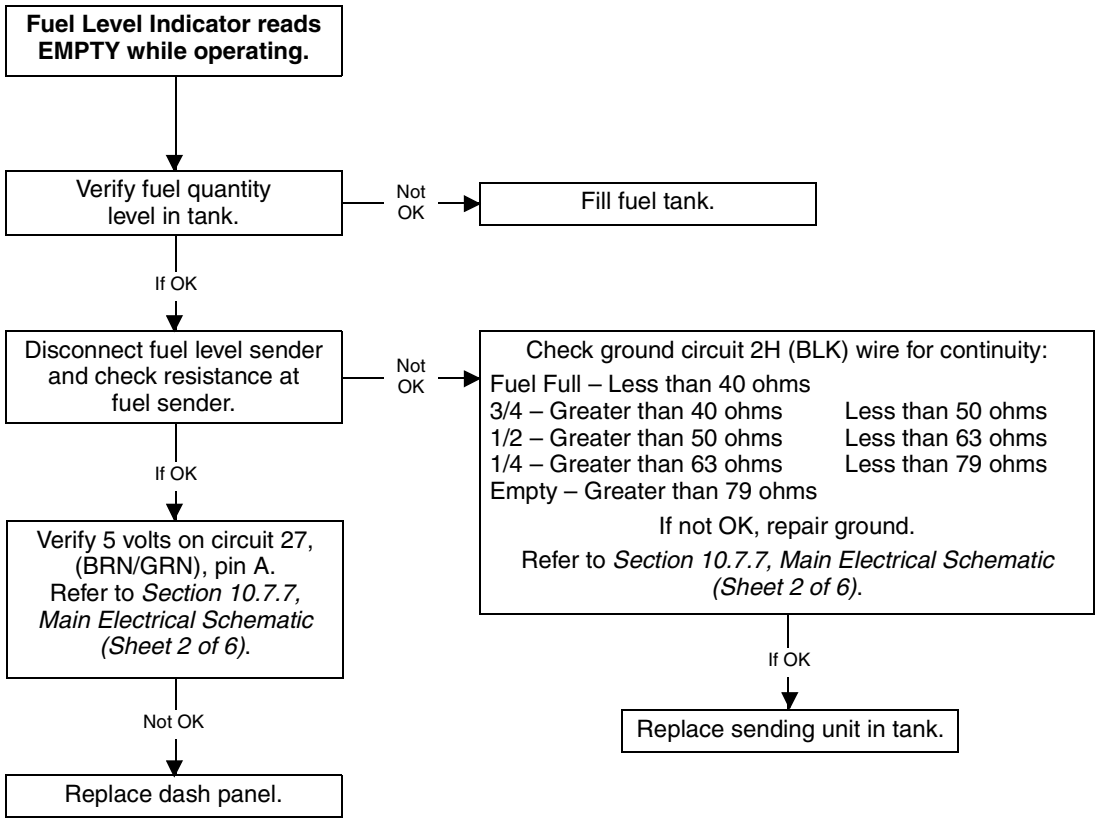


10.9.7 Fuel Level Indicator Troubleshooting

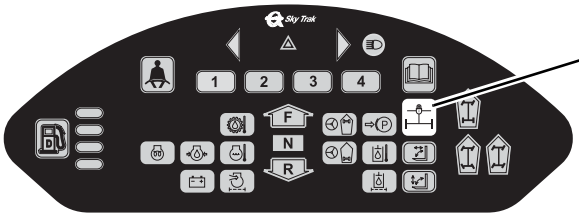


Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**



10.9.8 Stabil-TRAK Indicator Troubleshooting



Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**

Stabil-TRAK Indicator ON with boom below 40° with ignition ON.

↓

Check proximity switch connection with boom below 40°. Proximity switch L.E.D. should be on.

Not OK → Adjust proximity switch or repair connection and check for voltage on circuit 65 (ORN/BLU) to boom proximity switch. If 12 volts is not present, repair circuit 65. Refer to *Section 10.7.6, Main Electrical Schematic (Sheet 1 of 6)*.

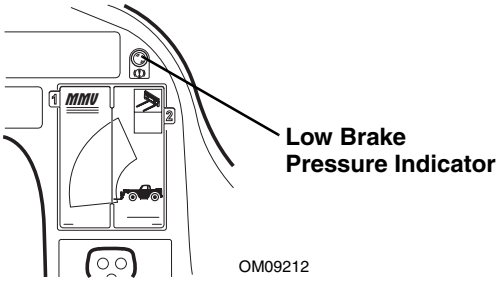
If OK ↓

Replace proximity switch and retest.

If OK ↓

If Stabil-TRAK indicator is still ON, replace dash panel.

10.9.9 Low Brake Pressure Indicator Troubleshooting



Before troubleshooting any electrical circuit, ALWAYS begin by checking the following:

1. **Fuses.**
2. **Batteries for proper charge.**
3. **All connections relating to circuit are clean and tight.**

Low Brake Pressure Indicator ON with engine running.

↓

Check both accumulator charge pressures. Refer to *Section 9.13, Accumulators*.

Not OK → Recharge accumulators as necessary. Refer to *Section 9.13, Accumulators*.

If OK ↓

Check accumulator charge valve pressures. Refer to *Section 9.7, Hydraulic System Testing*.

Yes ← Retest and see if Low Brake Pressure Indicator is ON with the engine running.

No ↓

Problem solved.

If OK ↓

Check low brake pressure switch for continuity.

- Low brake pressure switch is closed when service brake hydraulic system pressure drops below safe operating level. (Light On)
- Low brake pressure switch is opened when service brake hydraulic system pressure rises above safe operating level. (Light Off)

Not OK → Replace switch.

10.10 ENGINE START CIRCUIT

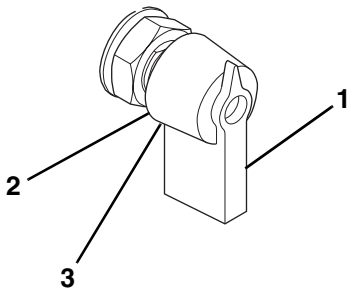
The purpose of the engine start circuit is to energize the starter solenoid and engage the starter motor to start the engine. To start the engine, the ignition switch (**1**) must be in the START (**2**) position, parking brake switch must be in the ON position and transmission shift control switch (travel select lever) must be in the NEUTRAL (center) position.

When the ignition switch is turned to the START (**2**) position, and with the transmission in NEUTRAL (N), the starting circuit activates the starter relay, starter solenoid, and fuel shutoff solenoid. The fuel shutoff solenoid opens a valve that supplies fuel to the injection pump.

10.10.1 Starting Circuit

The starting circuit functions as follows:

1. 24V direct current from the battery flows through the positive (+) battery cable to the starter solenoid.
2. 12V direct current also flows through the ignition switch circuit breaker and to the ignition switch.
3. When the ignition is pushed IN and turned to the START (**2**) position, current flows through contacts in the ignition switch, through the fuse panel, to the parking brake switch.

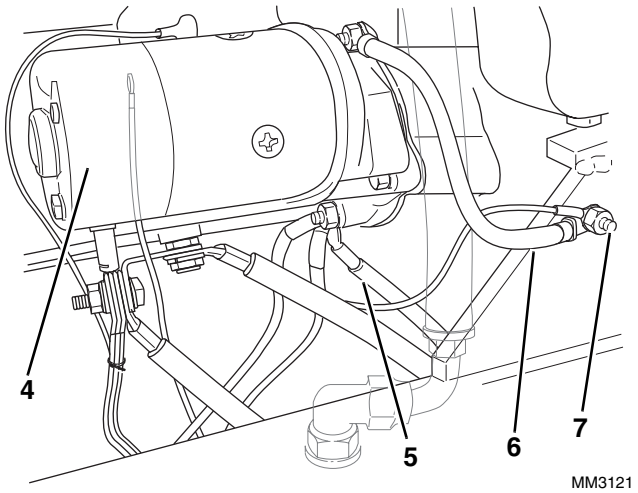


OM4760

4. If the parking brake is set, current flows through contacts in the brake switch to the neutral engage relay.
5. If the transmission select lever is in NEUTRAL (N), current flows through the neutral engage relay to energize the coil of the engine start relay. (This closes the contacts in the engine start relay.) The engine start relay contacts close and current flows to the engine start solenoid. (The flow of current closes internal contacts in the engine start solenoid that allow current to flow through starter solenoid.) The engine start solenoid coil energizes and its contacts close allowing current to flow to the starter motor.
6. The starter solenoid engages a gear on the starter pinion shaft to mesh with the flywheel, and the starter pinion and gear begin to spin, in turn rotating the flywheel, crankshaft and related components within the engine.
7. When the ignition switch was initially turned, the fuel shutoff solenoid opened a valve to supply to the fuel injection pump. As the starter rotated the engine components, the fuel injection pump and related lines and injectors supplied fuel to the cylinders.
8. When the pistons compress injected fuel, ignition occurs, the engine starts and the starter pinion retracts.
9. As the engine runs it operates an alternator that recharges the battery used during the starting cycle.
10. When the ignition switch is released after starting the engine, the ignition switch returns to the neutral RUN (**3**) position where it directs current to the fuse panel that distributes electrical current for the operation of vehicle controls, including the joystick, gauges and other equipment.

10.10.2 Starter

The starter (**4**) is located on the left side of the engine (the right side of the vehicle), just inboard of the hydraulic oil reservoir.



The starter operates when the attached starter solenoid engages a gear on the starter pinion shaft to mesh with the flywheel, and the starter pinion and gear begin to spin, in turn rotating the flywheel, crankshaft and related components within the engine.

The starter is grounded via the negative (-) battery cable (**5**) and the starter ground strap (**6**). The negative (-) battery cable is routed from the battery to the main ground stud on the bottom starter mounting flange. The starter ground strap is routed from the ground stud on the top starter mounting flange to the frame ground stud (**7**), located on a triangular weldment above the hydraulic reservoir.

a. Testing the Starter on the Engine

If the starter does not engage when the ignition switch is turned, check the following:

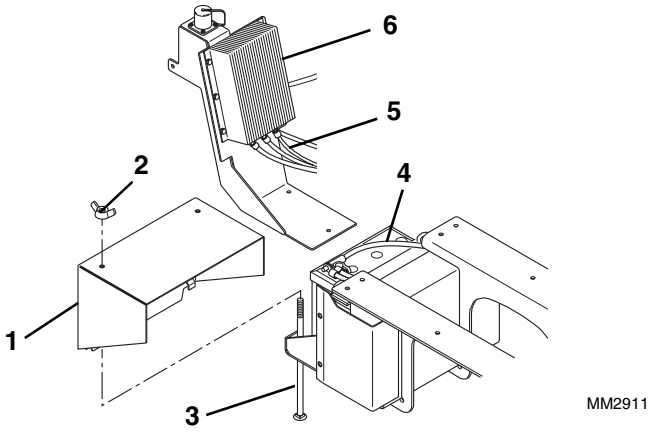
1. The main fuse may be blown, requiring replacement. Check for the cause of the blown fuse.
2. There may be a defect in the ignition switch, ignition wiring, or starter solenoid.
3. Check battery condition. Clean the battery posts and the connectors at each end of the battery cables. Also check the ground cable behind the starter mounting bolt and the frame ground stud, just above the hydraulic oil reservoir fill cap.
4. Check for broken wiring and damaged insulation on the wiring. Replace all broken or damaged wiring.
5. Check all connections at the starter solenoid, ignition switch, and wiring harness plugs. Clean and tighten all connections.
6. If the starter still does not operate after these checks have been performed, check the starting circuit.

b. Starter Circuit Checks

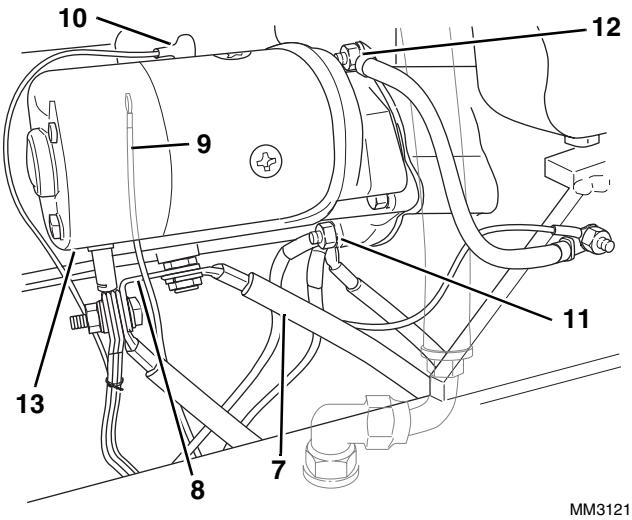
1. Check wires and connections for looseness, corrosion, damage, etc.
2. If a “whirring” noise is heard, but the engine does not turn over, the starter is spinning but not engaging the flywheel. The starter drive or solenoid that pushes the drive forward to engage the flywheel may be defective. Missing or damaged teeth on the flywheel can also prevent the starter from cranking the engine.
3. If the starter only “clicks”, it may indicate that the battery is discharged, or that there is a loose or corroded battery cable connection. Check the battery state of charge and battery condition first, then check the cables and cable connections.
4. For additional information on the starting circuit refer to *Section 10.7.12, Engine Start Circuit and Troubleshooting*.

c. Starter Removal

1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



4. Label and disconnect the positive (+) battery cable (**7**) and starter terminal (**8**). Leave the wires connected to the starter terminal.
5. Label and disconnect the blue wire (**9**) from the starter solenoid housing stud and white wire from the boot connection (**10**) on top of the starter. Note how the wires are installed for ease of installation later.



6. Loosen, but **DO NOT** remove, the three fasteners securing the starter to the flywheel housing. Support the starter securely, as it is relatively heavy and will fall if not supported.
7. Support the starter and remove the fasteners securing the starter to the engine. Label and remove the wires connected to the bottom starter mounting bolt (**11**). Label and remove the negative (-) ground cable from the top starter mounting bolt (**12**).
8. Remove the starter (**13**) from the vehicle.

d. Starter Cleaning and Drying

1. While the starter is out, wipe away any grease or dirt that has accumulated around the starter mounting opening.
2. If reinstalling the starter, clean the exterior of the starter with an approved solvent. **DO NOT** submerse the starter or allow the solvent to contact the starter bushings.
3. Dry the starter with a clean, lint-free cloth.

e. Starter Periodic Maintenance

A starter requires no routine maintenance beyond the occasional inspection of the electrical connections, which must be clean and tight. The starter is not serviceable; replace a defective starter with a new unit.

f. Starter Installation

1. Position the starter (**13**) in its mounting opening on the flywheel housing. Secure the starter with three fasteners. Position the ground cable over the top starter mounting bolt (**12**). Position cables, labeled for the bottom starter mounting, over the bottom starter mounting bolt (**11**). Torque hex nuts to 3.4 lb/ft (4,6 Nm) and torque capscrews to 32 lb/ft (43 Nm).
2. Connect the white wire to the boot connection (**10**) on top of the starter and blue wire (**9**) to the starter solenoid stud.
3. Connect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.

10.11 CHARGING CIRCUIT

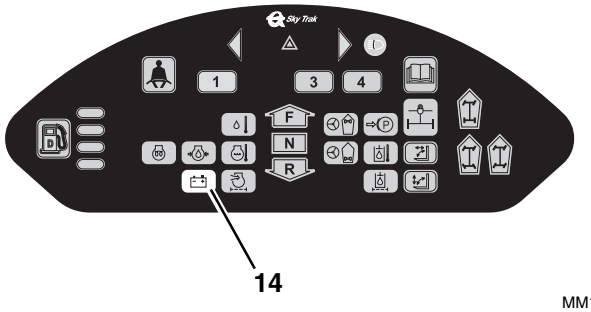
The purpose of the charging circuit is to maintain battery voltage between 13.8 and 14.2 volts. The ignition switch must be in the RUN position with the engine running for the charging system to operate.

The charging circuit consists of the battery and a belt-driven alternator with an internal voltage regulator. These components work together to provide electrical power for the vehicle, including the starting system, operator's display panel, horn, solenoids, back-up alarm, joystick, logic panel and all accessories.

Current flows from the positive post of the battery to the BATT terminal on the starter motor.

When the ignition switch is in the RUN position, excitation and the alternator begins emitting a charge. Current flows from the alternator B+ terminal to the starter motor B terminal, then through the positive (+) battery cable to the battery. The circuit in the instrument panel connects to the battery positive terminal through the fuse panel and detects field voltages in excess of 16 volts or system voltages that is less than 2-4 volts below battery voltage. Either of these conditions will cause the warning light in the operator's display panel to illuminate.

The warning indicator (**14**), a battery-shaped icon on the operator's display panel, illuminates for three seconds when the engine is started and will remain illuminated if the engine is not running. The warning indicator illuminates when the battery is at a low state of charge, and when the alternator is no longer able to charge the battery.



MM1971

The negative (-) post of the battery (**4**) is connected to the main chassis ground, a stud located on a weldment at the hydraulic reservoir. Other ground leads routed directly from the main chassis ground are provided to the alternator, fuel shutoff switch, maintenance reset switch and spliced within the wiring harness to other electrical system grounds.

The alternator includes an internal voltage regulator that limits alternator voltage to a pre-set value and helps prevent circuit overloads, power surges, etc. during peak-voltage output.

Beyond inspecting the fan belt every 1,000 hours of engine operation, there is no periodic maintenance required for the charging circuit. When inspecting the fan belt, also check the electrical wiring and connectors.

Under normal conditions the alternator will have no problem keeping the battery charged. The only condition in which the battery may cause a problem is when it has been completely discharged for an extended period of time. In this condition, the alternator may be unable to recharge the battery, and a battery charger will be required for recharging.

Before using a battery charger, an attempt can be made to recharge the battery by slave starting the vehicle (refer to *Section 2.13.17, c. Slave Starting*). Allow the engine to run, which enables the alternator to charge the battery.

WARNING: **DO NOT** charge a frozen battery. A frozen battery may explode and cause serious personal injury. Allow the battery to thaw before "slave starting" the vehicle or connecting a battery charger.

CAUTION: Before performing ANY welding on vehicle, disconnect the negative (-) battery cable at the negative (-) battery terminal. Failure to remove the negative (-) battery cable will result in damage to vehicle electronic systems.

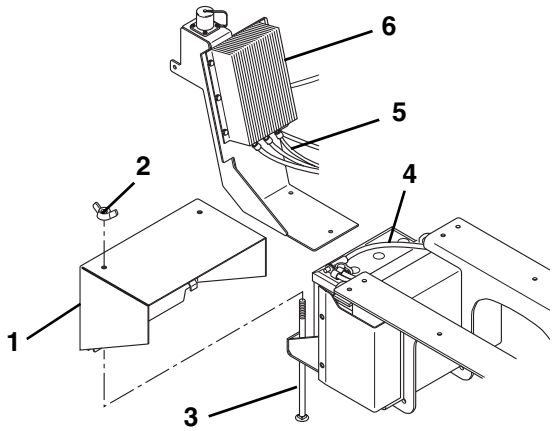
If the alternator charging warning indicator illuminates, perform the following checks:

1. Check the battery cable connections at the battery and verify that they are clean and tight.
2. Check the external alternator wiring and connections and verify that they are in good condition.
3. Check the fan belt condition and tension (refer to *Section 2.13.8, Engine Fan Belt & Air Conditioner Compressor Belt*).
4. Verify that the alternator mounting hardware is tight.
5. Run the engine and check the alternator for noise. A loose drive pulley, loose mounting hardware, worn or dirty internal alternator bearings, a defective stator or defective diodes can cause noise. Replace a worn or defective alternator.
6. For additional information on the charging circuit refer to *Section 10.7.13, Charging Circuit and Troubleshooting*.

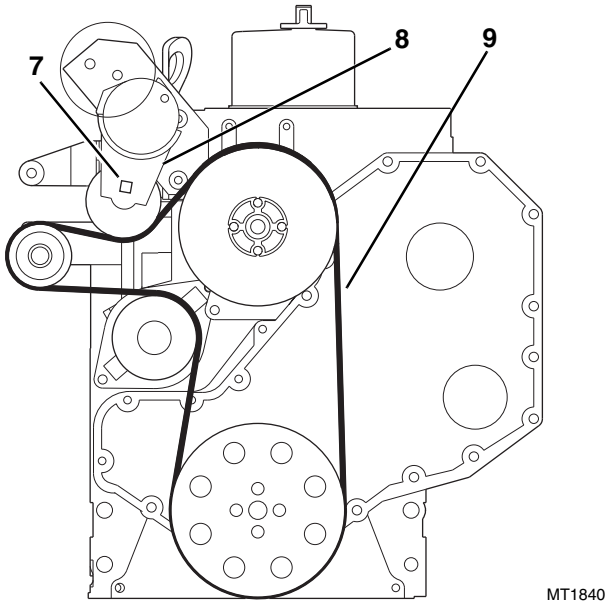
10.11.1 Alternator

a. Alternator Removal

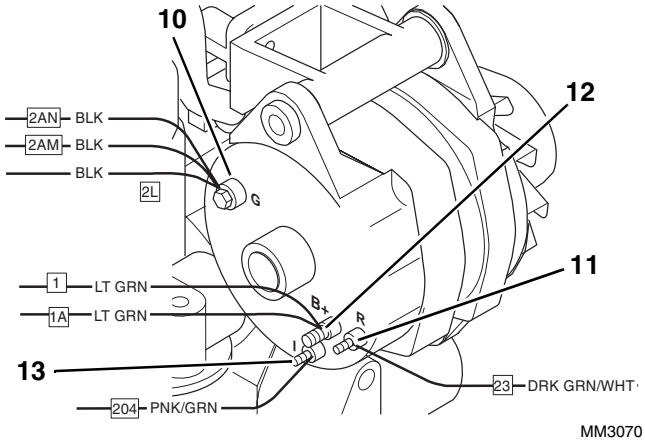
1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



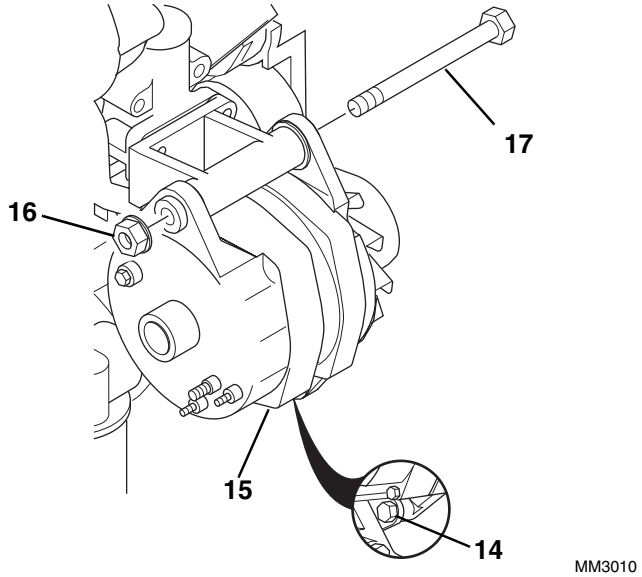
4. Install a 1/2" square drive ratchet into the square hole (**7**) in the tensioner bracket (**8**). Turn the ratchet to lift the bracket and remove the engine fan belt (**9**).



5. Label and disconnect the alternator ground wire (**10**), R (**11**), B+ (**12**), and I (**13**) wire leads.



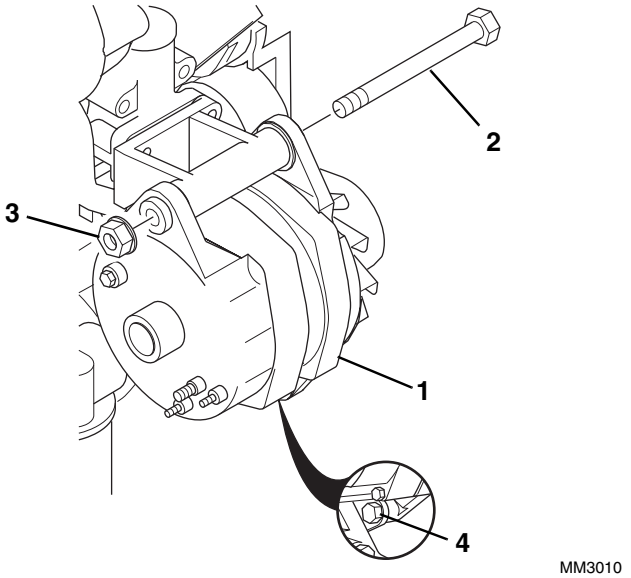
6. Remove the lower alternator bracket capscrew (**14**) on the bottom of the alternator (**15**).



7. While supporting the alternator with one hand, remove the upper alternator mounting locknut (**16**) and capscrew (**17**). Remove the alternator from the vehicle.

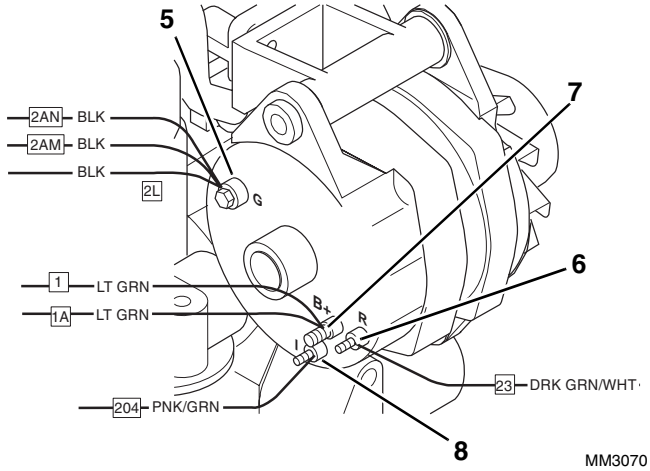
b. Alternator Installation

1. Position the alternator (**1**) and align with the upper alternator mount on the engine bracket. Insert the upper ("longer") mounting capscrew (**2**) through the rear mount and alternator. Secure the capscrew with the locknut (**3**). **DO NOT** tighten locknut completely at this time.



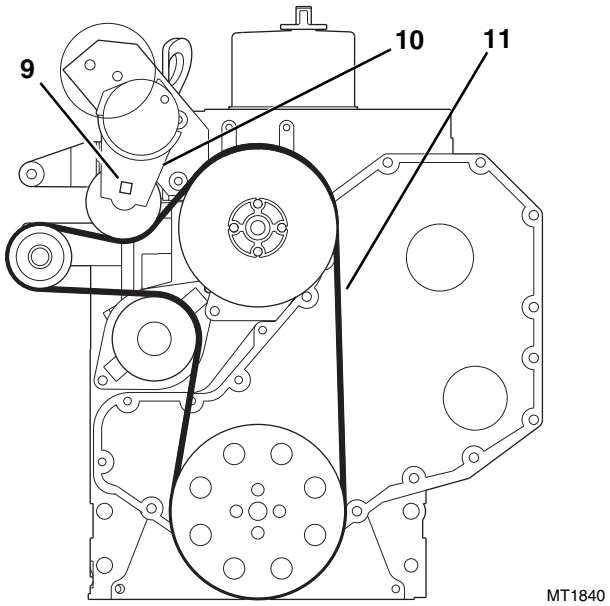
MM3010

2. Align the lower alternator mount hole with the lower mounting tab on the engine and insert the lower mounting capscrew (**4**). Tighten the lower capscrew and upper locknut (**2**) securely.



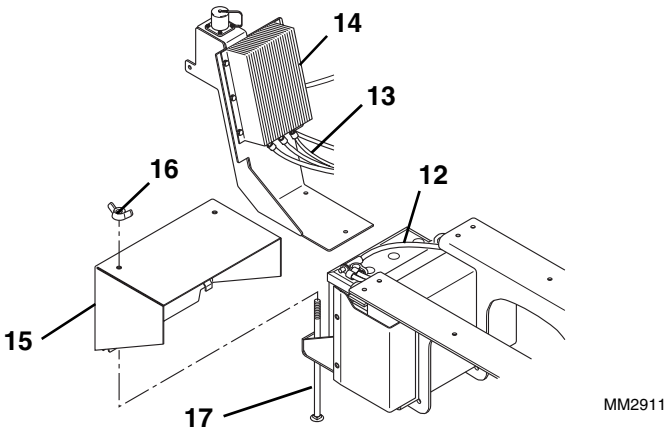
MM3070

3. At the rear of the alternator, reattach all wires to their proper terminals (**5**), (**6**), (**7**), and (**8**).



MT1840

4. Place a 1/2" square drive ratchet into the square hole (**9**) on the tensioner bracket (**10**). Apply pressure against the tensioner bracket and properly route the fan belt (**11**) onto the alternator and engine pulleys. Check the tensioner pulley to verify that it is pivoting freely to provide the proper tension on the belt. Check for proper fan belt deflection (refer to *Section 2.13.8, Engine Fan Belt & Air Conditioner Compressor Belt*).
5. Connect the negative (-) battery cable (**12**) at the battery negative (-) terminal on the battery in the engine side battery box.
6. Connect the negative (-) battery equalizer cable (**13**) at the bottom of the battery equalizer (**14**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
7. Replace battery box cover (**15**). Use the wing nuts (**16**) and carriage bolts (**17**) to secure the cover in place.



10.11.2 Batteries

> **WARNING:** All lead acid batteries generate hydrogen gas, which is highly flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery, and possible severe personal injuries. Wear safety glasses when working near batteries. In case of contact with acid, flush immediately with water.

Two batteries are used in this vehicle. They are both 12-volt, lead acid type, negative (-) ground, maintenance-free batteries rated at 1225 cold-cranking amps. Refer to *Section 2.13.17, Batteries* for general information.

a. Battery Description

The battery equalizer maintains a balanced charge on the two batteries in series to keep them at full charge levels. The batteries provide extra power when the electrical load requirements of the vehicle exceed the supply from the charging system in the event of an alternator or charging system failure. The battery also acts as a voltage stabilizer in the electrical system, smoothing out or reducing temporarily high voltage.

When starting the engine, allow the starter to crank for a maximum of 15 seconds only, then wait a minimum of two minutes to help avoid burning out the starter. Also, **DO NOT** let the engine idle excessively, as low engine rpm can also lead to battery discharge.

Keep the battery from freezing by maintaining a full charge. A completely discharged battery will freeze at 18° F (8° C).

Distilled water may occasionally need to be added through the vent filler caps on the top of the batteries. The vent filler caps prevent loss of electrolyte from the batteries and they contain small pressure activated vent hole to permit escape of gas pressure. The vent holes allow gas and pressure produced in the battery during charging to escape.

The vents in the filler caps require keeping the battery in an upright position to help prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out.

DO NOT exceed this 45° angle when carrying or installing a battery.

The battery has top-post terminals. Keep the terminals clean, and securely tighten clean cable clamps onto the posts. Grease or special spray sealers may be applied over the connections.

b. Visual Inspection of the Battery

Inspect for damage such as a cracked or broken case or cover that could permit loss of electrolyte. If obvious physical damage is noted, replace the battery. Handle the battery with care. Determine the cause of damage and correct as needed before installing the new battery.

c. Battery Load Test

1. Disconnect both the negative (-) battery cable (first), and the positive (+) battery cable from the battery. Make sure that the negative and positive battery terminal posts are clean to help assure a good electrical connection.
2. Attach voltmeter and battery load tester clamps to the battery terminal posts.

3. Remove the surface charge from any battery that has just been charged (by a battery charger or by the vehicle alternator). **DO NOT** remove the surface charge from a battery that has been in storage. To remove the surface charge, apply a 300-ampere load across the terminals for 15 seconds. Then turn off the load and wait for 15 seconds to allow the battery to recover and normalize.
4. Battery temperature should be estimated by touch and also by the surrounding temperature it was exposed to during the preceding few hours before testing. Select the nearest estimated temperature from the chart below and determine the minimum voltage that must be maintained while the battery supplies a specified electrical load.
5. Apply a 260-ampere load test to check the charge acceptance of the battery. Observe the voltage after 15 seconds with the load connected, then turn off the load.

Note: *The accuracy of this test procedure depends on closely following the load, time and temperature specifications.*

Relation of Battery Temperature to Minimum Voltage	
Temperature	**Minimum Voltage**
70° F (21° C) and above	9.6
50° F (10° C)	9.4
30° F (-1° C)	9.1
15° F (-10° C)	8.8
0° F (-18° C)	8.5

6. If voltage is at or above the value determined in step 4, the battery is good and may be returned to service.
7. If voltage is below the value determined in step 4, check the charge acceptance of the battery one more time before discarding it. If the voltage continues to read below the value determined in step 4, replace the battery.

d. Battery Charging

Charge rates between 3 and 50 amperes are generally satisfactory as long as spewing of electrolyte does not occur, or the battery does not feel excessively hot (over 125° F [52° C]). Battery temperature can be estimated by touching or feeling the battery case. If spewing of electrolyte occurs or temperature exceeds 125° F (52° C), commonly referred to as “boiling” the battery, the charging rate must be reduced or temporarily halted to permit cooling. Failure to do so will destroy the battery.

When charging a battery, keep this point in mind:

- Battery charging consists of a charge current in amperes for a period of time in hours. Thus, a 25-ampere charging rate for 2 hours would result in a 50-ampere hour charge to the battery.

The time required for a charge will vary due to the following conditions:

- ***Size of battery:*** For example, a completely discharged, large, heavy-duty battery requires more than twice the recharging as a completely discharged small passenger car battery.
- ***Temperature:*** For example, more time will be required to charge a battery at 0° F than at 80° F. When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first, then, in time, the battery will accept a higher rate as the battery warms.
- ***State of Charge:*** A completely discharged battery requires more than twice as much charge as a half-charged battery. Because the electrolyte is nearly pure water and therefore a poor conductor in a completely discharged battery, the current accepted is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.
- ***Charger Capacity:*** A charger that can only supply 5 amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.

e. Battery Troubleshooting

If a battery has tested satisfactorily but then fails to perform satisfactorily for no apparent reason, the following items are among the more popular factors that may help understand the cause:

1. Vehicle accessories left on, causing battery discharge.
2. Charging system defect, such as slipping fan belt, high wiring resistance, or faulty alternator.
3. A vehicle electrical load exceeds alternator output capacity (common with the addition of electrical accessories such as radio equipment, lights, air conditioning, or window defogging/de-misting devices).
4. Electrical system defects, such as shorted wires.
5. Extended slow speed driving with many accessories on, and excessive engine idling (both cases **DO NOT** allow engine rpm to reach a sufficient speed to enable alternator output to sufficiently charge the battery).
6. Loose or poor battery cable-to-post connections, previous improper charging of a run-down battery, or loose battery hold-down hardware.
7. High resistance connections or defects in the starting system.
8. Failure to disconnect the battery before long periods of vehicle storage. Small current drains of vehicle accessories that are connected all the time can also discharge the battery in a six- to eight-week period. A battery left in a discharged condition for a prolonged period of time is subject to freezing and can become difficult to recharge.

f. Slave Starting with a Booster Vehicle

Note: *Use this information in addition to that found in Section 2.13.17, c. Slave Starting.*

Follow the following procedure exactly, and **DO NOT** cause sparks to occur:

1. Engage the park lock of the booster vehicle and place its transmission in NEUTRAL [N]. DO NOT allow both vehicles to touch each other in any manner, as this could establish a ground connection and counteract the jump-starting process.

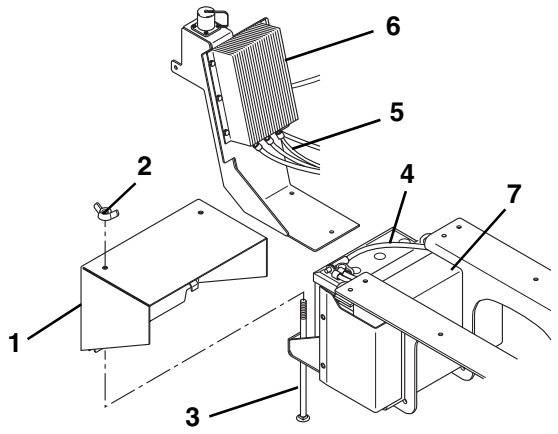
WARNING: Any other procedure than that outlined in these instructions could result in:

- Personal injury caused by electrolyte spewing out of the top vent holes on the battery.
- Personal injury or property damage due to battery explosion;
- Damage to the starting systems of both vehicles.

2. Continue with the jump starting instructions found in *Section 2.13.17, c. Slave Starting*.

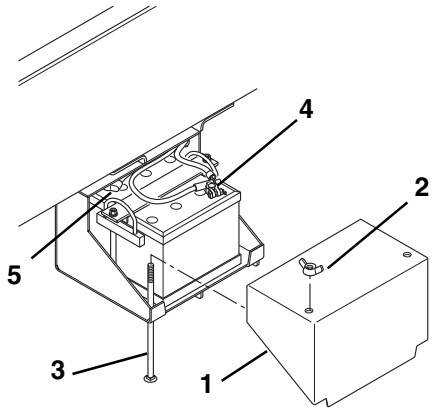
g. Battery Removal

1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



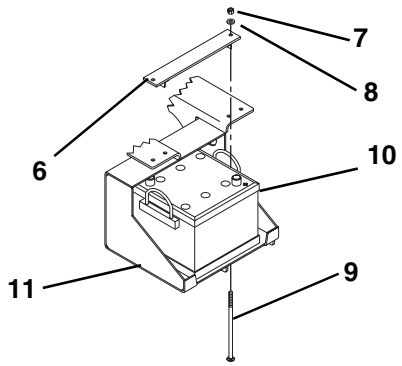
MM4220

4. Remove the cab side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
5. Disconnect the positive (+) battery cable (**4**) at the positive (+) terminal on the battery in the cab side battery box.



MM3141

6. Disconnect the positive (+) battery cable (**12**) at the positive (+) terminal on the battery in the engine side battery box.
7. Disconnect the negative (-) battery cable (**5**) from the cab side battery.
8. Remove the battery hold down strap (**6**) on each battery. Remove the two locknuts (**7**), flat washers (**8**), carriage bolts (**9**) and hold down strap (**6**).



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9. Carefully slide the battery (**10**) out of the battery box (**11**) and remove the battery from the vehicle.

Note: *The best time to clean the battery compartment is when the battery is removed from the vehicle.*

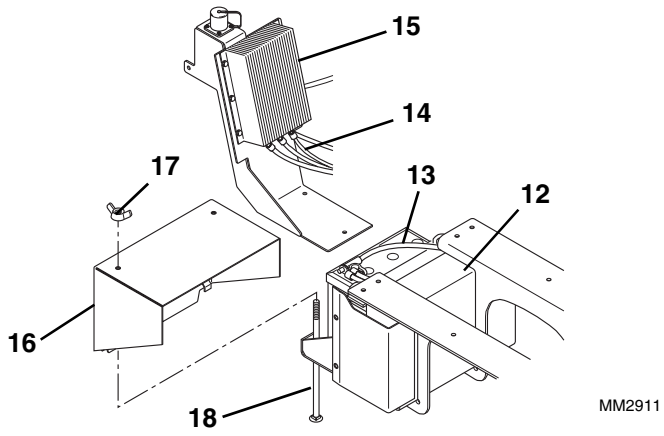
h. Battery Inspection, Cleaning and Drying

1. Periodically inspect the battery for accumulation of dirt or corrosion on the battery, terminals, cable ends, and battery retaining hardware. Also check that the battery case and cover are not cracked or leaking, and that the terminal posts are not broken or loose.
2. Prepare a mixture of baking soda and water and obtain a non-metallic scrub brush. Dip the brush in the mixture and scrub the battery and cable terminals. Also clean the battery mounting area on the vehicle frame before replacing the battery.
3. Dry the battery with a clean, lint-free cloth.

i. Battery Installation

1. Carefully slide the battery (**10**) into the battery box (**11**).
2. Install the battery hold down strap (**6**). Use two carriage bolts (**9**), flat washers (**8**) and locknuts (**7**) for each battery hold down strap. Attach the strap properly to help prevent the battery from shifting, moving and vibrating. Vibration is harmful to a battery. **DO NOT** overtighten the fasteners.
3. Connect the negative (-) battery cable (**5**) to the cab side battery.
4. Connect the positive (+) battery cable (**12**) at the positive (+) terminal on the battery in the engine side battery box.
5. Connect the positive (+) battery cable (**4**) at the positive (+) terminal on the battery in the cab side battery box.
6. Replace the cab side battery box cover (**1**). Secure in place using wing nuts (**2**) and carriage bolts (**3**).

7. Connect the negative (-) battery cable (**13**) at the battery negative (-) terminal on the battery in the engine side battery box.
8. Connect the negative (-) battery equalizer cable (**14**) at the bottom of the battery equalizer (**15**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
9. Replace the engine side battery box cover (**16**). Secure in place using wing nuts (**17**) and carriage bolts (**18**).

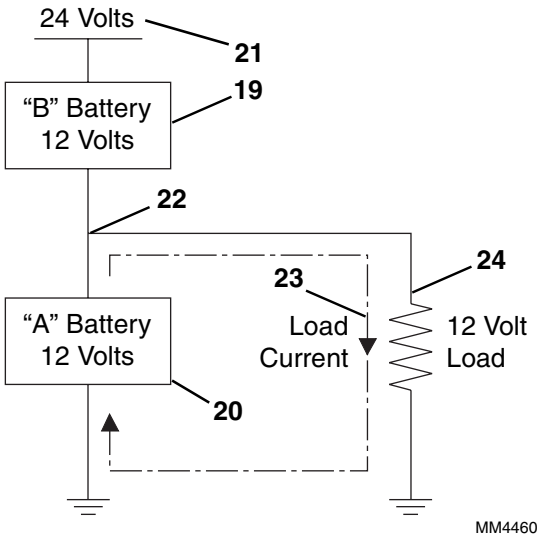


10.11.3 Battery Equalizer

a. Battery Equalizer System Description

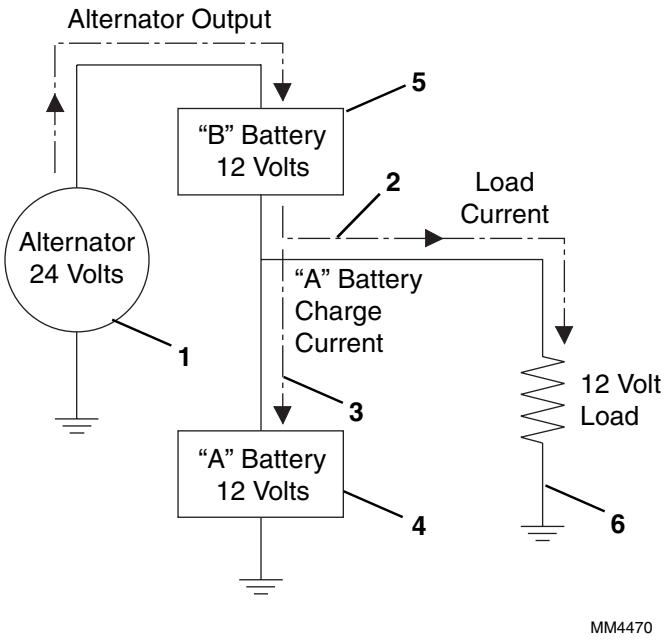
The need for a dual voltage system arises when not all equipment or accessories on a vehicle use a 24V operating supply.

The 24V system normally consists of two-12V batteries (**19** and **20**) connected in series, with a 24V (**21**) alternator providing power. It seems that the most logical place to obtain 12V power is at the junction (**22**) between the two batteries. However, a problem arises if the system is constructed in this fashion.



Consider the situation when the engine is OFF (alternator is not generating current), and 12V power is used. Load current (**23**) comes only from the 12V "A" battery, none of which is being furnished by the top "B" battery. After a time, the 12V loads (**24**) will discharge the "A" battery while leaving the "B" battery charged up. Since the "B" battery has not been discharged it will not need any electrical current to recharge; however, the "A" battery will.

When the engine is started and the alternator (**1**) furnishes current to the load (**2**) and charge current (**3**) to the “A” battery (**4**). All the current now flows through the “B” battery (**5**), since it is in series with the load and the “A” battery.



When this happens, a condition exists where the “B” battery overcharges because it does not need recharging, and the “A” battery does not get the charge it requires. Charging current for the “A” battery is impeded by the already charged “B” battery and reduced by the amount of current that flows to the load (**6**). Even if there were no load at this point, the same problem would exist due to the imbalance of the battery charges.

When operating the system in this manner, the life of the batteries is dramatically shortened. The “A” battery fails prematurely because lead sulfate builds up on the battery plates, reducing the capacity. The “B” battery fails when its electrolyte “gasses” evaporate and damage occurs to its plates and separators in the dry battery cells as a result of overcharging. Failure time can be as short as a few weeks for heavy 12V loads.

If there is no 12V load, a 24V system with a two-battery “stack” can operate well without an equalizer. However, the batteries must be of *the same type and age*. Without a battery equalizer, current drawn from one battery and not the other will cause an imbalance. This imbalance accumulates over time. Because the effects of the imbalance are cumulative, battery degradation occurs even with very small loads, such as a radio, clock or small lamp.

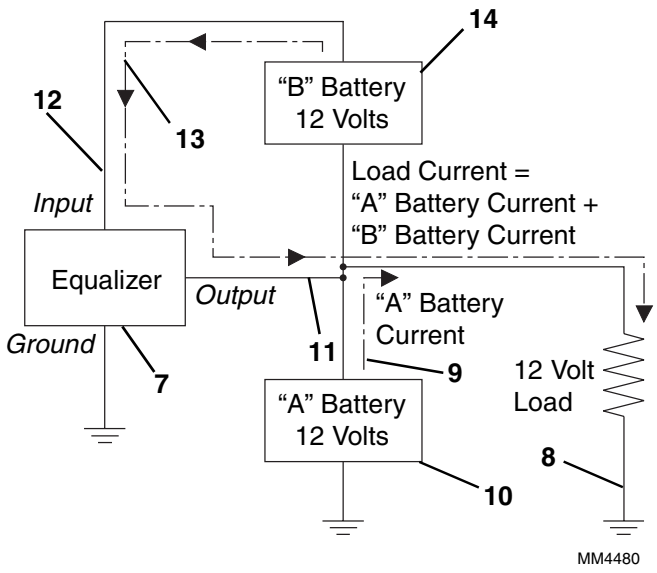
The equalizer was developed as a solution to the problem described above. Technically, equalizers are specialized DC-DC converters. These devices convert electrical power from one voltage level to another at relatively high efficiencies. Used in battery balancing applications, the converters are called *“equalizers”*.

The term *“equalizer”* is derived from the fact that these devices balance or *equalize* the charge states in the system batteries. In the case of 12/24V, dual voltage system, the equalizer output voltage is equal to half of the input voltage. This is true for any input voltage within the operating range of the device. The operation is as follows:

Equalizer Operation: Engine OFF

The following figure shows an equalizer (**7**) installation, with engine OFF, and a 12V load (**8**) applied. Assume that the batteries are equally charged to start with. As the load draws current (**9**) from the “A” battery (**10**), the voltage on that battery begins to drop. Then, in order to maintain the output (**11**) condition of half of the input (**12**) voltage, the equalizer output current increases. This raises the voltage across the “A” battery until both battery voltages become equal.

Notice that the current (**13**) required to maintain the output voltage is taken from the “B” battery (**14**). In other words, the load power is actually furnished by both batteries, not just the “A” battery. The “B” battery will not furnish *all* of the power, because, if its voltage begins to drop, the voltage at the equalizer output would then be greater than half the input voltage and the output current would reduce to zero. The “A” battery would then furnish the load current.



With an equalizer installed, both batteries will maintain equal charges, and 12V-load power will be drawn from both batteries equally.

As a consequence of the above operation, it can be stated that if one of the batteries is discharged, the battery with the most charge will furnish power to the 12V load. This can be understood using the above description and considering that one battery has a reduced terminal voltage due to its lower charge state. Eventually, the battery charges will balance, and then both batteries will furnish power to the load.

This section describes the battery equalization process for batteries at rest. The point here is that the equalizer is operating even when the engine is OFF, which is common for these devices.

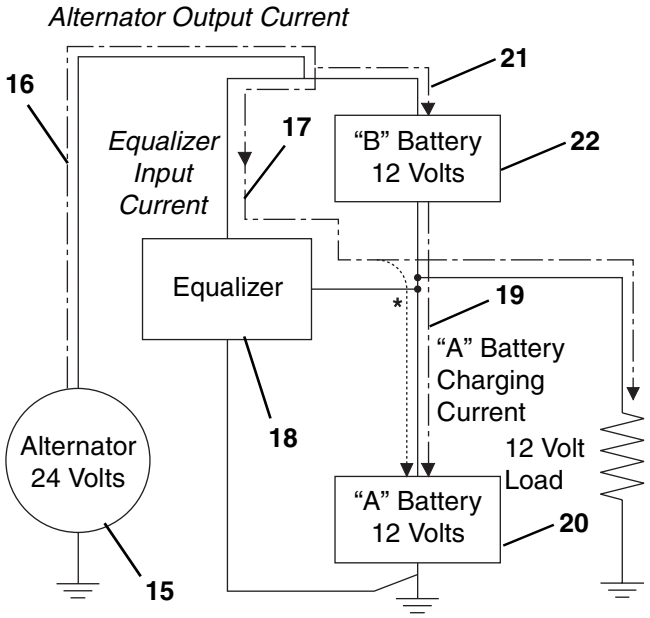
The equalizer is designed to operate continuously. It is built with a "sleep" mode that reduces circuit draw to typically 2.6mA after the batteries are balanced.

Note: *24V loads do not impose a battery imbalance condition. Since the batteries are in series, all current delivered to the 24V load is, necessarily delivered by both batteries equally.*

Equalizer Operation: Engine ON

Note: *Nominal charge voltage for 24V vehicular systems is 27.6 to 28.4V and 13.8 to 14.2V for 12V systems. For our purposes we will use 28V and 14V, respectively. Approximate temperature = 73°F (23°C).*

Consider the situation with the engine running. The alternator (**15**) is producing (**16**) 28V, which is also the input voltage (**17**) to the equalizer (**18**). The equalizer now generates half of this (i.e.14V) at its output. This provides the optimum charge voltage (**19**) for the "A" battery (**20**). This also means that there must be 14V charge voltage (**21**) for the "B" battery (**22**), therefore, both batteries receive optimum charge voltage with the equalizer in operation.



* - Current required for battery balancing

The Battery

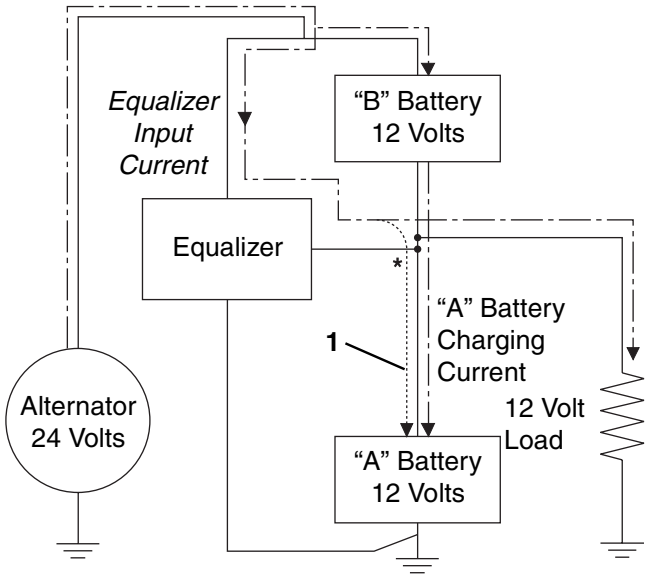
When a charged 12V automotive battery is allowed to stand without a load, its terminal voltage is measured to be about 12.6V at room temperature. (Standard lead acid type automotive battery.) To charge the battery, a 14V source is applied across its terminals, and current is allowed to flow into the battery.

The amount of charge current that a battery will accept is determined by the state-of-charge of the battery and its capacity. At 14V, the battery will only take the amount of current required, or is capable of receiving, to charge it. (The battery will still draw current after charging fully, however, this is relatively small compared to the charging current.) With this in mind, it is seen that a larger alternator will not charge a battery faster than a smaller one, providing the battery charging requirements and load requirements do not exceed the output limits of the alternator.

Given the proper charging voltage, the battery will determine the amount of current that it requires for charge.

If the battery is “low” (discharged), the charge current will be high. 50 amps or more is not uncommon to charge a low battery such as a Group 27. Heavy charging may be in the 100 to 200-amp range for 4D or 8D types. As the charge is replenished, the charge current decreases to a few amps or less for a fully charged battery.

Alternator Output Current



* - Current required for battery balancing

MM4490

If the charge voltage changes across a battery, so will the current flow into the battery. Increasing the voltage will cause the current to rise and vice versa. This can lead to overcharging or undercharging conditions of the battery, and a reduction of battery life. Because of this, it is very important to keep the system voltage regulated at the optimum level.

Some charging systems today are equipped with temperature sensing voltage regulators, which adjust the charge voltage automatically. This does not present a problem to the equalizer, as the output to input voltage is a fixed ratio, i.e. = half. The equalizer will maintain proper battery balancing (**1**) under all voltage conditions.

b. Battery Equalizer Maintenance

Very little maintenance is required for the equalizer (**2**). Generally, keep the fins clean so that the unit will cool as it should. Do not allow oil, dirt, etc. to build up on the surfaces, as it acts like insulation, inhibiting the cooling ability of the fins. Keep material from clogging the space between the fins, blocking the flow of air.

Periodically check the connections. Clean as required.

Connection problem symptoms are:

- Hot wire or connection(s)
- Discolored stud, nuts, fuse cover, or insulation
- Low or no output

Heat is a telltale sign of bad connections. Look for discoloring of studs, nuts, fuse cover, or insulation from excessive heat.

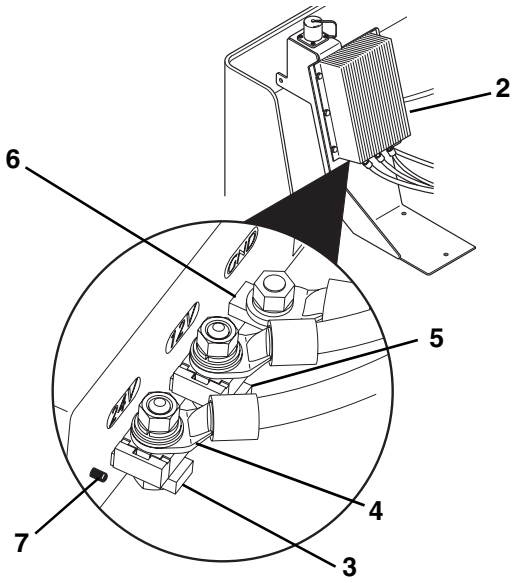
The best way to check a connection is by measuring the voltage across the connection. The higher the reading, the worse the connection. A “good” wire connection should drop less than about 0.025V (25mV) when about 100 amps is flowing through the connection.

Before measuring the equalizer connections, start the engine and turn ON heavy 12V loads. This will make poor connections easier to find.

For the fuse connections, a voltage reading of 0.025V (25mV) or less is good when the equalizer output current is about 75A.

Measure from the equalizer stud (**3**) to wire terminal (**4**) with a digital voltmeter. When the drop approaches 0.05V (50mV) or more, the connection should be cleaned and re-torqued.

Note: *From the factory, the fuse connections will measure about 17mV @ Output current = 75 amps.*

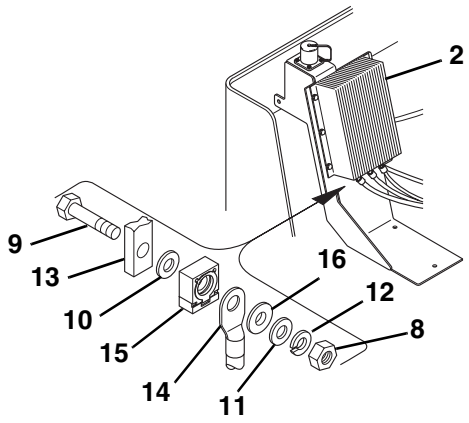


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*To clean and re-torque the 24V (**3**) and 12V (**5**) connections:*

1. Disconnect the wire and fuse from equalizer stud.
2. Clean the threads of the nut (**8**) and capscrew (**9**) by burnishing them with steel wool, “Scotchbrite,” wire brush, etc.
3. Clean the contact surfaces of the remaining hardware (**10**, **11** and **12**) by sanding them on a flat surface with fine grit sandpaper or “Scotchbrite.”
4. Use fine grit sandpaper or “Scotchbrite” to clean the surfaces of the equalizer stud (**13**) and wire terminal (**14**).
5. To reassemble, first insert the capscrew (**9**) through the stud (**13**) on the equalizer (**2**).
6. Place a flat washer (**10**) and fuse (**15**) onto the capscrew (**9**). Position fuse as required to best see through the clear window.
7. Place the cable (**14**) onto the capscrew.
8. Place the nylon shoulder washer (**16**) onto the capscrew and place against the cable with the hub toward the cable.
9. Secure in place with a flat washer (**11**), lockwasher (**12**) and nut (**8**). Torque the nut to a maximum of 100 lbs/in (11 Nm).

*To replace a blown fuse in the 24V (**4**) and 12V (**5**) connections, refer to replacement procedure described in Section 2.13.18, d. Fuse and Relay (Fuel Shut Off Solenoid)*



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*To clean and re-torque the GND (**6**) connection:*

1. The difference between the GND connection (**6**) and the two positive connections, is that there are only three pieces of hardware. There is one capscrew (**9**), lockwasher (**12**) and nut (**8**) securing the negative cable to the equalizer stud (**13**).
2. Follow steps 2, 3 and 4 to clean the threads and contact surfaces of the negative connection.
3. To reassemble, first insert the capscrew (**9**) through the stud (**13**) on the equalizer (**2**).
4. Place the cable (**14**) onto the capscrew (**9**).
5. Secure in place with a lockwasher (**12**) and nut (**8**). Torque the nut to a maximum of 100 lbs/in (11 Nm).

c. Battery Equalizer Testing

The 24V voltage must be within the 18-32V equalizer operating voltage range, or the equalizer will turn off into a self-protection mode.

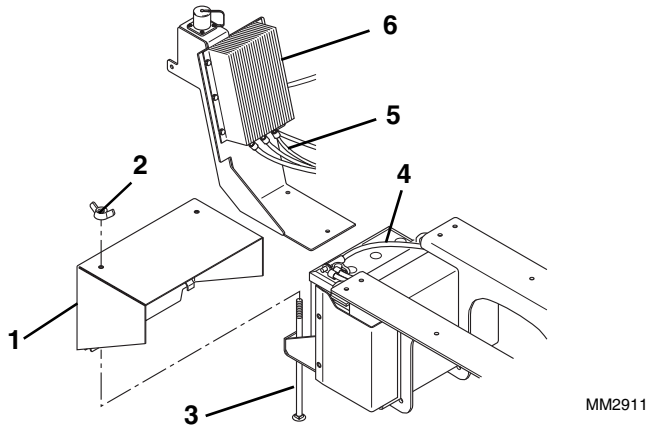
The normal 12V measurement should be within ±1% of the 24V measurement, divided by two. (approximately ±0.2V):

12V Measure = (24V Measure) ÷ 2 ±1% (±0.2V)

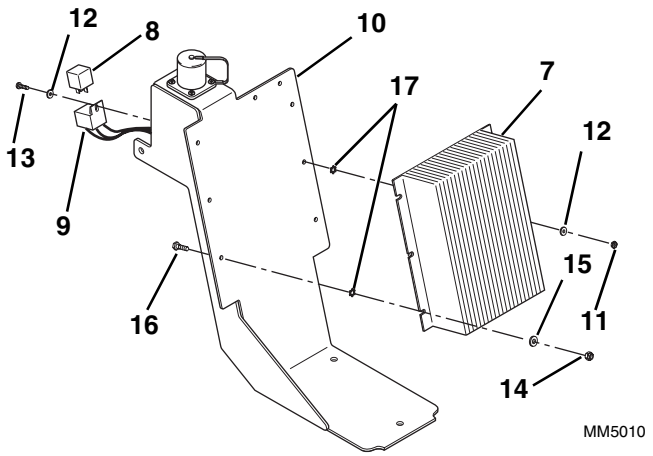
1. Find the 24V measurement by taking the voltage from the 24V equalizer stud (**3**) to the GND equalizer stud (**6**).
2. Find the 12V measurement by taking the voltage from the 12V equalizer stud (**5**) to the GND equalizer stud (**6**).
3. Turn the ignition switch to the RUN position.
   - If the 12V voltage is lower than normal and the status indicator is OFF, the equalizer should be replaced.
   - If the 12V voltage is higher than normal and the status indicator is OFF, check the “A” battery or charging system for faults. The equalizer is not the problem.

d. Battery Equalizer Removal

1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



4. Disconnect and label the two positive cables connected to the battery equalizer (**7**).
5. Remove the fuel shut off relay (**8**) from the wire harness bracket (**9**) mounted on the battery equalizer mounting bracket (**10**).



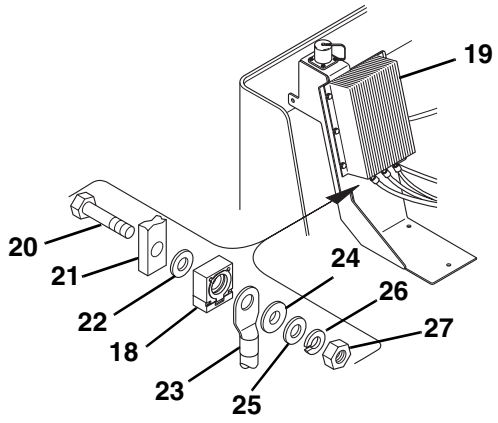
6. Remove the nut (**11**), flat washers (**12**) and slotted pan head screw (**13**) from the bracket.
7. Remove the five elastic locknuts (**14**), flat washers (**15**), and capscrews (**16**) securing the equalizer to the mounting bracket. Carefully remove the equalizer and remove the six external tooth lockwashers (**17**) from between the mounting bracket and the equalizer.

e. Battery Equalizer Install

1. Place the equalizer against the mounting bracket.

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

2. Place one external tooth lockwasher (**17**) between the mounting bracket (**10**) and the equalizer (**7**) and install the capscrews (**16**), flat washers (**15**) and new elastic locknuts (**14**) in five places. DO NOT fully tighten the hardware at this time.
3. Install the fuel shut off relay wire harness mounting bracket (**9**) in the remaining mounting hole. Place the remaining external tooth lockwasher (**17**) between the equalizer (**7**) and mounting bracket (**10**) and secure in place using a slotted pan head screw (**13**), two flat washers (**12**) and nut (**11**). Fully tighten all equalizer mounting hardware.
4. Install the fuel shut off relay (**8**) into the mounting harness bracket (**9**).
5. Insert the capscrew (**20**) through the tab (**21**) on the equalizer (**19**).
6. Place a flat washer (**22**) and fuse (**18**) onto the capscrew. Position fuse as required to best see through the clear window.
7. Place the positive cable (**23**) onto the capscrew.
8. Place the nylon shoulder washer (**24**) onto the capscrew and place against the positive cable with the hub toward the cable.
9. Secure in place with a flat washer (**25**), lockwasher (**26**) and nut (**27**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
10. Repeat steps 5 through 9 for the other positive cable.
11. Connect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
12. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
13. Replace engine side battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.



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CAUTION: Before starting the engine after an equalizer installation, be sure that both batteries are charged. The high starting current can cause the charged battery to reverse the voltage on a discharged battery. With the equalizer connected normally, it then "sees" a reverse power connection. Protection diodes inside the equalizer will then act to "blow" one of the fuses, or generate excessive heat.

Any 12V accessories, gauges, etc. connected to the discharged battery during starting, will also have the reverse voltage applied to their power connections. This may result in damage to these items.

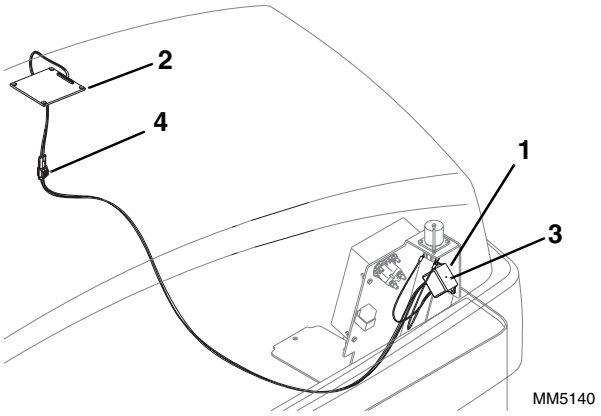
10.11.4 Battery Solargizer®

a. Battery Solargizer® System Description

Solargizer® is a registered trademark of PulseTech® Products Corporation.

The Solargizer® system is a battery conditioner that keeps the battery's lead plates clean and able to charge/discharge at maximum efficiency. It does this by "pulsing" the battery thousands of times per second at a frequency designed to prevent and reverse the "sulfate" that builds on battery plates when discharged. The Solargizer® is not a battery charger and although it does reduce the required maintenance, it does not eliminate it.

The Solargizer® system consists of a control box (**1**), mounted in the engine compartment, to provide the pulse and the solar panel (**2**), mounted to the top of the engine cover, to provide power to the control box.



b. Solargizer® Testing

There is an LED (**3**), on the outside face of the control box (**1**), that indicates whether the Solargizer® is operating.

The easiest way to see this is with the vehicle facing the sun and the engine OFF, open the engine cover just far enough to put your head inside the engine compartment. Allow the engine cover to rest on your shoulders. This will obscure the daylight and allow you to clearly see whether the LED is ON.

The LED may occasionally flash or blink during periods of reduced sunlight, when it is cloudy or when there is shade across the solar panel. That does not mean the Solargizer® is not working. It means that it is not collecting enough energy from the sun, on a constant basis, to power the pulsing circuit and LED. During periods when the LED is flashing there is still pulsed energy going to the battery set to break up the lead sulfate crystals but it is not as efficient as when there is bright unobstructed sunlight.

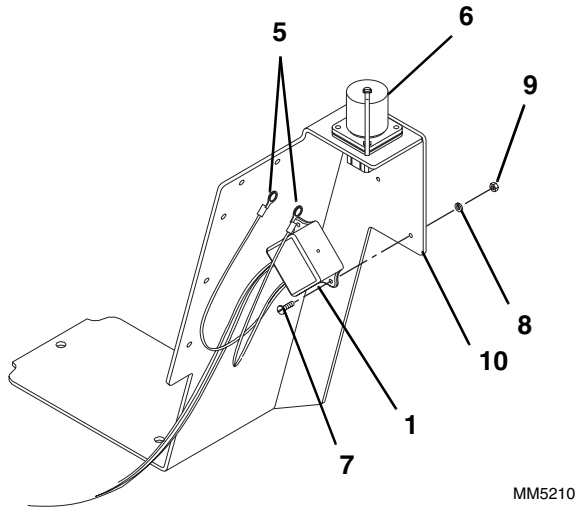
If you are trying to see if the LED is operating when there is not direct sunlight available, the vehicle can be brought into a building and an artificial light source, strong incandescent bulb (100W or greater) or halogen light, may be used.

If the LED is not illuminated:

1. Ensure that the solar panel is cleaned off and in direct sunlight then check all the connection points to ensure corrosion has not developed. Clean any corrosion and replace the connections.
2. If all connection points are clean and tight choose a point between the solar panel and the control box to cut the wire (cut one wire at a time to prevent creating a short or cover the solar panel). Using a voltmeter connect to the positive and negative leads. With the panel in direct sunlight the voltmeter should read between 4.0 and 4.5 volts DC. If the reading is between 4.0 and 4.5 the panel is working fine and there is a problem with the control box. If in direct sunlight there is no voltage reading or it is below 4.0 volts there is a problem with the solar panel.

c. Solargizer® Control Box Removal

1. Disconnect the connectors (**4**) between the control box (**1**) and the solar panel (**2**).
2. Label and disconnect the positive and negative battery cables and the Solargizer® wire leads (**5**) connected to the slave receptacle (**6**).
3. Remove the two slotted pan head screws (**7**), lockwashers (**8**) and nuts (**9**) securing the Solargizer® to the equalizer mounting bracket (**10**).
4. Remove the Solargizer® from the vehicle.



d. Solargizer® Control Box Installation

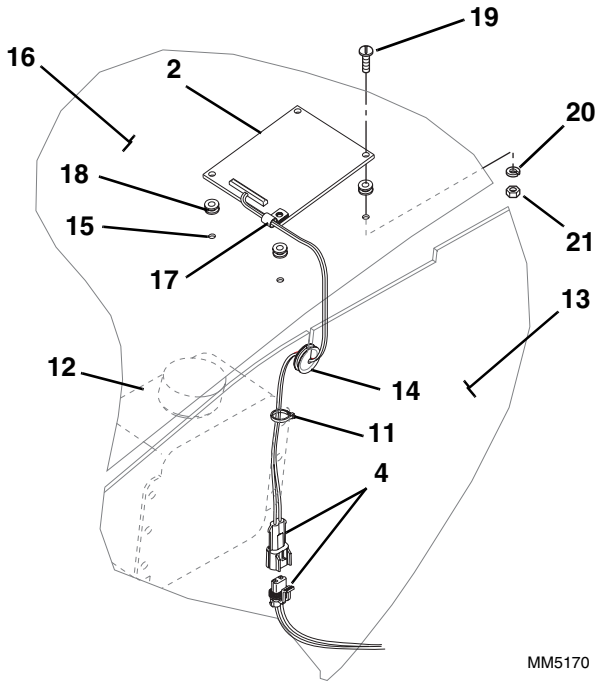
1. Install the control box (**1**) to the equalizer mounting bracket (**10**).
2. Secure in place with two slotted pan head screws (**7**), lockwashers (**8**) and nuts (**9**).
3. Reconnect the Solargizer® wire leads (**5**) along with the positive and negative battery cables to the appropriate negative and positive studs on the slave receptacle (**6**).
4. Connect the connectors (**4**) between the control box and the solar panel.

e. Solar Panel Removal

1. Disconnect the connectors (**4**) between the solar panel (**2**) and the control box (**1**).
2. Cut the wire tie (**11**) securing the wires to the wiper washer reservoir (**12**) on the engine panel (**13**). Pull the wire out of the grommet (**14**) in the engine panel.
3. Remove the hardware securing the panel to the hood. Set aside for later reassembly.
4. Remove the panel from the vehicle.

f. Solar Panel Installation

1. Position the panel (**2**) over the four mounting holes (**15**) in the engine hood (**16**).
2. Slide the wire clip (**17**) over wires near the left front mounting hole.
3. Place the four grommets (**18**) between the solar panel (**2**) and the engine hood (**16**).
4. Secure the panel (**2**) and grommets (**18**) to the hood using four slotted pan head screws (**19**), lockwashers (**20**) and nuts (**21**).
5. Install wires into split in grommet (**14**) with enough slack to be able to close the engine hood without straining the wires.
6. Secure wires close to the inside surface of the engine panel by securing them in place using a wire tie through the wiper washer reservoir (**12**) top mounting hole.
7. Connect the connectors (**4**) between the solar panel and the control box.



10.12 ELECTRICAL SYSTEM COMPONENTS

Electrical components include warning devices such as the indicators in the operator's display panel, horn, back-up alarm, and other components such as the joystick, logic panel, various solenoids and all accessories.

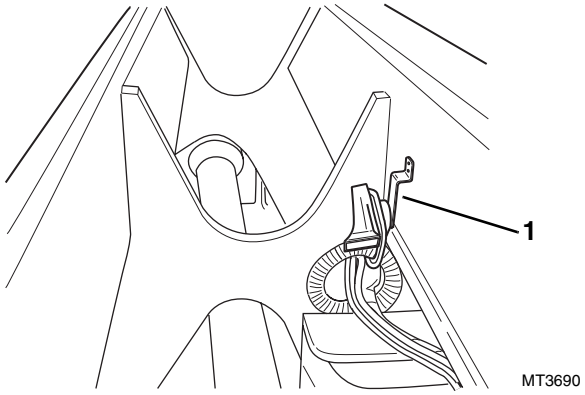
Examine the appropriate wiring diagrams and schematics earlier in this section to help understand the wiring circuits involved.

10.12.1 Warning Devices

Vehicle warning devices include the horn, instrument panel warning lights, and the back-up alarm.

a. Horn

The horn (**1**) is mounted forward of the cab on the vehicle frame.



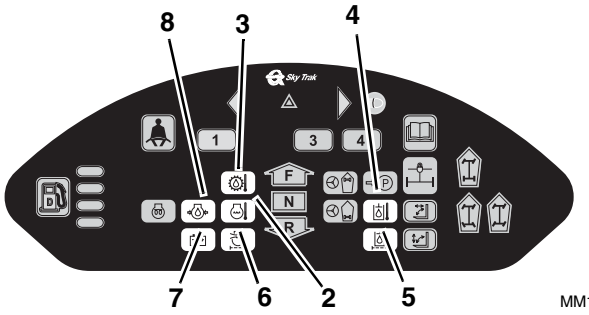
The horn sounds when the momentary-contact horn button on the center of the steering wheel is pressed. When the blackout light system is activated the horn will not operate. Removal of the horn button is discussed in *Section 3.5.1, a. Steering Wheel Removal* of this manual.

The horn sound is produced by a solenoid-actuated diaphragm in the horn that develops a resonating air column in the horn trumpet, which is shaped to project the sound. If the horn doesn't sound when the horn button is pressed, check that the fuse is not blown.

Check for corrosion on the horn mounting that may be preventing a solid ground, and check for a loose horn wire. Test the horn switch for continuity when the horn button is pressed.

If the problem is still not located, remove the horn from the frame and test it using short, heavy-gauge wires connected to a fused or otherwise protected 6-amp minimum output, 12-volt DC power supply.

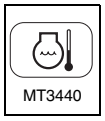
10.12.2 Warning Indicator Lights



There are eight subdued or "hidden" warning indicator lights present in the operator's display panel (**2** through **8**). These warning indicators illuminate during critical circumstances.

IMPORTANT: *All eight warning indicator lights demand immediate attention and vehicle service. In many cases, the vehicle should be shut down as soon as practical to help prevent serious mechanical failure. Appropriate service procedures for each circuit, as applicable, appear elsewhere in this section of the manual.*

a. Engine Coolant Temperature Warning Indicator



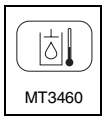
This indicator (**2**) is illuminated when the engine coolant temperature is above 210° F (99° C). An audible alarm will sound, and the engine must be shut down as soon as practical to help avoid engine damage. For additional information refer to *Section 10.9.1, Engine Coolant Temperature Warning Indicator Troubleshooting*.

b. Transmission Temperature Warning Indicator



This indicator (**3**) illuminates when the transmission fluid temperature exceeds 250° F (121° C). An audible alarm will also sound, and the vehicle should be stopped and the engine allowed to run at high idle for five minutes. If the light and alarm **DO NOT** cease after five minutes, the engine must be shut down to help avoid transmission damage. For additional information refer to *Section 10.9.2, Transmission Temperature Warning Indicator Troubleshooting*.

c. Hydraulic Oil Temperature Warning Indicator



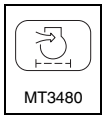
This warning light (**4**) will activate when the hydraulic oil temperature is above 195° F (91° C). The vehicle should be stopped and the engine allowed to idle at high idle for five minutes. If the light continues to illuminate after five minutes, the engine must be shut down to help avoid damage in the hydraulic system. For additional information refer to *Section 10.9.3, Hydraulic Oil Temperature Warning Indicator Troubleshooting*.

d. Hydraulic Oil Filter Restriction Warning Indicator



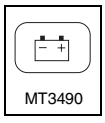
This warning light (**5**) will activate when a restricted hydraulic oil system filter is detected. The vehicle should be stopped and the engine allowed to run at high idle for five minutes. If the light remains illuminated or begins to flicker on and off at high idle, replace the hydraulic oil filter (refer to *Section 9, Hydraulic System* for further information). For additional information refer to *Section 10.9.4, Hydraulic Oil Filter Restriction Warning Indicator Troubleshooting*.

e. Engine Air Filter Restriction Warning Indicator



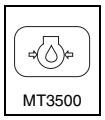
This warning light (**6**) will activate when a restricted engine air filter is detected. The vehicle should be stopped and the engine allowed to run at high idle for five minutes. If the light remains illuminated or begins to flicker on and off at high idle, replace the engine air filter (refer to *Section 8, Engine: Cummins 4BTA 3.9* for information on replacing the air filter). For additional information refer to *Section 10.9.5, Engine Air Filter Restriction Warning Indicator Troubleshooting*.

f. Alternator Charging Warning Indicator



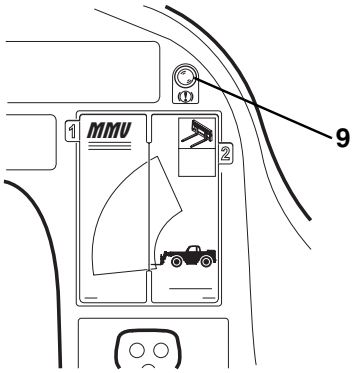
This light (**7**) illuminates when the charging system is not working properly. Check and service the alternator and battery as required. For additional information refer to *Section 10.7.13, Charging Circuit and Troubleshooting*.

g. Engine Oil Pressure Warning Indicator



This indicator (**8**) illuminates and an audible alarm sounds after 15 seconds if the engine is not started. This is normal. When the ignition switch is turned to the OFF position, the indicator is reset. Should the light and alarm begin during engine operation, the engine oil pressure is too low. The engine must be shut down as soon as practical to help avoid engine damage. For additional information refer to *Section 10.9.6, Engine Oil Pressure Warning Indicator Troubleshooting*.

h. Low Brake Pressure Warning Indicator



OM09211



This warning light (**9**) is located in the upper right corner of the front dash just above the load chart booklet.

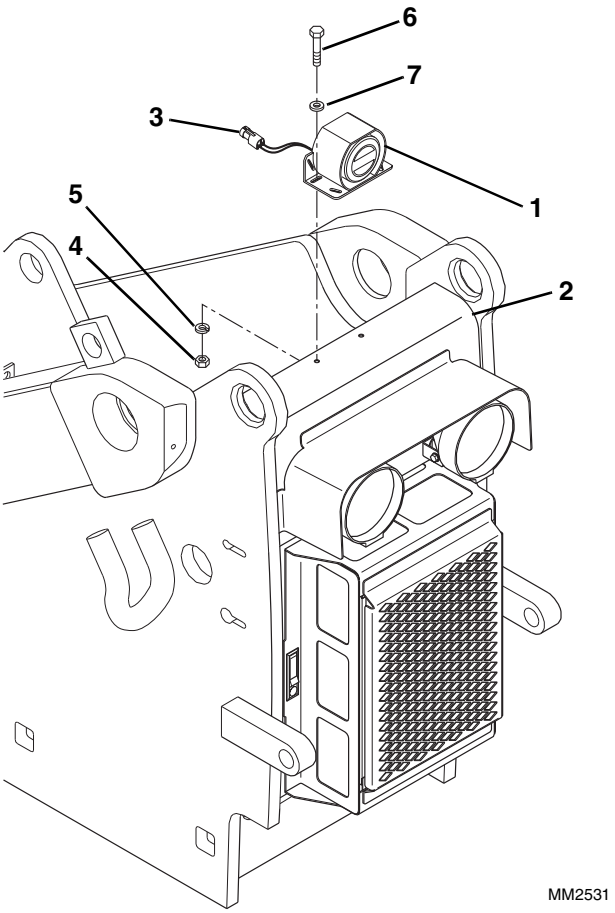
The red lamp lights and buzzer sounds when service brake hydraulic system pressure drops below the safe operating level. Under normal conditions, the light and buzzer will go out quickly after engine start. If the light or buzzer does not go out or comes ON during vehicle operation, shut off engine immediately, investigate, and repair before operating. DO NOT operate vehicle when low brake pressure light or buzzer is on.

If the low brake pressure light or buzzer remains ON, place the travel select lever in (N) NEUTRAL, place the neutral lock lever in the (N) NEUTRAL LOCK position, engage the parking brake switch and turn the engine OFF.

Have the service brake system serviced before using the vehicle again. Contact your local JLG Authorized Service Center (ASC) immediately to repair the system.

10.12.3 Back-Up Alarm

The back-up alarm (**1**) is located at the rear of the vehicle, above the rear door, mounted on the top of the rear cover (**2**) at the rear of the frame.



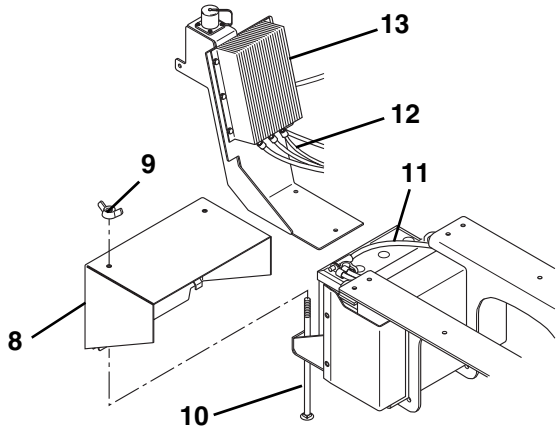
MM2531

When the transmission shift control switch (travel select lever) is shifted to the reverse position, the back-up alarm will automatically sound. Place the travel select lever in reverse to test the back-up alarm. The back-up alarm must not sound when the travel select lever is in NEUTRAL [N] or FORWARD [F]. Also, with the ignition switch in the RUN position, the back-up alarm will sound when the travel select lever is shifted into the REVERSE [R] position.

The back-up alarm is energized via current from the transmission shift control switch, part of the travel select lever mounted within the steering column. See the appropriate wiring schematic and diagram in this section to help understand the back-up alarm circuit. Refer to *Section 3.5.1, c. Transmission Range Selector and Turn Signal/Lights Lever Removal* for information on removing and replacing the transmission shift control switch.

a. Back-Up Alarm Removal

1. Remove engine side battery box cover (**8**). Remove wing nuts (**9**) and carriage bolts (**10**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**11**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**12**) at the bottom of the battery equalizer (**13**).



MM2911

4. Label and disconnect the wiring (**3**) from the back-up alarm (**1**).
5. Remove the two nuts (**4**) and lockwashers (**5**) securing the back-up alarm to the rear cover (**2**) at the rear of the vehicle frame. Remove the two capscrews (**6**), flat washers (**7**) and alarm (**1**) from the vehicle.

b. Disassembly

DO NOT disassemble the back-up alarm. Replace a defective or faulty alarm with a new one.

c. Inspection and Replacement

Inspect the wiring harness connector and alarm terminals for continuity and shorting. Replace a defective or faulty alarm with a new one.

d. Installation and Testing

Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

1. Position the back-up alarm (**1**) over the holes in the rear cover and secure with two capscrews (**6**), flat washers (**7**), lockwashers (**5**) and nuts (**4**).
2. Connect the wiring harness connector lead (**3**) to the back-up alarm.
3. Connect the negative (-) battery cable (**11**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**12**) at the bottom of the battery equalizer (**13**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**8**). Use the wing nuts (**9**) and carriage bolts (**10**) to secure the cover in place.
6. Test the alarm by turning the ignition switch to the RUN position and shifting the travel select lever into the reverse position. The back-up alarm should sound.

10.12.4 Operator Display Panel

The information under this heading deals mainly with the description and function of each indicator in the operator display panel. Appropriate service procedures for each circuit, as applicable, appear elsewhere in this section of the manual.

The operator display panel is of solid-state, printed circuit design and contains six wiring terminals or plugs, two printed-circuit boards mounted piggy-back style with standoffs, and a display panel that provides overall monitoring of vehicle functions and status. Due to the complex design and solid-state circuitry, the panel is non-serviceable. Electro-static discharge and moisture are two of the main reasons for malfunction.

> **CAUTION:** Before performing ANY welding on vehicle, disconnect the negative (-) battery cable at the negative (-) battery terminal. Failure to remove the negative (-) battery cable will result in damage to vehicle electronic systems.

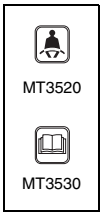
Prevent the panel from coming into contact with static or other electrical sources. When washing the vehicle, keep spray away from the operator's display panel. Replace a defective, malfunctioning or faulty panel with a new unit.

The operator's display panel provides important information in a "user friendly" design with easily-recognizable graphic and alpha-numeric indicators. The panel provides information the operator needs on vehicle and engine functions.

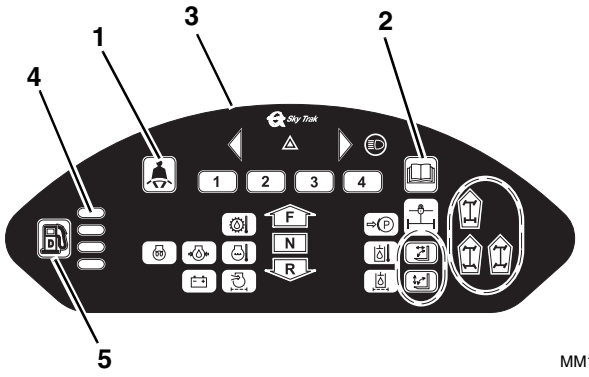
When testing circuits connected to the dash, disconnect the harness connector and test the harness side only.

a. Power-Up Lights

When the ignition switch is turned to power up the vehicle, all lights in the display panel will illuminate for three seconds as a test function. During this time, an audible alarm will also sound.



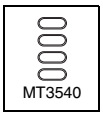
The Fasten Seat Belt and Read Manual symbols (**1** and **2**) will remain illuminated for five to seven seconds, reminding the operator to fasten the seat belt and to review the Owners/Operators Manual if there are any questions about safe and proper operation of the vehicle (a manual should be kept in the storage compartment beneath the seat at all times.)



b. Normal Operating Lights

After the engine starts, the operator's display panel (**3**) provides information via the following indicators:

Fuel Level Indicator Bars

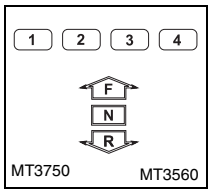


Each of the fuel level indicator bars (**4**) represents approximately 1/4 tank. The vehicle must be parked on a firm, level surface to ensure an accurate fuel level reading. The fuel level indicator bars will be illuminated with a low-light green hue, easily apparent for night visibility and in low-light conditions.

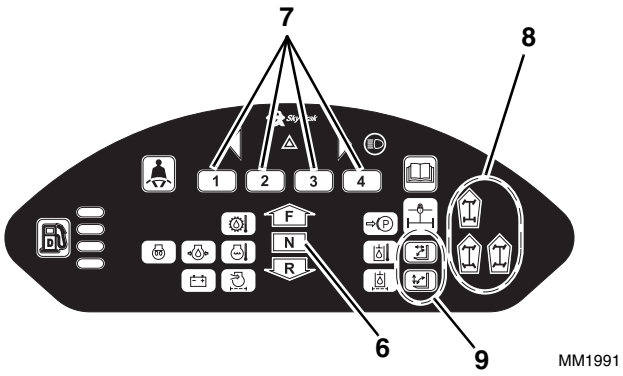


When approximately 1/8 tank is reached, the last fuel level indicator bar will stop illuminating, and the fuel level indicator symbol (**5**), a graphic of a fuel dispensing pump, will change from green to orange. When the fuel level indicator symbol changes from green to orange, refuel the tank. For additional information refer to *Section 10.9.7, Fuel Level Indicator Troubleshooting*.

Travel and Gear Select Indicators



The travel (**6**) and gear select indicators (**7**) illuminate to show the direction the travel select lever is in (F for FORWARD, N for NEUTRAL, and R for REVERSE) and the gear presently engaged (1, 2, 3 or 4).

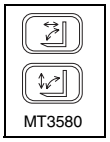


Steer Mode Indicators



The steer mode indicators (**8**) illuminate to show which of the steer modes (front-wheel, four-wheel, or crab) is presently engaged.

Attachment Tilt Mode Indicator

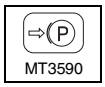


One of the two attachment tilt mode indicators (**9**) will illuminate to show which mode (extend/retract or raise/lower) is presently engaged.

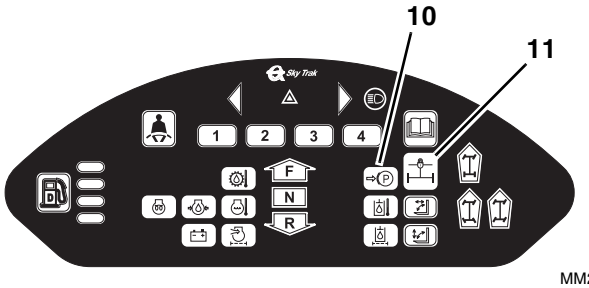
c. Function Indicator Lights

There are two subdued or "hidden" function indicator lights (**10** and **11**) in the display panel that illuminate only when a specific function is activated. They are:

Parking Brake Indicator

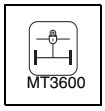


The parking brake indicator (**10**) illuminates any time the parking brake switch is applied and the ignition switch is in the RUN position.



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Stabil-TRAK Indicator

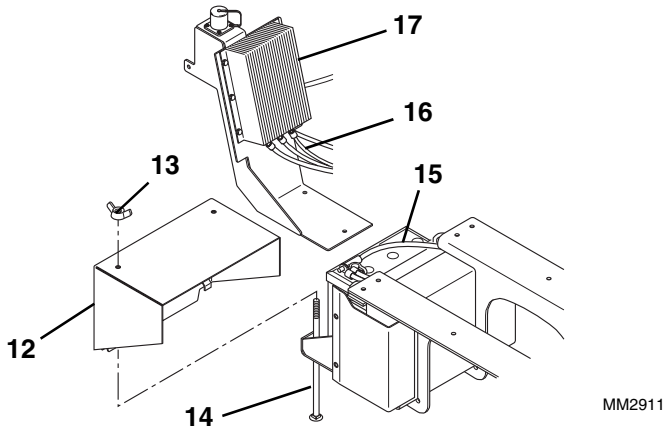


The Stabil-TRAK indicator (**11**) illuminates when the Stabil-TRAK system is activated. For additional information refer to *Section 10.9.8, Stabil-TRAK Indicator Troubleshooting*.

d. Operator's Display Panel Removal

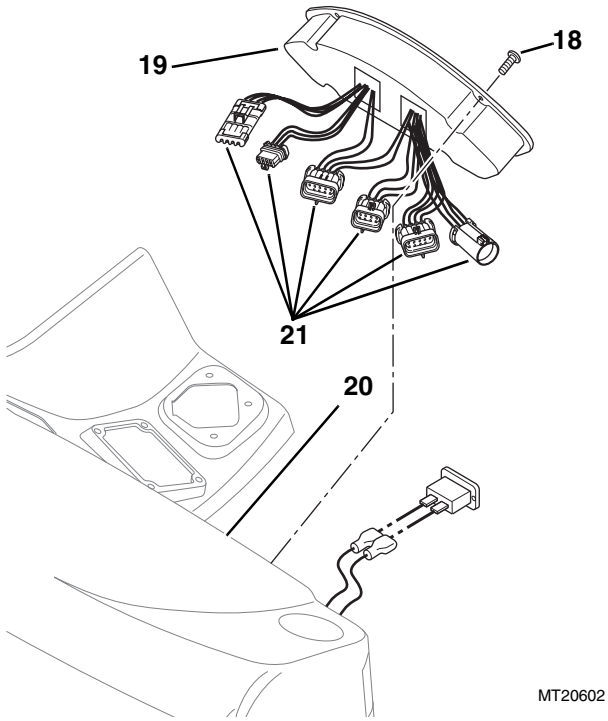
IMPORTANT: *Static electricity can cause damage to the operator's display panel. Avoid any manner of touching (hands, tools, etc.) the printed circuit boards and terminals. Disconnect the negative (-) battery cable at its battery terminal before beginning this procedure. Failure to comply can result in damage to the operator's display panel and malfunction of the instruments and indicator lights.*

1. Remove engine side battery box cover (**12**). Remove wing nuts (**13**) and carriage bolts (**14**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**15**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**16**) at the bottom of the battery equalizer (**17**).



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4. Remove the four internal-hex fasteners (**18**) securing the operator's display panel (**19**) to the dashboard housing (**20**).

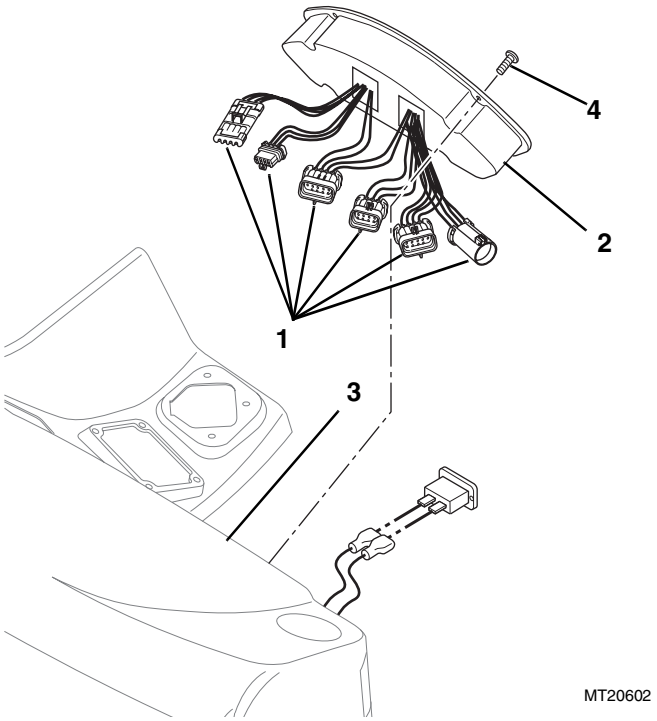


MT20602

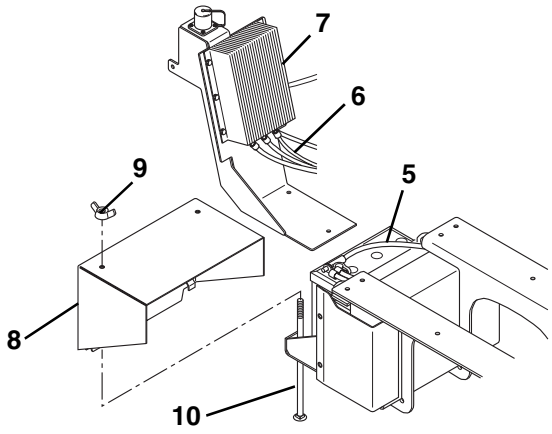
5. Disengage the quick-disconnect plug terminals (**21**) at the rear of the operator's display panel. Remove the panel from the vehicle.

e. Operator's Display Panel Installation

1. Connect the six quick-disconnect plug terminals (**1**) at the rear of the operator's display panel (**2**). Install the panel by positioning it into the dashboard housing (**3**) and aligning the four fastener mounting holes.
2. Install the four internal-hex fasteners (**4**) securing the operator's display panel (**2**) to the dashboard housing (**3**).

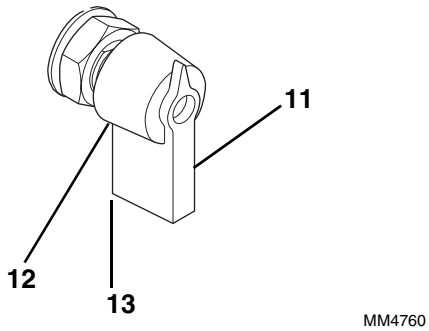


MT20602



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3. Connect the negative (-) battery cable (**5**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**6**) at the bottom of the battery equalizer (**7**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**8**). Use the wing nuts (**9**) and carriage bolts (**10**) to secure the cover in place.
6. Turn the ignition switch (**11**) to the RUN position (**12**) and observe that all operator's display panel functions are operative per the following diagnostic test.



MM4760

Operator's Display Panel Test

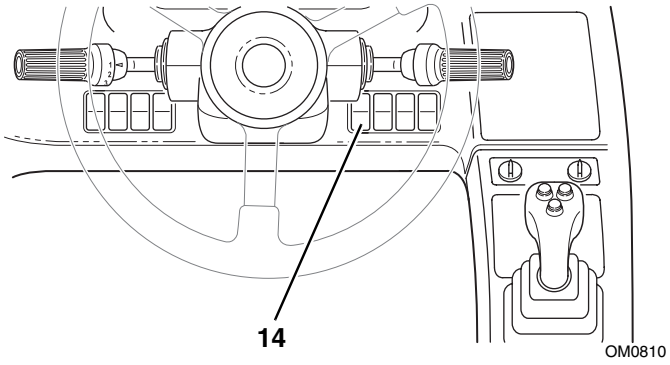
Check the following as the ignition (**11**) is switched into the "RUN" position (**12**):

1. All lights must illuminate for a minimum of 3 seconds.
2. An audible alarm must sound for a minimum of 3 seconds.
3. "Seat belt" light and "Read Manual" light must remain on for 5-7 seconds, with operator seated.
4. "Seat belt" light and "Read manual" light must illuminate when operator is removed from seat.
5. Warning lights and alarm must be OFF for an additional 15-20 seconds.

6. Engine oil pressure light and alarm will turn ON in 15 seconds if engine is not running.
7. One of three travel direction lights (F, N, or R) must always remain ON.
8. One of four gear selection lights must always remain ON “1, 2, 3, 4.”
9. One of three steer mode lights must always remain ON.
10. The appropriate fuel level indicator lights must always remain ON.

Note: *4 green bars = a full tank; 1 green bar = 1/4 tank, and at 1/8 tank, no green bars illuminate and the fuel dispensing pump symbol illuminates in orange.*

10.12.5 Front Windshield Wiper/Washer Switch





The front windshield wiper switch (**14**) is located on the dash panel to the right of the steering column and is pressed or “snapped” into a rectangular switch bezel. It is a three-position switch providing OFF (upper position), ON (center position) and WASH (lower position).

a. Removal

1. Remove engine side battery box cover (**8**). Remove wing nuts (**9**) and carriage bolts (**10**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**5**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**6**) at the bottom of the battery equalizer (**7**).
4. Carefully pry the windshield wiper switch and wire connector out of the mounting hole.
5. Disconnect the windshield wiper switch with bezel from the cab wiring harness connector.

b. Disassembly

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

c. Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean, lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity with the switch in the OFF, ON and WASH positions. (Refer to Section 10.7.29, “Front Wiper/Washer Circuit and Troubleshooting.”)
2. Replace the switch if it fails any of the tests in Step 1.

e. Installation and Testing

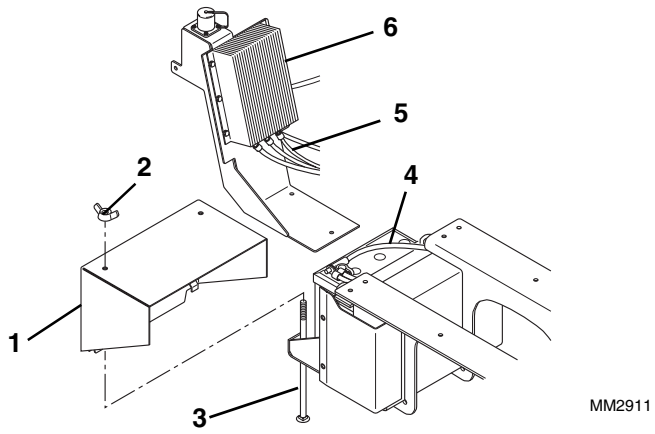
1. Connect the windshield wiper switch to the cab harness connector.
2. Position the switch over the rectangular switch bezel, and snap into position.
3. Connect the negative (-) battery cable (**5**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**6**) at the bottom of the battery equalizer (**7**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**8**). Use the wing nuts (**9**) and carriage bolts (**10**) to secure the cover in place.
6. Turn the ignition switch (**11**) to the RUN position (**12**) and test the windshield wiper LOW speed and HIGH speed functions. Turn the ignition switch (**11**) to the OFF (**13**) position.

10.12.6 Front Windshield Wiper Motor

a. Removal

Note: *It may be necessary to remove several hydraulic hoses from under the dash in order to remove and install the wiper motor housing. (Refer to Section 9.12.7, "Service Brake Valve." or Section 9.12.8, "Power Steering Valve.")*

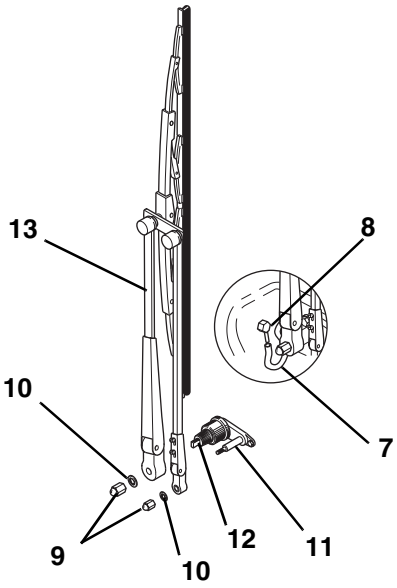
1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



MM2911

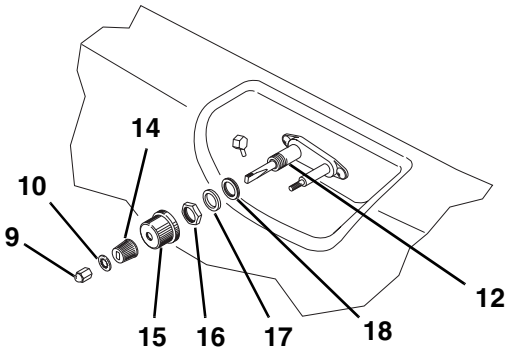
4. Remove the washer hose (**7**) from the hose connector on the wet kit adapter (**8**).
5. Remove the acorn nuts (**9**) and washers (**10**) from the pivot shaft (**11**) and the motor shaft (**12**). Set hardware aside for later reassembly.

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



SS3420

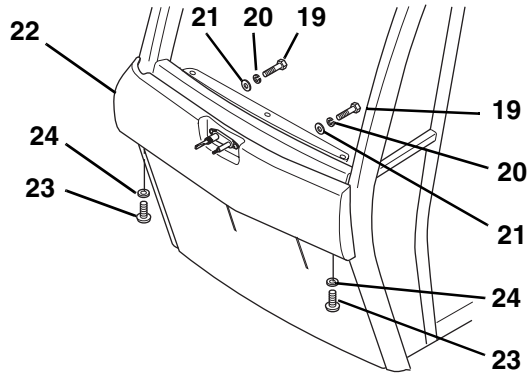
6. Remove the front wiper arm assembly (**13**) from the wiper motor shaft (**12**) and the pivot mount shaft (**11**).
7. Remove the driver (**14**), rubber cap (**15**), hex nut (**16**), metal washer (**17**) and fiber washer (**18**) from the shaft assembly (**12**).



SS2390

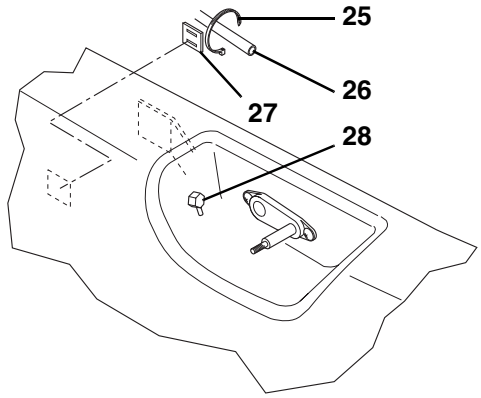
8. Remove the front dash. (Refer to *Section 3.2.3, b. Cab Removal*)

9. Remove the two capscrews (**19**), lockwashers (**20**) and flat washers (**21**) securing the front panel (**22**) in place on the inside of the cab. Remove the two button head capscrews (**23**) and flat washers (**24**) securing the panel in place on the outside of the cab. Save all hardware for later re-assembly.



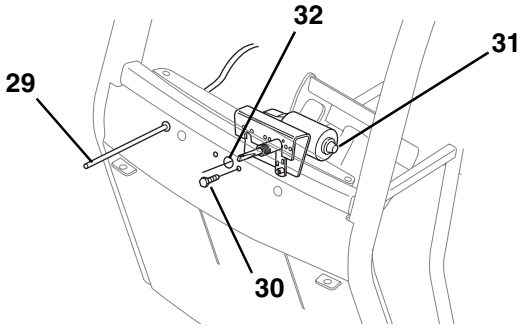
SS2390

10. Carefully begin to remove the front panel.



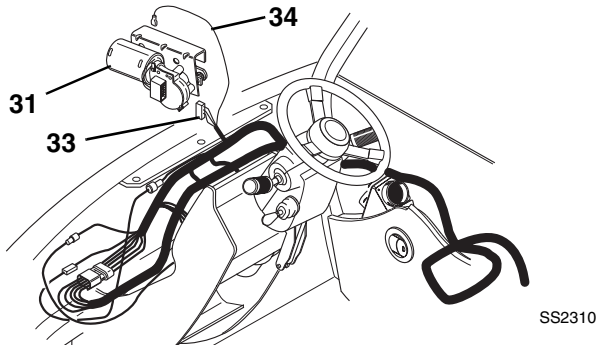
SS2380

11. Clip the tie wrap (**25**) securing the clear washer hose (**26**) to the tie wrap mount (**27**) on the backside of the front panel. Pull the end of the hose off the hose end of the wet kit (**28**). Set the front panel aside for later re-assembly.
12. Pull approximately 12" (305 mm) of the clear washer hose (**29**) to the outside of the cab.
13. Tag and remove any hydraulic or electrical components which will be in the way of removing the wiper motor.
14. Remove the two capscrews (**30**) securing the wiper motor (**31**) to the front of the cab.



SS2320

15. Label and disconnect the wires (**33** and **34**) going to the wiper motor.



SS2310

16. Remove the wiper motor (**31**) 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. Cleaning and Drying

Without submerging the motor, clean the motor with an approved solvent and dry with a clean, lint-free cloth.

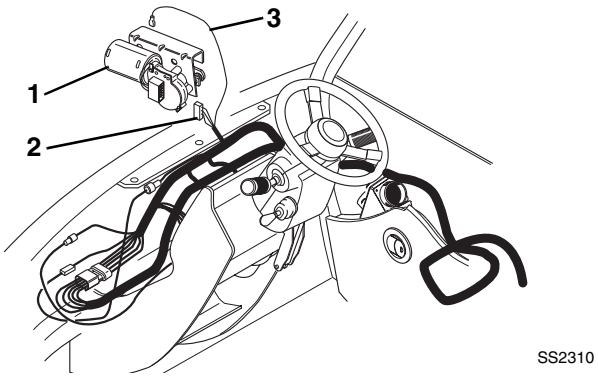
d. Inspection and Replacement

Inspect the motor terminals for continuity. Replace motor if continuity is not found. (Refer to Section 10.7.29, “Front Wiper/Washer Circuit and Troubleshooting.”)

e. Installation and Testing

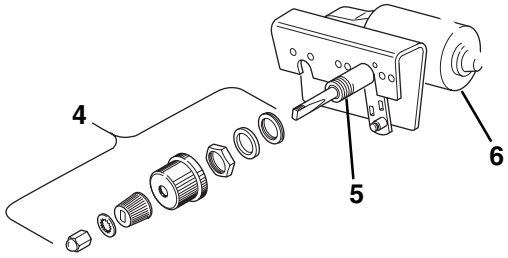
Note: *An assistant will be required for the installation of the front windshield wiper motor.*

1. Connect the closed cab harness to the front wiper motor (**1**). Push the three wire connector (**2**) all the way onto the terminals on the motor. Push the connector on the ground wire (**3**) onto the ground terminal on the motor.



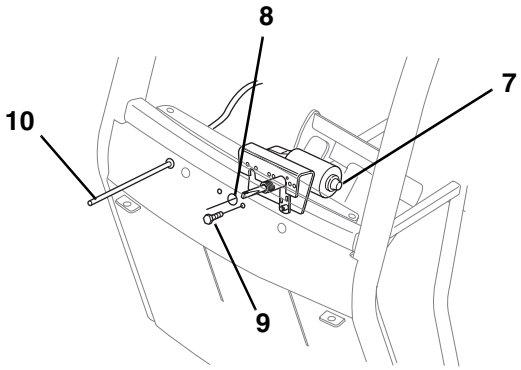
SS2310

2. Remove the hardware (**4**) from the shaft assembly (**5**) of the wiper motor (**6**). Save all the parts for reassembly.



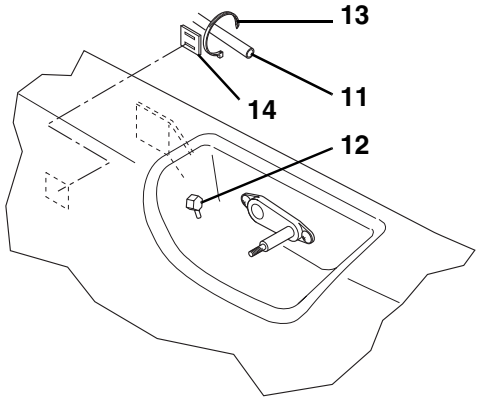
SS2320

3. Position the front wiper motor (**7**) with the shaft assembly on the left side and insert the front wiper motor shaft out through the front hole (**8**) of the cab. Be careful not to dislodge any of the connectors on the wiper motor. Secure the wiper motor to the front of the cab using two hex head screws (**9**). Tighten both screws securely.
4. Replace any hydraulic or electrical components which were removed earlier to remove the wiper motor.



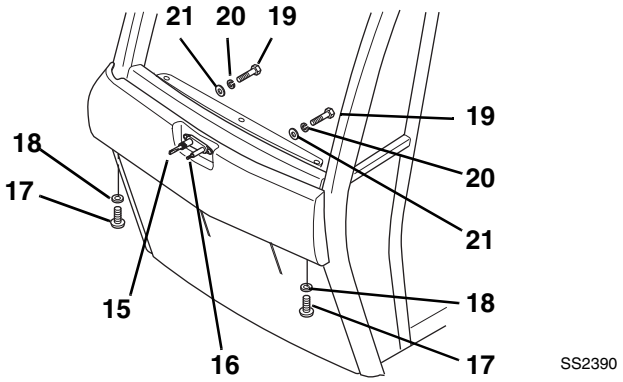
SS2320

5. Push the end of the clear washer hose (**11**) onto the hose end of the wet kit (**12**) on the backside of the front panel. Insert a new tie wrap (**13**) into the tie wrap mount (**14**). Wrap the tie wrap around the washer hose. Tighten the tie wrap to hold the clear hose in this position, but not to the point of pinching the hose shut.

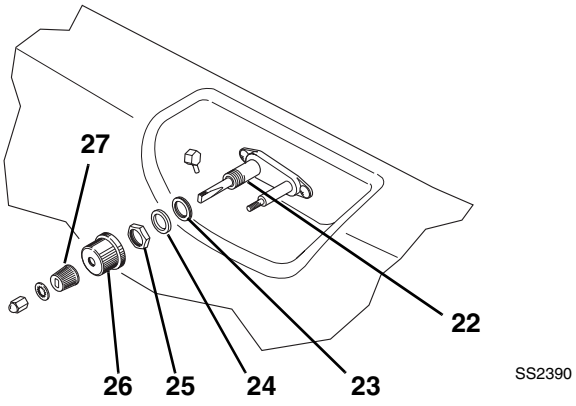


SS2380

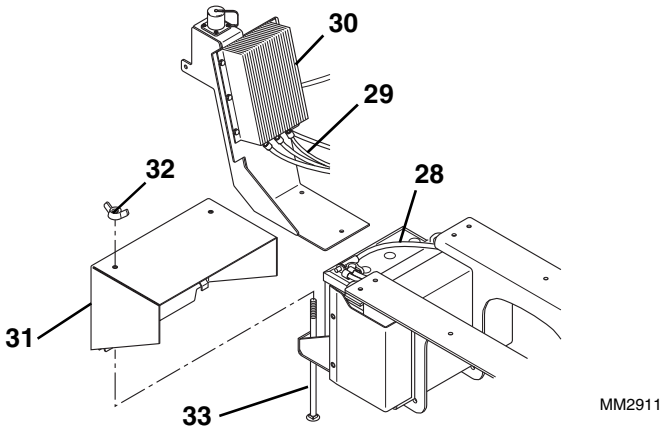
6. Place the front panel in place on the front of the cab by inserting the shaft assembly (**15**) through the center hole and the panto adapter (**16**).
7. Pull excess clear washer hose back through the rubber grommet as you position the front panel. Be careful not to pull the clear washer hose off of the wet kit.
8. Secure the front panel in place using two button head capscrews (**17**) and flat washers (**18**) from outside the cab and two capscrews (**19**), lockwashers (**20**) and flat washers (**21**) from inside the cab. Tighten the hardware securely.



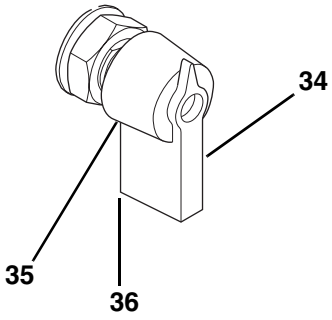
9. Reinstall the front dash. (Refer to *Section 3.2.3, c. Cab Installation*)
10. Reassemble the hardware onto the shaft assembly (**22**). Place the fiber washer (**23**) onto the shaft followed by the metal washer (**24**).
11. Secure in place with the hex nut (**25**) and tighten securely.
12. Place the rubber cap (**26**) over the hex nut (**25**).
13. Assemble the driver (**27**) to the threaded end of the shaft.

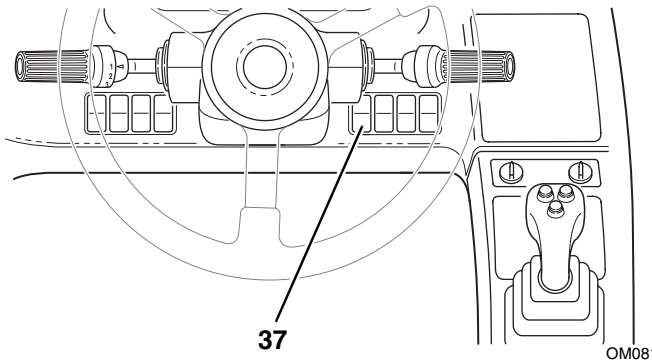


14. Connect the negative (-) battery cable (**28**) at the battery negative (-) terminal on the battery in the engine side battery box.
15. Connect the negative (-) battery equalizer cable (**29**) at the bottom of the battery equalizer (**30**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
16. Replace engine side battery box cover (**31**). Use the wing nuts (**32**) and carriage bolts (**33**) to secure the cover in place.

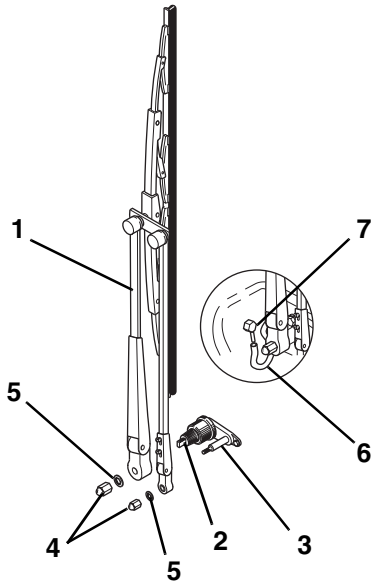


17. With the ignition switch (**34**) in the RUN position (**35**) press the front wiper switch (**37**) to the LOW (center) position and then to the OFF position to “Park” the front wiper motor on the left side of the windshield. Turn the ignition switch back to the OFF position (**36**).



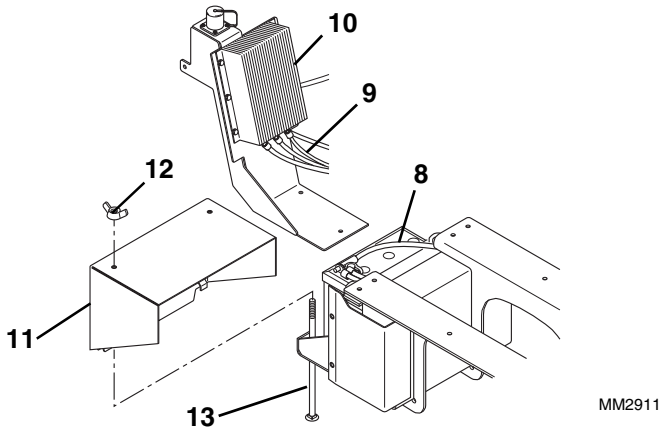


18. Assemble the front wiper arm assembly (**1**) to the wiper motor shaft (**2**) and the pivot mount shaft (**3**). The wiper blade should be parallel with the left side of the windshield.



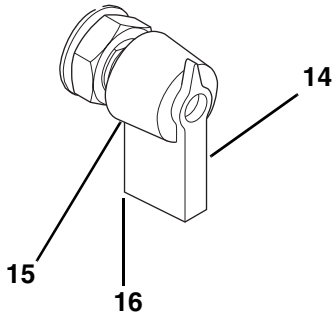
SS3420

19. Assemble the washers (**4**) and acorn nuts (**5**) to the pivot shaft (**3**) and the motor shaft (**2**). Tighten both securely.
20. Assemble the washer hose (**6**) onto the hose connector on the wet kit adapter (**7**).
21. Connect the negative (-) battery cable (**8**) at the battery negative (-) terminal on the battery in the engine side battery box.
22. Connect the negative (-) battery equalizer cable (**9**) at the bottom of the battery equalizer (**10**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
23. Replace engine side battery box cover (**11**). Use the wing nuts (**12**) and carriage bolts (**13**) to secure the cover in place.



MM2911

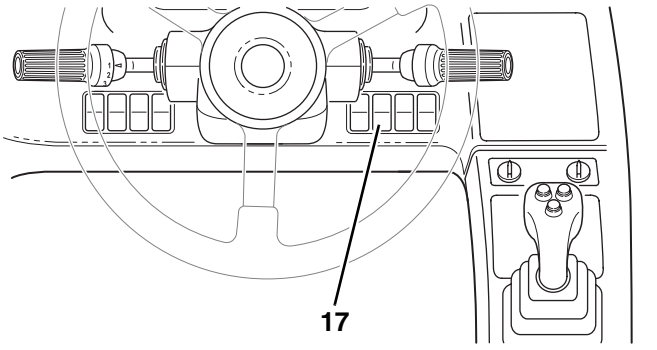
24. Turn ignition switch (**14**) to the RUN position (**15**), and operate windshield wiper in both ON and WASH positions to ensure proper operation and that correct wiper travel is achieved. Turn the ignition switch (**14**) to the OFF (**16**) position.



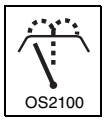
MM4760

25. If previously removed, install hydraulic hoses under the dash. (Refer to Section 9.12.7, “Service Brake Valve.” or Section 9.12.8, “Power Steering Valve.”)

10.12.7 Skylight Wiper/Washer & Rear Window Washer Switch



OM0810



The skylight wiper/washer and rear window washer switch (**17**) is located on the dash to the right of the steering column and is pressed or "snapped" into a rectangular switch bezel. It is a three-position switch providing OFF (upper position), ON (center position) for the skylight wiper and WASH (lower position) for the skylight and rear washers.

a. Removal

1. Remove engine side battery box cover (**11**). Remove wing nuts (**12**) and carriage bolts (**13**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**8**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**9**) at the bottom of the battery equalizer (**10**).
4. Carefully pry the skylight wiper switch, bezel and wiring out of the mounting hole.
5. Disconnect the skylight wiper switch from the cab harness connector.

b. Disassembly

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

c. Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean, lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity with the switch in the OFF and ON positions. (Refer to Section 10.7.30, "Skylight Wiper/Washer, Rear Washer Circuit and Troubleshooting.")
2. Replace the switch if it fails any of the tests in Step 1.

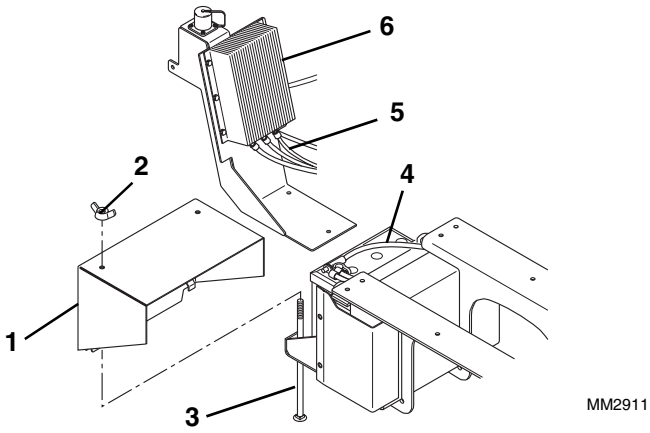
e. Installation and Testing

1. Connect the skylight wiper switch to the cab harness connector.
2. Position the switch over the rectangular switch bezel and snap into position.
3. Connect the negative (-) battery cable (**8**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**9**) at the bottom of the battery equalizer (**10**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**11**). Use the wing nuts (**12**) and carriage bolts (**13**) to secure the cover in place.
6. Turn the ignition switch (**14**) to the RUN position (**15**) and test the skylight wiper functions. Turn the ignition switch (**14**) to the OFF (**16**) position.

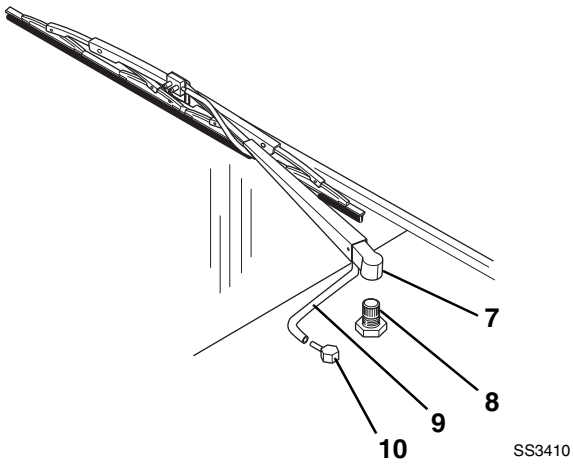
10.12.8 Skylight Wiper Motor

a. Removal

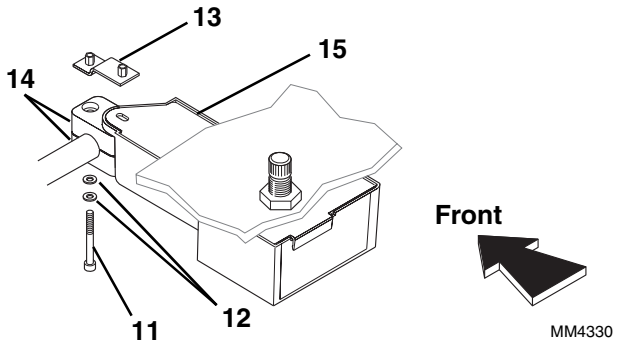
1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



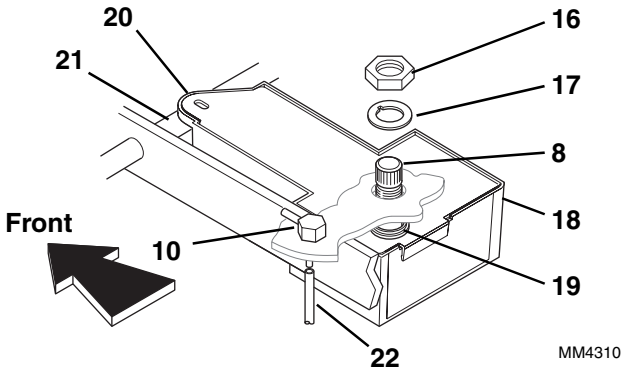
4. Remove the skylight wiper arm (**7**) from the skylight wiper motor shaft (**8**).
5. Disconnect the washer hose (**9**) from the top hose fitting (**10**).



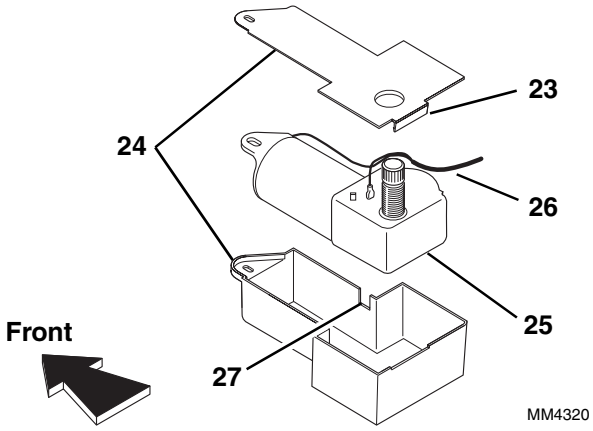
6. From inside the cab, remove the two screws (**11**) and four flat washers (**12**) from the wiper mount (**13**) and two clamp blocks (**14**) securing the front of the plastic case and wiper motor (**15**).



7. From the top of the cab, remove the hex nut (**16**) and metal washer (**17**) from the wiper motor shaft (**8**).



8. From inside the cab, carefully pull the plastic case (**18**), with the wiper motor inside, away from the roof. Make sure that the rubber washer (**19**), from between the top plastic cover and the roof, comes along with the plastic case. Save all hardware for later re-assembly.



9. Lift the tab (**23**) on the top plastic cover and unsnap the two plastic covers (**24**) of the plastic case to expose the skylight wiper motor (**25**).
10. Label and disconnect the cab harness (**26**) from the wiper motor.
11. Remove the wiper motor from the vehicle.

b. Disassembly

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

c. Cleaning and Drying

Without submerging the motor, clean the motor with an approved solvent and dry with a clean, lint-free cloth.

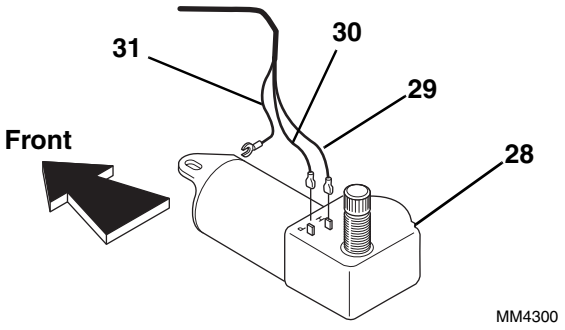
d. Inspection and Replacement

Inspect the motor terminals for continuity. Replace motor if continuity is not found. (Refer to Section 10.7.30, “Skylight Wiper/Washer, Rear Washer Circuit and Troubleshooting.”)

e. Installation and Testing

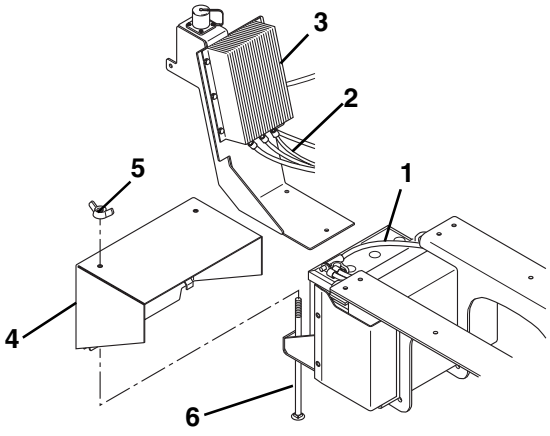
Note: *An assistant will be required for the installation of the skylight wiper motor.*

1. Hold wiper motor up toward cab top and install the cab harness connectors.
2. Attach the cab harness connectors to the terminals on the wiper motor (**28**). Assemble the wire 151 (**29**), purple w/yellow stripe, from the harness to terminal “H” on the wiper motor. Assemble the wire 84 (**30**), white w/brown stripe, from the harness to terminal “P” on the wiper motor. Assemble the black ground wire (**31**) to a bolt on the right side of the motor. Tighten securely.



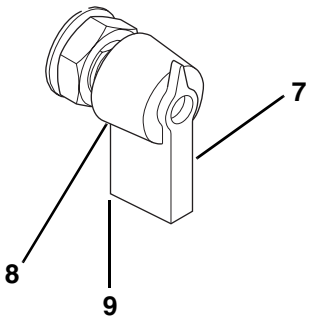
3. Assemble the two plastic covers (**24**) onto the wiper motor. Place the wires out the opening (**27**) on the right side of the lower cover and snap the two halves together.
4. Assemble the wiper motor to the roof. Place the lip (**20**) at the front of the plastic case above the round bar (**21**) of the cab roof. Place the rubber washer (**19**) onto the wiper motor shaft (**8**) and insert the wiper shaft up through the hole in the roof. Place the metal washer (**17**) onto the shaft and secure in place with the hex nut (**16**). Tighten securely.
5. From inside the cab, place the top half of the clamp block (**14**) between the lip (**20**) on the plastic case and the round bar (**21**) of the cab roof.
6. Place the wiper mount (**13**) above the top half of the clamp block (**14**) and the lip (**20**) of the plastic case and install the two screws (**11**) and four flat washers (**12**) and the lower clamp block (**14**). Tighten securely.
7. Push the clear washer hose (**22**) all the way onto the top hose fitting (**10**).
8. Assemble the skylight wiper arm (**7**) to the skylight wiper motor shaft (**8**) with the wiper blade on the right side of the skylight window. The wiper blade should be parallel to the edge of the window. Push the wiper arm all the way onto the motor shaft. Assemble the washer hose (**9**) onto the hose connection on the top hose fitting (**10**). Be sure to leave enough hose to allow for movement of the wiper arm.

9. Connect the negative (-) battery cable (**1**) at the battery negative (-) terminal on the battery in the engine side battery box.
10. Connect the negative (-) battery equalizer cable (**2**) at the bottom of the battery equalizer (**3**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
11. Replace engine side battery box cover (**4**). Use the wing nuts (**5**) and carriage bolts (**6**) to secure the cover in place.



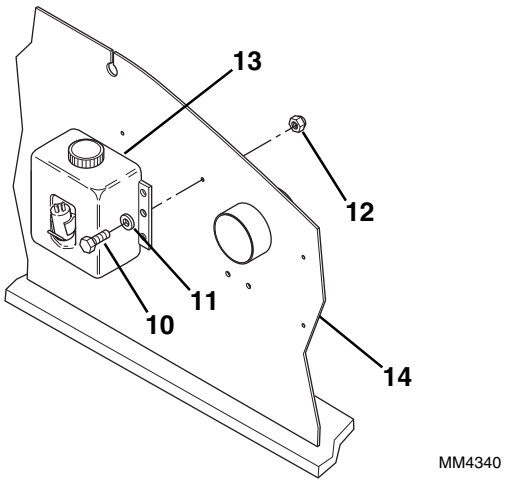
MM2911

12. Turn ignition switch (**7**) to the RUN position (**8**) and turn skylight wiper switch to the ON position. Ensure wiper stays on the window through a full stroke. Turn the skylight wiper switch to the OFF position.
13. Engage the washer switch and ensure washer fluid is sprayed on the roof window. Turn the ignition switch (**7**) to the OFF (**9**) position.



MM4760

10.12.9 Windshield/Skylight/Rear Wiper Washer Reservoir w/Pump

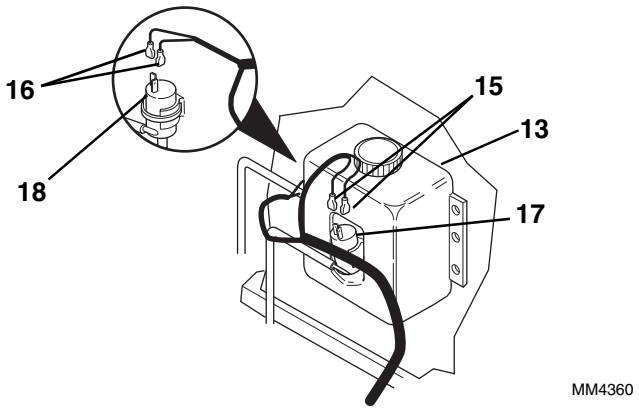


MM4340

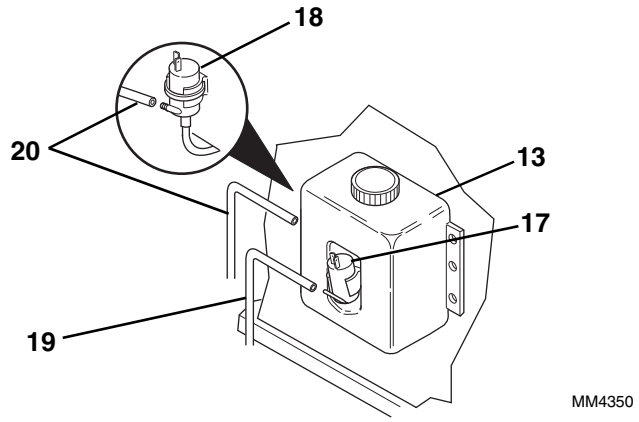
The wiper washer reservoir w/pump is a unit and cannot be serviced separately.

a. Removal

1. Remove engine side battery box cover (**4**). Remove wing nuts (**5**) and carriage bolts (**6**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**1**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**2**) at the bottom of the battery equalizer (**3**).
4. Remove the two capscrews (**10**), flat washers (**11**) and elastic locknuts (**12**) securing the wiper washer reservoir w/pump (**13**) to the engine panel (**14**).
5. Pull the washer reservoir (**13**) out and away from the engine panel (**14**).



6. Label and remove the cab harness connectors (**15** and **16**) from the connectors on the two pumps (**17** and **18**) on the wiper washer reservoir (**13**).



7. Remove the both windshield washer hoses (**19** and **20**) from the bottoms of the pumps (**17** and **18**) on the wiper washer reservoir (**13**).
8. Remove the wiper washer reservoir (**13**) from the vehicle.

b. Disassembly

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

c. Cleaning and Drying

Without submerging the pump, clean the pump and reservoir with an approved solvent and dry with a clean, lint-free cloth.

d. Inspection and Replacement

Inspect the electrical terminals for continuity. For additional information, refer to Section 10.7.29, “Front Wiper/Washer Circuit and Troubleshooting.” or Section 10.7.30, “Skylight Wiper/Washer, Rear Washer Circuit and Troubleshooting.”

e. Installation and Testing

1. Connect the clear washer hose (**19**), from the front wiper, to the front washer pump (**17**) on the wiper washer reservoir.
2. Connect the clear washer hose (**20**), from the skylight and rear wipers, to the rear washer pump (**18**) on the wiper washer reservoir.
3. Connect the cab wiring harness connectors (**15** and **16**) to the connectors on the two pumps (**17** and **18**) on the wiper washer reservoir (**13**).

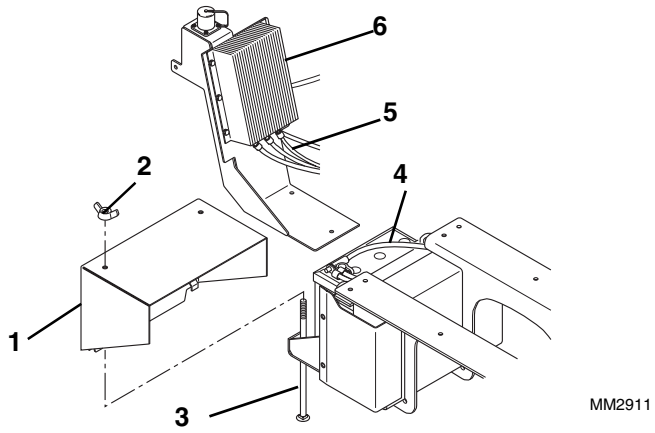
Note: *ALWAYS replace elastic locknuts with new elastic locknuts to help ensure proper fastening.*

4. Install the wiper washer reservoir w/pump using two capscrew (**10**), flat washers (**11**) and elastic locknuts (**12**) to secure it to the engine panel (**14**).
5. Fill the washer fluid reservoir with washer fluid.
6. Connect the negative (-) battery cable (**1**) at the battery negative (-) terminal on the battery in the engine side battery box.
7. Connect the negative (-) battery equalizer cable (**2**) at the bottom of the battery equalizer (**3**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
8. Replace engine side battery box cover (**4**). Use the wing nuts (**5**) and carriage bolts (**6**) to secure the cover in place.
9. Turn the ignition switch (**7**) to the RUN position (**8**) and press the washer switch. Verify that fluid is sprayed on both the windshield, roof and rear glass. Turn the ignition switch (**7**) to the OFF (**9**) position.

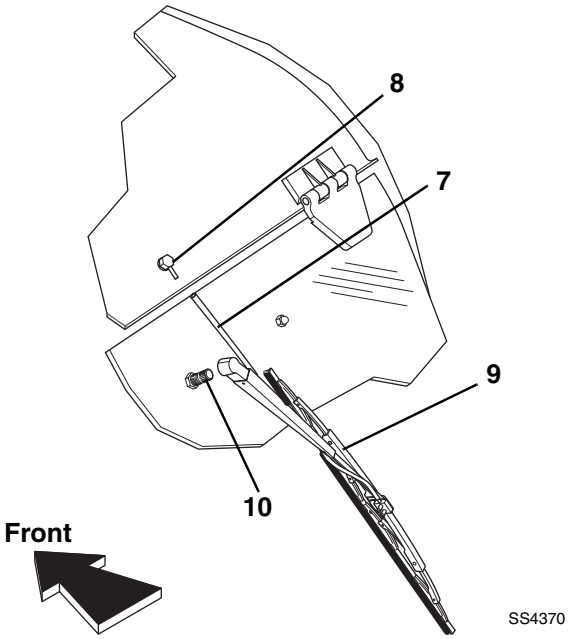
10.12.10 Rear Wiper Motor

a. Removal

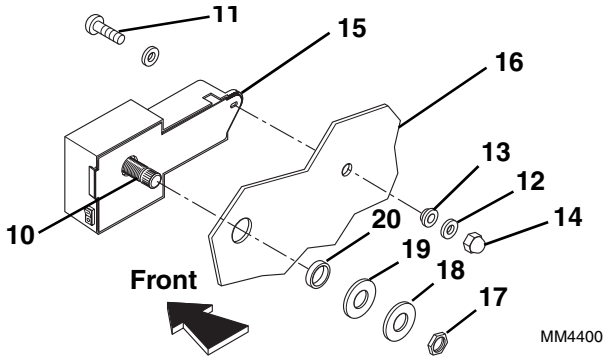
1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



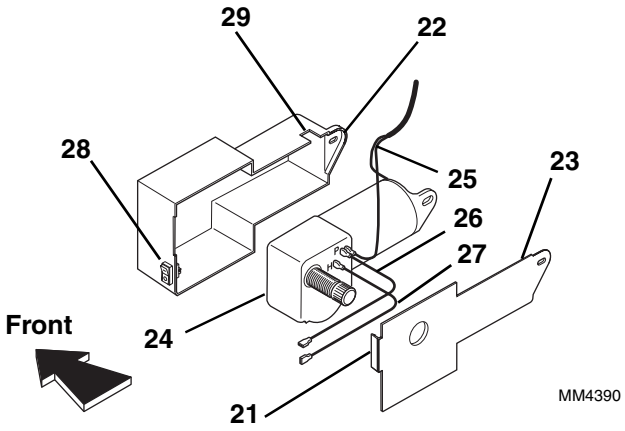
4. Disconnect the washer hose (**7**) from the top hose fitting (**8**).
5. Remove the roof wiper arm (**9**) from the roof wiper motor shaft (**10**).



6. From inside the cab, remove the round head screw (**11**), two black nylon flat washers (**12**), spacer (**13**) and acorn nut (**14**) securing the right side of the plastic case and wiper motor (**15**) to the rear window (**16**).



7. From the outside of the cab, remove the hex nut (**17**), metal washer (**18**), rubber washer (**19**) and spacer (**20**) from the wiper motor shaft (**10**). Save all hardware for later re-assembly



8. Lift the tab (**21**) on the rear plastic cover and unsnap the two plastic covers (**22** and **23**) of the plastic case to expose the roof wiper motor (**24**).
9. Label and disconnect the cab harness (**25**) and the two jumper wires (**26** and **27**) from the wiper motor.
10. Remove the wiper motor (**24**) and plastic covers (**22** and **23**) from the vehicle.
11. Disconnect the two jumper wires (**26** and **27**) running from the wiper motor switch (**28**) to the wiper motor (**24**).
12. Carefully pry the rear wiper motor switch (**28**) from the rectangular opening in the plastic case.

b. Disassembly

DO NOT disassemble the motor or the wiper motor switch. The motor and switch are not serviceable. Replace motor or switch if either are found to be defective.

c. Cleaning and Drying

Without submerging the motor or switch, clean with an approved solvent and dry with a clean, lint-free cloth.

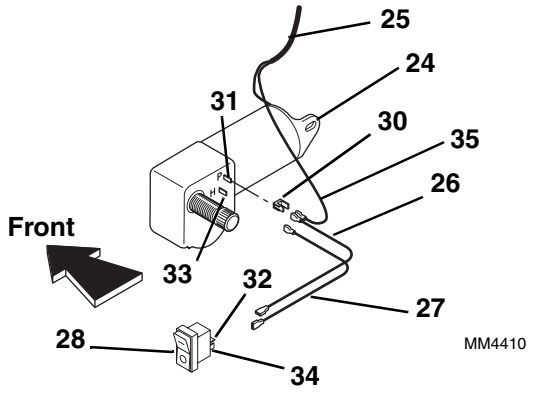
d. Inspection and Replacement

1. Inspect the motor terminals for continuity.
2. Replace motor if continuity is not found. (Refer to Section 10.7.31, “Rear Wiper Circuit and Troubleshooting.”)
3. Inspect the switch terminals for continuity with the switch in the OFF and ON positions. (Refer to Section 10.7.31, “Rear Wiper Circuit and Troubleshooting.”)
4. Replace the switch if it fails any of the tests in Step 3.

e. Installation and Testing

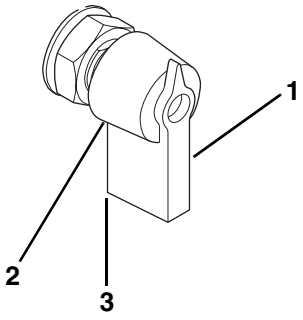
Note: *An assistant will be required for the installation of the rear wiper motor.*

1. Position the switch over the rectangular switch bezel, and snap into position.
2. Install the adapter (**30**) to the “P” terminal (**31**) on the motor (**24**).
3. Install jumper wire (**26**) to one of the blades on the adapter (**30**) and the other end to the “+” terminal (**32**) on the switch (**28**).
4. Install the other jumper wire (**27**) to the “H” terminal (**33**) on the motor and the other end to the “H” terminal (**34**) on the switch (**28**).
5. From the inside of the cab, hold the plastic case (**22**), with the wiper motor (**24**) installed, up toward the rear of the cab and install the cab harness connectors.
6. Assemble the wire 153 (**35**), green w/yellow stripe, from the harness to the adapter (**30**) on terminal “P” on the wiper motor. Assemble the black ground wire to a bolt on the right side of the motor. Tighten securely.

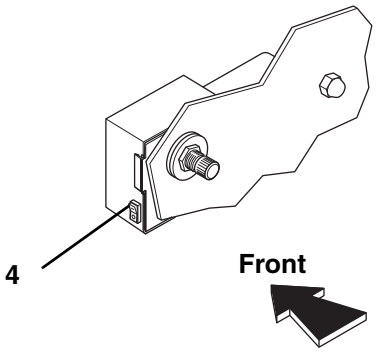


7. Route the wire harness out the opening (**29**) on the right side of the front cover (**22**). Assemble the rear plastic cover (**23**) over the wiper motor and snap the two plastic covers together.
8. Assemble the wiper motor (**24**) to the rear window (**16**). Place the spacer (**20**) onto the wiper motor shaft (**10**) and insert the wiper shaft with the spacer through the larger hole in the rear window. Place the rubber washer (**19**), metal washer (**18**), onto the shaft and secure in place with the hex nut (**17**). Tighten securely.
9. Secure right side of the wiper motor and plastic case with a round head screw (**11**), two black nylon flat washers (**12**), spacer (**13**) and acorn nut (**14**). Tighten securely.
10. Connect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
11. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
12. Replace engine side battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.

13. With the ignition switch (**1**) in the RUN position (**2**) press the rear wiper switch (**4**) to the ON position and then to the OFF position to “Park” the rear wiper motor on the right side of the rear window. Turn the ignition switch back to the OFF position (**3**).

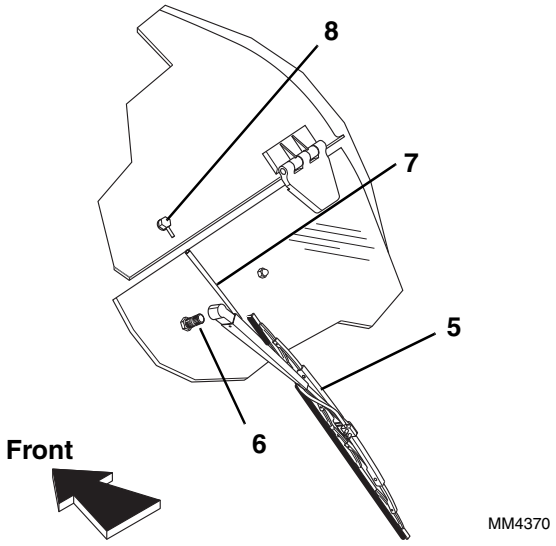


MM4760



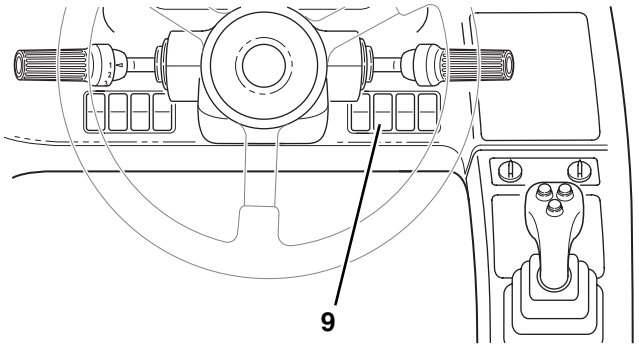
MM4420

14. Assemble the rear wiper arm (**5**) to the rear wiper motor shaft (**6**) with the wiper blade on the right side of the rear window. The wiper blade should be parallel to the edge of the window. Push the wiper arm all the way onto the motor shaft.
15. Assemble the washer hose (**7**) onto the hose connection on the hose fitting (**8**).



MM4370

16. Turn ignition switch (**1**) to the RUN position (**2**) and turn rear wiper switch (**4**) to the ON position. Ensure wiper stays on the window through a full stroke.

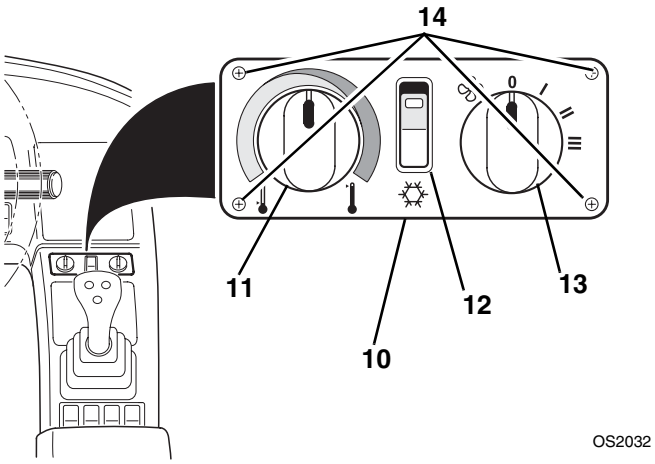


OM0810

17. Press and hold the bottom of the skylight wiper/ washer & rear window washer switch (**9**) to ensure fluid is sprayed on the roof and rear windows.
18. Position the skylight wiper/washer & rear window washer switch (**9**) in the center position to allow the roof wiper to clear fluid from the skylight window.
19. Press the skylight of the skylight wiper/washer & rear window washer switch (**9**) to turn the roof wiper off.
20. Turn the rear wiper switch (**4**) to the OFF position.
21. Turn the ignition switch (**1**) to the OFF (**3**) position.

10.12.11 Cab Heater/Air Conditioning 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. Refer to Section 3.4, Cab Heater/Air Conditioning Blower Box.*

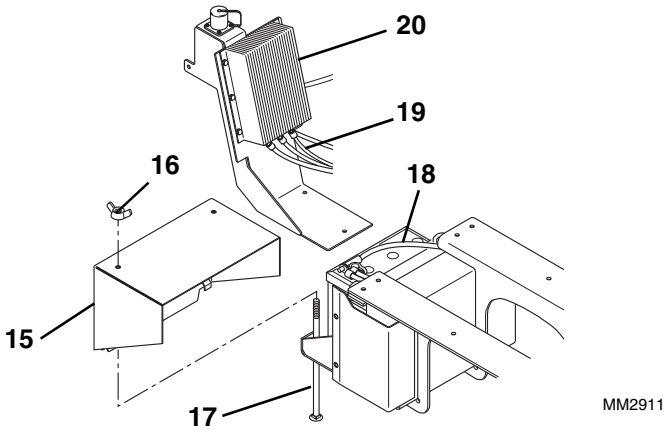


The cab heater and air conditioning controls (**10**) are located directly below the vehicles Capacity Chart Booklet. From left to right the control panel consists of: a temperature control knob (**11**), an A/C on-off rocker switch (**12**) and a variable speed fan control knob (**13**).

a. Cab Heater Controls Removal

Note: *After determining which control knob is not functioning, remove only the suspect control knob. In order to remove either control, the cab heater and fan control panel must be removed from the dash panel.*

1. Remove engine side battery box cover (**15**). Remove wing nuts (**16**) and carriage bolts (**17**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**18**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**19**) at the bottom of the battery equalizer (**20**).



4. Remove the setscrew from the variable speed fan control knob (**13**) or temperature control knob (**11**).
5. Remove the screws (**14**) and backing locknuts from the cab heater and fan control panel (**10**).
6. Pull the control panel out from the dash panel, and if removing variable speed fan control (**13**), remove the cab harness connector.
7. If removing the temperature control knob (**11**), disconnect the cable connector and remove control knob.
8. Remove the hex locknut from the suspect control shaft.
9. Remove the control from the panel.
10. If removing the air conditioning rocker switch label and disconnect the cab harness connector. Carefully pry the switch out of the mounting hole.

b. Disassembly

DO NOT disassemble the cab heater and air conditioning variable speed fan, temperature controls or the air conditioning switch. The controls and switch are not serviceable. Replace controls or switch if found to be defective.

c. Cleaning and Drying

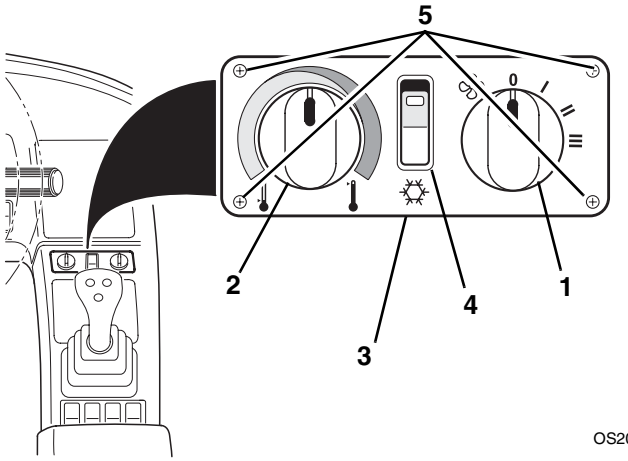
Without submerging the variable speed fan, temperature controls or the air conditioning switch, clean them with an approved solvent and dry with a clean, lint-free cloth.

d. Inspection and Replacement

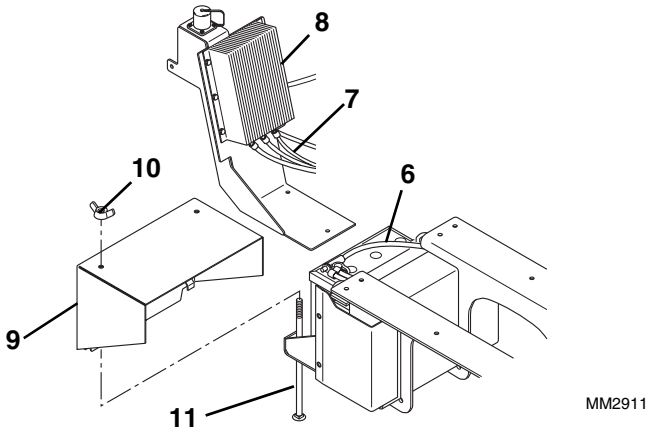
For additional information refer to Section 10.7.26, “Cab Heater & Air Conditioning Blower Motor Circuit and Troubleshooting.”

e. Installation and Testing

1. Check that the variable speed fan control (**1**) is in the OFF position.
2. If installing the temperature control (**2**) attach the control cable (not shown) to the back of the control.
3. Insert the control shaft (**1** or **2**) through the control panel (**3**), ensuring that the knob will in the vertical position when installed on the shaft.
4. Install the hex locknut on the shaft and tighten.
5. Connect the cab harness connector to the variable speed fan control.
6. Install the knob (**1** or **2**) and tighten setscrew, securing the knob to the control.
7. Snap air conditioning rocker switch (**4**) into mounting hole on the control panel. Connect cab harness connector to the back of the rocker switch.



8. Install the screws (**5**) and backing locknuts, securing the control panel to the dash panel.
9. Connect the negative (-) battery cable (**6**) at the battery negative (-) terminal on the battery in the engine side battery box.
10. Connect the negative (-) battery equalizer cable (**7**) at the bottom of the battery equalizer (**8**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
11. Replace engine side battery box cover (**9**). Use the wing nuts (**10**) and carriage bolts (**11**) to secure the cover in place.



12. Turn the ignition switch (**2**) into the START (**5**) position and start the vehicle. Allow the ignition switch to return to the RUN (**4**) position and let the engine warm up to normal operating temperature.
13. Turn the temperature control (**2**) and the variable speed fan control (**1**) all the way to the right to see if the controls are operating correctly. Make sure the variable speed fan control (**1**) operates in each of the speed positions.
14. Turn the temperature control (**2**) all the way to the left, the variable speed fan control (**1**) all the way to the right and press the top half of the air conditioning rocker switch (**4**) to engage the air conditioning.

10.12.12 Load Moment Indicator (LMI)

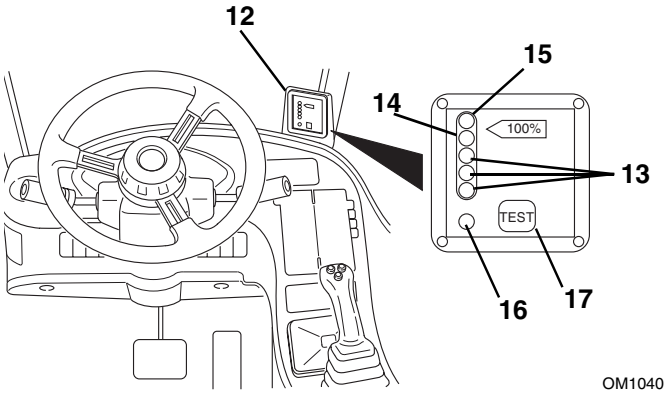
a. LMI Description

The LMI is intended for continuously monitoring the longitudinal load moment effect of the front fork load on the vehicle, by measuring the load on the rear axle.

It must be emphasized that the system is generally used to indicate forward stability and will not necessarily warn of sideways tipover.

The load sensor/transducer is mounted on the right rear axle bridge casting, and the load indicator display (**12**) is mounted inside the cab on the right side of the dash. The display has a vertical arrangement of five LEDs three green (**13**), one amber (**14**), and one red (**15**). The LEDs progressively light to indicate the percentage of safe working load (SWL) being carried.

When the vehicle ignition is first turned ON (and carrying no load), the Load Indicator display will show only the green “POWER ON” LED (**16**). See the table below for the % of SWL for each display light.



Display	Approximate % of SWL
No lights	≤ 51
1st Green	52 - 64
2nd Green	65 - 79
3rd Green	80 - 93
Amber	94 - 99
Amber flashing	100 - 107
Red	≥ 108

The accuracy/repeatability of the system is typically ± 1 display LED under normal conditions. The accuracy of the system will be affected by uneven ground, the stability system cylinder being locked, or having the steering at full lock. Larger changes in the display may be seen in these conditions.

When the display has reached “100%” (all green lights, plus amber light flashing) then the vehicle is carrying its maximum SWL, as indicated on the vehicle's load chart. The red light plus the audible alarm represents 108% SWL and greater, so there is no further visual or audible change from there on to the “tip up condition.” In this red range the driver should act to minimize the instability, by retracting the load.

Each day, the Load Moment Indicator System should be tested by pressing the TEST (**17**) button. This will cause all lights to flash on, and the audible warning to sound. The TEST button can also be pressed at any time during operation.

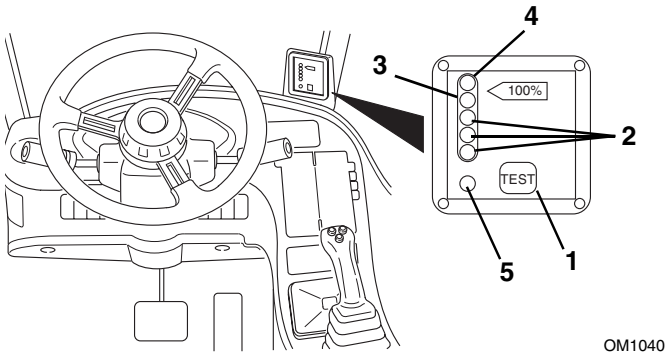
The display has a mute/dim facility, which allows the driver to set the level of brightness and sound level of the alarm. The four possible combinations are selected by holding the TEST button continuously while the display sequences through each combination. Release the TEST button to select when the preferred combination occurs.

The combinations are:

- Full brightness/Full volume
- Full brightness/Muted volume
- Dim brightness/Full volume
- Dim brightness/Muted volume

b. Calibration

1. Place the vehicle in the 0% calibration position, i.e. vehicle level, brakes off, steering straight ahead, boom retracted, 11k carriage with the forks lowered but not resting on the ground, and no load on forks.
2. Turn off the ignition.
3. Press and hold the TEST button (**1**), and turn on the ignition. The display will show all LEDs (**2**, **3** and **4**) ON and the sounder OFF. Keep holding the TEST button (**1**) for 30 seconds until the display changes again to show the red LED (**4**) only. This indicates that the system is now in calibration mode, and waiting for the first reference point. Release the button. DO NOT turn off the ignition. If the button is released too early the display will revert back to normal operation. Short intermittent beeps will then be emitted to indicate the system is waiting for an input.
4. Check that the vehicle is still positioned correctly for the 0% reference, and press the TEST button (**1**) ONCE. The system will give a single, short beep indicating that the 0% point is set. The display will change to show one red LED (**4**) and one amber LED (**3**) (and continuing intermittent beeps), indicating that the system is ready and waiting for the 100% reference. (NOTE - if a long beep is emitted from the sounder during calibration, this indicates a fault condition. Refer to *Section 10.12.12, c. Fault Conditions*)
5. With the vehicle level, and the brakes OFF, pick up the calibrated 6,000 lb load and extend until the front of the backrest of the carriage is 16-ft from the front of the front tires.



6. When in position, press the TEST button ONCE to set the 100% reference. The display will again give a single beep to confirm that it is set.
7. The display should now change back to normal operation, and show 100%, i.e. all green and amber LEDs lit and flashing.
8. System calibration has now been completed. No further action is required.

Note: *The system allows five minutes for each part of the calibration procedure to be completed. During this time the system will emit a short beep every five seconds to remind the operator. If the calibration procedure is not completed within the five minutes allowed, the system will automatically revert to normal operation with the previous calibration settings. If the ignition is switched OFF during calibration the system will automatically revert to the previous calibration settings.*

c. Fault Conditions

There are five system errors, which can be indicated by the display as detailed in list that follows. In normal operation, when an error occurs the sounder will operate continuously for ten seconds. After ten seconds the sounder will stop, and the display will flash all LEDs (**2**, **3** and **4**) continuously, except under conditions of input current limiting or low supply, when the displayed code and sounder remain on continuously. To repeat the fault condition display, press the TEST button (**1**). The calibration range fault is indicated only when the TEST button is pressed to enter the second reference point. In this case, the sounder only turns on for two or three seconds. The fault code is displayed during this time, and then the display reverts back to the PREVIOUS CALIBRATION STAGE, in order to allow the operator to correct the fault, if possible, before continuing.

The “POWER ON” LED (**5**) does not form part of the display, and must not be included when identifying the fault conditions.

1. *Low voltage supply fault*
   (RED + 1st and 3rd GREEN LEDs)

   The supply voltage has fallen below 9 Volts. If this fault occurs, turn off the ignition, and provide the correct power supply.

2. *Transducer signal out of range fault*
   (RED + 1st GREEN LED)

   The transducer signal is outside its valid operating range indicating a transducer installation or wiring fault. If this fault occurs only at the 0% reference calibration stage, this indicates that the transducer mounting surface is not flat enough.

3. *Calibration range fault*
   (RED + 2nd GREEN LED)

   The signal change between 0% and 100% during calibration is too small or too large. If this occurs, a transducer installation or application problem is indicated. Check the transducer is mounted in the correct location/orientation, that the surface is flat, and that it is fixed securely.

4. *Display circuit fault*
   (RED + 2nd and 3rd GREEN LEDs)

   The display unit is faulty. Switch the power OFF and ON again. If the fault does not clear, then a replacement display is needed.

5. *Calibration required fault*
   (RED + 3rd GREEN LED)

   No calibration data is present. This occurs when a new (uncalibrated) unit is fitted, or if calibration becomes corrupted or lost.

Display

If Power ON LED is not showing, check the power supply

Ensure the connector is properly latched.

Transducer

Check that output is in the range 40-60 mA when in the 0% condition

Checks should be made to ensure that the connector is properly latched

Check that the wiring insulation is not damaged

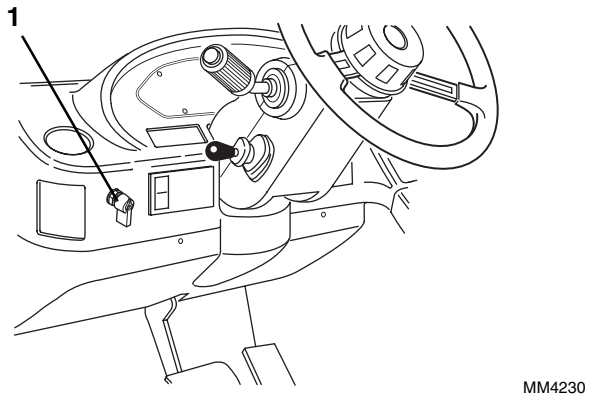
LMI pin-out

Pin	Display Unit Color	Sensor Function
1	Blue	bat -
2	green	sig -
3	Red	bat +
4	Yellow	sig +

10.13 SWITCHES AND SOLENOIDS

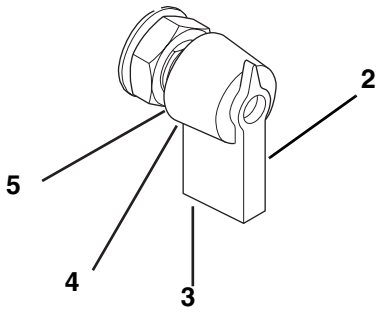
10.13.1 Ignition Switch

The ignition switch (**1**) is located on the lower left side of the dash. It is a key-operated switch used to start the engine and to run the vehicle.



MM4230

The ignition switch (**2**) is turned clockwise from the OFF (**3**) position to the RUN (**4**) position and then pushed in and turned to the START (**5**) position. The START position is spring-loaded to return the switch to the RUN (**4**) position. The START (**5**) position must be momentarily held in place for normal starting and for ether to be injected into the cylinders.



OM1500

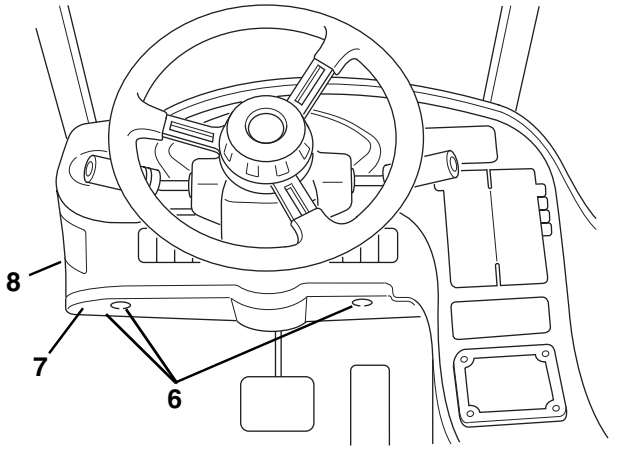
In the OFF position (**3**) the entire electrical system is shut down, with power at the ignition switch and the starter solenoid only.

In the RUN position (**4**), all controls and indicators are operable.

When the parking brake switch is ON and the transmission is in NEUTRAL [N], pushing and turning the ignition switch to the START position (**5**) engages the starter to start the engine and injects ether into the cylinders.

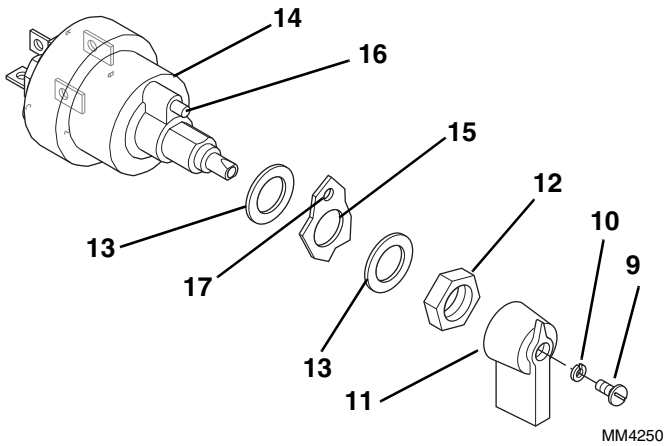
a. Ignition Switch Removal

1. Remove engine side battery box cover (**9**). Remove wing nuts (**10**) and carriage bolts (**11**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**6**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**7**) at the bottom of the battery equalizer (**8**).
4. Remove the three self-drilling screws (**6**) (one screw is not visible in figure) securing the lower dash cover (**7**) to the front dash (**8**). Remove the lower dash cover (**7**).



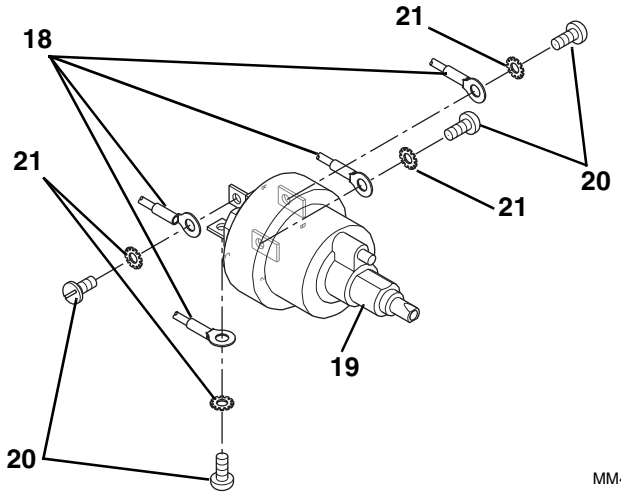
MT2050

5. Remove the screw (**9**) and lockwasher (**10**) holding the knob (**11**) in place.
6. Remove the hex nut (**12**) and both flat washers (**13**) securing the ignition switch (**14**) to the mounting hole (**15**) in the dash.
7. Reach up and under the dash to work the ignition switch and wiring out from behind the dash panel.



MM4250

8. Label and disconnect the wires (**18**) connected to the ignition switch (**19**). Remove the screws (**20**) and external tooth lockwashers (**21**) securing the wires to the pins on the back of the switch. Save the hardware for later re-assembly. Remove the switch from the vehicle.



MM4260

b. Disassembly

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

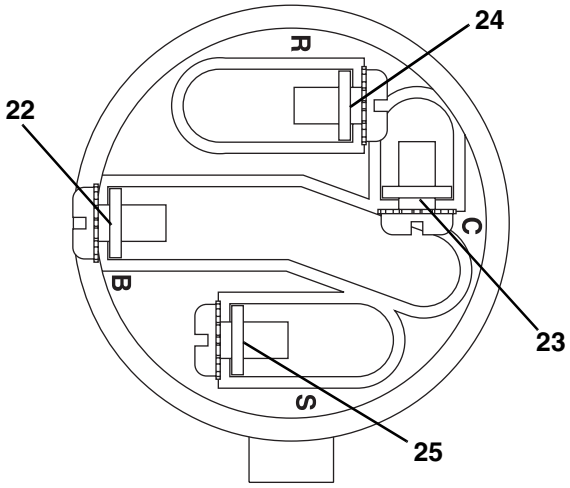
c. Inspection and Replacement

To determine the proper operation of the ignition switch, and using the charts below, test the terminals on the back of the switch for continuity with an ohmmeter.

Test the Ignition switch for continuity, by checking from the terminal “B” to each of the other terminals in each switch position. Continuity (X) should be present as indicated in the following table:

Test from “B”(22) to:	Switch Position		
	OFF	RUN	START
“C” (**23**)	X		
“R” (**24**)		X	
“R” (**24**) & “S” (**25**)			X

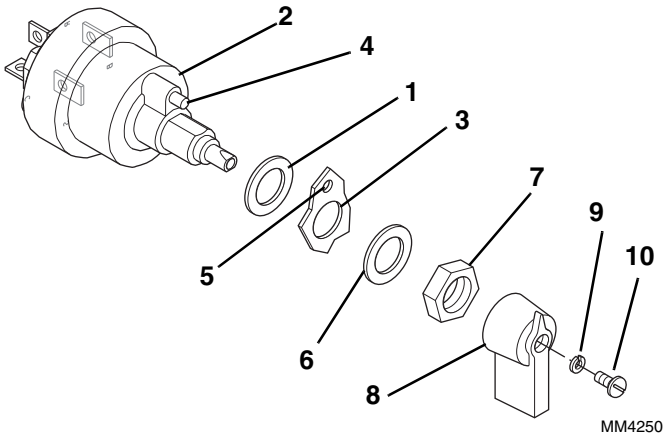
If all terminals do not show proper continuity, replace the ignition switch.



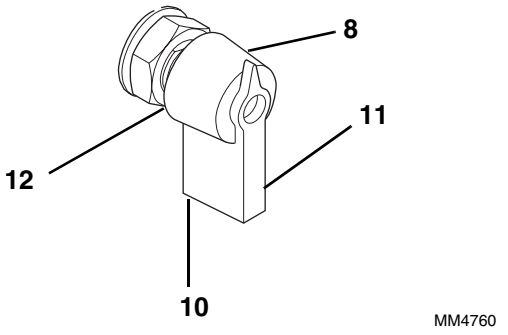
MM4430

d. Ignition Switch Installation

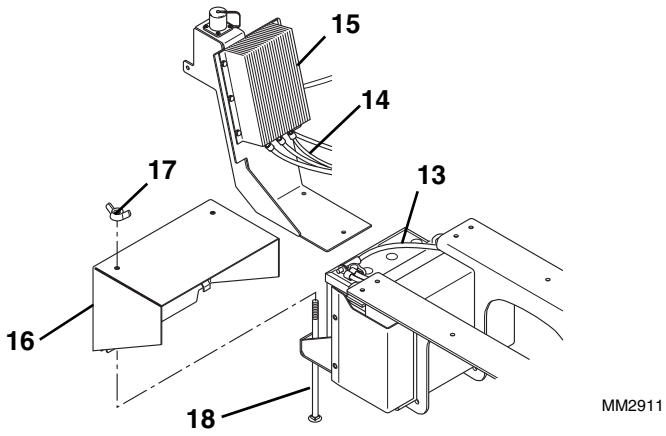
1. Connect the ignition switch to the wire ends of the cab harness.



2. Install one of the flat washers (**1**) onto the threaded portion of the ignition switch (**2**).
3. Reach up and under the dash to work the threaded portion of the ignition switch (**2**), with the flat washer (**1**), into the ignition switch mounting hole (**3**) on the left side of the dash. Make sure that the alignment tab (**4**) goes into the small hole (**5**) above the ignition switch mounting hole. Install the flat washer (**6**) and hex nut (**7**) to secure the ignition switch to the dash. DO NOT overtighten.



4. Align the ignition switch knob (**8**) so that when the ignition switch is in the OFF position (**10**), the tab (**11**) is positioned vertically (straight up and down). Install the lockwasher (**9**) and screw (**10**) to secure the knob (**8**) in place.
5. Connect the negative (-) battery cable (**13**) at the battery negative (-) terminal on the battery in the engine side battery box.
6. Connect the negative (-) battery equalizer cable (**14**) at the bottom of the battery equalizer (**15**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
7. Replace engine side battery box cover (**16**). Use the wing nuts (**17**) and carriage bolts (**18**) to secure the cover in place.



e. Transmission Neutral Start Feature

The transmission neutral start feature is a safety feature designed to prevent the engine from starting with the transmission in FORWARD [F] or REVERSE [R].

Shifting into NEUTRAL [N] activates the neutral relay (in the relay and fuse panel). When the travel select lever is in NEUTRAL [N], electrical power flows to the starter relay, allowing the starter to engage and start the engine.

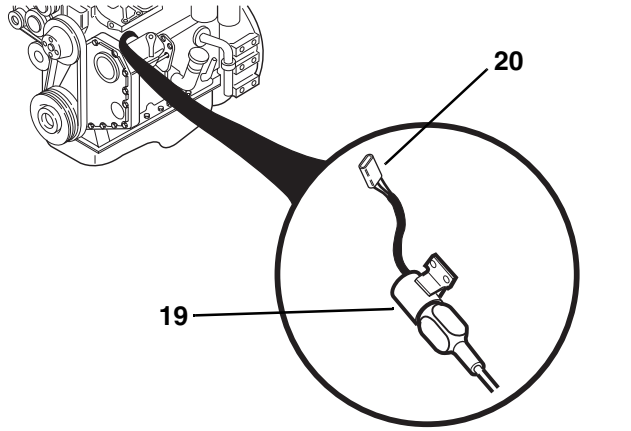
Test the transmission neutral start circuit as follows:

- The starter MUST NOT operate with the travel select lever in FORWARD or REVERSE.
- The starter MUST NOT operate when the park lock is OFF (disengaged).
- The starter MUST operate with the travel select lever in NEUTRAL.

If the starter fails to turn the engine with the travel select lever in NEUTRAL [N] and the ignition switch (**11**) is in the START position (**12**), refer to *Section 10.7.12, Engine Start Circuit and Troubleshooting*. The neutral position contacts in the shift switch are non-repairable. Replace the switch if defective.

10.13.2 Fuel Shutoff Solenoid

The fuel shutoff solenoid (**19**), located on the rear of the fuel injection pump is a solenoid that lets fuel enter the injection pump when the ignition switch is turned to the START or RUN positions. The fuel shutoff solenoid is connected to mechanical linkage.



a. Fuel Shutoff Solenoid Test

1. Disconnect the wiring connector at the fuel shutoff solenoid lead (**20**).
2. Energize the fuel shutoff solenoid using a 24-volt DC source. Connect the (+) POSITIVE lead of the 24-volt DC source to the white wire in the fuel shutoff solenoid connector and the (-) NEGATIVE lead of the 24-volt DC source to a good ground. Watch for the solenoid plunger to retract. If the plunger does not retract, replace the fuel shutoff solenoid with a new part.
3. Refer to the following table for a resistance check, with an ohmmeter, between specified wires. **DO NOT** apply any type of voltage source when performing the following resistance checks.

Wires Tested:	Resistance
White Wire to Black Wire (Pull Coil)	.82 ohms (approx.)
Red Wire to Black Wire (Hold Coil)	41.3 ohms (approx.)

b. Fuel Shutoff Solenoid Removal

1. Remove engine side battery box cover (**16**). Remove wing nuts (**17**) and carriage bolts (**18**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**13**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**14**) at the bottom of the battery equalizer (**15**).
4. Remove the fuel shutoff solenoid (**19**) from the fuel injector pump.
5. Remove the two bolts securing the solenoid to the mounting plate. Remove the nut holding the linkage to the arm on the fuel injection pump. Save the hardware for later re-use.

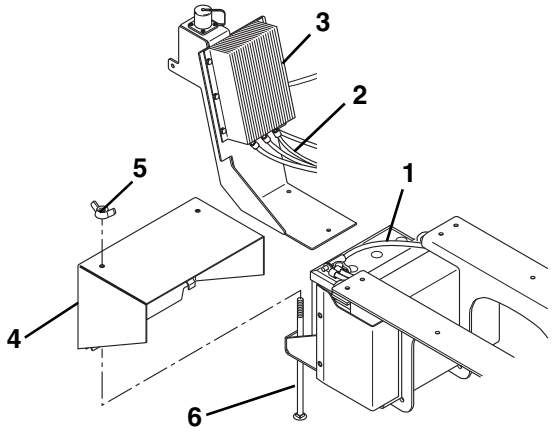
c. Fuel Shutoff Solenoid Disassembly

DO NOT disassemble a fuel shutoff solenoid. Replace a defective fuel shutoff solenoid with a new part.

d. Fuel Shutoff Solenoid Installation

1. Clean the exterior of the fuel injector pump.
2. Using the hardware removed earlier, install the nut holding the linkage to the arm on the fuel injection pump. Install the two bolts to secure the solenoid to the mounting plate.
3. Connect the wiring connector at the fuel shutoff solenoid lead (**20**).

4. Connect the negative (-) battery cable (**1**) at the battery negative (-) terminal on the battery in the engine side battery box.
5. Connect the negative (-) battery equalizer cable (**2**) at the bottom of the battery equalizer (**3**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
6. Replace engine side battery box cover (**4**). Use the wing nuts (**5**) and carriage bolts (**6**) to secure the cover in place.

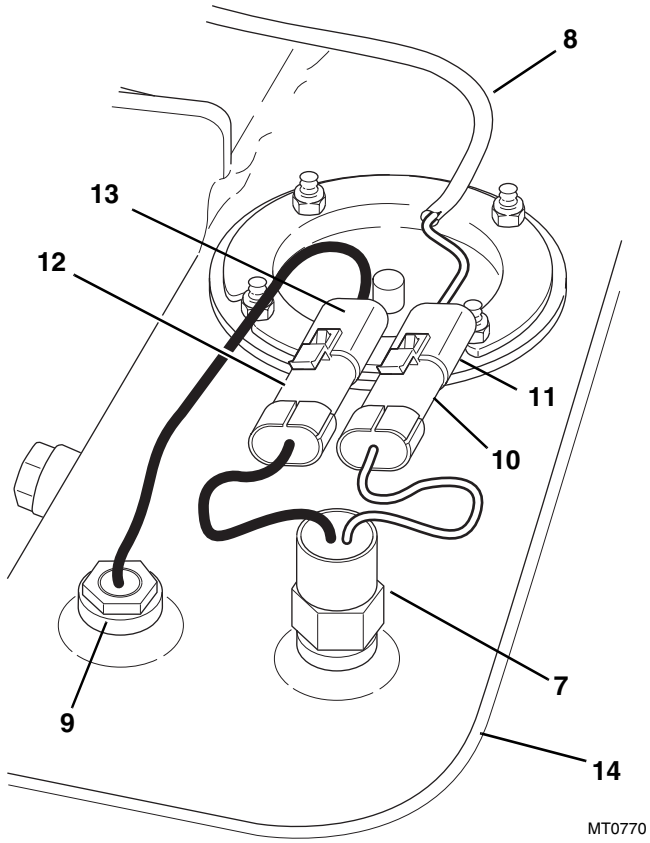


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7. Clear personnel and any obstructions from the area around the vehicle.
8. Start the engine.
9. If the engine starts, the fuel run solenoid is functioning.
10. If the engine fails to start, the fuel run solenoid may have a poor ground connection. Visually check the wiring at the fuel run solenoid leads and/or check for continuity with a voltmeter as required.
11. Check for fuel and/or oil leakage around the solenoid.

10.13.3 Hydraulic Oil Filter Pressure Switch

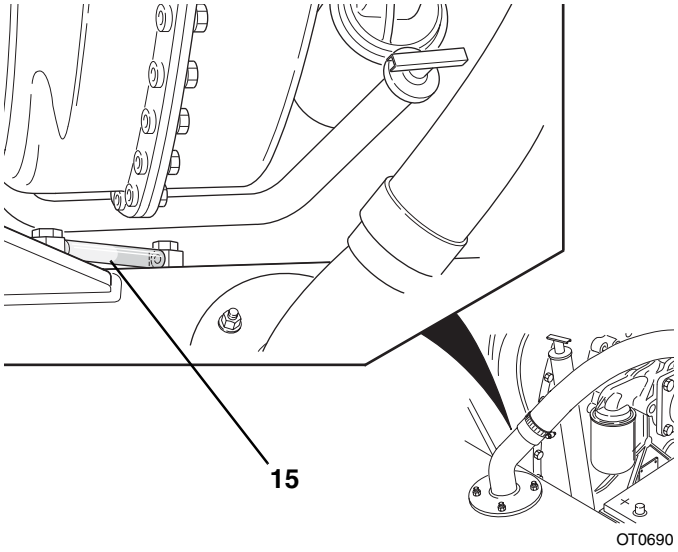
The hydraulic oil filter pressure switch (**7**) is threaded into a fitting welded at the top rear of the hydraulic oil reservoir.



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The switch is connected to the wiring harness (**8**) and to the hydraulic oil temperature switch (**9**). When the 25 psi (1,7 kPa) hydraulic oil system filter is clogged or restricted and the internal pressure of the filter rises to 25 psi (1,7 kPa), the switch closes and the hydraulic oil filter restriction indicator illuminates on the operator's display panel. The vehicle should be stopped and the engine revved at high idle for five minutes. If the light remains illuminated or begins to flicker ON and OFF at high idle, shut down the engine and inspect the hydraulic system. (Refer to *Section 10.9.4, Hydraulic Oil Filter Restriction Warning Indicator Troubleshooting*.)

Examine the fluid in the hydraulic oil sight glass (**15**) to check whether there is a sufficient amount of fluid in the system (the oil level should be at the mid-point of the sight glass with all hydraulic cylinders retracted) and whether the fluid is contaminated. Replace the hydraulic oil filter as required.



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a. Hydraulic Oil Filter Pressure Switch Removal

1. Remove engine side battery box cover (**4**). Remove wing nuts (**5**) and carriage bolts (**6**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**1**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**2**) at the bottom of the battery equalizer (**3**).
4. Label and disconnect the hydraulic oil filter pressure switch lead (**10**) from the harness connector (**11**).
5. Label and disconnect the hydraulic oil temperature switch lead (**12**) from the hydraulic oil filter pressure switch connector (**13**).
6. Unthread the hydraulic oil filter pressure switch (**7**) from the hydraulic reservoir (**14**).

b. Disassembly

DO NOT disassemble the hydraulic oil filter pressure switch. Replace a defective or faulty switch with a new one.

c. Cleaning and Drying

DO NOT submerge the hydraulic oil filter pressure switch. Clean only with an approved solvent and dry with a clean, lint-free cloth.

d. Inspection and Replacement

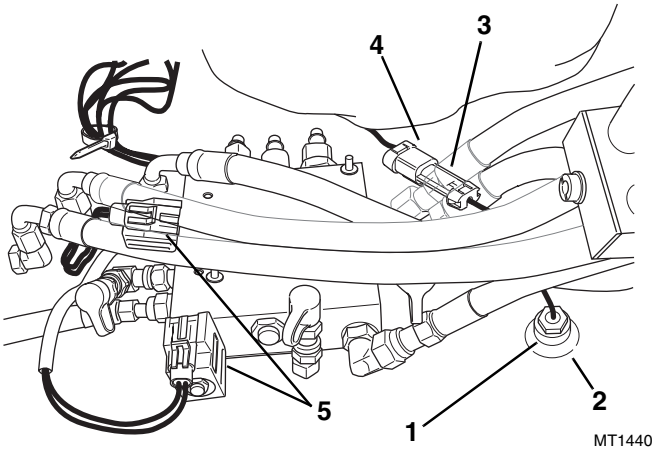
Inspect switch wiring for continuity and shorting. Replace a defective or faulty switch with a new one.

e. Installation and Testing

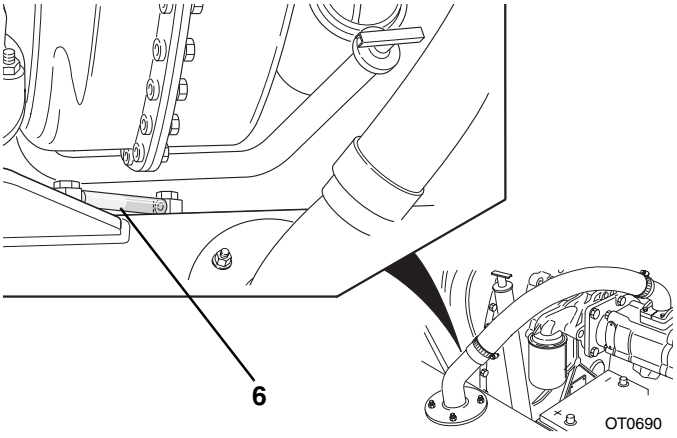
1. Thread the hydraulic oil filter pressure switch (**7**) into its welded fitting on the hydraulic reservoir (**14**). Tighten securely.
2. Connect the hydraulic oil filter pressure switch lead (**10**) to the harness connector (**11**). Connect the hydraulic oil temperature switch lead (**12**) to the hydraulic oil filter pressure switch connector (**13**).
3. Connect the negative (-) battery cable (**1**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**2**) at the bottom of the battery equalizer (**3**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**4**). Use the wing nuts (**5**) and carriage bolts (**6**) to secure the cover in place.
6. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
7. Start the engine, check for hydraulic fluid leaking at the hydraulic oil filter pressure switch, and allow the hydraulic fluid to reach operating temperature.
8. Cycle the boom several times and check whether the hydraulic oil filter restriction indicator illuminates on the operator's display panel.

10.13.4 Hydraulic Oil Temperature Switch

The hydraulic oil temperature switch (**1**) is threaded into a welded fitting (**2**) at the lower inside wall of the hydraulic oil reservoir.

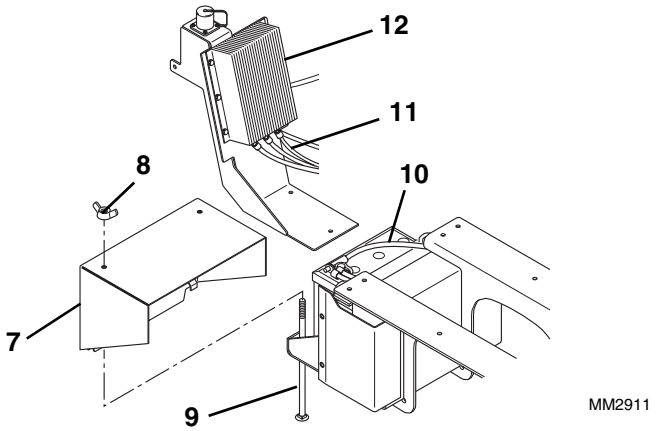


The hydraulic oil temperature switch is connected to the wiring harness and operator's display panel. When the hydraulic oil temperature is above 195° F (91° C), the hydraulic oil temperature warning indicator on the operator's display panel illuminates. The vehicle should be stopped and the engine allowed to run at high idle for five minutes. If the warning indicator continues to illuminate after five minutes, the engine must be shut down to help avoid damage in the hydraulic system. Examine the fluid in the hydraulic oil sight glass (**6**) to check whether there is a sufficient amount of fluid in the system (the oil level should be at the bottom of the sight glass with all hydraulic cylinders retracted) and whether the fluid is contaminated. Replace the hydraulic oil filter as required. Explore other causes for excessive temperature, such as high air temperature, plugged oil cooler or lines, loose fan belt, plugged radiator, etc. (Refer to *Section 10.9.3, Hydraulic Oil Temperature Warning Indicator Troubleshooting*.)



a. Hydraulic Oil Temperature Switch Removal

1. Remove engine side battery box cover (**7**). Remove wing nuts (**8**) and carriage bolts (**9**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**10**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**11**) at the bottom of the battery equalizer (**12**).



4. Label and disconnect the switch wiring connector (**3**) from the harness connector (**4**).
5. Unthread the switch (**1**) from the hydraulic reservoir welded fitting (**2**).

b. Hydraulic Oil Temperature Switch Disassembly

DO NOT disassemble the hydraulic oil temperature switch. Replace a defective or faulty switch with a new switch.

c. Hydraulic Oil Temperature Switch Cleaning and Drying

DO NOT submerge the hydraulic oil temperature switch. Clean only with an approved solvent and dry with a clean, lint-free cloth.

d. Hydraulic Oil Temperature Switch Inspection and Replacement

Inspect switch wiring for continuity and shorting. Replace a defective or faulty switch with a new switch.

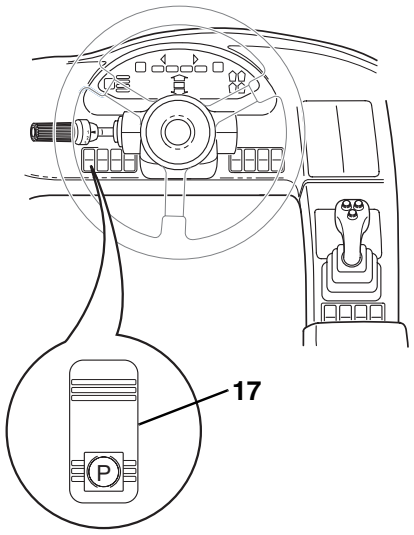
e. Installation and Testing

1. Thread the switch (**1**) into its welded fitting (**2**) on the hydraulic reservoir. Tighten securely.
2. Connect the switch wiring connector lead (**3**) to the harness connector (**4**).
3. Connect the negative (-) battery cable (**10**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**11**) at the bottom of the battery equalizer (**12**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**7**). Use the wing nuts (**8**) and carriage bolts (**9**) to secure the cover in place.
6. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
7. Start the engine, check for hydraulic fluid leaking at the hydraulic oil temperature switch, and allow the hydraulic fluid to reach operating temperature. Cycle the boom several times and check whether the hydraulic oil temperature warning indicator illuminates on the operator's display panel.

10.13.5 Parking Brake Switch

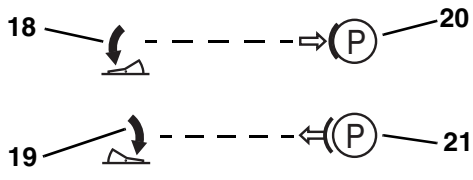
The parking brake switch (**17**) is located on the dash to the left of the steering column and is pressed or "snapped" into a rectangular switch bezel. The parking brake switch must be ENGAGED to permit engine starting.

Note: *The parking brake may be used to stop in an EMERGENCY situation; however, notify the operator to use caution as the stop will be abrupt and the operator and the load may be jolted forward unexpectedly.*



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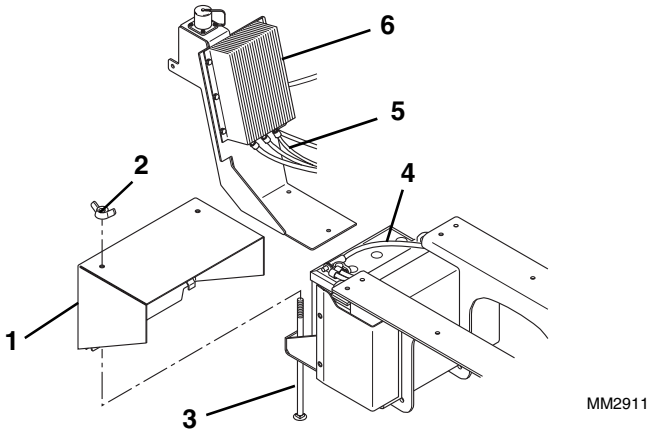
The parking brake switch is a two-position toggle switch; the two positions are engaged (**18**) and disengaged (**19**). The switch is marked with an engaged (**20**) and disengaged (**21**) symbol. When engaged, the parking brake switch completes the parking brake circuit. The parking brake solenoids on the auxiliary function valve (**5**) are normally de-energized, allowing the parking brake to engage. When the parking brake solenoids are energized, the parking brake is disengaged. The system is designed so that, when electrical power is OFF the parking brake is engaged. (Refer to *Section 10.13.5, Parking Brake Switch*.)



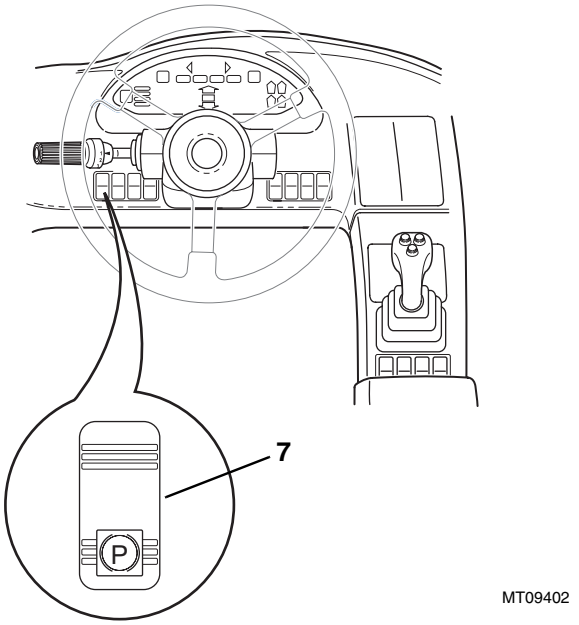
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a. Parking Brake Switch Removal

1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



4. Carefully pry the parking brake switch (**7**) and wiring out of the mounting hole.



5. Label and disconnect the wiring from the parking brake switch. Remove the switch from the vehicle.

b. Parking Brake Switch Disassembly

DO NOT disassemble the parking brake switch. Replace a defective or faulty switch with a new switch.

c. Parking Brake Switch 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.

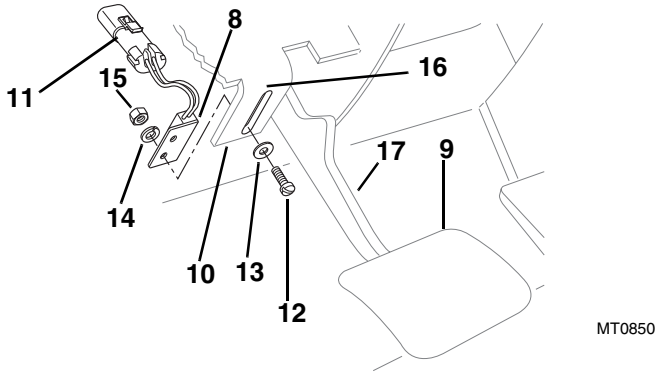
d. Parking Brake Switch Installation and Testing

1. Route the wiring from the dash through the bezel, then connect the wiring to the parking brake switch (**7**) as labeled during switch removal.
2. Properly position the “P” on the switch (**7**), then press or “snap” the switch into place in the bezel.
3. Connect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.
6. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
7. Start the engine, engage the park lock switch, place the travel select lever in FORWARD [F] or REVERSE [R] and second gear and apply full throttle. The vehicle should remain motionless in both FORWARD and REVERSE positions.
8. To test for proper parking brake switch disengagement, firmly depress the service brake pedal, disengage the park lock switch, place the travel select lever in either forward or reverse and in first gear, and slowly press the throttle pedal while releasing the service brake pedal. The parking brake should release and the vehicle should travel freely.

Note: *The parking brake indicator on the operator’s display panel must illuminate when the parking brake switch is engaged, and not illuminate when the parking brake switch is disengaged.*

10.13.6 Service Brake Switch

The service brake switch (**8**) is located next to the service brake pedal (**9**) and attached to a cab weldment (**10**) and connected to a wiring harness lead (**11**). Two screws (**12**), flat washers (**13**) pass through the weldment (**10**) and service brake switch (**8**) and are secured with two flat washers (**14**) and elastic locknuts (**15**). The weldment has a machined slot (**16**) which allows adjustment of the proximity switch.



The service brake switch (**8**) is a proximity type switch that is normally in a closed position until the brake pedal (**9**) is pressed and the brake pedal arm (**17**) begins to move through its arc. The proximity sensor detects the brake pedal arm metal and opens the circuit. The service brake switch circuit is also spliced into the Stabil-TRAK circuit through the dash panel logic. (Refer to *Section 10.9.8, Stabil-TRAK Indicator Troubleshooting*.)

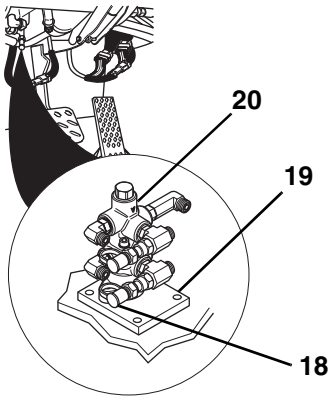
a. Service Brake Switch Removal

If the service brake switch (**8**) is suspect, remove the switch. Remove the two screws holding the switch. Disconnect the switch from the cab harness (**11**) and remove from vehicle. Test the switch for continuity and shorting. Replace a defective or faulty switch.

b. Service Brake Switch Installation and Adjustment

Note: *The service brake switch adjustment will require two people. Enlist the help of an assistant before attempting follow the adjustment procedure.*

1. When installing the service brake switch (**8**), make sure that the switch face is parallel with the brake pedal arm (**17**) and is no more then 1/4" (6,35 mm) from the brake pedal arm.
2. Leave the two screws (**12**), attaching the brake switch to the cab structure (**10**), just loose enough to adjust the brake switch.



WARNING: **NEVER** attempt to adjust the service brake switch without an assistant. Anytime the engine is running and the parking brake is disengaged, there must be an operator located in the cab and the two front tires must be blocked. Death or serious personal injury could result from the vehicle lurching forward or backward and running over the person attempting to adjust the service brake switch.

3. Connect a 1000 psi (69 bar) pressure gauge to the test port (**18**) closest to the mounting plate (**19**) on the service brake valve (**20**).
4. Start the engine and run it at low idle.
5. Depress and hold the brake pedal to maintain 150 psi (10,3 bar) brake pressure.
6. Position the brake switch so the brake lights come on at the 150 psi (10,3 bar) brake pressure.
7. Tighten the two attaching screws (**12**).
8. Block both front tires, position the boom above 40°, have the engine running at idle, the transmission in forward 4th gear and the park brake released. Slowly depress the brake pedal. The Stabil-TRAK dash light must come on with a service brake pressure of 150 ±15 psi (10,3 ±1 bar). Re-adjust the brake switch position as required to achieve the required pressure.
9. Remove the pressure gauge.

In order to test the switch for proper operation, the boom must be raised above the 40° position, the parking brake switch must be in the OFF position and the vehicle must be in a forward or reverse gear mode. Proper operation of the switch will activate the Stabil-TRAK dash panel indicator. If the Stabil-TRAK indicator does not activate when all conditions are met, the sensor must be adjusted.

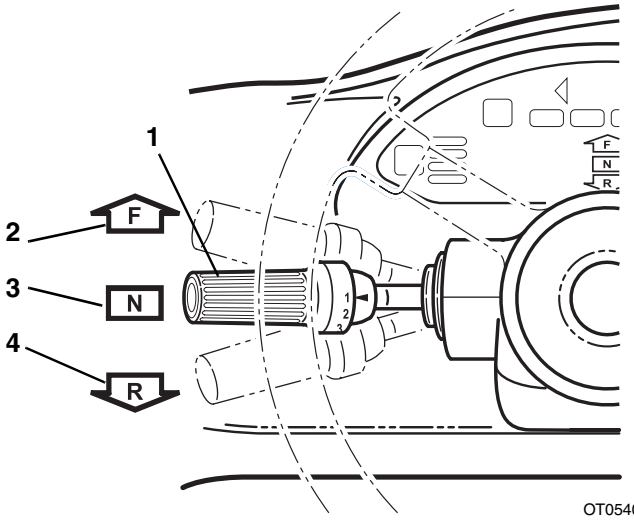
10.13.7 Transmission Shift Control Switch

a. Travel Select Lever (1)

The transmission shift control switch (travel select lever) is located on the left side of the steering column. The switch has three positions:

FORWARD (**2**) [F, all the way up],
NEUTRAL (**3**) [N, center position], and
REVERSE (**4**) [R, all the way down].

The switch or lever must be in the NEUTRAL [N] position to permit engine starting.



Moving the lever (**1**) opens and closes electrical contacts in the switch, allowing electricity to flow to the appropriate relays and on to the transmission shift solenoids.

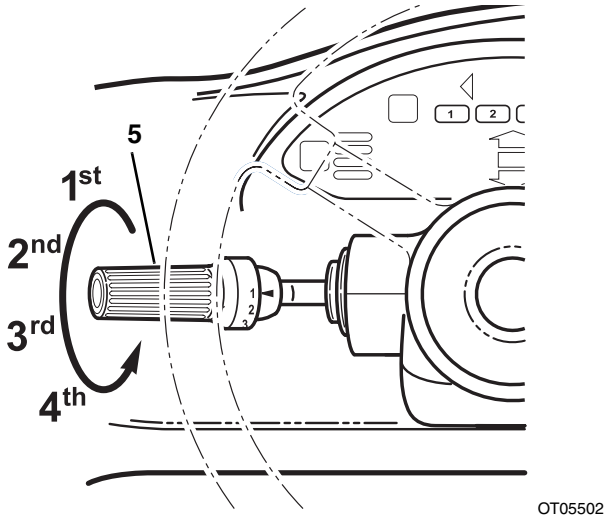
Travel selections are changed by grasping the lever, pulling it toward the steering wheel, then UP or DOWN to the desired selection, FORWARD (**2**) [F] or REVERSE (**4**) [R].

When the switch is shifted to the REVERSE (**4**) [R] position, the back-up alarm will automatically sound. (Refer to *Section 10.8.1, Transmission, Forward - First Gear Circuit* or subsequent circuit diagrams and also, *Section 10.13.8, b. Travel Select Lever and Wiring Harness Testing*.)

Refer to *Section 3.5.1, c. Transmission Range Selector and Turn Signal/Lights Lever Removal* and *Section 3.5.1, d. Transmission Range Selector and Turn Signal/Lights Lever Installation* for removal and installation instructions.

b. Gear Select Lever

The gear select lever (**5**) is part of the transmission shift control switch (travel select lever). The lever has a twist-grip handle with four positions.



The vehicle has four forward gears and three reverse gears.

First gear is used for the highest torque and pulling power, and the higher-numbered gears are for increasing vehicle travel speed.

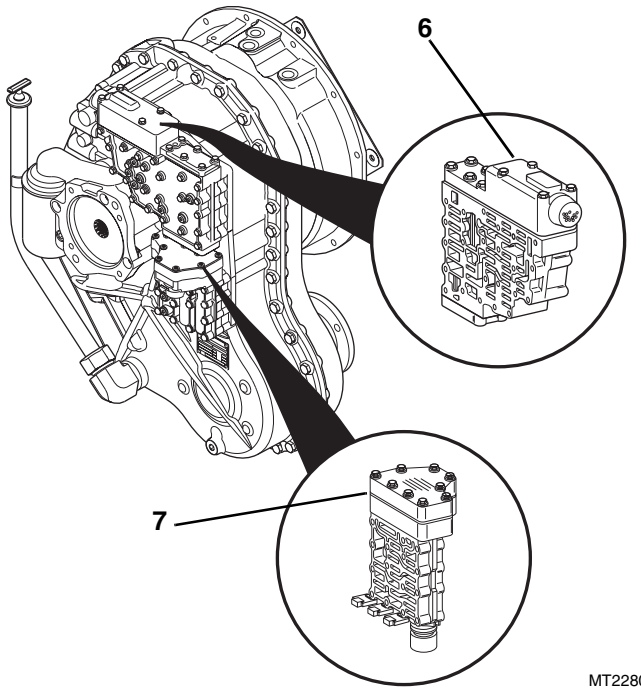
Refer to *Section 3.5.1, c. Transmission Range Selector and Turn Signal/Lights Lever Removal* and *Section 3.5.1, d. Transmission Range Selector and Turn Signal/Lights Lever Installation* for removal and installation instructions.

Refer to the Owners/Operators Manual for this vehicle for information on how travel direction and gear select control should be indicated on the operator's display panel.

10.13.8 Transmission Solenoid Valves

The transmission is shifted via six solenoids. Three solenoids valves Y1, Y2, and Y3 are contained in an UPPER spool-type solenoid cartridge assembly (valve body) (**6**).

The remaining three solenoid valves Y4, Y5 and Y6 are contained in the LOWER spool-type solenoid cartridge assembly (valve body) (**7**). While each 12-volt solenoid coil at the transmission is the same, the internal wiring to the solenoids is different and connected so that the various transmission clutches can be actuated via input from the transmission shift control switch (travel select lever). By placing the transmission shift control switch (travel select lever) in any given position a combination of solenoids is activated, which in turn engages a set combination of internal clutches. (Refer to *Section 10.13.8, b. Travel Select Lever and Wiring Harness Testing* and *Section 10.13.8, c. Upper and Lower Transmission Valve Body Solenoid Testing*.)



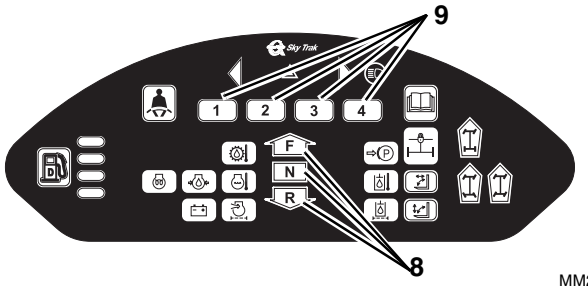
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If the transmission is not shifting properly, the transmission shift control switch (travel select lever), dash panel, wiring harness or transmission shift solenoids should be checked in order to determine which component is defective. Specific information to determine which travel position and corresponding component is not responding can be found by referring to *Section 10.8.1, Transmission, Forward - First Gear Circuit* and subsequent circuits and troubleshooting charts. Replace a defective component.

a. Travel Select Lever and Dash Panel Testing

If the transmission is not shifting properly, it must be determined which component is defective. The following test will determine if the problem is in the travel select lever or dash panel.

Turn the ignition switch to the RUN position. Move the travel select lever to the FORWARD [F], REVERSE [R] and NEUTRAL [N] positions (**8**) and through each gear selection. Note that the corresponding dash panel shift indicators (**9**) are activated. If the dash panel lights are working properly, the problem is in the transmission harness or the transmission shift solenoids.

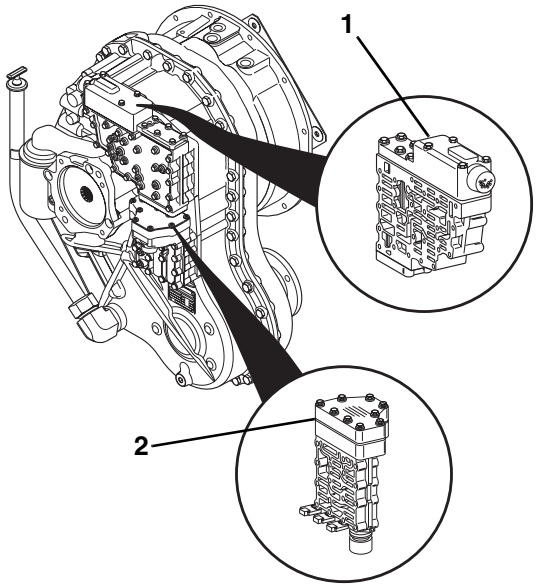


MM2001

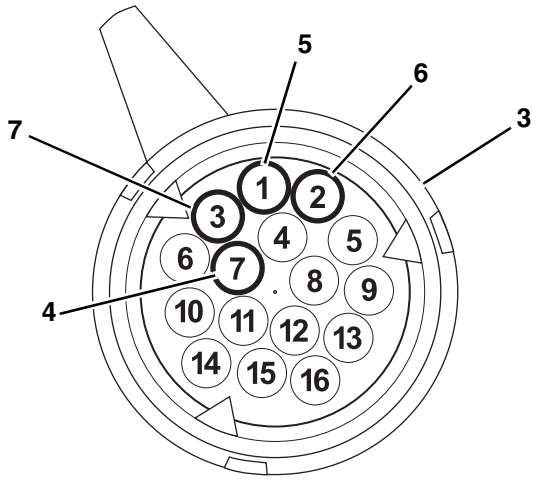
b. Travel Select Lever and Wiring Harness Testing

Note: *An assistant will be required to be **seated** and operate the travel select lever in order to perform the following test.*

1. Remove the plug from the **UPPER** (**1** and **3**) and **LOWER** (**2** and **8**) transmission solenoid valve bodies. Turn the ignition switch to the RUN position.



MT2280



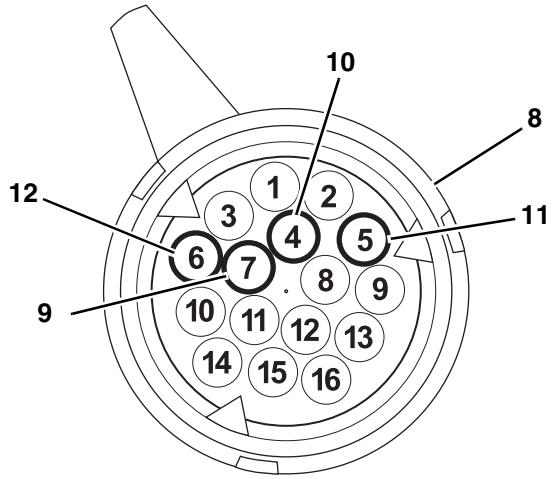
MT1110

Note: *In order to perform the solenoid test, the Parking Brake Switch must be in the OFF position.*

2. Have an assistant place the travel select lever in the position that is not functioning correctly.

Note: *Only use a DMM with 10 megohm impedance to prevent damage to the dash panel board.*

3. Check the harness side pin connections with a DMM for battery voltage corresponding to the direction and gear that has been selected. Refer to the chart that follows. Place the negative (-) lead on pin 7 (ground) (**4** or **9**) and the positive (+) lead on the pin to be tested, and test for battery voltage. If battery voltage is not present on any of the pins that have been tested, the wiring harness is suspect and should be replaced. If battery voltage is present, the harness is functioning properly.



MT1120

Note: *The following chart shows which solenoids are active with any given selection of the transmission shift control switch (travel select lever) and gear select position.*

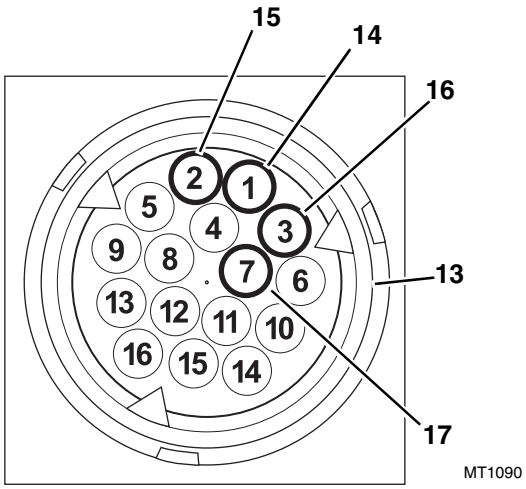
		Upper Valve Body			Lower Valve Body		
Solenoid Valve Callout		**Y1 (5)**	**Y2 (6)**	**Y3 (7)**	**Y4 (10)**	**Y5 (11)**	**Y6 (12)**
Driving Direction	**Speed**						
Forward	First	•		•		•	•
Forward	Second	•		•		•	
Forward	Third	•		•	•		•
Forward	Fourth	•			•		•
Reverse	First		•	•		•	•
Reverse	Second		•	•	•	•	
Reverse	Third		•	•	•		•

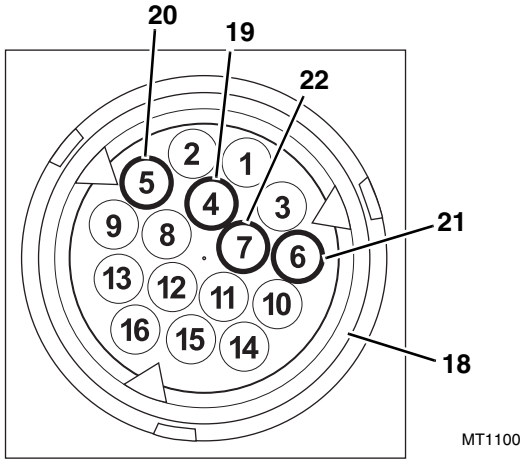
c. Upper and Lower Transmission Valve Body Solenoid Testing

Inspect the solenoid connector plugs (**13** and **18**). Following the chart below, test each pin connection on the upper transmission valve body connector for continuity and shorting. Each solenoid should have between 25.0 and 30.0 ohms of resistance when testing with an ohm/volt meter. Replace a defective solenoid valve. (Refer to *Section 10.13.8, d. Transmission Upper Valve Body Solenoid Removal*.)

Solenoid Pin Position	Active Solenoid	Callout
1	Y1	**14**
2	Y2	**15**
3	Y3	**16**
7	Ground	**17**
4	Y4	**19**
5	Y5	**20**
6	Y6	**21**
7	Ground	**22**

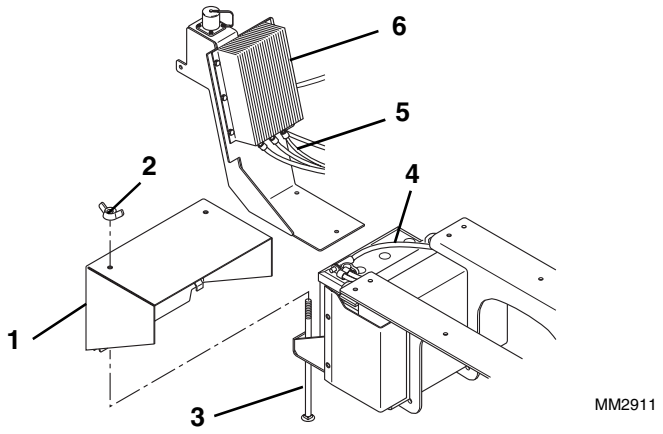
Note: *All six solenoids within both upper and lower solenoid valve body housings are of the same design.*



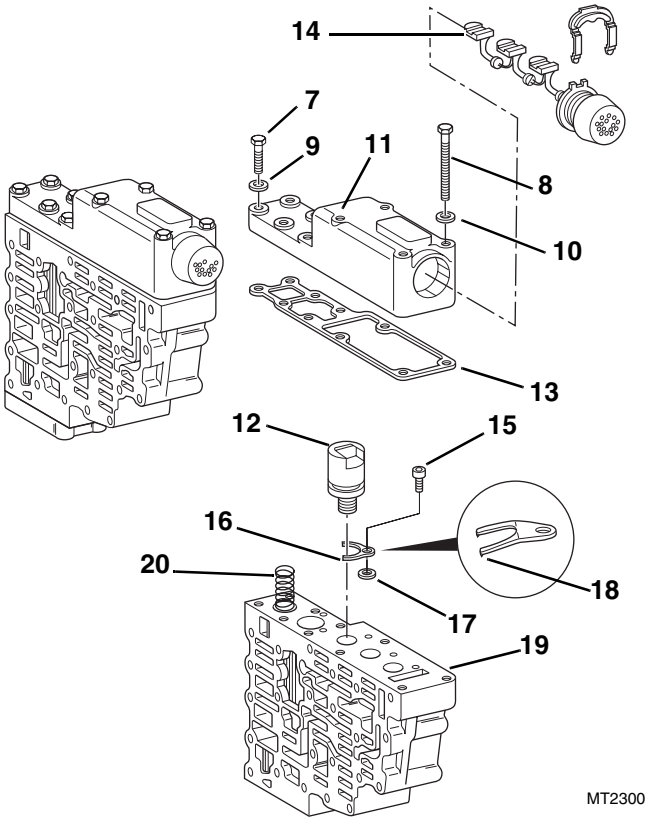


d. Transmission Upper Valve Body Solenoid Removal

1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



4. Remove the ten capscrews (**7** and **8**), ten washers (**9** and **10**) and protective cover (**11**) secured over the transmission solenoid cartridge valve (**12**). Inspect the protective cover gasket (**13**), replace if torn or missing.



5. Disconnect the internal wire connector (**14**) from the solenoid valve that is being removed. Label the internal wire connections if removing more than one solenoid valve.
6. Remove the solenoid capscrew (**15**), retaining plate (**16**) and flat washer (**17**) securing the solenoid valve (**12**) to the transmission.
7. Remove the solenoid valve (**12**) and replace.

e. Transmission Upper Valve Body Solenoid Installation

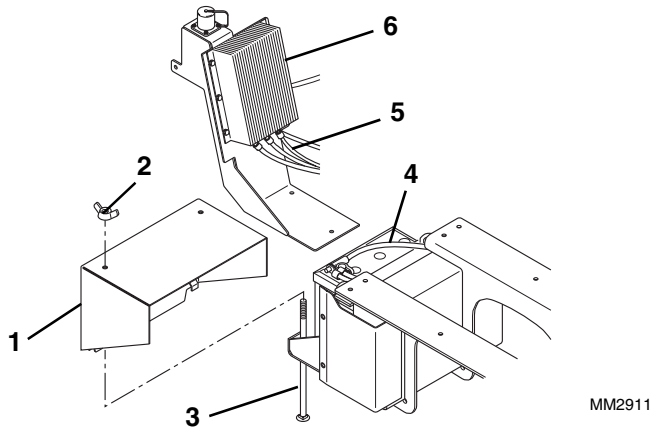
Note: *When installing the solenoid valve into the valve body, position the solenoid valve wires so they do not interfere with the protective cover plate.*

1. Install the flat washer (**17**), solenoid valve (**12**) along with the retaining plate (**16**). Connect the internal wire connector to solenoid. Insure that the claw side (**18**) of the retaining plate is facing down toward the valve body surface (**19**).
2. Install the solenoid capscrew (**15**) and torque to 53 lb/in (6 Nm).
3. Install the protective cover gasket (**13**) on the valve body. Position the protective cover (**11**) over the gasket. Install six washers (**9**) and capscrews (**7**) and hand tighten until the valve body spring (**20**) (upper valve body only) is compressed and the cover plate sits flush over the gasket.
4. Install the four lockwashers (**10**) and four capscrews (**8**). Torque to 84 lb/in (9,5 Nm).
5. Connect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
6. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
7. Replace engine side battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.
8. Test the operation of the transmission. Put the transmission through its entire range of gears (speeds) in both FORWARD [F] and REVERSE [R] and check that the transmission also shifts into NEUTRAL [N].
9. Verify that each function works properly, that the transmission does not engage when in NEUTRAL [N] and that the proper indicators illuminate on the operator's display panel.

For further transmission information, refer to *Section 7, Transmission: ZF 4 WG-98 TS*.

f. Transmission Lower Valve Body Solenoid Removal

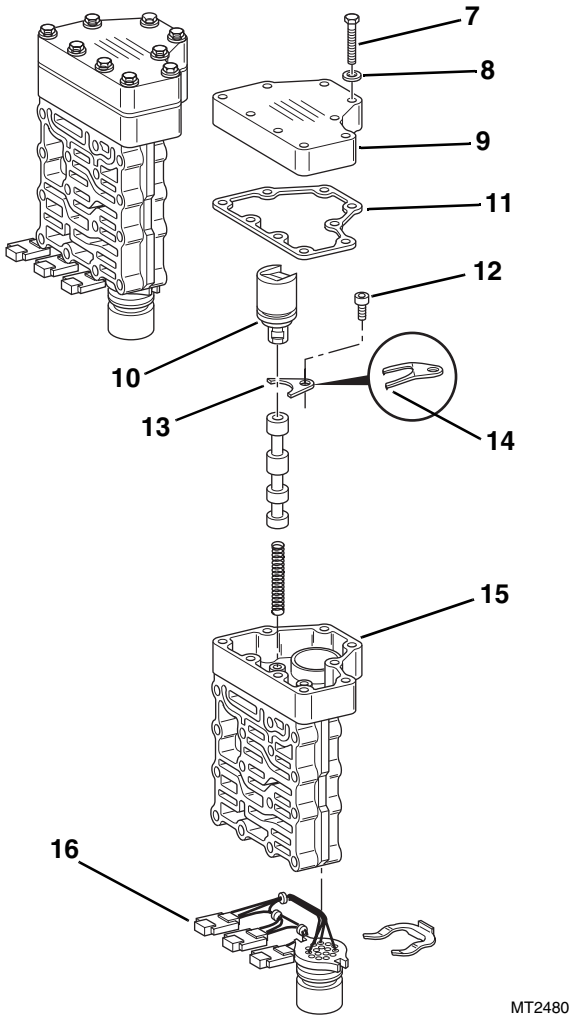
1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).



4. Remove the nine capscrews (**7**), washers (**8**) and protective cover (**9**) secured over the solenoid valves (**10**). Remove and inspect the protective cover gasket (**11**). Replace if torn or missing.
5. Remove the capscrew (**12**) and retainer plate (**13**). Disconnect the internal wire connector (**16**) from the solenoid. Remove solenoid valve (**10**).

g. Transmission Lower Solenoid Valve Inspection

DO NOT further disassemble the transmission solenoid. Replace a defective or faulty valve solenoid.



h. Transmission Lower Solenoid Valve Installation

1. Install the solenoid valve (**10**), along with the retaining plate (**13**). Insure that the claw side (**14**) of the retaining plate is facing down toward the valve body surface (**15**). Install the capscrew (6) and torque to 53 lb/in (6 Nm). Connect the internal wire connector (**16**) to the solenoid.
2. Install the protective cover gasket (**11**) on the valve body (**15**). Position the protective cover (**9**) over the gasket and valve body. Install the nine washers (**8**) and capscrews (**7**). Torque cover screws to 84 lb/in (9,5 Nm).

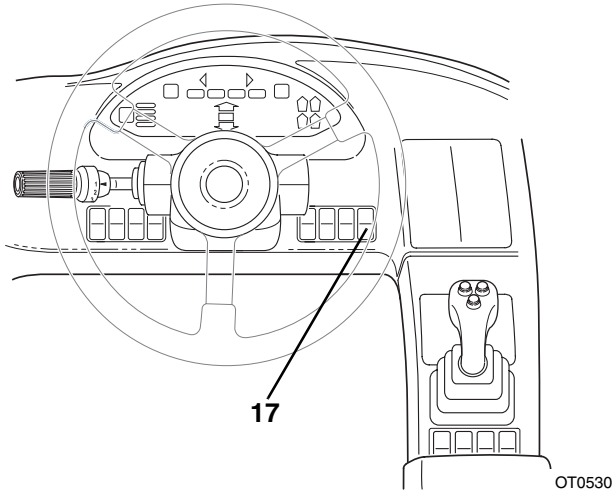
3. Connect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**5**) at the bottom of the battery equalizer (**6**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**1**). Use the wing nuts (**2**) and carriage bolts (**3**) to secure the cover in place.
6. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
7. Test the operation of the transmission. Put the transmission through its entire range of gears (speeds) in both FORWARD [F] and REVERSE [R] and check that the transmission also shifts into NEUTRAL [N].
8. Verify that each function works properly, that the transmission does not engage when in NEUTRAL [N] and that the proper indicators illuminate on the operator's display panel.

For further transmission information, refer to *Section 7, Transmission: ZF 4 WG-98 TS*.

10.13.9 Attachment Tilt Mode Switch

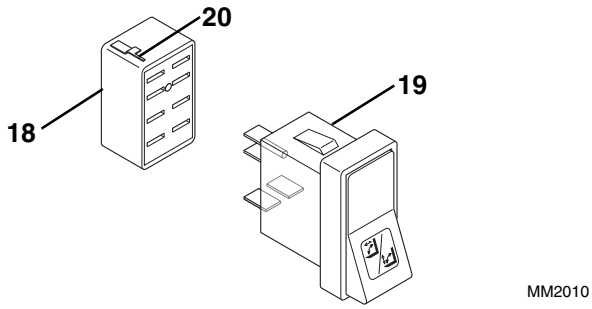
The attachment tilt mode switch (**17**) is located on the dash to the right of the steering column.

The switch is pressed or "snapped" into a rectangular switch bezel. The attachment tilt mode switch is a two-position switch that allows the operator to chose between the boom lift/lower function and the extend/retract function accompanying the attachment tilt capability. For detailed information, refer to *Section 10.13.10, Joystick* and *Section 10.7.20, Attachment Tilt Mode Circuit and Troubleshooting*.

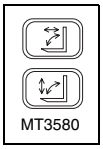


a. Attachment Tilt Mode Switch Removal

1. Remove engine side battery box cover (**1**). Remove wing nuts (**2**) and carriage bolts (**3**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**4**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**5**) at the bottom of the battery equalizer (**6**).
4. Carefully pry the bank of four switches (**17**) and wiring out of the mounting hole in the dash. Slide the attachment tilt mode switch off the rest of the bank of switches.
5. Disconnect the wire harness connector (**18**) from the attachment tilt mode switch (**19**) by pressing down on the alignment tab (**20**) on the wire harness connector (**18**). Remove the switch from the vehicle.



b. Attachment Tilt Mode Switch Disassembly



DO NOT disassemble the attachment tilt mode switch (**1**). Replace a defective or faulty switch.

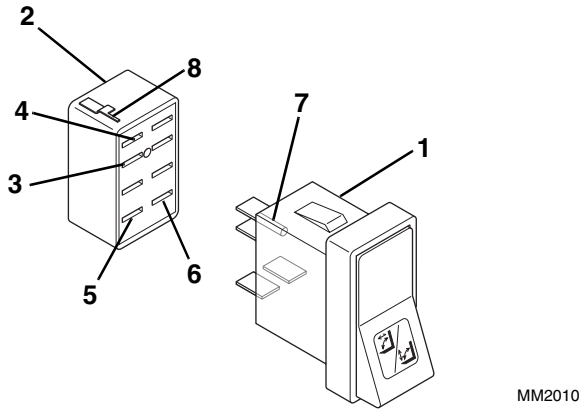
c. Attachment Tilt Mode Switch Inspection and Replacement

Inspect the switch terminals for continuity and shorting in all three switch positions. Replace a defective or faulty switch.

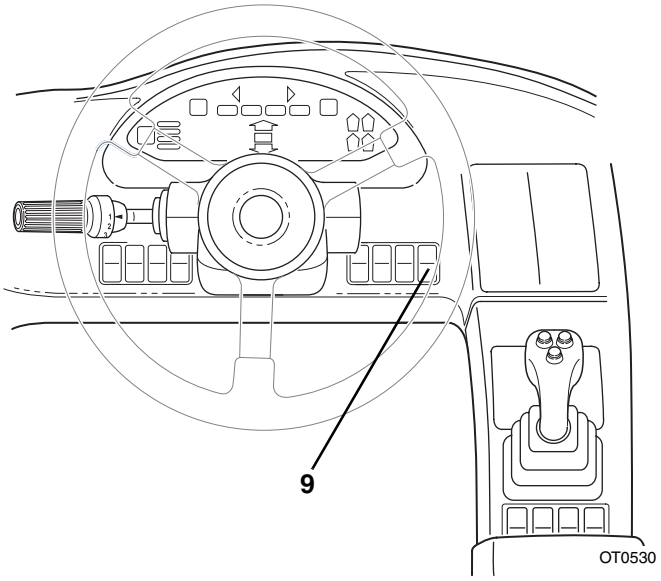
d. Attachment Tilt Mode Switch Installation

1. Pull the wire harness connector (**2**) through the dash (**9**). Line up the tab on the harness connector (**8**) and the pin (**7**) on the attachment tilt mode switch (**1**) and snap the two pieces together.

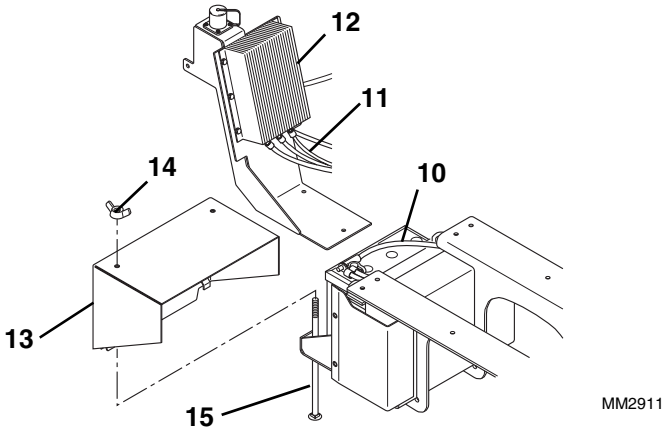
Wire Number	Wire Color	Callout
137	LT BLU/ORN	**3**
138/138A	GRN/BLU	**4**
139	ORN/GRY	**5**
2PP	BLK	**6**



2. Slide the attachment tilt mode switch back onto the bank of switches and then snap the whole bank of switches into the mounting hole in the dash (**9**).
3. Connect the negative (-) battery cable (**10**) at the battery negative (-) terminal on the battery in the engine side battery box.



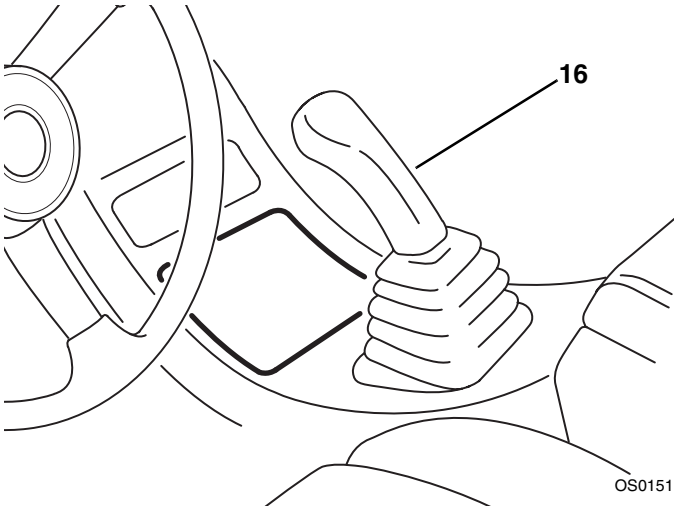
4. Connect the negative (-) battery equalizer cable (**11**) at the bottom of the battery equalizer (**12**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**13**). Use the wing nuts (**14**) and carriage bolts (**15**) to secure the cover in place.



6. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
7. Start the engine, and check the operation of the attachment tilt mode switch functions with the switch in both positions.

10.13.10 Joystick

The multi-function joystick (**16**) controls boom movement, attachment tilt and vehicle frame sway (refer to *Section 10.7.17, Frame Sway Circuit and Troubleshooting*.)



The joystick is equipped with several momentary switches ("buttons") that enable the joystick to operate in four specific modes. The mode available per selection is displayed on a logic panel located just forward of the joystick. The logic panel will illuminate an indicator for the specific mode that corresponds with the movement of the joystick and the button(s) selected.

Two functions can be accomplished at the same time by moving the joystick in between quadrants. For example, moving the stick forward will lower the boom, and moving the stick to the left will retract the boom; moving the joystick forward and to the left will both lower and retract the boom at the same time.

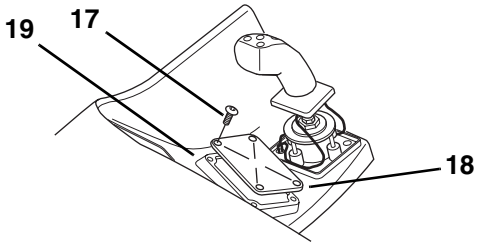
The speed of movement relates to the amount of joystick movement away from the center position. The overall speed of movement also depends directly on engine rpm.

IMPORTANT: *When the joystick is in an off-center position, the mode will change immediately upon releasing any button.*

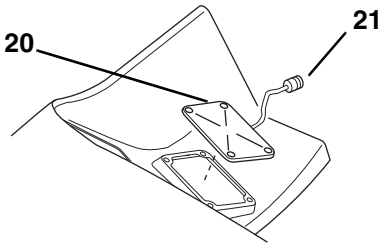
Joystick mode operation can be checked according to the joystick operation instructions found in the Owners/Operators Manual for this vehicle. Operational checks will indicate whether the system is working properly. If a designated function does not occur as described, check both the electrical and hydraulic circuit involved to determine the cause. (Refer to *Section 10.7.18, Boom Extend/Retract Circuit and Troubleshooting* and *Section 10.7.19, Boom Lift/Lower Circuit and Troubleshooting*.)

a. Joystick Button Testing

1. Remove the four button head capscrews (**17**) securing the logic panel (**18**) to the side console (**19**).



2. Carefully pry the panel (**20**) up away from the console and locate the six-wire connector (**21**) that comes from the joystick.



3. Inspect the wiring and connector plug for obvious signs of shorts, damage, etc.
4. Disconnect the harness half. Test only the joystick half.

5. Using an ohm/volt meter, test for continuity in the joystick button switches when they are depressed. The wiring should have zero (0) ohms of resistance when testing with an ohm/volt meter. Using the chart below test each joystick button switch for proper function.

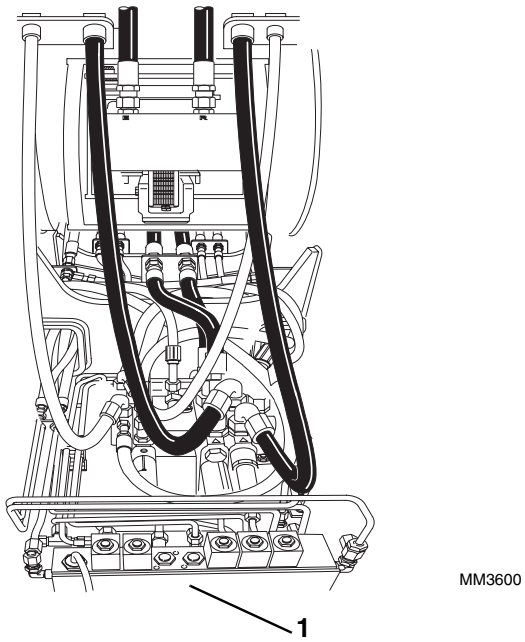
Joystick Wire Color / Function Chart	
YELLOW	Common wire
GREEN	Middle button
WHITE	Top left
BLUE	Top right button
RED	Front button

Note: *Battery positive (+) is accessed via wire 43, the fused GRY/BRN 16-gauge wire. The ground wire, 2E, is a black (BLK) 16-gauge wire.*

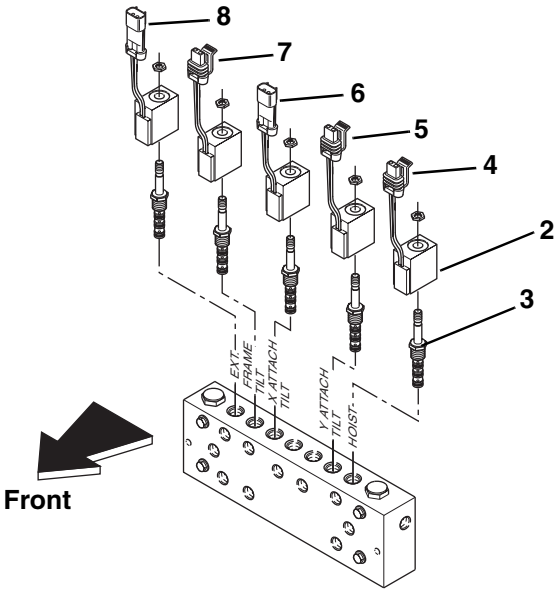
b. Joystick Function Solenoid Valves

Joystick commands are actuated both electrically and hydraulically via a set of solenoid-operated control valves mounted in an array at the pilot select manifold (**1**). The pilot select manifold is located inside the rear cover at the back of the vehicle.

As the solenoid coils (**2**) are energized/de-energized, the cartridge valves (**3**) work to open and close oil passages, thereby directing hydraulic fluid flow to the proper hydraulic circuit for the function selected.



MM3600



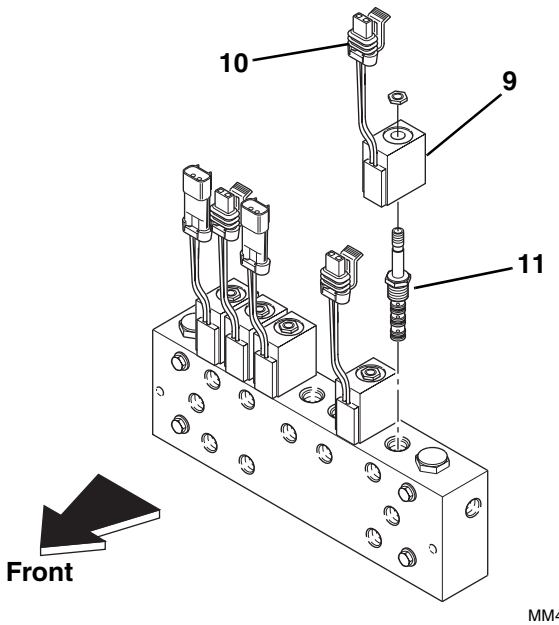
MM3680

c. Solenoid Coil and Cartridge Valve Replacement

If a solenoid coil (**9**) is suspected of malfunctioning, disconnect the coil wiring lead (**10**) and test the coil for proper resistance (7-10 ohms). Replace solenoid if open or short to ground. Also inspect the valve cartridge (**11**), o-rings, and the other hydraulic and electrical components in the circuit to accurately determine the cause of the problem.

The solenoid coils are of the same design. If testing more than one coil, insure that the coil wiring leads are correctly re-connected. The following chart shows the solenoid coil function, coil wire tie color, harness wire color and harness wire number.

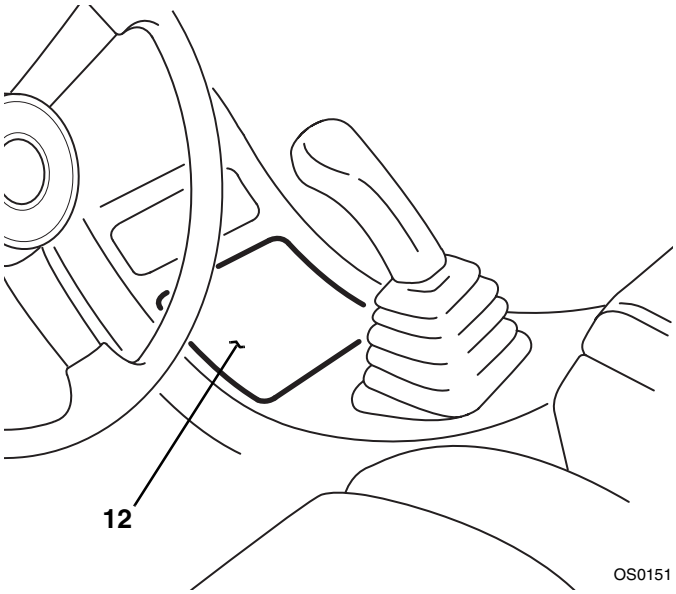
Joystick Solenoid Coil Identification Chart			
Solenoid Coil Function	**Coil Wire Tie**	**Harness Wire Color**	**Harness Wire Number**
HOIST (**4**)	BLU	ORG/GRN	36
“Y” ATTACH TILT (**5**)	YEL	RED/YEL	40
“X” ATTACH TILT (**6**)	RED	GRN/RED	39
FRAME SWAY (**7**)	GRN	BLU/WHT	38A
EXTEND (**8**)	WHT	WHT/RED	37



MM4270

10.13.11 Logic Board Panel

The logic board or side console panel (**12**) is secured to the right side dash panel, in front of the joystick. The panel consists of a solid-state printed circuit board and various indicators that illuminate per joystick and attachment tilt selections.



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The logic board panel is of solid-state, printed circuit design and contains a wiring terminal or plug and, a printed-circuit board and a display panel that provides monitoring of joystick and attachment tilt functions and status.

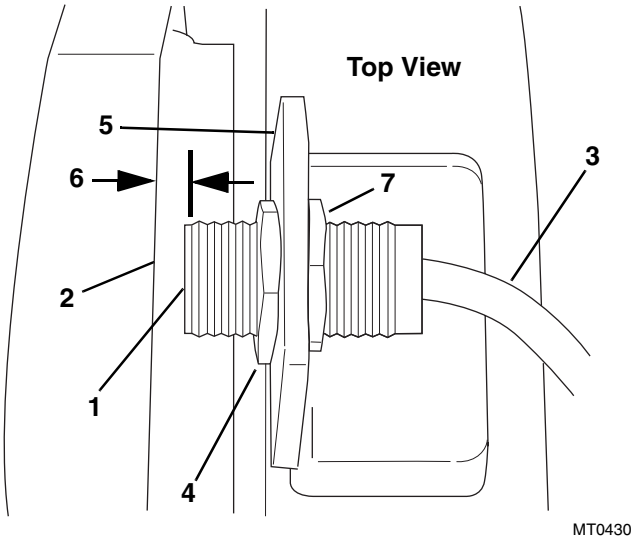
Due to the complex design and solid-state circuitry, the panel is non-serviceable. Electro-static discharge is one of the main reasons for panel malfunction. Prevent the panel from coming into contact with static or other electrical sources. When washing the vehicle, keep spray away from the logic board panel. Replace a defective, malfunctioning or faulty panel with a new unit.

The logic board panel provides important information in a “user-friendly” design with easily-recognizable graphic and arrow indicators. The panel provides information the operator needs on joystick and attachment tilt functions at any given time.

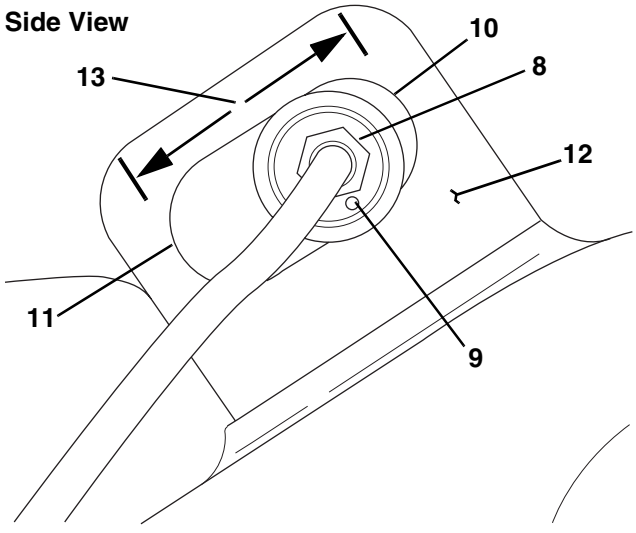
The panel (**12**) is mounted with four button head capscrews and well nuts for easy replacement.

Boom Sensor (Proximity Switch)

The boom sensor (**1** or **8**) is a proximity switch located on the rear of the vehicle frame at the boom pivot point. When energized, the sensor creates a magnetic field and detects the presence of the boom (**2**), as the boom is raised or lowered past the sensor. Depending on conditions (including boom raised above or below 40°, parking or service brakes ON or OFF, Stabil-TRAK engaged or not, etc.), the boom sensor and its electrical circuitry will either allow or disallow certain hydraulic functions. When the boom is below 40°, a red L.E.D. light (**9**) is illuminated on the boom sensor. The L.E.D. light will turn off when the boom is above 40°.



MT0430



MT3120

Boom Sensor Replacement and Adjustment

The boom sensor (**1**) is removed by disconnecting the wire lead (**3**) from the wiring harness connector, removing the sensor mounting nut (**4**), and removing the sensor from the mounting bracket (**5**) on the vehicle.

IMPORTANT: *The boom sensor mounts into a slotted mounting bracket. The sensor must be positioned in the slot so the Stabil-TRAK dash light will illuminate (as seen from the operator's position) when the boom is raised and reaches exactly 40°.*

To install and adjust a boom sensor:

1. Place the sensor into the mounting bracket (**5**). Thread the sensor mounting nut (**4**) onto the boom sensor.
2. Adjust the sensor mounting nuts (**4** and **7**) to achieve a 1/8"-3/16" (3,17-4,76 mm) gap (**6**) between the sensor (**1**) and the boom (**2**). Tighten the inner sensor mounting nut (**4**) to 36 lb/in (4 Nm).
3. Connect the boom sensor to the wiring harness lead (**3**).
4. Operate the boom through its full range of motion; the boom must **NEVER** touch the sensor.
5. As the boom is raised, ensure that the Stabil-TRAK dash light illuminates when the boom reaches the 40° (as seen from the operator's position) raised position. If the light does not illuminate at the 40° position, loosen the inner sensor mounting nut (**4**) and adjust boom sensor position up (**10**) or down (**11**) within the machined slot (**13**) of the weldment (**12**) until the Stabil-TRAK dash panel light illuminates. Tighten the inner sensor mounting nut (**4**) to 36 lb/in (4 Nm).

Note: *The boom sensor has a L.E.D. (**9**) that is illuminated when the boom is below 40°.*

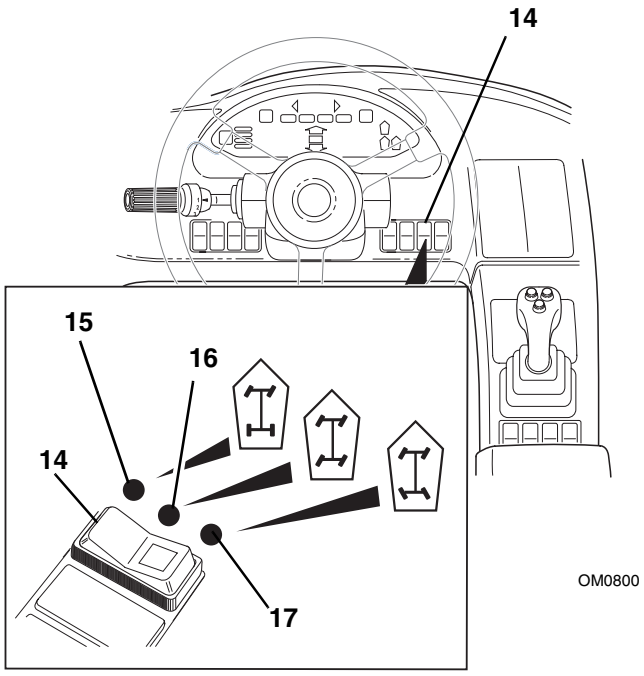
6. Check the function of the Stabil-TRAK system as described in *Section 11, Stabil-TRAK™ System*.

10.13.12 Steering

Certain steering functions are dependent upon electrical operations, described below. Consult the Owners/Operators Manual for further information related to steering.

a. Steer Select Switches

The steer select switch (**14**) is located below and to the right of the steering wheel column. It is a three-position switch that is part of a stack of four switches that are pressed or “snapped” into a rectangular mounting hole in the dash.



The three-position switch (**14**) is a single-pole, double throw toggle switch that has three positions (**15**, **16** and **17**). It has a multiple-connector plug on its underside that connects to the cab wiring harness. Wiring from the plug connects the switch with power from the fuse panel bus bar, and to the operator’s display panel and the steer select solenoids on the vehicle.

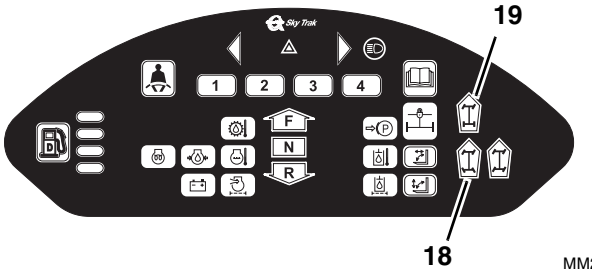
Steer select indicators on the right side of the operator’s display panel illuminate per the switch selected mode, and the steer select solenoids are energized or de-energized accordingly to provide the type of steering selected. The switch allows four-wheel steer (the rear wheels turn opposite the front wheels), two-wheel steer (the front wheels only), or crab steer (the rear wheels turn in the same direction as the front wheels).

b. Steer Modes and Conditions

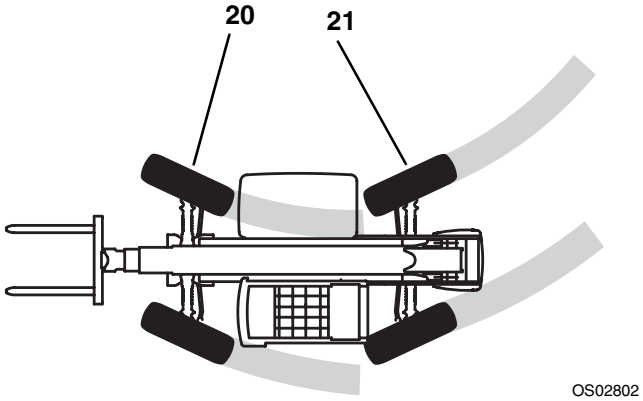
Four-Wheel Steer Mode

With the steer select switch (**14**) in the center position (**16**), the following conditions must be met:

1. Four-wheel steer mode light (only) (**18**) must be illuminated on the operator’s display panel.



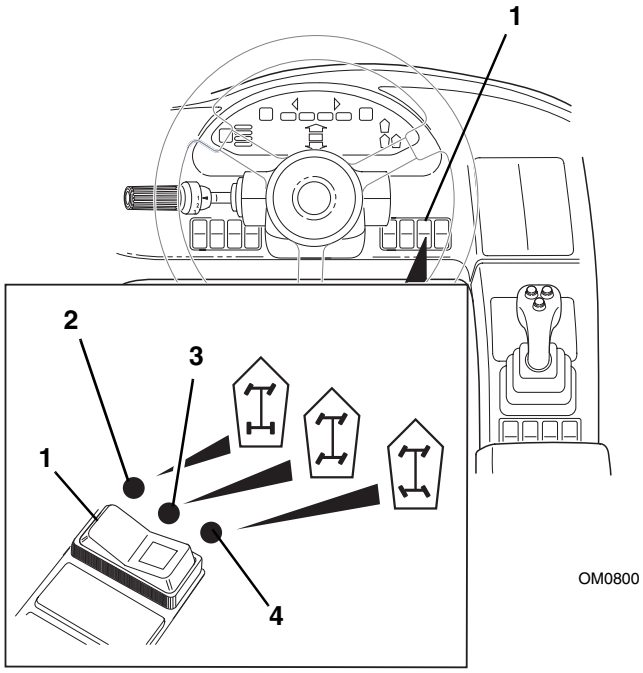
2. Front wheels (**20**) must steer in the direction that the steering wheel is turned.



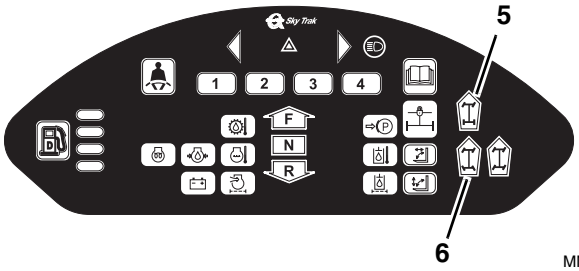
3. Rear wheels (**21**) must steer in the opposite direction from which the steering wheel is turned (refer to *Section 10.7.15, Four Wheel Steer Circuit and Troubleshooting*).

Front-Wheel Steer Mode

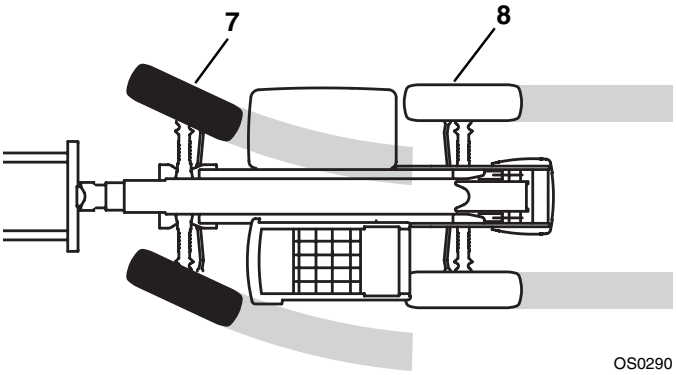
With the steer select switch (**1**) in the forward position (**2**), the following conditions must be met:



1. Front-wheel steer mode light (**5**) (only) must be illuminated on the operator's display panel.



2. The front wheels (**7**) must steer in the direction that the steering wheel is turned.

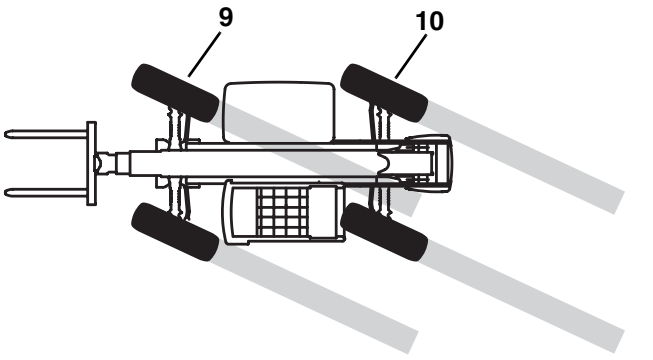


3. Rear wheels (**8**) must remain in a fixed forward position and not move (refer to *Section 10.7.14, Front Steer Circuit and Troubleshooting*).

Crab-Steer Mode

With the steer select switch in the rear most position (**4**), the following conditions must be met:

1. Crab-steer mode light (**6**) (only) must be illuminated on the operator's display panel.
2. Front wheels (**9**) must steer in the direction that the steering wheel is turned.



3. Rear wheels (**10**) must steer in the direction that the steering wheel is turned (refer to *Section 10.7.16, Crab Steer Circuit and Troubleshooting*).

c. Four Wheel Steer Indexing

If the vehicle does not drive “straight,” the steering could not be synchronized or “out of phase.” Perform the Four Wheel Steer indexing procedure to synchronize the steering.

1. With the steer select switch (**1**) in the four wheel steer position (**4**), turn the steering wheel fully left.
2. While holding the steering wheel fully left, toggle the steer select switch to the front wheel steer position (**2**).
3. Steer the front wheels back to center.
4. Toggle the steer select switch back to four wheel steer position. (**4**)
5. Turn the steering wheel fully left.
6. Toggle the steer select switch back to the front wheel steer position (**2**).
7. Steer the front wheels fully left.
8. Toggle the switch to the four wheel steer position (**4**) and return to center.

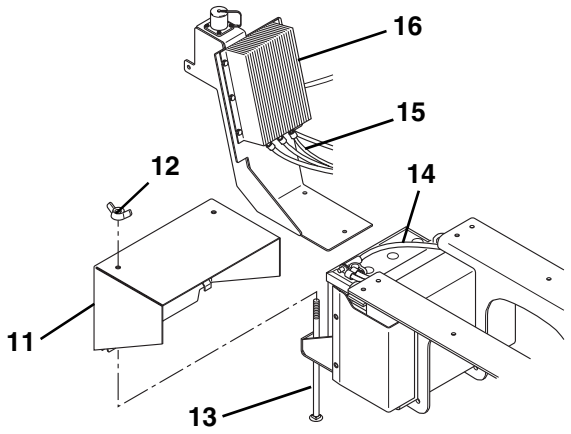
The vehicle should now be properly indexed in four wheel steer. If the steering is still not synchronized, repeat the procedure. (Refer to *Section 10.7.14, Front Steer Circuit and Troubleshooting* and subsequent circuits and troubleshooting charts.)

10.13.13 Steer Select Switches

For additional information refer to *Section 10.7.14, Front Steer Circuit and Troubleshooting*.

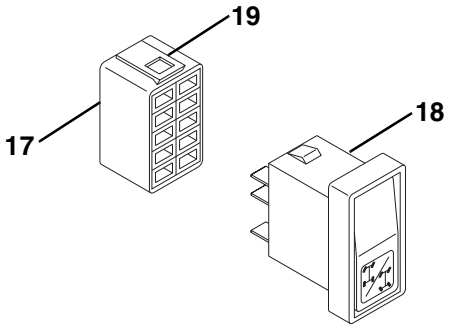
a. Steer Select Switch Removal

1. Remove engine side battery box cover (**11**). Remove wing nuts (**12**) and carriage bolts (**13**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**14**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**15**) at the bottom of the battery equalizer (**16**).



MM2911

4. Carefully pry the bank of four switches (**1**) and wiring out of the mounting hole in the dash. Slide the steering select switch off the rest of the bank of switches.
5. Disconnect the wire harness connector (**17**) from the steering select switch (**18**) by pressing down on the tab (**19**) on the wire harness connector (**17**). Remove the switch from the vehicle.



MM2030

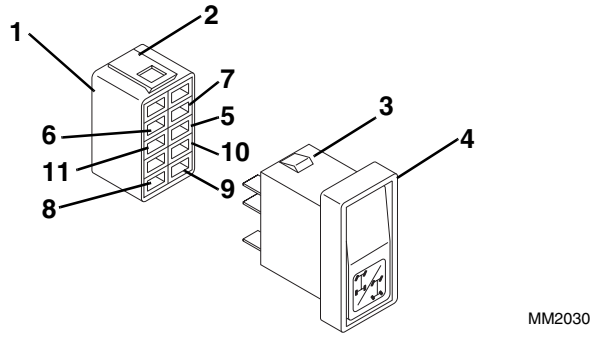
b. Steer Select Switch Disassembly, Inspection and Replacement

DO NOT disassemble the switch. Replace a defective or faulty switch with a new one. Inspect the switch and the wiring harness connector terminals for continuity and shorting in all three switch positions. Inspect the switch terminals for continuity in the “up” and “down” positions and for shorting in the “middle” position. Replace a defective or faulty switch with a new one.

c. Steer Select Switch Installation and Testing

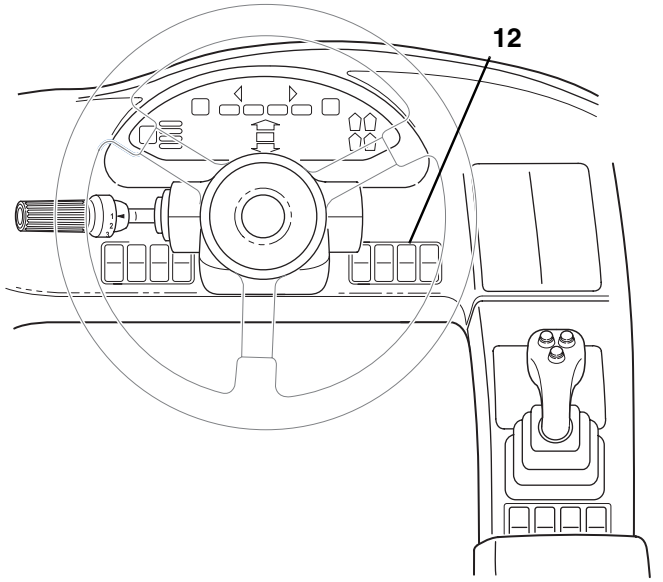
1. Pull the wire harness connector (**1**) through the mounting hole in the dash (**12**). LIne up the tab on the harness connector (**2**) and the tab (**3**) on the steering select switch (**4**) and snap the two pieces together.

Wire Number	Wire Color	Callout
17	PNK/WHT	**5**
18/18A	GRY/GRN	**6**
19/19A	YEL/BLK	**7**
102	LT GRN	**8**
2F	BLK	**9**
J74	BLK	**10** & **11**



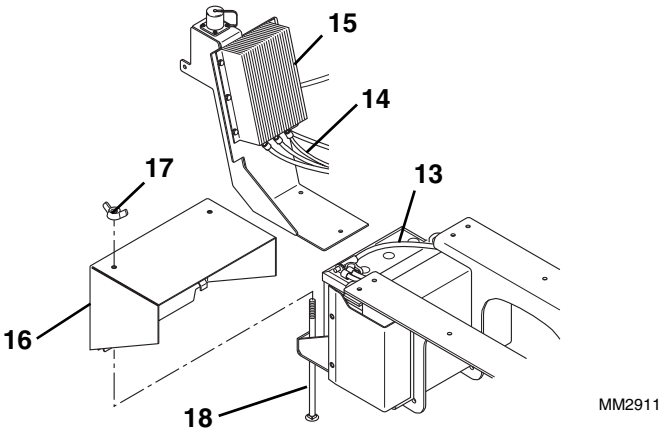
MM2030

2. Slide the steering select switch back onto the bank of switches and then snap the whole bank of switches into the mounting hole in the dash (**12**).



OT0530

3. Connect the negative (-) battery cable (**13**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**14**) at the bottom of the battery equalizer (**15**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**16**). Use the wing nuts (**17**) and carriage bolts (**18**) to secure the cover in place.



MM2911

6. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
7. Start the engine, and check the operation of the steer select switch functions with the switch in all three positions.

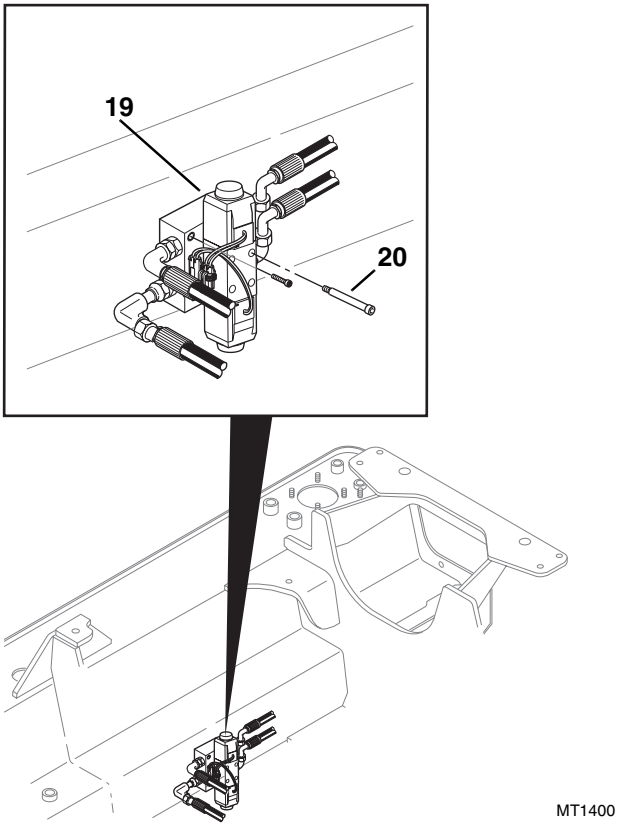
10.13.14 Steer Select Valve

The steer select valve (**19**), is secured to the steer select manifold and frame with four capscrews (**20**) and o-rings (**21**) near the hydraulic fluid reservoir.

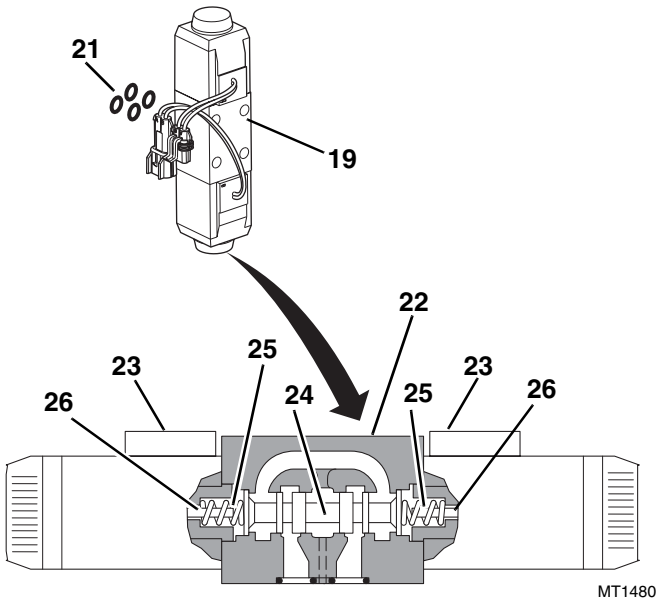
It contains two solenoids that direct hydraulic fluid through hoses and ultimately help operate the steering. The valve is a direct dual-solenoid operated, spool-type directional control valve. The steer select valve controls the start, stop and direction of hydraulic fluid flow to the steering cylinders mounted on each axle. The valve consists of a housing (**22**), two solenoids (**23**), a control spool (**24**), and two return springs (**25**).

In the de-energized state, the spool (**24**) is held by the return springs (**25**) in the center position. The spool is shifted through the action of the two wet-pin type solenoids (**23**).

The force of an acting solenoid works against the push pin (**26**) on the end of the spool (**24**). The spool is shifted from its normal position to the end position for selected flow. The selected flow pattern is covered in *Section 9, Hydraulic System*.



MT1400



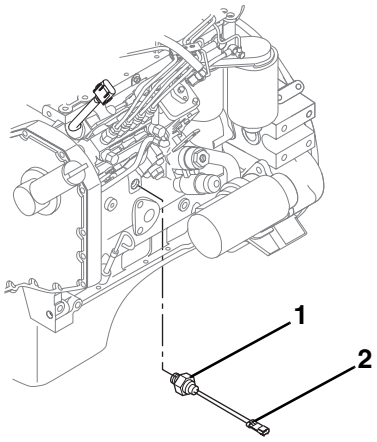
MT1480

When the solenoid is de-energized, the control spool (**24**) is returned to its normal condition by the centering springs (**25**).

Check the steer select valve solenoids for proper operation and check the wiring for continuity or shorts. When energized/de-energized, the solenoid should move and/or an audible “click” should be heard; check for the presence of voltage with a voltmeter. Replace a defective or faulty steer select valve with a new unit. (Refer to *Section 10.7.14, Front Steer Circuit and Troubleshooting* subsequent circuits and troubleshooting charts.)

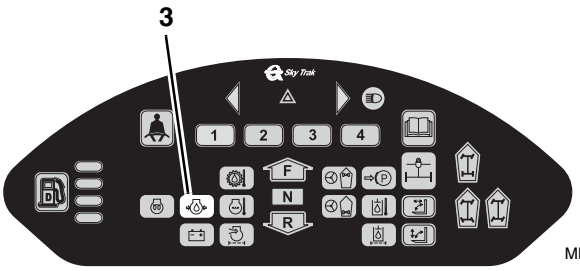
10.13.15 Engine Low Oil Pressure Sender

The engine oil pressure sender (**1**) is located on the engine and is connected via the engine wiring harness, bulkhead connector and cab wiring harness to the operator's display panel.



MT2390

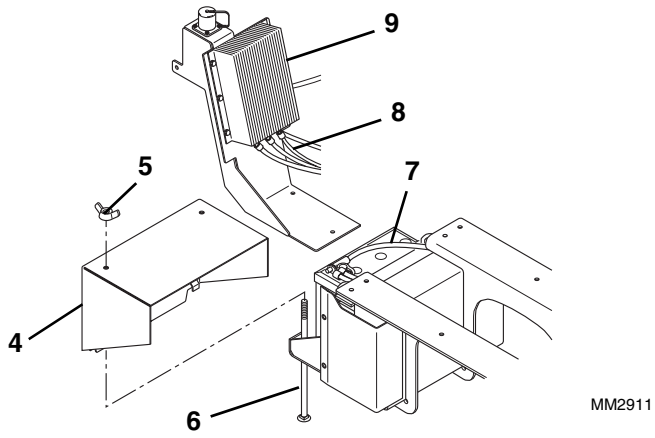
The operator's display panel indicator (**3**) illuminates when engine oil pressure is too low to properly lubricate the engine. The warning indicator illuminates when oil pressure is below 8.7 psi (0,6 bar) and an audible alarm will also sound. When the engine has attained normal oil pressure, the sender opens and the operator's display panel indicator and alarm turn OFF. (Refer to *Section 10.9.6, Engine Oil Pressure Warning Indicator Troubleshooting*.)



MM1921

a. Engine Oil Pressure Sender Removal

1. Remove engine side battery box cover (**4**). Remove wing nuts (**5**) and carriage bolts (**6**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**7**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**8**) at the bottom of the battery equalizer (**9**).
4. Unplug the engine low oil pressure sender connector (**2**) from the wiring harness connector.



MM2911

5. The sender (**1**) is threaded into the engine block. Remove the sender.

b. Engine Oil Pressure Sender Disassembly

DO NOT disassemble the sender. Replace a defective or faulty sender.

c. Engine Oil Pressure Sender Inspection and Replacement

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

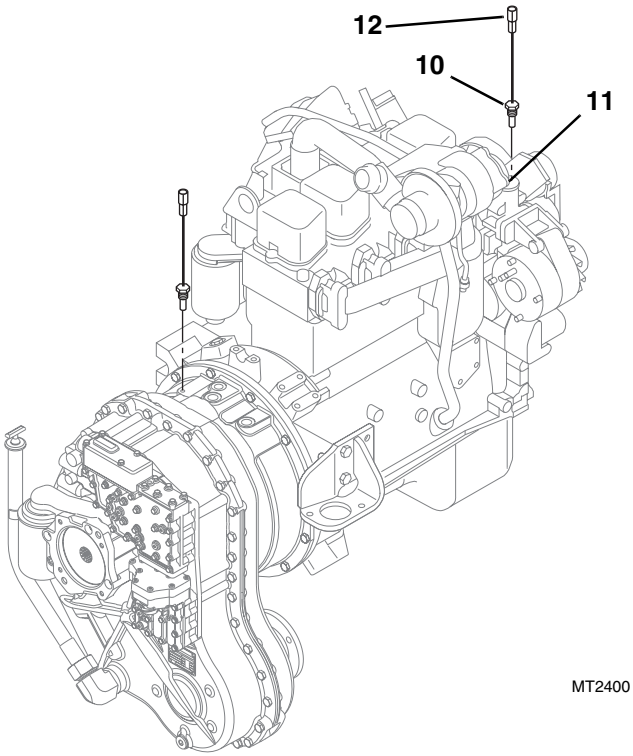
d. Engine Oil Pressure Sender Installation and Testing

1. Thread the sender (**1**) into the engine block snugly, then connect the wiring harness connector lead to the engine low oil pressure sender connector (**2**).

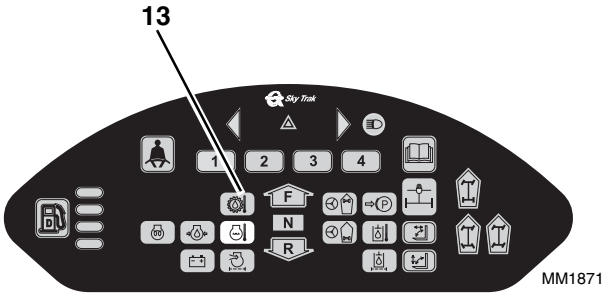
2. Connect the negative (-) battery cable (**7**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Connect the negative (-) battery equalizer cable (**8**) at the bottom of the battery equalizer (**9**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
4. Replace engine side battery box cover (**4**). Use the wing nuts (**5**) and carriage bolts (**6**) to secure the cover in place.
5. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
6. Start the engine, allow it to reach operating temperature, and observe the operator's display panel for sender indication. If the sender is not defective, the problem could be elsewhere; possibly in a shorted wire, improper-running engine, defective display, etc.

10.13.16 Engine Coolant High Temperature Sender

The engine coolant high temperature sender (**10**) is threaded into the engine block (**11**) and is connected (**12**) via the engine wiring harness, bulkhead connector and cab wiring harness to the operator's display panel.



When the engine coolant temperature exceeds normal limits and rises above 210° F (99° C), the sender heats up, closing contacts within the sending unit. The operator's display panel indicator (**13**) illuminates and an audible alarm will sound. When the engine coolant temperature is below 210° F (99° C), the contacts within the sending unit open and the operator's display panel indicator and alarm turn OFF. (Refer to *Section 10.9.1, Engine Coolant Temperature Warning Indicator Troubleshooting*.)



a. Engine Coolant High Temperature Sender Removal

1. Remove engine side battery box cover (**4**). Remove wing nuts (**5**) and carriage bolts (**6**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**7**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**8**) at the bottom of the battery equalizer (**9**).
4. Unplug the engine coolant high temperature sender connector (**12**) from the wiring harness connector.
5. The sender (**10**) is threaded into the engine block (**11**). Remove the sender.

b. Engine Coolant High Temperature Sender Disassembly

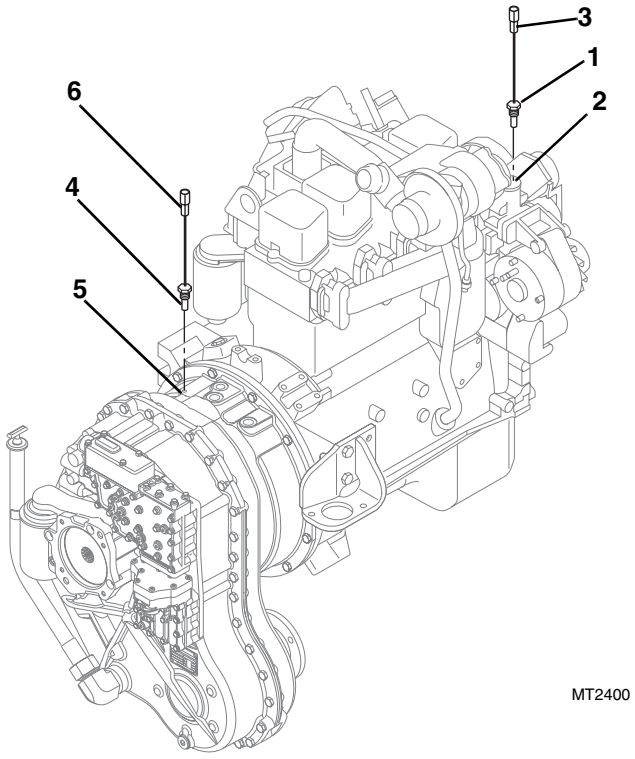
DO NOT disassemble the sender. Replace a defective or faulty sender.

c. Engine Coolant High 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 one.

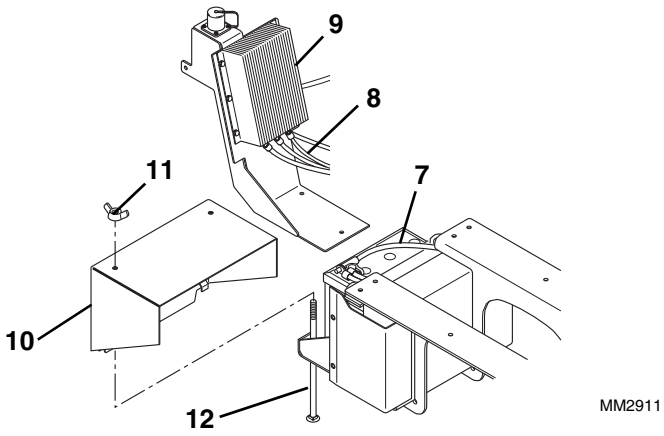
d. Engine Coolant High Temperature Sender Installation and Testing

1. Thread the engine coolant high temperature sender (**1**) into the engine block (**2**) snugly, then connect the sender (**3**) to the wiring harness connector.



MT2400

2. Connect the negative (-) battery cable (**7**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Connect the negative (-) battery equalizer cable (**8**) at the bottom of the battery equalizer (**9**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
4. Replace engine side battery box cover (**10**). Use the wing nuts (**11**) and carriage bolts (**12**) to secure the cover in place.



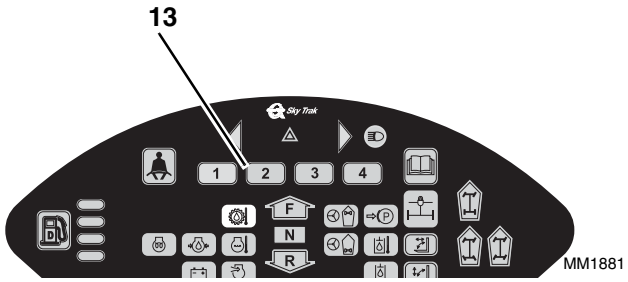
MM2911

5. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
6. Start the engine, allow it to reach operating temperature, and observe the operator's display panel for sender indication. If the sender is not defective, the problem could be elsewhere; possibly in a shorted wire, improper-running engine, improper coolant, obstructed or faulty radiator, water pump, loose fan belt, defective display, etc.

10.13.17 Transmission Temperature Sender

The transmission temperature sender (**4**) is threaded into the transmission housing (**5**) and is connected (**6**) via the engine wiring harness, bulkhead connector and cab wiring harness to the operator's display panel.

When the transmission fluid temperature rises above 250° F (121° C), the sender heats up, closing contacts within the sending unit. The operator's display panel indicator (**13**) illuminates and an audible alarm will sound. When the transmission temperature is below 250° F (121° C), the contacts within the sending unit open and the operator's display panel indicator and alarm turn OFF. (Refer to *Section 10.9.2, Transmission Temperature Warning Indicator Troubleshooting*.)



a. Transmission Temperature Sender Removal

1. Remove engine side battery box cover (**10**). Remove wing nuts (**11**) and carriage bolts (**12**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**7**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**8**) at the bottom of the battery equalizer (**9**).
4. Unplug the sender connector (**6**) from the wiring harness connector.
5. The sender (**4**) is threaded into the transmission housing or case (**5**). Remove the sender.

b. Transmission Temperature Sender Disassembly

DO NOT disassemble the sender. Replace a defective or faulty sender with a new one.

c. Transmission Temperature Sender Inspection and Replacement

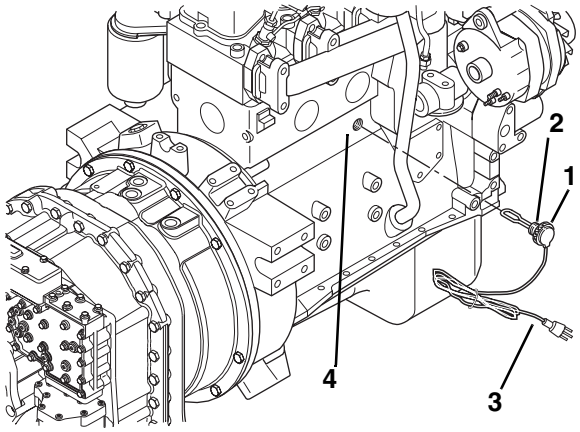
Inspect the sender and the wiring harness connector terminals for continuity. Replace a defective or faulty sender.

d. Transmission Temperature Sender Installation and Testing

1. Thread the sender (**4**) into the transmission housing (**5**) snugly, then connect the sender connector (**6**) to the wiring harness connector.
2. Connect the negative (-) battery cable (**7**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Connect the negative (-) battery equalizer cable (**8**) at the bottom of the battery equalizer (**9**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
4. Replace engine side battery box cover (**10**). Use the wing nuts (**11**) and carriage bolts (**12**) to secure the cover in place.
5. Clear the area around the vehicle of personnel and any obstructions to vehicle travel.
6. Start the engine, allow all systems to reach operating temperature, and observe the operator's display panel for sender indication. If the sender is not defective, the problem could be elsewhere; possibly in a shorted wire, clogged or defective transmission cooler, defective display, etc.

10.13.18 Engine Block Heater

The engine is equipped with an engine block heater (**1**) that can be plugged into a standard 110/120V A.C. grounded outlet to heat the engine coolant. When temperatures are below 10° F (-12° C), the block heater should be used.



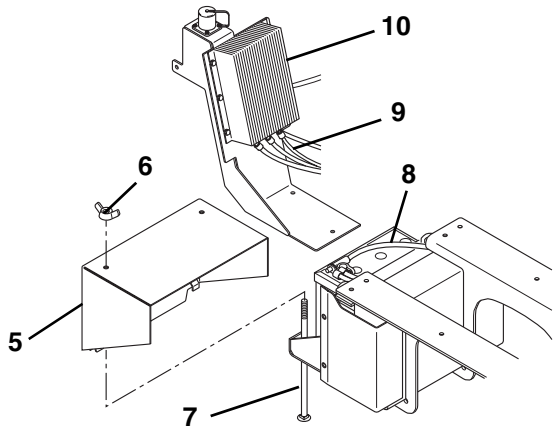
MM5180

a. Engine Block Heater Removal

1. Level the vehicle, ground the attachment, place the travel select lever in NEUTRAL (N), engage the parking brake switch, engage the neutral lock lever and shut off the engine. Secure accident prevention tags to the steering wheel and ignition switch (refer to *Section 1.5, Accident Prevention Tag Usage*).

WARNING: **DO NOT** attempt this procedure when the engine is hot. Wait for the engine, muffler, and tailpipes to cool down before proceeding. Failure to do so could result in severe burns.

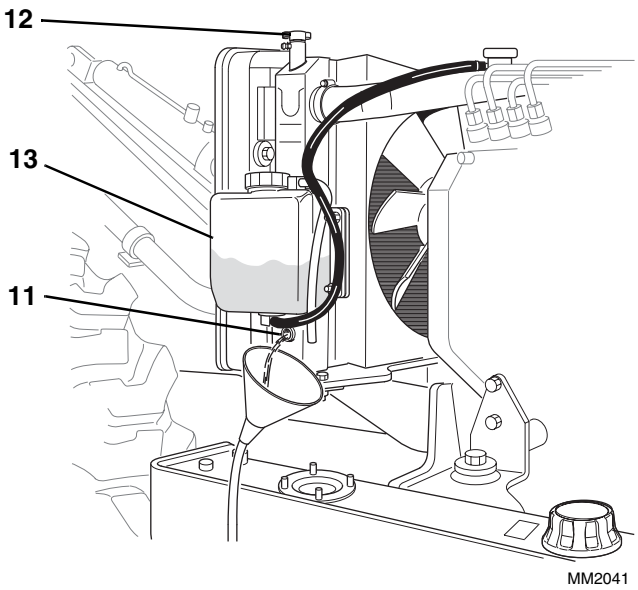
2. Unlatch and open the engine cover. Allow the engine to cool before proceeding. Draining the cooling system while the engine is hot can cause cracks in the engine block.
3. Remove engine side battery box cover (**5**). Remove wing nuts (**6**) and carriage bolts (**7**) and set cover and mounting hardware aside for later re-assembly.
4. Disconnect the negative (-) battery cable (**8**) at the battery negative (-) terminal on the battery in the engine side battery box.
5. Disconnect the negative (-) cable (**9**) at the bottom of the battery equalizer (**10**).



MM2911

WARNING: Hot coolant can cause severe burns or eye injury. **NEVER** remove the radiator cap while the engine is hot. The cooling system is under pressure. Wear protective clothing and safety glasses.

6. Place a suitable container beneath the radiator drain plug (**11**) or petcock. Slowly turn the radiator cap (**12**), located in the upper radiator hose, to the first stop and allow any pressure to escape. Remove the radiator cap.



7. Place a funnel at the base of the radiator to channel the drained coolant into the container. Open the radiator drain plug (**11**) or petcock and allow the coolant to drain into the funnel. Transfer the coolant into a properly labeled container. Dispose of properly if coolant needs to be replaced. Close the radiator drain plug or petcock.
8. Remove plastic retainer (**1**) from around engine block heater element (**2**) and 110 volt cord (**3**). Using a 29 mm socket, remove heating element from engine block.

b. Engine Block Heater Disassembly

DO NOT disassemble the heater element (**1**). Replace a defective or faulty heater with a new one.

c. Engine Block Heater Inspection and Replacement

Inspect the block heater element (**1**) and the 110 volt cord (**3**) for cuts or exposed wires. Replace a defective or faulty block heater.

d. Engine Block Heater Testing

Note: *The following test should be performed with a cold engine.*

The coolant heater unit (**1**) can be tested on the machine by plugging the 110 volt cord (**3**) into a 110 volt outlet. After 20 to 30 minutes, place your hand on the engine block (**4**) next to the heater. If the heater element is functioning properly, you will feel the heat at that location. If the block is cold, the heater element is defective and should be replaced.

e. Engine Block Heater Installation

1. Apply Teflon tape to engine block heater element threads (**2**) and install element. **DO NOT** over tighten. Plug-in 110 volt cord (**3**) into heater element and install the knurled retainer (**1**) around coolant heater element and 110 volt cord (**3**).
2. Fill radiator with coolant.
3. Connect the negative (-) battery cable (**8**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**9**) at the bottom of the battery equalizer (**10**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**5**). Use the wing nuts (**6**) and carriage bolts (**7**) to secure the cover in place.

Note: *When the coolant heater is not in use, secure the 110 volt cord with a wire tie to prevent damage to cord.*

6. Fill the cooling system. Run the engine to operating temperature. Visually check for leaks with the engine running. Check the coolant level in the overflow bottle (**13**) and fill, or drain, as necessary.

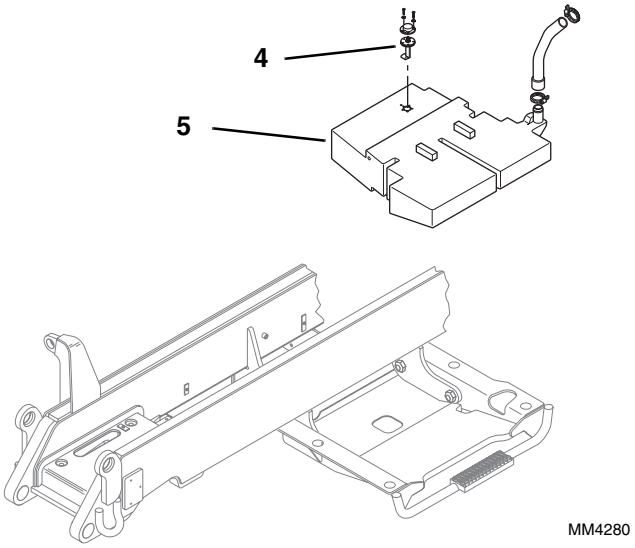
10.13.19 Fuel Level Indicator and Fuel Level Sender

The fuel level indicator bars (**1**) and fuel level indicator symbol (**2**) can be found on the left side of the operator's display panel.



MM1931

The fuel level indicators (**1**) work in conjunction with the fuel level sender (**4**). The submerged, coil-type fuel sender is secured to the fuel tank (**5**), beneath the cab, and is connected via the engine wiring harness, bulkhead connector and cab wiring harness to the operator's display panel.



MM4280

The operator's display panel fuel level indicator bars (**1**) illuminate to show the approximate fuel level in 1/4 tank increments. The fuel level indicator bars will be illuminated with a low-light green hue, easily apparent for night visibility and in low-light conditions. When approximately 1/8 tank is reached, the last fuel level indicator bar (**3**) will stop illuminating, and the fuel level indicator symbol (**2**) will change from green to orange. When the fuel level indicator symbol changes from green to orange, refuel the tank.

The fuel level sender wiring harness connector can be accessed from beneath the cab without removing the cab. The cab must be removed to access the fuel tank and fuel sender. Refer to *Section 3.2.3, b. Cab Removal* in this manual for cab and fuel tank removal instructions.

The fuel level sender (**4**) consists of a resistance, float-type fuel level sender mounted in the top of the fuel tank (**5**), and the wiring connecting it with the fuel indicators in the operator's display panel.

The resistance of the fuel sender is 33.5 ohms for a full tank of fuel and 240 ohms for an empty tank. The fuel level indicator bars in the operator's display panel receive a signal sensed within the electronic circuitry of the operator's display panel. Examine the fuel level sender circuit in the appropriate wiring diagram and schematic earlier in this section.

Battery voltage is applied to the circuit and the circuit divides at the fuel level indicator bars. One path continues to ground through the operator's display panel and fuel level indicator connector plug. Another electrical path goes to ground through the variable resistor of the fuel level sender.

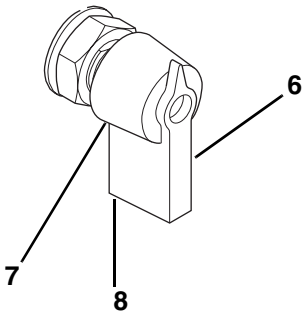
When the fuel level reaches approximately 1/8 of a tank, the resistance of the sender increases. This in turn changes the operator's display panel, causing the green fuel level indicator bars to turn OFF, and resulting in the orange fuel indicator symbol (shaped like a standard fuel pump) to turn ON.

When the tank is more than 1/8 full, the sender resistance is lower. On the operator's display panel, the green fuel level indicator bars illuminate according to the amount of resistance supplied.

a. Fuel Level Indicator Testing

1. With approximately eight gallons (30,4 liters) of fuel in the fuel tank (**5**), the bottom fuel level indicator bar (**3**) should illuminate, indicating approximately 1/4 tank of fuel.
2. The fuel level sender wiring harness connector can be accessed from beneath the cab without removing the cab. Beneath the cab, disconnect the fuel level sender wiring harness connector. Connect a jumper wire across the two wires in the harness connector.

3. From the operator's position, turn the ignition switch (**6**) to the RUN (**7**) position. **DO NOT** start the engine. Observe the fuel level indicator bars on the operator's display panel. The reading must be at the FULL mark, with all four bars illuminated after the engine start-up bulb test is completed.



MM4760

4. Turn the ignition switch to the OFF (**8**) position. The bars should turn OFF.

Note: *The cab must be partially removed to access the fuel tank and fuel sender. Refer to Section 3.2.3, b. Cab Removal in this manual for cab and fuel tank removal instructions.*

b. Fuel Level Circuit Tests

For additional information refer to *Section 10.9.7, Fuel Level Indicator Troubleshooting*.

If the fuel level indicators are suspected of giving a false reading, perform the following checks:

1. Check for loose or defective wiring, faulty ground connections, and corrosion on the fuel tank sender and wiring lead.
2. If the fuel level indicator bars do not illuminate after the engine start-up bulb test is completed and when the ignition switch is turned to the RUN (**7**) position, use a test lamp to determine whether current is flowing from the ignition switch to the fuel level indicator wiring connector behind the operator's display panel (the panel can be unfastened and raised slightly to do this).
3. If the fuel level indicator bars (**1**) do not illuminate, check the fuel tank for fuel.
4. If the fuel level indicators do not illuminate, and a faulty or defective fuel sender in the fuel tank has been ruled out, and wiring and connectors have been checked and ruled out, the operator's display panel is defective and must be replaced in its entirety.
5. Check that the ignition terminal has current, and that the fuse in the fuse panel is not blown.
6. Check for broken, shorted, frayed, disconnected or damaged wiring between the fuel level indicator wiring at the operator's display panel, fuse and relay panel, ignition switch, and from the fuel sender on the fuel tank through the wiring in the cab.
7. Check the fuel level sender. The resistance of the fuel sender is 33.5 ohms for a full tank of fuel and 240 ohms for an empty tank. A defective fuel level sender in the fuel tank may also prevent the fuel level indicator bars from illuminating.

Excessive fuel level indicator bar "fluctuation" may be caused by loose wire connections or a defective fuel sender in the fuel tank.

A full tank reading at all times may occur if the wiring to the fuel sender in the tank is broken, if the sender is not properly grounded, or if the sender is defective.

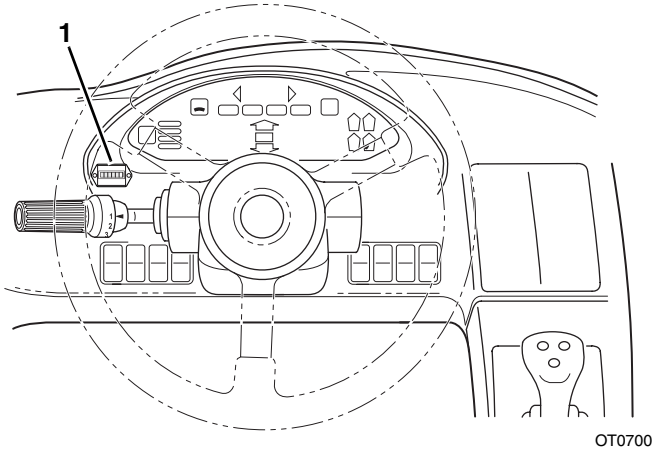
If the fuel level indicator bars indicate inaccurately, the fuel sender in the tank may be defective or there may be low voltage at the fuel level indicator connector to the operator's display panel.

If the fuel level indicator bars fluctuate when other electrical items are used, there may be a defective, corroded or improper ground. Check the cab harness ground stud under the dash, the engine to chassis ground, and the negative (-) battery cable and ground stud cable near the hydraulic reservoir fill cap under the engine cover.

The cab must be partially removed to access the fuel tank. Refer to *Section 3.2.3, b. Cab Removal* in this manual for cab and fuel tank removal instructions.

10.13.20 Hourmeter

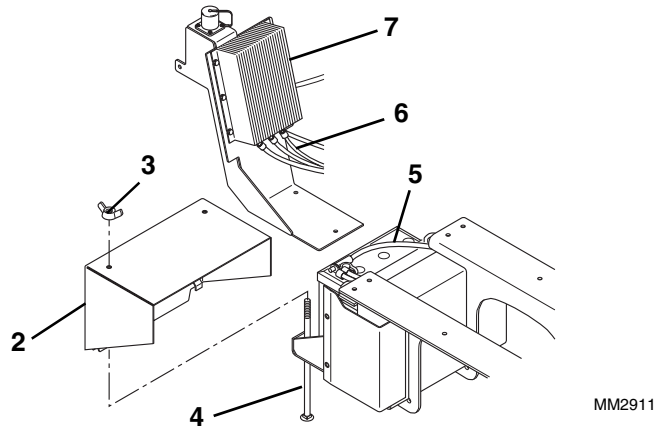
The hourmeter (**1**) is a non-repairable instrument that records hours of vehicle engine operation in tenth of an hour increments and is located just to the left of the dash panel. The hourmeter is an analog device, similar to an odometer, and will display 99,999.9 hours before resetting to zero. If trouble is suspected, time the hourmeter for six minutes to verify that a tenth of an hour has been recorded. The meter is secured to the dashboard with two screws; there are two wires at the rear of the meter; one is connected to a sensor on the engine, the other provides grounding.



OT0700

a. Hourmeter Removal

1. Remove engine side battery box cover (**2**). Remove wing nuts (**3**) and carriage bolts (**4**) and set cover and mounting hardware aside for later re-assembly.
2. Disconnect the negative (-) battery cable (**5**) at the battery negative (-) terminal on the battery in the engine side battery box.
3. Disconnect the negative (-) cable (**6**) at the bottom of the battery equalizer (**7**).



MM2911

4. Remove the two screws securing the hourmeter (**1**) to the dash console. Gently begin removing the hourmeter from the dashboard until the two wires are visible. Note or label the wires respective of their colors and locations. Disconnect (unplug) both wire terminals at the rear of the hourmeter.

b. Hourmeter Installation

1. Attach the black and green wires to the wire terminals at the rear of the meter.
2. Insert the hourmeter (**1**) into the opening in the left side of the dash console. Secure with two screws.
3. Connect the negative (-) battery cable (**5**) at the battery negative (-) terminal on the battery in the engine side battery box.
4. Connect the negative (-) battery equalizer cable (**6**) at the bottom of the battery equalizer (**7**). Torque the nut to a maximum of 100 lbs/in (11 Nm).
5. Replace engine side battery box cover (**2**). Use the wing nuts (**3**) and carriage bolts (**4**) to secure the cover in place.
6. Start the engine. Observe the hourmeter for function with the engine running to verify operation. Time the hourmeter for six minutes to verify that a tenth of an hour has been recorded.

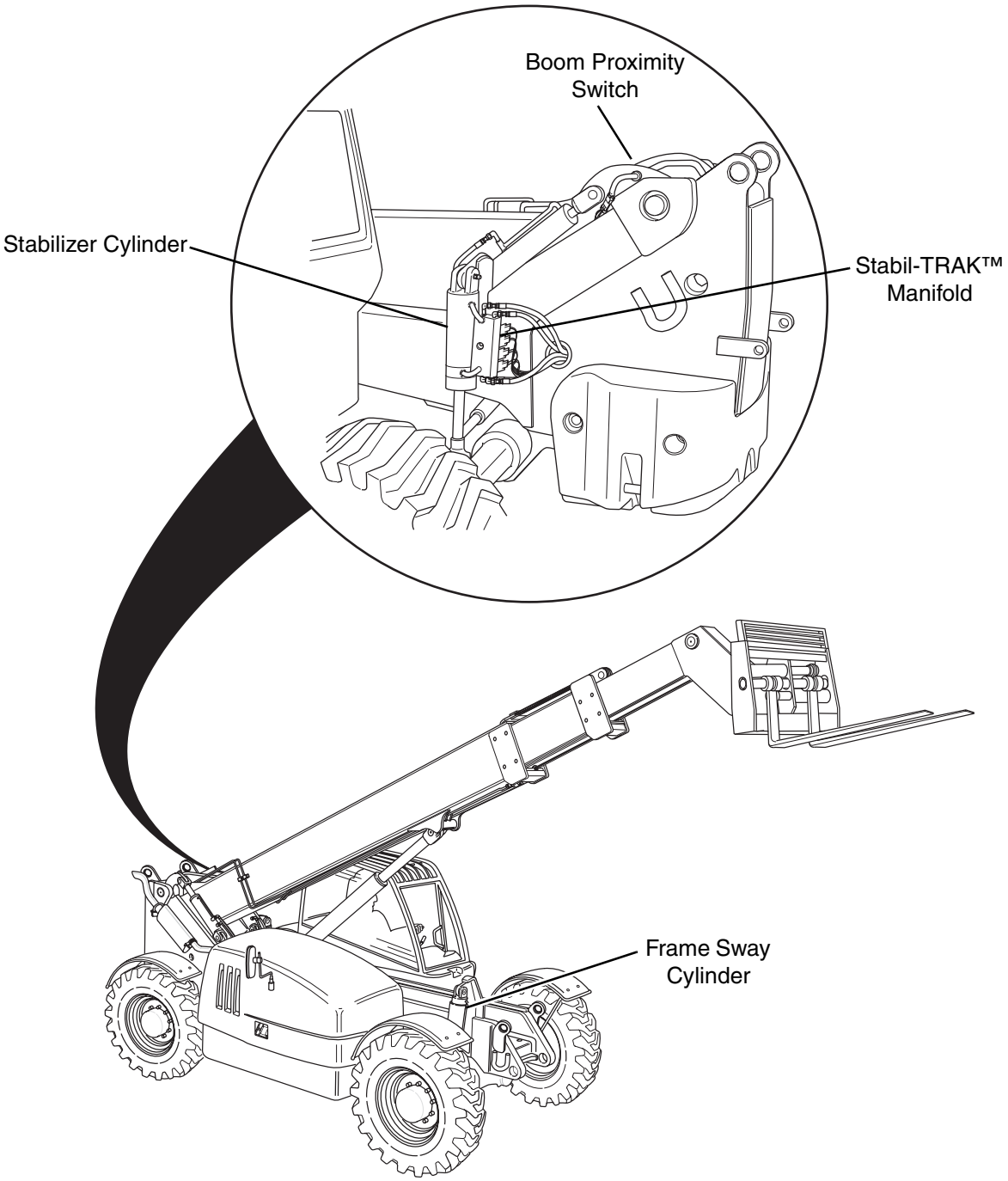
Section 11
Stabil-TRAK™ System

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11.1 STABIL-TRAK™ SYSTEM 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 name and location of the major assemblies of the Stabil-TRAK™ system. The following illustration identifies the components that are referred to throughout this section.

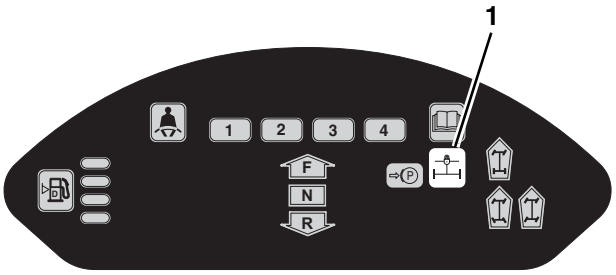


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11.2 STABIL-TRAK™ DESCRIPTION

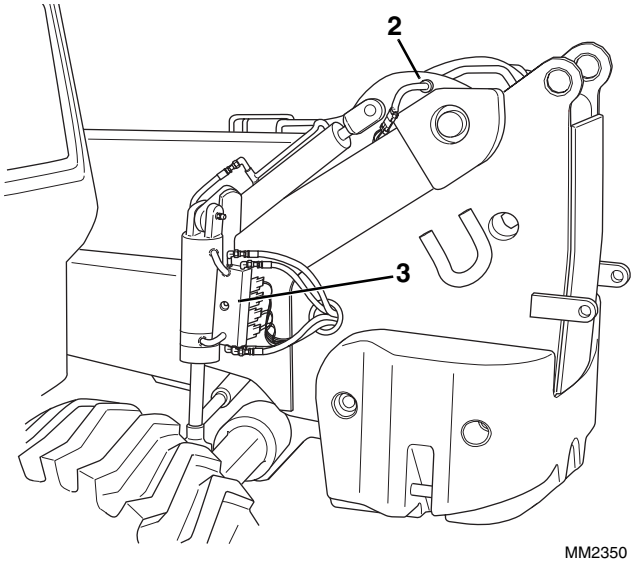
The patented rear axle lock or Stabil-TRAK™ system works to stabilize the vehicle under various conditions. The SKY TRAK Owners/Operators Manual contains basic Stabil-TRAK™ information; a copy of the Owners/Operators Manual should always be available in the storage pocket in the cab door.

The operator's display panel Stabil-TRAK™ indicator (**1**) goes ON when the Stabil-TRAK™ system is in the LOCKED mode.



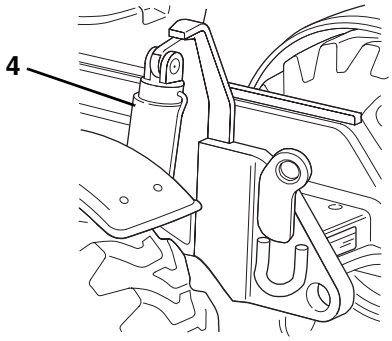
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The stabilizing system operates via an interface between the boom proximity switch (**2**), park brake switch, service brake switch and neutral engage relay, hydraulic and electrical circuits, logic circuits (built into the dash panel), and five solenoid-operated valves on the Stabil-TRAK™ manifold (**3**) attached to the stabilizer cylinder above the left side of the rear axle.



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The frame sway cylinder (**4**) is also involved in the Stabil-TRAK™ system, but only passively, as hydraulic oil travels between the frame sway cylinder and the Stabil-TRAK™ manifold to accommodate Stabil-TRAK™ system operation.



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The Stabil-TRAK™ lock system can only be activated when the boom angle is greater than 40° and one or more of the following functions are activated:

- Engaging the Parking Brake Switch
- Placing the Travel Select Lever in [N] NEUTRAL
- Depressing and holding the Service Brake

With the boom lowered to an angle of less than 40°, the rear axle lock system is not active and none of these functions will affect the Stabil-TRAK™ system.

11.3 STABIL-TRAK™ OPERATION

The rough terrain telescopic handler rarely operates on ground that is a smooth, flat surface. As its name infers, the “Construction Rough Terrain Telescopic Handler” is typically found on worksites with numerous holes, trenches, rocks and slopes.

To negotiate this type of terrain, rough terrain telescopic handlers are designed with a free oscillating rear axle. This design enables the operator to drive over changes in terrain with minimal concern for what the rear tires are going over.

With oscillation, the rear axle will rotate upward or downward when a tire meets with anything causing it to raise or lower. The rear of the vehicle moves up or down approximately one-half the distance of the tires movement, while giving the vehicle minimal lateral movement. The oscillation capability is necessary for traveling across rough terrain.

The rear axle is capable of oscillation; the front axle is normally locked to the vehicle frame by the frame sway cylinder. The frame sway cylinder does allow for adjustment of the frame and load to a level position when traveling on a rough terrain worksite, or for leveling a load.

The least stable condition for the rough terrain telescopic handler is when the boom is raised and the carriage is empty. This is because the center of gravity is now high and closest to the rear apex of the stability triangle.

11.3.1 Understanding the Stabil-TRAK™ System

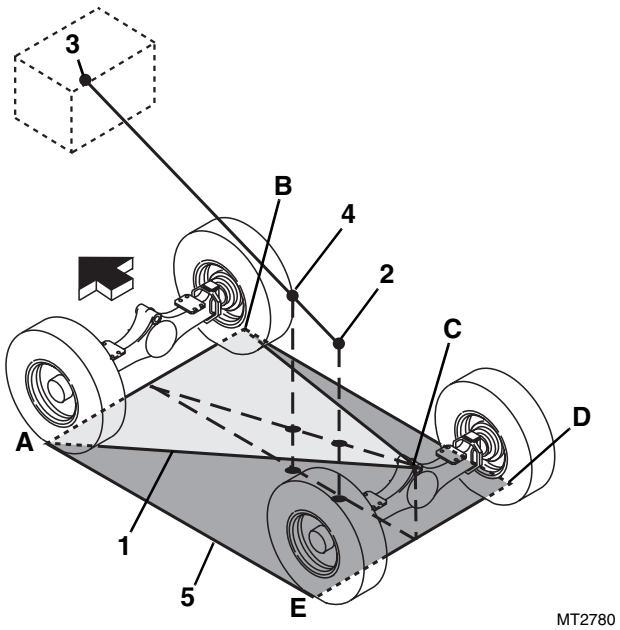
The following information explains the difference between a typical telescopic handler and the benefits that the Stabil-TRAK™ system provides.

Most telescopic handlers operate within a 3-point stability triangle (**1**) as defined by points **A**, **B** and **C**.

Point **2** in the illustration represents the center of gravity of an unloaded vehicle. The load has its own center of gravity represented by point **3**. When the vehicle is loaded, the vehicle and load become one mass with a combined center of gravity, represented by point **4**.

As the boom is lowered or extended, point **4** will move forward in the 3-point stability triangle, or backward in the 3-point stability triangle as the boom is raised. Point **4** can also move left or right toward the edges of the stability triangle if the frame is tilted. As long as point **4** remains in the boundaries of the 3-point stability triangle (**1**), the vehicle will remain stable. If point 4 ever goes beyond the boundaries of the stability triangle, the vehicle can tip over.

In the LOCKED MODE, the exclusive Stabil-TRAK™ System provides a 4-point stability rectangle (**5**) by positively locking the frame to the rear axle through the stabilizer cylinder. The vehicle is then supported at four points; **A**, **B**, **D** and **E**. While in the LOCKED MODE, it is clear that point **4** will remain within the entire boundary of the 4-point stability rectangle, giving the operator more flexibility in positioning the load.

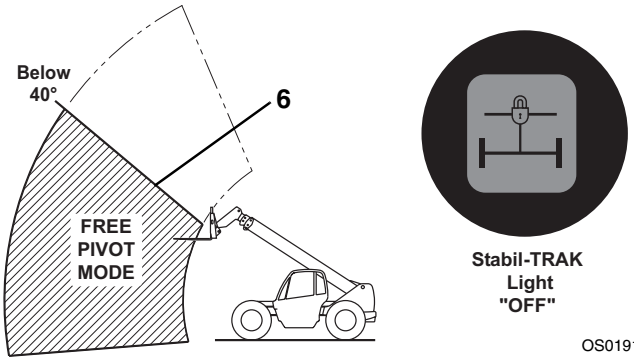


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The following describes the three basic modes of the patented Stabil-TRAK™ system. The vehicle may operate in any one of the following three modes.

a. Free Pivot Mode (6)

With the boom below 40°, the Stabil-TRAK™ system is in the FREE PIVOT MODE and the rear axle is allowed to pivot freely. The frame sway control will function normally.



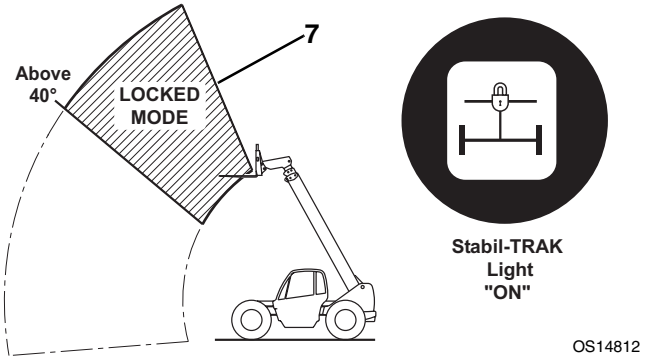
OS01912

b. Locked Mode (7)

With the boom above 40° and by activating one or more of the functions (as follows), the Stabil-TRAK™ system is in the LOCKED MODE and the rear axle is locked so it is rigid with the frame. The Stabil-TRAK™ light will be ON.

- Engaging the parking brake switch
- Placing the travel select lever in [N] NEUTRAL
- Depressing and holding the service brake pedal

The frame sway control will function slower than normal in this mode.

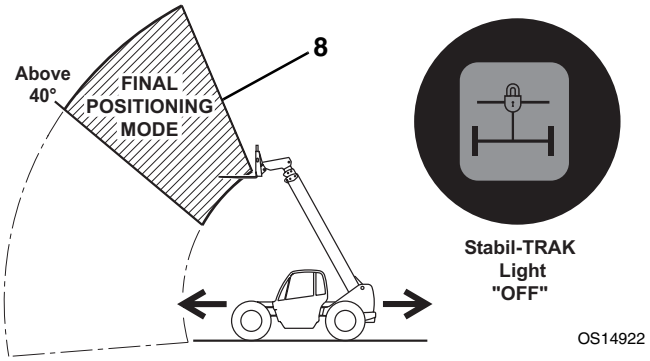


c. Final Positioning Mode (8)

With the boom above 40°, the Stabil-TRAK™ system is now in the FINAL POSITIONING MODE. In this mode the rear axle is UNLOCKED and is allowed to pivot, but will respond SLOWLY to changes in terrain. The Stabil-TRAK™ light will be OFF.

The frame sway control function will function normally in this mode.

To check that the Stabil-TRAK™ System is functioning properly, refer to “Stabil-TRAK™ System Test” on page 11.28 for the proper system function.



11.3.2 Stabil-TRAK™ Solenoid Valves

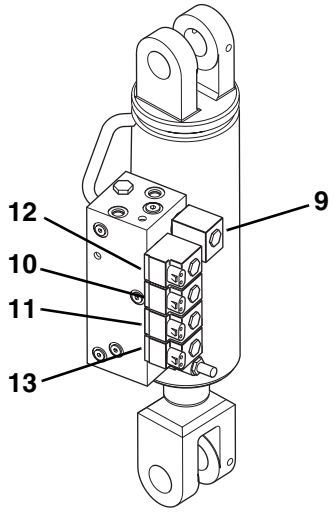
There are five Stabil-TRAK™ solenoid valves (**9**) attached to the Stabil-TRAK™ manifold, attached to the stabilizer cylinder above the left side of the rear axle.

If a solenoid valve is suspected of malfunctioning, disconnect the coil wiring lead and test the coil for proper resistance (7-9 ohms) and for proper voltage from the harness (12 VDC). Replace the solenoid coil if open or shorted to ground.

Also inspect the valve cartridge, o-rings, and the other hydraulic and electrical components in the circuit to accurately determine the cause of the problem.

All solenoid cartridge valves 4A (**10**), *4B (**11**)*, 12A (**12**) and 12B (**13**) are identical and can be interchanged for diagnostic purposes.

Note: *There is an orifice plug beneath each of the solenoid cartridge valves, 4A (**10**) and 4B (**11**). These plugs **must** stay in these positions if you interchange the solenoid cartridge valves.*



In general, if there is a problem with the Stabil-TRAK™ system beyond common electrical troubles, the involved electrical and hydraulic circuits should each be checked and the exact source of the problem diagnosed before any parts are replaced.

11.4 STABIL-TRAK™ CIRCUIT OPERATION AND TROUBLESHOOTING

The function of the Stabil-TRAK™ system varies under different operating conditions. The basic modes include the FREE PIVOT MODE, FINAL POSITIONING MODE, and LOCKED MODE.

The hydraulic and electrical operation and troubleshooting information for each of these modes will be described on the following pages.

11.4.1 Troubleshooting Symptom Chart

Symptom	Conditions	Reference
With the boom below 40° when swaying the frame to the right, the left front tire comes off the ground.	Ignition ON, engine running Boom angle is below 40° Travel select lever is in [F] FORWARD or [R] REVERSE Park brake OFF Service brake DISENGAGED	Refer to *Section 11.4.3, Hydraulic Circuit Operation - Free Pivot Mode, Rod Oil Out* and *Section 11.4.4, Hydraulic Troubleshooting - Free Pivot Mode, Rod Oil Out* or *Section 11.4.7, Electrical Schematic - Free Pivot Mode* and *Section 11.4.8, Electrical Troubleshooting - Free Pivot Mode, Will Not Frame Sway Right*
With the boom below 40° when swaying the frame to the left, the right front tire comes off the ground.	Ignition ON, engine running Boom angle is below 40° Travel select lever is in [F] FORWARD or [R] REVERSE Park brake OFF Service brake DISENGAGED	Refer to *Section 11.4.5, Hydraulic Circuit Operation - Free Pivot Mode, Base Oil Out* and *Section 11.4.6, Hydraulic Troubleshooting - Free Pivot Mode, Base Oil Out* or *Section 11.4.7, Electrical Schematic - Free Pivot Mode* and *Section 11.4.9, Electrical Troubleshooting - Free Pivot Mode, Will Not Frame Sway Left*
While traveling, ride feels spongy (riding on 3 wheels).	Ignition ON, engine running Boom angle is above 40° Travel select lever is in [F] FORWARD or [R] REVERSE Park brake OFF Service brake DISENGAGED	Refer to *Section 11.4.10, Hydraulic Circuit Operation - Final Positioning Mode, Rod Oil Out* and *Section 11.4.11, Hydraulic Troubleshooting - Final Positioning Mode, Rod Oil Out* or *Section 11.4.12, Hydraulic Circuit Operation - Final Positioning Mode, Base Oil Out* and *Section 11.4.13, Hydraulic Troubleshooting - Final Positioning Mode, Base Oil Out* or *Section 11.4.14, Electrical Schematic - Final Positioning Mode* and *Section 11.4.15, Electrical Troubleshooting - Final Positioning Mode*
Stabil-TRAK™ light in dash panel is not ON.	Ignition ON, engine running Boom angle is above 40° Travel select lever is in [N] NEUTRAL, or Park brake ON or Service brake ENGAGED	Refer to *Section 11.4.21, Electrical Schematic - Locked Mode* and *Section 11.4.22, Electrical Troubleshooting - Locked Mode*

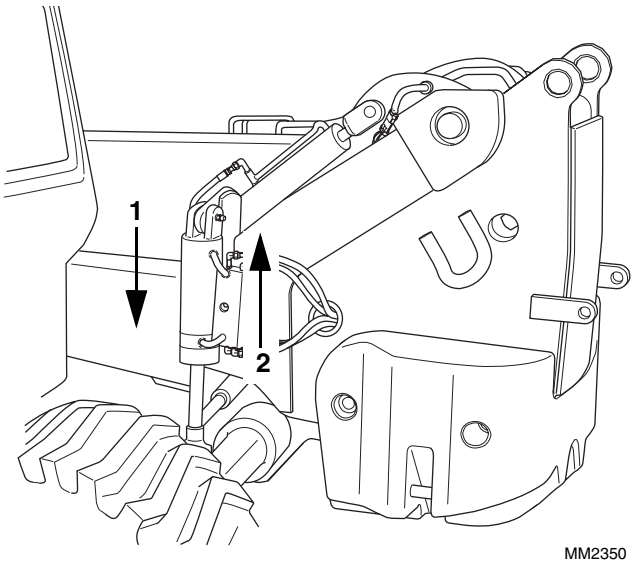
Symptom	Conditions	Reference
With the boom above 40° when swaying the frame to the right, the left front tire comes off the ground.	Ignition ON, engine running Boom angle is above 40° Travel select lever is in [N] NEUTRAL, or Park brake ON or Service brake ENGAGED	Refer to *Section 11.4.17, Hydraulic Circuit Operation - Locked Mode, Frame Sway Right* and *Section 11.4.19, Hydraulic Troubleshooting - Locked Mode, Will Not Frame Sway Right*
With the boom above 40° when swaying the frame to the left, the right front tire comes off the ground.	Ignition ON, engine running Boom angle is above 40° Travel select lever is in [N] NEUTRAL, or Park brake ON or Service brake ENGAGED	Refer to *Section 11.4.18, Hydraulic Circuit Operation - Locked Mode, Frame Sway Left* and *Section 11.4.20, Hydraulic Troubleshooting - Locked Mode, Will Not Frame Sway Left*

11.4.2 Stabilizer Cylinder Oil Flow

In the FREE PIVOT and FINAL POSITIONING MODE, oil flow from the stabilizer cylinder will be in one of two directions; ROD OIL OUT or BASE OIL OUT.

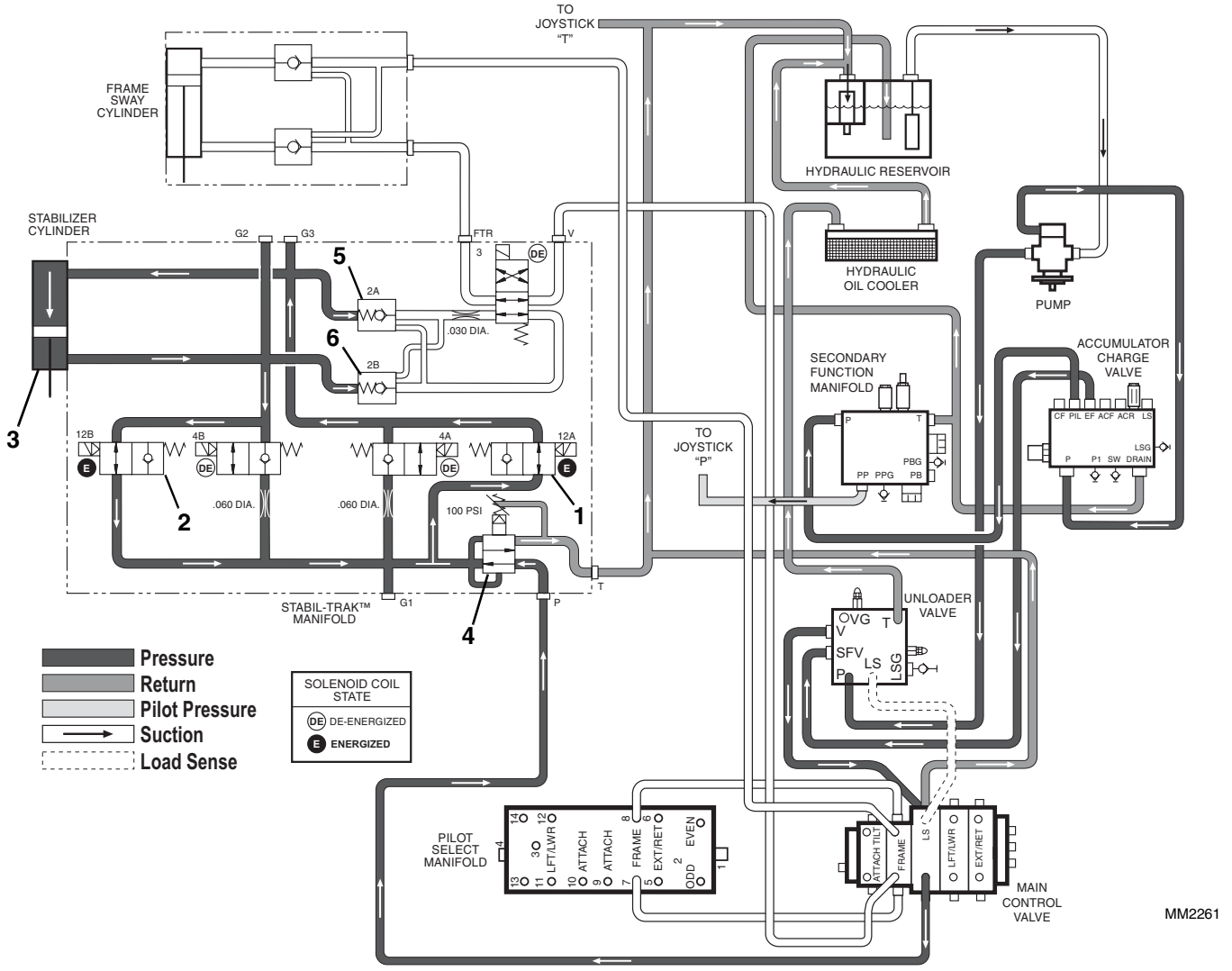
ROD OIL OUT flow will occur when the left side of the rear axle is lower than the right side (left wheel in a pothole, or the right wheel passing over an obstruction), causing the cylinder to extend (**1**).

BASE OIL OUT flow will occur when the right side of the rear axle is lower than the left (right wheel in a pothole, or the left wheel passing over an obstruction), causing the cylinder to compress (**2**).



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11.4.3 Hydraulic Circuit Operation - Free Pivot Mode, Rod Oil Out



Conditions:

- Boom angle is below 40°
- Rear axle pivots freely
- Travel select lever in [F] FORWARD or [R] REVERSE position
- Park brake OFF
- Service brake DISENGAGED

Operation:

Note: *Refer to Section 11.4.7, Electrical Schematic - Free Pivot Mode, for the electrical schematic for this circuit.*

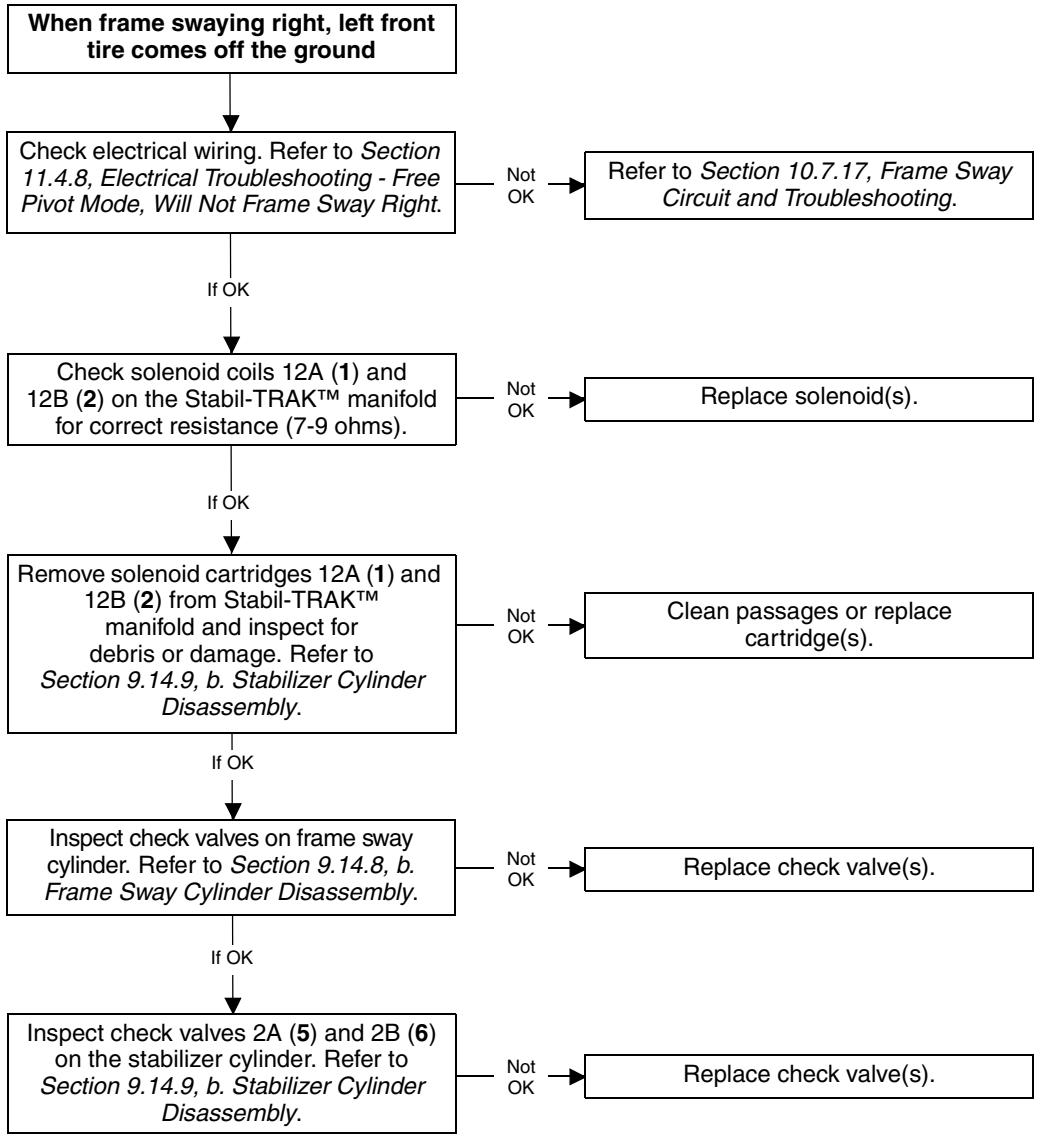
When the conditions are met, solenoids 12A (**1**) and 12B (**2**) are energized. As the left side of the rear axle moves down, the rod extends, forcing hydraulic oil out from the rod end of the stabilizer cylinder (**3**). The oil then flows through the solenoid-operated valves 12B (**2**) and 12A (**1**), to the base side of the stabilizer cylinder.

Because the volume of oil needed on the base side is greater than that needed on the rod side, the extra oil needed is supplied from the main hydraulic system through a 100 psi (7 bar) reducing cartridge (**4**) in the Stabil-TRAK™ manifold.

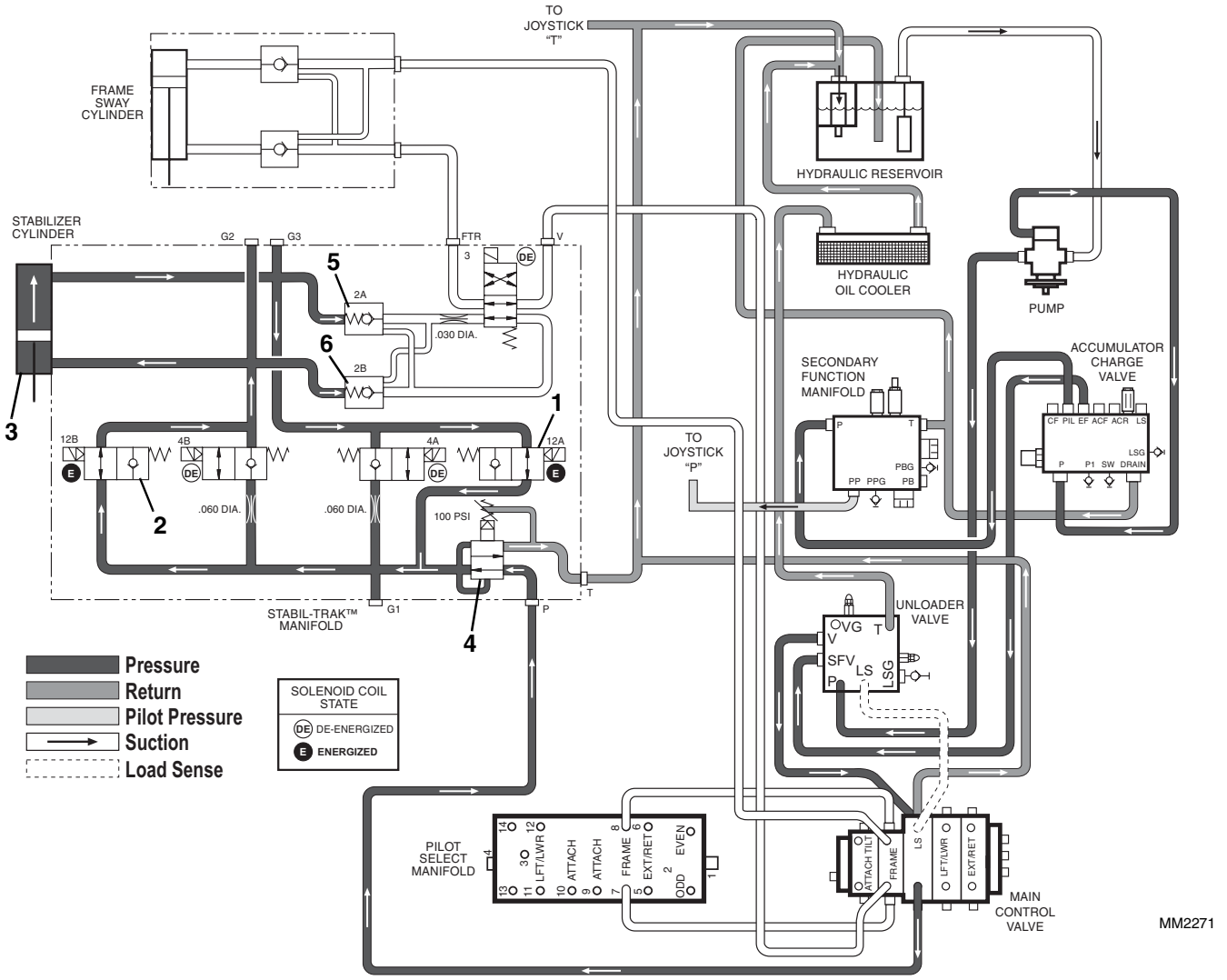
11.4.4 Hydraulic Troubleshooting - Free Pivot Mode, Rod Oil Out

Conditions:

- Ignition ON, engine running
- Boom angle is below 40°
- Travel select lever in [F] FORWARD or [R] REVERSE
- Park brake OFF
- Service brake DISENGAGED



11.4.5 Hydraulic Circuit Operation - Free Pivot Mode, Base Oil Out



Conditions:

- Boom angle is below 40°
- Rear axle pivots freely
- Travel select lever in [F] FORWARD or [R] REVERSE position
- Park brake OFF
- Service brake DISENGAGED

Operation:

Note: *Refer to Section 11.4.7, Electrical Schematic - Free Pivot Mode, for the electrical schematic for this circuit.*

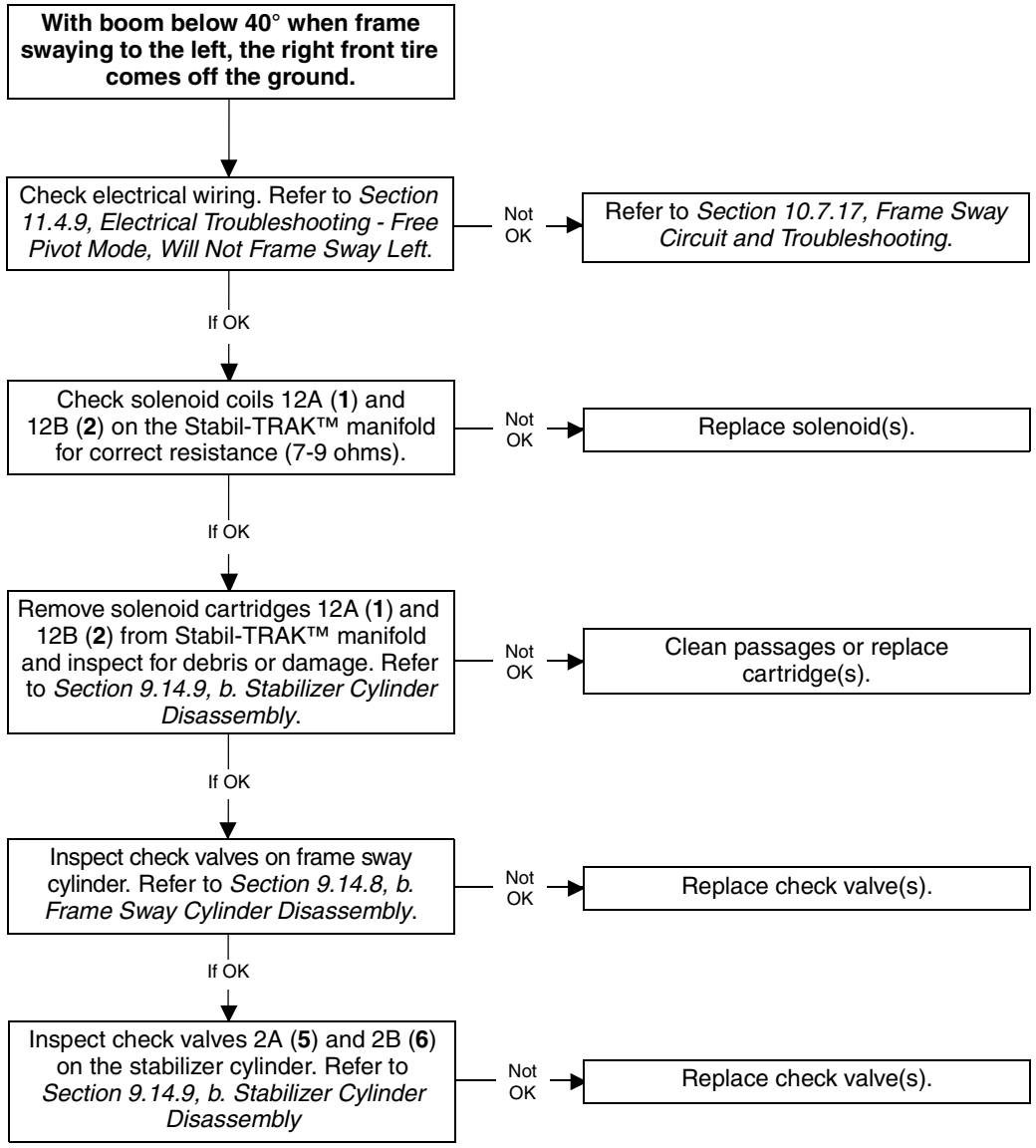
When the conditions are met, solenoids 12A (**1**) and 12B (**2**) are energized. As the left side of the rear axle moves down, the rod is forced up, forcing hydraulic oil out from the base end of the stabilizer cylinder (**3**). The oil then flows through the solenoid-operated valves 12A (**1**) and 12B (**2**), to the rod side of the stabilizer cylinder.

Because the volume of oil needed on the rod side is less than that needed on the base side, excess oil is returned to the tank through a 100 psi (7 bar) reducing cartridge (**4**) in the Stabil-TRAK™ manifold.

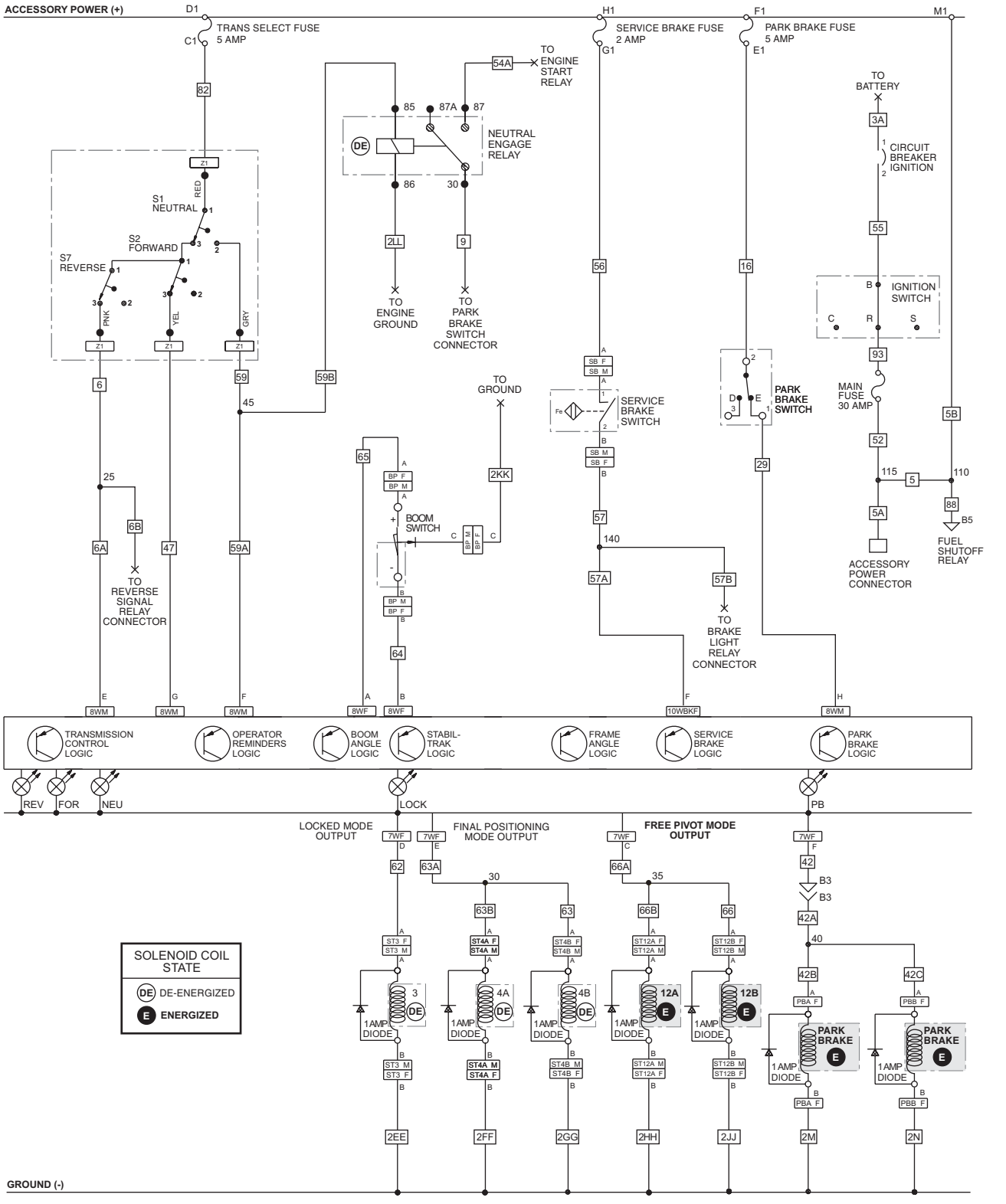
11.4.6 Hydraulic Troubleshooting - Free Pivot Mode, Base Oil Out

Conditions:

- Ignition ON, engine running
- Boom angle is below 40°
- Travel select lever in [F] FORWARD or [R] REVERSE
- Park brake ON
- Service brake DISENGAGED



11.4.7 Electrical Schematic - Free Pivot Mode



MM2281

11.4.8 Electrical Troubleshooting - Free Pivot Mode, Will Not Frame Sway Right

Conditions:

- Ignition ON, engine running
- Boom angle is below 40°
- Travel select lever in [F] FORWARD or [R] REVERSE
- Park brake OFF
- Service brake DISENGAGED

With boom below 40° when frame swaying to the right, the left front tire comes off the ground.

Check wire and connector to solenoid 12B on Stabil-TRAK™ manifold for battery voltage.
- Not OK → Repair as necessary.
- If OK ↓

Check solenoid coil for correct resistance (7-9 ohms).
- Not OK → Replace solenoid coil.
- If OK ↓

Remove solenoid cartridge from manifold and inspect for debris or damage.
- Not OK → Clean or replace cartridge.
- If OK ↓

Inspect manifold passages for debris or obstruction. Clean if necessary.
- Not OK → Replace stabilizer cylinder.

11.4.9 Electrical Troubleshooting - Free Pivot Mode, Will Not Frame Sway Left

Conditions:

- Ignition ON, engine running
- Boom angle is below 40°
- Travel select lever in [F] FORWARD or [R] REVERSE
- Park brake OFF
- Service brake DISENGAGED

With boom below 40° when frame swaying to the left, the right front tire comes off the ground.

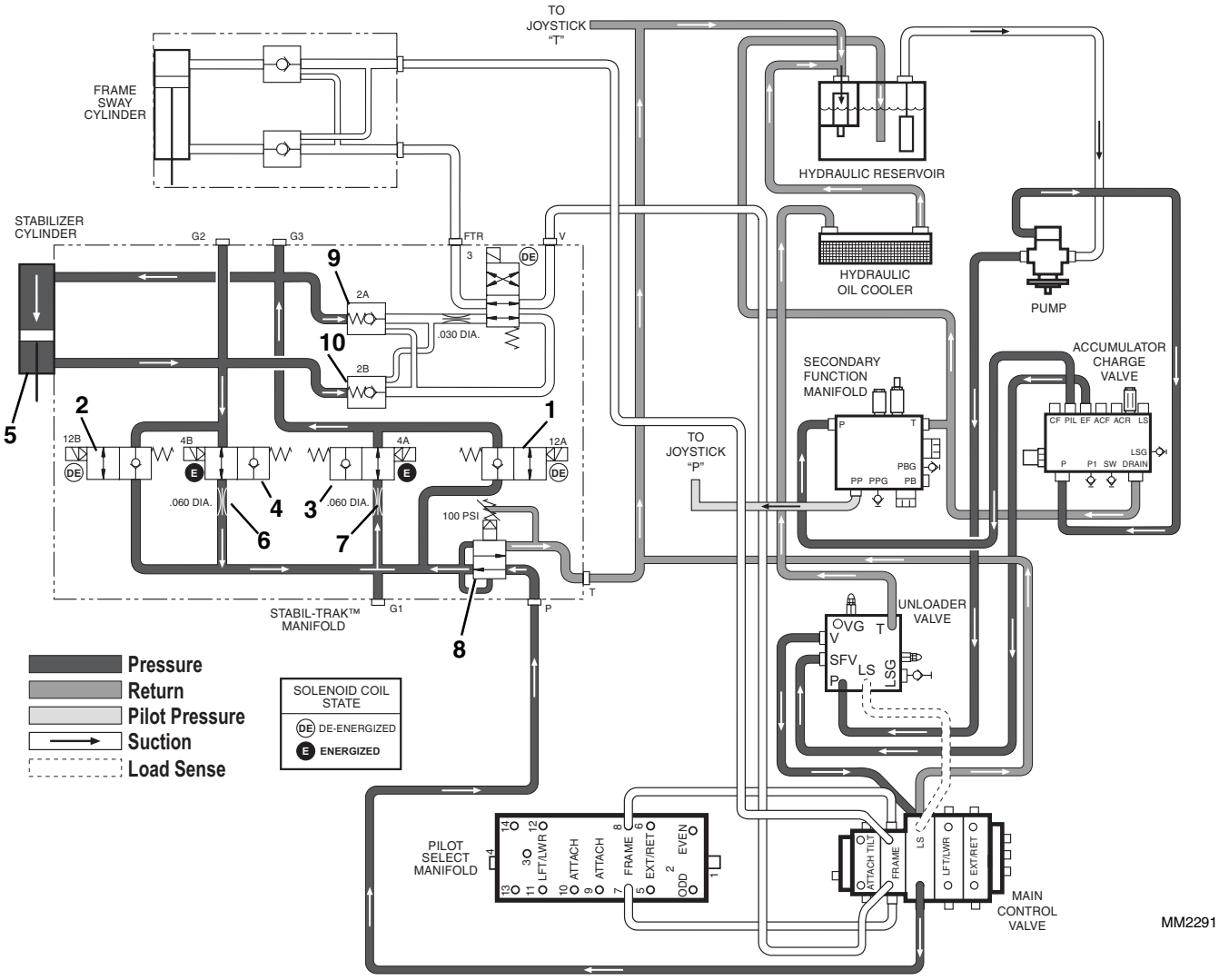
Check wire and connector to solenoid 12A on Stabil-TRAK™ manifold for battery voltage.
- Not OK → Repair as necessary.
- If OK ↓

Check solenoid coil for correct resistance (7-9 ohms).
- Not OK → Replace solenoid coil.
- If OK ↓

Remove solenoid cartridge from manifold and inspect for debris or damage.
- Not OK → Clean or replace cartridge.
- If OK ↓

Inspect manifold passages for debris or obstruction. Clean if necessary.
- Not OK → Replace stabilizer cylinder.

11.4.10 Hydraulic Circuit Operation - Final Positioning Mode, Rod Oil Out



Conditions:

- Boom angle is above 40°
- Park brake OFF
- Service brake DISENGAGED
- Travel select lever in [F] FORWARD or [R] REVERSE position

Operation:

Note: *Refer to Section 11.4.14, Electrical Schematic - Final Positioning Mode, for the electrical schematic for this circuit.*

As the boom is raised above 40°, the boom proximity switch is deactivated causing solenoids 12A (**1**) and 12B (**2**) to de-energize and solenoids 4A (**3**) and 4B (**4**) to energize. This allows oil to flow from the rod end of the stabilizer cylinder (**5**), through solenoid-operated valve 4B (**4**), through a .060" orifice (**6**), through another .060" orifice (**7**), then through solenoid-operated valve 4A (**3**), then to the base end of the stabilizer cylinder.

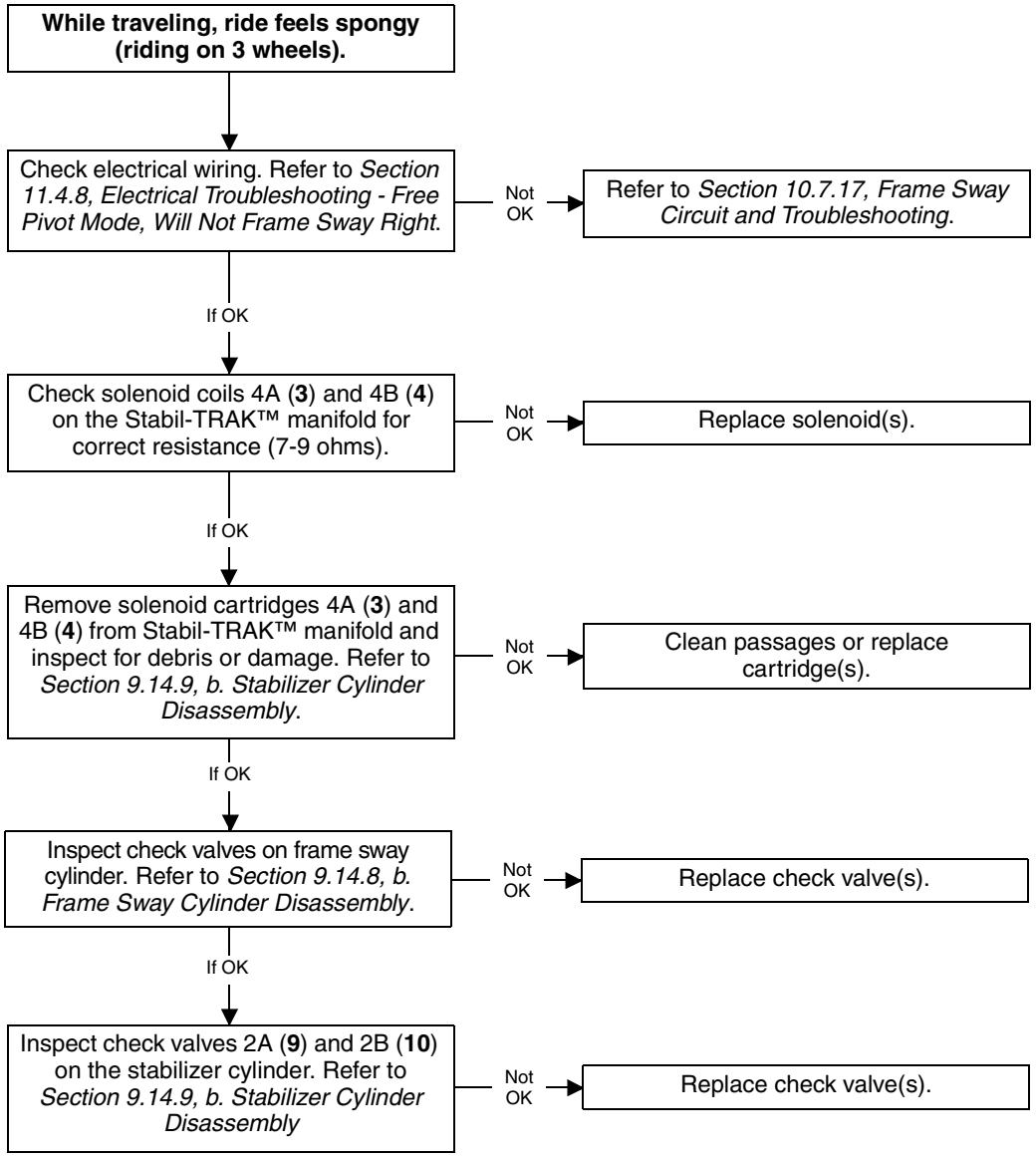
The .060" orifices (**6** and **7**) in solenoid-operated valves 4A (**3**) and 4B (**4**) will slow the movement of the rear axle in reaction to terrain changes. The frame sway will react normally in this mode.

Because of the greater volume of oil required, extra oil is required from the system through the 100 psi (7 bar) reducing cartridge (**8**) in the Stabil-TRAK™ manifold. The restrictions produce the slow movement, or FINAL POSITIONING mode.

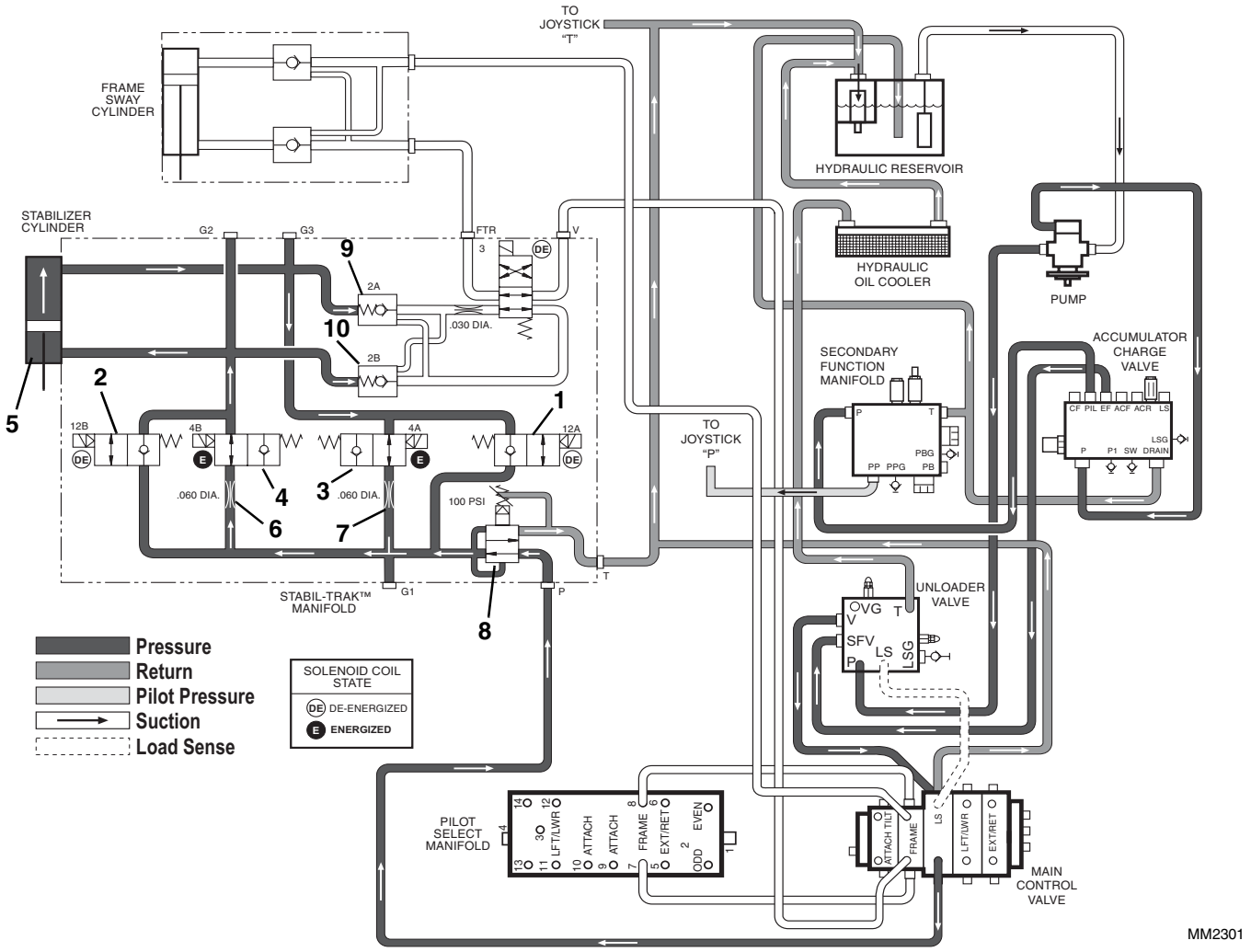
11.4.11 Hydraulic Troubleshooting - Final Positioning Mode, Rod Oil Out

Conditions:

- Ignition ON, engine running
- Boom angle is above 40°
- Travel select lever in [F] FORWARD or [R] REVERSE
- Park brake OFF
- Service brake DISENGAGED



11.4.12 Hydraulic Circuit Operation - Final Positioning Mode, Base Oil Out



Conditions:

- Boom angle is above 40°
- Park brake OFF
- Service brake DISENGAGED
- Travel select lever in [F] FORWARD or [R] REVERSE position

Operation:

Note: *Refer to Section 11.4.14, Electrical Schematic - Final Positioning Mode, for the electrical schematic for this circuit.*

As the boom is raised above 40°, the boom proximity switch is deactivated causing solenoids 12A (**1**) and 12B (**2**) to de-energize and solenoids 4A (**3**) and 4B (**4**) to energize. This allows oil to flow from the base end of the stabilizer cylinder (**5**), through solenoid-operated valve 4B (**4**), through a .060" orifice (**6**), through another .060" orifice (**7**), then through solenoid-operated valve 4A (**3**), to the rod end of the stabilizer cylinder.

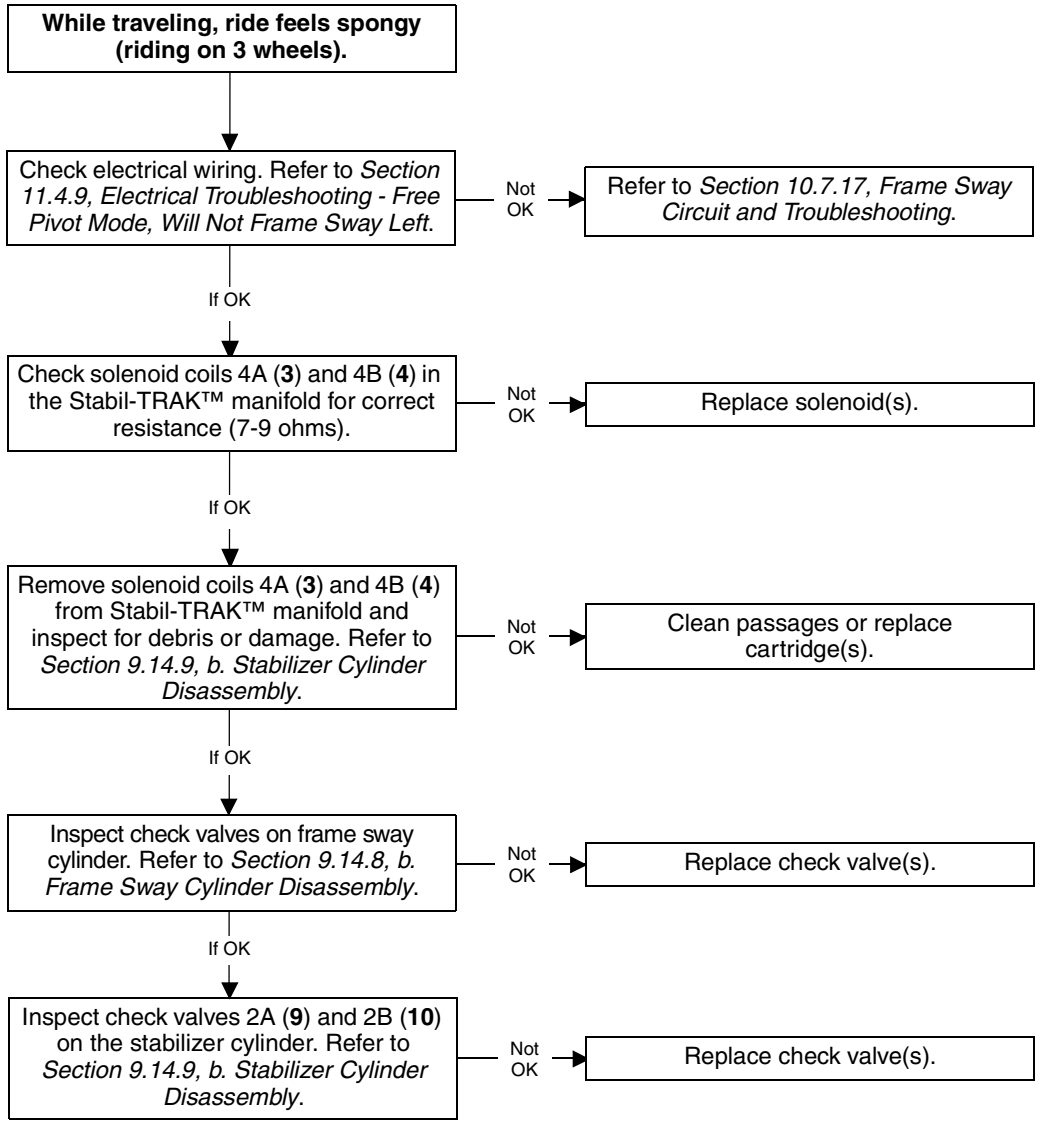
The .060" orifices (**6** and **7**) in solenoid-operated valves 4A (**3**) and 4B (**4**) will slow the movement of the rear axle in reaction to terrain changes. The frame sway will react normally in this mode.

Because of the greater volume of oil in the base end, extra oil is returned to the tank through the 100 psi (7 bar) reducing cartridge (**8**) in the Stabil-TRAK™ manifold. The restrictions produce the slow movement, or FINAL POSITIONING mode.

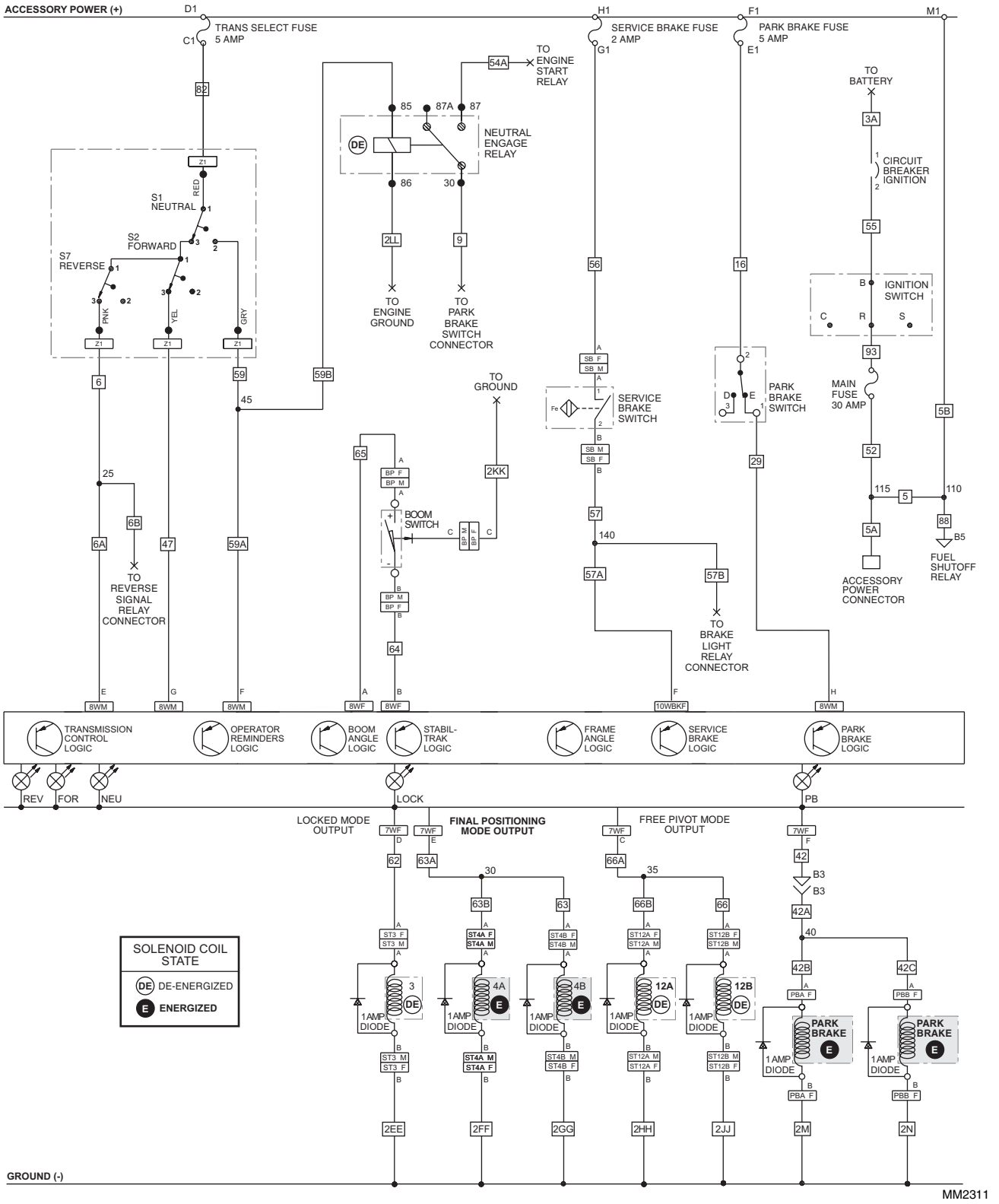
11.4.13 Hydraulic Troubleshooting - Final Positioning Mode, Base Oil Out

Conditions:

- Ignition ON, engine running
- Boom angle is above 40°
- Travel select lever in [F] FORWARD or [R] REVERSE
- Park brake OFF
- Service brake DISENGAGED



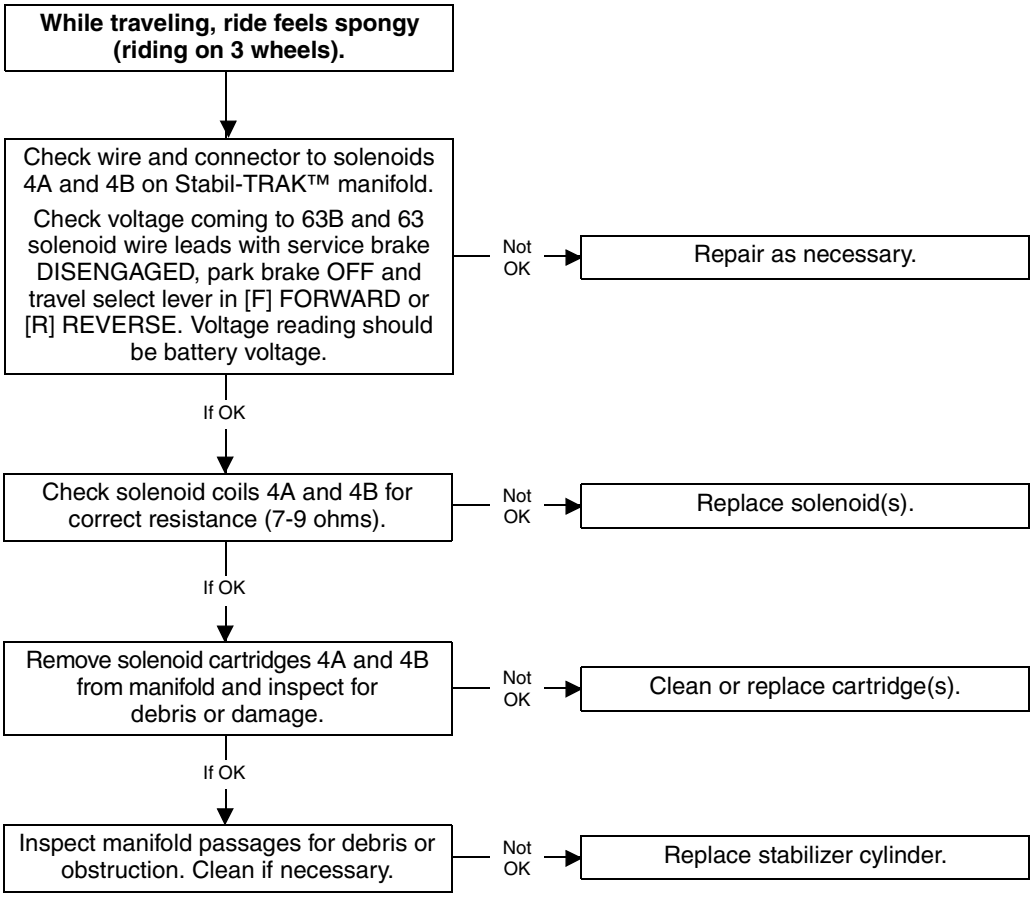
11.4.14 Electrical Schematic - Final Positioning Mode



11.4.15 Electrical Troubleshooting - Final Positioning Mode

Conditions:

- Ignition ON, engine running
- Boom angle is above 40°
- Travel select lever in [F] FORWARD or [R] REVERSE
- Park brake OFF
- Service brake DISENGAGED



11.4.16 Hydraulic Circuit Operation - Locked Mode

Note: *The electrical schematic shown in illustration on page 26, shows the Stabil-TRAK™ system in the LOCKED MODE.*

a. Conditions:

- Boom angle is above 40°
- Park brake ON, or service brake ENGAGED, or travel select lever in [N] NEUTRAL

b. Operation:

Note: *Refer to Section 11.4.21, Electrical Schematic - Locked Mode, for the electrical schematic for this circuit.*

When the conditions are met, solenoids 4A (**1**), 4B (**2**), 12A (**3**), and 12B (**4**) are de-energized and solenoid 3 is energized. In the LOCKED MODE, oil is prevented from flowing through the Stabil-TRAK™ manifold due to check valves in solenoid-operated valves 4A (**1**), 4B (**2**), 12A (**3**), and 12B (**4**).

11.4.17 Hydraulic Circuit Operation - Locked Mode, Frame Sway Right

When the joystick control is placed in the frame sway mode, the frame sway solenoid-operated valve in the pilot select manifold is energized. As the joystick is moved to the right, oil flows through the solenoid-operated valve in the pilot select manifold, and then flows to the frame sway spool valve section in the main control valve.

This pilot pressure causes the spool valve to shift position, allowing oil to flow through the valve to the Stabil-TRAK™ manifold, port V.

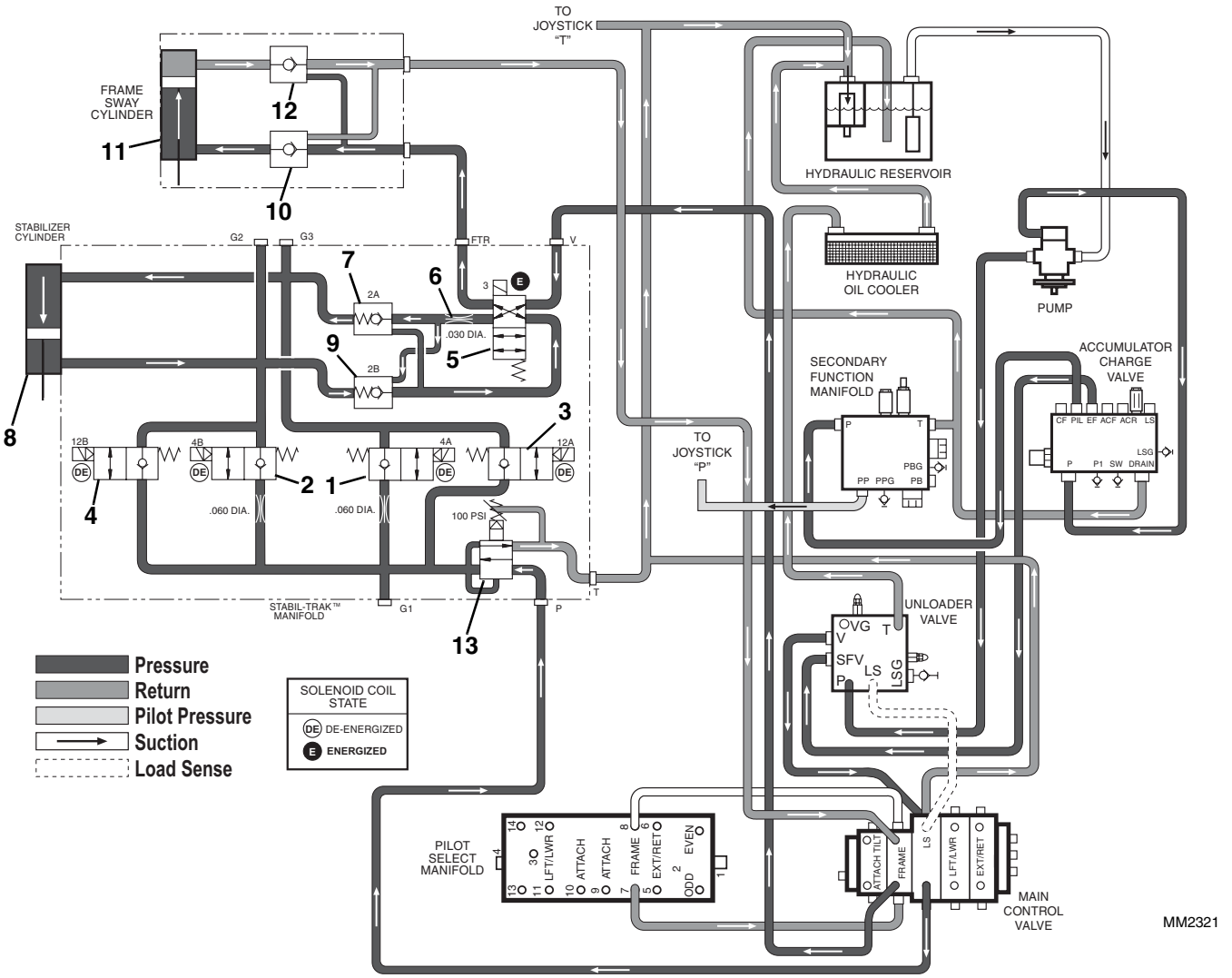
Oil entering the Stabil-TRAK™ manifold at port V flows through solenoid cartridge valve 3 (**5**), through a .030" orifice (**6**) and check valve 2A (**7**), to the base end of the stabilizer cylinder (**8**). The orifice slows the movement of the frame sway.

Some of this oil is diverted to the pilot line of check valve 2B (**9**), opening the valve.

Rod end oil from the stabilizer cylinder flows through check valve 2B (**9**), opened by pilot pressure in the Stabil-TRAK™ manifold. The oil then flows through cartridge valve 3 (**5**), out of the Stabil-TRAK™ manifold at port FTR, through a check valve (**10**), to the rod end of the frame sway cylinder (**11**).

Oil from the base end of the frame sway cylinder flows through a piloted-open check valve (**12**) and back through the frame sway spool valve in the frame sway section of the main control valve, dumping the returned oil to the reservoir.

Pressurized oil entering the Stabil-TRAK™ manifold at port P is stopped at the four closed solenoid-operated valves 4A (**1**), 4B (**2**), 12A (**3**), and 12B (**4**). At this time pilot pressure will cause the 100 psi relief valve (**13**) to change position, allowing the excess oil to vent to the reservoir.


TO JOYSTICK "T"
FRAME SWAY CYLINDER
12
11
10
HYDRAULIC RESERVOIR
HYDRAULIC OIL COOLER
PUMP
STABILIZER CYLINDER
G2
G3
FTR
V
7
6
2A
3
E
.030 DIA.
9
2B
5
8
3
SECONDARY FUNCTION MANIFOLD
ACCUMULATOR CHARGE VALVE
CF PIL EF ACF ACR LS
LSG
P P1 SW DRAIN
P T
PBG
PP PPG PB
12B
4B
4A
12A
DE
2
1
4
.060 DIA.
.060 DIA.
100 PSI
TO JOYSTICK "P"
T
STABIL-TRAK™ MANIFOLD
G1
P
13
UNLOADER VALVE
VG T
V
SFV
LS
LSG
P
Pressure
Return
Pilot Pressure
Suction
Load Sense
SOLENOID COIL STATE
DE DE-ENERGIZED
E ENERGIZED
PILOT SELECT MANIFOLD
14 12 3 LFT/LWR 11 13
10 ATTACH
9 ATTACH
8 6 FRAME EXT/RET 5 7
EVEN 2
ODD 1
ATTACH TILT
FRAME
LS
LFT/LWR
EXT/RET
MAIN CONTROL VALVE
MM2321

11.4.18 Hydraulic Circuit Operation - Locked Mode, Frame Sway Left

a. Conditions

- Boom angle is above 40°
- Park brake ON, or service brake ENGAGED, or travel select lever in [N] NEUTRAL

b. Operation

Note: *Refer to Section 11.4.21, Electrical Schematic - Locked Mode, for the electrical schematic for this circuit.*

When the joystick control is placed in the frame sway mode, the frame sway solenoid-operated valve in the pilot select manifold is energized. As the joystick is moved to the left, oil flows through the solenoid-operated valve in the pilot select manifold, and then flows to the frame sway spool valve in the frame sway section of the main control valve.

This pilot pressure causes the spool valve to shift position, allowing oil to flow through the valve to a spool valve, allowing oil to flow through a check valve (**1**) to the base end of the frame sway cylinder (**2**).

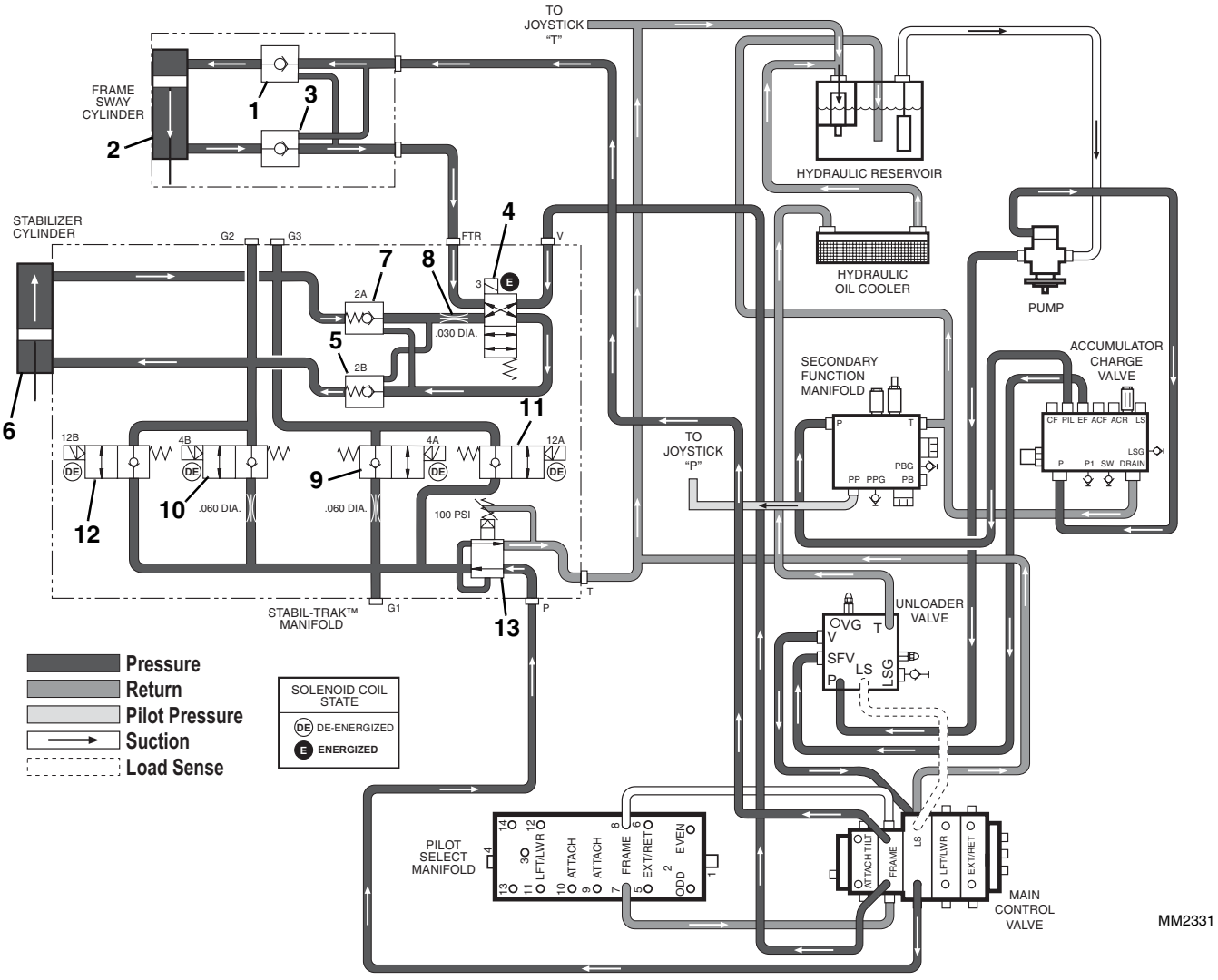
Some of this oil is diverted to the pilot line of the check valve (**3**) on the return side of the frame sway cylinder, opening the valve.

Oil from the rod end of the frame sway cylinder flows through the check valve (**3**) opened by incoming pilot pressure oil, to the FTR port of the Stabil-TRAK™ manifold.

Oil entering at port FTR flows through solenoid valve 3 (**4**) through check valve 2B (**5**), to the rod end of the stabilizer cylinder (**6**). Some of this oil is diverted to the pilot line of check valve 2A (**7**), opening the valve.

Oil from the base end of the stabilizer cylinder flows through check valve 2A (**7**) and through a .030" orifice (**8**). This orifice slows the movement of the frame sway. The oil then flows through solenoid-operated valve 3 (**4**), through port V, to the frame sway spool valve in the main control valve. Oil flows through the valve, dumping the returned oil to the reservoir.

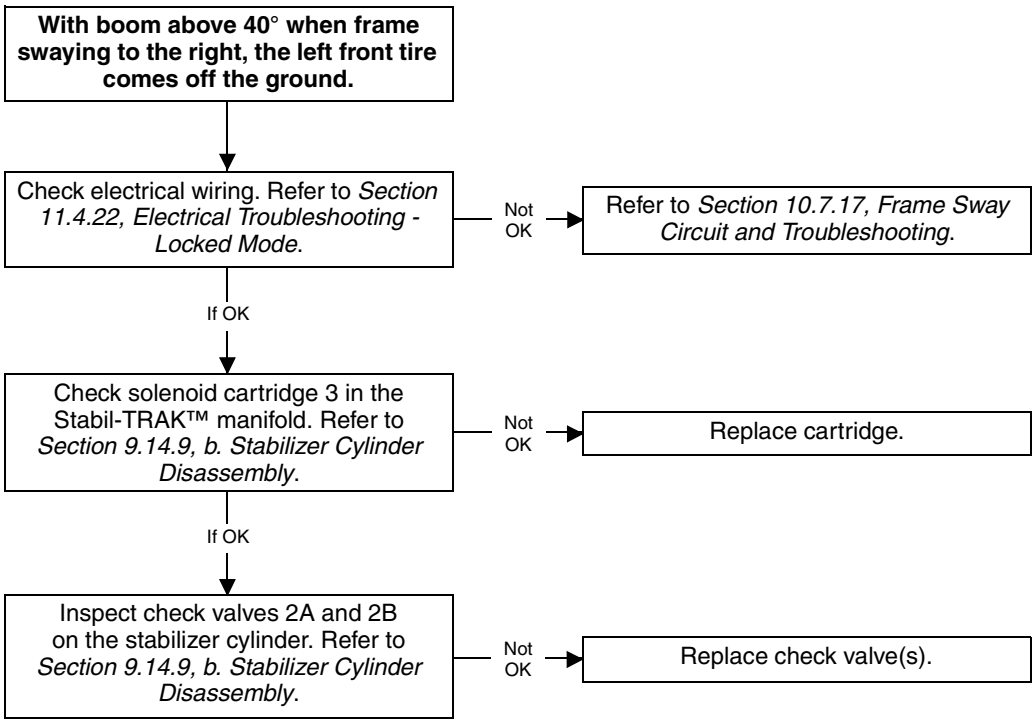
Pressurized oil entering the Stabil-TRAK™ manifold at port P is stopped at the four closed solenoid-operated valves 4A (**9**), 4B (**10**), 12A (**11**), and 12B (**12**). At this time pilot pressure will cause the 100 psi relief valve (**13**) to change position, allowing the excess oil to vent to the reservoir.


TO JOYSTICK "T"
FRAME SWAY CYLINDER
1
2
3
HYDRAULIC RESERVOIR
HYDRAULIC OIL COOLER
PUMP
STABILIZER CYLINDER
G2
G3
FTR
V
4
7
8
2A
2B
5
.030 DIA.
6
11
12B
4B
4A
12A
9
10
12
.060 DIA.
.060 DIA.
100 PSI
13
T
P
G1
STABIL-TRAK™ MANIFOLD
SECONDARY FUNCTION MANIFOLD
PBG
PP PPG PB
ACCUMULATOR CHARGE VALVE
CF PIL EF ACF ACR LS
LSG
P P1 SW DRAIN
TO JOYSTICK "P"
UNLOADER VALVE
VG T
V
SFV LS LSG
P
Pressure
Return
Pilot Pressure
Suction
Load Sense
SOLENOID COIL STATE
DE DE-ENERGIZED
E ENERGIZED
PILOT SELECT MANIFOLD
LFT/LWR
ATTACH
ATTACH
FRAME
EXT/RET
EVEN
ODD
ATTACH TILT
FRAME
LS
LFT/LWR
EXT/RET
MAIN CONTROL VALVE
MM2331

11.4.19 Hydraulic Troubleshooting - Locked Mode, Will Not Frame Sway Right

Conditions:

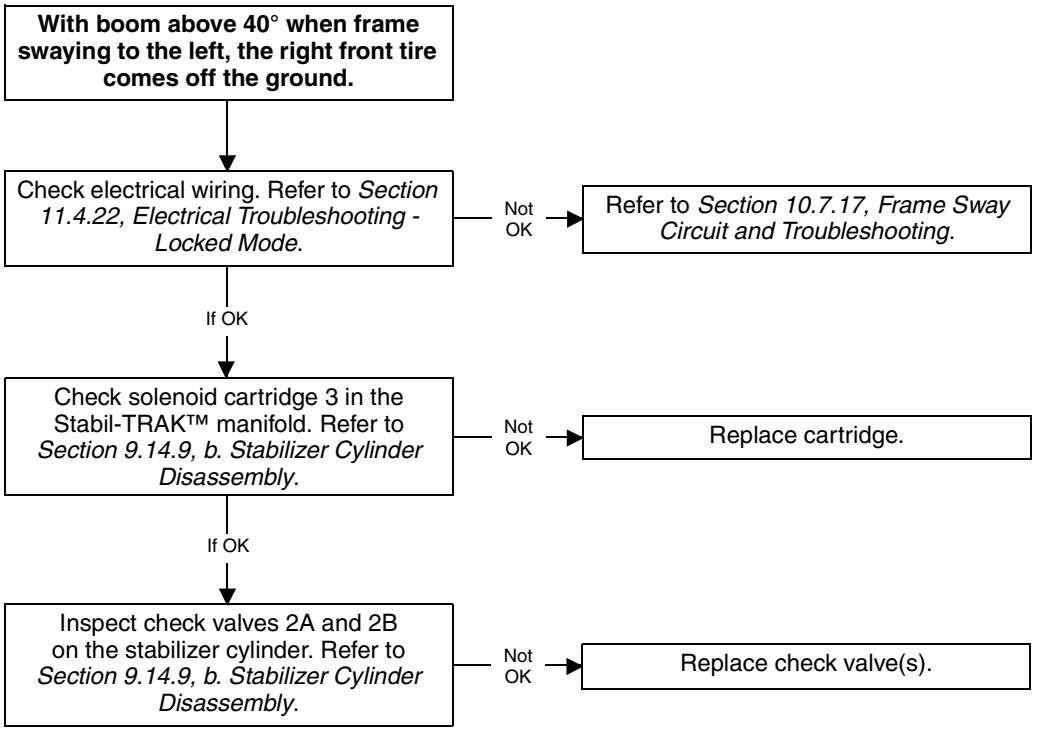
- Ignition ON, engine running
- Boom angle is above 40°
- Travel select lever in [N] NEUTRAL, or park brake ON or service brake ENGAGED



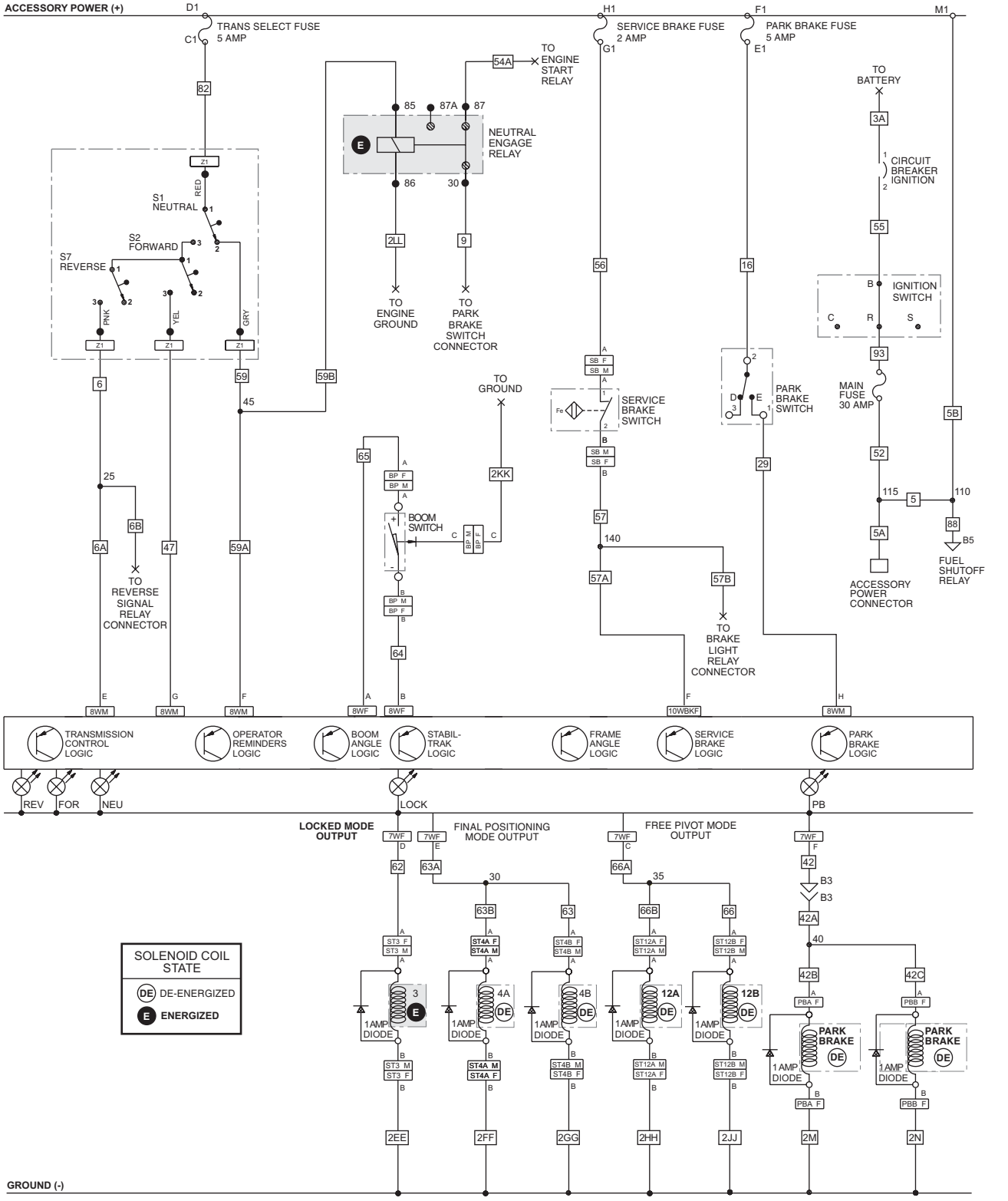
11.4.20 Hydraulic Troubleshooting - Locked Mode, Will Not Frame Sway Left

Conditions:

- Ignition ON, engine running
- Boom angle is above 40°
- Travel select lever in [N] NEUTRAL, or park brake ON or service brake ENGAGED



11.4.21 Electrical Schematic - Locked Mode

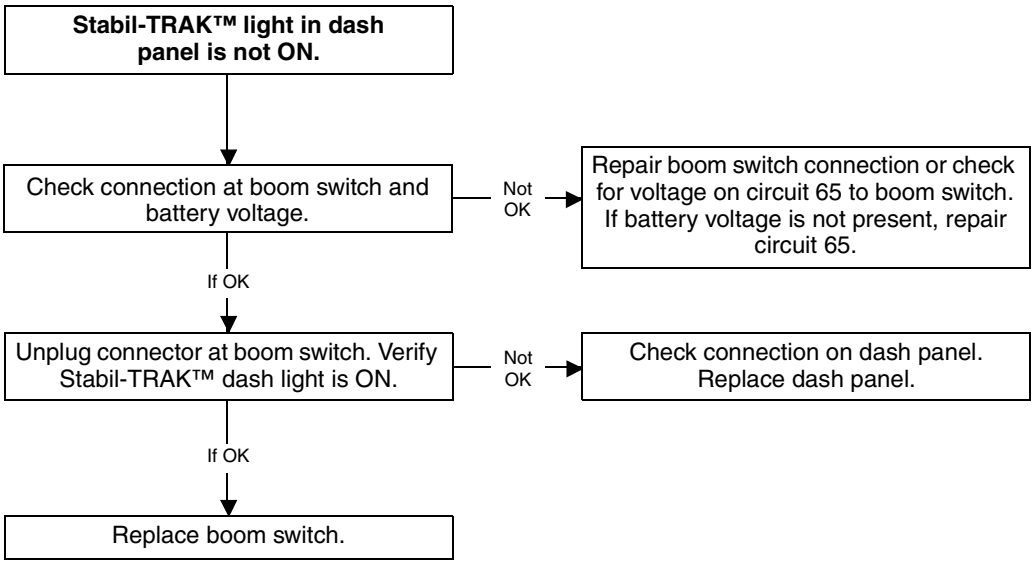


MM2341

11.4.22 Electrical Troubleshooting - Locked Mode

Conditions:

- Ignition ON, engine running
- Boom angle is above 40°
- Travel select lever in [N] NEUTRAL, or park brake ON or service brake ENGAGED



11.5 STABIL-TRAK™ SYSTEM TEST

IMPORTANT: *The operator must know that the Stabil-TRAK™ system is active and functioning properly.*

To test the function of the Stabil-TRAK™ system, read the Stabil-TRAK™ System Test instructions and follow Steps 1 through 9 of *Section 11.5.2, Stabil-TRAK™ System Test Procedures*.

11.5.1 Stabil-TRAK™ System Test Instructions

- Test the Stabil-TRAK™ system with the vehicle on a level surface.
- Remove any attachment from the quick attach before performing the test.
- Perform the test with the boom fully retracted. **DO NOT** extend the boom at any time during the test.
- **DO NOT** raise the boom above 60° for Steps 3-6.
- **DO NOT** raise the boom above 45° for Steps 7-9.
- Follow Steps 1 through 9 of the Stabil-TRAK™ system test procedure exactly as written.

IMPORTANT: *If the Stabil-TRAK™ light goes OFF and the front left tire lowers to the ground at any time during Steps 4* through *7, the test was not performed properly or the Stabil-TRAK™ system is not functioning properly. Carefully repeat the steps starting with Step 1.*

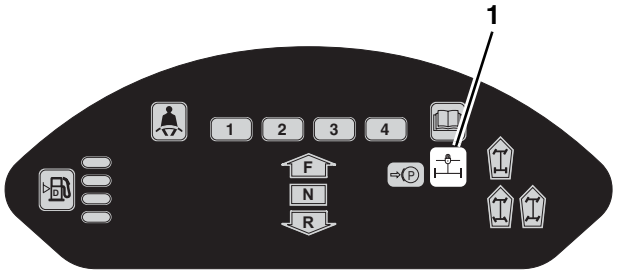
If the Stabil-TRAK™ light goes OFF and the front left tire lowers to the ground consistently during Steps 4 through 7, the Stabil-TRAK™ system is not functioning properly and the test should be stopped immediately. If the Stabil-TRAK™ system is not functioning properly, follow the procedures in *Section 11.4, Stabil-TRAK™ Circuit Operation and Troubleshooting*, to repair the system**.**

> **WARNING:** **DO NOT** operate this vehicle unless you are in the seat with the seat belt fastened around you. Death or serious injury could result if the belt is not securely fastened.

11.5.2 Stabil-TRAK™ System Test Procedures

Step 1:

a. Place the vehicle on a level surface with 0° sway.
b. Have the boom fully retracted and horizontal.
c. Place an 8" (203 mm) wood or cement block in front of the front left tire.
d. Enter the vehicle.
e. Fasten the seat belt.
f. Turn the key to the RUN position.
g. Check to be sure the Stabil-TRAK™ light (**1**) is OFF.



MT27102

Step 2:

a. Start the engine.
b. Turn the parking brake switch OFF.
c. Move the range select lever to [1] FIRST gear.
d. Move the travel select lever to the [F] FORWARD position.
e. Drive the vehicle up on the block.
f. Use the frame sway control to level the vehicle back to 0°.

Step 3:

a. Depress the service brake pedal.
b. Move the travel select lever to the [N] NEUTRAL position.
c. Raise the boom to exactly 60°. The Stabil-TRAK™ light should come ON when the boom angle is at about 40° and remain ON.

Step 4:

a. Use your left foot to depress the service brake pedal.
b. Move the travel select lever to the [R] REVERSE position.
c. Ease your left foot partially off the service brake pedal so that the Stabil-TRAK™ light remains ON.
d. With your right foot, increase the engine rpm slightly, as necessary, just enough to back the vehicle off the block. While backing off the block, the front left tire should remain off the ground.

IMPORTANT: *Perform Steps 5* through *9 with the engine rpm at idle.*

Step 5:

a. Keep the service brake pedal depressed.
b. Move the travel select lever to the [N] NEUTRAL position.
c. Take your foot off the service brake pedal. The Stabil-TRAK™ light should remain ON and the front left tire should remain off the ground.

Step 6:

a. With the travel select lever in the [N] NEUTRAL position, engage the parking brake switch.
b. Move the travel select lever to the [F] FORWARD position. The Stabil-TRAK™ light should remain ON and the front left tire should remain off the ground.

Step 7:

a. With the parking brake switch ON, move the travel select lever to the [N] NEUTRAL position.
b. Lower the boom to exactly 45°.
c. Frame sway the vehicle no more than 5° to the left.
d. Frame sway the vehicle back to 0°.
e. Frame sway the vehicle no more than 5° to the right.

Note: *Observe that frame sway will be slower than normal during this test.*

f. The Stabil-TRAK™ light should remain ON and the front left tire should remain off the ground. The front left tire should not raise or lower during frame sway.
g. Frame sway back toward 0°, leaving the vehicle swayed to the right approximately 1° to 2°.

Step 8:

a. Depress the service brake pedal.
b. Disengage the parking brake switch.
c. With the range select lever in [1] FIRST gear, move the travel select lever to the [R] REVERSE position.
d. Release the service brake pedal to deactivate the Stabil-TRAK™ system.
e. The Stabil-TRAK™ light should go OFF.
f. The front left tire should return to the ground while the vehicle travels in reverse.
g. Depress the service brake pedal to stop the vehicle.

Step 9:

a. With the service brake pedal depressed and the boom angle at exactly 45°, move the range select lever to [3] THIRD gear.
b. Move the travel select lever to [F] FORWARD.
c. Release the service brake pedal to deactivate the Stabil-TRAK™ system. The Stabil-TRAK™ light should go OFF.
d. Slowly drive the vehicle forward against the block to stop the vehicle from moving forward.
e. With the front left tire against the block, frame sway the vehicle no more than 5° to the left.
f. Check that the front left tire remains on the ground. It is normal for the front left tire to raise slightly when swaying to the left, but the tire should immediately lower when the frame sway function is stopped.
g. Frame sway the vehicle back to 0° and pause briefly.
h. Frame sway the vehicle no more than 5° to the right.
i. Check that the front right tire remains on the ground. It is normal for the front right tire to raise slightly when swaying to the right, but the tire should immediately lower when the frame sway function is stopped.
j. Frame sway the vehicle back to 0°.
k. Depress the service brake pedal.
l. Shift the travel select lever to [N] NEUTRAL.
m. Lower the boom.

If Steps 1-9 prove positive, the Stabil-TRAK™ system is functioning properly and the vehicle can be returned to service. If any of these steps indicate that the Stabil-TRAK™ system is not functioning properly, follow the procedures in *Section 11.4, Stabil-TRAK™ Circuit Operation and Troubleshooting*, to repair the system.

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DANGER
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Accident Prevention Tags





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