MANITOU
HANDLING YOUR WORLD

MUSTANG
BY MANITOU

608
708
708T
MLA-6
MLA-7
MLA-T 516

Articulated Loader
Operator's Manual

50940509 Rev. I 04/25

⚠ WARNING

This product can expose you to lead which is known to the State of California to cause cancer and birth defects or other reproductive harm.

For more information go to www.P65Warnings.ca.gov

⚠ WARNING

Breathing diesel engine exhaust exposes you to chemicals known to the state of California to cause cancer and birth defects or other reproductive harm.

- **Always start and operate the engine in a well-ventilated area.**
- **If in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system.**
- **Do not idle the engine except as necessary.**

For more information go to www.P65warnings.ca.gov/diesel.

⚠ WARNING ⚠

THIS OPERATOR'S MANUAL IS PROVIDED FOR OPERATOR USE

DO NOT REMOVE FROM THIS MACHINE

Do not start, operate or work on the machine until you carefully read and thoroughly understand the contents of this Operator's Manual.

Failure to follow safety, operating and maintenance instructions can result in serious injury to the operator or bystanders, poor operation, and costly breakdowns.

If you have any questions on proper operation, adjustment or maintenance of the machine, contact your dealer or the Manitou Group Service Department before starting or continuing operation.

The following warranty applies to machines built after the publication date of this manual. Contact Manitou Service for warranty information for earlier machines.

Effective from 07/01/2024

GENERAL CONDITIONS OF WARRANTY FOR NEW EQUIPMENT and PARTS

NEW EQUIPMENT AND PARTS

MANITOU Group, under MANITOU® and GEHL® brands warrants that its new Equipment (means the machine, its parts and attachments), and Parts (spare part or attachments sold without the Equipment), that are approved and sold by MANITOU Group, are free from any defect (means absence or imperfection of what is delivered) in materials and/or workmanship related to its manufacture for the period defined below.
This Commercial Warranty is activated only through the MANITOU Group's direct commercial partners (Purchasing Customers / Dealers).
During this period, the warranty may be transferred to a third-party customer, subject to the following general conditions. No third party has any authority to make any warranty on behalf of MANITOU Group. Any warranty above and beyond the warranty offered in this General Conditions of Warranty is the sole responsibility of the party offering it.
As used in these General Conditions of Warranty, "*MANITOU Group*" refers to the Manitou entity that sold the Equipment or Parts, including Manitou BF and/or any of its subsidiaries, as the case may be.
MANITOU Group warranty requires full compliance with the instructions contained in the User/Operator's Manual of the Equipment or Parts

WARRANTY PERIOD

	Whichever comes first	As of
STANDARD CONNECTED MACHINES [1]	**24 (Twenty-four) MONTHS or 2000 (Two Thousand) HOURS**	The date of Registration[2] of the Equipment
NOT CONNECTED MACHINES	**12 (Twelve) MONTHS or 2000 (Two Thousand) HOURS**	
ELECTRIC-POWERED EQUIPMENT[3][4]: TRACTION LITHIUM BATTERY Capacity Including Battery SOH (State of Health)[5]	**5 (Five) YEARS or 3 000 (Three Thousand) HOURS**	
PARTS	**6 (Six) MONTHS from the assembly of the Part on the Equipment OR 12 (Twelve) MONTHS from the date of invoicing of the Part by MANITOU Group**	

[1] provided that all of the following conditions are met: 1- the Equipment is equipped as standard with a communication system integrated in the Connected Machine allowing data transmission; 2- a Subscription Agreement is duly signed on the day of the Commissioning of the Equipment and such Subscription Agreement is still in force at the time the warranty claim is made.

[2] "*Registration*" means the first start-up carried out at the customer's premises, at the end of which the end-customer shall acknowledge that the delivered Equipment conforms to the order, is in perfect working order and presentation condition, and that the User/Operator's Manual and the safety instructions have been received. The commissioning order must be signed/accepted by the customer.

[3] The warranty is specifically associated with the serial number of the battery integrated into the Equipment Registered.

[4] Excluding Warehousing range

[5] State Of Health : The Battery Capacity Warranty covers gradual capacity losses of the battery once it falls below 70% State of Health.

Warranty repairs or replacements made will not extend the warranty period.

THE WARRANTY COVERS

The costs, in accordance with the rates defined by MANITOU Group, of:

- **The repair of defective parts sold by MANITOU Group or their replacement with Parts sold by MANITOU Group** (repair is preferred to replacement, replacement covered if economically/ ecologically justified and replacement with REMAN manufactured parts is preferred over new parts) -

For ELECTRIC-POWERED EQUIPMENT: TRACTION LITHIUM BATTERY : during the first two years, the battery will be replaced with a new one only if repair is impossible. After the first two years, and till the end of the warranty period, the battery will be replaced with a battery having between 90% and 70% of SOH level (at least equivalent to what the defective battery should have had at the time of the defect).

- **Labor for dismantling and reassembly.**

All other costs, including diagnostic costs, transport, towing, customs and taxes, are excluded.

For the application of the warranty, MANITOU Group reserves the right to base its decision on the results of additional analyses, such as extractions of data (including data from MANITOU Group Services or Equipment)s, serial number records, oil, fluid or fuel analyses, etc.
For ELECTRIC-POWERED EQUIPMENT: TRACTION LITHIUM BATTERY, decision is based on battery health status, battery mileage, energy provided by the battery, and, when necessary, technical battery usage data necessary for recalculating its health status.

Only qualified, and trained personnel (with specific licensed tools) from the MANITOU Group's business partners are authorized to perform warranty service.

THE WARRANTY DOES NOT COVER

Repairs / interventions / deteriorations / damage caused by or arising from:

GENERAL CONDITIONS OF WARRANTY FOR NEW EQUIPMENT and PARTS

- Misuse, misapplication, improper storage, or failure to operate the Equipment or Parts in accordance with the User/Operator's Manual and other MANITOU Group policies referred to therein (including recommended maintenance and servicing) ;
- Modifications to the Equipment or Parts, including its safety and software systems, not expressly authorized by MANITOU Group ;
- Failure to comply with good practices and state of art ;
- The use of unauthorized accessories ;
- The use of parts, fluids, or components other than those expressly authorized by MANITOU Group ;
- An accident, vandalism, fire, negligence, or other circumstances outside the control of MANITOU Group, including a climactic event or natural disaster ;
- An unfavorable environment (e.g., chemicals, dust, salt, corrosion, or erosion...) ;
- Maintenance or repair services performed by a party that is not authorized by MANITOU Group and/or by persons not trained by MANITOU Group ;
- Parts which are guaranteed directly by the manufacturers and/or their representatives. In such a case, the manufacturer must be contacted directly.
- Improper handling, packaging, or shipping.

The costs of regular maintenance and servicing, as well as normal wear and tear parts related to the use and number of hours of the Equipment and the ingredients, are not covered by this warranty, including, but not limited to:
- Bulbs, fuses, spark plugs, brake linings and discs, clutch system, belts, tires, paint, screen wiper blades, jib pads, polyurethane wheels, and quick couplers, etc.;
- Oils, brake fluid, cooling fluid, ice washing fluid, grease, etc.;
- Parts related to the maintenance of the Equipment (e.g., oil, air, fuel, particle filters, etc.) and parts with abnormal degradation;
- Adjustments, periodic servicing, fuel circuit cleaning, filter maintenance, etc.;

The extended warranty granted on a "commercial" basis by MANITOU Group is not an acknowledgement of liability.

MANITOU Group shall not be held liable for any direct or indirect damage resulting from the performance of its obligations under this warranty - including the consequences of immobilization of the Equipment during the warranty period - such as machine rental, financial losses, production losses, operating loss, loss of profit, commitment of the buyer to third parties).
MANITOU Group MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED (INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE), EXCEPT AS EXPRESSLY STATED IN THIS GENERAL CONDITIONS OF WARRANTY.
ANY OF THESE LIMITATIONS EXCLUDED BY LOCAL LAW SHALL BE DEEMED DELETED FROM THIS WARRANTY; ALL OTHER TERMS WILL CONTINUE TO APPLY. SOME LAWS DO NOT PERMIT THE EXCLUSION OR LIMITATION OF THESE WARRANTIES AND THE BUYER MAY HAVE GREATER RIGHTS UNDER THESE POLICY LAWS.

The conditions of application are more precisely defined in the Warranty Manual.

Only General Conditions of Warranty written in French or English are binding. The other languages are only courtesy versions.
The General Conditions of Warranty are governed by the law defined in the General Conditions of Sales of the Equipment or the Part.

The foregoing supersedes all prior versions of the General Conditions of Warranty.

MANITOU Group reserves the right to modify the terms and conditions herein at any time.

Delivery Checklists

The following checklist is an important reminder of valuable information and inspections that MUST be made before delivering the machine to the customer. Check off each item after the action is taken.

PRE-DELIVERY CHECK:

Machine has not been damaged in shipment. Check for dents and loose or missing parts. Correct or replace components as required.

- ❑ Battery is securely mounted and not cracked. Cable connections are tight.
- ❑ Cylinders, hoses, and fittings are not damaged, leaking, or loosely connected.
- ❑ Cooler/radiator hoses and fittings are not damaged, leaking, or loosely connected.
- ❑ Filters are not damaged, leaking, or loosely secured.

Wheel bolts/nuts are properly torqued according to the information in Wheels/Tires on page 60.

Tires are properly inflated according to the tire manufacturer specifications.

Machine is properly lubricated and no grease fittings are missing or damaged.

Hydraulic system reservoir, engine crankcase, and drive gearcases are filled to their proper levels.

Engine radiator is filled to proper level and has proper anti-freeze protection.

All adjustments are made to comply with settings provided in the Maintenance section, starting on page 161.

All guards, shields, and decals are in place and secured.

Model and serial numbers for the machine are recorded in the spaces provided on this page.

IMPORTANT

Start the engine and test run the machine while checking that all controls operate properly.

All drive and hydraulic controls operate properly and are not damaged or binding.

Drive controls are properly adjusted for correct neutral position.

Operate the hydraulics transport lock-out button and make sure it properly disables the lift structure hydraulics.

Verify the drive hydraulics are disabled when the parking brake is engaged.

All instrument panel gauges, indicator lights, etc. function properly.

All installed lights (work/road lights) function properly.

Hydraloc™ system functions properly as described in the Operator's Manual.

I acknowledge the pre-delivery procedures were performed on the machine as outlined on this page.

_____
Dealership's Name

_____
Dealer Representative's Name

_____
Date Checklist Filled Out

_____
Model & Serial Number

_____
Engine Serial Number

AT DELIVERY CHECK:

The following checklist is an important reminder of valuable information that MUST be passed on to the customer at the time of delivery. Check off each item as you explain it to the customer. Review with the customer the contents of this Operator's Manual, especially:

The Index for quickly locating topics.

The Safety and Operation chapters for information regarding safe operation of the machine.

The Maintenance and Troubleshooting chapters for information regarding proper maintenance of the machine. Explain that regular lubrication and maintenance are required for continued safe operation and long machine life.

A copy of the product warranty is included on the inside front cover of this Operator's Manual.

Give this Operator's Manual and the AEM Safety Manual to the customer, and instruct the customer to read and completely understand the content of each manual before operating the machine.

Explain that the customer must consult the engine manual (if provided) for related specifications, operating adjustments, and maintenance instructions.

Completely fill out the Owner's Registration, including customer's signature, and return it to the company.

_____
Customer's Signature

_____
Date Delivered

RETAIN FOR CUSTOMER'S RECORDS

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Remove dealer's file copy at this line.

The following checklist is an important reminder of valuable information and inspections that MUST be made before delivering the machine to the customer. Check off each item after the action is taken.

PRE-DELIVERY CHECK:

Machine has not been damaged in shipment. Check for dents and loose or missing parts. Correct or replace components as required.

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Start the engine and test run the machine while checking that all controls operate properly.

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Drive controls are properly adjusted for correct neutral position.

Operate the hydraulics transport lock-out button and make sure it properly disables the lift structure hydraulics.

Verify the drive hydraulics are disabled when the parking brake is engaged.

All instrument panel gauges, indicator lights, etc. function properly.

All installed lights (work/road lights) function properly.

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Model & Serial Number

_____
Engine Serial Number

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The Safety and Operation chapters for information regarding safe operation of the machine.

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_____
Customer's Signature

_____
Date Delivered

RETAIN FOR DEALER'S RECORDS

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Table of Contents

NOTES

Introduction

Safety Symbol

Manitou Group, in cooperation with the Society of Automotive Engineers, has adopted this:

Safety Alert Symbol

This symbol identifies potential safety hazards, which, if not properly avoided, could result in injury. When you see this symbol in this manual or on the machine, you are reminded to BE ALERT! Your personal safety is involved!

Legal Notices

Software IP

Any extraction, decompilation, modification, duplication, or distribution of onboard software is strictly prohibited. Manitou shall have no liability for and hereby disclaims all direct and indirect liability for the consequences resulting from the use of any prohibited onboard software. Contact MANITOU for any request to correct or adapt onboard software for the purposes of interoperability.

Data Privacy

Manitou connected machines are equipped with boxes that collect technical data concerning the machines (such as geolocation, operating, and component data). This data, which is organized, processed, and enriched by Manitou's own algorithms and knowledge, constitutes a protected database in accordance with Article L.341-1 of the French Intellectual Property Code.

It is strictly forbidden to access all or part of this database or to use this data (whether or not intentional) without Manitou's express authorization. In the event that Manitou authorizes an individual to access all or part of this database, Manitou, as producer of this database, only grants the user a personal, non-exclusive, and non-transferrable right to use the database, and only via access to a computer platform hosted on a server owned or controlled by Manitou.

In any case, the following activities are strictly prohibited:

- any extraction, reproduction, representation, reuse by making available to the public, diffusion, or transfer, whether permanent or temporary, on any support, and by any means and in any form whatsoever, of all or a qualitatively or quantitatively substantial part of the contents of the database,
- any extraction, reproduction, representation, reuse by making available to the public, diffusion, transfer, or repeated and systematic extraction of qualitatively or quantitatively insubstantial parts of the contents of the database when these operations clearly exceed the conditions of normal use of the database by the user of the machine for his or her own needs,
- any use of a means of circumventing technical measures for the protection of databases or the source code of the software embedded in the boxes, in accordance with Article L.331-5 of the Intellectual Property Code.

In the event that the above measures are absolutely essential to enable the use of the software, in accordance with its intended purpose, or to obtain the information necessary for interoperability with other independently created software, the user must first contact Manitou, which may, at its sole discretion, take necessary measures or provide access to only the information strictly necessary for interoperability.

Contents and Use of this Manual

This Operator's Manual provides information about the safe and proper operation and maintenance for the machine. Major points of safe operation and maintenance are detailed in the *Safety* chapter of this manual.

This manual also includes general troubleshooting and specification information about the machine.

Follow the instructions in the *Safety*, *Operation*, and *Maintenance* chapters concerning accident prevention regulations, safety and occupational regulations, and machine and traffic regulations. Manitou Group is not liable for damage resulting from the failure to follow these regulations.

⚠ CAUTION

Improper operation, inspection, and maintenance of the machine can cause injury or death. Read and understand the contents of this manual COMPLETELY and become familiar with the machine before operating it.

It is the owner's or employer's responsibility to fully instruct each operator in the proper and safe operation and maintenance of the machine.

A storage location is provided behind the operator's seat for storing the Operator's Manual. After using the manual, return it to the storage container.

The Operator's Manual is considered a permanent part of the machine and should be with the machine at all times. If the machine is resold, include this operator's manual as part of the sale.

Replace the Operator's Manual promptly if it becomes damaged, lost, or stolen.

Some illustrations in this manual may show doors, guards and shields open or removed for illustrative purposes only. BE SURE all doors, guards and shields are in their proper operating positions BEFORE starting the engine to operate the machine.

Because of ongoing product improvements, information included in this manual may not exactly match the machine. Manitou Group reserves the right to modify and improve products at any time without notice or obligation.

Safety Symbol and Signal Words

This manual and decals on the machine warn of safety hazards and should be read and observed closely.

Manitou Group, in cooperation with the Society of Automotive Engineers, has adopted this:

Safety Alert Symbol

This symbol is used throughout this operator's manual and on the decals on the machine. It identifies potential safety hazards, which, if not properly avoided, could result in injury. When you see this symbol in this manual or on the machine, you are reminded to BE ALERT! Personal safety is involved!

Signal Words

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

The word "CAUTION" indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury.

IMPORTANT: *The word "IMPORTANT" indicates situations that can result in possible damage to the machine.*

NOTE: *The word "NOTE" indicates special or particularly useful information.*

Machine Orientation

"Right" and "left", as described in this manual, are determined from a position sitting in the operator's seat and facing forward.

Proper Machine Use

⚠ WARNING

Improper use of the machine can result in property damage, injury or death.

The machine is designed only for digging, picking up, raising, transporting, and unloading materials. Approved attachments use is also allowed (see "Attachments" on page 16). Using the machine in any other way is considered contrary to the intended use. Compliance with, and strict adherence to, the conditions of operation, service, and repair as specified by the manufacturer, also constitute essential elements of the intended use.

The machine was designed and built according to the best available technology and approved safety regulations in the countries where it is sold. However, it is impossible to completely safeguard against abusive, improper use. The operator must always consider potential safety risks and hazards during operation. Accident prevention regulations, all road traffic regulations, and all other generally recognized safety and occupational medicine regulations must be observed at all times.

The machine must be maintained in proper operating condition. Any damaged or malfunctioning parts must be repaired or replaced immediately.

Any arbitrary modification carried out to the machine may relieve the manufacturer of liability for any resulting damage or injury.

Service and Registration

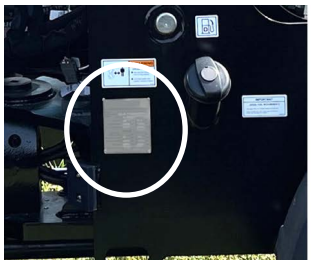
The wide Manitou dealership network stands ready to provide any assistance that may be required, including genuine service parts. All parts should be obtained from or ordered through your dealer.

When ordering service parts, provide complete information about the part and the quantity required. Also provide the model and serial numbers of the machine. For your safety and continued proper operation, use only genuine service parts. Record the model and serial numbers in the spaces below for quick reference.

Machine Model and Serial Numbers

Machine Model Number:_____

Machine Serial Number:_____

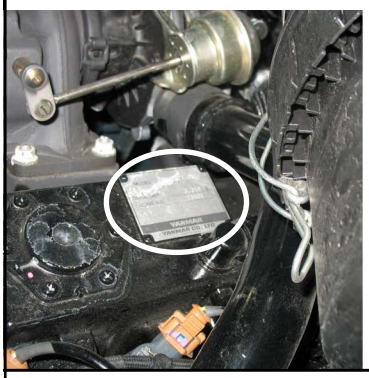


LATER MACHINES: Model/Serial Number Plate
(Located on right side of front chassis)

EARLY MACHINES: Model/Serial Number Plate
(Located on left side of front chassis)

Component Serial Numbers

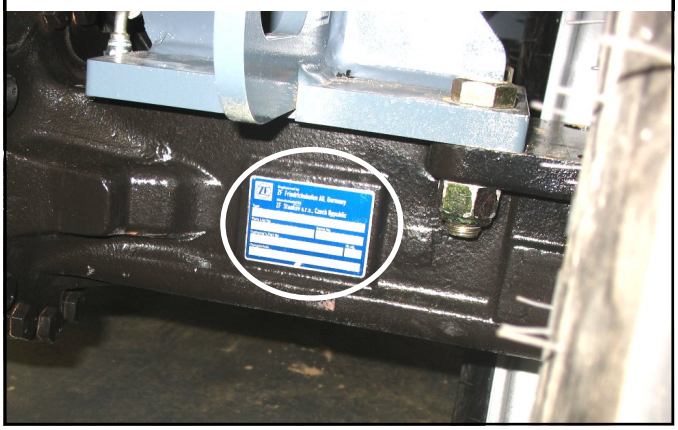
Engine Serial Number:_____

Yanmar Engines	Deutz Engines (Tier 4 Shown; others similar)
	

Hydraulic Pump
Serial Number:_____

Front Axle
Serial Number:_____

Rear Axle
Serial Number:_____



Component Identification

Non-telescopic Machines

Item	Description
A	Lift Cylinder
B	Tilt Cylinder
C	Fuel Filler
D	Steering Wheel
E	Tie-Down Points
F	Operator's Seat
G	Lift Structure

Item	Description
H	Multi-Function Joystick
I	Parking Brake Lever
J	Steering Lock Bar
K	Lift Structure Support
L	Engine Cover
M	Rear Position/Hazard Lights
N	Seat Plate (according to ISO 7096)

Telescopic Machines

Item	Description
A	Lift Cylinder
B	Extension Cylinder
C	Fuel Filler
D	Steering Wheel
E	Tie-Down Points
F	Operator's Seat
G	Telescopic Lift Structure

Item	Description
H	Multi-Function Joystick
I	Parking Brake Lever
J	Steering Lock Bar
K	Engine Cover
L	Rear Position/Hazard Lights
M	Seat Plate (according to ISO 7096)
N	Auxiliary Hydraulics Connections

Early/Later Series Telescopic Machines Identification

Areas throughout this manual refer to “Early Series” and “Later Series” telescopic machines.

The “Early” and “Later” series telescopic machines differ in some important ways.

Use the information in this section to positively identify between the “Early” and “Later” telescopic machines.

Counterbalance Valve (Later Series Telescopic Machines Only)

- Later Series telescopic machines are equipped with a counterbalance valve (V, Fig. 1).

  NOTE: *The counterbalance valve is located on the left at the top back of the lift structure, at the base end of the lift structure extend cylinder.*

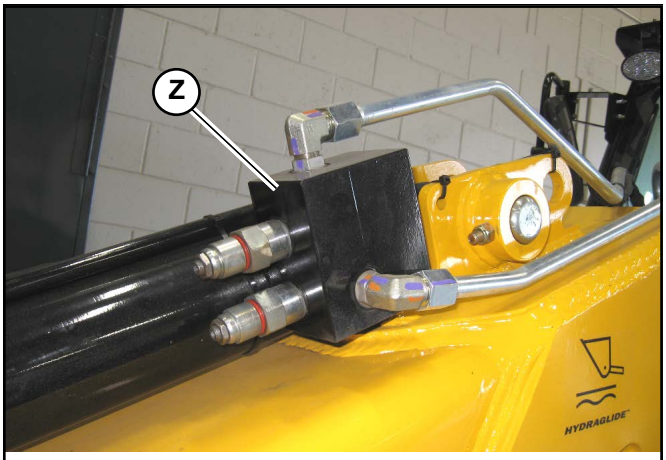


Fig. 1 – Counterbalance Valve (Later Series Telescopic Machines

- Early Series telescopic machines do not have a counterbalance valve (Fig. 2).

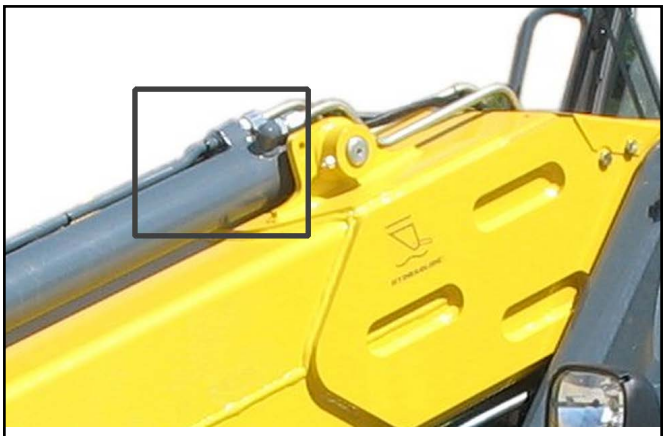


Fig. 2 – No Counterbalance Valve (Early Series Telescopic Machines

Attachments

Table 1: Attachments

Attachments	Model	Width	Height	Depth	Capacity[a]
Dirt / Construction Bucket	600 Series	1676 mm[b] (66 in.)	709 mm (27.9 in.)	909 mm (35.8 in.)	0.57 m^3 (0.75 $yds.^3$)
	600 Series 700 Series	1880 mm (74 in.)	780 mm (30.7 in.)	975 mm (38.4 in.)	0.76 m^3 (1.00 $yds.^3$)
		2133 mm[c] (84 in.)	709 mm (27.9 in.)	909 mm (35.8 in.)	0.76 m^3 (1.00 $yds.^3$)
U/T Bucket	600 Series 700 Series	2133 mm (84 in.)	871 mm (34.3 in.)	1125 mm (44.3 in.)	1.15 m^3 (1.50 $yds.^3$)
	700 Series	2286 mm (90 in.)	937 mm (36.9 in.)	1252 mm (49.3 in.)	1.53 m^3 (2.00 $yds.^3$)
Light Material Bucket	600 Series 700 Series	2134 mm (84 in.)	874 mm (34.4 in.)	1222 mm (48.1 in.)	1.28 m^3 (1.67 $yds.^3$)
Pallet Forks	600 Series 700 Series	N/A	N/A	1067 mm (42 in.)	N/A
		N/A	N/A	1219 mm (48 in.)	N/A

a. To determine load weights, multiply maximum material density by bucket capacity. Refer to “Common Materials and Densities” on page 63.
b. 600 Series bucket used for rated capacity testing.
c. 700 Series bucket used for rated capacity testing.

The attachments determine how the machine is used.

⚠ WARNING

Use of unapproved attachments could result in serious injury or property damage.

Contact Edge Attachments (http://www.edgeattach.com/) before using attachments or equipment not approved by Manitou Group. Use of non-approved attachments or unauthorized modifications is prohibited.

Do not use the machine for any applications or purposes other than those described in this manual or manuals supplied with attachments. Contact your dealer before using attachments or equipment not approved by Manitou Group. Use of non-approved attachments or unauthorized modifications is prohibited.

Using Attachments

Read all documentation provided with attachments to learn how to safely operate and maintain them.

Vibration Information

Compact construction equipment is generally used in harsh environments. This type of usage can expose an operator to uncomfortable levels of vibration. It is useful to understand exposure to vibration levels when operating compact equipment and what can be done to reduce vibration exposure. As a result, equipment operation can be more efficient, productive, and safe.

An operator's exposure to vibration occurs in two ways:

- Whole-Body Vibration (WBV)
- Hand-Arm Vibration (HAV)

WBV issues are primarily addressed in this manual because evaluations have shown that operation of mobile compact construction equipment on work sites typically results in HAV levels less than the allowed exposure limit of 2.5 m/s2. Member States of the European Union must comply with the Physical Agents (vibration) Directive, 2002/44/EC.

Effective control of vibration exposure for an operator involves more than just vibration levels on the machine. The work site, how the machine is used, and proper training all play important roles in reducing vibration exposure.

Vibration exposure results from:

- Work site conditions.
- How the machine is operated.
- The machine characteristics.

Common causes of high WBV levels:

- Using a machine that is improper for the task.
- Work site with potholes, ruts, and debris.
- Improper operating techniques, such as driving too fast.
- Incorrect adjustment of the seat and controls.
- Other physical activities while using the machine.

Vibration Measurement and Actions

The vibration directive places the responsibility for compliance on employers. Actions that should be followed by employers include:

- Assess the levels of vibration exposure.
- Determine from this assessment if operators will be exposed to vibration levels above the limits stated in the directive.
- Take appropriate actions to reduce operator's exposure to vibration.
- Provide operators with information and training to reduce their exposure to vibration.
- Keep good records and update operations and training on a regular basis.

If the assessment concludes that vibration level exposure is too high, one or more of the following actions may be necessary:

1. Train operators:
   - Perform operations (accelerating, steering, braking, etc.) in a smooth manner.
   - Adjust the controls, mirrors, and seat suspension for comfortable operation. Do not make adjustments when the machine is in use.
   - Travel across the smoothest parts of the work site and avoid ruts and potholes.

2. Choose proper equipment for the job:
    - Use machines with the proper power and capacity.
    - Select machines with good suspension seats.
    - Look for controls that are easy to use.
    - Ensure good visibility from the operator's position.
3. Maintain the work site:
    - Smooth ruts and fill potholes in traffic areas whenever possible.
    - Clean up debris frequently.
    - Vary traffic patterns to avoid exposure to rough terrain.
4. Maintain equipment. Check that seat suspension and all controls work smoothly and properly.

Vibration Levels

See "Vibration Levels" on page 62 for a table listing typical whole-body vibration levels for the machine.

Fire Extinguisher

An installation location for a fire extinguisher is on the shelf behind the operator's seat (Z, Fig. 3) on the left.

IMPORTANT: *Installation of a fire extinguisher according to DIN-EN 3 must be performed by an authorized dealer.*

IMPORTANT: *Inspect the fire extinguisher at regular intervals as recommended by the fire extinguisher equipment manufacturer(s).*

Fig. 3 – Location for Fire Extinguisher

NOTE: *A fire extinguisher is neither included as standard equipment nor available as an option from Manitou Group.*

Manufacturer Information

Products described in this manual are manufactured by Manitou Group

NOTE: *Not all models and options described in this manual are available in all areas.*

Indicator and Operation Symbols

Table 2: Indicator and Operation Symbols

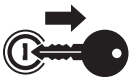
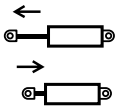
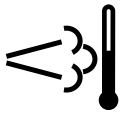
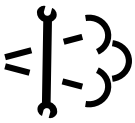
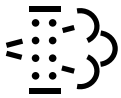
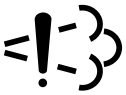
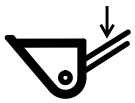
 Safety Hazard	 Safety Hazard	 Hydraulic Oil Filter	 Fast Speed	 Slow Speed	 Hydraulic Oil	 Hydraglide™
 Engine Start	 Engine Stop	 Engine Run	 Wear Seat Belt	 Hydraulic Pressure Relief	 Service Hours	 Engine Oil Pressure
 Remove Key	 Crush Hazard	 Road Lights/High Beam	 Crush Hazard	 Hot Surface Hazard	 Rotating Fan — Keep Away	 Safety Lock
 Read Operator's Manual	 Parking Brake	 Windshield Wiper/ Washer	 Diesel Fuel	 Fan	 Auxiliary Hydraulics Flow	 Work Lights
 Lift Structure Float	 Drive System Error	 Pre-Heat	 Engine Coolant Temp	 Engine Air Filter	 Horn	 Tie-Down Point
 Critical Error	 Engine Error Code	 Elevated EGT Temp	 DPF Regen Accept	 DPF Regen Cancel/Inhibit	 DPF Service	 DPF Regen
 Engine Emissions Error Code	 Lift Point	 Windshield Wiper	 Charging Fault	 Fuel Level	 Engine Power	 Temperature
 Hydraulic Oil Temp. Warning	 Engine Oil	 Road Lights/Low Beam	 Differential Lock	 Fuel Filter	 Hitch Lock	 Hitch Unlock

Table 2: Indicator and Operation Symbols

 Engine RPM	 Fuel Consumption	 Constant Speed	 Beacon	 Electrical Auxiliary Power	 Engine Off Lift Structure Lower	 30 kph (3-Speed)
 Lift Structure Float Detent Lock Disable	 Audible Alert	 Secondary Auxiliary Hydraulics				

Safety

Safety Symbol and Signal Words

The manuals and decals on the machine warn of safety hazards. Read and closely follow the information on these decals.

Manitou Group, in cooperation with the Society of Automotive Engineers, has adopted this:

Safety Alert Symbol

Be alert when you see the Safety Alert Symbol in the manuals and in or on the machine. The Safety Alert Symbol identifies potential safety hazards, which, if not properly avoided, could result in injury or death.

Signal Words

DANGER

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

WARNING

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

CAUTION

The word "CAUTION" indicates a potentially hazardous situation that, if not avoided, may result in injury or machine damage.

- Before operating or working on the machine, you must first read and understand the related safety information. The warnings and instructions must be provided to operators in a language they can read and understand.
- Before operating the machine, the operator must read and understand the related operating information and use the correct operating procedures. Complete safety information should be presented to all new operators regardless of previous experience. Make sure to comply with any local rules/laws which require certification before operating the machine.
- Operators must not be physically or mentally impaired or under the influence of drugs or alcohol. It is recommended that the operator be capable of obtaining a valid motor vehicle operator's license. Do not allow minors or unqualified persons to operate the machine, or to be near the machine unless they are properly supervised.
- Do not use the machine for any applications or purposes other than those described in the Operator's Manual, or in manuals supplied with any attachments used with the machine.
- Use of the machine is subject to certain hazards that cannot be eliminated by mechanical means, and these require the operator to use intelligence, care, and common sense. Examples of such hazards include, but are not limited to: hillside operation, overloading, load instability, poor maintenance, operating too fast for conditions, and use of the machine for a purpose for which it was not intended or designed.
- Manitou Group always considers operator's safety during the design process. Guards and shields are provided to protect the operator and bystanders from moving parts and other hazards. Operators must be alert, however, because some areas cannot be guarded or shielded without preventing or interfering with proper operation.

- Certain uses of the machine may require additional safety equipment. Users must examine the worksite for hazards and provide safety equipment as required to protect against those hazards.
- The information in this manual does not replace any applicable safety rules and laws. Before operating the machine, learn the rules and laws for the local area. Make sure the machine is equipped as required according to these rules/laws.
- Remember that some health risks may not be immediately apparent. Exhaust gases and noise pollution may not be visible, but these hazards can cause permanent injuries.
- Photographs and illustrations in this document may show doors, guards, shields, and panels open or removed for informational purposes. Make sure all doors, guards, shields, and panels are attached in the correct operating positions before operating the machine.

Mandatory Safety Shutdown Procedure

BEFORE cleaning, adjusting, lubricating, fueling, or servicing the machine, or leaving it unattended:

1. Bring the machine to a complete stop on a level surface. If the machine must be parked on a slope, park across the slope and chock the wheels to prevent movement.
2. Be sure all working equipment and/or attachments are stopped and the auxiliary hydraulics valve is in neutral.
3. On telescopic machines, retract the lift structure.
4. Empty the attachment. Lower the lift structure and the attachment to the ground. If the lift structure must be left in the raised position, make sure it is properly supported.
5. Place the forward/reverse drive switch (on top of the joystick) into the neutral position.
6. Apply the parking brake.
7. Move the throttle to the low-idle position and allow the engine to cool.
8. Shut off the engine. Make sure that parts have stopped moving before continuing.
9. Turn the ignition key to the ON/RUN position and move the joystick in all directions to verify the hydraulic system is de-pressurized.
10. Press the auxiliary hydraulics pressure relief switch to relieve pressure in the auxiliary hydraulics circuit.
11. Turn off the ignition.
12. Unfasten the seat belt, remove the ignition key, and take it with you. Exit the machine using the hand-holds and steps.
13. Allow at least 2 minutes after turning off the ignition before disconnecting the battery or turning off the battery disconnect switch. Battery power is needed for computer/system maintenance functions which continue after the ignition is turned off.
14. Always turn off the battery disconnect switch when parking the machine inside an enclosure.

ONLY when these precautions have been taken can you be sure it is safe to proceed. Failure to follow this procedure could result in death or serious injury.

Before Starting

- Unless specifically instructed for Manitou Group-approved service, do not remove or modify the Roll-Over Protective Structure/Falling Object Protective Structure (ROPS/FOPS). Unauthorized modifications such as welding, drilling or cutting, can cause the ROPS/FOPS to fail and increases the risk of injury or death. A damaged ROPS/FOPS cannot be repaired and must be replaced.
- Do not make unauthorized modifications to any part of the machine. Unauthorized modifications to the machine can cause injury or death. The owner is responsible for any safety hazards resulting from unauthorized modifications.

- Manitou Group equipment is designed and intended to be used only with approved attachments. To avoid possible personal injury, equipment damage, and performance problems, use only approved attachments that are within the rated capacity of the machine (see “Payloads/ Capacities” on page 51). Manitou Group cannot be responsible if the machine is used with non-approved attachments. Custom attachments are not supported, recommended, or warranted by Manitou Group for reliability or safety. Contact your dealer or Manitou Group for attachment approval and compatibility information.
- Optional kits are available through your dealer. Please contact Manitou Group for information on attachment compatibility with optional kits.
- Before using the machine, perform a walk-around inspection. Look for damage, loose or missing parts, leaks, and other problems. Fix/ repair any problem as required before using the machine.
- Inspect the machine for trash and debris before use. Clean the machine as required. Trash, debris, or any other materials can obstruct machine operation and can be a fire hazard.
- Keep the operator’s area, steps, platforms, and hand-holds clean and free of oil, dirt, ice, and unsecured objects.
- Walk around the machine and warn any nearby persons before starting the machine. Do not start the machine until all persons are clearly away from it.
- Check for proper tire pressure in all tires before operating the machine and adjust it if necessary. Improperly and/or unevenly inflated tires adversely affect machine stability.
- Check the tires for damage, deep cuts, abrasions and gouges in the wear surface and sidewalls that may affect tire performance. Do not operate the machine if the tires are worn past their service life.
- Check that the wheel fasteners are properly tightened. Properly torque the wheel fasteners if necessary. See “Wheels and Tires” on page 198.
- Know what is underneath the work site before starting to dig. Contact the proper local authorities for utility line locations BEFORE starting to dig. In North America, contact the North American One-Call Referral System at 8-1-1 in the U.S., or 1-888-258-0808 in the U.S. and Canada. Below-ground hazards also include water mains, tunnels and buried foundations.
- Work crew members should observe and monitor terrain and soil conditions at the job site, along with traffic, weather-related hazards, and any above- or below-ground obstacles or hazards:
  - Always check the job site for terrain, above- and below-ground hazards and obstructions, such as water mains, tunnels, and buried foundations
  - Keep bystanders out of, and away from, the work area. Anyone near the machine is at risk of being injured
  - Remove all objects from the worksite as required.
- Before working near power lines (above and/or below ground), contact your power utility and make a safety plan.
- Be cautious of dark and wet patches when working or traveling over frozen ground, especially if the temperature is changing.
- Use caution around excavations and/or ditches. Be sure the surface can support the machine and load. Be sure the surrounding ground has adequate strength to support the weight of the machine and the load.
- Use caution on loose ground. Working with heavy loads over loose, soft ground or uneven terrain could cause the machine to tip and could lead to death or serious injury.
- Make sure any installed lighting system is operating properly before using the machine.
- Always keep windows, lights, and mirrors clean. Poor visibility can cause accidents.
- Do not use the machine or start the engine if there is any indication that maintenance/service work is in progress.

- Never use ether or other starting fluids. The machine is equipped with engine pre-heating, which can detonate ether or other starting fluids. Explosions can cause injury and/or damage.
- Replace all damaged safety decals and a lost or damaged operator's manual. A storage location is provided in the machine for the operator's manual. Always return the operator's manual to the storage location after use.
- Read the operator's manual for each attachment before using the attachment(s).
- Use 3 points of contact when entering or exiting the machine. Always face the machine and use the handholds and steps when getting on and off the machine (see "Cab Entry and Exit" on page 101). Do not jump off the machine.
- Adjust the seat to allow full use of all controls. Never adjust the seat during machine operation.
- Always wear Personal Protective Equipment (PPE) as required for the job and working conditions. Hard hats, goggles, protective shoes, gloves, reflector-type vests, respirators, and ear protection are examples of PPE that may be required.
- Do not wear loose fitting clothing, long hair, jewelry, or loose personal items while operating or servicing the machine.

During Operation

- Only start the engine or operate the controls while seated in the operator's seat.
- Always fasten the seat belt securely and properly. Never operate the machine without the seat belt fastened around the operator and/or any other safety devices in place.
- Always keep your head and appendages inside the operator's station while operating the machine. Shut down the machine before reaching outside the operator's station.
- After starting the machine, check all indicators and displays for normal conditions. Check all controls for proper operation. Listen for abnormal sounds. Remain alert for developing hazardous conditions.
- If the engine stalls for any reason, always turn the ignition key all the way counter-clockwise to the "OFF" position before re-starting the engine.
- Operator visibility is limited in certain areas. Items like ROPS/FOPS posts, attachments, the lift structure, items in the cab, and others can obstruct the operator's view and could mask hazards or people in the area around the machine. It is very important the operator is aware of these masked visibility areas before operating the machine, especially on busy work sites.
- To reduce the hazards posed by masked visibility areas:
  - Use caution when raising or lowering attachments; masked visibility areas can change dramatically when attachments and/or the lift structure is moved
  - Look around the machine before operating. Objects near the machine and close to the ground can be difficult to see from the cab
  - Always look in the direction of travel, including reverse. A backup alarm is not a substitute for looking behind you when operating the machine in reverse
  - Maintain visibility with the attachment/load at all times, especially on telescopic machines with the lift structure extended.
  - Keep bystanders out of and away from the work area
  - Never allow anyone under a raised lift structure. Lowering the lift structure or a falling load can result in death or serious personal injury.
  - Keep the lift structure as low as possible, and retracted on telescopic machines, while traveling. See "Lift Structure Travel Position" on page 118.

- Control the machine with extra caution until fully familiar with all the controls and handling. Practice until control is safe and efficient. New operators must learn to operate the machine in an clear area away from other persons. Make sure to comply with any local rules/laws that require certification before operating the machine.
- Carry the load low. On telescopic machines, always retract the lift structure before traveling. Move the controls smoothly and gradually and operate at speeds appropriate for the conditions.
- The loading zone where the lift structure is raised (and also extended on telescopic machines) should be level and free of dips, holes, or bumps which would compromise rated capacity and machine stability. This requirement is more important for telescopic machines.
- Always be aware of load weights prior to operating the machine. Do not exceed the machine's rated operating capacity, including the type and weight of the attachment. Study any load chart or other capacity information provided with or on the machine to understand capacity under all working conditions (see "Payloads/Capacities" on page 51). Be aware that capacity may be reduced when the machine is turned or in other circumstances.
- Do not raise or drop a loaded bucket or attachment suddenly. Abrupt movements under load can cause serious instability.
- Do not raise the lift structure so the lift cylinder slams against the extension limit. The resulting jolt could spill the load.
- The wheelbase of the machine changes when the steering wheel is turned. Tight turns reduce the wheelbase, rated capacity and machine stability. Additionally, rated capacity and stability are further compromised when:
  - Raising a load
  - When the machine is not laterally level
  - And/or when the travel drive is in operation.
- Do not use the machine to transport people. Never use the machine as a lift for personnel. Never carry riders. Do not allow others to ride on the machine or attachments, because they could fall or cause an accident.
- Do not leave the operator's station without first retracting and lowering the lift structure to the ground or engaging the lift structure support device. When the lift structure is lowered or supported, stop the engine. Remove the ignition key before leaving the operator's station.
- Do not allow anyone under a raised lift structure without the lift structure support device engaged. A lowering lift structure or a falling load can result in death or serious personal injury.
- Stop the machine and place the controls in the neutral position before fastening attachments. Make sure that attachments are securely fastened to the lift structure before using them.
- Be aware that attachments affect the handling and balance of the machine. Adjust the operation of the machine as necessary when using attachments.
- Before coupling or uncoupling the hydraulic lines for the attachment, stop the machine and relieve the pressure in the auxiliary hydraulics circuit.
- Make sure the attachment is lowered to the ground before activating the lift structure float. Never activate the float function with the attachment raised, because this will cause the lift structure and attachment to drop suddenly.
- Be aware of overhead obstacles. Any object near the lift structure could represent a potential hazard or cause the operator to react suddenly and cause an accident. Use a spotter or signal person when working near bridges, electrical or phone lines, work site scaffolds, or other obstructions.
- Do not place limbs near moving parts. Severing of body parts can result.
- Do not run the engine in/near enclosed areas without providing proper ventilation for the exhaust. Exhaust gases contain carbon monoxide, an odorless and deadly gas.

- Avoid slowing suddenly while carrying a load. Sudden slowing can cause the load to fall off the attachment, or cause the machine to tip over.
- Avoid slowing suddenly while carrying a load. Sudden slowing can cause the load to fall off the attachment, or cause the machine to tip over.
- Use a signal person if you cannot see the entire work area clearly, in high traffic areas, or whenever the operator's view is not clear.
- Stay alert for people moving through the work area. When loading a truck, the operator should always know where the driver is.
- Exposed hydraulic hoses could react with explosive force if struck by falling or overhead items. Never allow hoses to be hit, bent or interfered with during operation. Extra guards may be required. Replace any damaged hoses.
- If equipped, always activate ride control when traveling on public roads, long distances, or on uneven terrain. When activated, ride control helps to prevent the load from bouncing, which may cause instability.
- Do not move the lift structure or attachment during travel. If equipped, use the lockout button to deactivate the lift and tilt during transport.
- Do not use the machine in an environment where the hot components of the machine could present a fire hazard, such as hay or straw storage facilities.
- To avoid being thrown forward, do not drive into materials at high speeds. Injury could result.
- Constant speed and the 3-speed high-speed range should only be used for transport on roads with flat, level surfaces. Never carry loads or elevate the lift structure when using constant speed. Keep the lift structure as low as possible.
- Do not turn off the ignition switch while traveling. Turning off the ignition applies the brake, which may cause loss of control, injury and/or tipping of the machine.
- Reduce speed before shifting from high to low travel speed. Down-shifting from high- to low-speed drive while traveling at high-speed may cause the machine to tip and can cause injury, loss of control and damage to the machine.
- Keep bystanders out of, and away from, the work area. Anyone near the machine is at risk of being injured.
- Do not open the engine hood while the engine is running unless specifically instructed for Manitou-approved service.
- In cold weather, avoid sudden travel movements and stay away from even slight slopes. The machine can slide sideways on icy slopes.
- Snow accumulation can hide potential hazards. Use care while operating in or clearing snow.
- If the machine becomes damaged or malfunctions, stop the machine immediately and lock and tag it. Repair the damage or malfunction before operating the machine again.
- Never travel over obstacles or slopes that will cause the machine to tilt severely. Travel around any slope or obstacle that would cause a tilt greater than 10°.
- Avoid sharp turns and high speeds while carrying loads, especially on slopes. The stability of the machine is reduced during sharp turns, and the load may shift, greatly increasing the possibility of a rollover.
- If the machine becomes damaged or malfunctions, stop the machine immediately and lock and tag it. Repair the damage or malfunction before using the machine again.
- Never jump off the machine. Always leave the machine using the steps and hand-holds. Never get on or off a moving machine.
- If unable to exit out the left door, use the right window.

Provision for Stability/Avoiding Rollover and Tipover Accidents

IMPORTANT: *Also refer to "Articulated Loader Stability" on page 29.*

- Machine stability and capacity are affected by:
  - Load being carried.
  - Height of the load.
  - The amount of lift structure extension on telescopic machines.
  - Machine speed.
  - Turn angle.
  - Width of the machine across the tires.
  - Abrupt control movements.
  - Driving over uneven and/or un-level terrain.
  - Operation on out-of-level (laterally) ground.
  - Tight turns reducing wheelbase.
  - Combinations of the factors above.

  DISREGARDING ANY OF THESE FACTORS CAN CAUSE THE MACHINE TO TIP OR CAN THROW THE OPERATOR OUT OF THE SEAT OR MACHINE, WHICH COULD RESULT IN DEATH OR SERIOUS INJURY. Operators must assess these variables appropriately to assure safe, stable operation.

  Do not exceed the machine's rated operating capacity (see "Payloads/Capacities" on page 51).

- To avoid tipping, travel with the bucket or attachment as low as possible during transport and while turning. Retract the lift structure on telescopic machines. Observe minimum ground clearance. Keep the bottom of the bucket or load no higher than wheel axle height during transport and turning.

- On telescopic machines, fully retract the telescopic lift structure before raising/lowering. Extending/retracting while raising/lowering the lift structure at the same time reduces operating capacity and stability.

  ALWAYS:
  - FIRST raise the lift structure and THEN extend it.
  - FIRST retract the lift structure and THEN lower it.

- To avoid tipping, travel with the load/attachment as low as possible during transport and while turning. Observe the minimum ground clearance. Keep the bottom of the load no higher than wheel axle height during transport and turning.

- Operate the controls smoothly to prevent jerking and bouncing.

- Avoid steeps slopes. Do not make sharp turns on slopes. Drive up and down slopes, not across them. Drive slowly on slopes. Keep the heavy end of the machine pointed uphill.

- Raise the lift structure only on level (laterally) ground.

- Be sure the surrounding ground has adequate strength to support the weight of the machine and the load. Stay away from:
  - Ditches
  - Overhangs
  - Weak support surfaces
  - Loading dock edges
  - Ramps
  - Excavations
  - Retaining walls
  - Trenches.

- To cross railroad tracks, ditches, curbs or similar surfaces, cross perpendicular to the obstacle and drive slowly.

- Never travel over obstacles or slopes that will cause the machine to tilt severely. Travel around any slope or obstacle that would cause a tilt greater than 10°.

- Avoid sharp turns and high speeds while carrying loads, especially on slopes. The stability of the machine is reduced during sharp turns, and the load may shift, greatly increasing the possibility of a rollover.
- When unloading trucks or raising loads off elevated surfaces, approach the load straight ahead and back straight away with the load.
- Load and unload only on solid, level ground. Rated capacity and stability specifications are based upon operation on a level surface.
- Maintain visibility with the attachment/load at all times.
- Slowly lower the load as low as possible, and retract the lift structure on telescopic machines, before traveling and before turning. See "Lift Structure Travel Position" on page 118.
- The machine is most stable in the straight position (0° turn). The load rating decreases as steering angle is increased. 45° (40° on telescopic machines) maximum turn is the lowest load capacity position.
- Keep tires inflated to recommended pressure.
- Evenly distribute the load on the attachment. Secure unstable loads so they do not shift or fall.
- On telescopic machines, do not extend or retract the lift structure to push or pull a load or object.
- Maintain visibility with the attachment/load at all times, especially on telescopic machines with the lift structure extended.
- Do not try to exit the machine if tipping occurs. Trying to escape from a tipping machine can result in death or serious personal injury. If the machine becomes unstable and starts to tip, keep the seat belt fastened, hold on firmly and brace yourself. Lean away from the point of impact and stay with the machine. The machine is equipped with rollover protection, which can only protect the operator if they are in the operator's seat.
- Any damage or serious impact to the ROPS/FOPS requires ROPS/FOPS replacement. The ROPS/FOPS must be replaced if an rollover incident occurs. The protection offered by the ROPS/FOPS will be impaired if it has been damaged in a rollover incident.

Telescopic Machines

IMPORTANT: *Also refer to "Articulated Loader Stability" on page 29.*

The additional reach and height provided by the telescopic lift structure require discipline and extra care to assure safe operation:

- On telescopic machines, fully retract the telescopic lift structure before raising/lowering. Extending/retracting while raising/lowering the lift structure at the same time reduces operating capacity and stability.

  ALWAYS:

  - FIRST raise the lift structure and THEN extend it.
  - FIRST retract the lift structure and THEN lower it.
- Use care; extending the lift structure decreases stability in all operating conditions.
- Never exceed the rated capacity of the machine. See "Payloads/Capacities" on page 51. Extending the lift structure decreases capacity.
- The lift structure should be extended only to reach/place loads when the machine is stationary and positioned in a straight line (not turned). Never travel with the lift structure extended.
- Maintain visibility with the attachment/load at all times, especially with the lift structure extended. Remember that as load height increases, depth perception decreases.
- Do not extend or retract the lift structure to push or pull a load or object.
- Make sure the lift structure is retracted and the bucket is lowered to the ground before activating lift structure float.

- On telescopic machines, if the float switch is not turned on and the joystick is pushed into or pulled out of the float position, lift structure motion will stop/start suddenly and may cause the machine to jerk and/or bounce. See “Telescopic Machines Raise Float Operation” on page 121.

Articulated Loader Stability

The articulated (pivot-frame) design of the machine allows sharper turning and increased traction. With this design however, individual or combined conditions can effect the stability of the machine.

To avoid overturn accidents, it is important to understand and recognize conditions that may decrease stability. Be aware of operating conditions and consider all factors before operating the machine and handling loads.

Effect of Articulation (Turning) on Stability

When an articulated loader is straight (not turned) (A, Fig. 4) and is on a flat, smooth surface, the stability of the machine is similar to non-articulating loaders where loads are carried over the center mass of the machine. Loads are supported between the four wheels, with a wide base of support. In this condition, loads are less likely to tip the machine to either side.

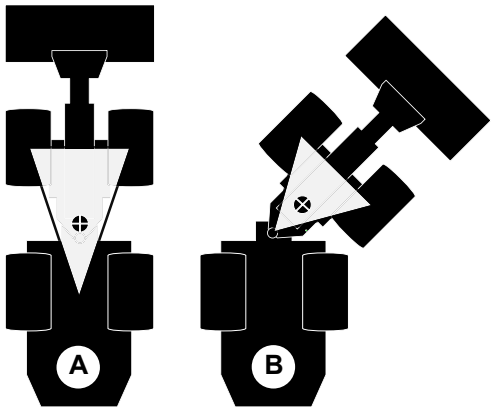


Fig. 4 – Effect of Articulation

As an articulated loader is turned (B), loads are not carried over the center mass of the machine, but are shifted forward toward the articulation joint. This shrinks the support base and changes it to be more triangular in shape, decreasing stability.

Additionally, as an articulated loader is turned, the load center shifts from the center of the machine to the side. As the load center moves from the center of the support base, the potential for an overturn accident increases.

Effect of Lift Structure Lowering on Stability

Lowering the lift structure (C, Fig. 5) shifts the load center forward (D). To avoid overturn accidents, make sure the load is within the rated capacity for the lift structure angle. Consider all operating conditions before lowering the lift structure. Refer to the following sections:

- Load capacity specifications starting on page 57.
- “Telescopic Machines Load/Level Indicators (Telescopic Machines)” on page 78.
- “Special Considerations for Telescopic Machines” on page 116.
- “Longitudinal Load Moment Indicator (LLMI) – EU Telescopic Machines Only” on page 117.

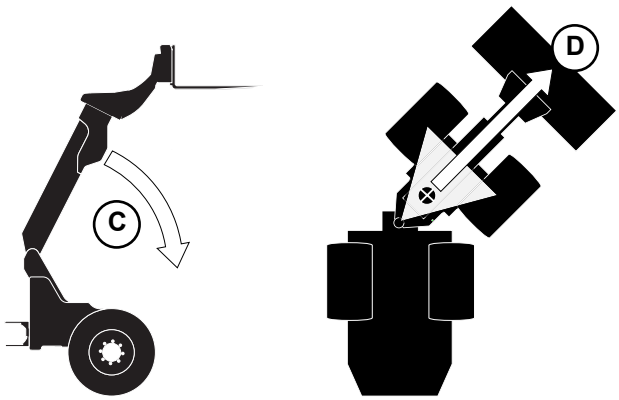


Fig. 5 – Effect of Lift Structure Lowering

Effect of Lift Structure Extension on Stability (Telescopic Machines Only)

Extending the lift structure (E, Fig. 6) moves the load center forward (F). To avoid overturn accidents, make sure that the load stays within the rated capacity for the lift structure angle and extension. Consider all operating conditions before extending the lift structure. Refer to the following sections:

- Load capacity specifications starting on page 57.
- "Telescopic Machines Load/Level Indicators (Telescopic Machines)" on page 78.
- "Special Considerations for Telescopic Machines" on page 116.
- "Longitudinal Load Moment Indicator (LLMI) – EU Telescopic Machines Only" on page 117.

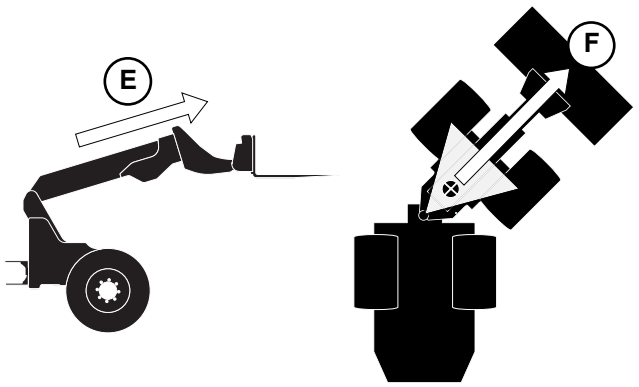


Fig. 6 – Effect of Lift Structure Extension

Effect of Uneven or Unstable Ground on Stability

Articulated loaders offer increased traction on uneven surfaces (G, Fig. 7) because the tires follow the contours of the ground. However, the load center can shift (H) when the wheels are not contacting the ground along the same plane, which reduces stability.

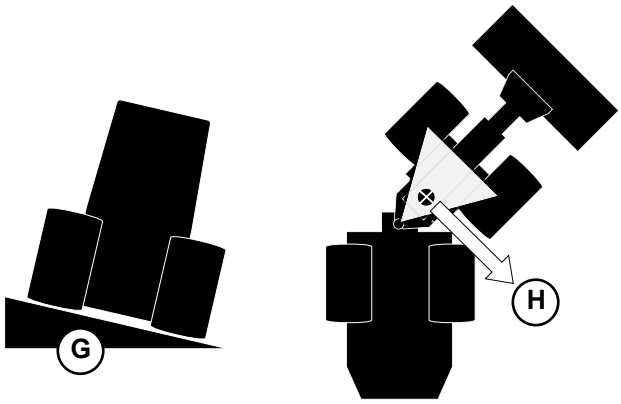


Fig. 7 – Effect of Uneven Ground

To avoid overturn accidents, only load or unload the machine on a firm, level surface. Follow all precautions when traveling with a load, and consider all operating conditions when operating the machine on uneven, unstable, or inclined ground.

Effect of Machine Travel on Stability

Turning the machine (I, Fig. 8) while traveling shifts the load center in a direction opposite the turn. Load center movement increases with sharper turns and higher travel speeds. To avoid overturn accidents, follow all precautions when traveling with a load. Carry the load close to the ground and retract the lift structure on telescopic machines. Consider load stability and all operating conditions before operating the machine and traveling with a load.

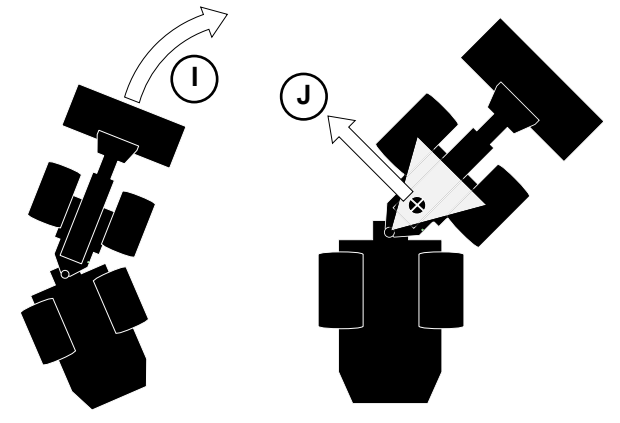


Fig. 8 – Effect of Travel

Effect of Load Movement on Stability

If the load shifts or moves, the load center will move as well. If the load rocks or swings, the load center will move back and forth as well (Fig. 9). To avoid overturn accidents, keep the load stable. Make sure that materials will not shift, and avoid sudden changes in direction that could cause a load to become unstable or swing. Consider load stability and all operating conditions before moving a load.

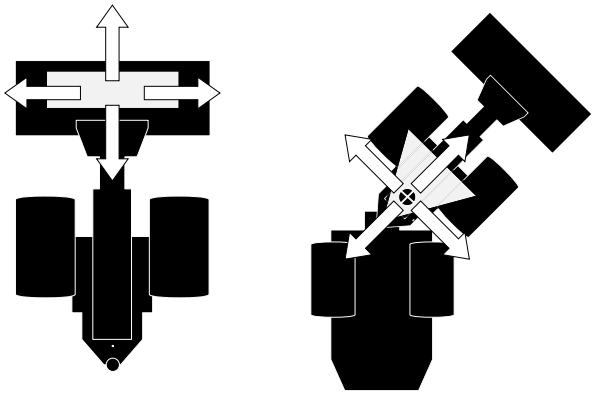


Fig. 9 – Effect of Load Movement

Applications with Load-Handling Devices

- Specific procedures and precautions may be required, when using load-handling devices (e.g., slings, chains) for transporting and placing loads:
  - Only use the machine with load-handling and safety devices properly in place.
  - The load must be secured to prevent falling or slipping.
  - Persons guiding the load must stay in visual contact with the operator.
  - The operator must guide the load to the ground while avoiding any rotating, swinging, or unnecessary movements. Tag lines may be required.
  - Avoid moving the machine with a raised load if the path of the machine is not sufficiently level to allow for safe control of the machine and/or load.
  - Persons securing loads may only approach the machine from the side, so the persons are visible to the operator.
  - The operator must give permission before persons may approach the load. The operator may only give permission after the machine and the attachment are stationary.
  - Do not use any load-handling devices that are damaged or of inadequate rated capacity.
  - Lifting and lowering pipes, culverts, or other containers may require a spotter and/or additional assistant.

Parking the Machine

- Park the machine according to local parking rules on a firm, level surface away from:
  - Traffic
  - High walls
  - Drop-offs
  - Areas of potential water accumulation or run-off
  - Areas of potential high winds.
- If it is necessary to park on a slope, park across the slope. Block/chock the tires, if equipped.
- To avoid collisions while parking on streets, use clearly visible safety devices such as barriers, caution signs, and lights so the machine can be easily seen at night.
- After the machine has been parked properly, shut down the machine according to the "Mandatory Safety Shutdown Procedure" on page 22.

Electrical Energy

- Stay away from high-voltage electric lines and avoid contact with any electrically charged conductor or gas line. Contact or being close to high-voltage electric lines can cause electrocution. The machine does not have to make physical contact with power lines for current to be transmitted. Refer to the following table for information about safe distances from electrical sources. Depending on atmospheric conditions, such as

rainy weather, larger safe operating distances will be needed. Use a spotter and hand signals when near power lines not clearly visible to the operator.

Table 3: Electrical Energy Safe Distances[1]

Rated Voltage	Safe Distance
50 < U < 1000	2300 mm (91 in.)
1000 < U < 30000	2500 mm (99 in.)
30000 < U < 45000	2600 mm (103 in.)
45000 < U < 63000	2800 mm (111 in.)
63000 < U < 90000	3000 mm (119 in.)
90000 < U < 150000	3400 mm (134 in.)
150000 < U < 225000	4000 mm (158 in.)
225000 < U < 400000	5300 mm (209 in.)
400000 < U < 750000	7900 mm (311 in.)

1. CFR 1910.269

- Do the following if the machine comes into contact with a live wire:
  - Do not leave the machine
  - If possible, drive the machine out of the danger area
  - Warn others not to approach or touch the machine
  - Have the power to the live wire turned off
  - Do not leave the machine until power to the live wire has been safely turned off.
- Only trained technicians should work on the machine's electrical system.
- Inspect electrical components at regular intervals. Turn off the machine immediately if any problems are found, such as loose connections or scorched cables. Repair any problems found before starting the machine.
- Only use original equipment (OEM) electrical components, such as fuses and circuit breakers, with the correct specifications.

Maintenance and Service Safety Practices

- Only properly trained personnel with full awareness of safe procedures should perform maintenance or service on the machine. Certification may be required in certain circumstances.
- Use warning tag/control lockout procedures during service. Alert others with warning notices and/or by tagging the operator's controls and/or other machine areas if required.
- Use solid support blocking. Never rely on jacks or other unsafe supports. Never work under any equipment supported only by jacks.
- Do not use the lift structure or any other machine component to support the machine for maintenance or service.
- Never allow anyone under the raised lift structure and do not exit the machine if the lift structure is raised unless the lift structure support is properly applied. Disconnecting or loosening any hydraulic connections, parts failure, and hydraulic pressure venting all can cause the lift structure to drop.
- Never bypass the key switch to start the machine. Use the proper jump-starting procedure. Refer to "Jump-Starting" on page 152.
- Do not search for fluid leaks using your hands. Use a piece of paper or cardboard. Escaping fluid under pressure can be invisible, cause serious burns, can penetrate the skin and cause serious injury. Injected fluid must be surgically removed by a doctor or gangrene may result. If any fluid is injected into your skin, seek medical attention immediately.
- Always wear safety glasses with side shields when striking metal against metal. In addition, it is recommended that a softer (chip-resistant) material be used to cushion the blow, otherwise, serious injury to the eyes or other parts of the body could result.
- Use care when seating retainer pins—retainer pins can fly out or splinter when struck and could cause injury.

- Do not smoke while filling the fuel tank, or when maintaining or servicing the machine. Do not smoke near charging batteries. Keep spark- or flame-producing equipment or materials away.
- Stay away from hydraulic components that have been in recent operation. Do not loosen or disconnect any hydraulic components without first relieving hydraulic circuit pressure. To relieve hydraulic pressure, perform the "Mandatory Safety Shutdown Procedure" on page 22.
- Do not work on hot components. Severe burns can result. Wait for the components to cool. When the engine lube oil, gearbox lubricant, or other fluids require maintenance/service, wait for fluid temperatures to cool. Do not remove the radiator cap after the engine has reached operating temperature. At operating temperature, engine coolant is extremely hot and under pressure.
- Always use the correct parts and the proper fastener torques. Incorrect fastener connections can cause a dangerous condition.
- There should always be at least 2 people present if the machine must be moving/running to perform the procedure. All persons must maintain visual contact with each other. Keep a safe distance away from all rotating and moving parts.
- Always use proper tools while working on the machine. Inappropriate tools could break or slip, causing injury.
- Do not open the engine hood while the engine is running unless specifically instructed for Manitou-approved service.
- Do not postpone scheduled maintenance. Postponing scheduled maintenance can cause unsafe operating conditions. Postponing scheduled maintenance can also significantly reduce machine service life and cause serious and costly equipment failures.
- Only tow the machine as described in this manual. See "Towing" on page 156.
- Dispose of all oils and fluids properly. Used oils/fluids are environmental contaminants and may only be disposed of at approved collection facilities. Never drain or dispose of any oils/fluids onto the ground, in public waste collection containers, or in sewer systems or landfills. Check local regulations for other requirements.
- Safety equipment must be maintained in good condition.
- Safety-critical parts must be periodically replaced. Replace the following potentially fire-related components as soon as they begin to show signs of deterioration:
  - Fuel system components, such as hoses, fuel tank overflow drain hose, and the fuel filler cap.
  - Hydraulic system hoses, especially the pump outlet lines. Replace hydraulic hoses every 6 years from the date of manufacture, even if they do not appear damaged. The date of manufacture (month or quarter and year) is indicated on the hydraulic hoses.
- Keep connections and mounting straps tight. Hose routings should have gradual bends.
- After cleaning the machine, examine all fuel, lubricant, and hydraulic oil lines for leaks, chafe marks, and damage. Tighten any loose connections and repair or replace parts as necessary.
- Tubes, hoses, wires, and cables must be routed and connected properly.
- When handling oil, grease, and other chemical agents, carefully follow the product-related safety requirements listed in the Material Safety Data Sheet (MSDS).

- When washing the machine using water, do not direct the water onto electrical connections or electronic components. Water may cause malfunction or damage. Power washing or other high-pressure jets may cause physical damage.

Battery Hazards

- Before performing electrical service or arc welding on the machine, disconnect both cables from the battery.
- Do not turn on the machine when the battery fluid is below the minimum level. An explosion or rupture could result.
- Turn off all electrical equipment before connecting leads to the battery, including electrical switches on the battery charger or jump-starting equipment.
- When disconnecting the battery, remove the negative terminal cable first. When connecting the battery, connect the positive terminal cable first.
- When jump-starting, wear safety glasses or goggles when connecting cables. Connect the positive (+) cable first when installing jumper cables. Connect the negative (-) cable to chassis of the machine being jump-started as far from the discharged battery as possible. Disconnect the negative (-) cable first when removing jumper cables. Do not allow the machines to touch when jump-starting.
- Sparks, open flames, and static discharge can ignite explosive battery gas. To prevent sparks, before working on the battery:
  - Turn off all switches and the engine
  - Make sure battery terminals are tight
  - Avoid contacting the battery terminals with metal objects.
- Never jump-start a machine with a frozen battery. The battery could explode. Thaw a frozen battery before charging it or attaching jumper cables.
- Avoid contact with battery acid. If battery acid comes in contact with your eyes, thoroughly rinse your eyes with clean water for 10-15 minutes and seek medical assistance. If battery acid is swallowed, immediately seek medical assistance. In the United States, call the Poison Control Center at 1-800-222-1222.

Fire Hazards

- Clean the machine regularly to avoid the buildup of flammable debris, such as leaves and straw. Dirt/debris, particularly in the engine compartment, creates a fire hazard.
- Avoid circumstances where explosive dust or gases can be ignited by open flame, arcs, sparks, or heat. If damaged or not properly maintained, the electrical system can arc or produce sparks.
- A 2.27 kg (5 lb.) or larger multi-purpose “A/B/C” fire extinguisher should be mounted in the cab. Check the fire extinguisher periodically according to the manufacturer's instructions and local regulations. Make sure that work crew members are trained to use it properly.
- Add all fluids to the machine only in a well-ventilated area. Turn off the engine, park the machine with switches turned off, and allow the machine to cool before performing service checks.
- Add fuel to the machine only in a well-ventilated area. Turn off the engine and park the machine with switches turned off before refueling.
- Do not smoke while filling the fuel tank, or when maintaining or servicing the machine. Do not smoke near charging batteries. Keep spark- or flame-producing equipment or materials away.
- Replace the fuel filler cap immediately after refueling. Keep fuel and other fluid reservoir caps tight. Do not start the engine until all caps have been secured.
- Avoid spilling combustible fluids, such as oil or fuel, on a hot engine.

- Static electricity can produce dangerous sparks at the fuel-filling nozzle. Do not wear polyester, or polyester-blend clothing while fueling. Before fueling, touch the metal surface of the machine away from the fuel fill to dissipate any built-up static electricity. Do not re-enter the machine and stay near the fuel filling point during refueling to minimize the build-up of static electricity. Do not use cell phones while fueling. If refueling from a fuel truck, make sure the static line is connected from the machine to the fuel truck before fueling begins.
- Ultra-Low Sulfur Diesel (ULSD) poses a greater static ignition hazard than earlier diesel formulations. Avoid death or serious injury from fire or explosion. Make sure the entire fuel delivery system is in compliance with fueling standards for proper grounding and bonding practices.
- Oil from leaks can ignite on hot components. Repair any damaged or leaking components before using the machine.

Additional Safety Equipment

- Certain uses of the machine may require additional safety equipment. Examine the worksite for hazards and provide safety equipment as required to protect against those hazards.
- Contact your dealer for available safety guards if there is any risk of objects striking the operator's cab. Laminated glass or polycarbonate protection for the front, side or rear windows may need to be installed on the machine, depending upon particular work conditions.

Crystalline Silica Exposure

Exposure to crystalline silica (found in sand, soil and rocks) has been associated with silicosis, a debilitating and often fatal lung disease. Comply with all applicable rules and regulations for the workplace. Wear approved respiratory protection or use water spray or other means if there is no other way to control the dust.

A Silica rule "29 CFR 1929.1153" by the U.S. Occupational Safety and Health (OSHA) indicates a significant risk of chronic silicosis for workers exposed to inhaled crystalline silica over a working lifetime. Refer to the rule for more information regarding exposure limits and hazard prevention.

Transporting the Machine

Obey federal, state, and local over-the-road regulations. Check restrictions regarding weight, height, width, and length of a load. The hauling vehicle, trailer, and load must all be in compliance with applicable regulations. See "Loading and Transporting the Machine on a Transport Vehicle" on page 158.

Raising the Machine with a Crane

Only raise the machine according to the following guidelines, following the steps detailed in "Raising the Machine using a Crane" on page 154:

- The crane and rigging equipment must have sufficient capacity. See "Weights" on page 59.
- Secure the machine against unintentional movement. Use taglines as needed.
- Do not raise the machine with persons on or in the machine.
- Any person guiding the crane operator must be within sight or sound of the crane operator.
- Raise the machine only with the standard bucket installed, with the bucket empty and as low as possible.
- On telescopic machines, retract the lift structure.
- Persons must stay clear of, and not under, the machine when it is raised.
- Fasten the rigging equipment so the machine is horizontal when it is raised.

- Do not raise the machine by the cab. Attach the rigging equipment only at the lift points identified by this symbol:

- Raise the machine according to “Raising the Machine using a Crane” on page 154.

Loading and Transporting the Machine

- Load and transport the machine according to “Loading and Transporting the Machine on a Transport Vehicle” on page 158.
- The transport vehicle must support the height, width, length and weight of the machine. See “Dimensions” on page 55 and “Weights” on page 59.
- Remove any dirt, snow, or ice from the wheels on the machine and from the loading ramps and transport platform to prevent slipping.
- Secure the machine to the transport vehicle according to “Loading and Transporting the Machine on a Transport Vehicle” on page 158 to prevent unintentional movement.

Safety Decals

- Decals on the machine provide safety information and warn of hazards at areas on and around the machine.
- Warning and safety decals must be legible. Any missing or illegible decals must be replaced promptly. Obtain replacements from your authorized dealer. Refer to the Parts Manual for decal part numbers and ordering information.

New Decal Application

- Before applying the decal, clean the surface where the decal will be applied. Refer to the following pages for proper decal locations.
- If a part that must be replaced has a safety decal, the replacement part must have the same safety decal applied.

Non-Telescopic Machines

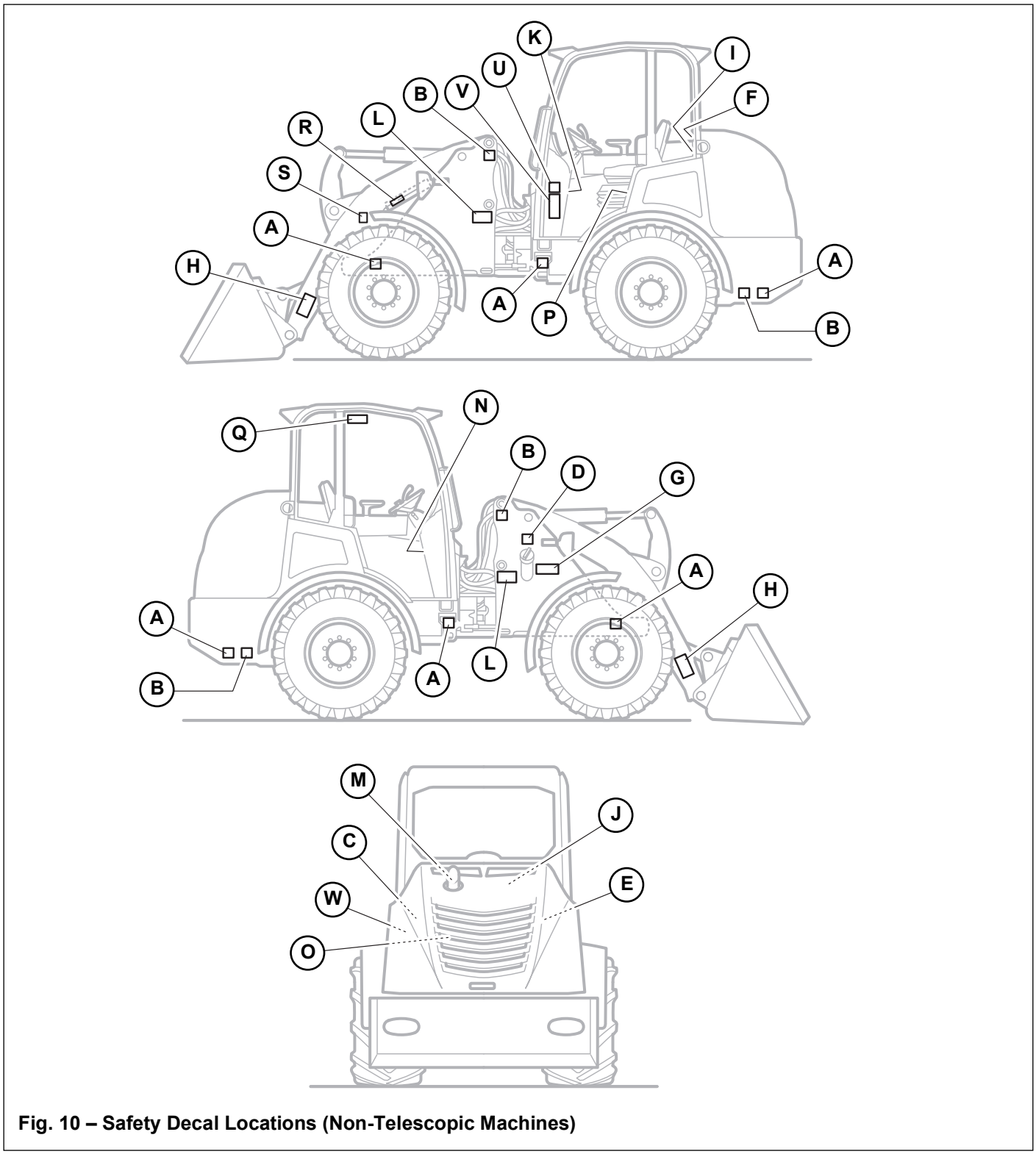


Fig. 10 – Safety Decal Locations (Non-Telescopic Machines)

Telescopic Machines

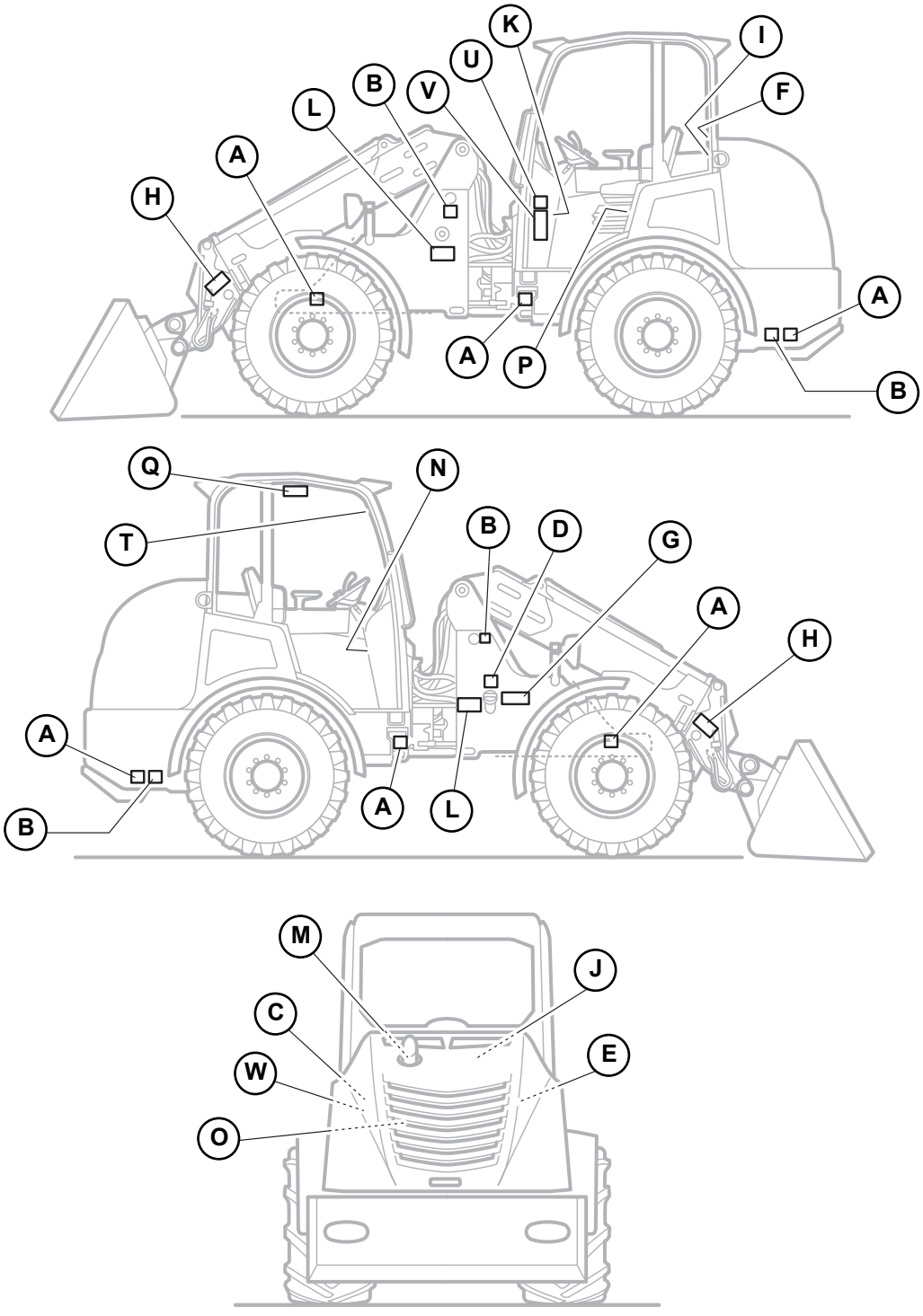


Fig. 11 – Safety Decal Locations (Telescopic Machines)

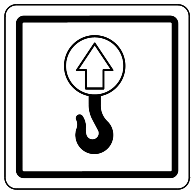
ANSI-Style and Common Safety Decal Locations

A

(Located at the tie-down points on the machine)

Tie-down point, located on both sides of the front and rear chassis. Only use tie-down points indicated on loader when transporting loader.

B

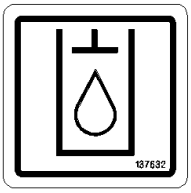


(Located near the top of the front frame and near the bottom rear of the rear frame, at the life points on the machine)

Lift Point Decal

Apply lift hooks only in these location. See "Raising the Machine using a Crane" on page 154.

C



(Located in the engine compartment on the hydraulic oil filler cap)

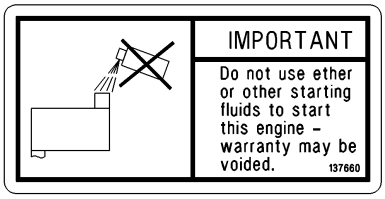
USE HYDRAULIC OIL ONLY!

D

(Located on the right side of the machine near the fuel filler neck)

USE DIESEL FUEL ONLY!

E



(Located on the engine air filter housing inside the engine compartment)

Caution Decal

IMPORTANT

Do not use ether or other starting fluids to start this engine

F

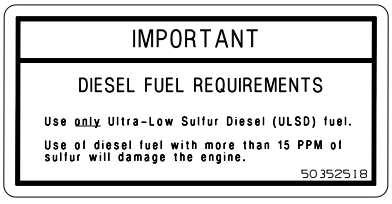
(Located inside the ROPS/FOPS behind the operator's seat)

Warning Decal

WARNING: Do not modify ROPS; replace damaged ROPS; wear seat belt

The protection offered by this ROPS will be impaired if it has been subjected to any modification, structural damage, or has been involved in an overturn incident, this ROPS must be replaced after a rollover. Seat belts must be worn while operating vehicle.

G



(Located on the right side of the machine near the fuel filler neck)

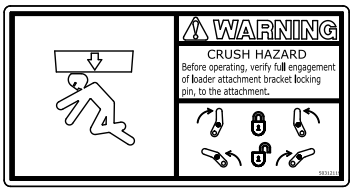
Caution Decal

IMPORTANT

- **Use ONLY Ultra-Low Sulfur Diesel (ULSD) fuel.**
- **Use of diesel fuel with more than 15 PPM of sulfur will damage the engine. See "Fuel System Maintenance" on page 185.**

ANSI-Style and Common Safety Decal Locations (Cont.)

H



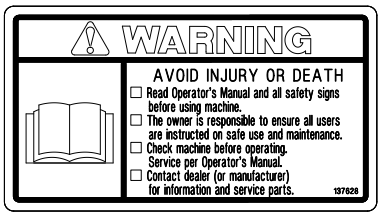
(Located on both sides of the lift structure near the attachment hitch)

Warning Decal

WARNING: CRUSH HAZARD

Before operating, verify full engagement of loader attachment bracket locking pin to the attachment.

I



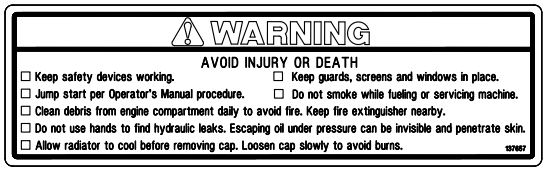
(Located on the manual storage box behind the operator's seat)

Warning Decal

WARNING: AVOID INJURY OR DEATH

- **Read Operator's Manual and all safety signs before using machine.**
- **The owner is responsible to ensure all users are instructed on safe use and maintenance.**
- **Check machine before operating. Service per Operator's Manual.**
- **Contact dealer (or manufacturer) for information and service parts.**

J



(Located in engine compartment near radiator)

Warning Decal

WARNING: AVOID INJURY OR DEATH

- **Keep safety devices working.**
- **Keep guards, screens and windows in place.**
- **Jump start per Operator's Manual procedure.**
- **Do not smoke while fueling or servicing machine.**
- **Clean debris from engine compartment daily to avoid fire. Keep fire extinguisher nearby.**
- **Do not use hand to find hydraulic leaks. Escaping oil under pressure can be invisible and penetrate skin.**
- **Allow radiator to cool before removing cap. Loosen cap slowly to avoid burns.**

K

(Located on the column below the steering wheel)

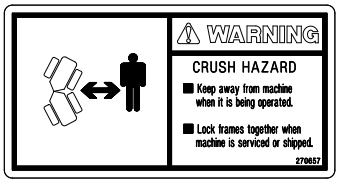
Warning Decal

WARNING: AVOID INJURY OR DEATH

- **Maintain 3-point contact during entry and exit.**
- **Inspect work area; avoid all hazards.**
- **Look in the direction of travel. Keep children and bystanders away.**
- **Start and operate machine only from seat.**
- **Never carry riders. Do not raise personnel in bucket.**
- **Operate only in well ventilated area.**
- **Keep away from electric power lines, avoid contact.**
- **Do not wear loose clothing while operating or servicing machine.**
- **Wear any needed Personal Protective Equipment.**

ANSI-Style and Common Safety Decal Locations (Cont.)

L



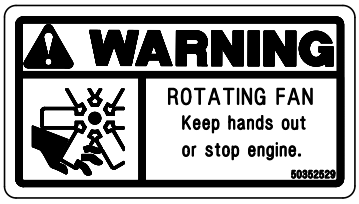
(Located on both sides of the front frame near the articulation joint)

Warning Decal

WARNING: CRUSH HAZARD

- **Keep away from machine when it is being operated.**
- **Lock frames together when machine is serviced or shipped.**

M



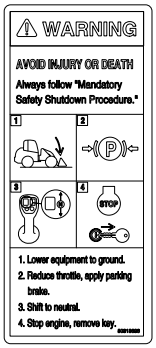
(Located in the engine compartment near the cooling fan)

Warning Decal

WARNING: ROTATING FAN

Keep hands out or stop engine

N



(Located on the column below the steering wheel)

Warning Decal

WARNING: AVOID INJURY OR DEATH

Always follow "Mandatory Safety Shutdown Procedure."

1) Lower equipment to ground.

2) Reduce throttle, apply parking brake.

3) Shift to neutral.

4) Stop engine, remove key.

O

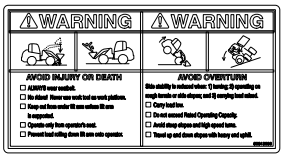
(Located in the engine compartment near the exhaust components)

Warning Decal

WARNING: HOT SURFACE

Do not touch hot engine or hydraulic system parts.

P



(Located inside the canopy/cab near the parking brake lever)

Warning Decal

WARNING: AVOID INJURY OR DEATH

- **ALWAYS wear seatbelt.**
- **No riders! Never use work tool as work platform.**
- **Keep out from under load arm unless load arm is supported.**
- **Operate only from operator's seat.**
- **Prevent load rolling down load arm onto operator**

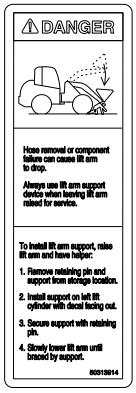
WARNING: AVOID OVERTURN

Side stability is reduced when: 1) turning; 2) operating on rough terrain or side slopes; and 3) carrying load raised.

- **Carry load low.**
- **Do not exceed Rated Operating Capacity.**
- **Avoid steep slopes and high speed turns.**
- **Travel up and down slopes with heavy end uphill.**

ANSI-Style and Common Safety Decal Locations (Cont.)

R



Non-Telescopic Machines Only

(Located on the lift structure raise/tilt support device)

DANGER

DANGER: Keep Out From Under Load Arm

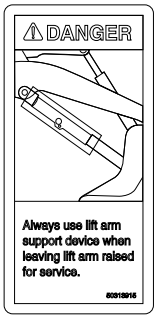
Hose removal or component failure can cause load arm to drop.

Always use load arm support device when leaving load arm raised for service.

To install load arm support, raise load arm and have helper:

1) **Remove remaining pin and support from storage location.**
2) **Install support on left lift cylinder with decal facing out.**
3) **Secure support with retaining pin.**
4) **Slowly lower load arm until braced by support.**

S



Non-Telescopic Machines Only

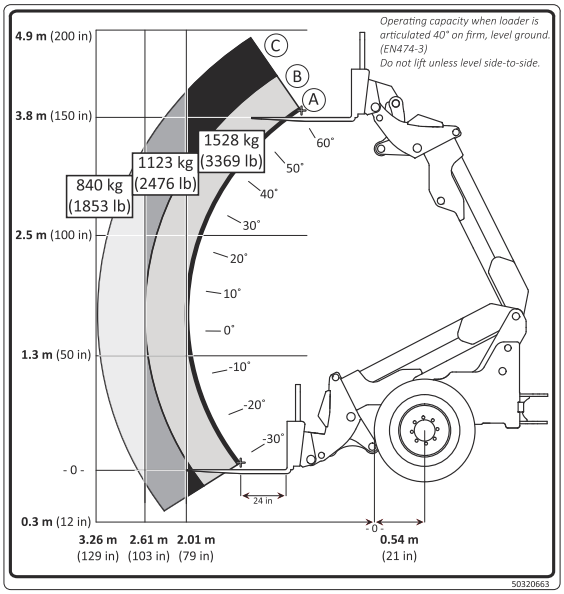
(Located near the lift structure raise/ tilt support device)

DANGER

DANGER: Keep Out From Under Unsupported Load Arm

Always use load arm support device when leaving load arm raised for service.

T



Telescopic Machines Only

(Located inside the ROPS/FOPS at the top right corner of the windshield)

IMPORTANT: Refer to pallet fork "Telescopic Machines Load/Level Indicators (Telescopic Machines)" on page 78.

U

(Located on the left side of the column below the steering wheel)

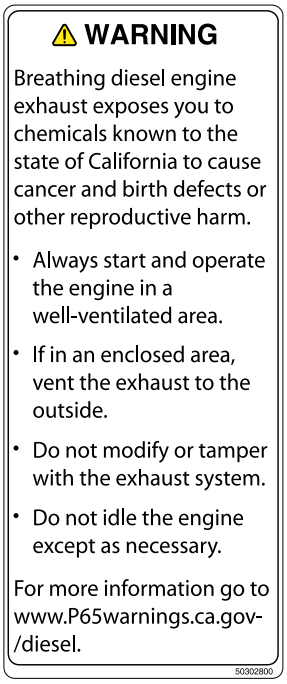
Warning Decal

This product can expose you to lead which is known to the State of California to cause cancer and birth defects or other reproductive harm.

For more information go to www.P65Warnings.ca.gov

ANSI-Style and Common Safety Decal Locations (Cont.)

Ⓥ



(Located on the left side of the column below the steering wheel)

Warning Decal

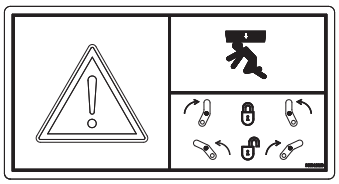
Breathing diesel engine exhaust exposes you to chemicals known to the state of California to cause cancer and birth defects or other reproductive harm.

- **Always start and operate the engine in a well-ventilated area.**
- **If in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system.**
- **Do not idle the engine except as necessary.**

For more information go to www.P65warnings.ca.gov-/diesel.

ISO-Style Safety Decal Locations

H



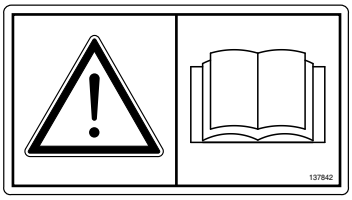
(Located on both sides of the lift structure near the attachment hitch)

Warning Decal

WARNING: CRUSH HAZARD

Before operating, verify full engagement of loader attachment bracket locking pin to the attachment.

I



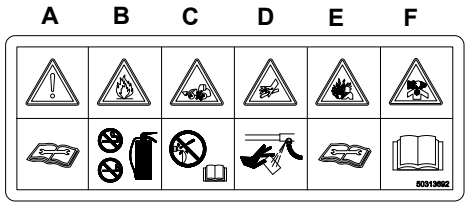
(Located on the manual storage box behind the operator's seat)

Warning Decal

WARNING: AVOID INJURY OR DEATH

- Read Operator's Manual and all safety signs before using machine.
- The owner is responsible to ensure all users are instructed on safe use and maintenance.
- Check machine before operating. Service per Operator's Manual.
- Contact dealer (or manufacturer) for information and service parts.

J



(Located in engine compartment near radiator)

Warning Decal

WARNING: AVOID INJURY OR DEATH

A) Safety alert / Keep safety devices in place and in working order.

B) Fire hazard / Do not smoke while fueling or servicing the machine. Clean debris from the engine compartment to avoid fires. Keep fire extinguisher nearby.

C) Run-over hazard / Jump-start the machine only according to the operator's manual. See ""Jump-Starting" on page 152.

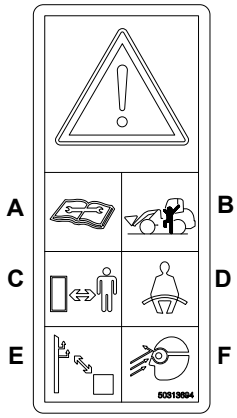
D) Oil injection hazard / Do not use hands to find hydraulic leaks. Escaping oil under pressure can penetrate skin. Use a piece of cardboard to find leaks.

E) Burn hazard / Allow radiator to cool before removing cap. Loosen cap slowly to avoid burns.

F) Suffocation hazard / Operate only in a well-ventilated area.

ISO-Style Safety Decal Locations (Cont.)

K



(Located on the column below the steering wheel)

Warning Decal

General Operating Warnings

A) Check machine before operating. Service according to Operator's Manual. Contact dealer (or manufacturer) for information and service parts.

B) Maintain 3-point contact during entry and exit. Do not grasp steering wheel during entry and exit.

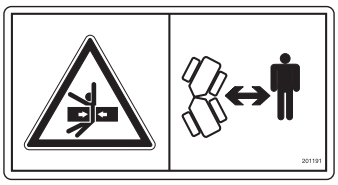
C) Inspect work area. Avoid all hazards. Look in the direction of travel. Keep children and bystanders away.

D) Start and operate machine only from operator's seat.

E) Keep away from power lines.

F) Wear personal protective equipment as needed. Do not wear loose clothing while operating or servicing machine.

L



(Located on both sides of the front frame near the articulation joint)

Warning Decal

WARNING: CRUSH HAZARD

- **Keep away from machine when it is being operated.**
- **Lock frames together when machine is serviced or shipped.**

M

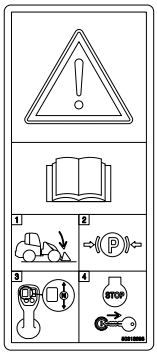
(Located in the engine compartment near the cooling fan)

Warning Decal

WARNING: ROTATING FAN

Keep hands out or stop engine

N



(Located on the column below the steering wheel)

Warning Decal

WARNING: AVOID INJURY OR DEATH

Always follow "Mandatory Safety Shutdown Procedure."

1) Lower equipment to ground.

2) Reduce throttle, apply parking brake.

3) Shift to neutral.

4) Stop engine, remove key.

O

(Located in the engine compartment near the exhaust components)

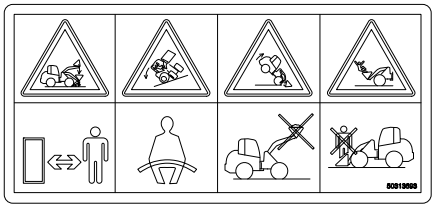
Warning Decal

WARNING: HOT SURFACE

Do not touch hot engine or hydraulic system parts.

ISO-Style Safety Decal Locations (Cont.)

P



(Located on the frame inside the canopy/cab)

Warning Decal

General Operating Warnings

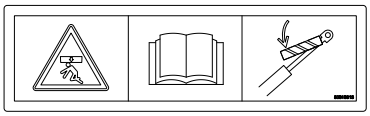
A) Crush hazard / Keep out from under lift structure unless lift structure is supported.

B) Side tip hazard / Avoid steep slopes and high-speed turns. Travel up and down slopes with heavy end uphill. Fasten seat belt.

C) Forward tip hazard / Carry load low. Do not exceed rated operating capacity.

D) Fall hazard / No riders! Never use attachment as work platform.

R



(Located on the lift structure raise/tilt support device)

DANGER

DANGER: Keep Out From Under Lift Structure

Hose removal or component failure can cause lift structure to drop.

Always use lift structure support device when leaving lift structure raised for service.

To install lift structure support, raise lift structure and have helper:

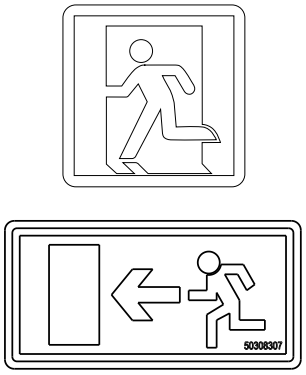
1) Remove remaining pin and support from storage location.

2) Install support on left lift cylinder with decal facing out.

3) Secure support with retaining pin.

4) slowly lower lift structure until braced by support.

Q

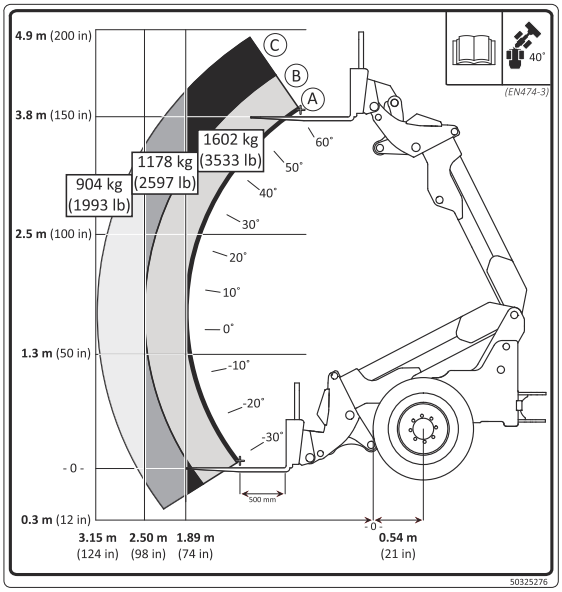


(Located near the top of the right cab window)

Emergency Exit

The right cab windows opens to allow for emergency exit.

T



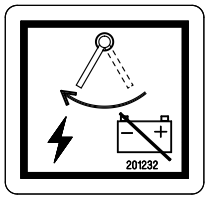
Telescopic Machines Only

(Located inside the ROPS/FOPS at the top right corner of the windshield)

IMPORTANT: Refer to "Telescopic Machines Load/Level Indicators (Telescopic Machines)" on page 78.

ISO-Style Safety Decal Locations (Cont.)

W



(Located in the engine compartment on the left side next to the battery disconnect switch)

Rotate switch counter-clockwise to disable the electrical system; clockwise to enable.

NOTES

Specifications

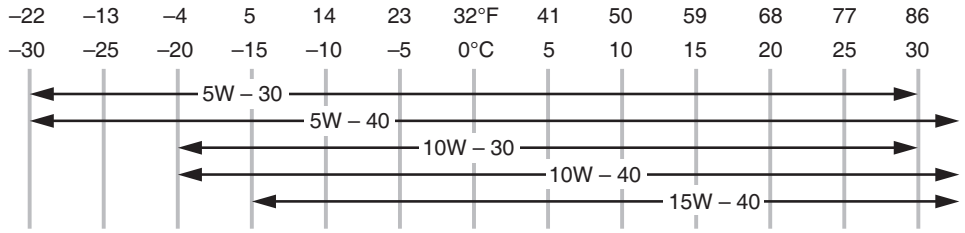
Fluids/Lubricants Types and Capacities

NOTE: *Capacities shown are approximate.*

Table 4: Fluids/Lubricants Types and Capacities

Component/Application	Type	Quantity
Hydraulic Oil Tank	Manitou MV 60 hydraulic oil, or equivalent	73.7 L (19.5 gal.)
Hydraulic System – Total		98.4 L (26.0 gal.)
Grease Fittings, Lift Structure	Lithium-saponified, brand-name multi-purpose grease MPG-A	As required
Battery Terminals	SP-B acid-proof Grease	As required
Engine Coolant	Long life coolant ASTM D4985, D6210 (United States) SAE J814C, J1941, J1034 or J2036 (international) (See “Coolant Compound Table” on page 59)	600 Series: 14.4 L (3.8 gal.) 700 Series: 17.0 L (4.5 gal.)
Radiator Cap Pressure	–	1.1 bar (16 psi)
Brake Fluid	Automatic Transmission Fluid (ATF)	N/A
Axle Oil	UTTO Fluid (Mobil 424 or equivalent)	
Front Axle		
Planetary Drive		600 Series: 0.3 L (0.3 qt.) 700 Series: 0.6 L (0.6 qt.)
Axle Housing		600 Series: 3.5 L (3.7 qt.) 700 Series: 3.6 L (3.8 qt.)
Total Fill		600 Series: 4.1 L (4.3 qt.) 700 Series: 4.8 L (5.1 qt.)
Rear Axle		
Planetary Drive		600 Series: 0.3 L (0.3 qt.) 700 Series: 0.6 L (0.6 qt.)
Axle Housing		600 Series: 4.1 L (4.3 qt.) 700 Series: 4.7 L (5.0 qt.)
Total Fill		600 Series: 4.7 L (5.0 qt.) 700 Series: 5.9 L (6.2 qt.)
Air Conditioning (option)	R-134a/HFC-134a refrigerant	1089 g. (2.4 lbs.) @ 24° C (76° F)

Table 4: Fluids/Lubricants Types and Capacities

<table>
<tr><th>Component/Application</th><th>Type</th><th>Quantity</th></tr>
<tr><td rowspan="2">Engine Oil (with filter)</td><td>600 Series Service Classification: CK-4
700 Series Service Classification:
• Tier 4 engines and before: CK-4, DQC III-18LA, or DQA IV18 LA
• Stage 5 engines following 250 hour oil change intervals: CK-4, DQC III-18LA, or DQA IV18 LA
• Stage 5 engines following 500 hour oil change intervals: DQC III-18LA or DQA IV18 LA ONLY
IMPORTANT!
500 hour oil change interval MUST meet Deutz Certification DQC III-18LA or DQA IV18 LA.</td><td>600 Series: 10.5 L (11 qts.)
700 Series: 8.5 L (9 qts.)</td></tr>
<tr><td colspan="2"> 
</td></tr>
<tr><td rowspan="2">Diesel Fuel Tank</td><td>DPF Models:
ULSD[1] ultra-low sulfur only, below 15 PPM. ASTM D975 with biodiesel[2] content limited to 20% (B20) of DIN EN14214 type (no additives allowed!)</td><td rowspan="2">608 / MLA-6: 95 L (25 gal.)
708 / 708T / MLA-7 / MLA-T 516: 102 L (27 gal.)</td></tr>
<tr><td>Non-DPF Models:
ASTMD975-94 (no additives allowed)
DIN EN 14214 Biodiesel (no additived allowed)
LSD or ULSD[1] ow sulfur or ultra-low sulfur, below 500 PPM. Up to 20% (B20) mixture of biodiesel[2] allowed</td></tr>
</table>

1. Ultra-Low Sulfur Diesel (ULSD) fuel lubricity must have a maximum scar diameter of 0.45 mm, as measured by ASTM D6079 or ISO 12156-1, or a minimum of 3100 grams as measured by ASTM D6078. Contact your fuel supplier for details. Specification 1-D S15 or 2-D S15, ASTM D975.
2. The use of biodiesel affects service intervals. For more information about the use of biodiesel, specification requirements, and service intervals, see the engine operation manual

Payloads/Capacities

NOTE: *Pallet fork load center is the distance from the front face of the forks to the center of mass of the load.*

Non-Telescopic Machines

Table 5: Weights and Capacities[1] (Non-Telescopic Machines)

Description	600 Series (Canopy)	600 Series (Cab)	700 Series (Canopy)	700 Series (Cab)
Rated Operating Capacity (with standard bucket)	1115 kg (2459 lbs.)	1189 kg (2622 lbs.)	1310 kg (2889 lbs.)	1389 kg (3063 lbs.)
Static Tipping Loads				
Standard Bucket - Straight[2]	2907 kg (6409 lbs.)	3059 kg (6743 lbs.)	3378 kg (7446 lbs.)	3587 kg (7907 lbs.)
SAE J732 Standard Bucket - 45° Turn[2]	2230 kg (4917 lbs.)	2379 kg (5244 lbs.)	2621 kg (5778 lbs.)	2779 kg (6126 lbs.)
SAE J1197 Standard Pallet Forks 1066 mm (42 in.) - Straight 533 mm (21 in.) load center	2259 kg (4980 lbs.)	2405 kg (5302 lbs.)	2741 kg (6044 lbs.)	2882 kg (6354 lbs.)
SAE J1197 Standard Pallet Forks 1066 mm (42 in.) - 45°Articulated 533 mm (21 in.) load center	1778 kg (3921 lbs.)	1885 kg (4157 lbs.)	2174 kg (4793 lbs.)	2271 kg (5006 lbs.)
SAE J1197 Standard Pallet Forks 1220 mm (48 in.) - Straight 610 mm (24 in.) load center	2164 kg (4770 lbs.)	2293 kg (5055 lbs.)	2632 kg (5802 lbs.)	2764 kg (6094 lbs.)
SAE J1197 Standard Pallet Forks 1220 mm (48 in.) - 45°Articulated 610 mm (24 in.) load center	1704 kg (3757 lbs.)	1816 kg (4004 lbs.)	2090 kg (4609 lbs.)	2197 kg (4844 lbs.)
SAE J1197 Standard Pallet Forks 1000 mm (40 in.) - Straight 500 mm (20 in.) load center	2296 kg (5063 lbs.)	2439 kg (5378 lbs.)	2791 kg (6152 lbs.)	2929 kg (6457 lbs.)
SAE J1197 Standard Pallet Forks 1000 mm (40 in.) - 45°Articulated 500 mm (20 in.) load center	1797 kg (3962 lbs.)	1931 kg (4257 lbs.)	2197 kg (4843 lbs.)	2331 kg (5139 lbs.)

1. Measured on firm and level ground. Equipped with full fluids and 75 kg (165 lbs.) operator. Equipped with 405/70-20 (16/70-20) 145 G tires, in narrowest position.
2. 600 Series equipped with 1675 mm (66”) dirt/construction bucket. 700 Series equipped with 2135 mm (84”) dirt/construction bucket.

Telescopic Machines

NOTE: *All values per ISO 14397-1*

Table 6: Static Tipping Loads Capacities[1] (Telescopic Machines[2])

Description	700 Series (Canopy)	700 Series (Cab)
Standard Bucket - Straight Retracted[3]	3420 kg (7539 lbs.)	3499 kg (7714 lbs.)
Standard Bucket - Straight Extended[3]	1748 kg (3854 lbs.)	1820 kg (4013 lbs.)
Standard Bucket - 40° Turn Retracted[3]	2409 kg (5312 lbs.)	2394 kg (5278 lbs.)
Standard Bucket - 40° Turn Extended[3]	1199 kg (2643 lbs.)	1176 kg (2592 lbs.)
Standard Pallet Forks 1066 mm (42 in.) - 533 mm (21 in.) load center (Straight and Retracted)	2694 kg (5940 lbs.)	2796 kg (6164 lbs.)
Standard Pallet Forks 42 in. 1066 mm (42 in.) - 533 mm (21 in.) load center (Straight and Extended)	1568 kg (3457 lbs.)	1556 kg (3430 lbs.)
Standard Pallet Forks 42 in. 1066 mm (42 in.) - 533 mm (21 in.) load center (Articulated 40° and Retracted)	1993 kg (4394 lbs.)	1966 kg (4334 lbs.)
Standard Pallet Forks 42 in. 1066 mm (42 in.) - 533 mm (21 in.) load center (Articulated 40° and Extended)	1064 kg (2345 lbs.)	1097 kg (2418 lbs.)
Standard Pallet Forks 1220 mm (48 in.) - 610 mm (24 in.) load center (Straight and Retracted)	2629 kg (5795 lbs.)	2694 kg (5939 lbs.)
Standard Pallet Forks 1220 mm (48 in.) - 610 mm (24 in.) load center (Straight and Extended)	1534 kg (3382 lbs.)	1551 kg (3420 lbs.)
Standard Pallet Forks 1220 mm (48 in.) - 610 mm (24 in.) load center (Articulated 40° and Retracted)	1910 kg (4211 lbs.)	1868 kg (4119 lbs.)
Standard Pallet Forks 1220 mm (48 in.) - 610 mm (24 in.) load center (Articulated 40° and Extended)	1051 kg (2316 lbs.)	1024 kg (2258 lbs.)
Standard Pallet Forks 1000 mm (40 in.) - 500 mm (20 in.) load center (Straight and Retracted)	2732 kg (6023 lbs.)	2829 kg (6237 lbs.)
Standard Pallet Forks 1000 mm (40 in.) - 500 mm (20 in.) load center (Straight and Extended)	1580 kg (3483 lbs.)	1582 kg (3487 lbs.)
Standard Pallet Forks 1000 mm (40 in.) - 500 mm (20 in.) load center (Articulated 40° and Retracted)	2003 kg (4416 lbs.)	1990 kg (4387 lbs.)
Standard Pallet Forks 1000 mm (40 in.) - 500 mm (20 in.) load center (Articulated 40° and Extended)	1130 kg (2491 lbs.)	1108 kg (2442 lbs.)

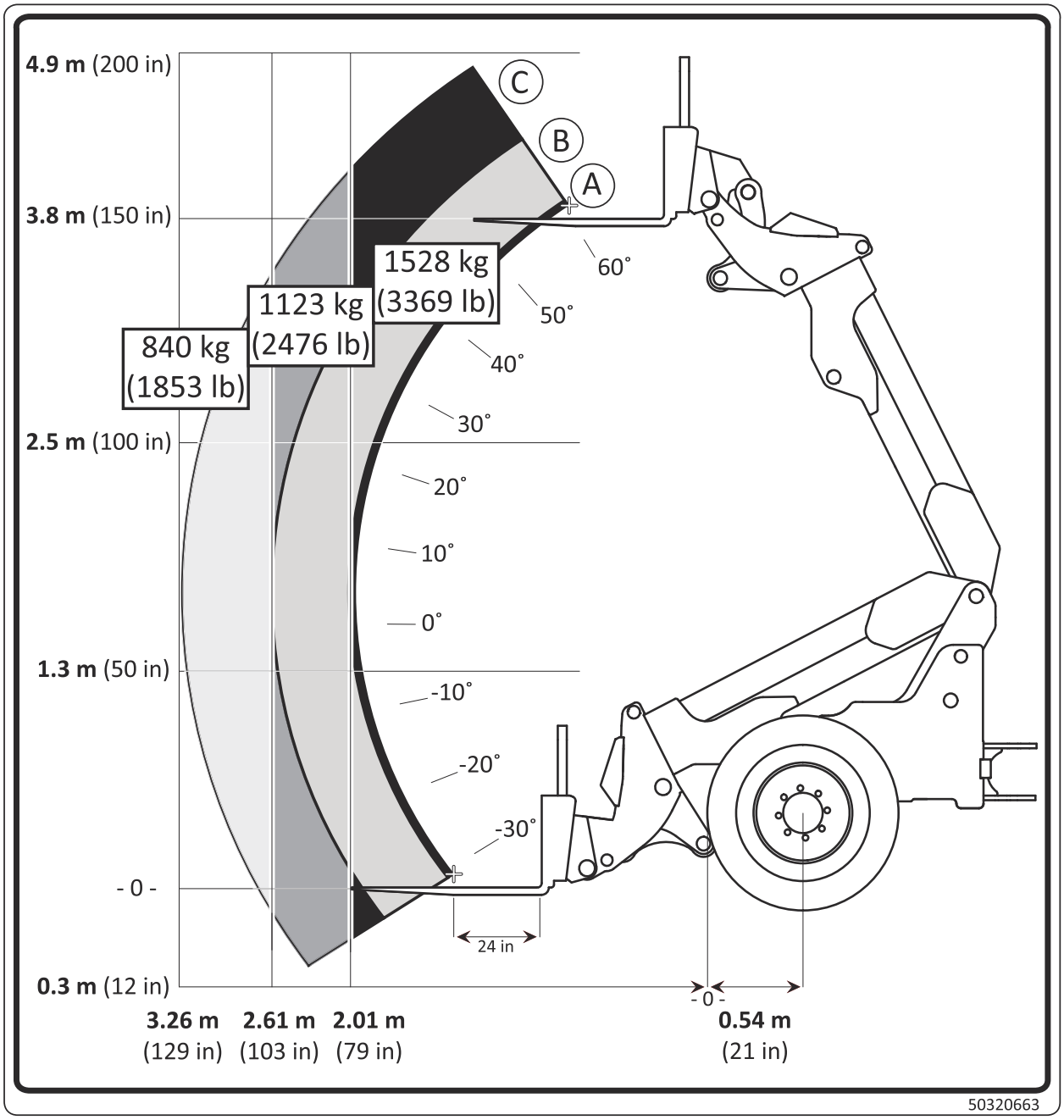
1. Measured on firm and level ground. Equipped with full fluids and 75 kg (165 lbs.) operator. Equipped with 405/70-20 (16/70-20) 145 G tires, in narrowest position.
2. IMPORTANT: Refer also to pallet fork capacities load charts on the following pages.
3. Equipped with 2135 mm (84”) dirt/construction bucket.

Pallet Fork Capacities Load Chart - Domestic (Telescopic Machines)

IMPORTANT: *The following chart shows operating capacity when the machine is articulated 40° on firm, level ground.*

DANGER

Do not raise loads unless the machine is level side-to-side. Refer to "Telescopic Machines Load/Level Indicators (Telescopic Machines)" on page 78.

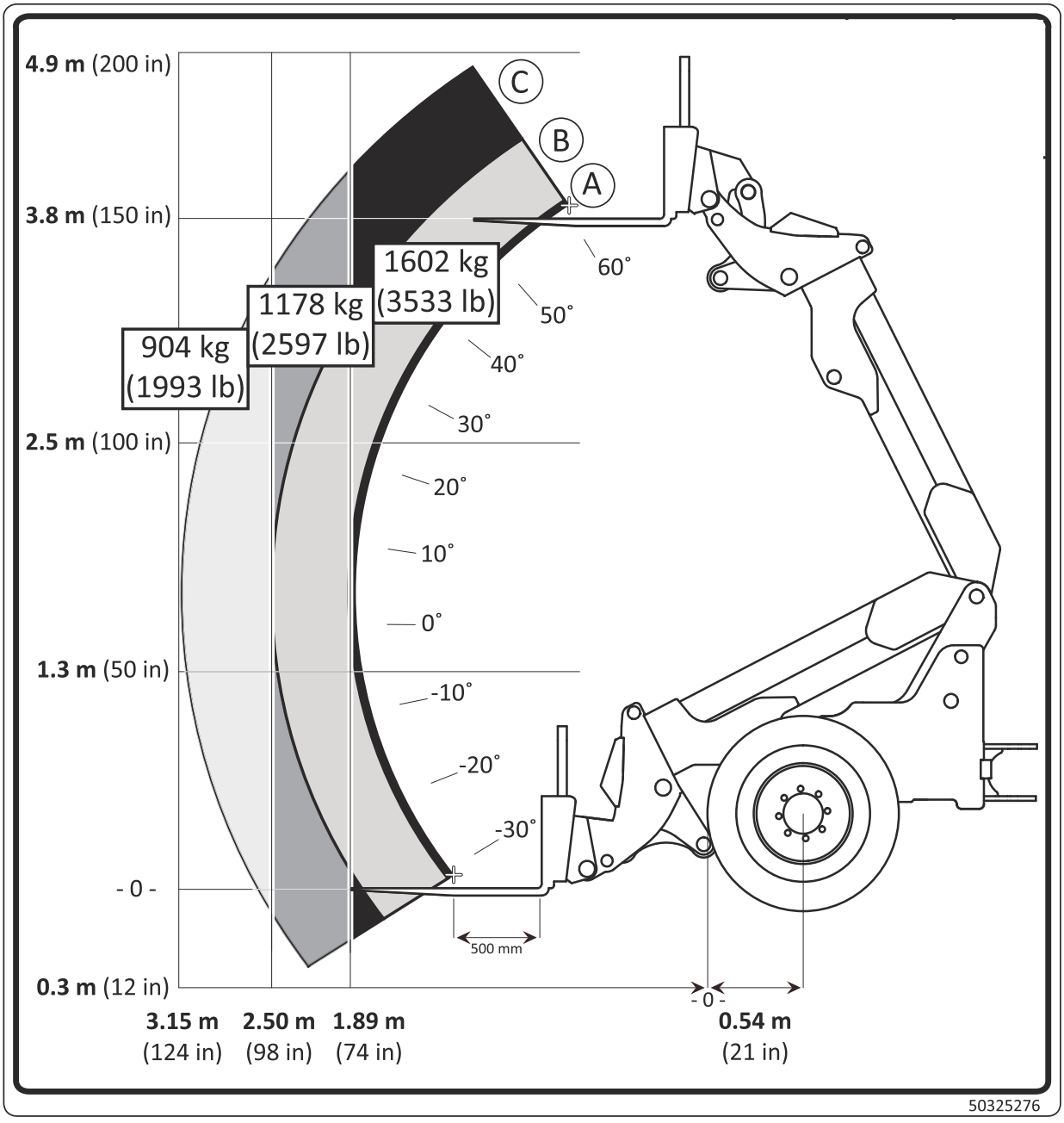


Pallet Fork Capacities Load Chart - EU (Telescopic Machines)

IMPORTANT: *The following chart shows operating capacity when the machine is articulated 40° on firm, level ground.*

⚠ DANGER

Do not raise loads unless the machine is level side-to-side. Refer to "Telescopic Machines Load/Level Indicators (Telescopic Machines)" on page 78.



Dimensions

Non-Telescopic Machines

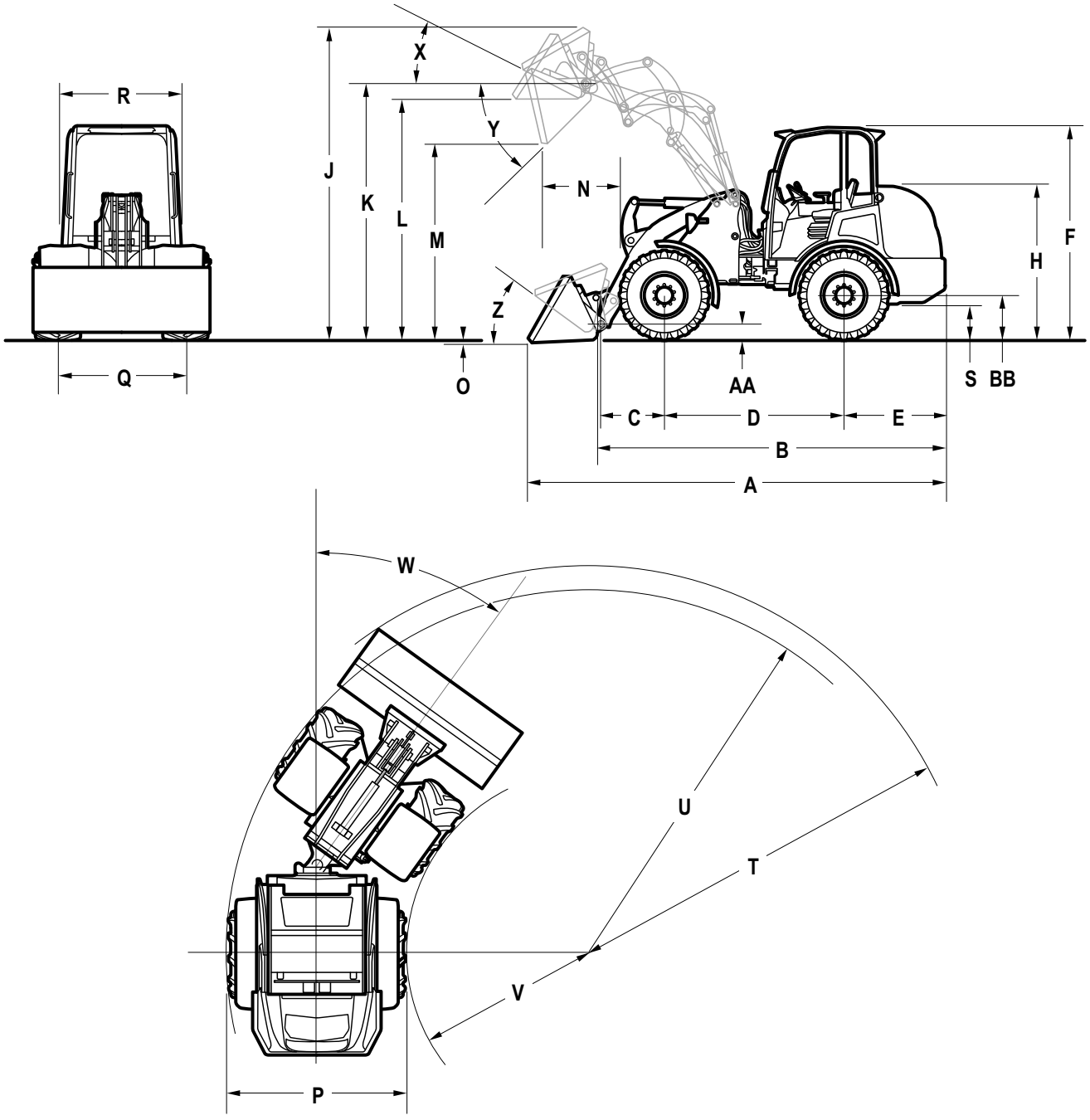


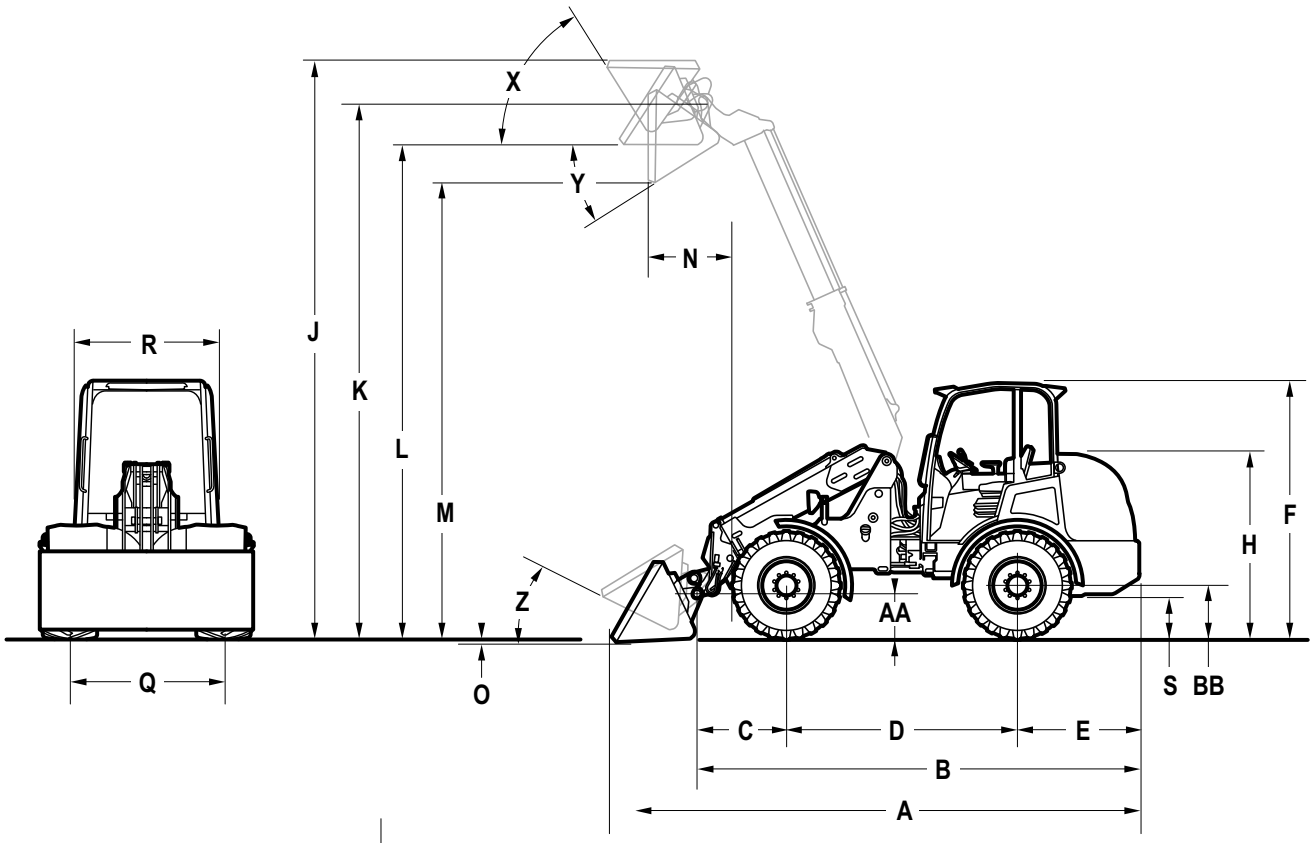
Table 7: Dimensions (Non-Telescopic Machines)

		Model 608/MLA-6	Model 708/MLA-7
A	Length with Bucket on Ground	5077 mm (199.9 in.)	5220 mm (205.5 in.)
B	Shipping Length	4260 mm (167.7 in.)	4443 mm (174.9 in.)
C	Front Wheel Center to Attachment Bracket	833 mm (32.8 in.)	931 mm (36.7 in.)
D	Wheelbase	2007 mm (79 in.)	2063 mm (81.2)

Table 7: Dimensions (Non-Telescopic Machines)

E	Rear Overhang	1326 mm (52.2 in.)	1323 mm (52.1 in.)
F	Height to Top of Cab	2467 mm (97.1 in.)	2476 mm (97.5 in.)
H	Hood Height	1775 mm (69.9 in.)	1768 mm (69.6 in.)
J	Maximum Operating Height	4008 mm (157.8 in.)	4160 mm (163.8 in.)
K	Bucket Hinge Pin Height	3315 mm (130.5 in.)	3474 mm (136.8 in.)
L	Ground Plane to Bucket Edge Height	3125 mm (123.0 in.)	3280 mm (129.0 in.)
M	Dump Clearance at Full Height	2515 mm (99.0 in.)	2710 mm (106.7 in.)
N	Dump Reach at Full Height	529 mm (20.9 in.)	569 mm (22.4 in.)
O	Digging Position (+ above / -below ground)	8 mm (0.3 in.)	
P	Width over Tires (Standard/Wide)	1645 mm (64.7 in.)/ 2017 mm (79.4 in.)	1736 mm (68.4 in.)/ 1957 mm (77.1 in.)
Q	Tire Gauge (Standard/Wide)	1230 mm (48.4 in.)/ 1595 mm (62.8 in.)	1327 mm (52.4 in.)/ 1544 mm (60.8 in.)
R	ROPS Width	1370 mm (53.9 in.)	1451 mm (57.1 in.)
S	Ground Clearance	370 mm (14.6 in.)	313 mm (12.3 in.)
T	Turning Radius with Bucket	3637 mm (143.2 in.)	4159 mm (155.3 in.)
U	Outer Turning Radius	3310 mm (130.3 in.)	3409 mm (134.2 in.)
V	Inner Turning Radius	1577 mm (62.1 in.)	1620 mm (63.8 in.)
W	Articulation Angle from Center	45°	
X	Rollback at Height	45°	
Y	Maximum Dump Angle at Full Height	45°	
Z	Bucket Rollback at Ground	45°	
AA	Attachment Pivot Clearance	190 mm (7.5 in.)	
BB	Wheel Radius	495 mm (19.5 in.)	
CC	Bucket Width – Standard	1676 mm (66 in.)	2134 mm (84 in.)

Telescopic Machines



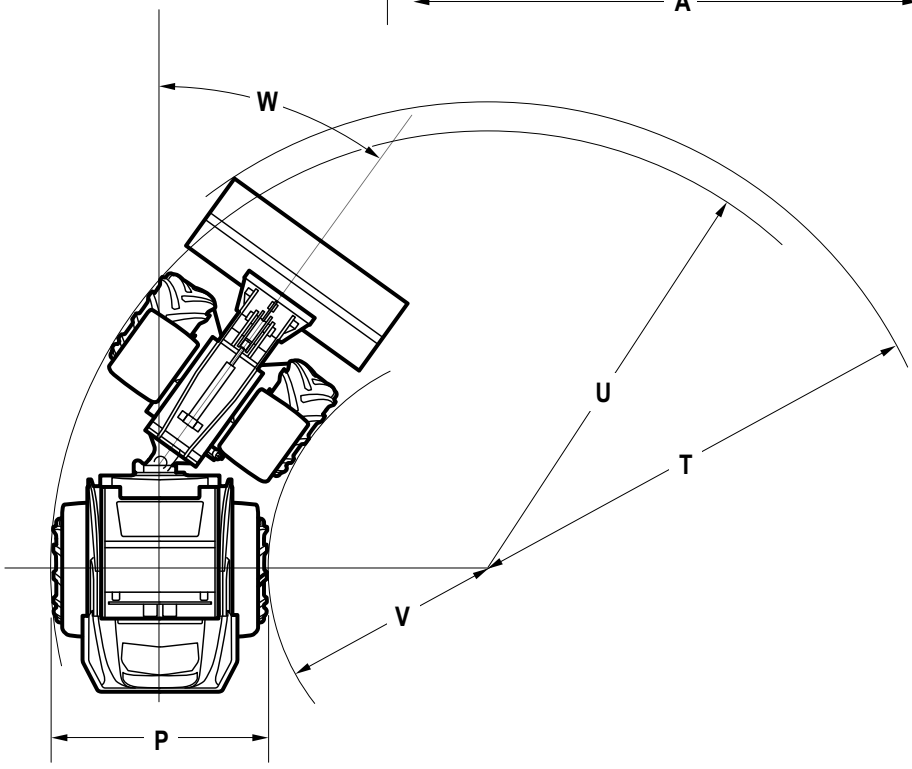


Table 8: Dimensions (Telescopic Machines)

		Model 708/MLA-7
A	Length with Bucket on Ground	5754 mm (225.6 in.)
B	Shipping Length	4950 mm (194 in.)
C	Front Wheel Center to Attachment Bracket	1205 mm (47.4 in.)
D	Wheelbase	2230 mm (87.8)
E	Rear Overhang	1352 mm (53.2 in.)
F	Height to Top of Cab	2476 mm (97.5 in.)
H	Hood Height	1768 mm (69.6 in.)
J	Maximum Operating Height (Retracted/Extended)	4885 mm (192.3 in.) / 5785 mm (227.8 in.)
K	Bucket Hinge Pin Height (Retracted/Extended)	3911 mm (154 in.) / 5027 mm (198 in.)
L	Ground Plane to Bucket Edge Height (Retracted/Extended)	3715 mm (146.3 in.) / 4836 mm (190.4 in.)
M	Dump Clearance at Full Height (Retracted/Extended)	3120 mm (122.8 in.) / 4238 mm (166.9 in.)
N	Dump Reach at Full Height (Retracted/Extended)	545 mm (21.5 in.) / 1128 mm (44.4 in.)
O	Digging Position (+ above / -below ground)	34 mm (1.3 in.)
P	Width over Tires (Standard/Wide)	1736 mm (68.4 in.) / 1957 mm (77.1 in.)
Q	Tire Gauge (Standard/Wide)	1327 mm (52.4 in.) / 1544 mm (60.8 in.)
R	ROPS Width	1451 mm (57.1 in.)
S	Ground Clearance	313 mm (12.3 in.)
T	Turning Radius with Bucket	4610 mm (181.5 in.)
U	Outer Turning Radius (Standard/Wide)	4105 mm (161.6 in.) / 4172 mm (164.3 in.)
V	Inner Turning Radius (Standard/Wide)	2302 mm (90.6 in.) / 2213 mm (87.1 in.)
W	Articulation Angle from Center	40°
X	Rollback at Height	62.5°
Y	Maximum Dump Angle at Full Height	44.5°
Z	Bucket Rollback at Ground	43°
AA	Attachment Pivot Clearance	175 mm (6.9 in.)
BB	Wheel Radius	495 mm (19.5 in.)
CC	Bucket Width – Standard	2134 mm (84 in.)

Weights

Non-Telescopic Machines

Table 9: Weights (Non-Telescopic Machines)

	600 Series (Canopy)	600 Series (Cab)	700 Series (Canopy)	700 Series (Cab)
Operating Mass[1]	4150 kg| (9150 lbs.)	4309 kg (9500 lbs.)	4781 kg (10540 lbs.)	4953 kg (10920 lbs.)
Maximum Permissible Weight	4992 kg (11005 lbs.)		5513 kg (12155 lbs.)	
Shipping Weight[2]	3867 kg (8526 lbs.)	4026 kg (8876 lbs.)	4447 kg (9805 lbs.)	4620 kg (10185 lbs.)

1. Equipped with standard bucket, driver, and full fluids.
2. Without operator and driver; 10% fuel.

Telescopic Machines

Table 10: Weights (Telescopic Machines)

	700 Series (Canopy)	700 Series (Cab)
Operating Mass (ISO 6016:2008)[1]	5485 kg (12,090 lbs.)	5579 kg (12,300 lbs.)
Maximum Permissible Weight	6000 kg (13227 lbs.)	
Shipping Weight (ISO 6016:2008)[2]	5054 kg (11,143 lbs.)	5155 kg (11,365 lbs.)

1. Equipped with standard bucket, driver, and full fluids.
2. Without operator and driver; 10% fuel.

Coolant Compound Table

Table 11: Coolant Compound Table

Outside Temperature	Water	Anti-corrosion agent		Antifreeze
Up to °F (°C)	% by volume	in¼gal (cm¼L)	% by Volume	% by volume
39 (4)	99	2.6 (10)	1	–
14 (- 10)	79			20
-4 (- 20)	65			34
-13 (- 25)	59			40
-22 (- 30)	55			45
-44 (-42)	50			50

Wheels/Tires

Table 12: Wheels

	600 Series	700 Series
Wheel Fastener Torque	325 Nm (240 lbs.-ft.)	550 Nm (406 lbs.-ft.)

Engine

Table 13: Engine

	600 Series	700 Series
Engine Make	Yanmar	Deutz
Engine Model	4TNV98CT-PGWL/1V (Stage 5/Tier 4/iT4)	TD 3.6 L4 (Stage 5/Tier 4)
Design	In-line 4 cylinder, 4-stroke diesel, turbocharged	
Exhaust Emission Compliance	EPA EU Stage 5/Tier 4 final/EU Stage III B	
Displacement	3.318 L (202.5 cu. in.)	3.621 L (221 cu. in.)
Bore and Stroke	98 x 110 mm (3.9 x 4.3 in.)	98 x 120 mm (3.9 x 4.7 in.)
Compression Ratio	17.3 : 1	17.2 : 1
Gross Power (ISO/TR 14396 : SAE J 1995)	48 kW (64.4 hp) @ 2300 rpm	55 kW (74.3 hp) @ 2300 rpm
Peak Torque	280 Nm (206 lbf.-ft.) @ 1560 rpm	330 Nm (243 lbf.-ft.) @ 1600 rpm
Low/High Idle (No Load)	1000 / 2300 rpm	1000 / 2310 rpm
Rated - Full Load Speed	2300 rpm	
Fuel Injection System	Direct injection	
Fuel Delivery	High-pressure common rail	
Fuel Filtering	In-line filter cartridge w/ water trap and replaceable element	
Firing Order	1-3-4-2	1-3-4-2
Normal Starting Aid	Glow plugs	
Cold Starting Aid (Optional)	400W-120V/200W - 230V block heater	700W- 120V/230V block heater
Lubrication	Pressure system w/replaceable filter	
Crankcase Ventilation	Closed	
Max. Inclined Angle (engine still supplied with oil)	30° in all directions	
Cooling System	Water / glycol	
Permissible Coolant Temperature	105° C (221°F)	110° C (230°F)
Thermostat Rating	82° C (180°F) cracking / 95° C (203°F) full open	86-90° C (187-194°F) cracking / 99-102° C (210-216°F) full open
Fan Ratio (Variable 0-100% w/ 25% step)	100% -1.26 : 1	
Aftertreatment System	Tier/Stage 4/5: DOC+DPF	Tier/Stage 4/5: DOC/DPF
Starter - Power	3 kW - 12 V	3.2 kW - 12 V
Alternator Voltage / Amperage	12 V / 100A	12 V / 95A
Operating Range–Ambient Temperature[1]	-15°C (+5°F) – +45°C (+113°F)	

1. Operation above temperature range may result in overheating; operation below temperature range may result in hard-starting.

Hydraulic System

Drive Hydraulics

Table 14: Hydraulic System : Drive Hydraulics

	600 Series	700 Series
Drive Speed	Low-speed range: 0-11 kph (0-7 mph) High-speed range: 0-20 kph (0-12 mph) 3-Speed high-speed (option) range: 0-30 kph (0-19 mph)	Low-speed range: 0-8 kph (0-5 mph) High-speed range: 0-20 kph (0-12.4mph) 3-Speed high-speed range: 0-30 kph (0-19 mph)
Hydrostatic Drive Motors		
Maximum working pressure	420 bar (6091 psi)	380 bar (5511 psi)
Flow @ 2300 rpm	131.1 L/min. (34.6 gpm)	156.4 L/min. (41.3 gpm)

Work Hydraulics

Table 15: Hydraulic System : Work Hydraulics

	600 Series	700 Series
Main Relief Valve Pressure	Standard-flow: 200 bar (2900 psi)	
High-Flow Relief Pressure	189.6 bar (2750 psi)	
Flow @ 2300 rpm	96.9 L/m (25.6 gpm) @ 2300 rpm	114.3 L/m (30.2 gpm) @ 2300 rpm

Sound Power/Pressure Levels (Non-Telescopic Machines)

Table 16: Sound Power/Pressure Levels (Non-Telescopic)

	600 Series	700 Series
Noise Level / Environmental Level (EU Dir. 2000/14/EC)[1]	101 dB(A)	
Operator Ear (EU Dir. 2006/42/EC)[2]	78.8 (±2.5) dB(A)	79 (±2.5) dB(A)

1. Declared sound power level per ISO 6395:2008 with closed cab @ 70% max. engine cooling fan.
2. Declared sound pressure level per ISO 6396:2008 with closed cab @ 70% max. engine cooling fan.

Sound Power/Pressure Levels (Telescopic Machines)

Table 17: Sound Power/Pressure Levels (Telescopic)

	600 Series	700 Series
Noise Level / Environmental Level (EU Dir. 2000/14/EC)[1]	101 dB(A)	
Operator Ear (EU Dir. 2006/42/EC)[2]	80 (±2.5) dB(A)	74.5 (±2.5) dB(A)

1. Declared sound power level per ISO 6395:2008 with closed cab @ 70% max. engine cooling fan.
2. Declared sound pressure level per ISO 6396:2008 with closed cab @ 70% max. engine cooling fan.

Vibration Levels

Table 18: Vibration Levels

	600 Series	700 Series
Whole-Body Vibration (ISO 2631-1)		
Mechanical Suspension Seat	≤ 0.84 m/s² (± 0.4)	≤ 0.90 m/s² (± 0.5)
Air Suspension Seat	≤ 0.81 m/s² (± 0.4)	≤ 0.85 m/s² (± 0.4)
Hand-Arm Vibration (ISO 5349-1)		
Steering Wheel	≤ 1.57 m/s² (± 0.8)	≤ 1.73 m/s² (± 0.9)
Joystick	≤ 1.23 m/s² (± 0.6)	≤ 1.30 m/s² (± 0.7)

Common Materials and Densities

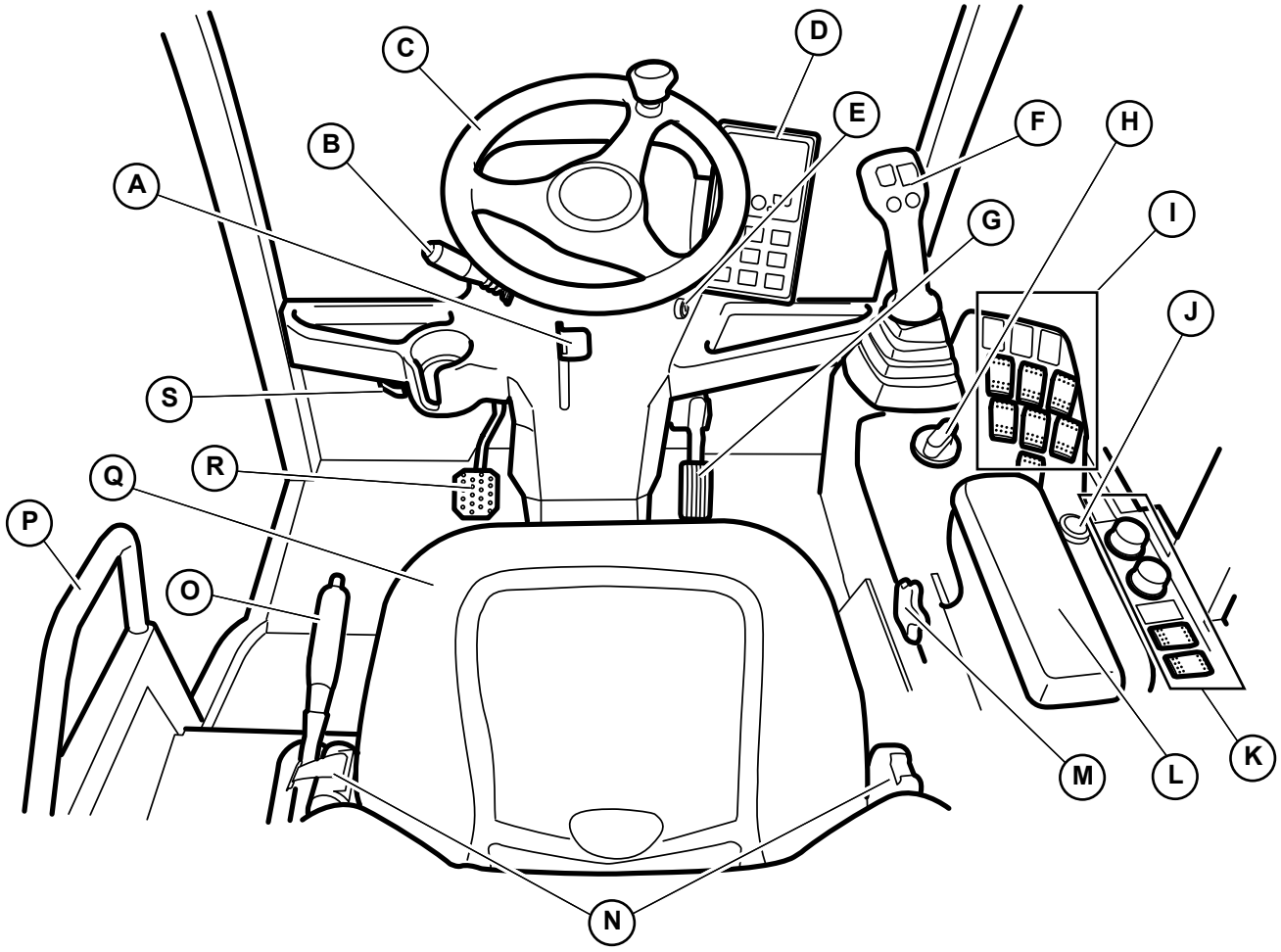
Table 19: Common Materials and Densities

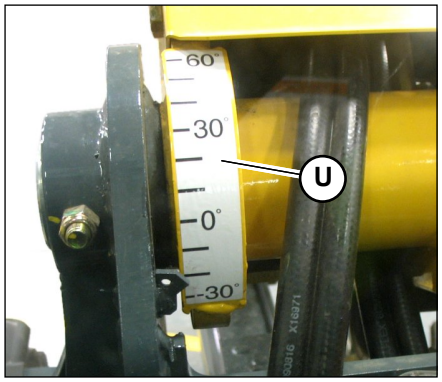
Material	Density	
	kg/m3	lbs./ft.3
Ashes	560-800	35-50
Brick-common	1792	112
Cement	1760	110
Charcoal	368	23
Clay, wet-dry	1280-1600	80-100
Coal	848-1008	53-63
Concrete	1840	115
Cinders	800	50
Coal-anthracite	1504	94
Coke	480	30
Earth-dry loam	1121-1442	70-90
Earth-wet loam	1281-1602	80-100
Granite	1488-1776	93-111
Gravel-dry	1602	100
Gravel-wet	1922	120
Gypsum-crushed	1840	115
Iron ore	2320	145
Lime	960	60
Lime stone	1440	90
Manure-liquid	1040	65
Manure-solid	720	45
Peat-solid	752	47
Phosphate-granular	1440	90
Potash	1088	68
Quartz-granular	1760	110
Salt-dry	1602	100
Salt-rock-solid	2160	135
Sand-dry	1728	108
Sand-wet	2000	125
Sand-foundry	1520	95
Shale-crushed	1440	90
Slag-crushed	1120	70
Snow	240-800	15-50
Taconite	1712	107

NOTE: *To determine load weights, multiply maximum material density by bucket capacity. Refer to "Payloads/Capacities" on page 51 for bucket capacities.*

NOTES

Indicators and Controls





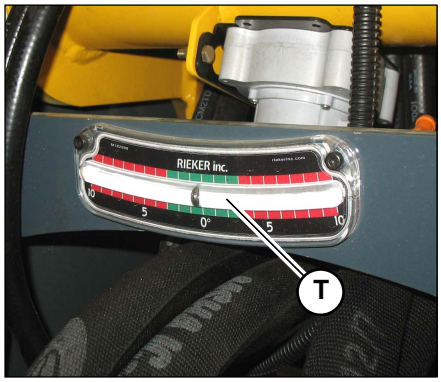


Fig. 12 – Controls

Table 20: Operator Controls

Ref.	Item	Description
A	Steering Column Adjustment	Adjusts steering column tilt and height (page 88).
B	Control Lever (Option)	Controls road lights, directional indicators, and horn (page 86).
C	Steering Wheel	Controls travel direction.
D	Multi-Function Display/Control Keypad	Displays operational status, error fault codes, and input/output diagnostic data (page 67). Controls HVAC, lights, windshield washers/wipers, hydraulic lock-out, attachment hitch lock/unlock (page 76), and cooling fan reverse (page 93).

Table 20: Operator Controls

Ref.	Item	Description
E	Ignition Switch	Controls accessory power, engine start, and run (page 80).
F	Multi-Function Joystick	Used to control lift structure/attachment movement, travel direction/speed range, auxiliary hydraulics, and differential lock (page 81).
G	Travel Pedal	Controls travel/engine speed (page 87).
H	Hand Throttle	Controls engine speed, separately from the travel pedal (page 86).
I	Switch Panel	Controls various features and functions, such as Hydraglide™, attachment float, beacon, constant speed, and accessory outlet power (page 77).
J	Electrical Accessory Socket	12VDC accessory outlet (page 97).
K	Heat/Air Conditioning (HVAC) Controls	Controls cab environment (page 94).
L	Armrest	Adjustable armrest (page 80).
M	Armrest Adjustment	Used to adjust armrest position (page 80).
N	Seat Belt	Always fasten seat belt before operating machine (page 80).
O	Parking Brake Lever	Engages parking brake (page 85).
P	Entry/Exit Hand-holds	Used for entering/exiting machine (page 101).
Q	Operator's Seat	Operate machine only when seated in the operator's position (page 80).
R	Brake/Inching Pedal	Press to gradually disengage transmission and control braking (page 86).
S	Auxiliary Circuit Pressure Relief	Relieves pressure in the auxiliary hydraulic circuit (page 136).
T	Lateral Level Indicator (Telescopic Machines Only)	Located in front of the operator on the back of the front frame. Indicates safe side-to-side level operation (page 79).
U	Lift Structure Angle Indicator (Telescopic Machines Only)	Located in front of the operator on the back of the left lift structure pillar pivot. Indicates the angle of lift structure elevation relative to the front chassis (page 78).

Multi-Function Display

The multi-function display is located in front of the steering wheel on the right. It provides the following functionality:

- Displays operational status such as engine fuel tank level, engine rpm, coolant temperature, operation time, and system voltage.
- Displays error fault codes and input/output diagnostic data.
- Configures display settings.

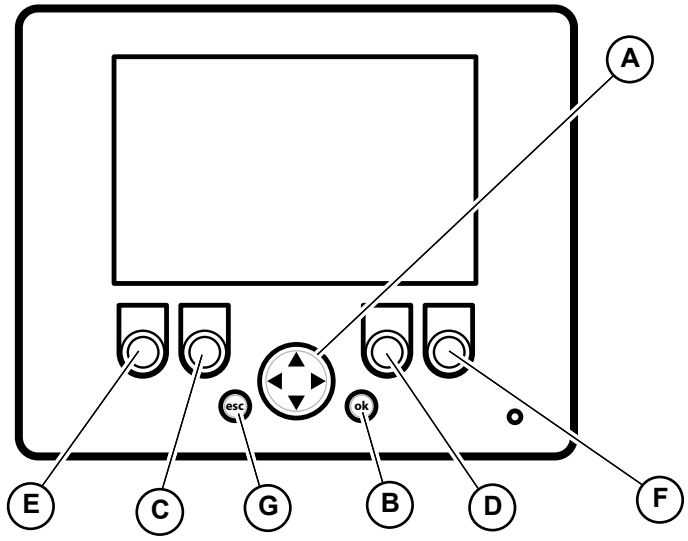


Fig. 13 – Multi-Function Display

Table 21: Multi-Function Display

Ref.	Item	Description
A	Navigation Rocker Button	Used for general screen navigation and other various functions, depending upon screen and context.
B	OK Button	Used for various functions, depending upon screen and context.
C	Increase Brightness/Return Button	Used for various functions, depending upon screen and context: • Used to increase display brightness. Corresponds to the ☼ symbol on the display screen. • Used to return to previous screen. Corresponds to the ↩ symbol on the display screen.
D	Decrease Brightness Button	Used to decrease display brightness. Corresponds to the ☼ symbol on the display screen.
E	Regen/Return Button	Used for various functions, depending upon screen and context: • Switches to the Regen display mode if the symbol is displayed on the screen. Also initiates DPF regeneration if all appropriate conditions are met. • Used to return to previous screen. Corresponds to the ↩ symbol on the display screen.
F	Regen Inhibit Button (DPF-equipped engines)	Press for 5 seconds to inhibit DPF reset regeneration. Displays the symbol.
G	ESC (Escape) Button	Press to exit secondary screens, toggle the LLMI audible alarm ON/OFF, and return to previously selected status screen.

⚠ WARNING

If the LCD is broken, care must be taken with any leaking fluid. If LCD fluid gets on your skin, wipe with a cloth and wash the area with mild soap and water. If LCD fluid gets into your eyes, thoroughly rinse your eyes with clean water for several minutes and seek medical assistance. If LCD fluid is swallowed, rinse your mouth thoroughly with clean water, then drink a substantial volume of water and induce vomiting. Then seek medical assistance.

Multi-Function Display Symbols

The following table describes symbols used on the multi-function display.

NOTE: *Values may not display for all parameters, depending upon installed options and equipment.*

Table 22: Symbol Descriptions

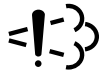
Symbol	Description	Symbol	Description
	Engine crankshaft revolutions per minute.		Parking brake.
	Accumulated operation time. Time is displayed in hours and accumulates when the engine is running.		Display brightness increase. Press button (C, Fig. 13) when this symbol is displayed to increase screen brightness.
	Battery charging circuit voltage.		Display brightness decrease. Press button (D, Fig. 13) when this symbol is displayed to decrease screen brightness.
	Fuel level in fuel tank.		Return to previous. Press button (B, Fig. 13) when this symbol is displayed to return to the previous screen.
	Coolant temperature. IMPORTANT: Running the engine in an overheated condition can damage the engine.		Diesel Particulate Filter (DPF) regeneration (DPF models). See “Diesel Particulate Filter (DPF) Regeneration Procedures” on page 148.
	Percentage of engine power based on load.		Diesel Particulate Filter (DPF) regeneration inhibit. See “Diesel Particulate Filter (DPF) Regeneration Procedures” on page 148. Strike-through line through the symbol is displayed in red when DPF regeneration is inhibited.
	Ambient engine compartment temperature.		Diesel Particulate Filter (DPF) regeneration in-progress (elevated temperature). See “Diesel Particulate Filter (DPF) Regeneration Procedures” on page 148.
	Directional/hazard lights.		Engine emissions error code.
	Critical error warning. Causes error screen(s) to display. See “Error/Status/History Screens” on page 75.		Amber error condition warning. Causes error screen(s) to display. See “Error/Status/History Screens” on page 75.

Table 22: Symbol Descriptions

Symbol	Description	Symbol	Description
	Engine oil pressure warning.		Engine air intake restriction.
	Hydraulic oil temperature warning.		Hydraulic oil filter restriction warning.
	High speed.		Differential lock.
	Constant speed.		Low speed.
	Engine pre-heat.		Road lights.
F	Forward travel direction.	N	Drive in neutral.
	Real-time fuel consumption rate. Displayed in gallons/hour (SAE) or liters/hour (METRIC).	R	Reverse travel direction.
	Audible Alarm (See “Longitudinal Load Moment Indicator (LLMI) – EU Telescopic Machines Only” on page 117).		30 kph (3-speed).

Multi-Function Display Screens

NOTE: *Values may not display for all parameters, depending upon installed options and equipment. For all machines except EU telescopic, press left/right sides of navigation rocker button (A, Fig. 13) to switch between display mode screens.*

Table 23: Status and Maintenance Screens

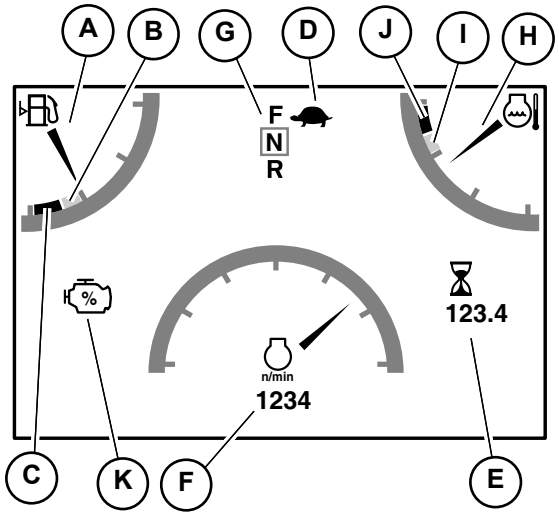
Display Mode	Description
Status/Maintenance Screens	
Non-Telescopic Machines  	Tri-Gauge Display (Non-Telescopic Machines) A. Fuel level. B. Fuel level amber warning region. Indicates low fuel level. C. Fuel level red stop region. Indicates almost empty fuel tank. D. Drive speed selection icon (low/high). E. Accumulated operation time. **NOTE:** *Operation time is displayed in hours and accumulates when the engine is running.* F. Engine crankshaft revolutions per minute. G. Travel direction selection (F=Forward / N=Neutral / R=Reverse). H. Engine coolant temperature. I. Engine coolant temperature amber warning region. Indicates elevated coolant temperature (above 212°F/100°C). J. Engine coolant temperature red stop warning region. Indicates serious coolant overheating condition (above 220°F/104°C). **IMPORTANT:** *Running the engine in an overheated condition can damage the engine.* K. Allows a selection between several parameters. Press the top/bottom of navigation rocker button (A, Fig. 13) to switch between parameters: • Percentage of engine power based on load. • Ambient engine compartment temperature. • Coolant temperature. • Accumulated operation time. • Fuel level in fuel tank. • Engine crankshaft revolutions per minute. • Battery charging circuit voltage.

Table 23: Status and Maintenance Screens

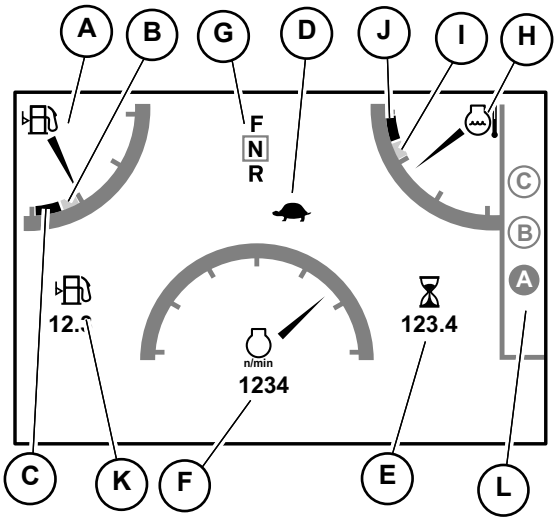
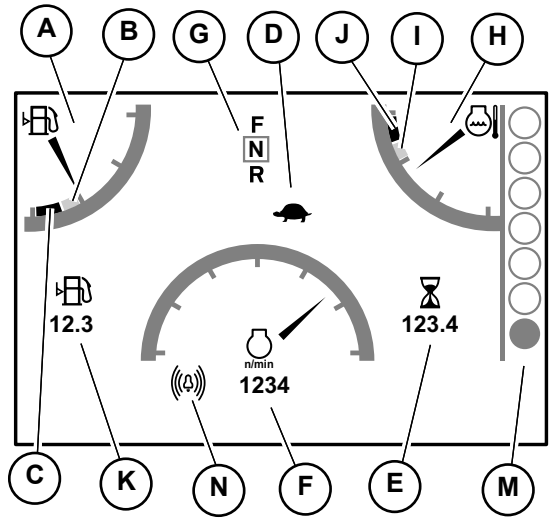
Display Mode	Description
Domestic Telescopic Machines  **EU Telescopic Machines**  	Tri-Gauge Display (Telescopic Machines) A. Fuel level. B. Fuel level amber warning region. Indicates low fuel level. C. Fuel level red stop region. Indicates almost empty fuel tank. D. Drive speed selection icon (low/high). E. Accumulated operation time. **NOTE:** *Operation time is displayed in hours and accumulates when the engine is running.* F. Engine crankshaft revolutions per minute. G. Travel direction selection (F=Forward / N=Neutral / R=Reverse). H. Engine coolant temperature. I. Engine coolant temperature amber warning region. Indicates elevated coolant temperature (above 212°F/100°C). J. Engine coolant temperature red stop warning region. Indicates serious coolant overheating condition (above 220°F/104°C). **IMPORTANT:** *Running the engine in an overheated condition can damage the engine.* K. Allows a selection between several parameters. Press the top/bottom of navigation rocker button (A, Fig. 13) to switch between parameters: • Percentage of engine power based on load. • Ambient engine compartment temperature. • Coolant temperature. • Accumulated operation time. • Fuel level in fuel tank. • Engine crankshaft revolutions per minute. • Battery charging circuit voltage. L. Lift structure extension display (See “Lift Structure Extension Indicator (Domestic Telescopic Machines Only)” on page 78). M. LLMI display (See “Longitudinal Load Moment Indicator (LLMI) – EU Telescopic Machines Only” on page 117). N. LLMI audible alert indicator. **NOTE:** *Press the esc (escape) button (G, Fig. 13) to toggle the LLMI audible alert ON/OFF.*

Table 23: Status and Maintenance Screens

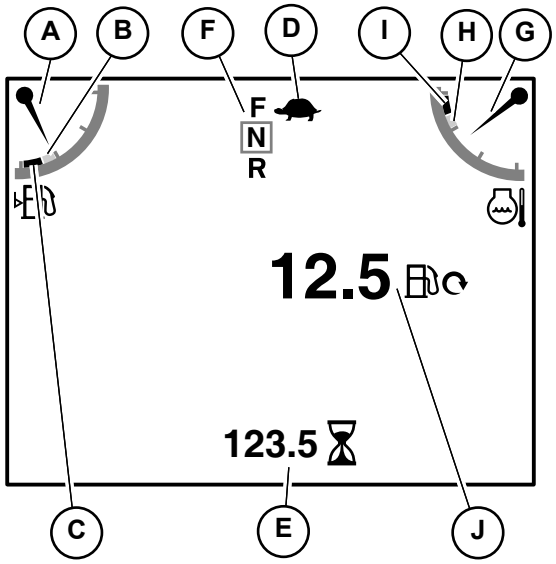
Display Mode	Description
	Dual Gauge Display (Non-Telescopic Machines) A. Fuel level. B. Fuel level amber warning region. Indicates low fuel level. C. Fuel level red stop region. Indicates almost empty fuel tank. D. Drive speed selection icon (low/high). E. Accumulated operation time. **NOTE:** *Operation time is displayed in hours and accumulates when the engine is running.* F. Travel direction selection (F=Forward / N=Neutral / R=Reverse). G. Engine coolant temperature. H. Engine coolant temperature amber warning region. Indicates elevated coolant temperature (above 212°F/100°C). I. Engine coolant temperature red stop warning region. Indicates serious coolant overheating condition (above 220°F/104°C). **IMPORTANT:** *Running the engine in an overheated condition can damage the engine.* J. Allows a selection between several parameters. Press the top/bottom of navigation rocker button (A, Fig. 13) to switch between parameters: • Fuel consumption rate. • Coolant temperature. • Engine power. • Engine ambient temperature. • Accumulated operation time. • Fuel level in fuel tank. • Engine crankshaft revolutions per minute.

Table 23: Status and Maintenance Screens

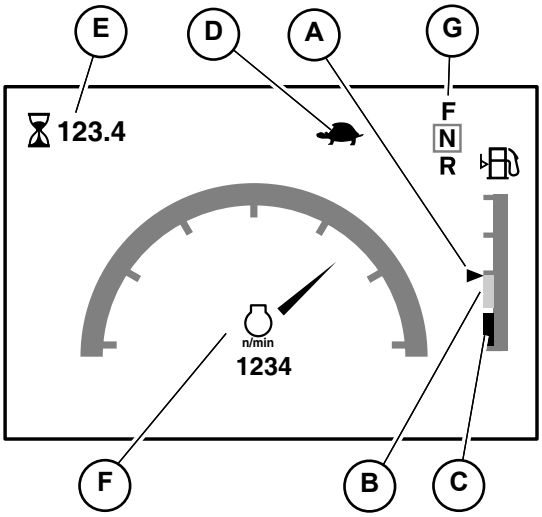
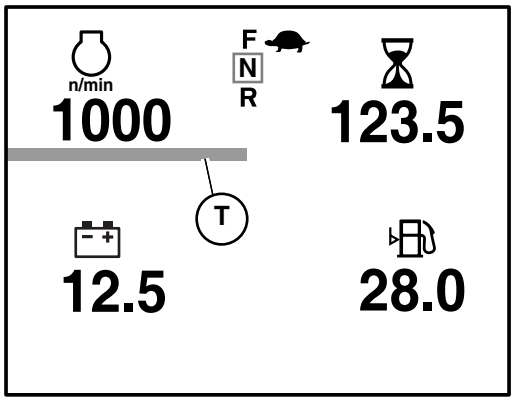
Display Mode	Description
	Single Gauge Display (Non-Telescopic Machines) A. Fuel level. B. Fuel level amber warning region. Indicates low fuel level. C. Fuel level red stop region. Indicates almost empty fuel tank. D. Drive speed selection icon (low/high). E. Accumulated operation time. **NOTE:** *Operation time is displayed in hours and accumulates when the engine is running.* F. Engine crankshaft revolutions per minute. G. Travel direction selection (F=Forward / N=Neutral / R=Reverse).
	Quad Gauge Display (Non-Telescopic Machines) Displays four different status parameters simultaneously. To change the displayed parameters, press and hold the ok button (E, Fig. 13) until orange bar (T) displays. Press the left/right side of navigation rocker button (A, Fig. 13) to select the parameter and press the top/bottom of navigation rocker button to change the selected parameter. Press the ok button again to dismiss orange bar (T).

Table 23: Status and Maintenance Screens

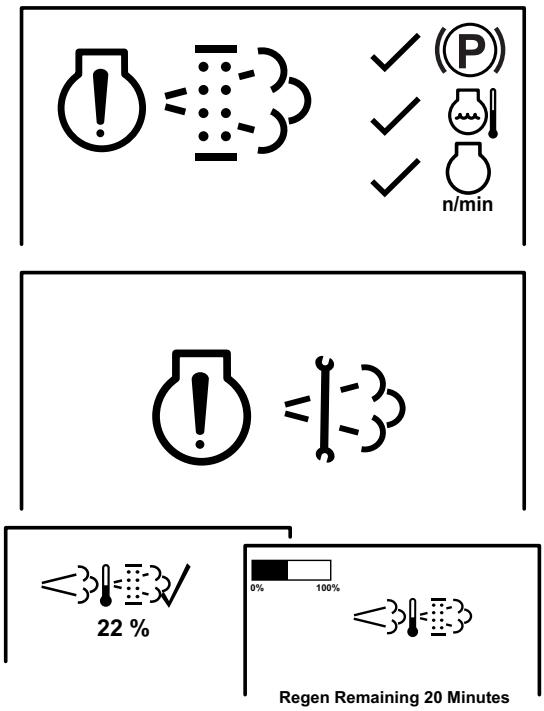
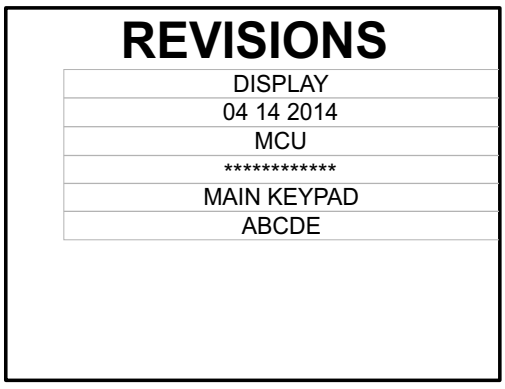
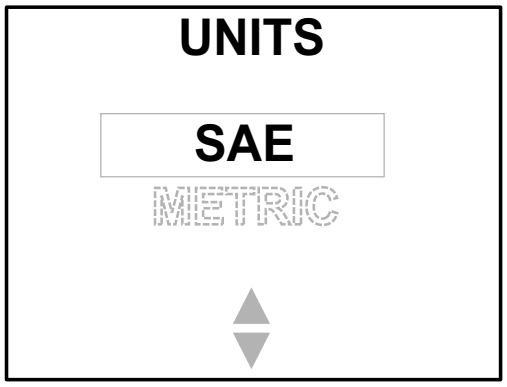
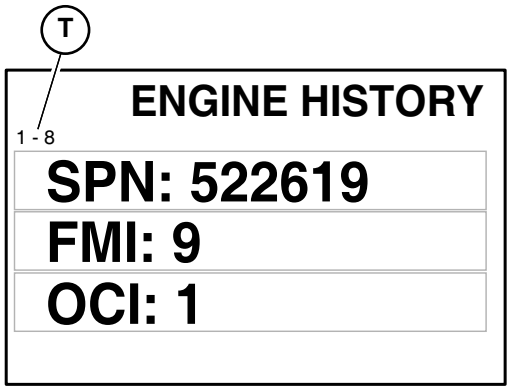
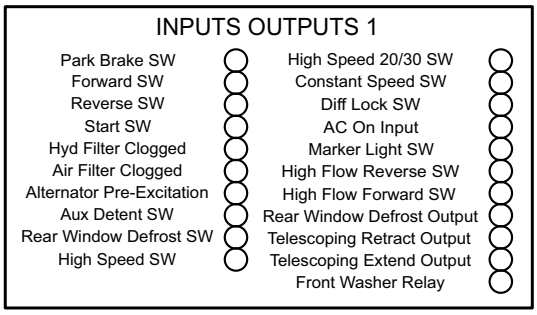
Display Mode	Description
	Regeneration Screens (DPF Models) These screens are associated with Diesel Particulate Filter (DPF) regeneration procedures and maintenance. See “Diesel Particulate Filter (DPF) Regeneration Procedures” on page 148.
Secondary Screens	
All Secondary Screens	Secondary screens are accessed by holding down the ok button (E, Fig. 13) for 10 seconds while either the single, dual, or tri-gauge display screen is displayed. Press the left/right side of navigation rocker button (A, Fig. 13) to switch between secondary screens. NOTE: Press “esc” button (G, Fig. 13) to exit secondary screens and return to the previously selected status screen.
	Revision Screen Displays information center electronic display software information.

Table 23: Status and Maintenance Screens

Display Mode	Description
	Units Screen Press the top/bottom of navigation rocker button (A, Fig. 13) to switch between SAE or metric units for values displayed in the screens.
	Error/Status/History Screens Displays engine, drive system, and control system error status and history code message information. The number of available messages is displayed at the top left of the screen (T). Press the left/right side of navigation rocker button (A, Fig. 13) to switch between screens and press the top/bottom of navigation rocker button to scroll through the codes. See “Error Codes” on page 224 for specific error code details.
	Input/Output Status Displays input/output electronic/CAN status. Press the left/right side of navigation rocker button (A, Fig. 13) to switch between input/output screens. Status colors indicate the following: • Green – Active • Blank – Inactive • Yellow – Short or open circuit

Control Keypad

The control keypad is located below the multi-purpose display.

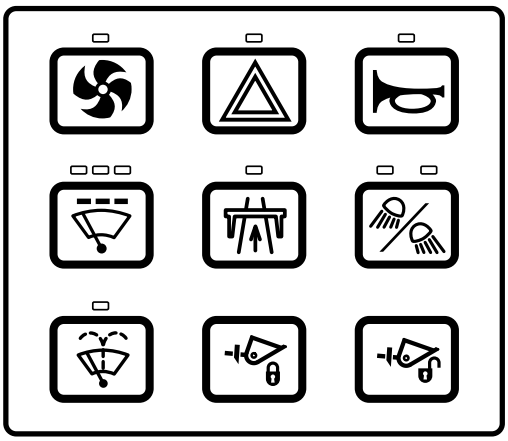


Fig. 14 – Buttons/Indicators

Table 24: Buttons/Indicators

Button	Description	Function
	Cooling Fan Reversing Button	Reverses cooling fan rotation. Clears cooling intake blockage. See “Cooling Fan Rotation Reversing Button” on page 93.
	Hazard Lights Button	Activates optional flashing road hazard lights. Operates even if the ignition switch is off.
	Horn Button	Activates horn. This button operates horn even with ignition switch turned off.
	Windshield Wiper Button	Turns windshield wiper on/off. Slow, medium, and fast settings are available. See “Windshield Wiper/Washer and Defrost” on page 96.
	Raise/Tilt Hydraulics Transport Lock-out Button	Deactivate the raise and tilt hydraulics. Used when driving the machine on roadways or when transporting loads longer distances. See “Hydraulics Transport Lock-out” on page 90.
	Work Lights Button	Operates the work lights. See “Work Lights Button” on page 94.
	Windshield Washer Button	Activates windshield washer. See “Windshield Wiper/Washer and Defrost” on page 96.
	Quick Attachment Hitch Lock	Press and hold to lock attachments onto the quick attachment hitch. See “Attachment Mounting” on page 91.
	Quick Attachment Hitch Unlock	Press and hold to unlock the quick attachment hitch to allow attachment removal. See “Attachment Mounting” on page 91.

Switch Panel

The switch panel is located to the right of the multi-function joystick.

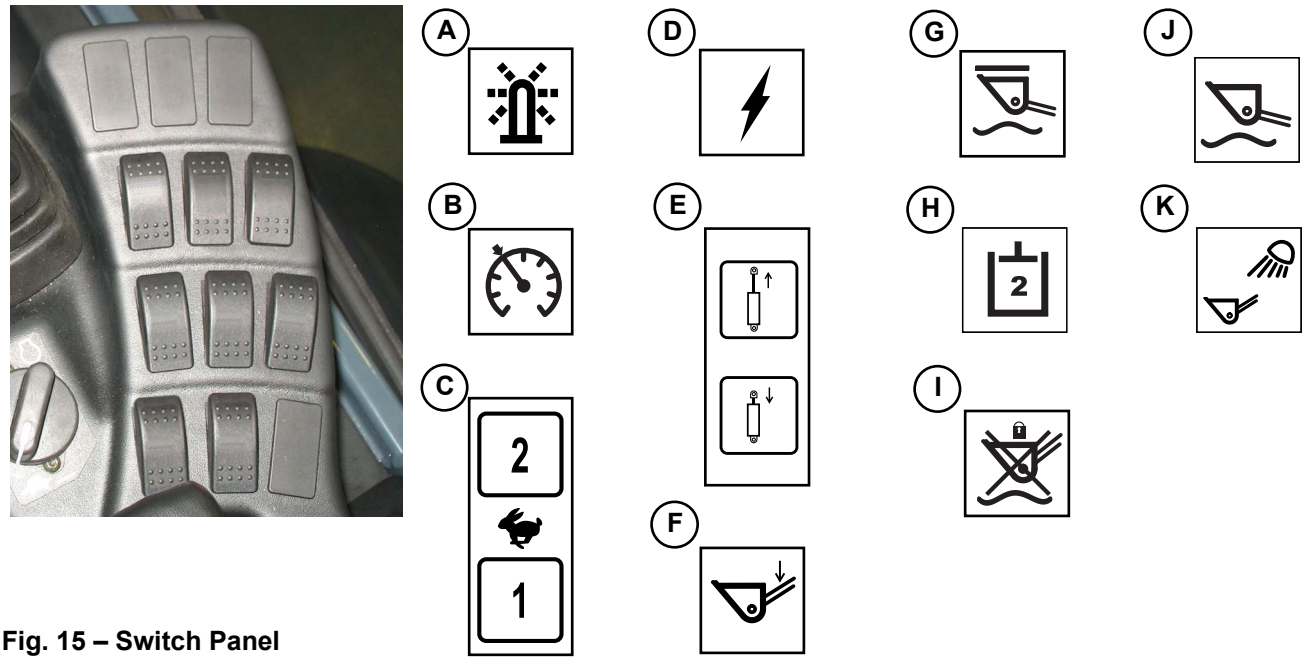


Fig. 15 – Switch Panel

Table 25: Switch Panel

Ref.	Description	Function
A	Beacon	Activates/deactivates rotating beacon (page 95).
B	Constant Speed	Activates/deactivates the constant speed option (page 89).
C	High/Low (2-and optional 3-speed) Travel Speed	Toggles between the high/low travel speeds (page 89).
D	Electrical Attachment Power	Activates/deactivates electrical attachment power (page 97).
E	High-Flow Auxiliary Hydraulics	Controls high-flow auxiliary hydraulics (page 91).
F	Engine Off Lift Structure Lower (non-telescopic machines only)	Used to lower the lift structure to the ground when the engine is stopped (page 90).
G	Hydraglide™ Cushion	Activates/deactivates load cushion/ride control feature (page 93).
H	Secondary Auxiliary Hydraulics (non-telescopic machines only)	Activates/deactivates second auxiliary hydraulic circuit (page 92).
I	Lift Structure Float Detent Lock Disable (non-telescopic machines only)	Disables lift structure float detent locks (page 82).
J	Raise Float Enable (telescopic machines only)	Enables raise float (page 83).
K	Telescopic Lift Structure Lights (telescopic machines only)	Activates/deactivates telescopic lift structure lights (page 95).

Audible Alerts

The control keypad also emits audible alerts (buzzer) under the following conditions:

Table 26: Audible Alerts

Alarm Duration	Description
5 seconds	Engine air filter is restricted.
	Hydraulic oil filter is restricted.
	Engine temperature too high.
	Engine oil pressure too low.
	Hydraulic oil temperature too high.
3 seconds	When ignition switch is on.

Telescopic Machines Load/Level Indicators (Telescopic Machines)

lift structureLift Structure Angle Indicator (Telescopic Machines)

The lift structure angle indicator (Y, Fig. 16) is located in front of the operator on the back of the left lift structure pillar pivot.

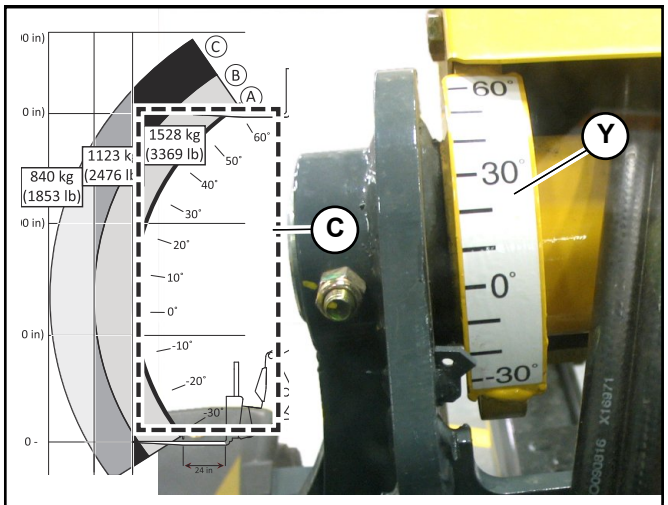


Fig. 16 – Lift Structure Angle Indicator

The lift structure angle indicator (Y) indicates the angle of lift structure elevation relative to the front chassis.

IMPORTANT: *The lift structure angle indicator (Y) corresponds to the angle values (C) shown on the pallet fork capacities load chart located inside the ROPS/FOPS at the top right corner of the windshield. Use the load chart and the lift structure angle indicator when using pallet forks to make sure not to exceed the load capacity of the machine.*

Lift Structure Extension Indicator (Domestic Telescopic Machines Only)

The lift structure extension indicator (X, Fig. 17) is located along the right edge of the multi-purpose display screen.

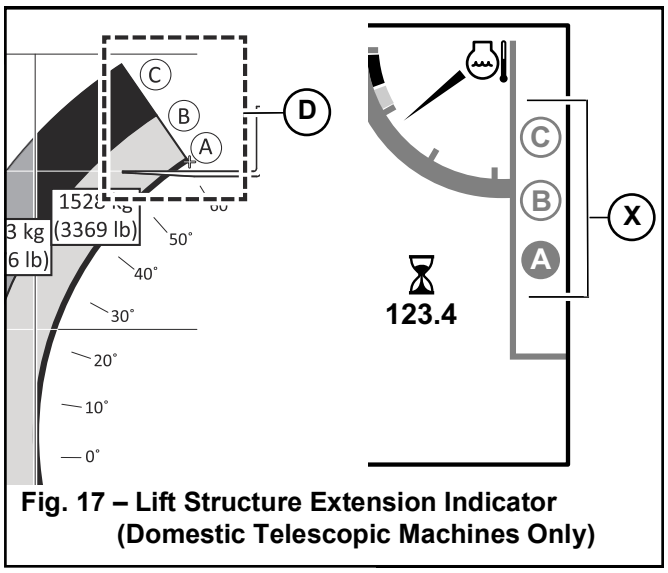


Fig. 17 – Lift Structure Extension Indicator (Domestic Telescopic Machines Only)

The lift structure extension indicator (X) indicates the amount of lift structure extension.

IMPORTANT: *The lift structure extension indicator (X) corresponds to the extension values (D) shown on the pallet fork capacities load chart located inside the ROPS/FOPS at the top right corner of the windshield. Use the load chart and the lift structure extension indicator when using pallet forks to make sure not to exceed the load capacity of the machine.*

Longitudinal Load Moment Indicator (LLMI) (EU Telescopic Machines Only)

Longitudinal Load Moment Indicator (LLMI) (Z, Fig. 18) is located along the right edge of the multi-purpose display screen.

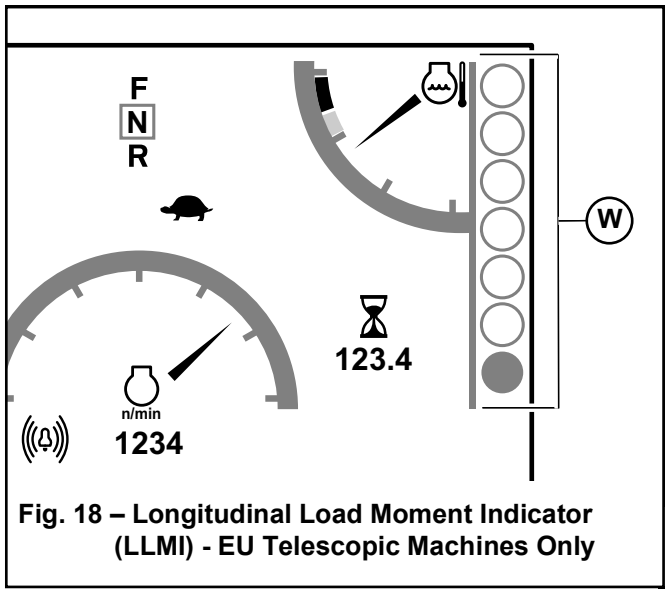


Fig. 18 – Longitudinal Load Moment Indicator (LLMI) - EU Telescopic Machines Only

The LLMI provides an indication of the effective capacity of the machine.

As the LLMI moves up and changes to red, the effective capacity of the machine is reduced.

⚠ WARNING

Read “Longitudinal Load Moment Indicator (LLMI) – EU Telescopic Machines Only” on page 117 before operating the machine

Lateral Level Indicator (Telescopic Machines)

Lateral level indicator (Z, Fig. 19) is located in front of the operator on the back of the front chassis.

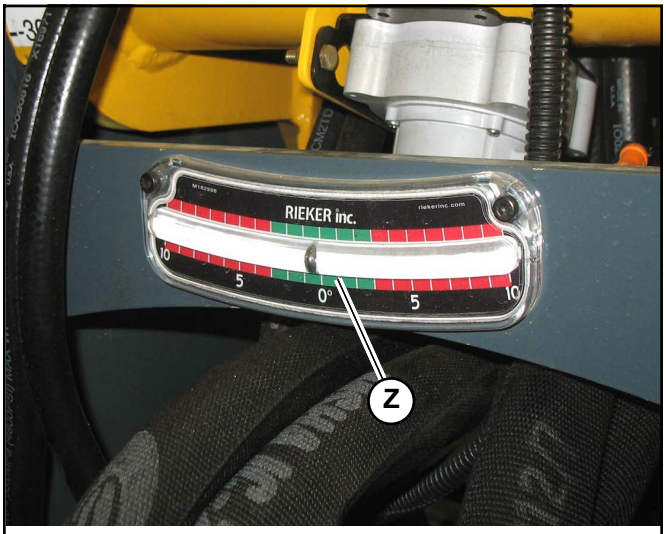


Fig. 19 – Lateral Level Indicator

The lateral level indicator (Z) enables the operator to check the side-to-side ground angle.

⚠ WARNING

DO NOT raise loads on a side hill with a slope or grade that is too steep for safe operation.

- **If the ball in lateral level (Z) is in the green zone, it is safe to raise the load.**
- **If the ball in the lateral level indicator (Z) is in the red zone, do not raise the load. The machine is in an unstable condition. Move the machine so the ball in the lateral level (Z) is in the green zone before raising the load.**

Ignition Switch

Fig. 20 – Ignition Key Switch

The ignition switch is located on the right side of the steering column. The ignition switch positions are:

- **OFF Position** (STOP)**:** With the key turned fully counterclockwise, power from the electrical system is disconnected from the controls and instruments. This is the only position where the key can be inserted or removed.
- **ON/RUN Position** **:** With the key turned one position clockwise from the OFF position, electrical power is supplied to all controls and instruments.
- **START Position** **:** With the key turned and held fully clockwise, the electric starter engages. Release the key to the ON/RUN position when the engine starts.

NOTE: *The engine will not start until after the multi-function display startup has completed and the icons are displayed on the screen.*

Operator's Seat/Armrest

The operator's seat has adjustments for:

- Forward and back horizontal seat/armrest position.
- Forward and back horizontal seat only position.
- Up and down vertical height/weight suspension.
- Backrest angle.

Refer to "Operator's Seat Adjustment" on page 103 for details about operator's seat adjustment.

Refer to "Armrest Height Adjustment" on page 104 for details about armrest adjustment.

⚠ WARNING

Never adjust the seat and/or the armrest when the machine is in operation. Make adjustments only when the engine is stopped.

After adjustments, make sure the seat/armrest adjustment levers/knobs are fully engaged/ tightened before using the machine.

Multi-Function Joystick

Multi-function joystick (J, Fig. 21) controls lift structure raise/lower, attachment tilt, and float functions. Buttons on the joystick control travel direction and speed, differential lock, and auxiliary hydraulic flow.

Additionally, on telescopic machines, the multi-function joystick controls telescopic lift structure extend/ retract. See “Telescopic Lift Structure Extend/Retract Control Switch (Telescopic Machines)” on page 81.

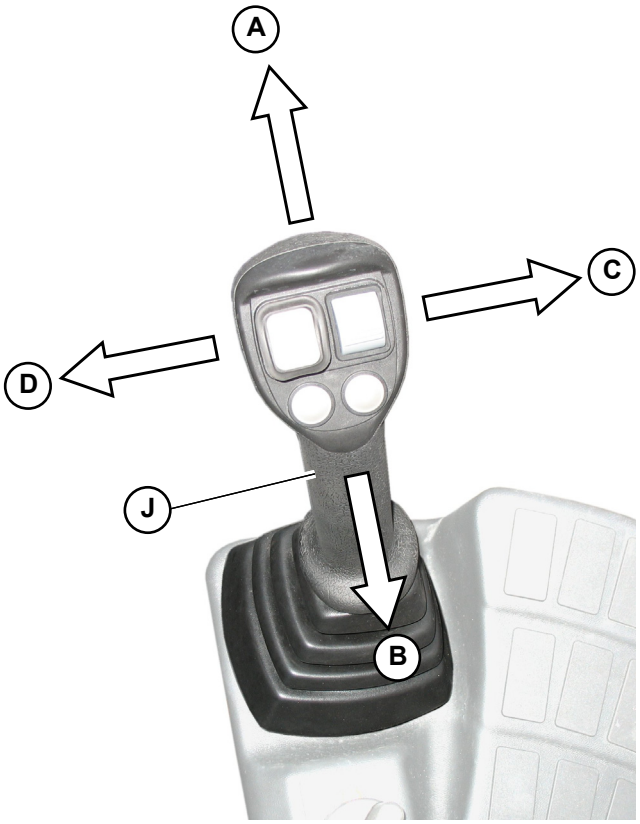


Fig. 21 – Multi-Function Joystick Control Pattern

Lift Structure/Attachment Tilt Control

- Push the joystick straight forward (A) to lower the lift structure.
- Pull the joystick straight back (B) to raise the lift structure.
- Move the joystick to the right (C) to tilt the attachment forward.
- Move the joystick to the left (D) to tilt the attachment back.

NOTE: *The speed of the raise/tilt motion is directly proportional to the amount of joystick movement and engine speed.*

IMPORTANT: *For detailed information about lift structure/attachment tilt operation, see “Lift Structure/Attachment Tilt Operation” on page 119.*

Telescopic Lift Structure Extend/Retract Control Switch (Telescopic Machines)

On telescopic machines, the rocker switch (U, Fig. 22) on the front of the multi-function joystick controls lift structure extend/retract.

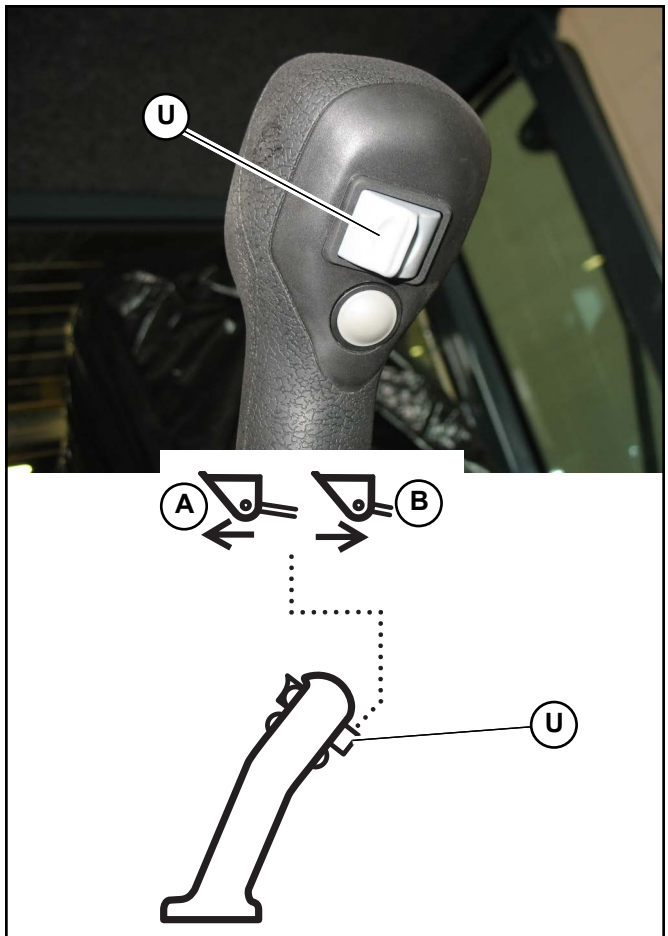


Fig. 22 – Telescopic Lift Structure Control Switch

- Move rocker switch (U) to the one side to extend (A) the lift structure.
- Move rocker switch (U) to the other side to retract (B) the lift structure.

NOTE: *The speed of the extend/retract motion is directly proportional to the amount of rocker switch movement and engine speed.*

Non-Telescopic Machines Float Controls

⚠ WARNING

Make sure the attachment is lowered to the ground before activating float. Activating float with an attachment raised will cause it to lower rapidly, which can cause severe injury or death.

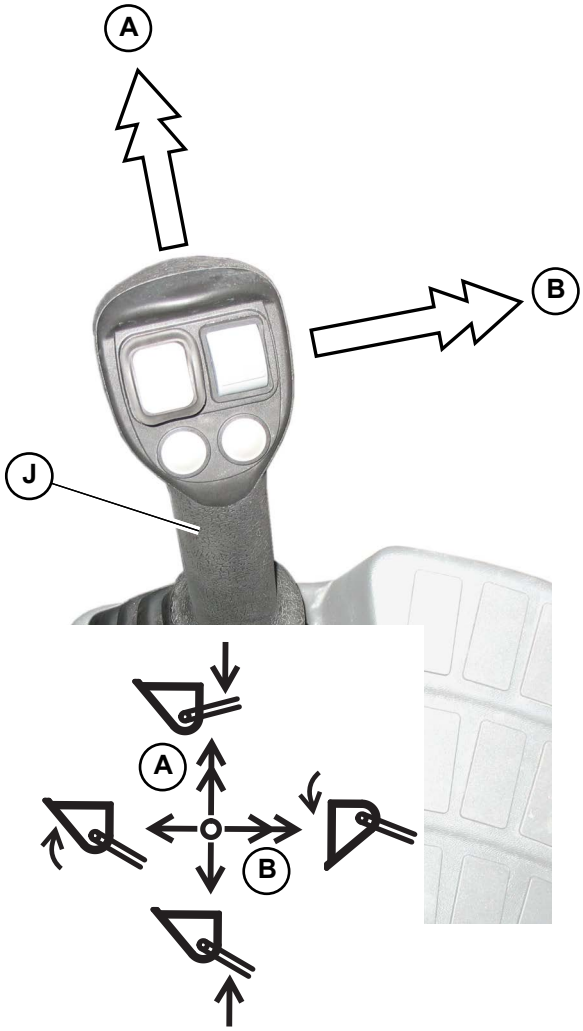


Fig. 23 – Non-Telescopic Machines Float Controls

- Hold joystick (J) all the way forward (A) until the lift structure float is engaged.
- Hold joystick (J) all the way to the right (B) until the tilt float is engaged.

Non-Telescopic Machines Lift Structure Float Detent Lock Disable (if equipped)

Switch (X, Fig. 24), located on the right switch panel, disables the lift structure raise/tilt float magnetic locks on non-telescopic machines. See "Non-Telescopic Machines Lift Structure Float Detent Lock Disable Operation (if so equipped)" on page 121 for more information.

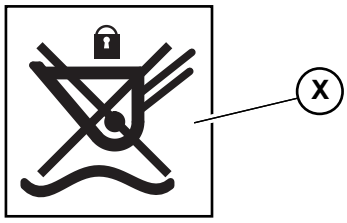


Fig. 24 – Non-Telescopic Machines Lift Structure Float Detent Lock Disable Switch

IMPORTANT: *For detailed information about float operation on non-telescopic machines, see "Non-Telescopic Machines Float Operation (Raise and Tilt)" on page 120.*

⚠ CAUTION

Float is still operational when the float detent lock disable switch is activated if the joystick is held in the float position. Float detent lock disable turns off ONLY the raise/tilt float LOCKING feature.

Telescopic Machines Raise Float Controls

⚠ WARNING

Make sure the attachment is lowered to the ground before activating float. Activating float with an attachment raised will cause it to lower rapidly, which can cause severe injury or death.

On telescopic machines, switch (P, Fig. 25), located on the right switch panel, enables lift structure float.

With switch (P) depressed, push joystick (J) forward past the detent to engage lift structure float.

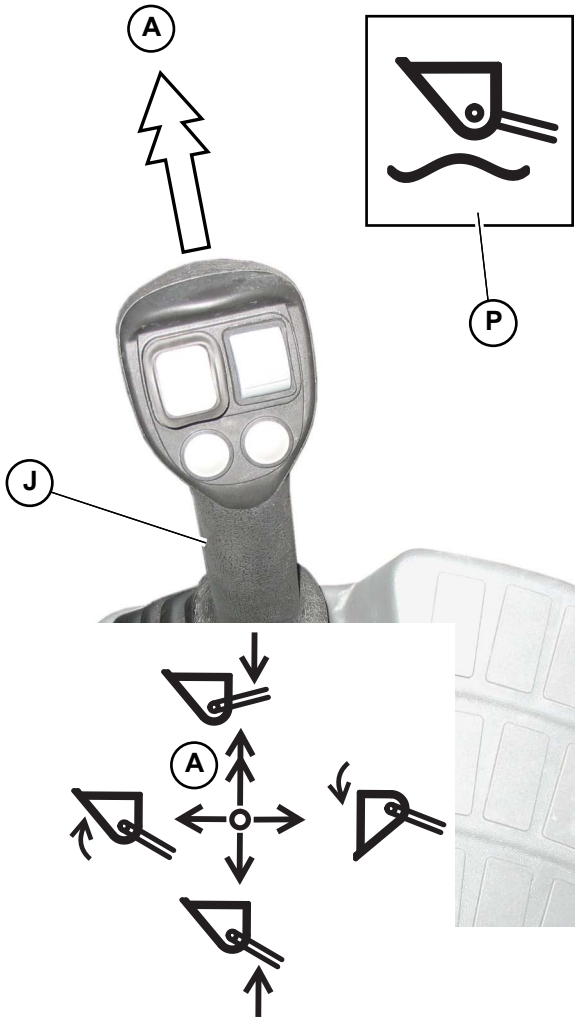


Fig. 25 – Telescopic Machines Float Controls

⚠ WARNING

If the joystick is pushed into - or pulled out of - the float position when switch (P) is not depressed, lift structure motion will stop/start suddenly and may cause the machine to jerk and/or bounce..

Travel Direction Switch

Travel direction switch (B, Fig. 26) controls forward/reverse travel direction. Refer to “Travel Direction Switch” on page 87 for more information.

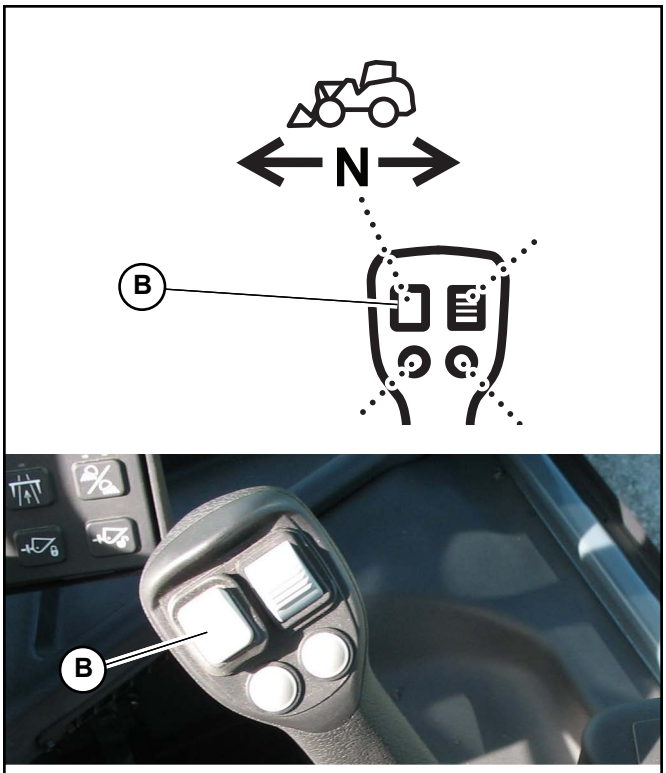


Fig. 26 – Travel Direction Switch

Travel Speed Range Selection Button

Travel speed range selection button (C, Fig. 27) toggles the high-speed travel mode on or off. Refer to “High/Low Travel Speed Selection” on page 89 for more information.

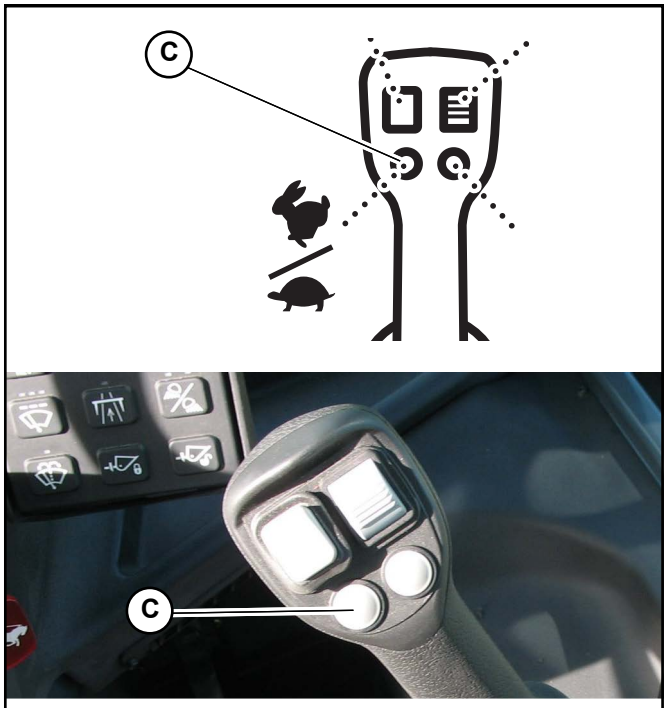


Fig. 27 – Travel Speed Range Selection Button

Differential Lock Button

Differential lock button (D, Fig. 28) toggles the differential lock on or off. Refer to “Differential Lock Operation” on page 113 for more information.

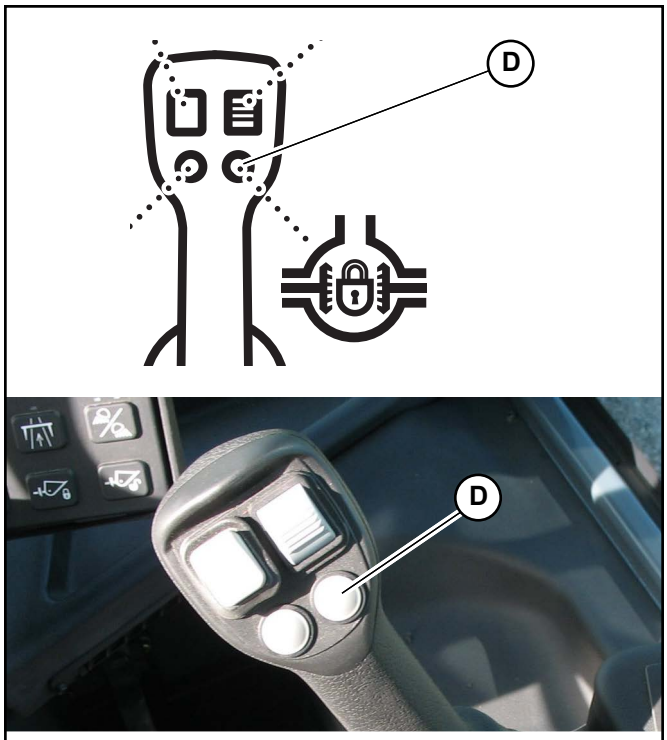


Fig. 28 – Differential Lock Selection Button

Auxiliary Hydraulics Control Switch

Auxiliary hydraulics control switch (E, Fig. 29) controls auxiliary hydraulics flow. Refer to "Auxiliary Hydraulic Control" on page 92 for more information.

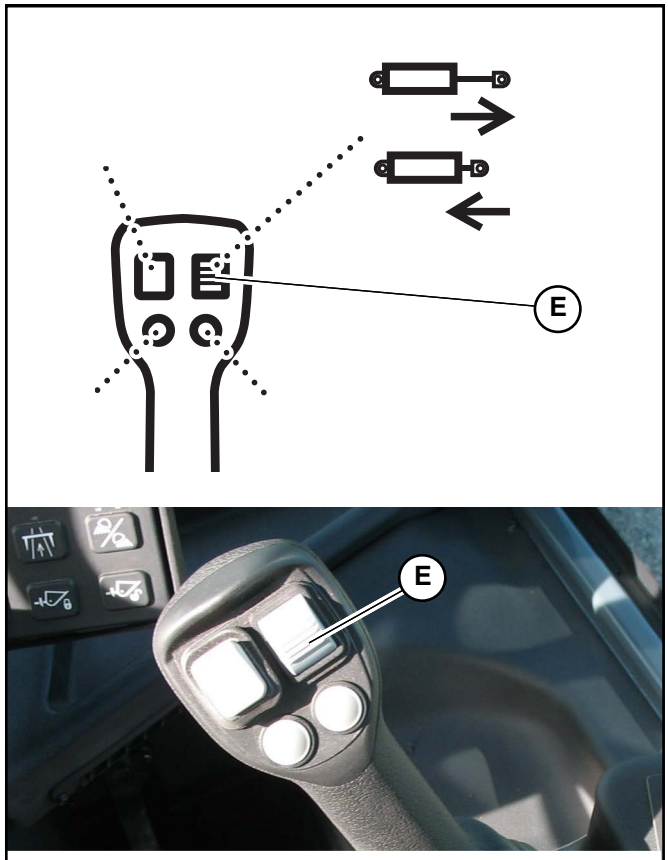


Fig. 29 – Auxiliary Hydraulics Control Switch

Parking Brake

To engage the parking brake, raise parking brake lever (H, Fig. 30) up.

To disengage the parking brake, raise lever (H) slightly, press button (K) and lower lever (H).

NOTE: *When the parking brake is engaged, the travel drive is disconnected.*

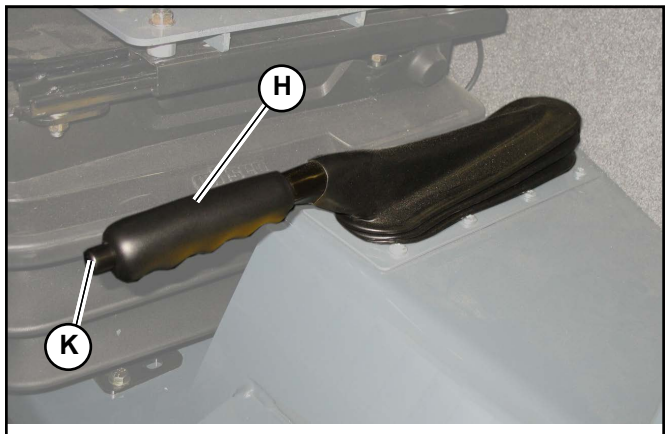


Fig. 30 – Parking Brake Lever

IMPORTANT: *If the optional backup alarm is installed and the parking brake is released, the backup alarm activates when the travel direction switch is in reverse.*

Parking Brake Adjustment/Service

Test the parking brake each time before using the machine. Adjustment and/or service is required if the parking brake does not keep the machine from moving when parking brake lever (H) is pulled up as far as possible. Refer to "Parking Brake Adjustment/ Service" on page 196.

Control Lever (Option)

The control lever (S, Fig. 31) on the steering column controls the horn, turn signals, position lights, and high/low beam road lights.

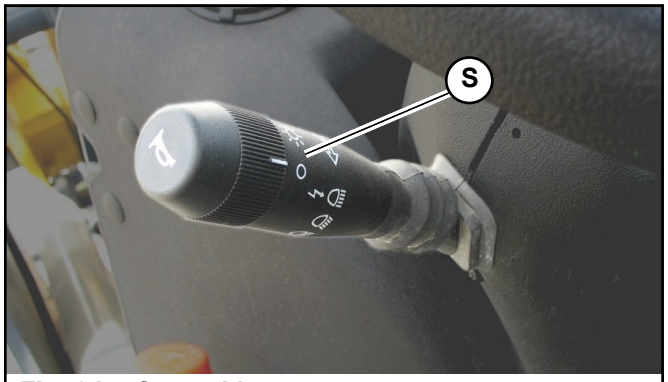


Fig. 31 – Control Lever

- Push the control lever inward to activate the horn.

  NOTE: *The horn can also be operated using the horn button on the control keypad.*

- Twist the end of the control lever to activate the position lights.
- Push/pull the control lever forward or back to activate the turn signals.
- Push the control lever downward to activate the road light “high” beams.
- Pull the control lever upward to activate the road light “low” beams.

Throttle Controls

Hand throttle (I, Fig. 32) is located just behind the multi-function joystick to the right of the operator’s seat.

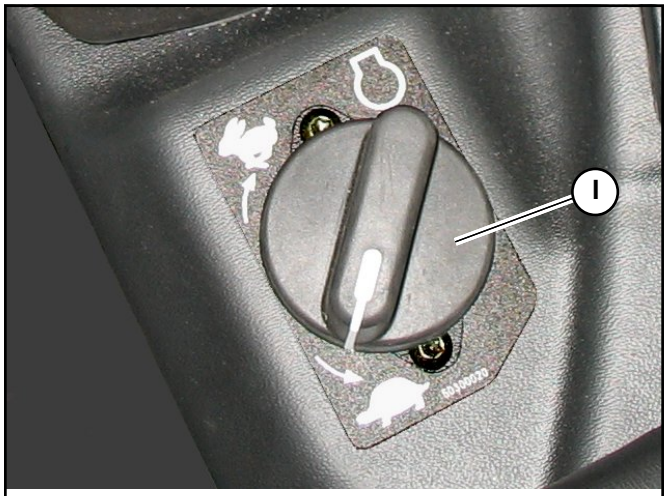


Fig. 32 – Hand Throttle Knob

NOTE: *The hand throttle controls engine speed separately from the travel pedal.*

NOTE: *Pressing the inching pedal reduces/stops hydraulic flow to the travel drive, allowing more power for lift structure operation.*

Travel Controls

NOTE: *When the parking brake is engaged, the travel drive is disconnected.*

Travel Direction Switch

Travel direction switch (Z, Fig. 33), on the multi-function joystick, controls travel direction (forward, reverse, neutral).

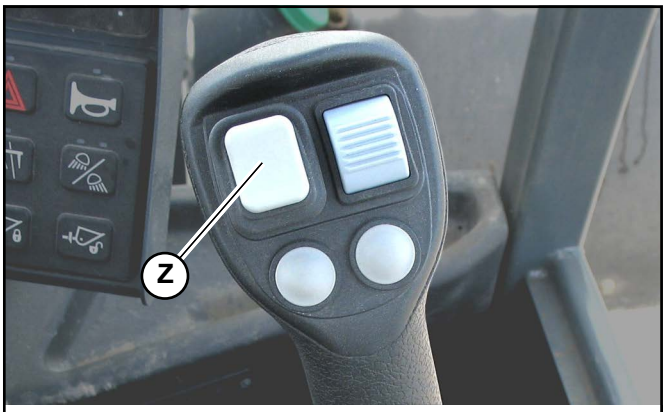


Fig. 33 – Travel Direction Switch

- Press the top of switch (Z) to engage forward travel. The F icon is selected on the multi-purpose display when forward travel is engaged.
- Press the bottom of switch (Z) to engage reverse travel. The R icon is selected on the multi-purpose display when reverse travel is engaged.
- Center switch (Z) to place travel drive in neutral. The N icon is selected on the multi-purpose display when the drive system is in neutral.

⚠ WARNING

Change travel direction only when stopped. Do not move the travel direction switch while traveling. The machine may react suddenly, causing an accident.

IMPORTANT: *If the machine is started with the travel direction switch in either the forward or reverse position, it must be returned to the neutral position before either the forward or reverse travel drive can be activated.*

IMPORTANT: *If the optional backup alarm is installed and the parking brake is released, the backup alarm activates when the travel direction switch is in reverse.*

Travel Pedal

Travel pedal (H, Fig. 34) controls travel and engine speed.

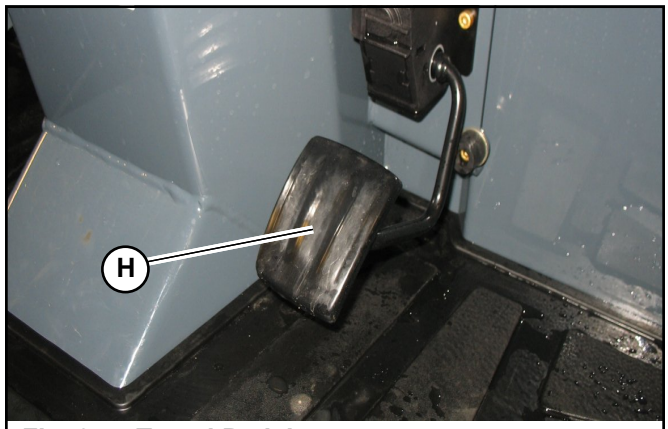


Fig. 34 – Travel Pedal

NOTE: *Pressing the inching pedal (Fig. 35) reduces/stops hydraulic flow to the travel drive, allowing more power for lift structure operation.*

Brake/Inching Pedal

Brake/inching pedal (G, Fig. 35) controls gradual travel drive transmission disengagement and braking.

NOTE: *Slightly depress pedal (G) to engage inching; firmly depress pedal (G) to engage the brake.*

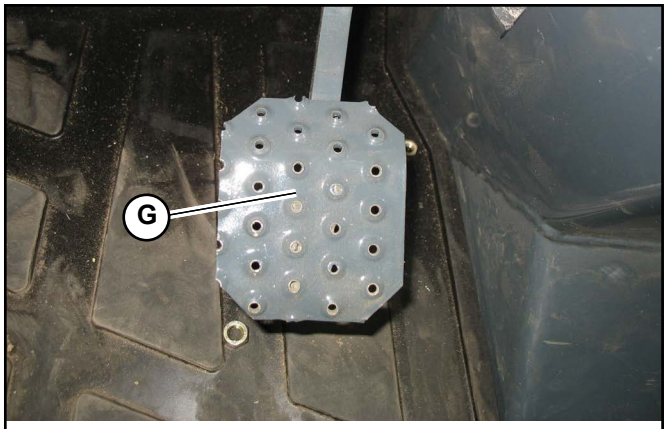


Fig. 35 – Brake/Inching Pedal

NOTE: *Pressing the inching pedal reduces/stops hydraulic flow to the travel drive, allowing more power for lift structure operation.*

Steering Wheel

Steering wheel (F, Fig. 36) controls travel direction.

Fig. 36 – Steering Wheel

Steering Column Adjustment

Adjust the steering column for visibility, utility, and comfort.

⚠ WARNING

Never adjust the steering column when the engine is running.

1. Pull adjustment lever (D, Fig. 37), located under the steering column, downward.

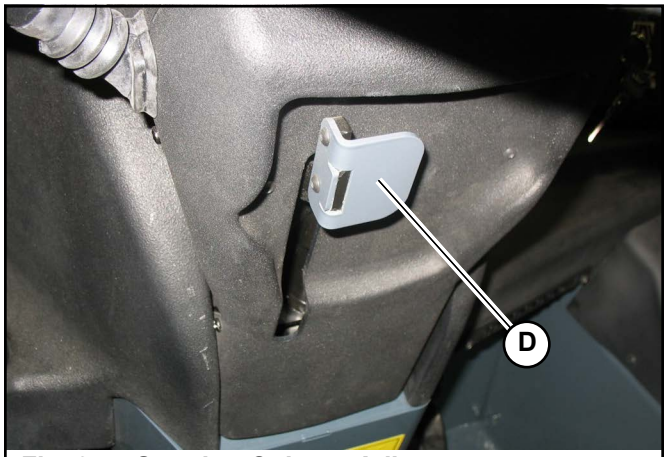


Fig. 37 – Steering Column Adjustment

2. Adjust the steering column to the desired height/tilt position.
3. Push adjustment lever (D) upward into the locked position.
4. Check that the steering column is locked in place.

High/Low Travel Speed Selection

The machine has two travel speed modes. Additionally, the 3-speed option raises the maximum speed when in high-speed mode.

NOTE: *Use the low-speed range for loading, unloading, and operations requiring precise speed control. Use the high-speed range for distance traveling.*

Pressing the speed mode select button (K, Fig. 38) toggles between the two speed modes. When in low-speed mode, the low-speed indicator is displayed on the multi-function display; when in high-speed mode, the high-speed indicator is displayed.

NOTE: *Low-speed mode is automatically selected when the machine is started.*

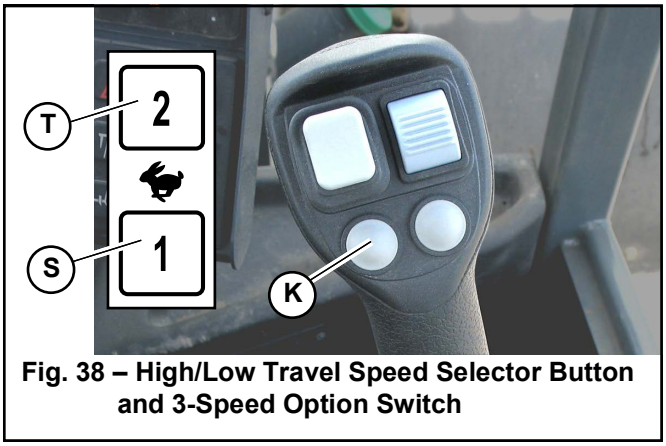


Fig. 38 – High/Low Travel Speed Selector Button and 3-Speed Option Switch

3-Speed Option

IMPORTANT: *For detailed information about 3-speed option operation, see "3-Speed Option" on page 113.*

The 3-speed option raises the maximum speed when in high-speed mode.

Pressing the "2" side (T, Fig. 38) of the 3-speed switch expands the speed range, and two high-speed indicators are displayed on the multi-function display.

Pressing the "1" side (S) of the switch returns to standard high-speed mode.

NOTE: *Low-speed mode is not affected by the 3-speed option.*

- Low-speed range:
  - 600 Series: 0-11 kph (0-7 mph).
  - 700 Series: 0-8 kph (0-5 mph).
- Standard high-speed range: 0-20 kph (0-12 mph).
- Optional 3-speed high-speed range: 0-30 kph (0-19 mph).

⚠ WARNING

Reduce speed before shifting from high to low travel speed. Down-shifting from high- to low-speed drive while traveling at high speed may cause the machine to tip and can cause injury, loss of control and damage to the machine.

Constant Speed (Option)

Switch (O, Fig. 39), located on the right switch panel, controls the optional constant speed function. See "Constant Speed Operation (Option)" on page 114 for more information.

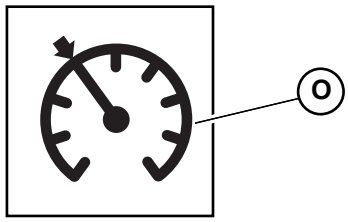


Fig. 39 – Constant Speed Switch

Differential Lock

IMPORTANT: *Stop the machine before engaging the differential lock. Do not engage the differential lock if turning on smooth, dry pavement. Damage to the axles may result.*

The differential lock can provide increased traction on loose and slippery surfaces.

Differential lock button (J, Fig. 40) activates the differential lock. See "Differential Lock Operation" on page 113 for more information.

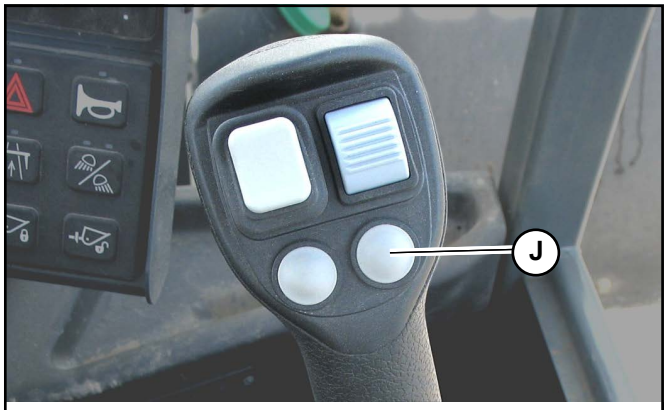


Fig. 40 – Differential Lock

Engine Off Lift Structure Lower

Non-Telescopic Machines

On non-telescopic machines, switch (F, Fig. 41), located on the right switch panel, allows for lowering the lift structure when the engine is not running.

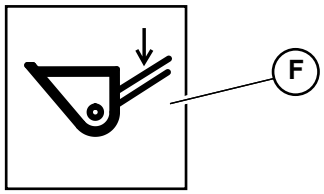


Fig. 41 – Power Off Lift Structure Lower (Non-Telescopic Machines)

While sitting in the operator's seat, press the orange lock button on the switch to enable the engine off load arm lower switch.

NOTE: *The ignition switch must be turned on and the operator's seat must be occupied for the engine off load arm lower to function.*

Telescopic Machines

⚠ WARNING

On early series telescopic machines, if the telescopic lift structure cannot be lowered because:

- **The engine stops and can't be restarted.**

- or -

- **A hydraulic system failure.**

Shut down the machine according to "Mandatory Safety Shutdown Procedure" on page 22. DO NOT attempt repairs. Call your dealer for assistance.

Hydraulics Transport Lock-out

Button (U, Fig. 42), located on the control keypad, controls the hydraulics transport lock-out function.

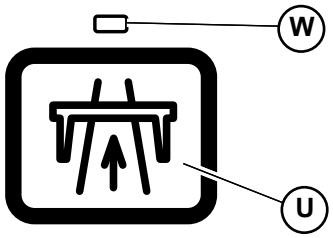


Fig. 42 – Hydraulics Transport Lock-out Button

Used to deactivate work hydraulics when driving the machine for longer distances and/or on public roads.

Position the lift structure for transport and press the hydraulics transport lock-out button (U) to prevent inadvertent raise/tilt movements. Pressing the button again will toggle the raise and tilt hydraulic functions back on.

NOTE: *Attachment raise and tilt hydraulics are deactivated when indicator (W) is lit.*

Attachment Mounting

The machine is equipped with a hydraulically operated quick attachment system for mounting a bucket or other attachments.

Quick Attachment Hitch

Buttons (G and H, Fig. 43) on the control keypad are used to operate the quick attachment system. Refer to "Connecting/Disconnecting Attachments" on page 130 for more information.

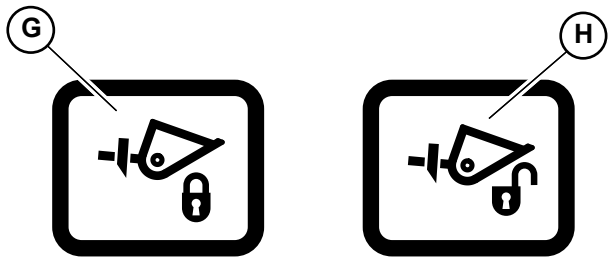


Fig. 43 – Quick Attachment System Control Buttons

Auxiliary Hydraulic System

Auxiliary hydraulics are used with attachments requiring hydraulic power.

Auxiliary Circuit Pressure Relief

Press auxiliary circuit pressure relief button (H, Fig. 44) to relieve pressure in the standard auxiliary hydraulic circuit before connecting/disconnecting hydraulically-powered attachment hoses.

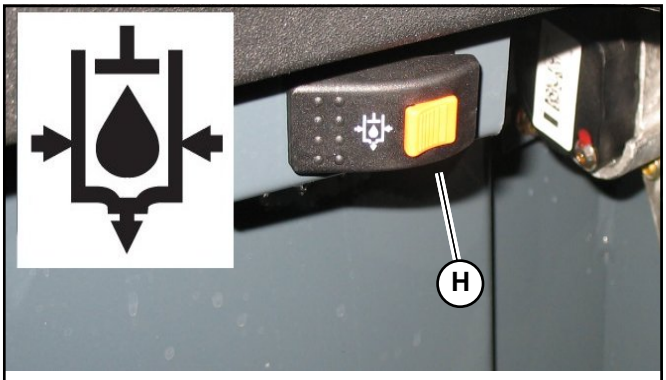


Fig. 44 – Auxiliary Hydraulics Pressure Relief Button

⚠ WARNING

Be sure no one is near the machine when relieving pressure from the auxiliary hydraulics circuit. Stored pressure may cause connected hydraulically-powered attachments to move when the circuit is de-pressurized.

NOTE: *To relieve pressure in the 2nd auxiliary circuit, the 2nd auxiliary hydraulics circuit must be toggled on when pressing auxiliary circuit pressure relief button (H). See "Auxiliary Circuit Pressure Relief" on page 91 and "Connecting Hydraulic Attachments to the Auxiliary Hydraulic Circuits" on page 136.*

Refer to "Powering Attachments with Hydraulic Function" on page 136 for auxiliary hydraulics operation information.

Auxiliary Hydraulic Control

Standard-Flow Auxiliary Hydraulics Control

Rocker switch (F, Fig. 45) controls the direction and amount of standard-flow auxiliary hydraulics.

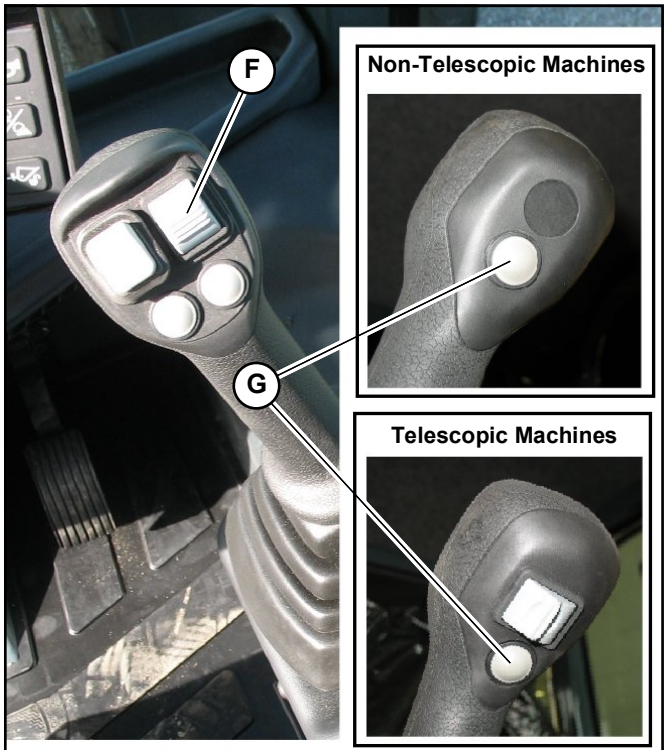


Fig. 45 – Standard-Flow Auxiliary Hydraulics Control Rocker Switch

Trigger button (G), located on the back of the joystick, is used with rocker switch (F) in the full-on position to latch the standard-flow auxiliary hydraulics continuously on when the rocker switch and trigger are released.

NOTE: *Engine speed controls continuous flow amount.*

To cancel continuous flow, either push trigger button (G) or move rocker switch (F) up or down.

⚠ WARNING

Make sure the auxiliary hydraulic control is in neutral before starting the machine or disconnecting the auxiliary hydraulic couplers.

For standard-flow auxiliary hydraulics operation, refer to "Standard-Flow Auxiliary Hydraulics Operation" on page 138.

2nd Auxiliary Hydraulics Circuit (Option)

The optional 2nd auxiliary hydraulics circuit provides an additional auxiliary circuit for powering attachments.

Switch (O, Fig. 46) on the switch panel switches between the standard and the optional 2nd auxiliary hydraulics circuits. The indicator in switch (O) is lit when the 2nd auxiliary hydraulic circuit is activated and the standard auxiliary hydraulic circuit is deactivated.

NOTE: *Switch (O) toggles between the 2nd auxiliary and the standard auxiliary circuits: when the 2nd auxiliary hydraulics circuit is toggled on, the standard auxiliary circuit is toggled off.*

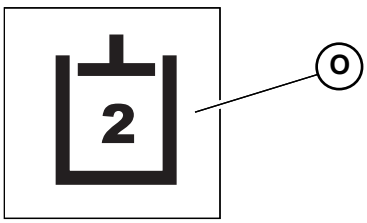


Fig. 46 – 2nd Auxiliary Hydraulics Circuit Option

Rocker switch (F, Fig. 45) and trigger button (G) operate the 2nd auxiliary hydraulics flow in the same manner as standard flow.

High-Flow Auxiliary Hydraulics Control (Option)

The high-flow auxiliary hydraulic system is used for operating certain hydraulic attachments (e.g., cold planer, snowblower) that require higher flows. High flow couplers are located on the attachment hitch at the front of the machine.

High-flow auxiliary switch (M, Fig. 47) activates the high flow auxiliary hydraulics circuit and controls oil flow direction.

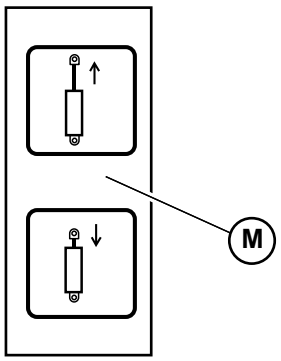


Fig. 47 – High-Flow Auxiliary Hydraulics Control Rocker Switch Icon

For high-flow auxiliary hydraulics operation information, refer to “High-Flow Auxiliary Hydraulics Operation” on page 139.

Hydraglide™ Button (Option)

Button (U, Fig. 48), located on the right switch panel, controls Hydraglide™ function.

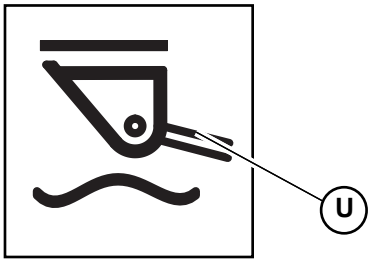


Fig. 48 – Hydraglide™ Control Switch Icon

Hydraglide™ cushions the lift structure during transport. It provides a smoother ride over uneven surfaces.

Press switch (U) to toggle Hydraglide™ on/off.

NOTE: *Indicator on the switch is lit when Hydraglide™ is activated.*

For Hydraglide™ operation information see “Hydraglide™ Ride Control System (Option)” on page 128.

Cooling Fan Rotation Reversing Button

Helps to prevent particulate matter from accumulating on the radiator.

Button (V, Fig. 49) on the control keypad manually turns cooling fan rotation reversing on for 60 seconds.

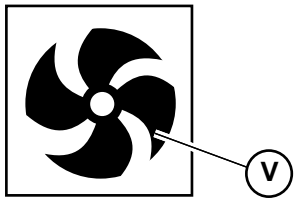


Fig. 49 – Fan Reversing Button

Cab Heat and Air Conditioning (HVAC)

The controls for cab heat and air conditioning are located to the right of the operator's position. The same controls operate both heating and air conditioning.

- Fan speed control knob (J, Fig. 50): Controls the fan speed and turns the heater and/or air conditioner systems on or off.

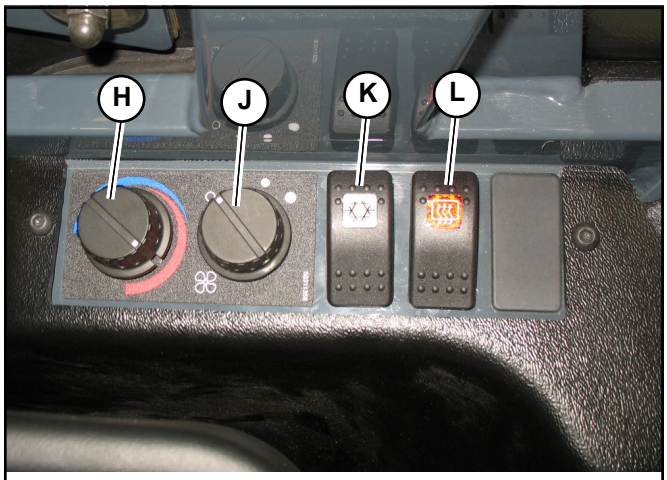


Fig. 50 – Heat/Air Conditioning Controls

- Temperature control (H): The rotary knob regulates the temperature of the heated air. Rotate clockwise to increase the temperature; counterclockwise to decrease the temperature.
- AC compressor switch (K): The rocker switch turns the air conditioning compressor on or off.
- Rear window defrost switch (L): Refer to “Windshield Wiper/Washer and Defrost” on page 96.

Work Lights Button

Button (W, Fig. 51), located on the control keypad, controls work light function.

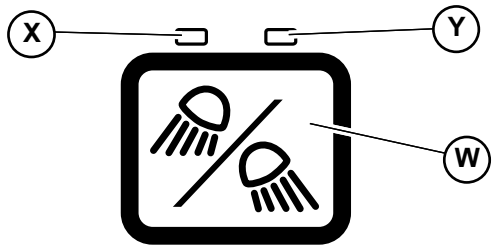


Fig. 51 – Work Lights Button and Indicators

⚠ WARNING

Switch off the work lights when traveling on public roads. Work lights can dazzle motorists and cause accidents.

Press button (W) once to activate the front work lights. Press the button again to activate both the front and rear work lights. Press the button a third time to turn the work lights off.

NOTE: *Indicator (X) is lit when the front work lights are activated; indicators (X) and (Y) are both lit when the front and rear work lights are on.*

Lift Structure Lights Button (Telescopic Machines Only)

Switch (X, Fig. 52), located on the switch panel, controls the lift structure lights (T, Fig. 53).

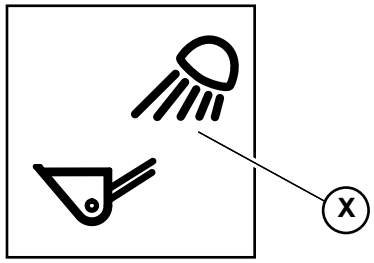


Fig. 52 – Lift Structure Lights Control Switch Icon

⚠ WARNING

Switch off the lift structure lights when traveling on public roads. The lights can dazzle motorists and cause accidents.

Press the top of switch (X, Fig. 52) to activate the lift structure lights. Press the bottom of switch (X) to turn the lift structure lights off.

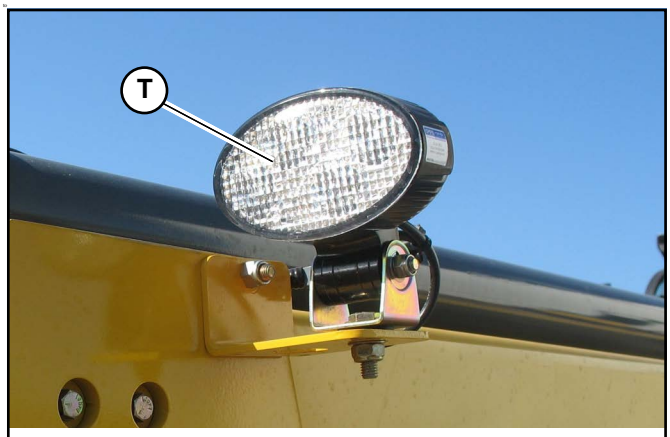


Fig. 53 – Lift Structure Lights

NOTE: *The indicator on lift structure lights switch (X) is lit when the lift structure lights are ON.*

Beacon/Strobe Light (Option)

On/off switch (T, Fig. 54) for optional beacon/strobe light (S) is located on the right switch panel.

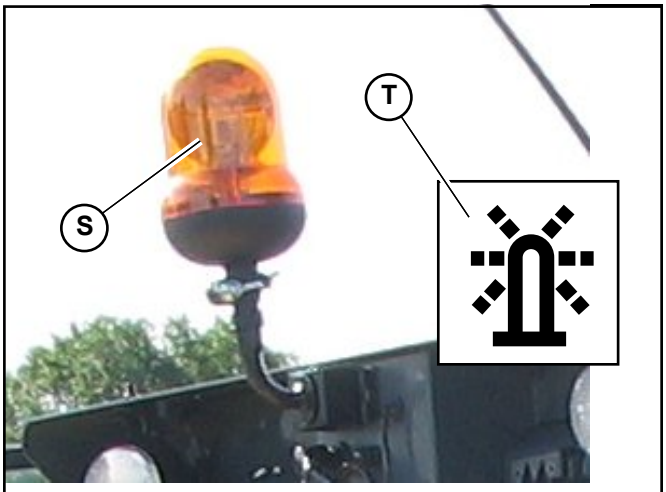


Fig. 54 – Beacon

Windshield Wiper/Washer and Defrost

Windshield Wiper Button

Button (F, Fig. 55) on the control keypad controls the front windshield wiper. Press button (F) once for 5 second intermittent, twice for 2 second intermittent, and three times for continuous wiper speed. Press the button a fourth time to turn the wiper off. Indicators above the button are lit according to the selected setting.

Windshield Washer Button

Push and hold button (C) on the control keypad to activate the windshield washer spray and wiper. Release the button to stop the spray; wiper continues for 5 seconds.

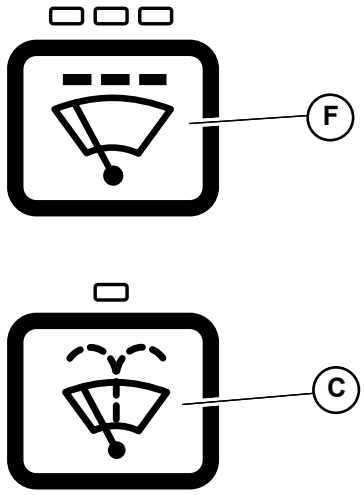


Fig. 55 – Wiper/Washer Buttons

Washer Fluid Reservoir

See “Windshield Washer Reservoir” on page 211 for windshield washer reservoir location and filling information.

Rear Window/Washer Switch

Press end (D, Fig. 56) of wiper switch (G) to activate the rear window wiper. Press other end (F) of wiper switch (G) to turn the wiper off.

NOTE: *Indicator (D) is on when the wiper is activated.*

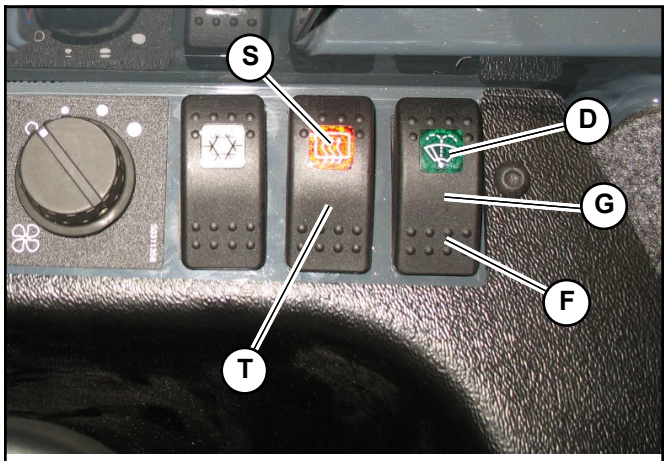


Fig. 56 – Rear Wiper/Washer Switch

Push and hold end (D) of wiper switch (G) to activate the washer spray. Release the button to stop the spray.

Rear Window Defrost Switch

Press switch (T) to activate the rear window defrost.

NOTE: *Indicator (S) is on when the rear window defrost is activated. Defrost shuts off automatically after 15 minutes.*

12V Accessory Power Outlet

A 12VDC accessory power outlet (P, Fig. 57) is located to the right of the armrest.

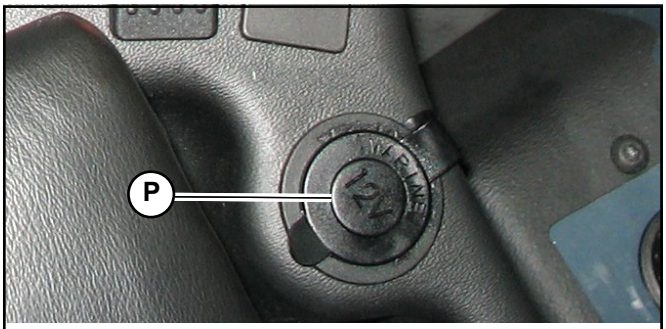


Fig. 57 – Standard 12V Accessory Power Outlet

NOTE: *Standard 12V accessory outlet (P) power is ON whenever the ignition switch is ON.*

External 12V Attachment Power Connections (Option)

Front (X, Fig. 58) or rear (Z) external 12VDC attachment power connections are available as an option.

On/off switches for the optional external 12VDC connections are located on the right switch panel.

12V Attachment Power Controls

Front Installation

1. Position (A, Fig. 59) activates connector pin 15/30 (continuous).

   NOTE: *Position (A) is a toggle; subsequent presses turns power on/off.*

2. Position (B) activates connector pin 82 (momentary).

   NOTE: *Position (B) is momentary; power is on when pressed and off when released.*

Rear Installation

1. Position (A, Fig. 59) activates connector pin 15/30 (continuous).

   NOTE: *Position (A) is a toggle; subsequent presses turns power on/off.*

2. Position (B) activates connector pin 15/30 (momentary).

   NOTE: *Position (B) is momentary; power is on when pressed and off when released.*

Non-Telescopic Machines Shown, Telescopic Machines Similar

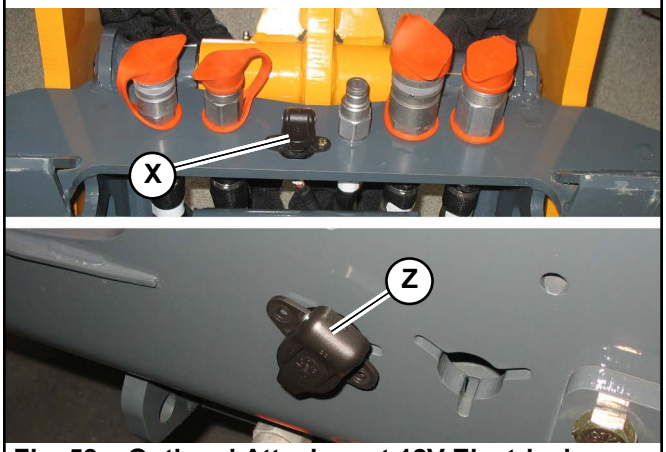
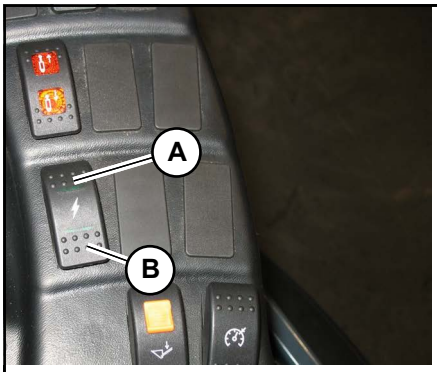


Fig. 58 – Optional Attachment 12V Electrical Connections



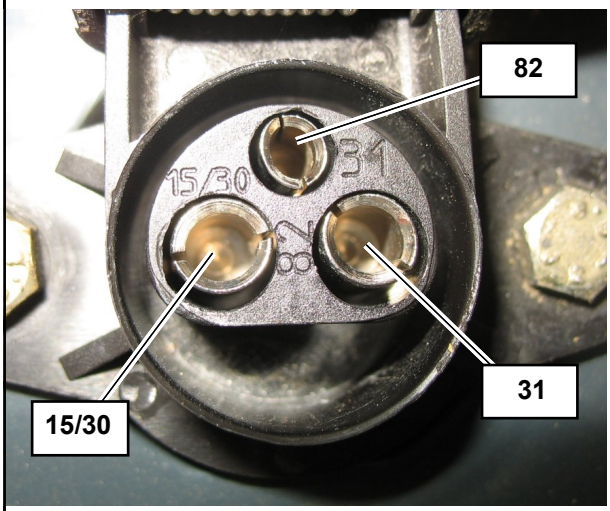


Fig. 59 – Switch Positions/Connector Pins

External 12V Attachment Power Extension Harness

An extension harness is available to allow for specialized attachment connection. Refer to the following diagram and table for extension harness connector pin-to-wire lead associations.

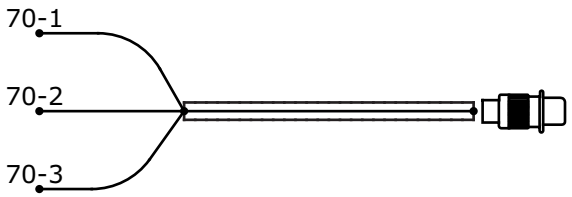


Fig. 60 – Extension Harness Diagram

Connector Pin	Wire Lead	Wire Color	Front Aux Function	Rear Aux Function
15/30	70-1	Black	Power (Continuous)	Power (Continuous/ Momentary)
31	70-3	Yellow/ Green	Ground	Ground
82	70-2	Black	Power (Momentary)	Unused

NOTE: *Refer to the documentation provided with the specific attachment for wiring assignments when using the extension harness.*

Battery Disconnect Switch

IMPORTANT: *Before the engine can be started, the battery disconnect switch (A, Fig. 61) must be in the "ON" position.*

The battery disconnect switch is located on the left inside of the engine compartment.

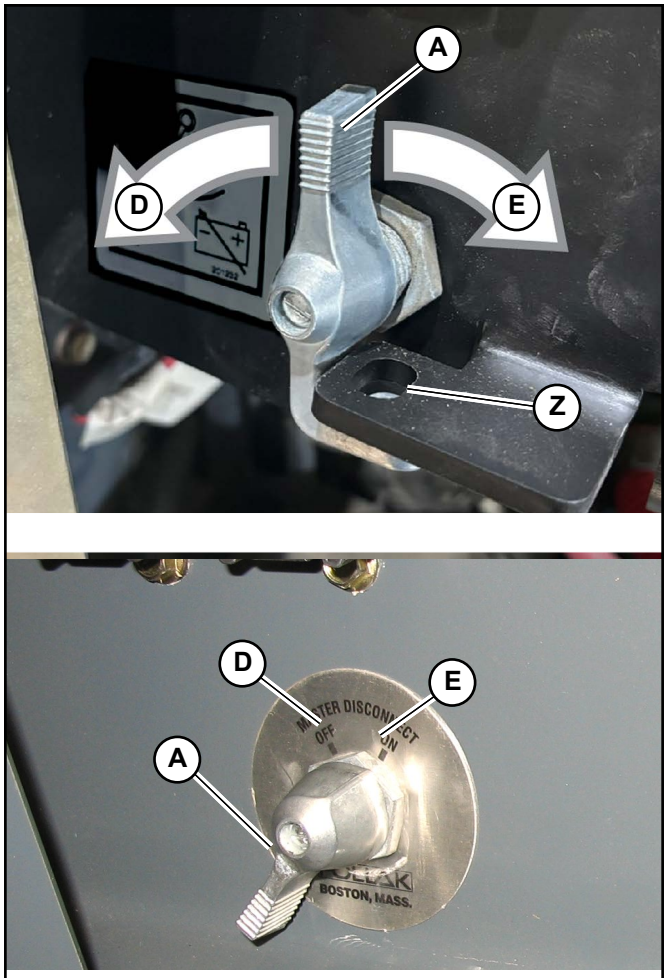


Fig. 61 – Battery Disconnect Switch

To disconnect the battery from the electrical system and disable all electrical functions: Turn the switch counter-clockwise to the "OFF" (D) position.

To connect the battery to the electrical system and enable all electrical functions: Turn the switch clockwise to the "ON" (E) position.

⚠ CAUTION

Always turn the battery disconnect switch (A) to the "OFF" position (D) when parking the machine inside an enclosure.

NOTE: *Newer machines allow for a padlock (Z) to lock the switch in the disconnected position.*

⚠ WARNING

Read and understand this entire manual. Follow warnings and instructions for operation and maintenance. Failure to follow instructions can result in injury or death.

Read and understand all safety decals before operating the machine. DO NOT operate the machine unless all factory-installed guards and shields are in place.

Be sure you are familiar with all safety devices and controls before operating the machine.

Know how to stop the machine before starting.

Use only Manitou-approved accessories or referral attachments. Manitou Group. cannot be responsible for safety if the machine is used with non-approved accessories or attachments.

Check for correct function after adjustments or maintenance.

Operational Checks

Pre-Start Checks

Complete these checks before starting the engine and using the machine. Repair any problems before using the machine.

Table 27: Pre-Start Checks

Check	Refer To:
Fuel tank filled?	"Adding Fuel" on page 186.
Engine oil level correct?	"Checking Engine Oil Level" on page 176.
Hydraulic system oil level correct?	"Checking Hydraulic Oil Level" on page 189.
Engine coolant level correct?	"Checking Coolant Level" on page 180.

Table 27: Pre-Start Checks

Check	Refer To:
Brake fluid level correct?	"Brake Fluid Reservoir" on page 195.
Windshield washer reservoir filled (if applicable)?	"Windshield Washer Reservoir" on page 211.
Grease fittings properly lubricated?	"General Lubrication" on page 167.
Tire inflation/condition	See page 198.
Wheel fastener torque (after first use or wheel replacement)	See page 198.
Pivot point operation/condition	
Safety decals/warnings condition/ legibility (replace/clean as required)	"Safety Decals" on page 36.
Engine air cleaner and air intake hoses condition/restrictions	"Engine Air Filters" on page 179.
Lights, signals, indicators, warning lights, indicators, and horn operating properly?	See page 86 and page 94.
Windows, lights, and steps clean?	
Attachment securely fastened to hitch?	"Power-A-Tach® System Hitch Operation" on page 130.
Overall machine condition (including attachments) for bends, cracks, broken or missing parts, hydraulic leaks, etc.	
Engine cover securely closed and latched?	
Rags, tools, debris, and other loose objects removed? (check especially after maintenance)	
Approved warning triangle, hazard warning light, and first aid kit in the machine?	As required by circumstance/local regulations.
Seat position correctly adjusted?	"Operator's Seat Adjustment" on page 103.
Armrest correctly adjusted?	"Operator's Seat Adjustment" on page 103.
Seat belt fastened?	"Seat Belt" on page 105.
Parking brake applied?	"Parking Brake" on page 85.

Checks During Operation

Complete these checks after starting the engine and during operation:

Table 28: Checks During Operation

Check	Refer To:
Always after Starting the Engine / During Operation	
Engine oil pressure and charge indicator lights not on?	“Multi-Function Display” on page 67.
Coolant temperature within specification?	“Multi-Function Display” on page 67.
Travel drive/brake/steering operating properly?	“Travel Drive Operation” on page 110.
Engine exhaust excessively smoky?	
Anyone hazardously close to the machine?	
Parking brake test	“Parking Brake Adjustment/Service” on page 196.
When Driving on Public Roads	
Attachments as low as possible?	“Lift Structure Travel Position” on page 118.
Lift structure retracted (telescoping machines)	See page 116.
Machine work hydraulics locked-out?	See page 129.

Parking Checks

Complete these checks when parking the machine:

Table 29: Parking Checks

Check	Refer To:
Always when Parking	
Mandatory safety shutdown procedure performed?	“Mandatory Safety Shutdown Procedure” on page 22.
Attachments lowered to the ground?	
Parking brake applied?	“Parking Brake” on page 85.
Machine cab locked (especially if the machine will not be supervised).	
When Parking on Public Sites	
Machine adequately secure/cab locked?	

Cab Entry and Exit

⚠ WARNING

Always perform the "Mandatory Safety Shutdown Procedure" on page 22 before exiting the machine.

Use only steps (S, Fig. 62) and handles (R) on the machine when entering/exiting the cab. Keep the steps and the handles clean to ensure a secure hold at all times. Never use operation controls as hand holds. Remove dirt (oil, grease, earth, snow, and ice) from handles (R), steps (S) and your shoes before entering the cab.

Always face the machine when entering or exiting.

Do not jump on or off the machine. Never climb onto or exit a moving machine.

Fig. 62 – Cab Entry/Exit Handles/Steps

Cab Door (Option)

Lock/unlock the door using the ignition key in the key slot in button (Z, Fig. 63). Operate the door latch outside the cab using button (Z) on the exterior door handle.

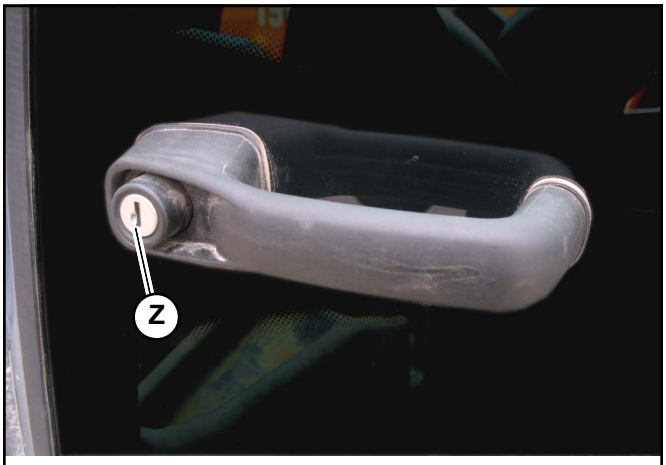


Fig. 63 – Cab Exterior Door Handle

Operate the door latch inside the cab using tab (Y, Fig. 64) located along the interior door frame.

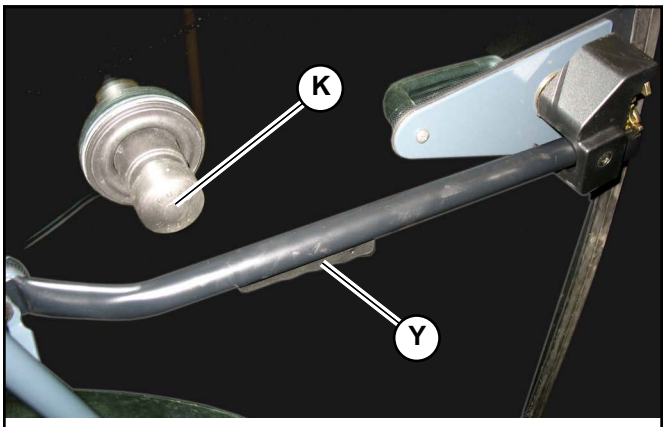


Fig. 64 – Cab Interior Door Lever

NOTE: *When fully opened, the left cab door can be latched in the open position against the side of the cab. To release, press latch (K).*

Door Prop

The cab door can be propped open for ventilation using link (X, Fig. 65). Rotate link (X) so tab (W) fits into the door latch.

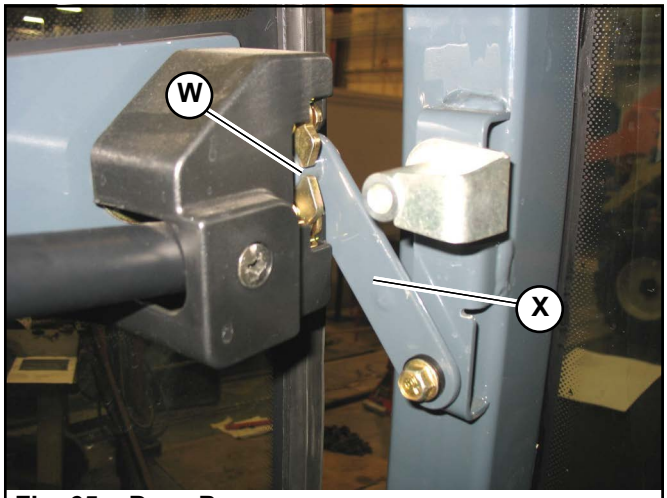


Fig. 65 – Door Prop

Cab Window Latches

Cab windows can be opened for ventilation. Open the rear cab window using latch (G, Fig. 66).

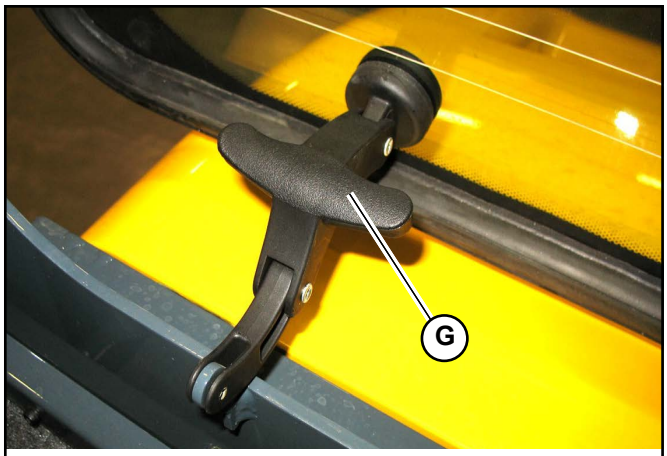


Fig. 66 – Rear Window Latch

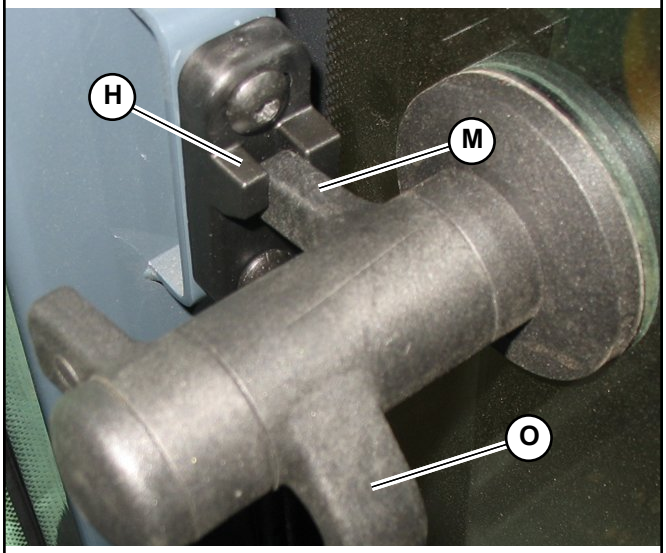
Open the right cab window using latch (O, Fig. 67):

1. Use latch (O) to move tab (M) down out of slot (H).
2. Push the window outward until tab (N) aligns with slot (H).
3. Twist latch (O) to securely seat tab (N) into slot (H).

⚠ CAUTION

Make sure right window is securely fastened in place before operating machine.

Window Closed



Window Open

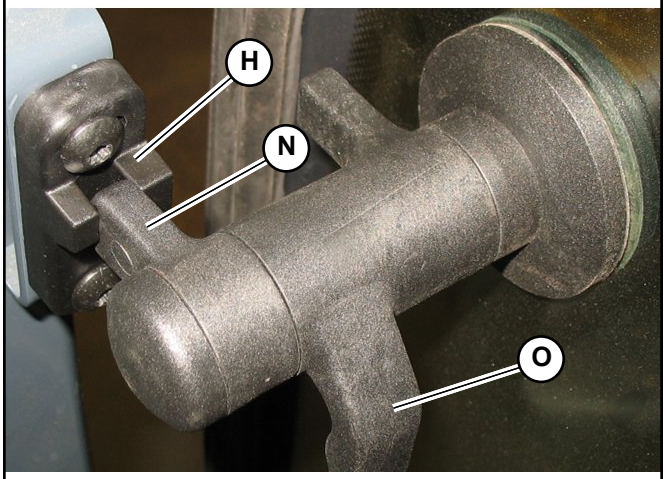


Fig. 67 – Right Window Latch

Emergency Exit

In the event the door is blocked, twist latch (O) on the right window to disengage tab (M or N) out of slot (H) and push the window fully open to allow exit from the machine.

Right Window Stop

When fully opened, the right cab window can be latched in the open position against the side of the cab. To release, press latch (T, Fig. 68).

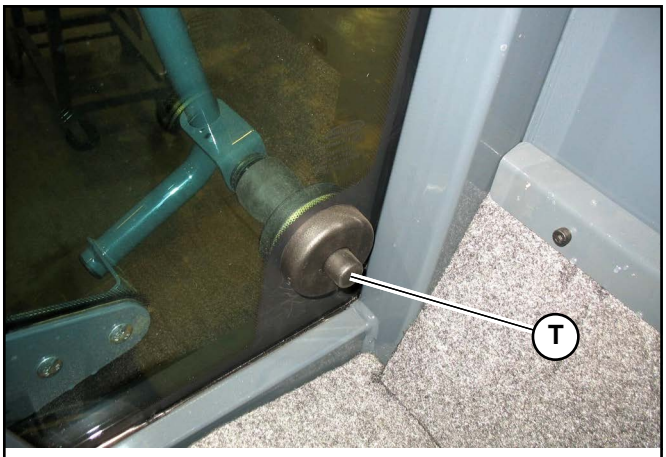


Fig. 68 – Right Window Stop

Operator's Seat Adjustment

The operator's seat has adjustments for:

- Forward and back horizontal seat and armrest position (G, Fig. 69).
- Forward and back horizontal seat position, separate from armrest position (H).
- Operator weight suspension (air suspension) (E).
- Seat height (F).
- Seat back tilt adjustment (J, Fig. 70).

⚠ WARNING

Never adjust the seat when the machine is in operation. Adjust the seat only when the machine is stopped.

After adjustments, make sure the seat adjustment levers are fully engaged before using the machine.

Seat/Armrest Forward and Back Horizontal Adjustment

NOTE: *Bar (G, Fig. 69) moves the operator's platform as one unit; Lever (H) moves the seat only.*

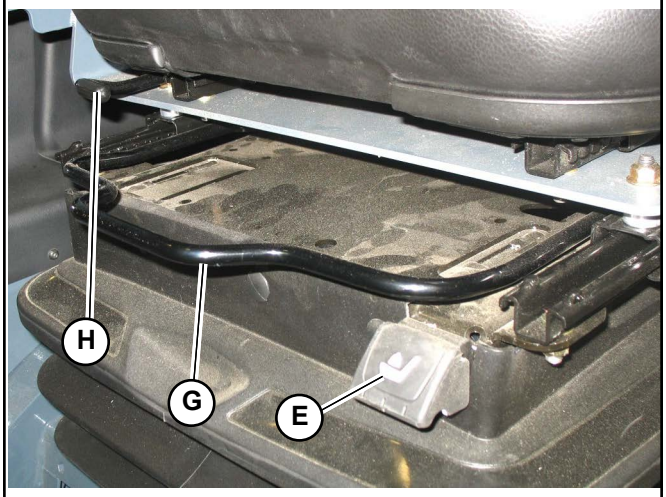
While sitting in the operator's seat, pull up on bar/lever (G or H, Fig. 69). Move the seat/operator's platform forward or back as desired. Release bar/lever (G or H) when the seat/operator's platform is in the desired position. Make sure the seat and operator's platform are locked in position after adjusting.

Seat Weight Suspension Adjustment

Air Suspension

While sitting in the operator's seat, press switch (E) as necessary to stiffen seat suspension as desired. Raise switch (E) to loosen seat suspension.

Air Suspension



Mechanical Suspension

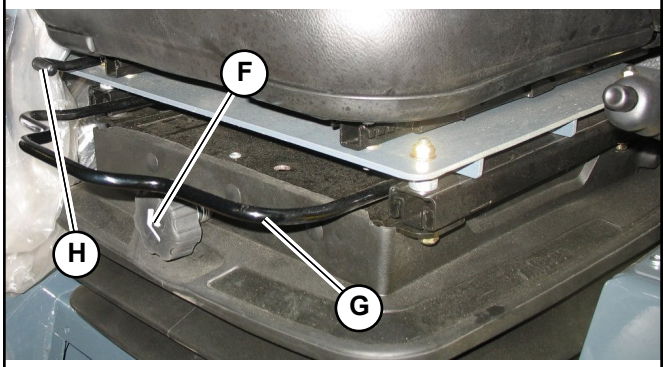


Fig. 69 – Operator's Seat Adjustments

Mechanical Suspension

While sitting in the operator's seat, turn knob (F, Fig. 69) as necessary to adjust the seat to the desired height.

Seat Back Tilt Adjustment

Seat back tilt is adjusted using knob (J, Fig. 70), located on the right side of the seat.

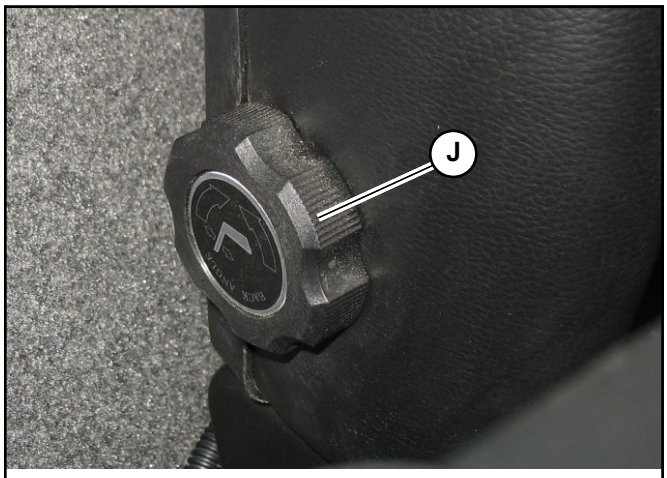


Fig. 70 – Seat Tilt Adjustment

Optional Deluxe Seat Back Adjustment

Adjust seat back tilt on the optional deluxe seat using lever (X, Fig. 71), located on the left side of the seat.

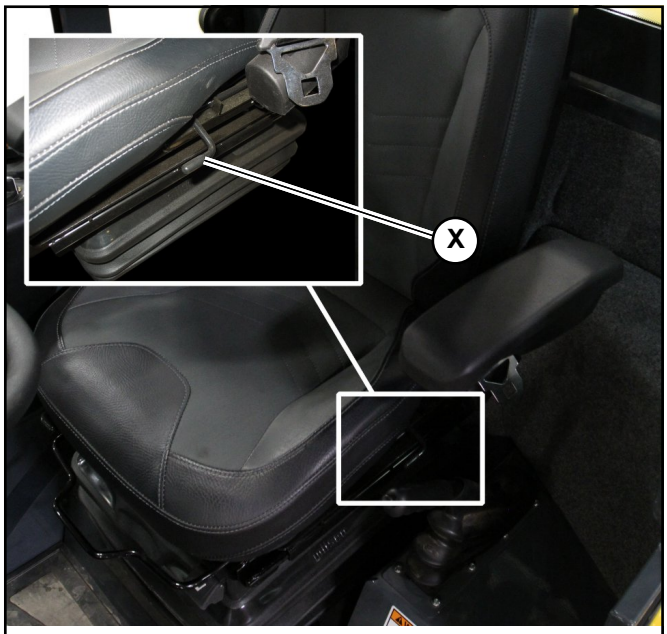


Fig. 71 – Optional Deluxe Seat Tilt Adjustment

Armrest Height Adjustment

Adjust the armrest height using knob (Z, Fig. 72). Securely tighten knob (Z) after positioning armrest.

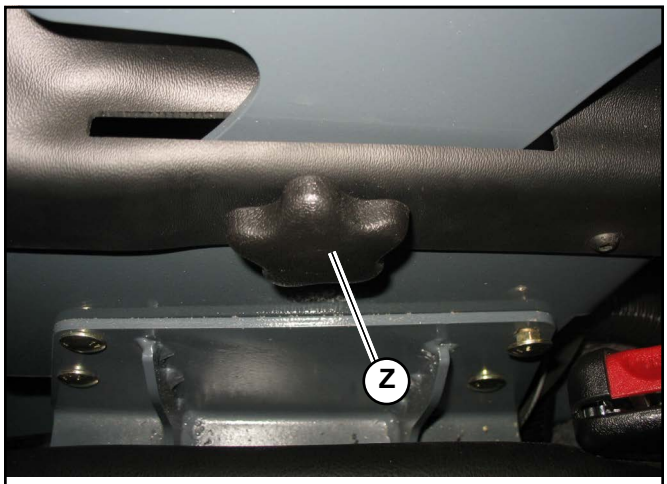


Fig. 72 – Armrest Adjustment

Optional Deluxe Seat Left Armrest Adjustment

Adjust the left armrest height on the optional deluxe seat using knob (Z, Fig. 73), located on the underside of the armrest.

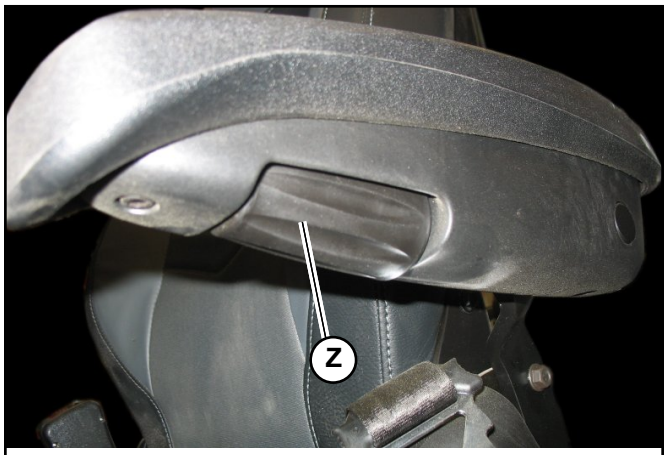


Fig. 73 – Optional Deluxe Left Armrest Adjustment

Seat Belt

⚠ WARNING

ALWAYS fasten the seat belt securely and properly. Never operate the machine without the seat belt fastened around the operator.

Keep the seat belt clean; dirt can impair seat belt operation. Check seat belt condition regularly and have damaged or worn belts immediately repaired by an authorized dealer.

After an accident, the seat belt strap is stretched and must be replaced with a new strap installed by an authorized dealer.

Fastening/Unfastening the Seat Belt

Remove hard, edged, or fragile objects from your pockets or clothes that might lie between the seat belt and your body.

Fasten the seat belt around your hips and waist and insert tongue (A, Fig. 74) into clasp (B) until it clicks securely in place. Slack in the seat belt should automatically retract into seat belt spool (K).

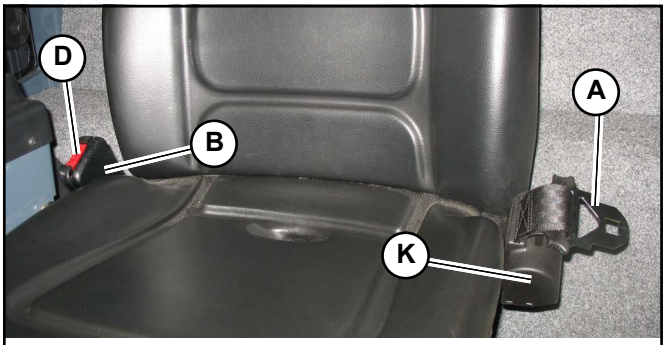


Fig. 74 – Seat Belt

Make sure the seat belt is not twisted when it is fastened and that it is fastened over the hips and not the stomach.

⚠ WARNING

If the seat belt spool does not retract slack in the seat belt, have it serviced immediately. Do not operate the machine until the seat belt is repaired.

Unfasten the seat belt by pressing button (D).

Dome Light

The dome light (Fig. 75) is located on the right side of the ROPS/FOPS headliner.

If dome light switch (W) is in the right (Z) (auto) position, the light activates by either sitting in the operator's seat or pressing a button on the keypad.

The light will deactivate:

- After approximately 30 seconds.
- If the ignition is turned on.
- If switch (W) is moved to the center (V) (OFF) position.

NOTE: *With dome light switch (W) in the right (Z) (auto) position, the light will activate even with the ignition off.*

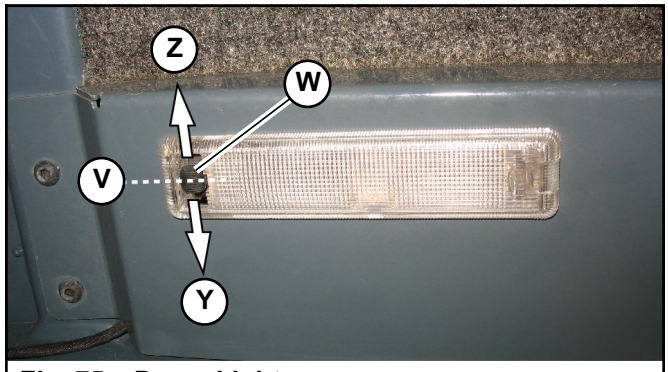


Fig. 75 – Dome Light

When the ignition is on, the dome light is continuously activated by moving switch (W) to the left (Y) (ON) position.

Starting the Engine

NOTE: *The machine cannot be push- or tow-started. Attempting to push or tow start the machine may damage the drive system.*

1. Complete the "Pre-Start Checks" on page 99.
2. Make sure battery disconnect switch (A, Fig. 76) is in the ON position (E).

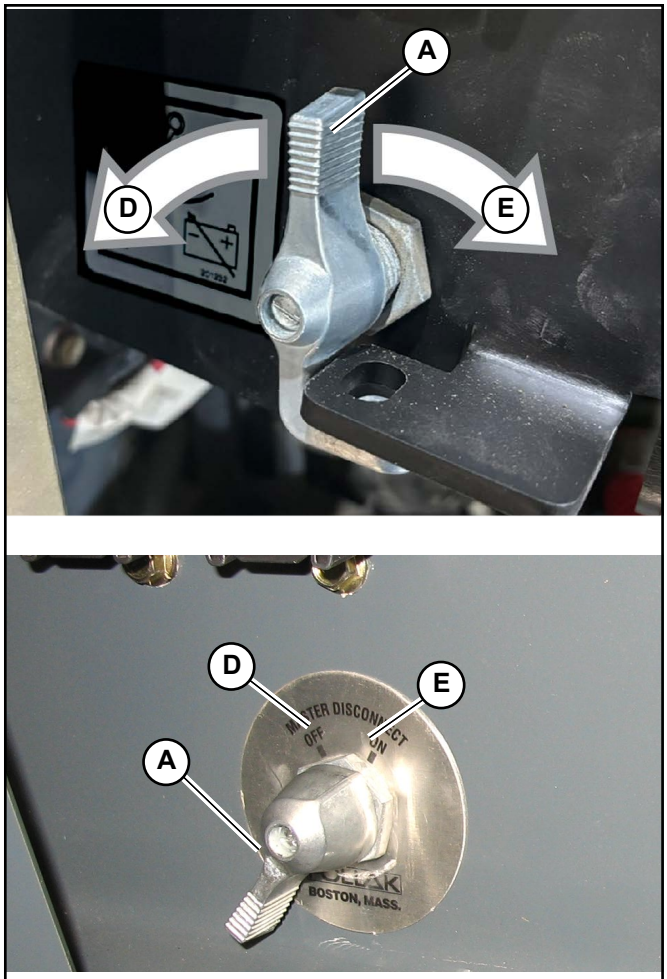


Fig. 76 – Battery Disconnect Switch

NOTE: *For more information about the battery disconnect switch, refer to page 98.*

3. Enter the machine using the provided steps and hand-holds according to "Cab Entry and Exit" on page 101.
4. Close the cab door, if equipped.
5. Sit in the operator's seat and adjust the seat and the armrest as required according to "Operator's Seat/Armrest" on page 80.
6. Adjust the steering column as required according to "Steering Column Adjustment" on page 88.

⚠ CAUTION

All controls must be within easy reach. The operator must be able to move the pedals, steering wheel, and joystick through the complete range of motion.

7. Fasten the seat belt.

⚠ WARNING

Always fasten the seat belt before operating the machine. Repair or replace any damaged seat belt parts before operation.

IMPORTANT: *The operator must be in the seat before the engine can be started.*

8. If necessary, raise parking brake lever (G, Fig. 77) into the upright position to engage the parking brake.

NOTE: *When the parking brake is engaged, the travel drive is in neutral (disconnected).*

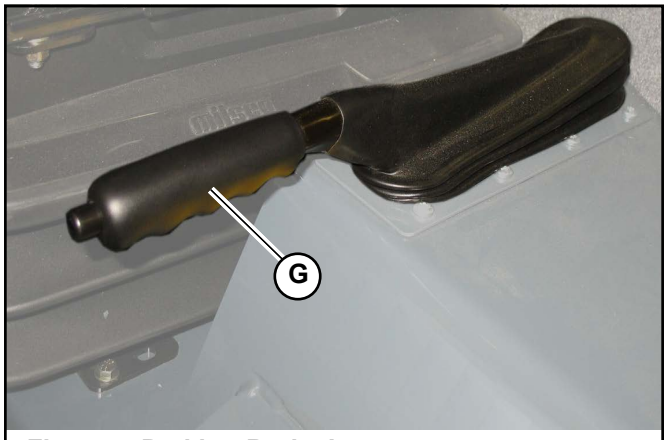


Fig. 77 – Parking Brake Lever

IMPORTANT: *Test the parking brake each time before using the machine. Adjustment/maintenance is required if the parking brake doesn't keep the machine from moving when parking brake lever (G) is pulled up as far as possible. Refer to "Parking Brake Adjustment/Service" on page 196.*

9. Make sure the multi-function joystick is centered in the neutral position.
10. Place travel direction switch (Z, Fig. 78) on the multi-function joystick into the middle, or neutral, position.

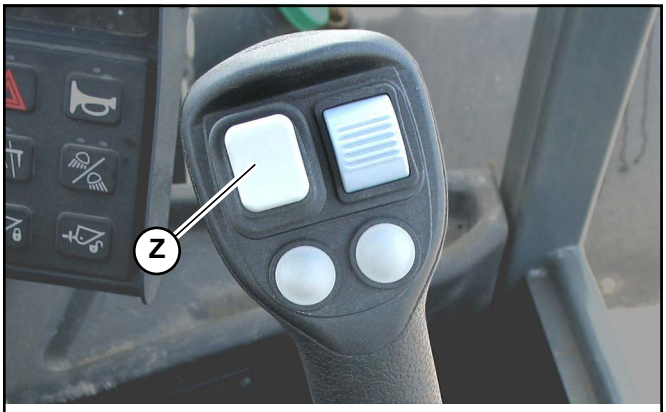


Fig. 78 – Travel Direction Switch

IMPORTANT: *If the machine is started with the travel direction switch in either the forward or reverse position, it must be returned to the neutral position before either the forward or reverse travel drive can be activated.*

NOTE: *For more information about the travel direction switch, refer to page 87.*

IMPORTANT: *Do not rest feet on the travel or brake/inching pedals when starting the machine. The engine will not start if the pedals are depressed.*

11. Insert the key into the starter key switch (Fig. 79) and turn the key clockwise to the first detent. Wait for the multi-function display to initialize completely.

Fig. 79 – Starter Key Switch

NOTE: *When the key is turned clockwise to the first detent, indicators on the multi-function display should light up; a tone sounds for a few moments as a reminder to fasten the seat belt. The battery voltage and pre-heat indicators might stay lit for 3-30 seconds. The pre-heat indicator may stay on for longer periods in colder ambient temperatures.*

12. When the pre-heat indicator light on the multi-function display goes out, turn the key clockwise until the starter activates. Release the key when the engine starts.
13. If the engine does not start after 15 seconds, turn the key all the way counter-clockwise, wait 1 minute and repeat steps 11-13. If the engine does not start after several attempts, see "Engine Troubleshooting" on page 217.
14. Before using the machine, perform the "Safety Interlock System Test" on page 109.

⚠ WARNING

In a clear, safe area, test all travel and work controls before operating the machine under working conditions. Any loss of control could result in death or serious injury.

Cold-Starting

If operating in temperatures below 0°C (32°F):

- Replace the engine oil with the proper viscosity oil according to the engine operator's manual. Refer to "Fluids/Lubricants Types and Capacities" on page 49 for proper oil specifications.
- Make sure the battery is fully charged.
- Install an optional engine heater. An engine heater is recommended for starting in temperatures below -10°C (14°F). Contact your dealer for engine heater options.

NOTE: *In ambient temperatures below -10°C (14°F), an engine heater is recommended to reduce starter load and aid engine warm up. Starting the machine at these temperatures without an engine heater can result in multiple glow/crank cycles or extended cranking time approaching 20 seconds.*

After Starting

Verify the battery charging and/or the engine oil pressure indicators turn off after the engine starts.

IMPORTANT: *If the charge and/or the engine oil pressure indicators do not go out when the engine is running, shut down the engine immediately and correct the problem. Damage to the engine may result if engine is run and the problem is not corrected.*

Perform the safety interlock system test according to "Safety Interlock System Test" on page 109.

IMPORTANT: *Do not run a cold engine at full throttle right after starting. Stressing a cold engine can damage the engine. Perform the following warm up procedure before using the machine after starting.*

IMPORTANT: *On 600 Series machines the maximum engine speed during startup is limited to 1500 rpm if the ambient temperature is below 15°F (-10°C). This limit remains for approximately 10 seconds or less after startup. Advancing the throttle during this 10 second time frame requires throttling the engine back to below 1500 rpm to disengage the 1500 rpm limit.*

IMPORTANT: *When the machine is not under load, do not run the engine at high speed (above 20% of full throttle) for extended periods of time. Damage to the engine can result.*

Engine Warm Up

⚠ WARNING

Operating the work hydraulics before the hydraulics are warmed up is dangerous. Response will be slow and the machine might move in unexpected ways. Additionally, operating the machine before proper warm-up can also damage the engine. Be sure to sufficiently warm up the machine before starting work.

IMPORTANT: *Operate the controls smoothly and slowly until the hydraulic oil has reached operating temperature.*

1. After starting, allow the engine to run at low idle for a minimum of 5 minutes with no load (no drive, raise, tilt, or auxiliary hydraulic functions).

   NOTE: *On 600 Series machines, low engine idle speed is increased to 1100 rpm until the engine reaches operating temperature.*

2. Run the engine at (1800) rpm with no load for 5 minutes.
3. Raise the lift structure so the attachment is off the ground.
4. Extend and retract each of the cylinders several times with no load.
5. Travel slowly forward and backward several times. Refer to "Travel Drive Operation" on page 110.
6. In cold weather, tilt the attachment all the way forward and keep it there for 20-25 seconds. Repeat this step until the attachment tilt speed is normal.

NOTE: *Engine speed may be limited during a cold start and/or during a travel drive error condition.*

See "Travel Drive Error Condition Operation (Limited and Safe Modes)" on page 115.

Run-In Period

The performance and service life of the machine is heavily dependent on using the machine carefully during its first 100 operating hours.

During the first 100 operating hours:

- Do not operate machine at the maximum rated operating capacity.
- Do not run the engine at a high speed for extended periods of time.
- Increase the load gradually while varying the engine speed.
- Follow the maintenance schedule. See "Maintenance Schedule" on page 163.

Stopping the Engine

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. Perform a visual inspection of the machine, checking for the following:
   - Hydraulic system leaks
   - Coolant system leaks
   - Fuel system leaks
   - Damage to the machine (tires, attachment hitch, attachment, etc.)

IMPORTANT: *Do not stop the engine at full throttle. Damage to the engine can result. Allow the engine to idle for approximately 2 minutes before shutting it off.*

⚠ WARNING

Always turn the battery disconnect switch to the "OFF" position when parking the machine inside an enclosure. Refer to "Battery Disconnect Switch" on page 98.

Engine Stalling

⚠ WARNING

If the engine should stall for any reason during operation, always turn the starter key all the way counter-clockwise to the "OFF" position before re-starting the engine according to "Starting the Engine" on page 106.

Safety Interlock System (Hydraloc™)

⚠ WARNING

NEVER attempt to bypass or defeat the safety interlock system. Serious personal injury or death could result.

The Hydraloc™ safety interlock system provides for operator safety. The interlock system:

- Prevents the engine from starting unless the operator is sitting in the operator's seat.
- Disables the lift structure (raise, tilt, and telescopic functions), auxiliary hydraulics, attachment tilt, and wheel drive hydraulics if the starter key switch is turned off and/or the operator's seat is not occupied.

NOTE: *Auxiliary hydraulics can be used with the operator out of the seat if the parking brake is engaged. See "Auxiliary Hydraulics Operation" on page 138.*

Safety Interlock System Test

Before using the machine, always check the safety interlock system daily for proper operation:

1. Sit in the operator's seat and start the engine.
2. If necessary, raise the parking brake lever slightly, press the button in the handle and lower the lever to release the parking brake.

3. Raise yourself a few inches off of the seat. The engine should stop within a few seconds.

   If the engine does not stop, check for seat switch malfunction.

4. Sit in the operator's seat and re-start the engine.
5. Raise the parking brake lever to engage the parking brake.
6. Move the travel direction rocker switch on the joystick to the forward, neutral, and reverse positions. The travel drive neutral **N** icon should remain displayed on the multi-function display.

   If the travel drive direction icon on the multi-function display changes from the neutral **N** icon, check the parking brake switch for malfunction.

7. Raise yourself a few inches off of the seat. With the parking brake engaged, the engine should continue to run.

   If the engine stops, check for parking brake switch malfunction.

8. Operate the raise/tilt using the joystick. Raise/tilt should not operate if the seat is not occupied.
9. On telescopic machines, operate the lift structure extend/retract using the rocker switch on the front of the joystick (refer to "Telescopic Lift Structure Operation" on page 116). The lift structure extend/retract should not operate if the seat is not occupied.
10. Press the attachment hitch lock/unlock buttons on the keypad. The attachment hitch lock/unlock should not operate if the seat is not occupied.

⚠ WARNING

If the Hydraloc™ safety interlock system does not operate as described, repair the system before operating the machine.

Travel Drive Operation

⚠ WARNING

Be sure that the area around the machine is clear of bystanders and obstacles. Never allow anyone to enter inside the turning radius and the machine path.

Signal your intention to move by sounding the horn.

Travel with the attachment as near to the ground as possible. On telescopic machines, fully retract the lift structure before traveling.

Lock-out the work hydraulics when traveling or transporting loads longer distances. See "Hydraulics Transport Lock-Out Operation" on page 129.

Avoid sudden stops, starts, or turns.

Do not switch off the starter key switch while traveling. Sudden braking will happen and loss of control could result.

Do not move the travel direction switch while traveling. The machine may react suddenly, causing an accident.

Reduce speed before shifting from high to low travel speed. Down-shifting from high- to low-speed drive while traveling at high speed may cause the machine to tip and can cause injury, loss of control, and damage to the machine.

Perform a visual check behind you before traveling in reverse. Traveling in reverse without checking could result in collision with a person or an obstacle.

Remove obstacles in the machine's path before traveling with a load.

⚠ WARNING

If the machine becomes unstable and starts to tip, keep the seat belt fastened, hold on firmly and brace yourself. Keep all body parts inside the machine. Lean away from the point of impact and stay with the machine. If tipping occurs, DO NOT jump from the machine. The machine is equipped with rollover protection, which only protects the operator while in the operator's seat. Trying to escape from a tipping machine can result in death or serious personal injury.

IMPORTANT: *If a tip-over occurs:*

- *Restore the loader to an upright position as soon as safely possible to prevent oil and fuel leakage. Clean up any fluid leakage.*
- *Inspect and repair any damage before re-starting the engine.*

1. Be sure that the area around the loader is clear of bystanders and obstacles.
2. Using the multi-function joystick, raise the lift structure/attachment. On telescopic machines, fully retract the lift structure before raising/lowering and while traveling. Keep the attachment as near to the ground as possible for good stability and visibility.
3. Press and hold the brake/inching pedal (E, Fig. 80) and release the parking brake by slightly raising lever (G) and pressing button (F). Push lever (G) downward and release button (F).

NOTE: *The drive system is switched to neutral (disconnected) when the parking brake is engaged. If the travel direction switch is in either the forward or reverse position, it must be returned to the neutral position when the parking brake is released before either the forward or reverse travel drive can be activated.*

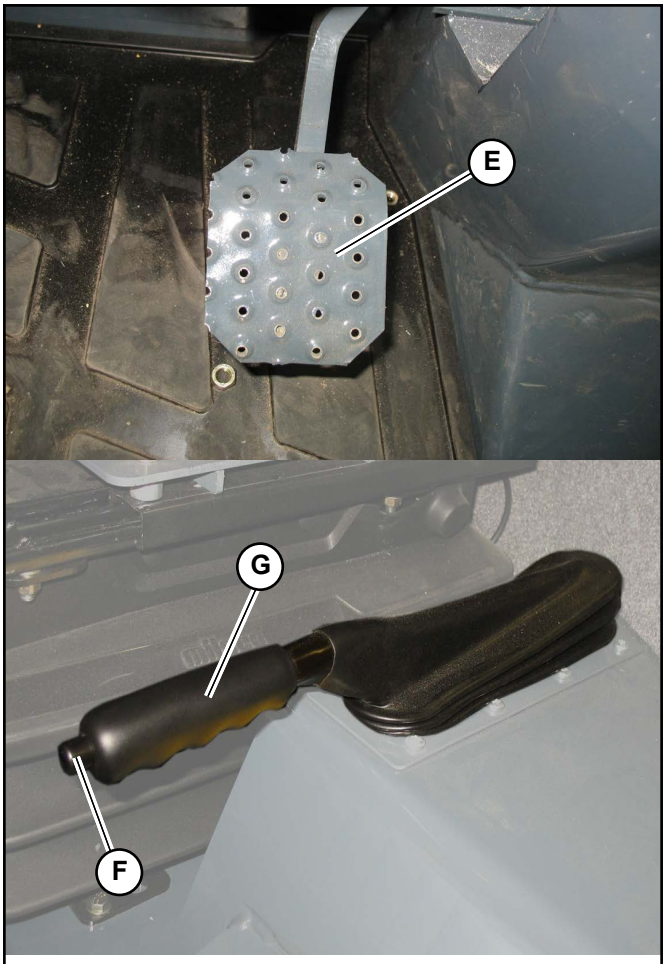


Fig. 80 – Brake/Inching Pedal and Parking Brake Lever

NOTE: *The parking brake icon (P) on the multi-function display should not be displayed when the parking brake is released.*

4. Use the travel direction switch (Z, Fig. 81) to change the forward/reverse travel direction.

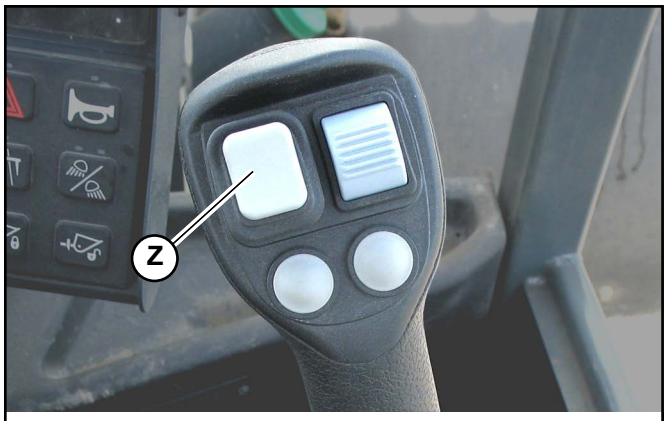


Fig. 81 – Travel Direction Switch

⚠ WARNING

Change travel direction only when stopped. Do not move the travel direction switch (Fig. 81) while traveling. The machine may react suddenly, causing an accident.

NOTE: *Selection indicator (S, Fig. 80) on the multi-purpose display moves to indicate the currently selected travel direction: F=Forward, N=Neutral, R=Reverse.*

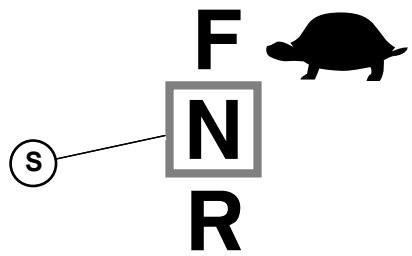


Fig. 82 – Travel Direction Icon Selection

5. Use high/low drive speed button (K, Fig. 83) to select either the high or low drive speed mode, according to the job requirements and work site conditions.

NOTE: *Additionally, the optional 3-speed (X) feature allows two speed ranges in the high speed mode. Refer to "3-Speed Option" on page 113.*

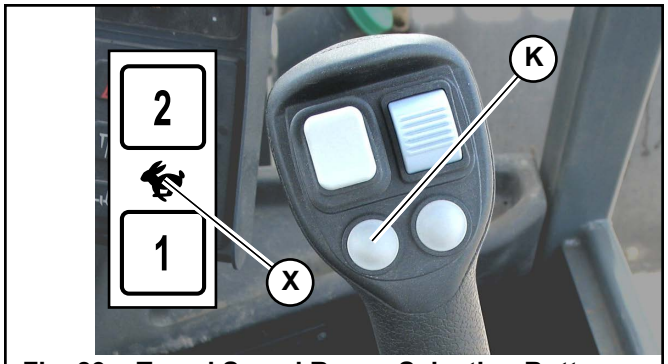


Fig. 83 – Travel Speed Range Selection Button

⚠ WARNING

Reduce speed before shifting from fast to slow travel speed. Down-shifting from fast- to slow-speed drive while traveling at fast speed may cause the machine to tip and can cause injury, loss of control, and damage to the machine.

6. Release the brake/inching pedal (E, Fig. 80) and slowly press travel pedal (U, Fig. 84). Driving speed is proportional to travel pedal movement.

NOTE: *Incomplete brake release could indicate the brake/inching pedal is out of calibration. See your local service center for brake/inching pedal calibration.*

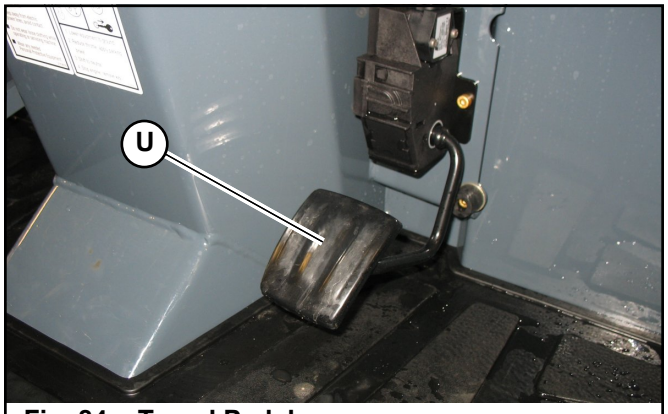


Fig. 84 – Travel Pedal

⚠ WARNING

Travel cautiously and under complete control at all times. Avoid sudden directional changes while traveling.

NOTE: *Use the travel pedal to control travel speed and engine speed. The hand throttle controls engine speed separately from the travel pedal. See "Throttle Controls" on page 86.*

NOTE: *Pressing the inching pedal reduces/stops hydraulic flow to the travel drive, allowing more power for lift structure operation.*

High/Low and Optional 3-Speed Travel Speed Modes

⚠ WARNING

Machine stability is affected by machine speed, especially on rough or hilly terrain while carrying heavy loads and while carrying loads raised above the height of the wheel axles. Always operate the machine at speeds appropriate for the conditions. Move the controls smoothly and gradually. Avoid sudden directional changes while traveling in the fast-speed mode.

Always use the slow travel speed mode in congested or populated areas.

High/Low Drive Speed Button

Press high/low drive speed mode select button (K, Fig. 85) to select either high or low drive speed according to the job requirements and work site conditions.

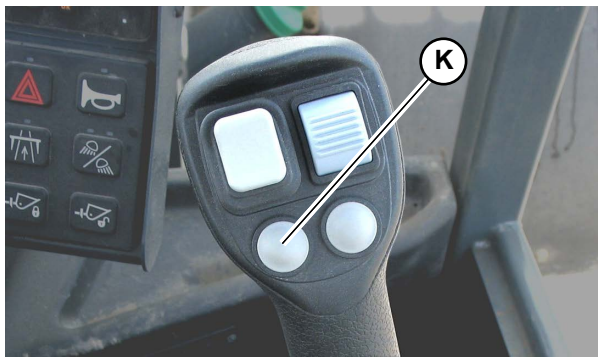


Fig. 85 – Travel Speed Selector

3-Speed Option

⚠ CAUTION

The 3-speed high-speed range should only be used for travel on roads with flat, level surfaces.

The 3-speed option provides two different speed ranges when in high-speed mode.

When activated, 3-speed provides an expanded speed range with a higher top travel speed when in high-speed mode.

NOTE: *3-speed affects high-speed mode only, which is toggled on/off using button (K).*

To activate 3-speed: press the "2" side (A) of the switch ( ).

To deactivate 3-speed: press the "1" side of the switch ( ).

See "High/Low Travel Speed Selection" on page 89 for additional information.

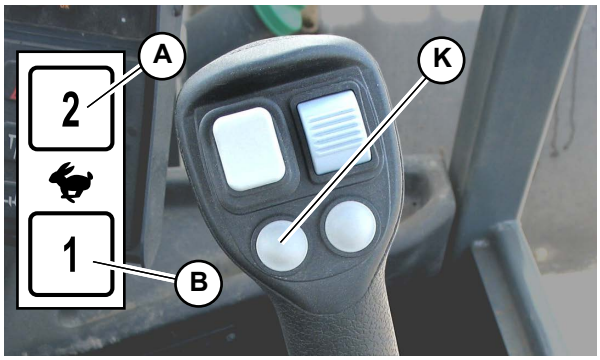


Fig. 86 – 3-Speed Option

Differential Lock Operation

IMPORTANT: *Stop the machine before engaging the differential lock. Do not engage the differential lock if turning on smooth, dry pavement. Damage to the axles may result.*

The differential lock can provide increased traction on loose and slippery surfaces.

NOTE: *The differential lock engages on both front and rear axles.*

To engage the differential lock, press and hold the differential lock button (T, Fig. 87). Release the button to disengage the differential lock.

NOTE: *The differential lock can be disengaged while driving. Drive in a line for a short distance to allow the differential clutch to disconnect for normal operation.*

NOTE: *Icon (S) appears on the multi-purpose display when the differential lock is activated.*

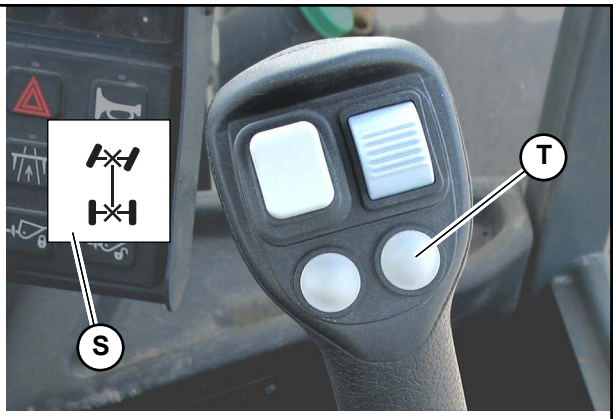


Fig. 87 – Differential Lock

Constant Speed Operation (Option)

⚠ WARNING

Constant speed should only be used on flat, level surfaces. Never carry loads or elevate the lift structure when using constant speed. Keep the lift structure as low as possible. See "Lift Structure Travel Position" on page 118.

Constant speed maintains a specific travel speed and constant auxiliary hydraulics continuous flow when engaged. Its purpose is to allow for attachment operation over long distances, such as snowblower operation.

To activate constant speed:

1. Set engine speed with the hand throttle to 1950 RPM or greater.
2. Use the travel pedal to set the ground speed.
3. Press and hold the constant speed switch (O, Fig. 88) until the constant speed icon is displayed on the multi-function display.

NOTE: *Constant speed is engaged when the constant speed icon is displayed.*

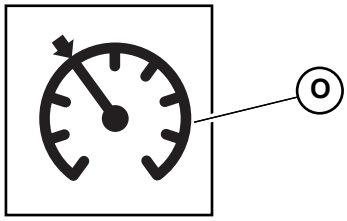


Fig. 88 – Constant Speed Switch

Constant speed is deactivated if:

- The brake/inch pedal is pressed.
- The constant speed switch (O) is pressed again.
- Engine rpm is reduced to 1900 RPM or lower.

⚠ CAUTION

Constant speed deactivates immediately when engine RPM falls to 1900 RPM. During normal machine operation, engine RPM can temporarily drop below 1900 rpm due to load, terrain, or road gradient change and cause constant speed to deactivate.

Travel Drive Error Condition Operation (Limited and Safe Modes)

For safety reasons, drive system error conditions will de-rate or disable the drive system.

Certain types of drive errors will cause restricted modes. See “Travel Drive Control Module Error Codes” on page 250.

- In less severe (LIMITED-Mode) error cases, the travel drive operates, but pump power is reduced by 50% and the drive motor operates in full displacement, causing the machine to move slowly.

  When a LIMITED-Mode error occurs, the travel direction switch on the joystick must be switched to “Neutral” (N) and then moved into either “Forward” (F) or “Reverse” (R) before the travel drive will operate.

- In severe (SAFE-Mode) error cases, the travel drive is disabled. The error can only be cleared by turning the power off.

If several errors occur at once, the errors are prioritized. The error with the lowest numeric Error Flash Code will display.

Backup Alarm (Option)

If the optional backup alarm is installed and the parking brake is released, the backup alarm activates when the travel direction switch is in reverse.

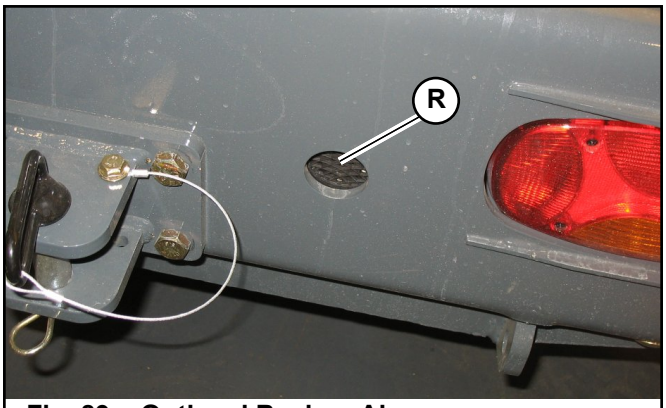


Fig. 89 – Optional Backup Alarm

IMPORTANT: *State and local regulations may have specific requirements for backup alarms. Make sure the machine is equipped as required to be in compliance with applicable regulations.*

⚠ DANGER

Do not rely exclusively on the backup alarm to alert others. Make sure that nobody is within the work area when traveling in reverse.

Special Considerations for Telescopic Machines

The additional reach and height provided by the telescopic lift structure require discipline and extra care to assure safe operation.

⚠ WARNING

- **Use care; extending the lift structure decreases stability in all operating conditions.**
- **Never exceed the rated capacity of the machine. See "Payloads/Capacities" on page 51. Extending the lift structure decreases capacity.**
- **Do not raise loads on a side hill with a slope or grade that is too steep for safe operation. When raising loads, make sure the lateral level indicator is in the green zone. Refer to "Lateral Level Indicator (Telescopic Machines)" on page 79.**
- **Always observe the lift structure angle indicator and the amount of lift structure extension in conjunction with the capacity load chart while extending the lift structure.**
- **The lift structure should be extended only to reach/place loads when the machine is stationary and positioned in a straight line (not turned). Never travel with the lift structure extended.**
- **Keep the attachment/load in sight at all times, especially if the lift structure is extended.**
- **Do not combine lift structure raising and extending or lowering and retracting operations. Combining such actions reduce operating capacity and stability. Always first retract the lift structure before lowering, and first raise the lift structure before extending.**
- **Do not extend or retract the lift structure to push or pull a load or object.**
- **Make sure the lift structure is retracted and the bucket is lowered to the ground before activating lift structure float.**

Telescopic Lift Structure Operation

⚠ WARNING

Fully retract the telescopic lift structure before raising/lowering. Extending/retracting while raising/lowering the lift structure at the same time reduces operating capacity and stability.

ALWAYS:

- **FIRST raise the lift structure and THEN extend it.**
- **FIRST retract the lift structure and THEN lower it.**

See "Lift Structure Extend/Retract (Telescopic Machines Only)" on page 122 for information about lift structure extend/retract operation.

Longitudinal Load Moment Indicator (LLMI) – EU Telescopic Machines Only

The Longitudinal Load Moment Indicator (LLMI) provides an indication of the effective capacity of the machine.The LLMI includes:

- A sight gauge (X, Fig. 90) located along the right edge of the multi-function display status screen.
- An audible alarm.

NOTE: *The LLMI audible alarm (Z) can be toggled ON/OFF by pressing the esc (escape) button (G, Fig. 13) on the multi-function display.*

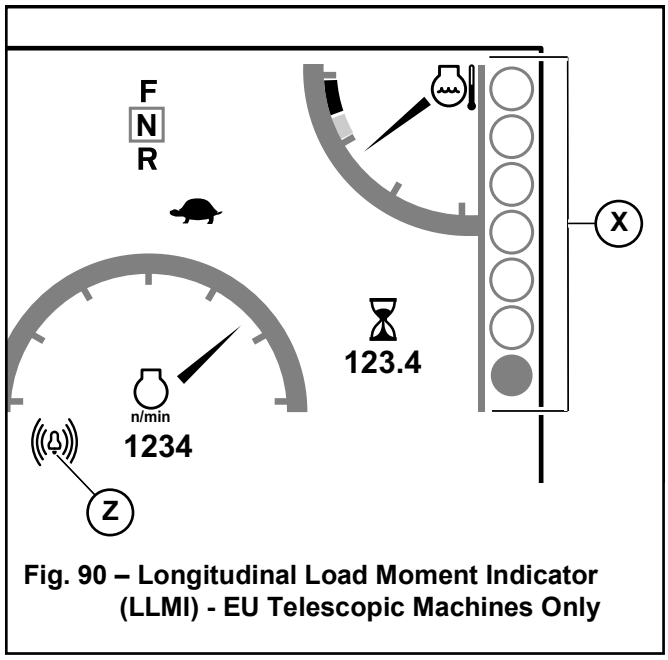


Fig. 90 – Longitudinal Load Moment Indicator (LLMI) - EU Telescopic Machines Only

The LLMI sight gauge (X, Fig. 90) indicates decreased machine capacity as the indicator moves up the scale from green through orange to red. The LLMI audible alarm also increases in frequency as the capacity decreases.

⚠ CAUTION

Always observe the LLMI during load handling operations. Move the lift structure carefully when approaching capacity limits.

⚠ WARNING

Avoid situations where the LLMI sight gage (X) moves up the scale into the red area.

IMPORTANT: *The LLMI is an indicator only; it does not limit the operation of the machine in any way.*

If the LLMI sight gauge reaches the red zone, DO NOT perform any movement that would further reduce capacity/stability, such as lowering and/or extending the telescopic lift structure. Perform movements to increase capacity/stability in the following order:

1. Retract the telescopic lift structure as far as possible.

⚠ CAUTION

Refer to "Pallet Fork Capacities Load Chart - EU (Telescopic Machines)" on page 54 when performing the following step.

2. If possible, raise or lower the lift structure as necessary to reduce the load.

⚠ WARNING

LLMI is compromised if the following conditions are not met:

- **The machine is not traveling (wheels are not rotating).**
- **The machine is resting on a solid, level and even surface.**
- **The machine is straight and not turned.**

⚠ WARNING

The LLMI is not intended to be used as a "risk of overturn" warning indicator in the case of:

- **A sudden overload.**
- **Traveling with the load elevated (lift structure raised).**
- **Traveling on rough or uneven terrain.**
- **Traveling across a slope or turning on a slope.**
- **Sharp turns or turning while traveling at a high rate of speed.**

Lift Structure Operation

⚠ WARNING

Never allow anyone under a raised lift structure that is not properly supported. A falling lift structure could result in severe injury or death.

If the lift structure must be left in the raised position, MAKE SURE the lift structure is properly and securely supported in the raised position.

The operator must not leave the operator's position if the lift structure is in the raised position unless the lift structure is properly and securely supported in the raised position.

⚠ WARNING

Do not raise loads exceeding rated operating capacity. See "Payloads/Capacities" on page 51.

⚠ WARNING

If the machine becomes unstable and starts to tip, keep the seat belt fastened, hold on firmly, and brace yourself. Keep all body parts inside the machine. Lean away from the point of impact and stay with the machine. If tipping occurs, DO NOT jump from the machine. The machine is equipped with rollover protection, which only protects the operator while in the operator's seat. Trying to escape from a tipping machine can result in death or serious personal injury.

IMPORTANT: *If a tip-over occurs:*

- *Restore the loader to an upright position as soon as safely possible to prevent oil and fuel leakage. Clean up any fluid leakage.*
- *Inspect and repair any damage before re-starting the engine.*

Lift Structure Travel Position

⚠ WARNING

To avoid tipping, travel and turn with the load as low as possible. Observe minimum ground clearance.

On telescopic machines, fully retract the lift structure before traveling. Keep the bottom of the load no higher than wheel axle height, while traveling and turning or tipping could occur, resulting in severe injury or death.

Lift Structure/Attachment Tilt Operation

⚠ WARNING

On telescopic machines, fully retract the telescopic lift structure before raising/lowering. Extending/retracting while raising/lowering the lift structure at the same time reduces operating capacity and stability. Always first retract the lift structure before lowering, and first raise the lift structure before extending. See "Lift Structure Extend/Retract (Telescopic Machines Only)" on page 122 for information about lift structure extend/retract operation.

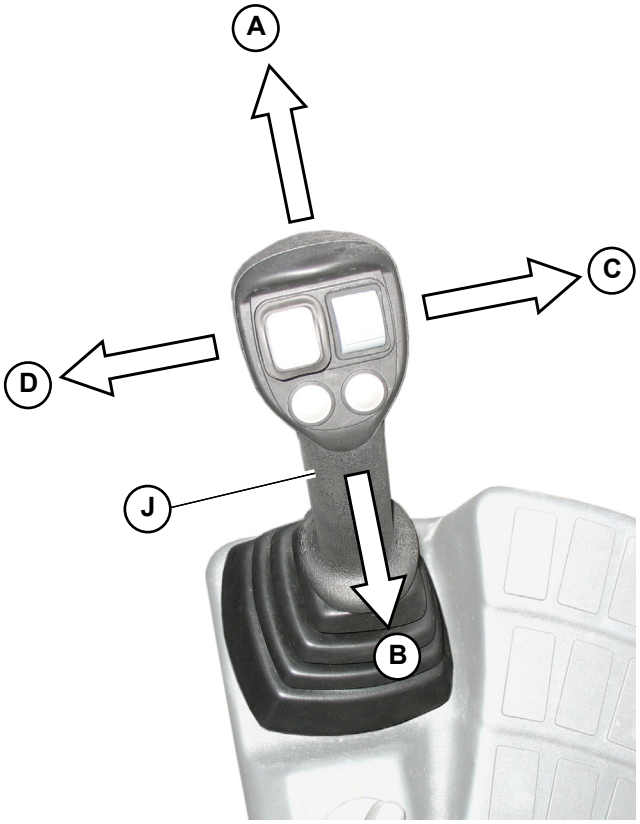


Fig. 91 – Multi-Function Joystick Control Pattern

- **Lift Structure Lower**
  Push the joystick straight forward (A, Fig. 91) to lower the lift structure.
- **Lift Structure Raise**
  Pull the joystick straight back (B) to raise the lift structure.
- **Attachment Tilt Forward**
  Move the joystick to the right (C) to tilt the attachment forward.
- **Attachment Tilt Back**
  Move the joystick to the left (D) to tilt the attachment back.

NOTE: *The speed of the raise/tilt motion is directly proportional to the amount of joystick movement and engine speed.*

IMPORTANT: *On telescopic machines, attachment tilt roll-back is limited when the lift structure is raised past a certain point.*

Engine Off Lift Structure Lower (Non-Telescopic Machines)

On non-telescopic machines, switch (F, Fig. 92), located on the right switch panel, allows lowering the lift structure when the engine is not running.

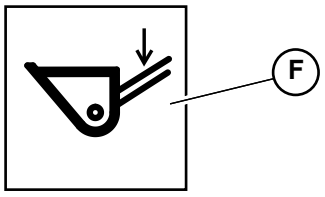


Fig. 92 – Power Off Lift Structure Lower (Non-Telescopic Machines)

While sitting in the operator's seat, press the orange lock button on the switch to enable the engine off lift structure lower switch.

NOTE: *The ignition switch must be turned on and the operator's seat must be occupied to enable engine off lift structure lower.*

⚠ WARNING

On telescopic machines, if the telescopic lift structure cannot be lowered because:

- **The engine stops and can't be restarted.**

- or -

- **A raise circuit hose bursts.**

Shut down the machine according to "Mandatory Safety Shutdown Procedure" on page 22. DO NOT attempt repairs. Call your dealer for assistance.

Non-Telescopic Machines Float Operation (Raise and Tilt)

⚠ WARNING

Make sure the attachment is lowered to the ground before activating either float function. Activating float with an attachment raised will cause it to lower rapidly, which can cause severe injury or death.

⚠ WARNING

Do not drive the machine at high speed with float activated. Damage to the machine and/or loss of control can result. Lift structure float may affect machine steering. Drive slowly and carefully when using float.

Float allows the lowered lift structure/attachment to follow ground contours while traveling over changing ground conditions.

NOTE: *On non-telescopic machines, float functions have magnetic locks that engage and hold float ON when the joystick is held in the float position. If so equipped, the lift structure float detent lock disable switch turns the magnetic locks off, while still allowing float to operate. See "Non-Telescopic Machines Lift Structure Float Detent Lock Disable Operation (if so equipped)" on page 121.*

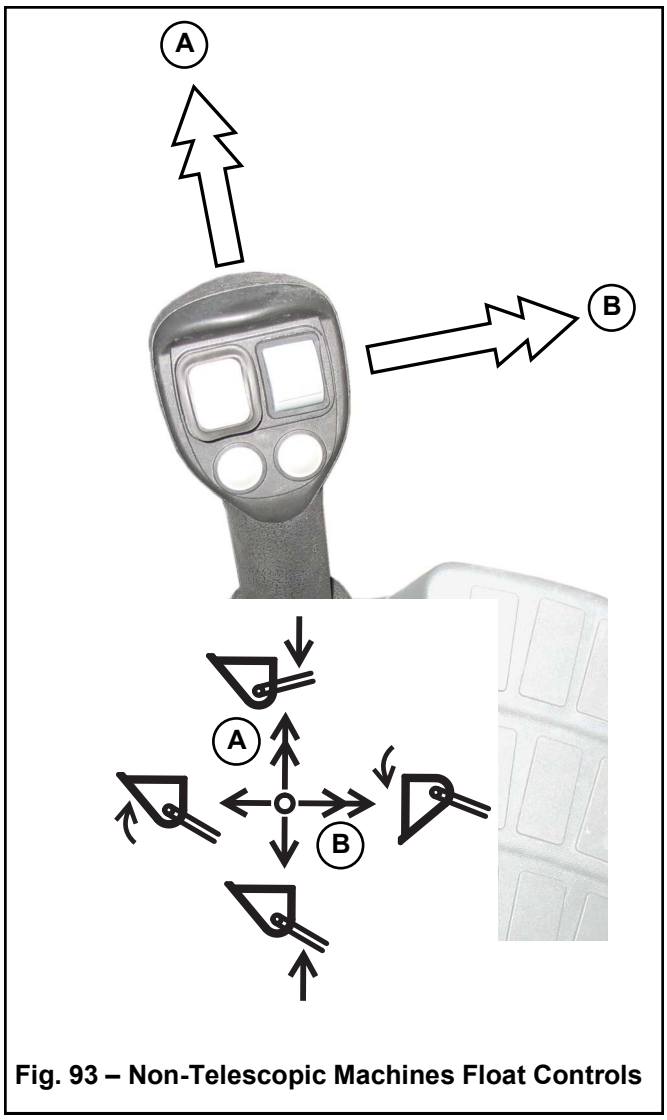


Fig. 93 – Non-Telescopic Machines Float Controls

- **Raise Float**
  Push the joystick forward, past the first position, into the front detent (A, Fig. 93) to activate the lift structure raise float.
- **Tilt Float**
  Move the joystick to the right, past the first position, into the right detent (B) to activate the attachment tilt float.

NOTE: *On non-telescopic machines, both raise float and tilt float can be operated simultaneously.*

Pull the joystick to the center neutral position to disengage float functions.

Non-Telescopic Machines Lift Structure Float Detent Lock Disable Operation (if so equipped)

Press lift structure float detent lock disable switch (X, Fig. 94) on the right switch panel to disables the raise/tilt magnetic latching locks.

NOTE: *The indicator in switch (X) is lit when the lift structure float detent locks are disabled.*

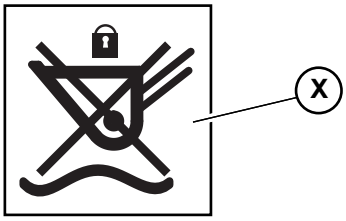


Fig. 94 – Non-Telescopic Machines Lift Structure Float Detent Lock Disable Switch

IMPORTANT: *Float function still operates if the joystick is held in either of the float positions when the lift structure float detent locks are disabled.*

Telescopic Machines Raise Float Operation

⚠ WARNING

Make sure the attachment is lowered to the ground before activating float. Activating float with an attachment raised will cause it to lower rapidly, which can cause severe injury or death.

⚠ WARNING

Do not drive the machine at high speed with float activated. Damage to the machine and/or loss of control can result. Lift structure float may affect machine steering. Drive slowly and carefully when using float.

1. Fully retract the lift structure and lower the attachment to the ground.
2. Press the top of switch (P, Fig. 95), located on the right switch panel.

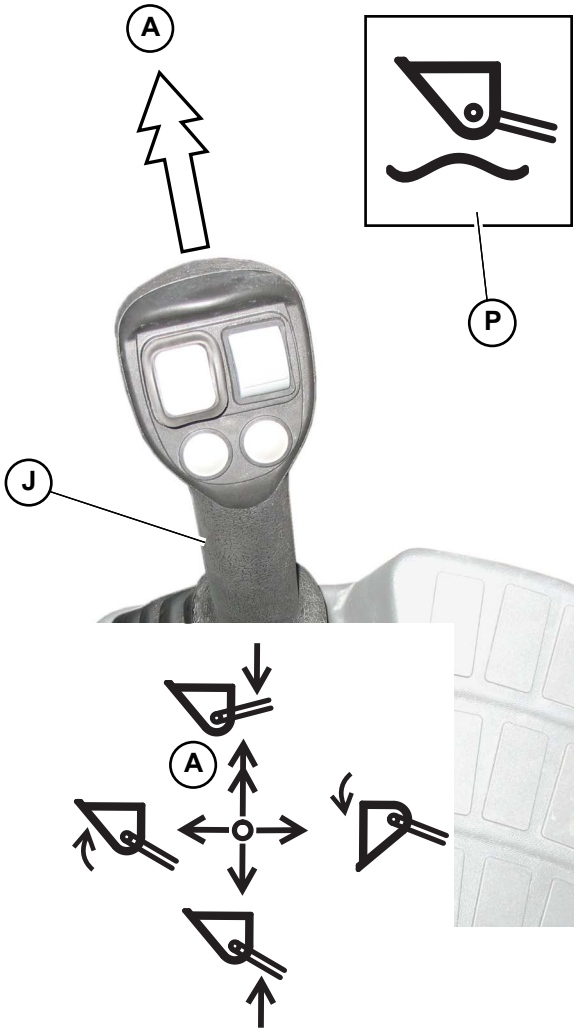


Fig. 95 – Telescopic Machines Float Controls

3. Push joystick (J) forward past the detent to engage lift structure float.

To disengage float, pull the joystick back out of the lift structure float detent.

Press the bottom of switch (P) to disable the lift structure float function.

⚠ WARNING

If switch (P) is not depressed and the joystick is pushed into or pulled out of the float position, lift structure motion will stop/start suddenly and may cause the machine to jerk and/or bounce.

Lift Structure Extend/Retract (Telescopic Machines Only)

⚠ WARNING

Fully retract the telescopic lift structure before raising/lowering and before traveling. Extending/retracting while raising/lowering the lift structure at the same time reduces operating capacity and stability.

ALWAYS:

- **FIRST raise the lift structure and THEN extend it.**
- **FIRST retract the lift structure and THEN lower it.**

⚠ WARNING

- **Use care when extending the lift structure. Extending the lift structure decreases capacity/stability in all operating conditions.**
- **Extending the lift structure decreases capacity. Never exceed the rated capacity of the machine. See “Payloads/Capacities” on page 51.**
- **The lift structure should be extended only to reach/place loads when the machine is stationary and positioned in a straight line (not turned). Never travel with the lift structure extended.**
- **Maintain visibility with the attachment/load at all times, especially with the lift structure extended.**
- **Do not extend or retract the lift structure to push or pull a load or object.**
- **Make sure the lift structure is retracted and the bucket is lowered to the ground before activating lift structure float.**

The rocker switch (U, Fig. 96) on the front of the multi-function joystick controls lift structure extend/ retract.

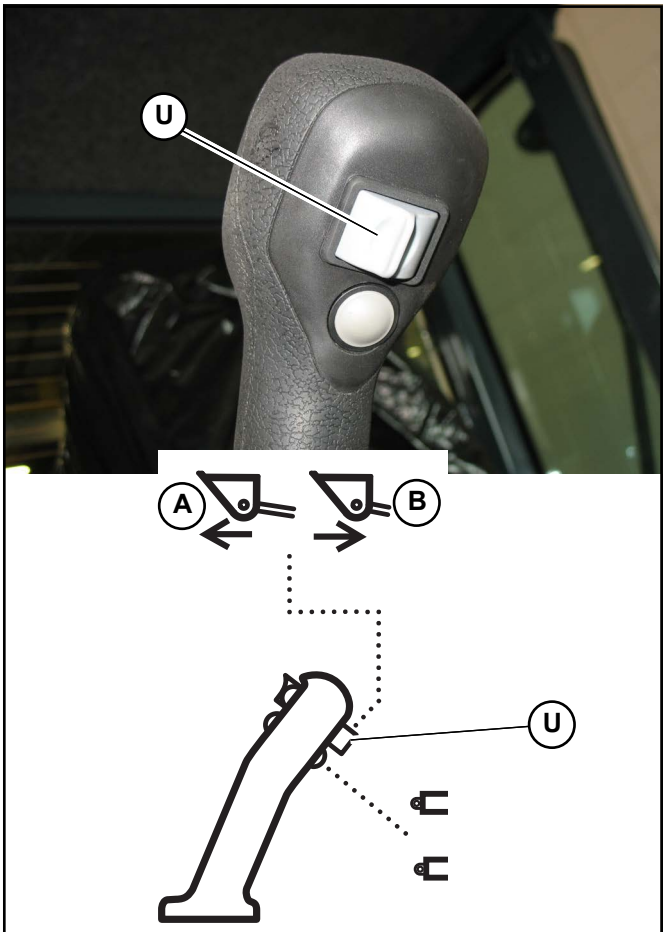


Fig. 96 – Telescopic Lift Structure Control Switch

- Move rocker switch (U) to one side to extend (A) the lift structure.
- Move rocker switch (U) to the other side to retract (B) the lift structure.

NOTE: *The speed of the extend/retract motion is directly proportional to the amount rocker switch movement and engine speed.*

Lift Structure Raise/Tilt Support (Non-Telescopic Machines Only)

⚠ WARNING

Never allow anyone under a raised lift structure that is not properly supported. A falling lift structure could result in severe injury or death.

If the lift structure must be left in the raised position, MAKE SURE the lift structure is properly supported in the raised position.

The operator must not leave the operator's position if the lift structure is in the raised position unless the lift structure support device is properly applied.

⚠ WARNING

A second person on the outside of the machine is required to assist with applying the lift structure support.

Engage Lift Structure Support

1. Empty and remove the attachment.
2. Bring the machine to a complete stop on a level surface.
3. Move the travel direction switch on the joystick to the neutral position and engage the parking brake.
4. Raise the lift structure until the lift cylinder is extended far enough to allow lift structure support (Z, Fig. 97) to fit over the left lift cylinder rod.

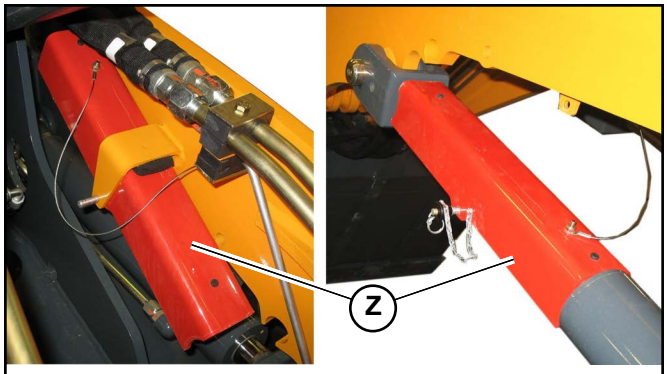


Fig. 97 – Lift Structure Raised to Extend Lift Cylinder Rods

5. Shut off the engine.
6. Move the joystick in all directions to verify that the lift structure and hitch plate do not move.
7. Stay in the machine, sitting in the operator's position. A second person, on the outside of the machine, must remove retaining pin (Y, Fig. 98) securing lift structure support (Z) in the storage position inside the lift structure.

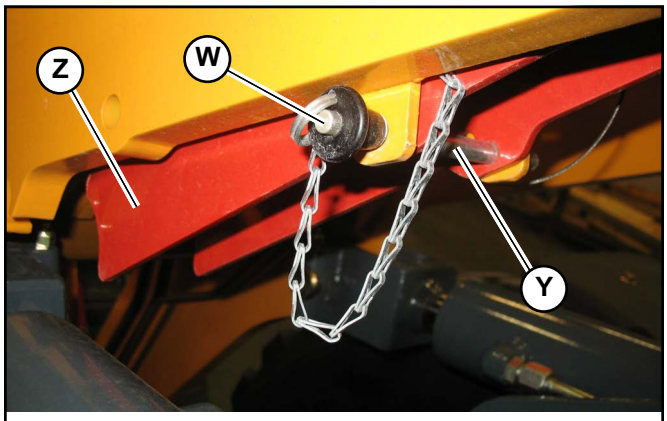


Fig. 98 – Lift Structure Support in Storage Position

NOTE: *Press button (W) to release catch on retaining pin (Y).*

8. Carefully position the lift structure support (Z, Fig. 99) over the exposed lift cylinder rod on the left lift cylinder as shown.

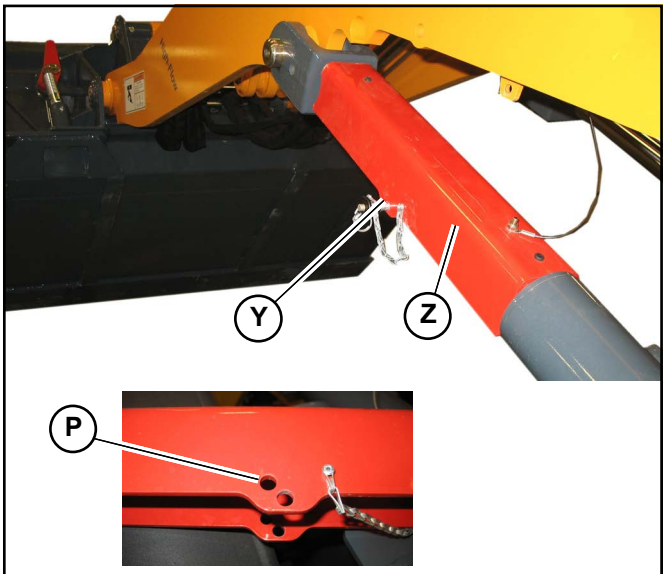


Fig. 99 – Lift Structure Supported

9. Retain support (Z) on lift structure cylinder rod using retaining pin (Y) through top hole (P).
10. Start the machine and lower the lift structure so lift structure support (Z) rests firmly against cylinder tube head and rod end. Verify that lift structure support (Z) is properly positioned as shown in Fig. 97.

⚠ WARNING

The lift structure support device must be properly positioned to prevent the lift structure from falling, which could result in severe injury or death.

11. Shut off the engine.
12. Move the joystick in all directions to verify that the lift structure and hitch plate do not move.
13. Unfasten the seat belt, remove the start key and take it with you. Exit the machine using the hand-holds.

Disengage Lift Structure Support

⚠ WARNING

A second person on the outside of the machine is required to assist with disengaging the lift structure support.

1. Start the engine and raise the lift structure until lift structure support (Z, Fig. 100) can be removed from the cylinder rod on the left lift cylinder.

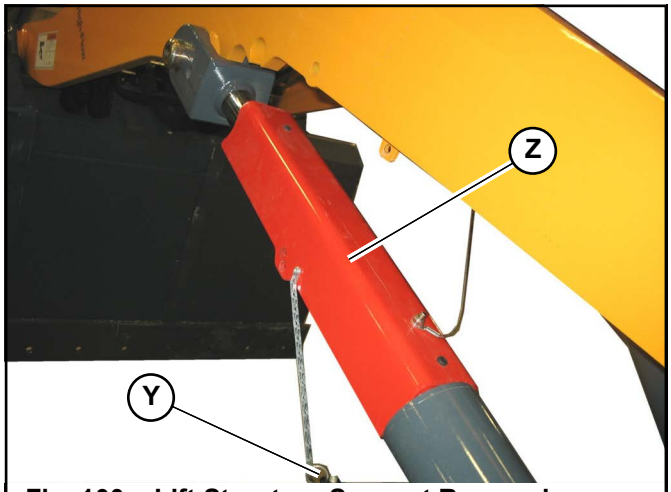


Fig. 100 – Lift Structure Support Removal

2. Move the travel direction switch on the joystick to the neutral position and engage the parking brake.
3. Shut off the engine.
4. Move the joystick in all directions to verify that the lift structure and hitch plate do not move.

5. Stay in the machine in the operator's position. A second person, on the outside of the machine, must press button (W, Fig. 102) to release the catch on the retaining pin and remove lift structure support (Z) from the lift cylinder.

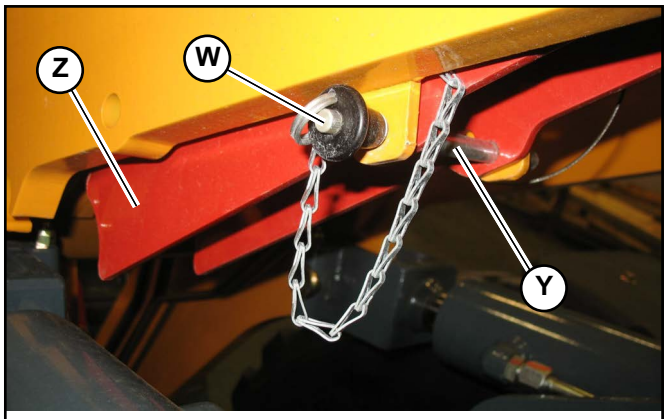


Fig. 101 – Lift Structure Support in Storage Position

6. Secure lift structure support (Z) in the storage position using retaining fastener (Y). Make sure fastener (Y) extends all the way through lift structure support (Z) and the storage bracket.

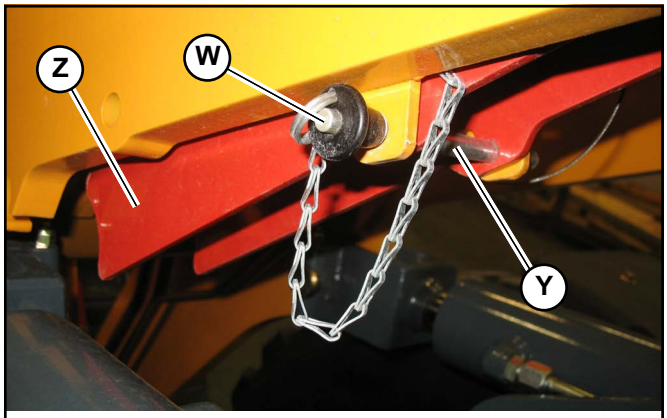


Fig. 102 – Lift Structure Support in Storage Position

Engage Tilt Support

Use the lift structure support to lock the attachment tilt when driving the machine long distances.

⚠ WARNING

A second person on the outside of the machine is required to assist with engaging the tilt support.

1. Empty and remove the attachment.
2. Bring the machine to a complete stop on a level surface.
3. Move the travel direction switch on the joystick to the neutral position and engage the parking brake.
4. Tilt the attachment hitch forward until the tilt cylinder is extended far enough to allow lift structure support (Z, Fig. 103) to fit over the tilt cylinder rod.

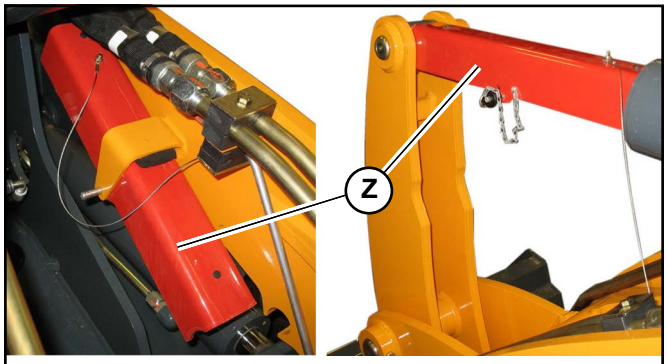


Fig. 103 – Tilt Cylinder Extended

5. Move the travel direction switch on the joystick to the neutral position and engage the parking brake.
6. Shut off the engine.
7. Move the joystick in all directions to verify that the lift structure and hitch plate do not move.
8. Stay in the machine, sitting in the operator's position. A second person, on the outside of the machine, must remove retaining pin (Y, Fig. 102) securing support (Z) in the storage position inside the lift structure.

NOTE: *Press button (W) to release catch on retaining pin (Y).*

9. The second person on the outside of the machine must carefully position support (Z, Fig. 104) over the exposed tilt cylinder rod as shown.

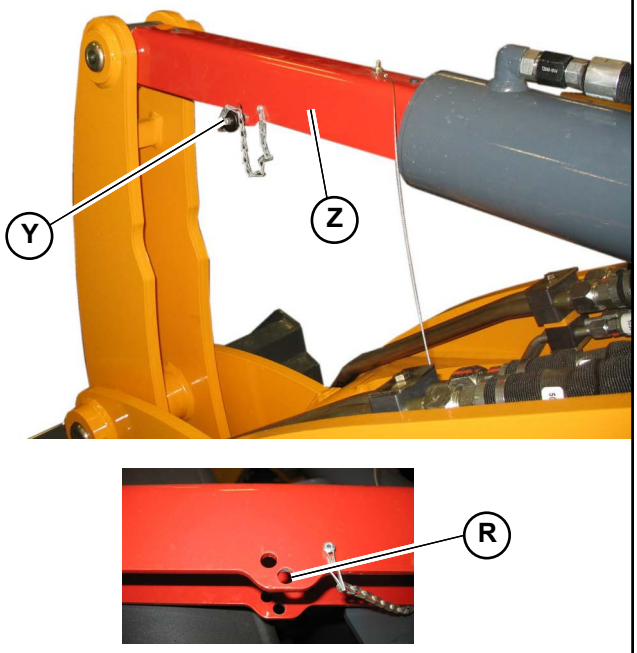


Fig. 104 – Tilt Locked

10. Retain support (Z) on tilt cylinder rod using retaining pin (Y) through bottom hole (R).
11. Start the machine and tilt back the attachment hitch so support (Z) rests firmly against cylinder tube head and rod end. Verify that support (Z) is properly positioned as shown in Fig. 104.
12. Shut off the engine.
13. Move the joystick in all directions to verify that the lift structure and hitch plate do not move.
14. Unfasten the seat belt, remove the starter key and take it with you. Exit the machine using the hand-holds.

Disengage Tilt Support

⚠ WARNING

A second person on the outside of the machine is required to assist with disengaging the tilt support.

1. Start the engine and tilt the attachment hitch forward until support (Z, Fig. 104) can be removed from the cylinder rod on the tilt cylinder.
2. Move the travel direction switch on the joystick to the neutral position and engage the parking brake.
3. Shut off the engine.
4. Move the joystick in all directions to verify that the lift structure and hitch plate do not move.
5. Stay in the machine in the operator's position. A second person, on the outside of the machine, must press button (W, Fig. 102) to release the catch on the retaining pin and remove support (Z) from the tilt cylinder.
6. Secure lift structure support (Z, Fig. 105) in the storage position using retaining fastener (Y). Make sure fastener (Y) extends all the way through support (Z) and the storage bracket.

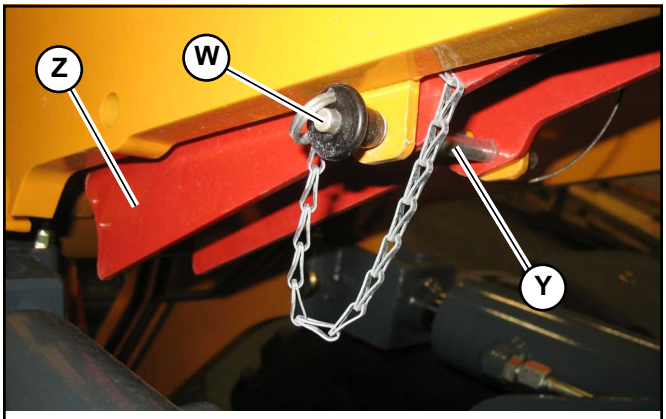


Fig. 105 – Lift Structure Support in Storage Position

Self-Leveling and Return-To Dig

Self-Leveling (Lift Structure Raise)

⚠ DANGER

Loads maintain a constant tilt angle during raise only if the attachment hitch is tilted all the way, or almost all the way, back before raising/ lowering the lift structure.

Be aware that attachment tilt does not stay constant if the attachment is not tilted back before raising/lowering the lift structure, unless compensated for using the joystick tilt control.

Use only approved pallet forks. Use special caution and maintain tilt control at all times when using pallet forks.

Self-leveling automatically keeps the tilt angle of the attachment constant, relative to the ground plane (Fig. 106), if the attachment (bucket) is tilted all the way, or almost all the way, back before the lift structure is raised/lowered (A).

IMPORTANT: *See "Return to Dig (Lift Structure Lower)" on page 128 for when the lift structure is lowered.*

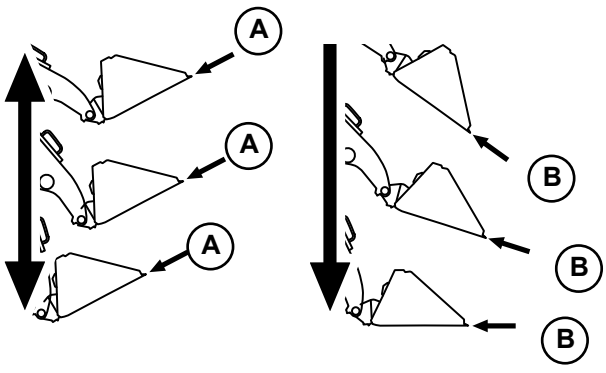


Fig. 106 – Self-Leveling and Return-To-Dig

Return to Dig (Lift Structure Lower)

If the attachment (bucket) is tilted forward all the way (full dump) before the lift structure is lowered, the attachment tilts toward level when the lift structure is lowered.

NOTE: *If the attachment (bucket) is tilted forward all the way (full dump) AND the lift structure is fully raised, the attachment (bucket) will rotate to level when lowered to the ground.*

Hydraglide™ Ride Control System (Option)

The hydraglide™ ride control system provides a smoother ride over uneven surfaces.

IMPORTANT: *Do not use Hydraglide™ when digging. Precise control of the digging operation is difficult with Hydraglide™ activated.*

⚠ CAUTION

Using Hydraglide™ while digging can shorten Hydraglide™ component service life.

⚠ WARNING

Do not use Hydraglide™ when using pallet forks.

Activate Hydraglide™ when driving on public roads, for lighter loads, and for light off-road travel. Deactivate Hydraglide™ when working with heavy loads, such as when picking up excavated material.

⚠ WARNING

Always activate Hydraglide™ when traveling on public roads, long distances and/or on uneven terrain. When activated, The hydraglide™ ride control system provides a smoother ride over uneven surfaces. This help to prevent bouncing on rough terrain which may cause instability.

⚠ WARNING

When Hydraglide™ is activated, the lift structure may drop slightly without a load, or several inches with a heavy load.

Press hydraglide switch (H, Fig. 107) to toggle Hydraglide™ on/off.

NOTE: *The indicator in switch (H) is lit when the Hydraglide™ option is activated.*

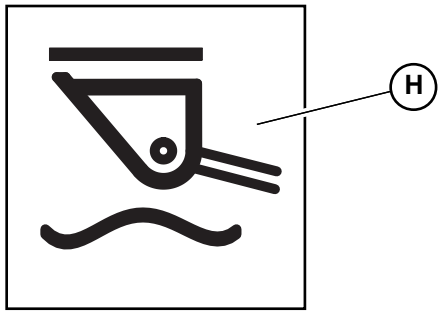


Fig. 107 – Hydraglide™ Switch/Indicator

Hydraulics Transport Lock-Out Operation

Button (U, Fig. 108), located on the control keypad, controls hydraulics transport lock-out function.

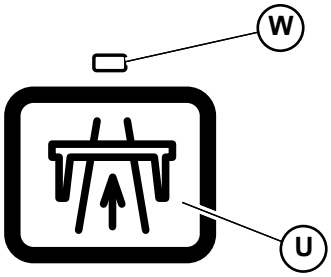


Fig. 108 – Hydraulics Transport Lock-out Button

The hydraulics transport lock-out feature is used to lock out work hydraulics when driving the machine for longer distances and/or transport on public roads.

Position the lift structure for travel (See "Lift Structure Travel Position" on page 118) and press the hydraulics transport lock-out button (U) to deactivate the attachment raise and tilt hydraulics and prevent inadvertent lift structure movement. Pressing the button again will toggle hydraulic function back on.

NOTE: *Attachment raise and tilt hydraulics are deactivated when LED (W) is lit.*

Connecting/Disconnecting Attachments

⚠ WARNING

Use only approved attachments. Contact your dealer or Manitou Group for information about approved attachments. Manitou Group cannot be responsible if the machine is used with non-approved attachments. Read the operator's manuals provided with all attachments used with the machine before starting the engine. A loaded attachment changes the center-of-gravity of the machine. Use caution! Never exceed the rated operating capacity—refer to weights and capacities information starting on page 51. Before using an attachment, verify the attachment is undamaged and properly connected and locked on the hitch.

⚠ WARNING

Know how an attachment operates and how it affects machine operation before working with the attachment.

⚠ WARNING

Keep bystanders away when connecting/ disconnecting attachments.

Power-A-Tach® System Hitch Operation

Connecting Attachments Using Power-A-Tach® System Hitch

1. On telescopic machines, fully retract the lift structure.
2. With the engine running, press and hold hitch unlock button (H, Fig. 109) until safety flags (K, Fig. 110) have moved all the way out.

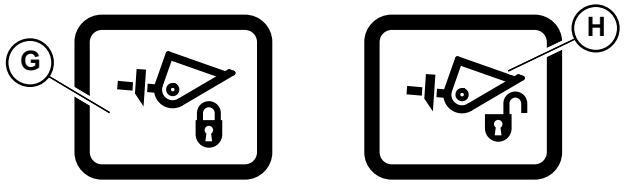


Fig. 109 – Quick Attachment System Control Buttons

Non-Telescopic Machines Shown, Telescopic Machines Similar

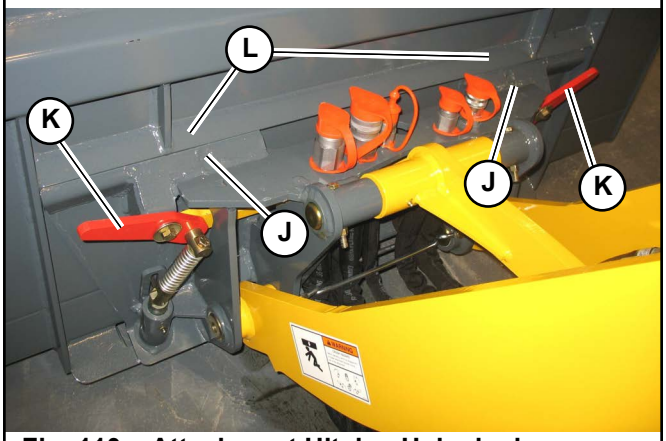


Fig. 110 – Attachment Hitch – Unlocked

3. Tilt the attachment plate forward and drive the machine straight forward toward the back of the attachment.
4. Lower the lift structure so tabs (J) on the top of the attachment plate are aligned just under lip (L) on the back of the attachment.
5. Tilt back and slightly raise the attachment plate until tabs (J) on the top of the attachment plate are engaged under and against lip (L) on the back of the attachment.

6. Raise the lift structure slightly until the attachment is hanging from lip (L) and tabs (J) are firmly inserted. Tilt the attachment plate back, as necessary, so the back of the attachment is resting flat against the attachment plate.
7. Press hitch lock button (G, Fig. 109) until safety flags (K, Fig. 111) have moved all the way in and are in a vertical position.

Non-Telescopic Machines Shown, Telescopic Machines Similar

Fig. 111 – Attachment Hitch – Locked

8. Make sure the locking pins (F, Fig. 112) are fully engaged and the attachment is secured tightly on the hitch.

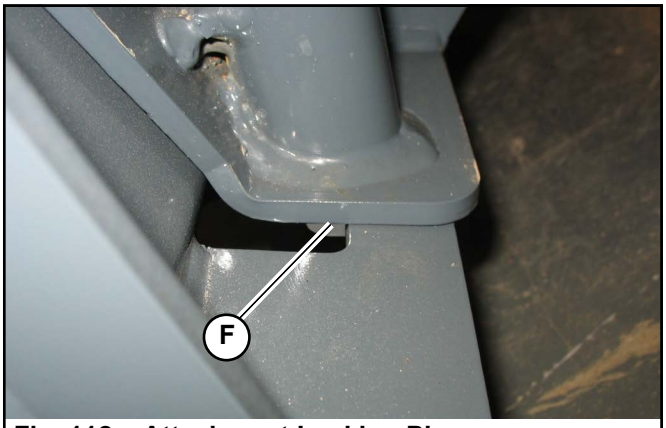


Fig. 112 – Attachment Locking Pins

⚠ WARNING

To prevent unexpected release of the attachment from the hitch, make sure safety flags (K, Fig. 111) are all the way in.

Locking pins (F, Fig. 112) must be fully engaged and the attachment must be secured tightly on the hitch before using the attachment. The attachment could fall off if it is not locked on the hitch and cause serious injury or death.

Disconnecting Attachments Using Power-A-Tach® System Hitch

⚠ WARNING

Position the attachment so it will stand and not tip over after disconnection. Serious injury can occur if an attachment tips over onto a person.

1. Empty the attachment and drive to an open, level area to disconnect the attachment.
2. On telescopic machines, fully retract the lift structure.
3. Lower the attachment to the ground.
4. With the engine running, press hitch and hold unlock button (H, Fig. 113) until safety flags (K, Fig. 114) have moved all the way out.

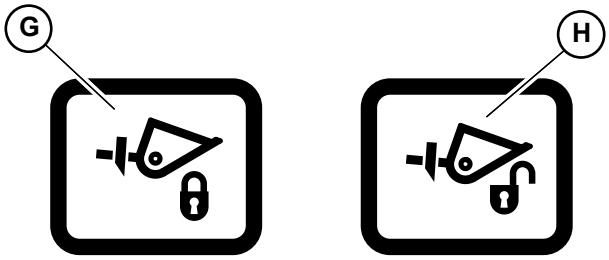


Fig. 113 – Quick Attachment System Control Buttons

Non-Telescopic Machines Shown,
Telescopic Machines Similar

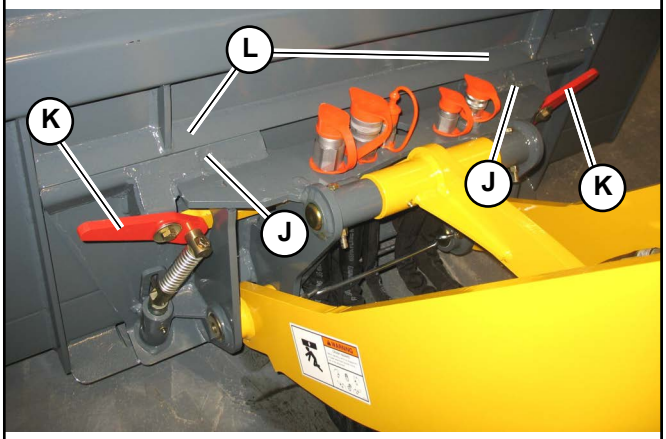


Fig. 114 – Attachment Hitch – Unlocked

5. Lower the lift structure until tabs (J, Fig. 114) on top of the attachment plate disengage out of lip (L) on the back of the attachment.

NOTE: *It may be necessary to tilt the attachment hitch forward to release the attachment.*

6. Look behind you for bystanders and obstacles. Drive straight back in reverse away from the attachment.

Euro-Style and 4-Point Hitch Operation

Connecting Attachments Using Euro-Style and 4-Point Hitches

1. With the engine running, press and hold hitch unlock button (H, Fig. 115) until locking pins (Z, Fig. 116) are fully retracted to the inside of the hitch.

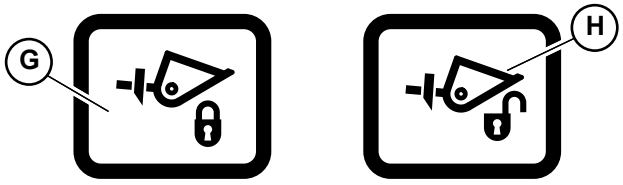


Fig. 115 – Quick Attachment System Control Buttons

Non-Telescopic Machines Shown,
Telescopic Machines Similar

Euro-Style Hitch

4-Point Hitch

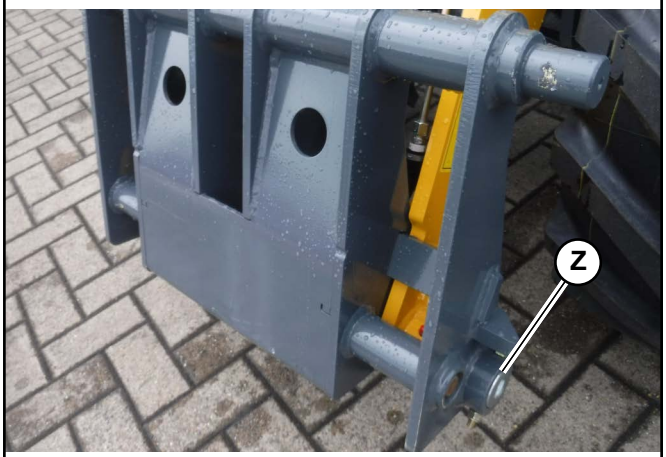
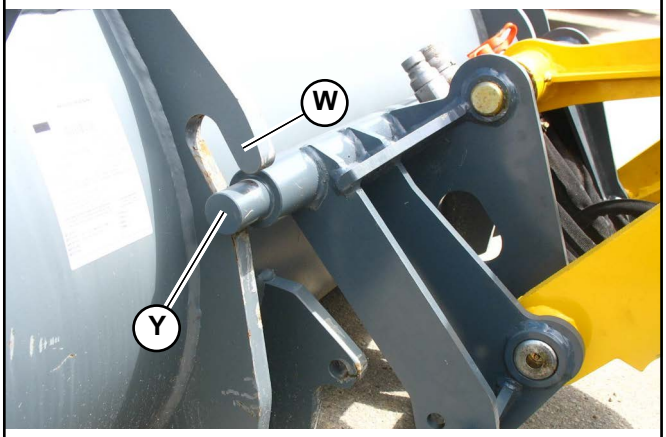


Fig. 116 – Attachment Locking Pins Retracted

2. On telescopic machines, fully retract the lift structure.
3. Tilt the attachment plate forward and drive the machine straight forward toward the back of the attachment.
4. Lower the lift structure so rods (Y, Fig. 117) on the top of the attachment plate are aligned just under hooks (W) on the back of the attachment.

Non-Telescopic Machines Shown, Telescopic Machines Similar

Euro-Style Hitch



4-Point Hitch

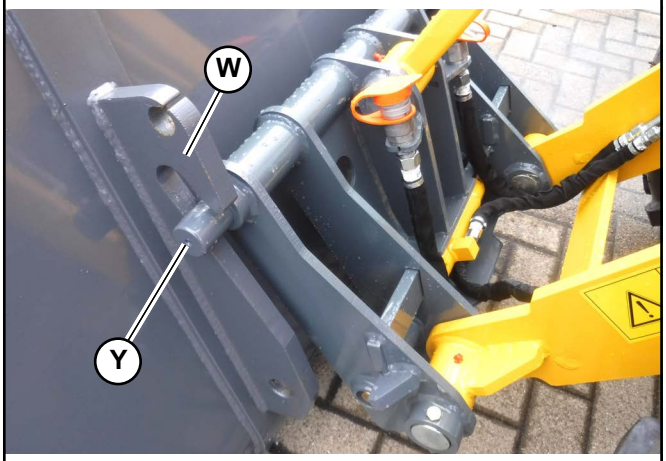
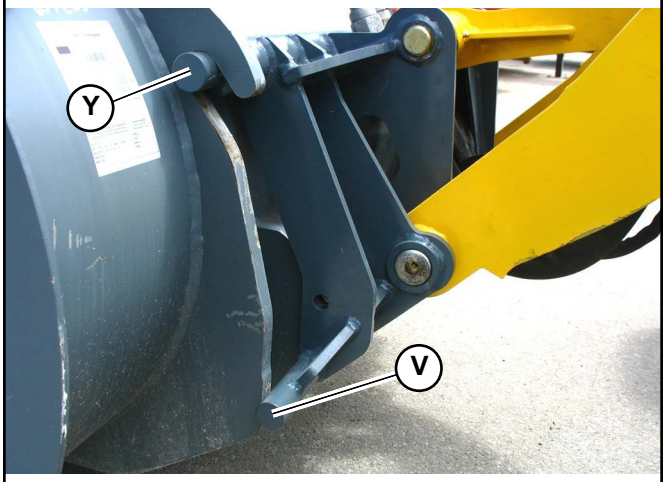


Fig. 117 – Attachment Hitch Positioning

5. Tilt back and raise the attachment plate until the attachment is hanging from rods (Y, Fig. 118). Tilt the attachment plate back until the back of the attachment is resting against rods (V) on the bottom of the attachment plate.

Non-Telescopic Machines Shown, Telescopic Machines Similar

Euro-Style Hitch



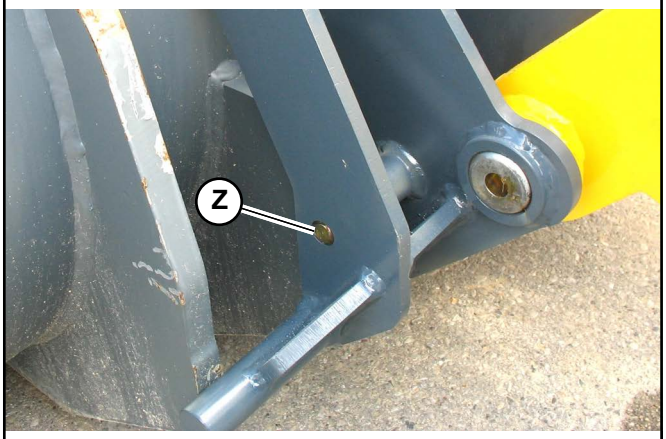
4-Point Hitch

Fig. 118 – Attachment Resting on Hitch

6. Press hitch lock button (G, Fig. 120) until both locking pins (Z, Fig. 119) on each side have moved all the way through the holes in the attachment.

Non-Telescopic Machines Shown, Telescopic Machines Similar

Euro-Style Hitch



4-Point Hitch

Fig. 119 – Attachment Hitch – Locked

7. Make sure the locking pins (Z) are fully engaged and the attachment is secured tightly on the hitch.

⚠ WARNING

To prevent unexpected release of the attachment from the hitch, locking pins (Z) must be fully engaged and the attachment must be secured tightly on the hitch before using the attachment. The attachment could fall off if it is not locked on the hitch and cause serious injury or death.

Disconnecting Attachments Using Euro-Style and 4-Point Hitches

⚠ WARNING

Position the attachment so it will stand and not tip over after disconnection. Serious injury can occur if an attachment tips over onto a person.

1. Empty the attachment.
2. On telescopic machines, fully retract the lift structure.
3. Drive to an open, level area to disconnect the attachment.
4. Lower the attachment to the ground.
5. With the engine running, press hitch and hold unlock button (H, Fig. 120) until locking pins (Z, Fig. 121) are fully retracted out of the holes in the attachment.

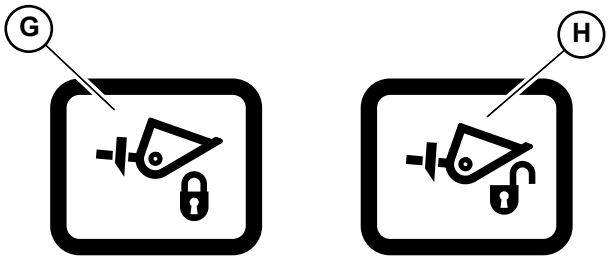
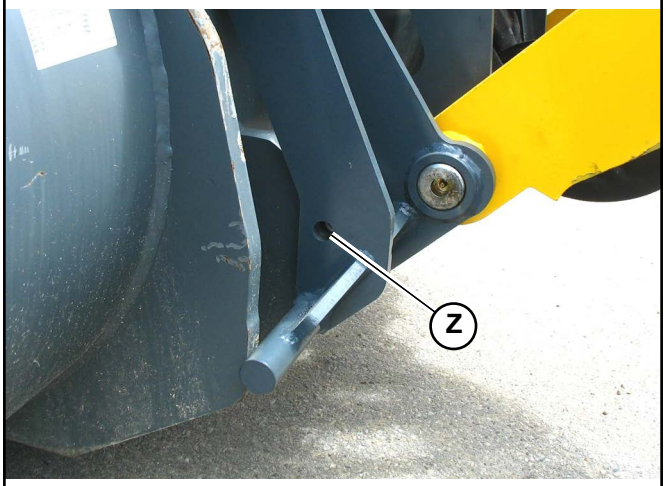


Fig. 120 – Quick Attachment System Control Buttons

Non-Telescopic Machines Shown, Telescopic Machines Similar

Euro-Style Hitch



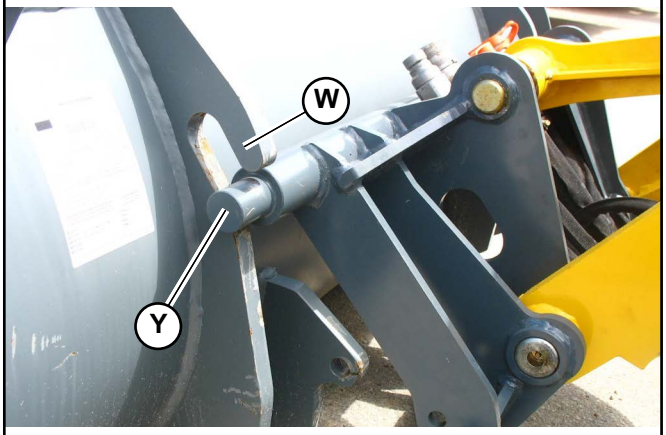
4-Point Hitch

Fig. 121 – Attachment Hitch – Unlocked

6. Lower and tilt the attachment hitch forward until rods (Y, Fig. 122) on top of the attachment plate disengage out of hooks (W) on the back of the attachment.

Non-Telescopic Machines Shown, Telescopic Machines Similar

Euro-Style Hitch



4-Point Hitch

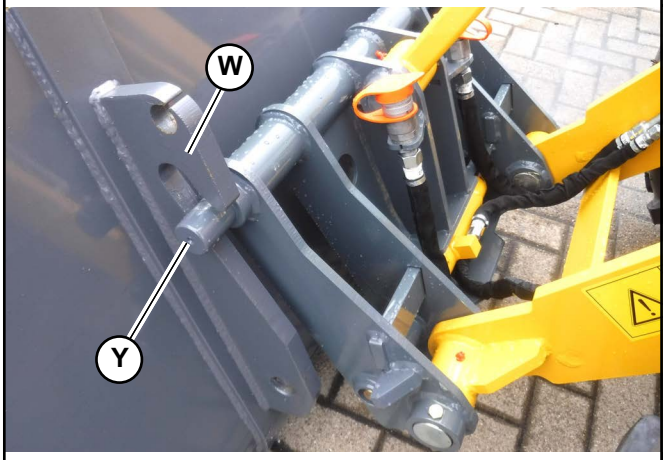


Fig. 122 – Attachment Removal

7. Look behind you for bystanders and obstacles. Drive straight back in reverse away from the attachment.

Powering Attachments with Hydraulic Function

Hydraulically-powered attachments are powered using the auxiliary hydraulics circuits.

Connecting Hydraulic Attachments to the Auxiliary Hydraulic Circuits

IMPORTANT: *Connect hydraulically-powered attachment hoses to the auxiliary circuits after the attachment is secured to the hitch.*

Disconnect hydraulically-powered attachment hoses from the auxiliary circuits before removing the attachment from the hitch.

NOTE: *The connection procedure is the same for both the standard and the optional high-flow auxiliary hydraulic circuits.*

⚠ CAUTION

Only connect high-flow attachment couplers to the high-flow auxiliary connectors.

1. Empty the attachment and lower it to the ground.
2. Stop the engine, but leave the ignition switch in the ON/RUN position.
3. From the operators position, press lock (X, Fig. 123) to release auxiliary circuit pressure relief button (H) and press and hold button (H) for 3-5 seconds to relieve the pressure in the auxiliary hydraulics circuit.

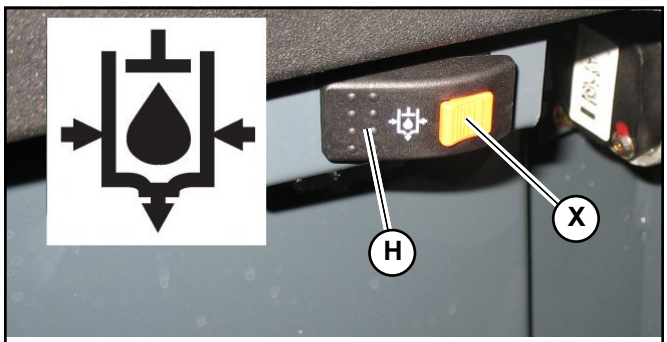


Fig. 123 – Auxiliary Hydraulics Pressure Relief Button

NOTE: *To relieve pressure in the 2nd auxiliary circuit, the 2nd auxiliary hydraulics circuit must be toggled on when pressing auxiliary circuit pressure relief button (H). See "2nd Auxiliary Hydraulics Circuit (Option - Non-Telescopic Machines Only)" on page 139.*

4. Apply the parking brake.
5. Turn off the ignition switch and remove the key and take it with you. Exit the machine using the handholds.
6. Remove the protective covers from the hydraulic connections (Fig. 124).
7. Clean the hydraulic connections on the hoses and the connections.
8. Push the hose connections firmly onto the auxiliary hydraulic connections until they snap into place.

⚠ CAUTION

Route the hydraulic hoses so they do not get pinched when the attachment is used. Damaged or burst hydraulic hoses could result.

IMPORTANT: *Always check the hydraulic function of the attachment before use to make sure the hydraulic hoses have not been installed in reverse.*

NOTE: *Pressure build-up caused by heat in hydraulic attachments left in direct sunlight can make it difficult to connect the quick-couplers to the fittings on the attachment.*

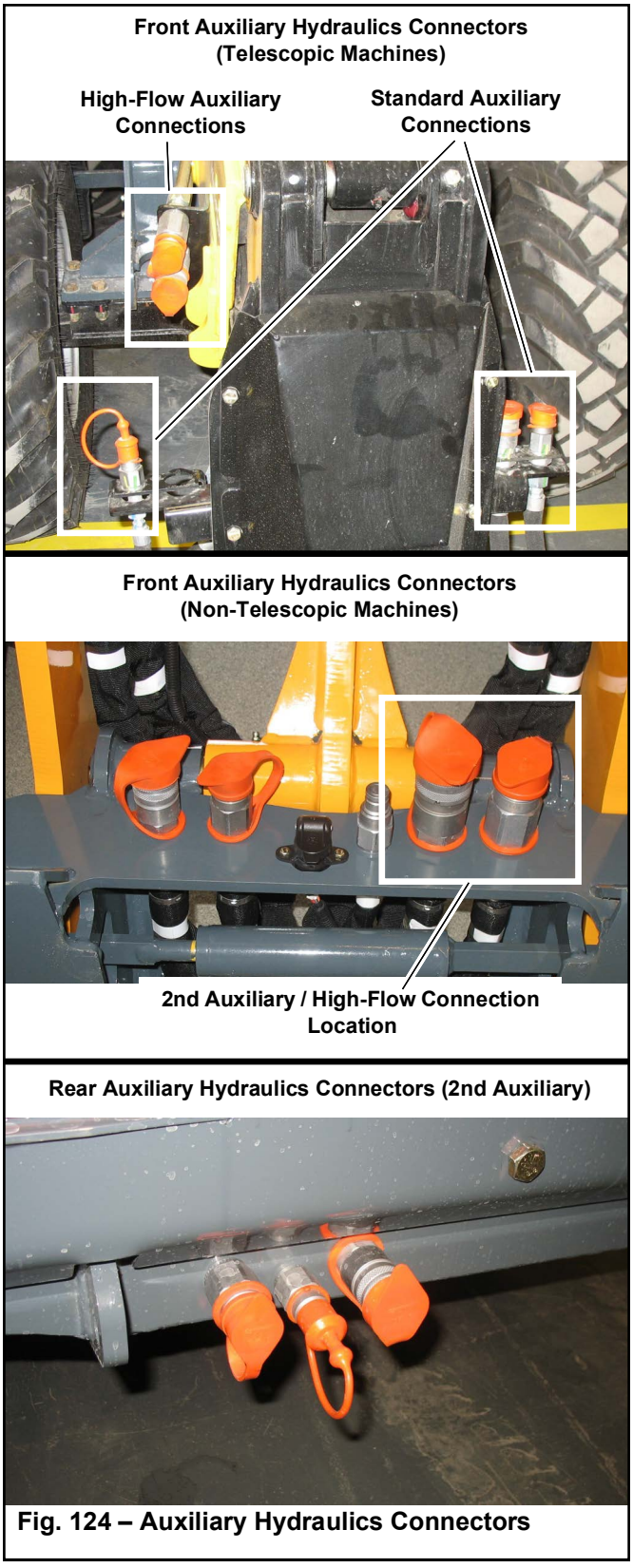


Fig. 124 – Auxiliary Hydraulics Connectors

Disconnecting Hydraulic Attachments from the Auxiliary Hydraulics Circuit

1. Empty the attachment and lower it to the ground.
2. Apply the parking brake.
3. From the operator's position, press and hold the auxiliary circuit pressure relief button (H, Fig. 123) for 3-5 seconds to relieve the pressure in the auxiliary hydraulics circuit.

NOTE: *To relieve pressure in the 2nd auxiliary circuit, the engine must be running and the 2nd auxiliary hydraulics circuit must be toggled on when pressing auxiliary circuit pressure relief button (H). See "2nd Auxiliary Hydraulics Circuit (Option - Non-Telescopic Machines Only)" on page 139.*

4. Shut off the engine and turn off the starter key switch. Remove the key and take it with you. Exit the machine using the handholds.
5. Push on the hose connection locking rings until the hose connections release.
6. Cap the hydraulic connections with the protective covers.

IMPORTANT: *Always cap the hydraulics after disconnecting to protect against hydraulic oil contamination.*

NOTE: *Connect attachment connectors together when the attachment is not being used, to keep pressure from building in the attachment and to keep the connector mating surfaces clean.*

Auxiliary Hydraulics Operation

Standard-Flow Auxiliary Hydraulics Operation

Rocker switch (F, Fig. 125) controls the direction and amount of auxiliary hydraulics standard-flow.

Auxiliary hydraulics control is proportional—the farther switch (F) is moved from center, the greater the flow through the auxiliary circuit. Flow direction is reversed when rocker switch (F) is moved in the opposite direction.

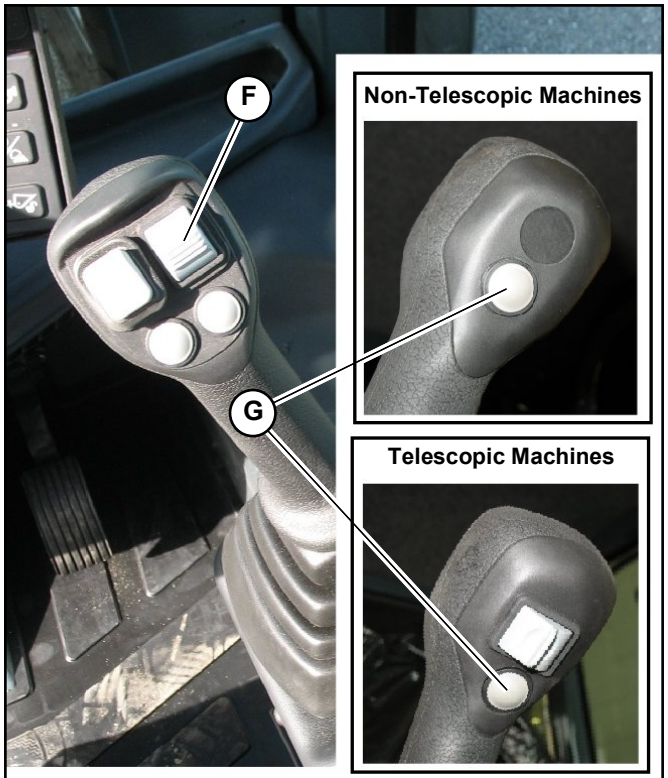


Fig. 125 – Standard-Flow Auxiliary Hydraulics Control Rocker Switch

To latch continuous auxiliary hydraulic flow, hold rocker switch (F) fully on in either the up or down direction and hold trigger button (G) for five seconds.

NOTE: *Standard-flow auxiliary hydraulics continuous flow can only be activated if rocker switch (F) is held in either the FULL up or down position.*

NOTE: *Continuous flow amount is controlled using engine speed.*

NOTE: *Standard flow auxiliary hydraulics will remain in continuous flow with the operator's seat unoccupied if the parking brake is engaged.*

To cancel continuous flow, either push trigger button (G) or move rocker switch (F) up or down.

NOTE: *When starter key switch power is turned off, auxiliary hydraulic function is reset to OFF.*

2nd Auxiliary Hydraulics Circuit (Option - Non-Telescopic Machines Only)

The 2nd auxiliary hydraulics circuit option provides an additional auxiliary circuit for powering attachments.

NOTE: *Connections for the 2nd Hydraulic circuit are mounted on either the front or rear of the machine (Fig. 124).*

Use switch (O, Fig. 126) to toggle the 2nd auxiliary hydraulics circuit on/off. The indicator in switch (O) is lit when the 2nd auxiliary hydraulic circuit is activated.

Rocker switch (F, Fig. 125) and trigger button (G) are used to control the 2nd auxiliary hydraulics flow, the same as when used to control standard auxiliary hydraulics flow.

NOTE: *When the 2nd auxiliary hydraulics circuit is toggled on, the standard auxiliary circuit is toggled off.*

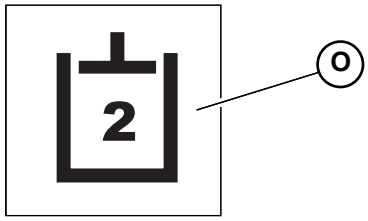


Fig. 126 – 2nd Auxiliary Hydraulics Circuit Option

High-Flow Auxiliary Hydraulics Operation

The high-flow auxiliary hydraulic system is used for operating certain hydraulic attachments (e.g., cold planer, snowblower) that require higher flows.

NOTE: *Connections for the high-flow auxiliary hydraulics circuit are mounted on the front of the machine (Fig. 124).*

High-flow auxiliary switch (M, Fig. 127) activates the high flow auxiliary hydraulics circuit and controls oil flow direction.

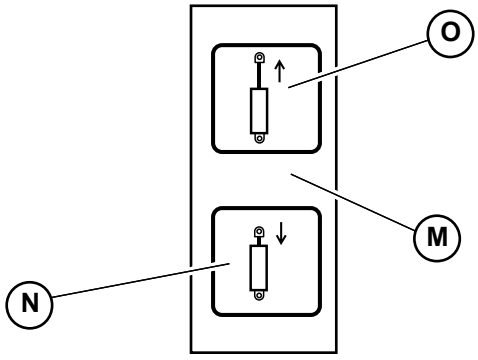


Fig. 127 – High-Flow Auxiliary Hydraulics Control Rocker Switch Icon

Press the (O) end of the switch to latch flow on in one direction; push the other (N) end of the switch to latch flow on in the reverse direction.

NOTE: *Indicator (O or N) in switch (M) is lit when auxiliary hydraulics high-flow is activated.*

NOTE: *Continuous flow amount is controlled using engine speed.*

To stop the high-flow auxiliary hydraulics flow, push and release either side of the switch.

NOTE: *Turning off the machine will also stop and reset the high-flow auxiliary hydraulics flow.*

⚠ WARNING

If the engine should stall for any reason during auxiliary high-flow hydraulics operation, always turn the starter key switch all the way counter-clockwise to the "OFF" position before re-starting the engine according to "Starting the Engine" on page 106.

14-Pin Connector (Option)

Optional 14-pin connector (T, Fig. 128), located on the top of the attachment hitch is intended for attachments equipped with 14-pin compliant connections using direct 12 volt actuation control.

Non-Telescopic Machines Shown, Telescopic Machines Similar

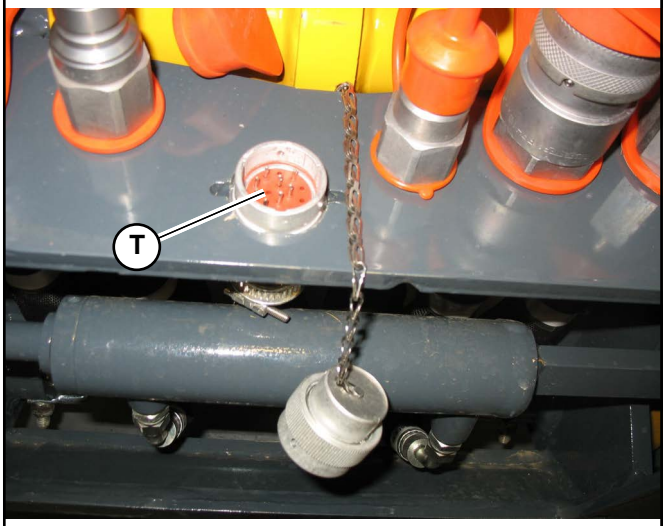


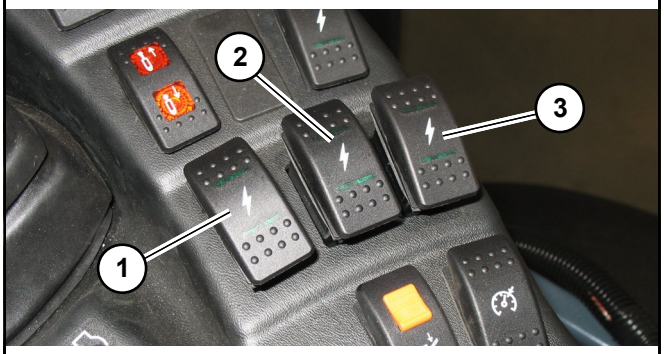
Fig. 128 – 14-Pin Connector (Option)

NOTE: *Contact your dealer for information about approved 14-pin-equipped attachments.*

Switch / Pin Assignments

Refer to Fig. 129 and Table 30 for details about 14-pin control switches and the associated pins in the 14-pin connector.

Switches



Connector End View

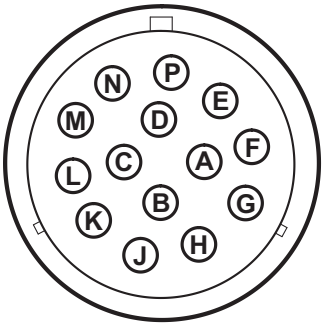


Fig. 129 – Switch-to-Pin Assignments

Table 30: 14-Pin Switch and Pin Assignments

Switch	Switch Position	Switch Type	Wire Color	Connector Pin	Amp
1	Forward	Momentary	Gray	D	15[1]
	Back		Orange	C	
2	Forward	Momentary	White	F	10[2]
	Back		Purple	E	
3	Forward	Momentary	Dk. Blue	H	10[2]
	Back		Tan	G	

Pin Description	Connector Pin	Amp
Ground	B	20
Power (with key ON)	K	15[1]
Not Assigned	L	N/A
Not Assigned	M	N/A
Not Assigned	N	N/A
Not Assigned	P	N/A
Not Assigned	J	N/A
Not Assigned	A	N/A

1. Pins C, D, and K have a combined total capacity of 15A.
2. Pins E, F, G, and H have a combined total capacity of 10A.

NOTE: *Depending upon the attachment, an adapter harness may be necessary. Refer to the documentation supplied with the attachment, or contact you dealer.*

Refer to "14-Pin Connector Fuses, Diodes and Relays (Option)" on page 208 for 14-connector electrical information.

Machine Intended Use - Buckets

Buckets are mainly used for digging, loosening, raising, moving, and loading loose or solid materials.

⚠ WARNING

Read the "Safety" section in this manual, starting on page 21, before working with a bucket. Pay special attention to the "During Operation" information, starting on page 24.

Always follow the information included in the "Safety" section. Serious injury or death can occur if the safety information is not followed.

Make sure the bucket is securely attached to the hitch before starting work. See "Power-A-Tach® System Hitch Operation" on page 130.

⚠ CAUTION

Follow the safety recommendations in "Telescopic Machines" on page 14.

Digging Tips

- On telescopic machines, dig only with the lift structure fully retracted.
- When digging in a pit, exit the pit outside the digging line through an area as level as possible.
- If possible, dig by removing adjacent strips.
- Drive forward when moving a full bucket out of the digging area.
- Drive in reverse when moving a full bucket down a steep slope.

Safety Instructions When Working with Buckets

⚠ WARNING

Do not tilt a bucket back when the lift structure is fully raised. Material may fall over the rear of the bucket and onto the operator's position.

When traveling, always set the lift structure as low as possible. On telescopic machines, fully retract the lift structure before traveling. See "Lift Structure Travel Position" on page 118.

Secure heavy or awkward loads. If necessary, fit the rear of the bucket with a guard to prevent material from falling out of the back of the bucket.

Whenever possible, drive in reverse when moving a bucket loaded with material down a steep slope.

Make sure you have a good view of the area where you are working and the material you are digging.

Machine Intended Use - Buckets

Scooping

⚠ WARNING

Use extreme care when digging around foundations or walls. Never remove material that might compromise a wall or foundation.

1. On telescopic machines, fully retract the lift structure.
2. Lower the bucket to the ground.
3. Tilt the bucket slightly forward so the bucket blade is pointing slightly down into the ground.
4. Drive forward until the bucket is filled with material. Adjust the bucket tilt as needed to remove an even layer of ground and to reduce wheel slip.
5. Tilt the bucket back and raise it to scoop up material.
6. Reduce engine speed and back out of the material.
7. Set the bucket as low as possible for travel. See "Lift Structure Travel Position" on page 118.

Loading

IMPORTANT: *When the bucket is tilted all the way, or almost all the way, back, the tilt angle of the attachment is kept constant when the lift structure is raised. Refer to "Self-Leveling and Return-To Dig" on page 128 for more information about the self-leveling feature.*

1. Approach the truck in a straight line, stop, and raise the bucket until the lower edge of the bucket clears the truck bed.
2. On telescopic machines, only extend the lift structure after it is raised. Do not raise and extend the lift structure at the same time.
3. Drive slowly straight forward and stop at the position where the bucket will be dumped.
4. Tilt the bucket forward and dump the material into the truck bed.

Tips When Loading Trucks

When loading trucks:

- The truck and machine working direction should form an angle of 45°. (Fig. 130).

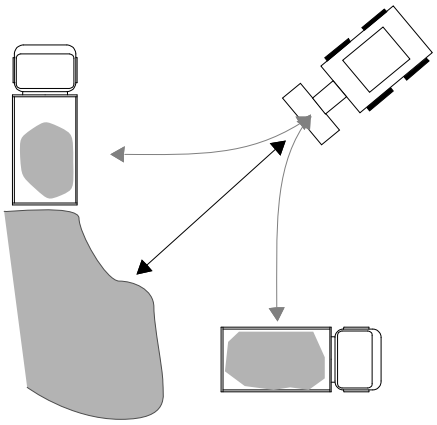


Fig. 130 – Loading Trucks

- Only raise a full bucket to the height needed for dumping when you are driving in a straight line toward the truck.
- On telescopic machines, only extend a full bucket as needed for dumping.
- If possible, dump with the wind behind you to keep dust away from your eyes, air filters, and fans.

Digging

1. On telescopic machines, fully retract the lift structure.
2. Lower the bucket to the ground.
3. Tilt the edge of the bucket down at an angle appropriate for ground hardness.
4. Drive forward slowly, digging into the ground with the cutting edge of the bucket.
5. When the bucket is full, raise the bucket and tilt it back.

Grading

Grading without Float

NOTE: *On telescopic machines, it is recommended to fully retract the lift structure when grading to minimize wear on the machine.*

1. Raise the bucket and tilt it forward.
2. Release material from the bucket while driving forward.
3. Tilt the bucket forward and lower the front edge until it is slightly above the ground.
4. Drive in reverse, smoothing the material released in step 2 with the front edge of the bucket.

Grading Using Float

NOTE: *On telescopic machines, fully retract the lift structure before grading.*

⚠ WARNING

Make sure the bucket is lowered to the ground before activating the lift structure and/or bucket tilt float. Activating float with an attachment raised will cause it to fall, which can cause severe injury or death.

Do not drive the machine forward at speed with the lift structure float activated. Damage to the machine and/or loss of control can result.

1. Lower the bucket to the ground.
2. On telescopic machines, press the top of the float enable switch (refer to “Telescopic Machines Raise Float Operation” on page 121).
3. Push multi-function joystick (A, Fig. 131) forward until it detents into the lift structure float position.

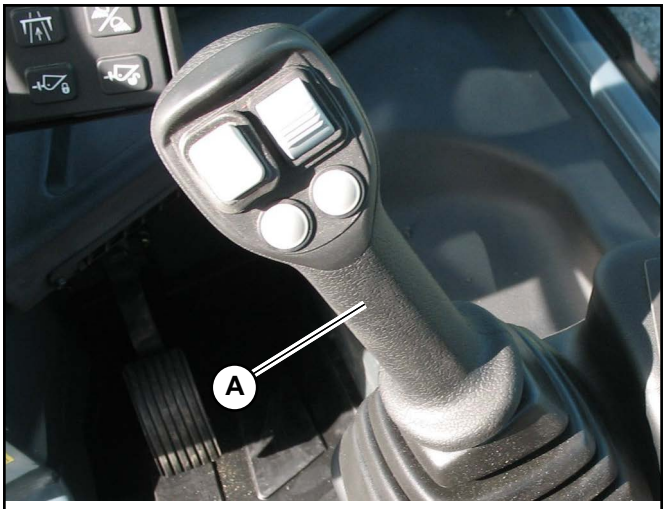


Fig. 131 – Multi-Function Joystick Float Control

⚠ CAUTION

Raise float may decrease ability to turn.

4. Tilt the bucket forward so it stands on the cutting edge.
5. Drive in reverse, dragging the floating bucket. Adjust the tilt angle of the bucket while driving in reverse to control the spread of the material.
6. When finished, pull the multi-function joystick back out of the float detent to deactivate the lift structure float.

Using Attachment Tilt Float

NOTE: *Telescopic machines are not equipped with tilt float.*

Tilt circuit float should be used for attachments that need to follow the contours of the traversed terrain but require the downward force of the load circuit.

1. Use the multi-function joystick to adjust the height of the attachment to the desired position. (attachment should be at ground level before tilt float is engaged).
2. Push the multi-function joystick to the right until it detents into the tilt circuit float position.

NOTE: *Raise and tilt float can be used in conjunction if it improves attachment performance.*

Backfilling

1. On telescopic machines, fully retract the lift structure.
2. Lower the bucket a few inches from the ground. Slowly drive up to the hole until the front edge of the bucket is over the near edge of the hole.
3. Tilt the bucket forward to dump material into the hole.
4. Tilt the bucket back and raise the bucket. Inspect the hole for proper filling.
5. Continue to dump material into the hole as necessary for proper fill.

Operating on Hard Surfaces

During operation on hard surface, keep the bucket level and push the multi-function joystick forward until it detents into the lift structure float position to permit the bucket to float on the work surface.

The cutting edge on the bucket will wear faster than normal if hydraulic down pressure is exerted on the bucket. The float position reduces the chance of surface gouging while removing snow or other material or when working with a blade.

Machine Intended Use - Pallet Forks

Safety Instructions When Working with Pallet Forks

⚠ WARNING

Read the "Safety" section in this manual, starting on page 21, before working with pallet forks. Pay special attention to the "During Operation"information, starting on page 24.

Follow all instructions in the Operator's Manual provided with the pallet forks.

DO NOT exceed pallet fork load center and/or load capacity. For non-telescopic machines refer to the pallet fork payload/ capacities table on page 51; for telescopic machines, refer to the pallet fork payload charts starting on page page 53.

Use only approved pallet forks. Use special caution and maintain tilt control at all times when using pallet forks.

Always follow the information included in the "Safety" sections. Serious injury or death can occur if the safety information is not followed.

Always approach the load from a straight-ahead position. Position the fork arms underneath the pallet, as far as they will go so the load is distributed as closely as possible to the fork frame. Position the fork arms as far apart as possible, as allowed by the load. Load both fork arms evenly.

Raise, move, and unload loads only on firm and level ground with sufficient load-bearing capacity.

Always travel with the load as close to the ground as is safely possible. See "Lift Structure Travel Position" on page 118.

Use pallet forks for material handling and/or material transport only.

Never raise a load using only one fork arm.

Make sure the fork arms are safely locked onto the fork frame before use.

Do not raise unstable material or material that is not properly secured on the fork arms.

Never leave a machine with the forks raised or a load unattended. Make sure all persons stay clear of suspended loads.

⚠ WARNING

Do not use high travel speed range when using pallet forks.

DO NOT use standard fork arms as reverse (inverted) forks.

Never allow a load to get closer than 6 m (20 ft.) to overhead electrical lines.

DO NOT push, pull, or shove the fork arms or move them in at a slanting angle; the resulting lateral forces can damage the fork arms.

DO NOT pull loads off the fork arms, or allow loads to fall onto the forks arms.

DO NOT tilt the pallet forks to raise loads.

DO NOT raise or move molten material with pallet forks.

Repair work on fork arms must be performed only by authorized personnel.

Always keep pallet fork arms clean.

Secure loads as directed in the Operator's Manual supplied with the pallet fork to prevent the loads from falling.

Never modify pallet fork arms.

Do not raise or transport people on the pallet forks.

Do not drive on public roads with pallet forks installed on the machine.

Do not stack loads which are not properly packaged or have damaged pallets/stacking containers. Do not stack loads on top of loads, which may have shifted.

Always tilt pallet forks back slightly during travel to help retain the load.

⚠ WARNING

Do not use bent, cracked, or otherwise damaged fork arms/pallet forks.

Always inspect pallet forks each time before using. Refer to the pallet fork manufacturer's documentation and/or contact the pallet fork manufacturer for information regarding safe pallet fork condition criteria:

- **Check the fork arm locks for proper function and/or damage. Do not use pallet forks with damaged locks or locks that do not function properly.**
- **Visually check the fork arm hooks and/or bends for cracks and/or deformations. Do not use fork arms that are cracked and/or have deformations that make the fork arms unsafe.**
- **Do not use fork arms that have bends or blades that have more than 10 percent of the original material worn away.**
- **Check the fork arms blades and tips for deformations or holes.**

Fork Carrier Blocking Systems Warning

Before operating the machine, make sure the fork carrier blocking systems (welded or removable), at the center (1, Fig. 132) and the outside (2) of the fork carriage frame are not damaged and/or missing.

⚠ DANGER

Damaged and/or missing fork blocking systems can cause the forks to fall off, which could result in death and/or serious injury.

Inspect the fork blocking system before operating the machine.

If the fork blocking system is damaged and/or missing, DO NOT use the machine until repairs have been made by an Authorized Dealer.

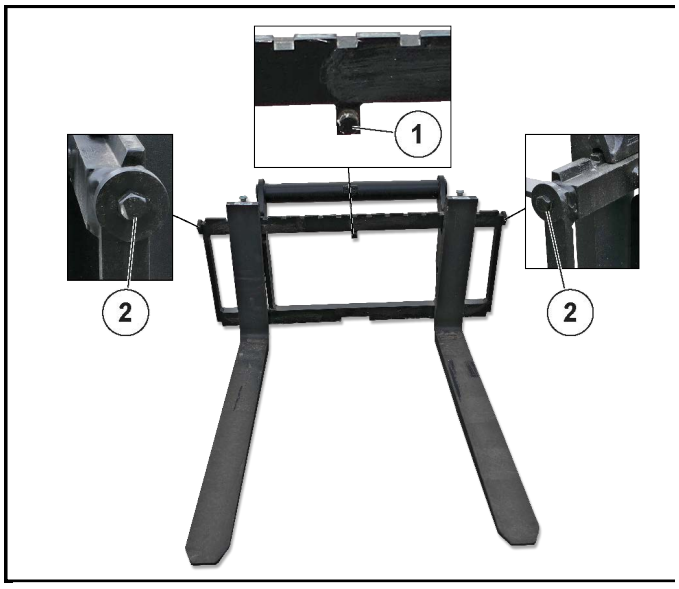


Fig. 132 – Fork Carrier Blocking Systems

Moving Loads Using Pallet Forks

⚠ DANGER

On telescopic machines, alway refer to the following sections when using pallet forks:

- **Load capacity specifications starting on page 57.**
- **"Telescopic Machines Load/Level Indicators (Telescopic Machines)" on page 78.**
- **"Special Considerations for Telescopic Machines" on page 116.**
- **"Longitudinal Load Moment Indicator (LLMI) – EU Telescopic Machines Only" on page 117.**

IMPORTANT: *If the pallet fork attachment is tilted all the way back, the self-leveling feature keeps the tilt angle of the attachment constant when the lift structure is raised/lowered. Refer to "Self-Leveling and Return-To Dig" on page 128 for more information about the self-leveling feature.*

Using Manitou-approved forks is critical. Manitou-approved forks are specially designed to be level when tilted all the way back.

⚠ DANGER

Loads maintain a constant tilt angle when raised ONLY if the attachment hitch is tilted all the way, or almost all the way, back before raising/ lowering the lift structure.

Use special caution and maintain tilt control at all times when using pallet forks.

Loading Pallet Forks

1. Stop the machine immediately in front of the material.
2. Position the fork arms parallel to the ground.

3. Make sure the fork arms are adjusted as far apart as possible, as allowed by the load, and both arms are the same distance away from the center-line of the load.
4. Adjust the height of the fork arms to fit the support area at the bottom of the pallet. On telescopic machines, extend the lift structures only as far as necessary.
5. Drive slowly and carefully straight forward until the fork frame contacts the material.
6. Make sure the pallet is evenly and safely positioned on the pallet fork arms.

Raising Loads Using Pallet Forks

7. On telescopic machines, fully retract the telescopic lift structure before raising/lowering the lift structure. Extending/retracting while raising/lowering the lift structure at the same time reduces operating capacity and stability.
8. Slowly raise the pallet forks. Do not raise the pallet forks any higher than required. Make sure to not exceed pallet fork load center and/or load capacity.
9. On telescopic machines, fully retract the lift structure.
10. Lower the load immediately if you are unsure of the load, the equipment, or in case of any unsafe circumstances.
11. Tilt the pallet fork frame back slightly, to help retain the load.

Moving Loads Using Pallet Forks

12. Make sure the area around and behind the machine is clear of bystanders and obstacles.
13. Slowly and carefully drive straight in reverse. When safe to do so, lower the pallet forks as low as is safely possible. See “Lift Structure Travel Position” on page 118.
14. Carry the load as low as safely possible during travel. On telescopic machines, fully retract the lift structure. See “Lift Structure Travel Position” on page 118.
15. If transporting the load a significant distance, lock-out the work hydraulics. See “Hydraulics Transport Lock-out” on page 90.
16. Drive slowly and carefully forward straight toward the place where the load will be set down.

Setting Down Loads Using Pallet Forks

NOTE: *If the load will be placed on top of stacked material, make sure to align the load in the center of the stack.*

⚠ WARNING

Do not stack loads which are not properly packaged or have damaged pallets/stacking containers. Do not stack loads, or on top of loads, which have shifted.

1. If the hydraulics transport lock-out was used, enable the work hydraulics. See “Hydraulics Transport Lock-out” on page 90.
2. Raise the pallet forks slightly above where the load will be placed.
3. On telescopic machines, extend the lift structure as necessary to properly position the load.
4. Tilt the pallet forks as needed to level the fork arms.
5. Carefully drive slowly forward until the load is positioned precisely above where the load will be placed. Use care when aligning the load with a stack.

6. Slowly and carefully lower the lift structure until the load is placed.
7. Make sure the fork arms are no longer bearing weight and are free to be retracted.
8. Make sure the area around and behind the machine is clear of bystanders and obstacles.
9. On telescopic machines, slowly and carefully drive straight in reverse until the pallet forks clear the load and then fully retract the lift structure.
10. Slowly and carefully drive straight in reverse away from the placed load.

Diesel Particulate Filter (DPF) Regeneration Procedures

NOTE: *This section applies to DPF-equipped machines only.*

The Diesel Particulate Filter (DPF) treats exhaust emissions in compliance with Tier 4 emission standards. The DPF filter relies on high exhaust temperatures. Periodic DPF maintenance (regeneration) is required, dependent upon machine operation load/temperature.

IMPORTANT: *Machines operated primarily at high loads and operating temperatures require less frequent DPF maintenance. Extended periods of engine idling rapidly increases DPF soot levels, requiring more frequent regeneration operations.*

- **Passive/Assist Regeneration:** Occurs automatically without operator input. Passive/assist regeneration does not effect machine operation.
- **Reset Regeneration:** Occurs automatically, but can be inhibited by the operator. Reset regeneration increases exhaust gas temperatures. Reset regeneration occurs approximately every 100 hours of operation. See “Reset Regeneration” on page 149.

  NOTE: *Reset regeneration effectiveness is improved if the machine is operated at mid- to high-throttle settings while this mode is in progress.*

- **Stationary Regeneration:** Requires operator action to initiate and takes approximately 25-30 minutes to complete. See “Stationary Regeneration” on page 149.

  IMPORTANT: *The machine cannot be operated and must be parked in a well-ventilated area away from flammable materials when stationary regeneration is in progress.*

Reset Regeneration

Reset regeneration occurs automatically (unless inhibited) approximately every 100 hours of operation.

NOTE: *Reset regeneration effectiveness is improved if the machine is operated at mid- to high-throttle settings while regeneration is in progress.*

When reset regeneration occurs, the DPF in-progress (elevated temperature) symbol (Fig. 133) displays on the screen.

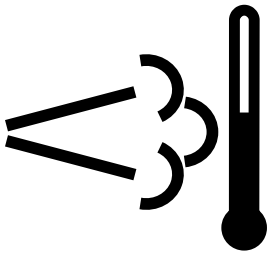


Fig. 133 – DPF Reset Regeneration In-Progress Icon

Reset Regeneration Inhibit

DPF regeneration inhibit prevents reset regeneration from occurring.

⚠ CAUTION

Permanently inhibiting regeneration is not recommended, as this will eventually cause significant reduction in engine power and will force premature DPF soot filter replacement.

To temporarily inhibit reset regeneration, hold down the button (U, Fig. 134) until the strikethrough in the Reset Regeneration symbol (W) turns to red.

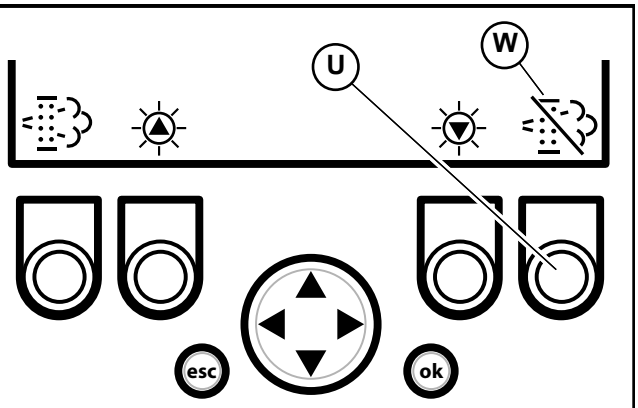


Fig. 134 – DPF Regeneration Inhibit Button

NOTE: *The DPF in-progress (elevated temperature) symbol (Fig. 133) will not be displayed when reset regeneration is inhibited.*

Stationary Regeneration

Stationary regeneration may be periodically required to reduce DPF soot build-up. The frequency of stationary regeneration is dependent upon machine operation and engine load.

The machine cannot be used during stationary regeneration and cannot be moved without interrupting the stationary regeneration process.

When stationary regeneration needs to be performed, the DPF Stationary Regeneration Request Screen (Fig. 135) displays.

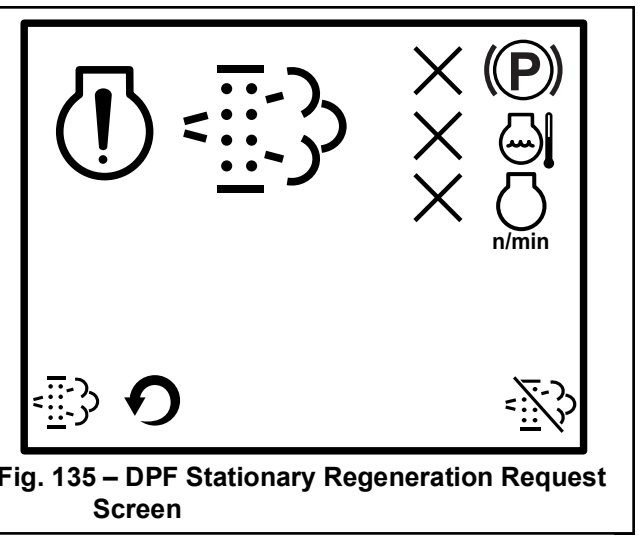


Fig. 135 – DPF Stationary Regeneration Request Screen

NOTE: *The stationary regeneration request screen can be temporarily dismissed by pressing the reset regeneration inhibit button (U, Fig. 134) for 3 seconds until the previous screen displays. The stationary regeneration request screen will return 1 minute after being dismissed and remain as long as the request is active.*

IMPORTANT: *Perform stationary regeneration as soon as possible when the stationary regeneration request screen displays. Postponing stationary regeneration for extended periods will cause significant reduction in engine power and will force premature DPF filter core replacement.*

To proceed with stationary regeneration:

1. Fill the fuel tank.
2. Park the machine in a safe, well-ventilated location away from flammable materials.
3. The following conditions need to be met before stationary regeneration will continue:
   a. Apply the parking brake by raising the parking brake lever (refer to "Attachment Mounting" on page 91). A checkmark is displayed next to the parking brake symbol (A, Fig. 136).

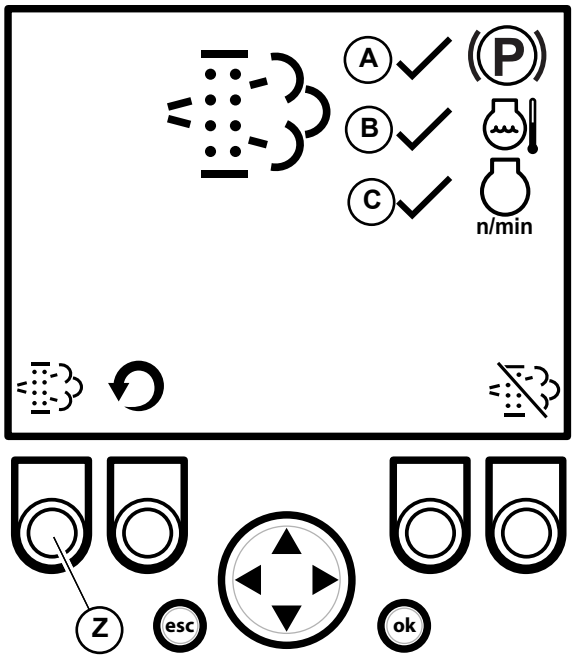


Fig. 136 – Stationary Regeneration

   b. When engine coolant has reached operating temperature (approximately 140° F / 60° C), a checkmark is displayed next to the coolant temperature symbol (B).
   c. Place throttle controls to the lowest speed setting. A checkmark is displayed next to the engine RPM (C) symbol when the engine is running at low idle.
4. When all three checkmarks (A, B, & C, Fig. 136) are displayed on the Stationary Regeneration screen, press and hold button (Z) until the Stationary Regeneration In-Progress screen (Fig. 137) displays.

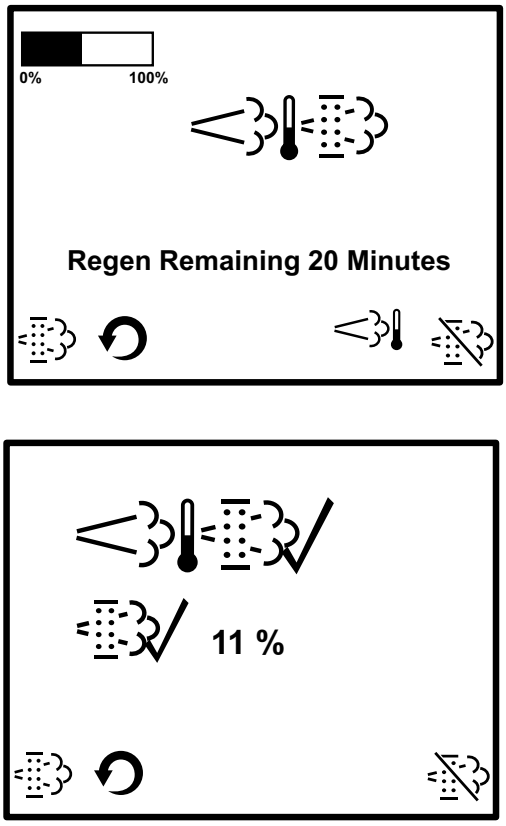


Fig. 137 – DPF Stationary Regeneration In-Progress Screens

NOTE: *Stationary regeneration can be interrupted at any time by releasing the parking brake, advancing the throttle, or stopping the engine. Stationary regeneration must start again from the beginning if it is interrupted.*

The stationary regeneration completion percentage is updated as the stationary regeneration progresses.

NOTE: *Stationary regeneration takes approximately 1/2 hour.*

⚠ CAUTION

It is not necessary to stay in the machine during stationary regeneration. Keep the machine under observation while regeneration is in progress in case of malfunction. Keep bystanders away from the machine while regeneration is in progress.

Forcing Stationary Regeneration

Stationary regeneration can be performed at any time when the regeneration symbol (X, Fig. 138) is enabled (not grayed-out).

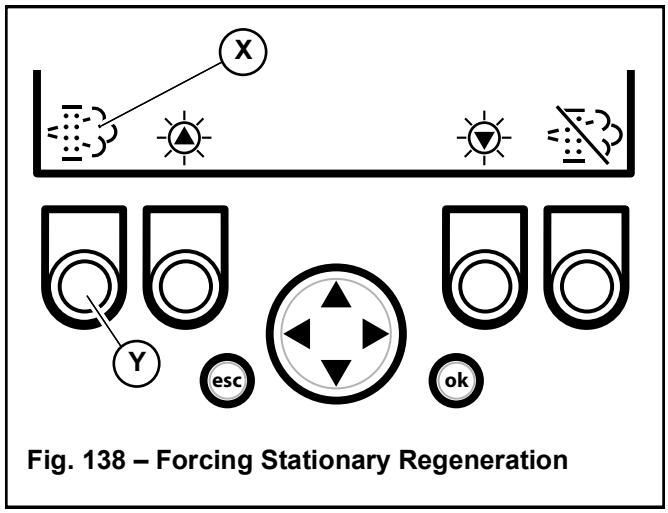


Fig. 138 – Forcing Stationary Regeneration

To perform stationary regeneration on-demand:

Press button (Y) associated with the DPF regeneration symbol (X), until the regeneration screen displays. Refer to “Stationary Regeneration” on page 149 to proceed with stationary regeneration.

DPF Maintenance

DPF soot filter replacement is required when the DPF Service screen (Fig. 139) displays.

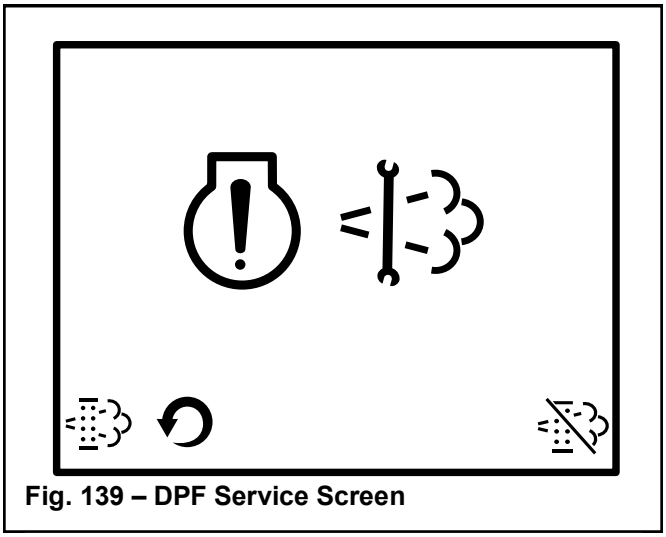


Fig. 139 – DPF Service Screen

A soot load indicator (Q, Fig. 140) is included on the display on machines equipped with Deutz stage 5 engines.

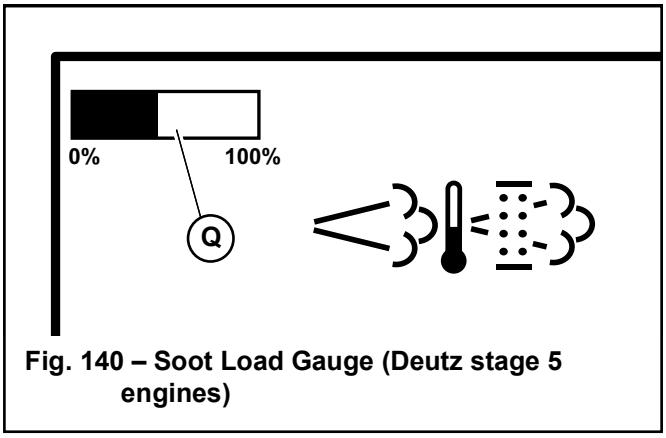


Fig. 140 – Soot Load Gauge (Deutz stage 5 engines)

DPF service is typically required when the regeneration process cannot lower the soot load below 100%.

NOTE: *Contact your dealer when the DPF Service screen displays.*

After Operation

⚠ WARNING

Park the machine on firm, level ground, and perform the "Mandatory Safety Shutdown Procedure" on page 22. If you must park on a slope or an incline, park across the slope and block the tires to prevent movement.

⚠ WARNING

If parking on a street, use barriers, caution signs, lights, etc. to increase the visibility of the machine and prevent collisions. This is especially important at night, during bad weather, and in high-traffic areas.

After performing the "Mandatory Safety Shutdown Procedure" on page 22, perform the following tasks and checks:

- Check for coolant, fuel, and/or oil leaks. Inspect all hoses, working components, covers, and chassis for damage or advanced wear. Repair or replace damaged, leaking, worn or otherwise compromised components before starting the machine again.
- Fill the fuel tank. See "Fluids/Lubricants Types and Capacities" on page 49.
- Remove any dirt and/or debris from the engine compartment.
- Remove any mud from the chassis. Clean any dirt or water from the cylinder rod surfaces to prevent corrosion and protect the cylinder seals.
- If parking the machine for an extended period, lock the cab door, the optional toolbox (if equipped), and the engine compartment. Take the keys with you.
- Always turn the battery disconnect switch to the "OFF" position when parking the machine inside an enclosure.

Jump-Starting

IMPORTANT: *Jump-start only if the machine cannot be started using the starter key switch. See "Starting the Engine" on page 106.*

IMPORTANT: *The machine cannot be tow-started because no direct mechanical connection exists between the wheels and the engine. Attempting to tow-start the machine may damage the drive system.*

⚠ WARNING

Two people are required for safe jump-starting. An additional person is required to remove the jumper cables with the operator remaining in the operator's seat once the engine is running.

⚠ WARNING

Do not jump-start a frozen battery, or it may explode. A discharged battery can freeze at 0°C (32°F).

IMPORTANT: *The external power source must deliver 12 volts. Supply voltages higher than 12 volts can damage the electrical systems of both machines. Only use authorized jumper cables that are in good condition.*

The booster battery must have a nominal voltage of 12 volts. The capacity (Ah, or Amp-hour rating) of the current-supplying battery must be approximately equal to that of the discharged battery. Factory-installed batteries are approximately 80 Ah capacity.

⚠ CAUTION

To reduce the risk of a short circuit, keep metal parts on your clothing and metal jewelry away from the positive (+) pole of the battery.

1. Make sure the battery disconnect switch is turned to the "ON" position. See "Battery Disconnect Switch" on page 98.

2. Turn the start/ignition switches of both machines to OFF. Be sure the machines are not touching each other. Place the travel direction switch into the neutral position and apply the parking brake.
3. If the machine with the booster battery has a drive transmission, place the transmission into neutral and apply the parking brake.
4. Check that battery jumper cables have a sufficient diameter. Route the jumper cables so that they cannot catch on any moving objects or components.
5. Connect the positive jumper cable to the positive (+) terminal (S, Fig. 141) on the discharged battery.

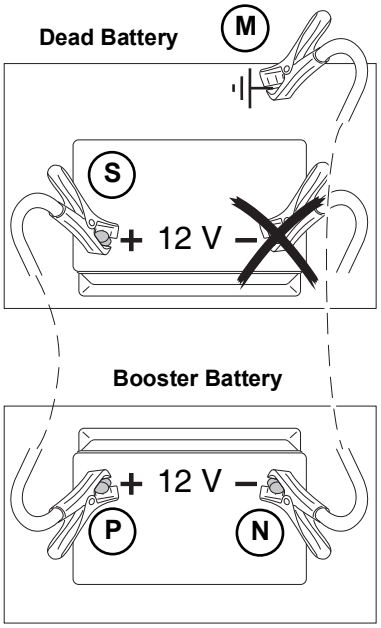


Fig. 141 – Booster Battery Connection

6. Connect the free end of the positive jumper cable to the positive (+) terminal (P) on the booster battery.
7. Connect the negative jumper cable to the negative (-) terminal (N) on the booster battery.
8. Connect the free end of the negative (-) jumper cable to the engine block or frame (ground) on the machine with the discharged battery—NOT to the negative post of the discharged battery. If connecting to the engine, keep the jumper clamp away from the battery, fuel lines, and moving parts.

⚠ WARNING

Do not connect the other end of the jump lead to the negative terminal of the dead battery. Gas emerging from the battery may ignite if sparks are formed.

9. Start the machine with the discharged battery. See "Starting the Engine" on page 106. If the engine does not start immediately, stop cranking after 10 seconds and repeat starting procedure after approximately 30 seconds.

After the Engine Starts:

1. With the operator remaining in the operator's seat, the jumper cables are disconnected by a second person in reverse order of steps 5 – 8 to avoid sparking near the battery.
2. Close the engine cover.
3. Allow the machine to run for at least 30 minutes to re-charge the battery.

Raising the Machine using a Crane

⚠ WARNING

The crane and the lifting gear must be adjusted to keep the lifting point directly over the center-of-balance of the machine (Y, Fig. 143). Always raise the machine so it is horizontal when it is raised.

The crane and lifting equipment must have sufficient capacity. Refer to "Weights" on page 59.

The machine must be secured against unintentional swinging movement. Use taglines as needed.

Close the cab doors (if applicable) and all covers before raising the machine with a crane.

Keep clear of suspended loads.

Do not lift with anyone on or inside the machine.

Attach the lifting equipment only at the identified lift points.

The crane raising crew must include experienced crane operators only. The crane operator must keep persons guiding the load within sight and/or sound at all times.

Raise the machine only with no attachments, with the exception that the standard bucket can remain attached. The bucket must be empty and as low as possible. See "Lift Structure Operation" on page 118.

Crane Lifting Preparation

IMPORTANT: *The crane and the lifting gear must be adjusted to keep the lifting point directly over the center-of-balance of the machine (9, Fig. 143). Always raise the machine so it is horizontal when it is raised. The crane and the lifting gear (cables/chains) must have a capacity greater than the weight of the machine. Refer to "Weights" on page 59.*

1. If a bucket is attached, make sure it is emptied.
2. On telescopic machines, fully retract the lift structure.
3. Secure the steering lock bar (B, Fig. 142) in the locked position using the spring pins (S) provided.

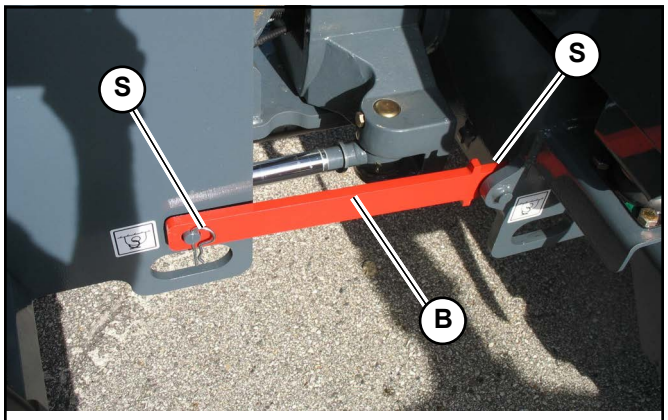


Fig. 142 – Steering Lock Bar

4. Shut down the machine according to "Mandatory Safety Shutdown Procedure" on page 22.
5. If equipped, close and lock the cab door. Do not allow anyone to stay in the cab.
6. Close and secure all covers.

7. Connect the lifting gear on both side of the machine at the front and rear lift points (12, Fig. 143 and Fig. 144) as shown.

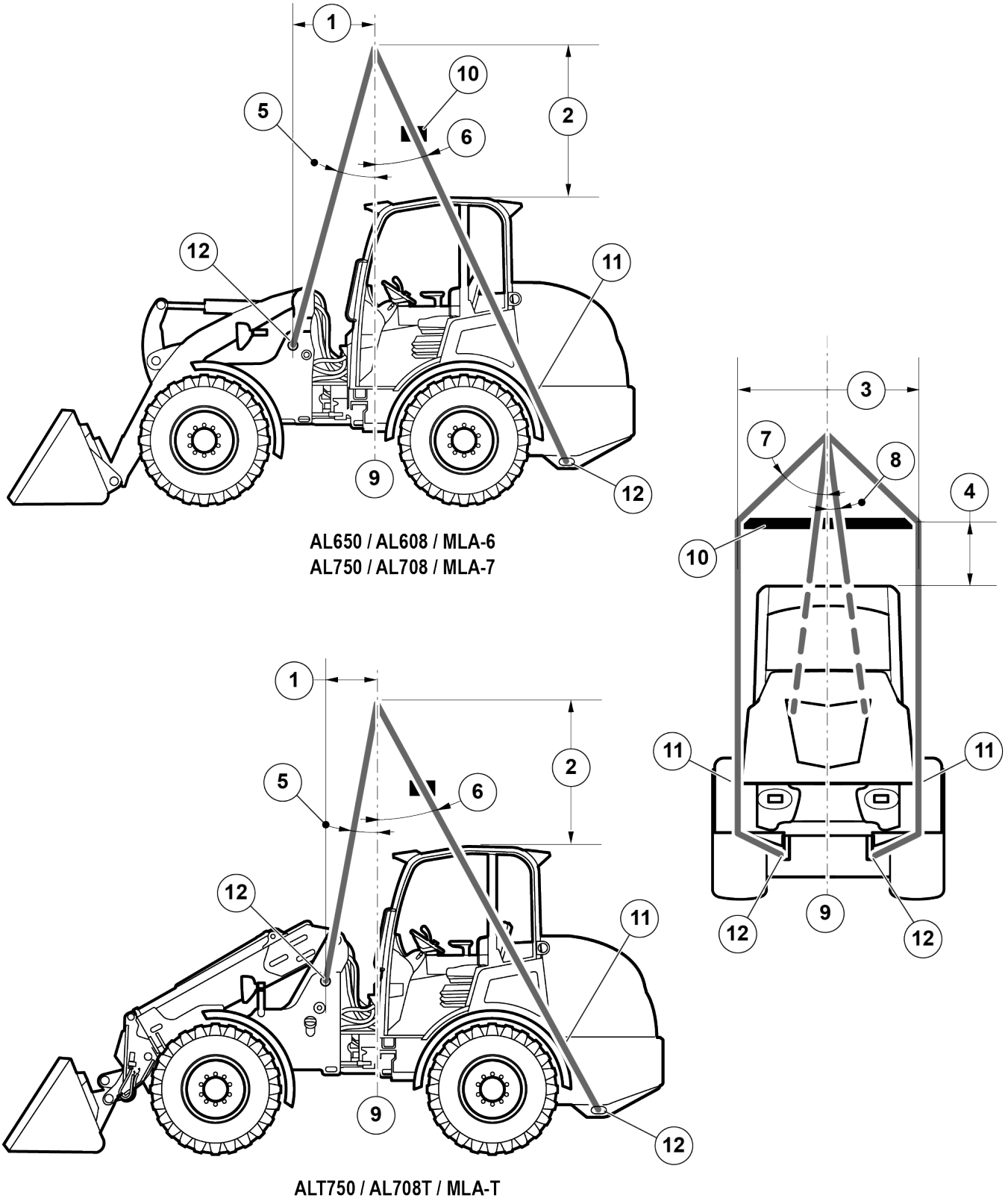


Fig. 143 – Crane Raising (Refer to Table 31)

Table 31: Crane Raising Lifting Equipment Specifications (Refer to Fig. 143)

Item	Models AL650 / AL608 / MLA-6	Models AL750 / AL708 / MLA-7	Models ALT750 / AL708T / MLA-T
1	629 mm (25 in.)	541 mm (21 in.)	418 mm (16 in.)
2	1143 (45 in.) Minimum		
3	1320 mm - 1422 mm (52 in. - 56 in.)	1397 mm - 1499 mm (55 in. - 59 in.)	
4	478 mm (19 in.)	247 mm (10 in.)	263 mm (10 in.)
5	15°	13°	10°
6	25°	26°	28°
7	7°		8°
8	46°	39°	
9	Center-of-Balance		
10	Lifting Beam		
11	Blocking		
12	Lifting Point		

NOTE: *Lift points (12, Fig. 144) are identified by the decal shown in Fig. 144.*

Fig. 144 – Lift Point Decal

⚠ CAUTION

To prevent damage to the ROPS/FOPS, the side and engine covers, or other installed components:

- **Insert a lift beam between the two legs of the rear lifting gear at point (10, Fig. 143).**
- **Provide blocking between the lifting gear and the machine at points (11, Fig. 143).**

8. Carefully raise the machine, keeping it as level as possible.

Towing

Precautions

⚠ WARNING

Tow the machine with another vehicle ONLY. Do not tow loads or other vehicles with the machine.

IMPORTANT: *The machine cannot be tow-started because there is no direct mechanical connection between the wheels and the engine. Attempting to tow-start the machine may damage the drive system.*

Only tow the machine if the steering and brakes are functional, if the machine cannot be repaired on-site, and if the machine cannot be moved using any other method. Only tow the machine until it is moved to a location where it can be safely repaired.

IMPORTANT: *If moving the machine more than a few hundred meters, use a flatbed truck or similar vehicle to transport the machine to prevent hydraulic system overheating. See "Loading and Transporting the Machine on a Transport Vehicle" on page 158.*

Preparation

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22. Position the lift structure as low as possible to allow for towing. On telescopic machines, fully retract the lift structure.
2. Remove hardware (H, Fig. 145) under the machine securing access panels (I). Remove the panels.

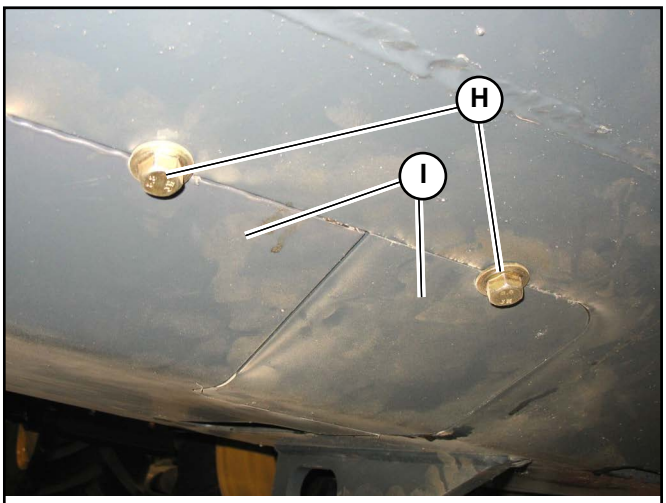


Fig. 145 – Hydraulic Pump Access

3. Loosen hydraulic system bypass screws (Z, Fig. 146) on the bottom of the pump three turns.

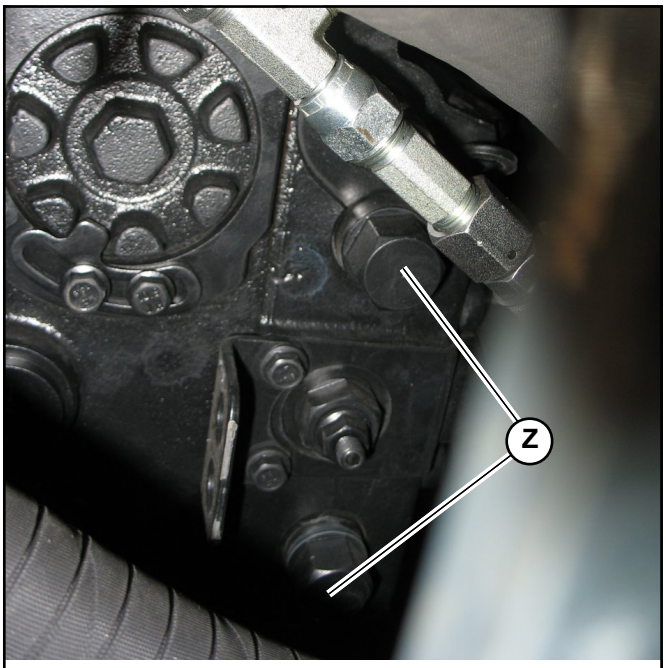


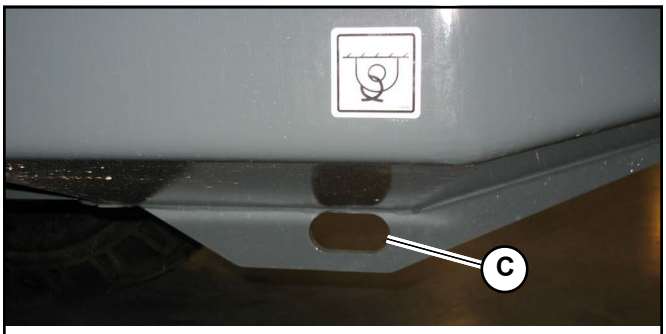
Fig. 146 – Hydraulic System Bypass Screws

⚠ CAUTION

Do not loosen bypass screws (Z) more than three turns. The screws can come out of the pump, resulting in a rapid loss of hydraulic fluid.

Towing Procedure

1. Attach the tow bar/cable to the rear frame tie-down points (C, Fig. 147) located at the rear of the machine.



Optional

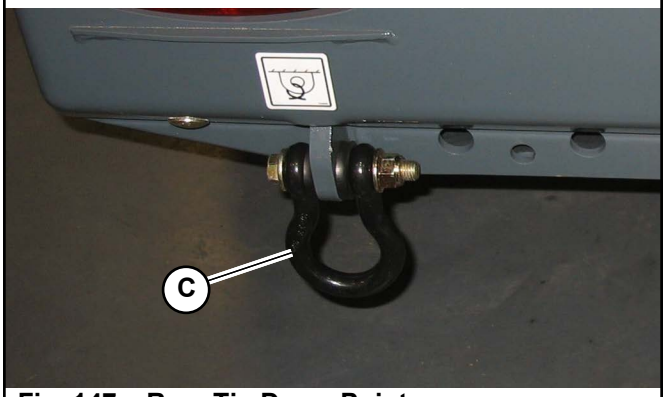


Fig. 147 – Rear Tie-Down Points

IMPORTANT: *Only use a tow bar or tow cable of sufficient capacity. Refer to "Weights" on page 59.*

⚠ WARNING

Do not allow anyone near the tow bar/strap/cable while towing. Use towing equipment with a capacity at least three times greater than the towing vehicle's pulling power. Do not exceed 5 km/h (3 mph) while towing or damage to the hydraulic system could occur.

After Towing

1. Torque hydraulic system bypass screws (Z, Fig. 146) to 70 Nm (52 lbs.-ft.).

NOTE: *Do not over-torque the bypass valve bolts.*

2. Replace access panels (I, Fig. 145) and secure with hardware (H).
3. Secure the machine against rolling and unauthorized use.

Loading and Transporting the Machine on a Transport Vehicle

⚠ WARNING

Do not exceed the transport vehicle's gross weight rating and the gross axle weight rating when loading and transporting the machine. The transport vehicle must have sufficient capacity for the size and weight of the machine. See "Specifications" on page 49.

Make sure the load does not fall short of the minimum axle load of the steering axle, otherwise the transport vehicle's steering could be seriously affected.

To prevent slipping, remove any mud, snow or ice from the tires on the machine to prevent slipping.

For proper vehicle stability, position the machine at the lowest possible position on the transport platform, with the center of gravity of the load over center line of the transport vehicle. Distribute partial loads to ensure an even load on the axles on the transport vehicle.

Secure the machine properly so it cannot slip, slide, roll, tip over or fall, or cause the transport vehicle to tip over under transport conditions. Use anti-slip bases and linings, load-securing straps and chains, clamping beams, protective paddings, nets, edge protectors, etc. as needed to properly secure the load. Consider all possible transport conditions such as: heavy braking, evasive maneuvers, and uneven or rough roadways.

Adjust transport speed to the load, to the road/ traffic conditions and to the handling of the transport vehicle.

Always use the proper tie-down points (C, Fig. 151) when using straps and chains.

Loading and Securing the Machine

⚠ WARNING

Secure the loading ramps to the transport vehicle before loading. Position the loading ramps at the shallowest possible angle. Do not exceed an angle of 15°. Only use ramps with anti-skid surfaces.

Make sure the loading area is clear and access to it is not obstructed.

Make sure the driver of the transport vehicle knows the overall height, width, and weight of the vehicle, including the loaded machine, before starting transport.

Know and follow the legal transport regulations for the area in which the transport will occur.

Make sure the loading ramps are free of mud, oil, grease, snow, ice, etc.

Know and follow the legal transport regulations for the area in which the transport will occur.

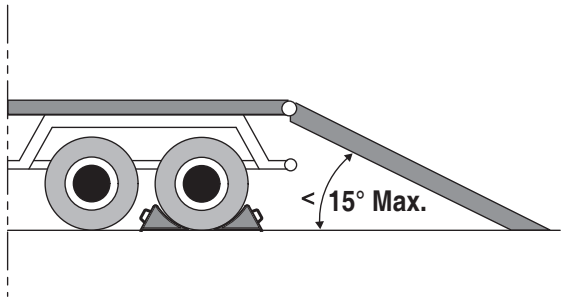


Fig. 148 – Loading Ramp Placement

1. Check the engine oil in the machine. The oil level must be at the "full" mark on the dipstick. Add oil if needed.

IMPORTANT: *When loading and driving on ramps, the engine can be damaged if the engine oil level is too low.*

2. Start the engine.
3. If a bucket is attached, make sure it is emptied.
4. Raise the hitch plate/attachment enough so that it will not touch the loading ramps.
5. On telescopic machines, fully retract the lift structure.
6. Slowly and carefully drive the machine straight in reverse onto the transport vehicle, with the bucket end facing down the ramp.
7. Do not adjust travel direction while traveling on the ramps. Instead, drive down off of the ramps, and re-align the machine with the ramps.
8. Position the machine at the lowest possible position on the transport platform, with the center of gravity of the load over center line of the transport vehicle.
9. Lower the bucket/attachment hitch onto the loading area.
10. Stop the engine.
11. Secure the steering lock bar (B, Fig. 149) in the locked position using the spring pins (S) provided.

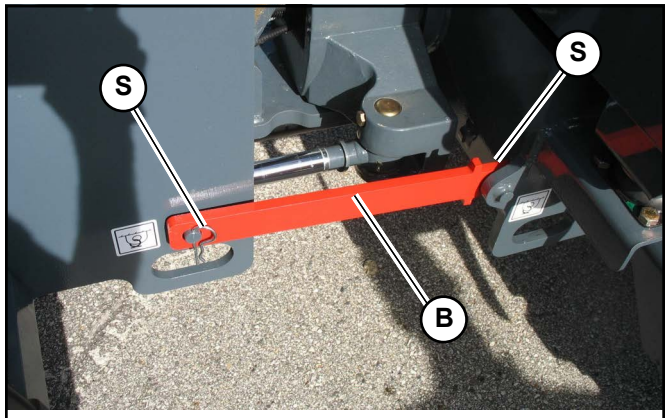


Fig. 149 – Steering Lock Bar

12. Remove the key from the starter switch.
13. Do not allow anyone to stay in the cab.
14. Close and lock the door; close and secure all covers.
15. Tie down the machine as follows:
    a. Make sure the authorized maximum height is not exceeded.

b. Place blocks in front and behind the tires to prevent movement.

c. Securely strap the machine to the platform at tie-down points (C, Fig. 150 and Fig. 151). Use only belts or chains of sufficient capacity.

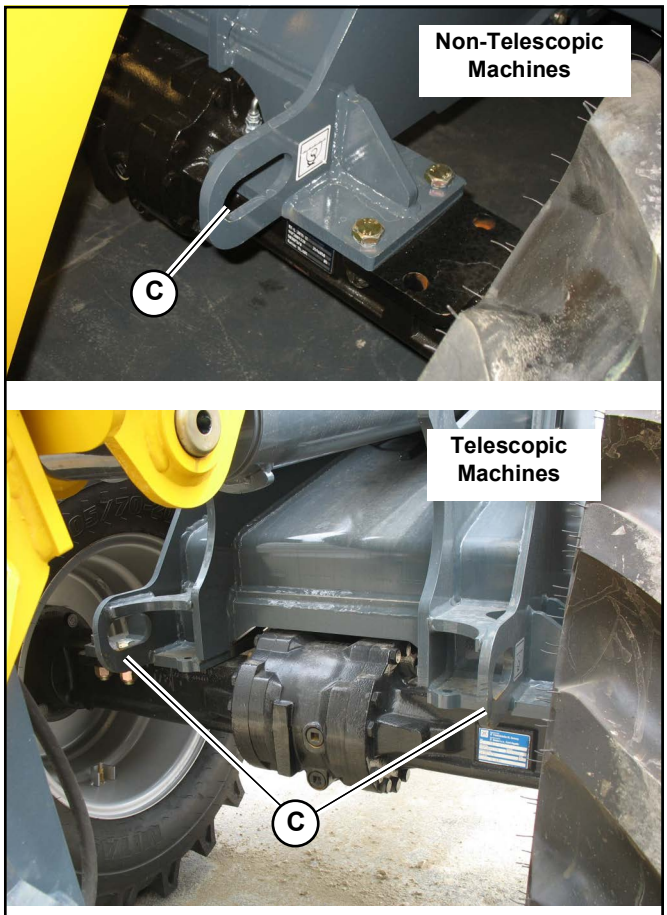


Fig. 150 – Front Tie-Down Points

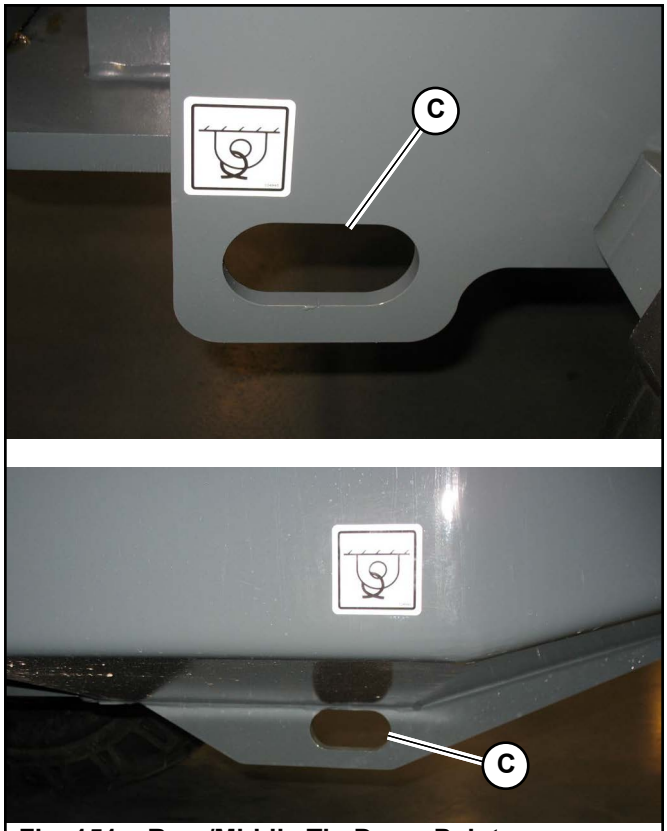


Fig. 151 – Rear/Middle Tie-Down Points

NOTE: *Tie-down points on the machine are identified by the symbol shown in Fig. 152.*

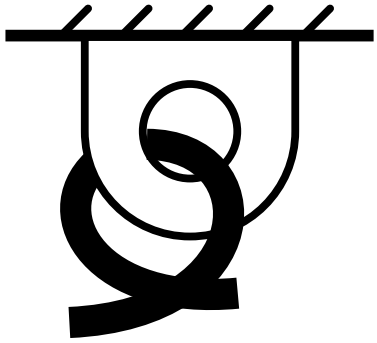


Fig. 152 – Tie-Down Point Identifier

IMPORTANT: *Before transporting the machine through heavy rain, close off the exhaust pipe with a cap or suitable adhesive tape.*

Maintenance

Proper care and service improves machine operational readiness and service life.

Perform maintenance as indicated in the "Maintenance Schedule" on page 163, or earlier if required by conditions.

⚠ WARNING

Read and understand the "Safety" Chapter in this manual, starting on page 21, before servicing the machine. Follow all applicable warnings and instructions. Check for correct function after performing maintenance. Failure to follow instructions can result in injury or death.

BEFORE performing any maintenance, perform the MANDATORY SAFETY SHUTDOWN PROCEDURE. See "Mandatory Safety Shutdown Procedure" on page 22.

Fluid leaks from hydraulic hoses or pressurized components can be difficult to see, but pressurized oil can have enough force to pierce the skin and cause serious injury. Always use a piece of wood or cardboard to check for suspected hydraulic leaks. Never use your hands. Obtain immediate medical attention if pressurized oil pierces the skin. Failure to obtain prompt medical assistance could result in gangrene or other serious damage to tissue.

Do not smoke or allow any open flames in the area while checking or servicing the hydraulic, battery, and fuel systems because all contain highly flammable liquids or explosive gases, which can cause an explosion or fire if ignited.

Wear a face shield when disassembling spring loaded components or working with battery acid. Always wear eye protection to protect eyes from electric arcs from shorts, fluids under pressure, and flying debris or loose material. Wear a helmet or goggles with special lenses when welding or cutting with a torch.

⚠ WARNING

When working beneath a raised machine, always use blocks, jack-stands, or other rigid and stable supports. Wear appropriate protective clothing, gloves, and shoes. Keep feet, clothing, hands, and hair away from moving parts.

NEVER weld on the machine without consulting the manufacturer:

- **Special metals may be used which require special welding techniques.**
- **Parts may be designed so that they should not be welded.**

NEVER cut or weld on fuel lines or tanks.

If repair welding is ever required, remove the positive (+) battery terminal connection before starting to weld. Be sure to attach the ground (-) cable from the welder as close as possible to the area to be repaired.

Allow only trained and authorized personnel, with full knowledge of safe procedures, to perform machine maintenance and service.

If any guards, shields, and covers are removed for maintenance, replace them in their original positions BEFORE starting the machine.

⚠ CAUTION

Do not use the machine when maintenance is due. Postponed maintenance can result in a serious reduction of the service life of the machine, costly equipment failures, and can contribute to unsafe operating conditions.

Do not perform maintenance or service not included in this manual. Maintenance and service not included in this manual should only be performed by an authorized repair shop.

IMPORTANT: *When washing the machine using water, do not direct the water onto any electrical connection, electrical component, or electronic components. Water may cause malfunction or damage. Power washing or other high-pressure jets may cause physical damage.*

Maintenance Schedule

IMPORTANT: *Maintenance intervals apply to average operating conditions and loads. More frequent maintenance may be required depending upon the level and type of use.*

Log all maintenance as it is performed in the "Maintenance Log" on page 214.

NOTE: *Refer the accumulated operation time on the multi-function display to determine maintenance interval timing. See "Maintenance Interval" on page 166.*

Checks, Cleaning and Inspection

Table 32: Checks Cleaning and Inspection

Service Procedure	Maximum Interval			
	10 Hours (or daily)	250 Hours (or every 6 months)	500 Hours (or annually)	1000 Hours (or every two years)
Clean machine.	X			
Inspect machine for general wear/damage	X			
Check bucket cutting edge	X			
Check safety interlock system	X			
Check tire condition and pressure	X			
Check engine oil level and condition	X			
Check coolant level and condition	X			
Check coolant system for leaks, dirt, and debris	X			
Check hydraulic oil level and condition	X			
Check brake fluid level	X			
Check fuel level and fill if necessary	X			
Check windshield washer system and wiper blades, if applicable	X			
Check exhaust for excessive smoke emission	X			
Check hydraulic cylinder piston rods for damage/wear; clean if necessary	X			
Check ROPS structure (all fasteners must be installed and tightly secured)	X			
Check water separator and drain water, if present	X			
Check hydraulic hoses and tubes for cracks, leaks, and/or debris	X			
Check hydraulic tank, valves, and cylinders for leaks and/or damage	X			
Check battery hold-down clamp and hardware (tightly secured and in good condition)	X			
Check wheel fastener torque (after first use or after wheel replacement)	X			
Check coolant anti-freeze mixture		X		
Check belt tension and condition		X		
Check engine cover latch/lock		X		
Check engine idle		X		
Clean radiator/oil cooler fins		X		
Calibrate LLMI (EU telescopic machines only)		X		
Check hinge pins, joint bushings, pivot bolts, and bearings			X	

Table 32: Checks Cleaning and Inspection

Service Procedure	Maximum Interval			
	10 Hours (or daily)	250 Hours (or every 6 months)	500 Hours (or annually)	1000 Hours (or every two years)
Check engine mounts			X	
Check exhaust system for damage			X	
Clean battery terminals			X	
Check electrical system for damage, wire routing			X	
Check fuel injectors				X

Leakage Check

Table 33: Leakage Check

Service Procedure	Maximum Interval		
	10 Hours (or daily)	250 Hours (or every 6 months)	500 Hours (or annually)
Check engine for oil/coolant leaks	X		
Check cooling system for leaks	X		
Check hydraulic system for leaks		X	
Check axles for leaks		X	

Lubrication and Filter Changes

Table 34: Lubrication and Filter Changes

Service Procedure	Maximum Interval					
	10 Hours (or daily)	50 Hours (or weekly)	150 Hours (or every 4 months)	250 Hours (or every 6 months)	500 Hours (or every 6 months)	1000 Hours (or annually)
Lubricate articulation joint (See Fig. 173 and Fig. 174 on page 172)	X					
Lubricate grease fittings according to lubrication diagram (See Fig. 154 on page 167)	X					
Telescopic lift structure lubrication (See page 173)		X				
600 Series: Change engine oil and filter					X	
700 Series: Change engine oil and filter				X[1]	X[1]	
Change cab air filter, if applicable				X[2]		
Lubricate all levers, cables, and hinges				X		
Change outer air cleaner filter element; check and change inner air cleaner element if necessary				X[2]		
Main fuel filter					X[3]	
Fuel/water filter					X[4]	
Hydraulic oil filter					X	
Change coolant						X
Change axle oil						X[5]
Change hydraulic oil						X[6]

1. 500 hour oil change intervals MUST meet Deutz Certification DQC III-18LA or DQA IV18 LA. All other classifications MUST follow 250 hour oil change intervals.
2. Replace if needed.
3. 700 Series: every 1000 hours; 600 Series: every 500 hours.
4. 700 Series: every 1000 hours; 600 Series: every 500 hours.
5. Every 1500 hours
6. Every 1000 hours; 500 hours under extreme conditions.

Functional Check

Table 35: Functional Check

Service Procedure	Maximum Interval		
	10 Hours (or daily)	250 Hours (or every 6 months)	500 Hours (or annually)
Check seat belt	X		
Check service and parking brake function	X		
Check joystick operation	X		
Check windshield wiper function, if applicable	X		
Check control switches/buttons, indicators, and audible warning devices	X		
Check installed lighting systems	X		

Maintenance Interval

⚠ CAUTION

Do not postpone maintenance. Postponed maintenance can result in a serious reduction to the service life of the machine, more serious and costly equipment failures, and can contribute to unsafe operating conditions.

NOTE: *The multi-purpose display includes accumulated operation time. See “Multi-Function Display” on page 67. Accumulated operation time value accumulates whenever the engine is running.*

Fig. 153 – Accumulated Service Hours

General Lubrication

IMPORTANT: *Use of lubricants not corresponding to manufacturer recommendations may invalidate warranty claims. Always dispose of waste lubrication oils and hydraulic oil according to environmental laws or take to a recycling center for proper disposal. DO NOT pour fluids onto the ground or down a drain.*

Refer to the following figures for grease fitting locations. See “Fluids/Lubricants Types and Capacities” on page 49 for proper grease specifications. Wipe dirt from the fittings before applying grease to prevent contamination. Replace any missing or damaged fittings. To minimize dirt build-up, avoid excessive greasing.

Non-Telescopic Machines

A1 – Lift Structure Top Pivot (Fig. 156)
B1 – Lift Cylinders (2) Base Ends (Fig. 157)
C1 – Lift Cylinders (2) Rod Ends (Fig. 158)
D1 – Tilt Cylinder Rod End (Fig. 159)
E1 – Tilt Cylinder Base End (Fig. 160)
F1 – Tilt Pivot (Fig. 161)
G1 – Bottom Tilt Link Pivot (Fig. 162)
H1 – Link/Hitch Pivot (Fig. 163)
I1 – Bottom Hitch Pivots (2) (Fig. 164)
J1 – Hitch Lock Pins (2) (Fig. 164)
K – Articulation/Steering Pivot (3) (Fig. 173 and Fig. 174)
L – Steering Cylinder Rod End (Fig. 175)
M – Steering Cylinder Base End (Fig. 176)
O – Drive Shaft (3) (Fig. 177)

Fig. 154 – Lubrication (Non-Telescopic Machines)

A2 – Lift Structure Top Pivot (Fig. 165)
B2 – Lift/Slave Cylinders Base Ends (Fig. 166)
C2 – Lift/Slave Cylinders Rod Ends (Fig. 167)
D2 – Extend Cylinder Base End (Fig. 168)
E2 – Extend Cylinder Rod End (Fig. 169)
F2 – Tilt Link Pivots (Fig. 170)
G2 – Hitch Pivot Top (Fig. 171)
H2 – Bottom Hitch Pivots (2) (Fig. 172)
I2 – Hitch Lock Pins (2) (Fig. 172)
K – Articulation/Steering Pivot (3) (Fig. 173)
L – Steering Cylinder Rod End (Fig. 175)
M – Steering Cylinder Base End (Fig. 176)
O – Drive Shaft (3) (Fig. 177)

Fig. 155 – Lubrication (Telescopic Machines)

General Lubrication Detail

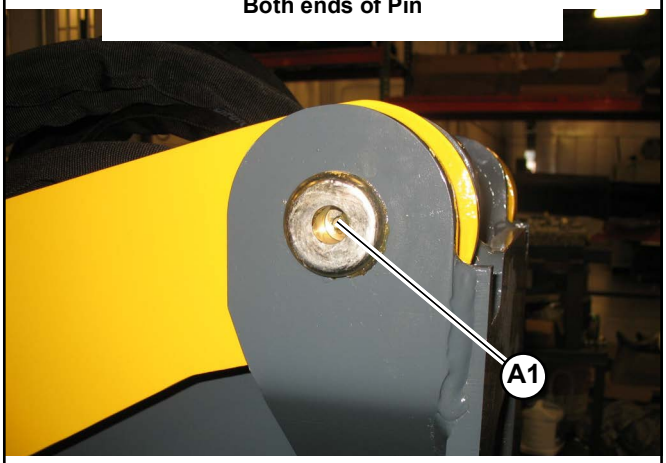


Fig. 156 – Lubrication - Non-Telescopic Machines - Lift Structure Pivot - Top

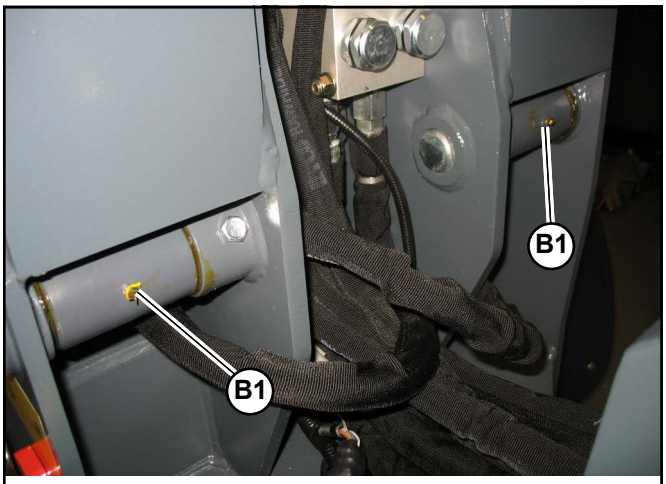


Fig. 157 – Lubrication - Non-Telescopic Machines - Lift Cylinders Base Ends

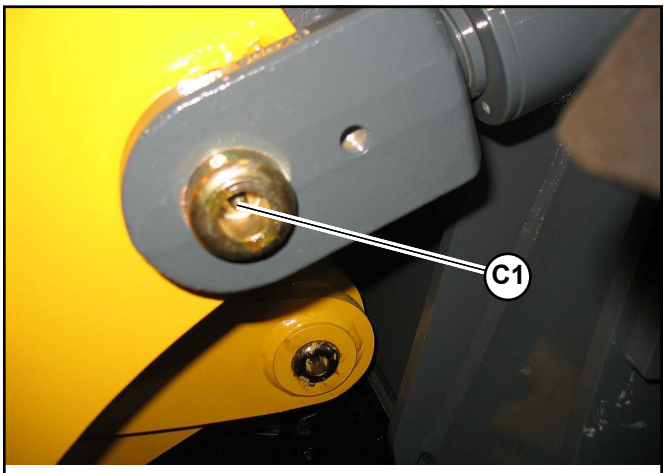


Fig. 158 – Lubrication - Non-Telescopic Machines - Lift Cylinders Rod Ends

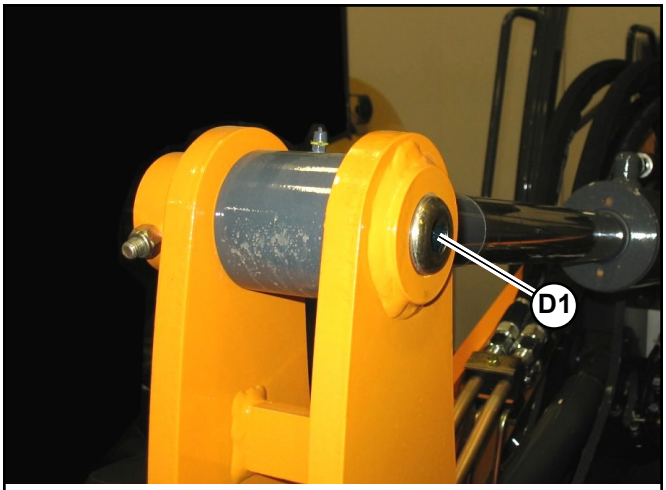


Fig. 159 – Lubrication - Non-Telescopic Machines - Tilt Cylinder Rod End

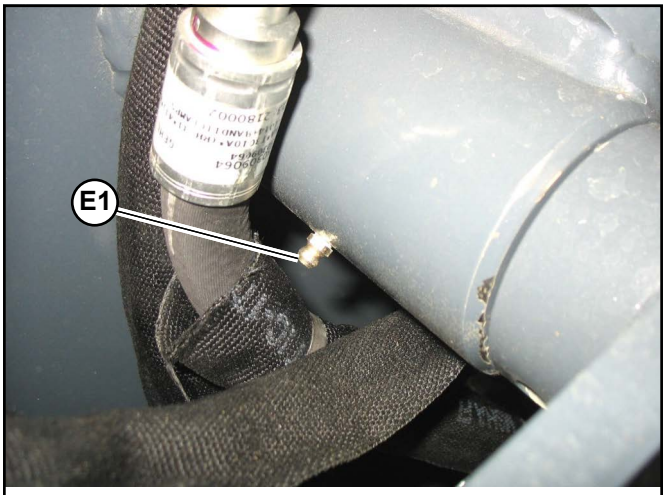


Fig. 160 – Lubrication - Non-Telescopic Machines - Tilt Cylinder Base End

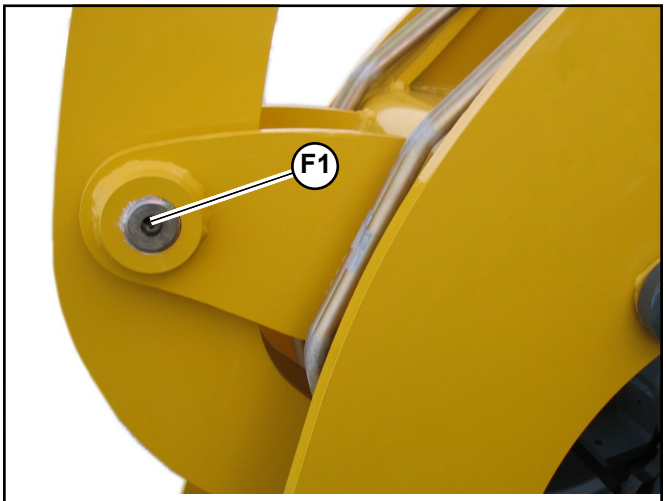


Fig. 161 – Lubrication - Non-Telescopic Machines - Tilt Pivot - Center

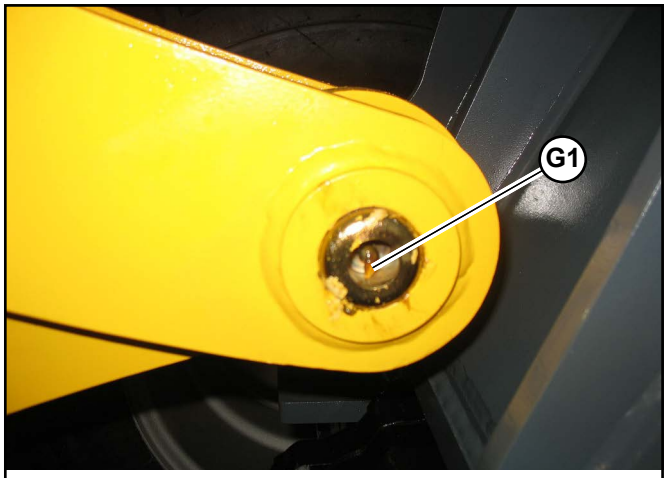


Fig. 162 – Lubrication - Non-Telescopic Machines - Bottom Tilt Link Pivot

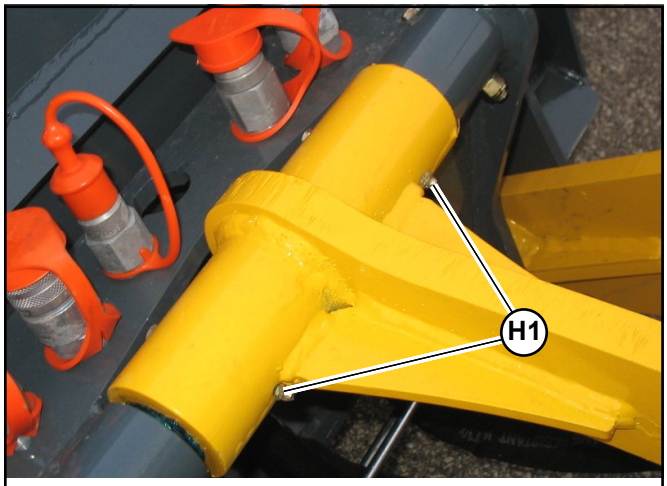


Fig. 163 – Lubrication - Non-Telescopic Machines - Link/Hitch Pivot

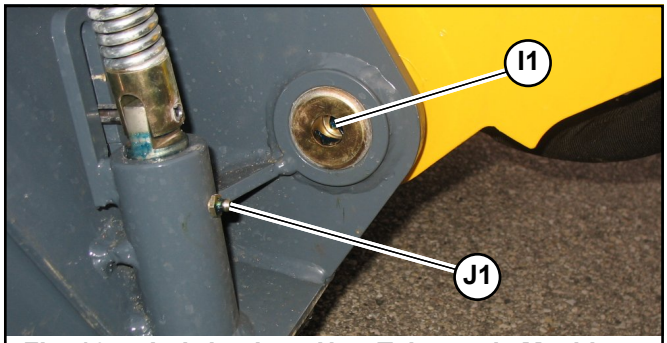


Fig. 164 – Lubrication - Non-Telescopic Machines - Hitch Pivot/Lock Pin

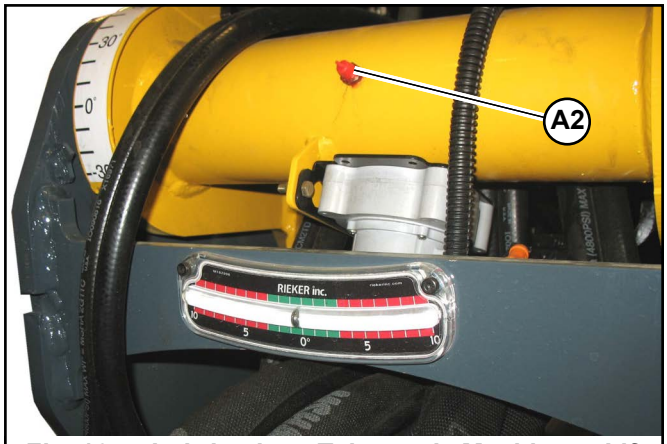


Fig. 165 – Lubrication - Telescopic Machines - Lift Structure Top Pivot

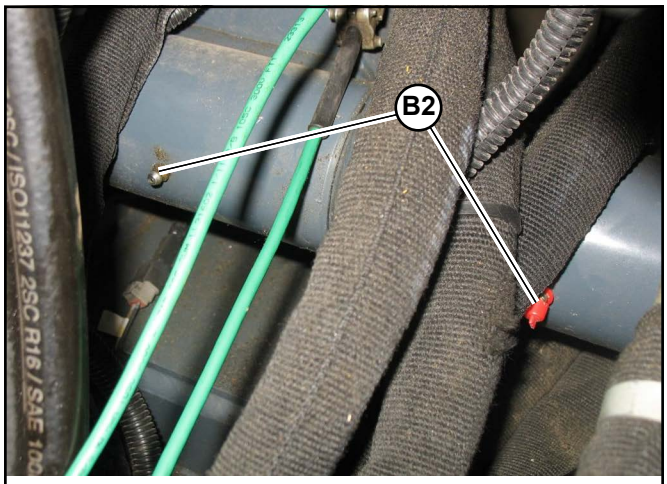


Fig. 166 – Lubrication - Telescopic Machines - Lift/Slave Cylinder Base Ends

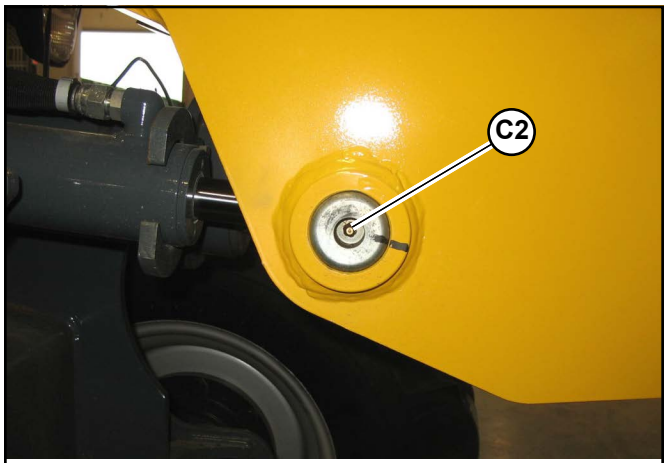


Fig. 167 – Lubrication - Telescopic Machines - Lift/Slave Cylinder Rod Ends

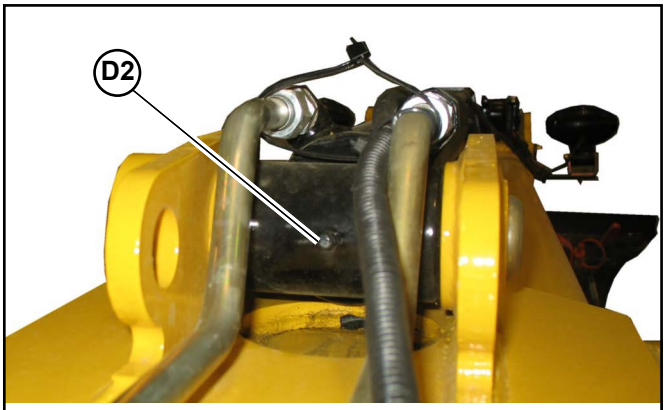


Fig. 168 – Lubrication - Telescopic Machines - Extend Cylinder Base End

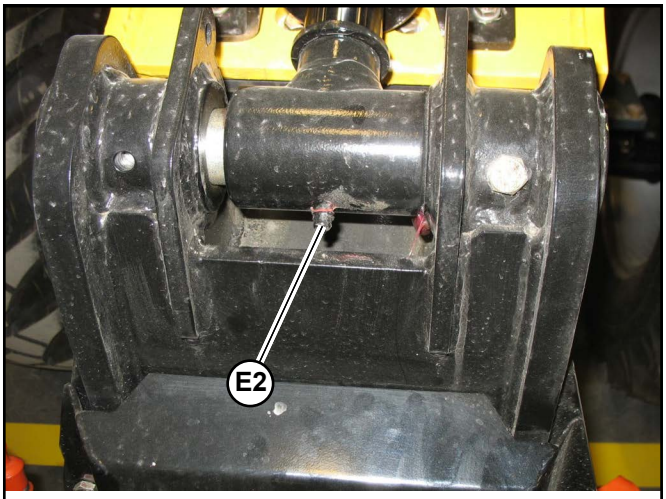


Fig. 169 – Lubrication - Telescopic Machines - Extend Cylinder Rod End

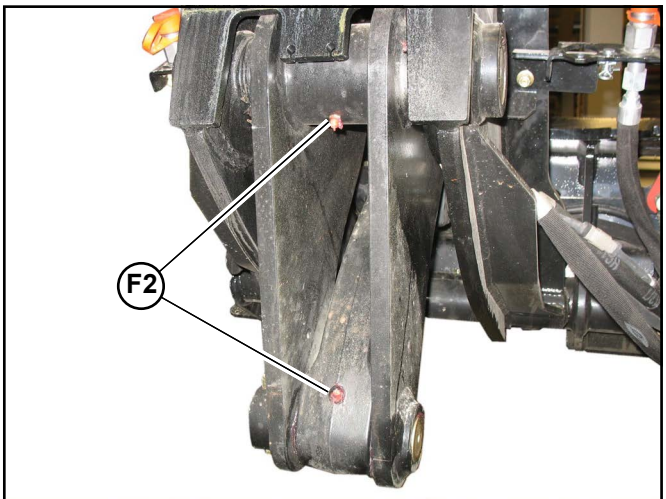


Fig. 170 – Lubrication - Telescopic Machines - Tilt Link Pivots

Fig. 171 – Lubrication - Telescopic Machines - Hitch Pivot Top

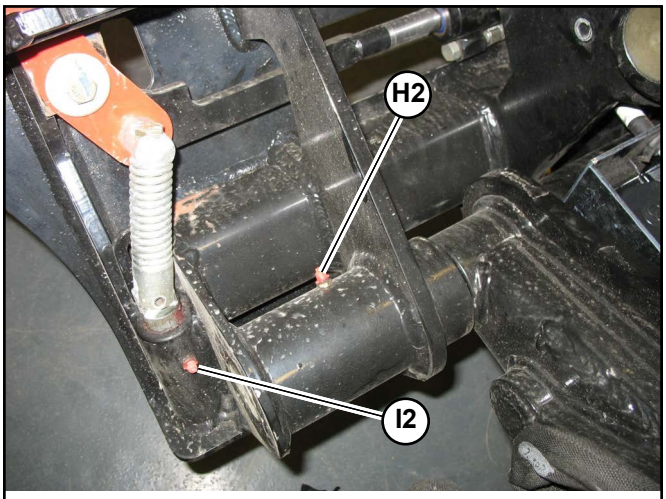


Fig. 172 – Lubrication - Telescopic Machines - Hitch Pivot Bottom / Hitch Lock Pins

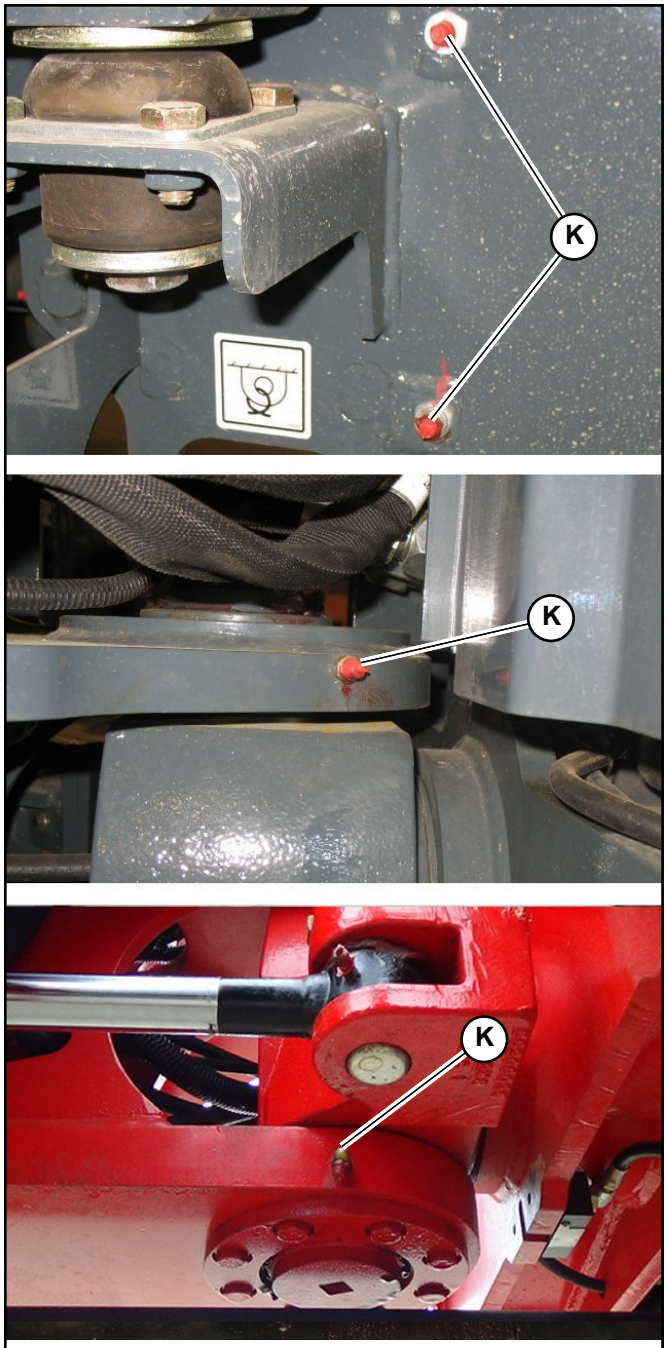


Fig. 173 – Lubrication - All Machines - Articulation/ Steering Pivot (Telescopic Machines)

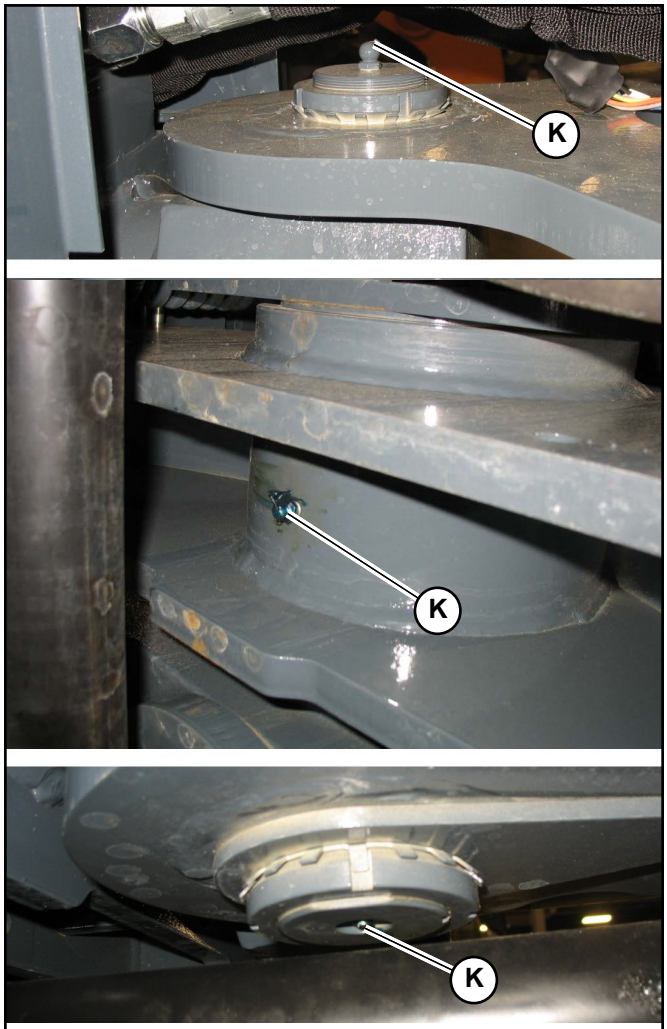


Fig. 174 – Lubrication - All Machines - Articulation/ Steering Pivot (Older Non-Telescopic Machines)

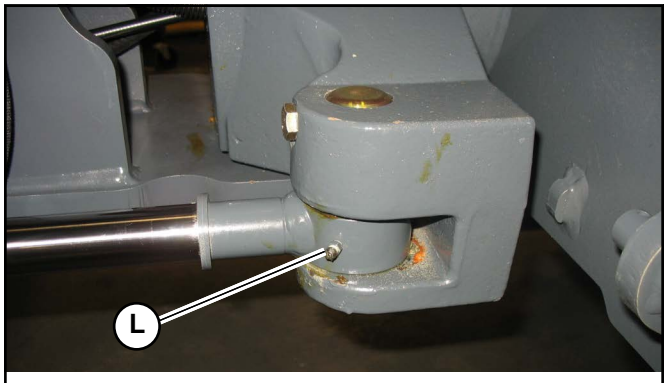


Fig. 175 – Lubrication - All Machines - Steering Cylinder Rod End

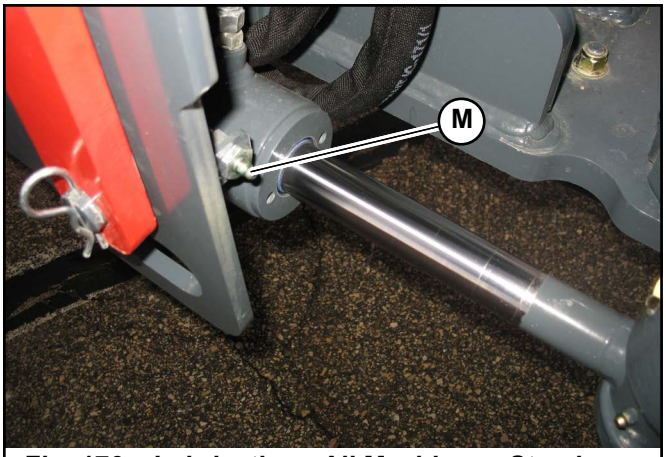


Fig. 176 – Lubrication - All Machines - Steering Cylinder Base End

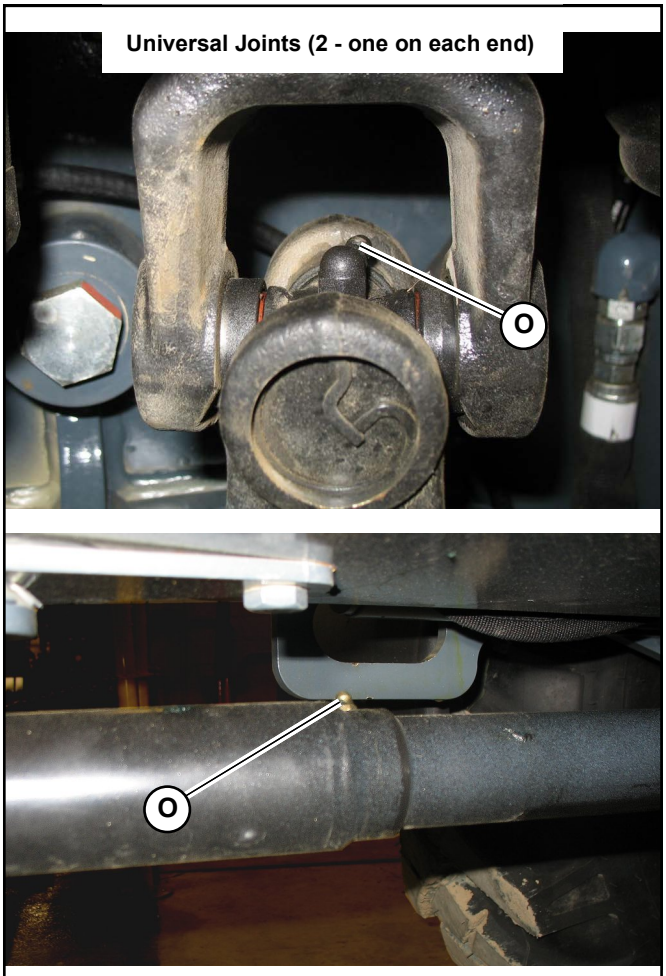


Fig. 177 – Lubrication - All Machines - Driveshaft

IMPORTANT: *Articulate (turn) the machine fully to the right before lubricating the driveshaft for proper grease distribution and best access to grease fittings.*

Telescopic Lift Structure Maintenance (Telescopic Machines Only)

Telescopic Lift Structure Section Lubrication

Weekly, or every 50 hours of operation or so, depending upon conditions, apply a lithium-based grease to the bottom edge (B, Fig. 178) of the lift structure telescopic section.

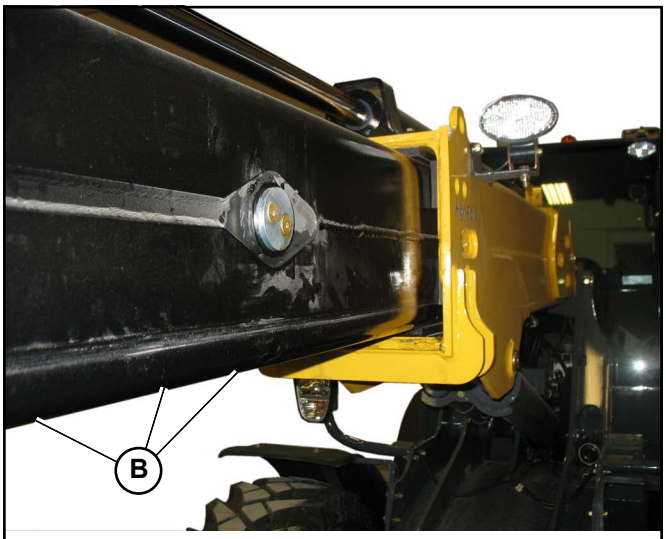


Fig. 178 – Telescopic Lift Structure Lubrication

NOTE: *A paint roller can be useful when applying grease.*

Telescopic Lift Structure Wear Pad Replacement

Annually, or every 500 hours of operation, measure gap (C, Fig. 179) between the lift structure telescopic section and the top wear pads.

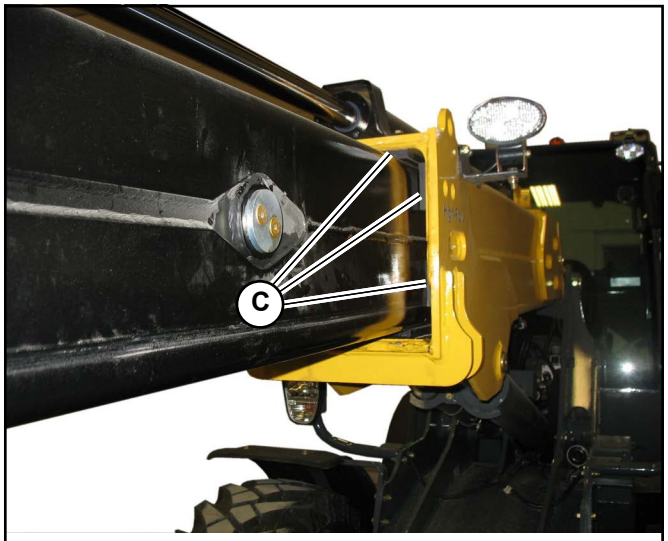


Fig. 179 – Telescopic Lift Structure Wear Pad Replacement

If gap (C) is 1/8” (3 mm) or greater, replace the telescopic lift structure wear pads. Refer to the Service Manual for wear pad replacement information.

LLMI Calibration (EU Telescopic Machines Only)

IMPORTANT: *LLMI calibration must be performed with the machine straight and not turned.*

Perform LLMI calibration every 250 hours of operation.

1. Park the machine in a smooth, level area, with enough overhead clearance to fully raise the lift structure.

NOTE: *A suitable, solid, substantial object, such as a dirt pile, should be located nearby to allow for using the lift structure to raise the rear tires of the machine off the ground later during the calibration procedure.*

2. Position the machine so it is straight and not turned. Place the travel direction switch on the joystick to the neutral position and apply the parking brake.
3. Press the “esc” button (F, Fig. 180) on the multi-purpose display twice, quickly.

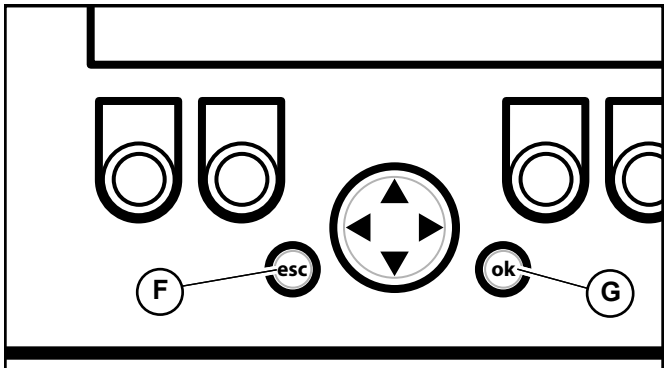


Fig. 180 – Multi-Purpose Display esc Button

4. Press the ok button (G) on the multi-purpose display.

Fig. 181 – LLMI Calibration Start Screen

5. Make sure the lift structure is fully retracted and raise the lift structure (H, Fig. 182) as far as it will go.

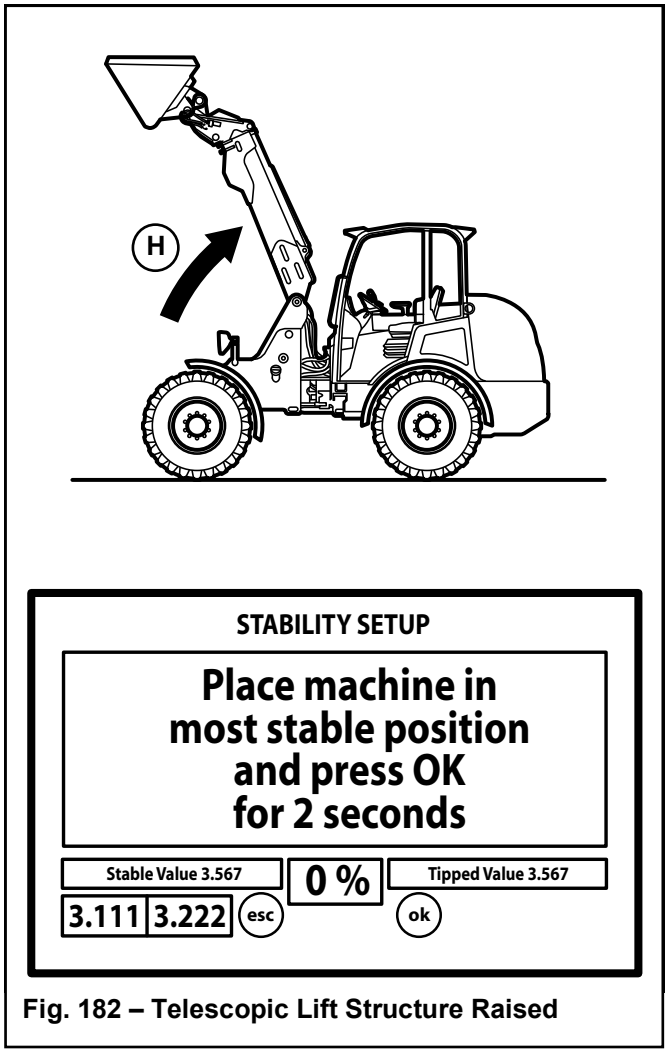


Fig. 182 – Telescopic Lift Structure Raised

6. Press the ok button (G, Fig. 180) on the multi-purpose display for 2 seconds.
7. Release the parking brake and drive the machine to a suitable, solid, substantial object such as a dirt pile (I, Fig. 183). Position the lift structure/ attachment under/into the object (I) so the rear wheels of the machine can be raised off the ground using the lift structure.
8. Apply the parking brake.
9. Slowly pull the joystick straight back to use the lift structure to raise the machine (J) until both rear wheels are off the ground (K).

NOTE: *Only raise the rear of the machine high enough so both rear wheels just clear the ground.*

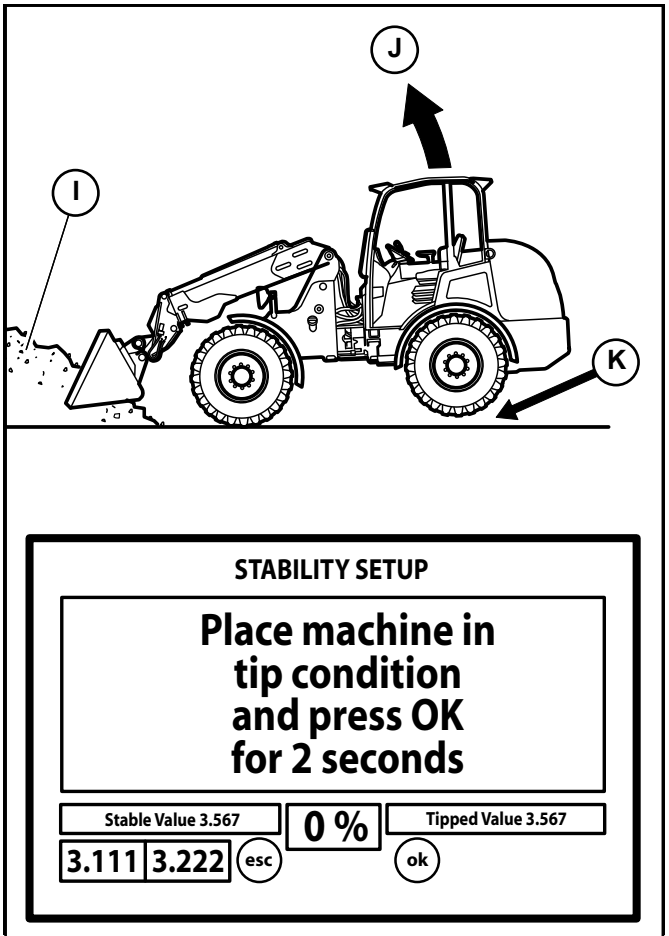


Fig. 183 – Rear Wheels Raised

10. Press the ok button (G, Fig. 180) on the multi-purpose display for 2 seconds.
11. Press the esc button (F, Fig. 180) on the multi-purpose display.

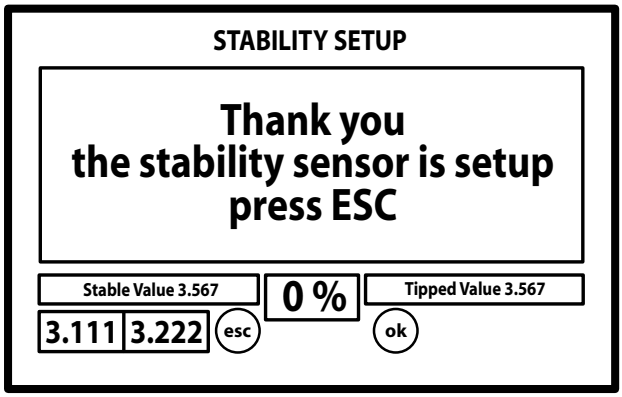


Fig. 184 – LLMI Calibration Completed Screen

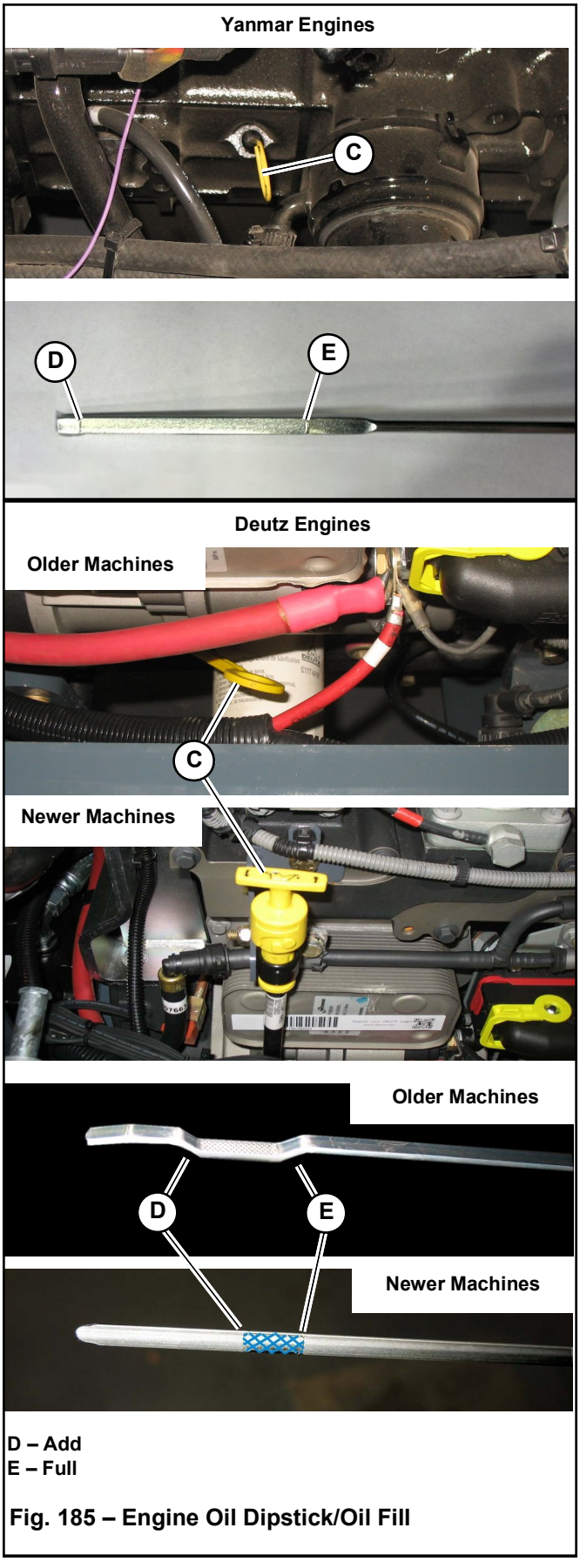
Engine Maintenance

Engine Oil

Checking Engine Oil Level

Check the engine oil level daily before starting the machine, or after every ten hours of use.

1. Park the machine on a level surface.
2. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
3. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.
4. Open the engine cover.
5. Twist and remove engine oil dipstick (C, Fig. 185) from the engine.
6. Wipe the dipstick with a clean cloth and replace it in the engine. Push it in until it is fully inserted/seated.
7. Remove the dipstick again. The oil level should be within the "Add" (D) and "Full" (E) marking.

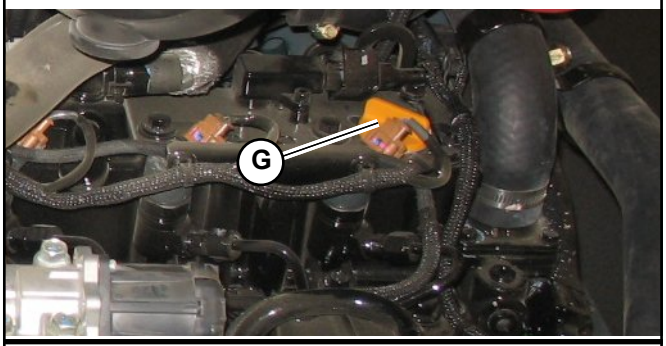


D – Add
E – Full

Fig. 185 – Engine Oil Dipstick/Oil Fill

8. If the oil level is below the “Add” marking:
   a. Clean the area around the oil fill cap (G, Fig. 186) with a clean cloth.
   b. Remove fill cap (G).
   c. Add oil through the fill cap opening until the level reaches the “Full” marking (E, Fig. 185) on the dipstick.
   d. Replace and tighten fill cap (G).

Yanmar Engines



Deutz Engines (Tier 4 shown; Others similar)

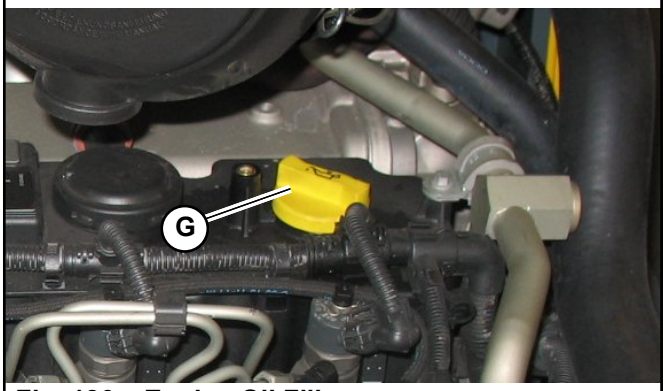


Fig. 186 – Engine Oil Fill

IMPORTANT: *Do not over-fill the engine with oil. Damage could result.*

Changing Engine Oil and Filter

Change the engine oil and filter after the first 50 hours of use, and every 250 hours thereafter.

1. Park the machine on a level surface.
2. Perform the “Mandatory Safety Shutdown Procedure” on page 22.
3. Wait until the engine has cooled, but is not completely cold. Oil will drain faster and more completely if it is warm.
4. Remove hardware (H, Fig. 187) securing lower engine access panel (I).

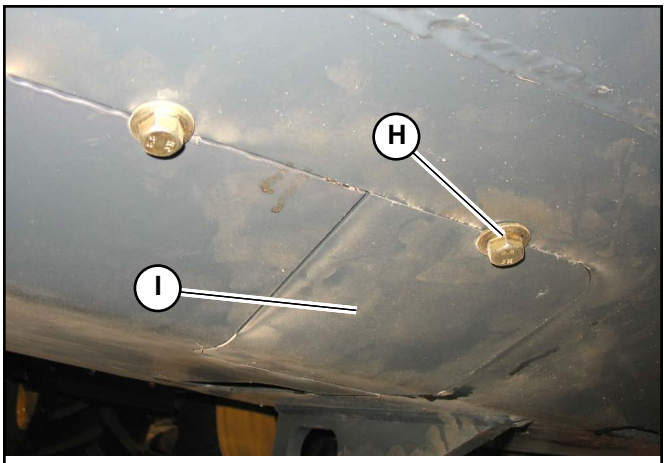


Fig. 187 – Lower Engine Access

5. Remove panel (I) to access engine oil drain plug (O, Fig. 188).

Yanmar Engine Shown; Deutz Engines Similar

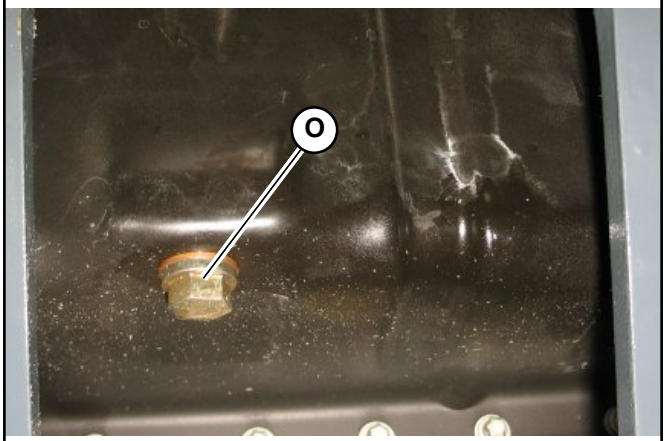


Fig. 188 – Engine Oil Drain Plug

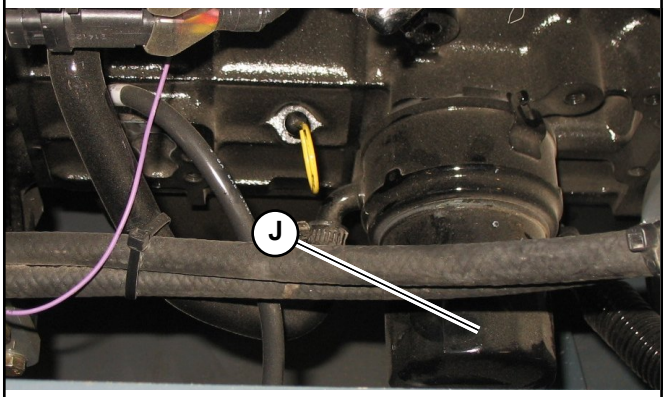
6. Position a waste oil collection container under the engine oil drain plug to catch draining oil.

IMPORTANT: *Dispose of waste engine oil according to environmental laws or take it to a recycling center for proper disposal. DO NOT pour waste engine oil onto the ground or down a drain.*

7. Remove drain plug (O) from the engine oil pan and allow the oil to drain into the waste oil collection container.

8. Remove oil filter (J, Fig. 189), using a filter wrench if necessary. Carefully clean the filter head mounting surface with a clean cloth.

Yanmar Engines



Deutz Engines (Older Machines Shown, Newer Machines Similar)

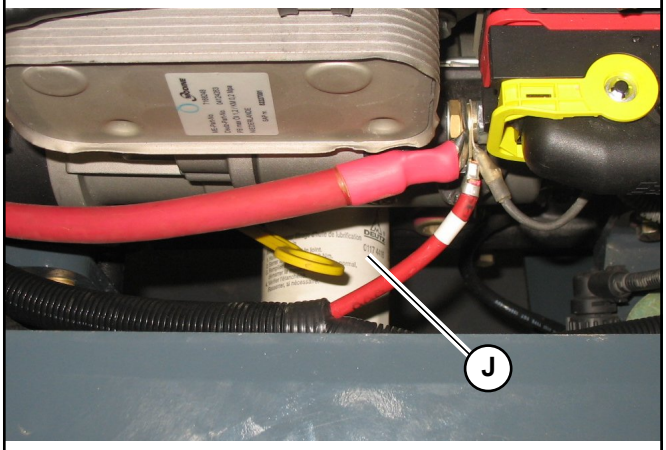


Fig. 189 – Engine Oil Filter

9. Apply a coating of clean oil to the new oil filter gasket. Install the filter and tighten 3/4 rotation past the point where the gasket first contacts the filter head.

10. Reinstall and tighten the drain plug.

IMPORTANT: *Do not over-fill the engine with oil. Damage could result.*

11. Clean the area around oil fill cap (G, Fig. 186). Remove oil fill cap (G) and add the recommended type and amount of oil. See "Fluids/Lubricants Types and Capacities" on page 49. Replace and tighten oil fill cap (G) after the oil is added.

    NOTE: *Oil capacity listed is approximate. Always verify proper oil level with the engine oil dipstick.*

IMPORTANT: *If the engine oil pressure indicator does not go out when the engine is running, shut down the engine immediately and correct the problem. Damage to the engine may result if engine is run and the problem is not corrected.*

12. Start the engine and verify that the engine oil pressure indicator turns off after the engine starts.

13. Allow the engine to run for several minutes at low idle. Watch for leaks at the oil filter and drain plug.

14. Check the oil level. Add oil if necessary until the oil level is at the "Full" mark on the dipstick (Fig. 185).

15. Replace engine drain plug access panel (I, Fig. 187). Secure with hardware (H).

Engine Air Filters

IMPORTANT: *Do not operate the engine without the air cleaner components installed or damage to the engine could occur.*

Check, and if necessary replace, the engine air filters after every 250 hours of use, or every 6 months, or whenever the engine air filter restriction indicator is displayed (K, Fig. 190).

NOTE: *The engine air filter restriction indicator (F, Fig. 190) on the multi-function display is displayed whenever the air cleaner becomes restricted. When this indicator is displayed, the air filters require inspection and may need replacement.*

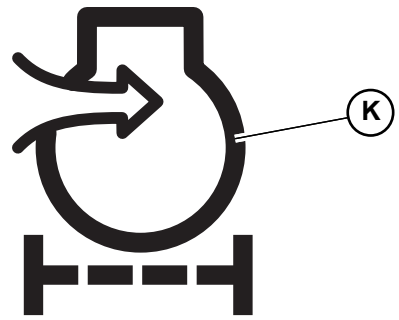


Fig. 190 – Engine Air Filter Restriction Indicator

The air cleaner consists of an outer (primary) filter element (L, Fig. 191), an inner (secondary) filter element (M).

Replace the inner filter element every third time the outer element is replaced, unless the outer element is damaged or the inner element is visibly dirty.

Make sure the air cleaner intake hose, clamps, and mounting bracket hardware are properly tightened.

Changing Air Filter Elements

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. Open the engine cover.

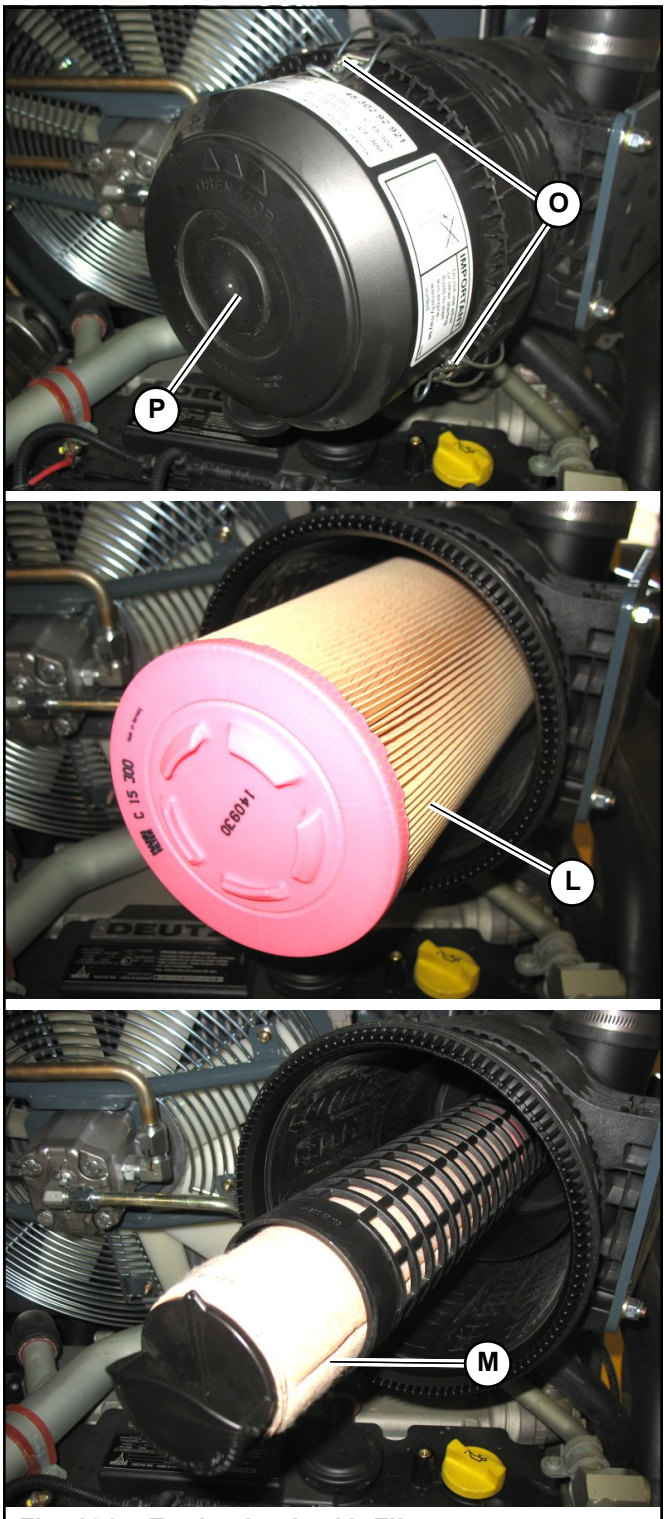


Fig. 191 – Engine Intake Air Filters

3. Unlatch clamp (O, Fig. 191) on the air cleaner housing and remove the air filter cover (P).
4. Clean debris from inside the air cleaner housing and air filter cover.
5. Carefully remove the outer filter element (L). Do not remove inner filter element (M) unless it will be replaced. If inner filter element (M) will not be replaced, skip to step 10.
6. Clean dirt from inside the air filter housing.

IMPORTANT: *To prevent debris from entering the engine intake manifold, do not remove inner filter element (M) while cleaning the inside of the housing.*

7. Remove the inner filter element (M).
8. Check the inside of the housing for damage.
9. Install a new inner filter element (M).
10. Install a new outer filter element (L).
11. Replace air filter cover (P). Latch clamps (O). Make sure the cover is tightly secured and is seated properly in the housing.

Engine Cooling System

Checking Coolant Level

Check the coolant level daily before starting the machine, or after every ten hours of use.

1. Park the machine on a level surface.
2. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
3. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.
4. Open the engine cover.
5. **Deutz engines:**

⚠ WARNING

Do not remove the radiator cap when the coolant is hot. Serious burns may occur.

Remove the radiator cap. The coolant level is correct when it is approximately in the center of coolant sight gauge (X, Fig. 192) near the top of the engine compartment.

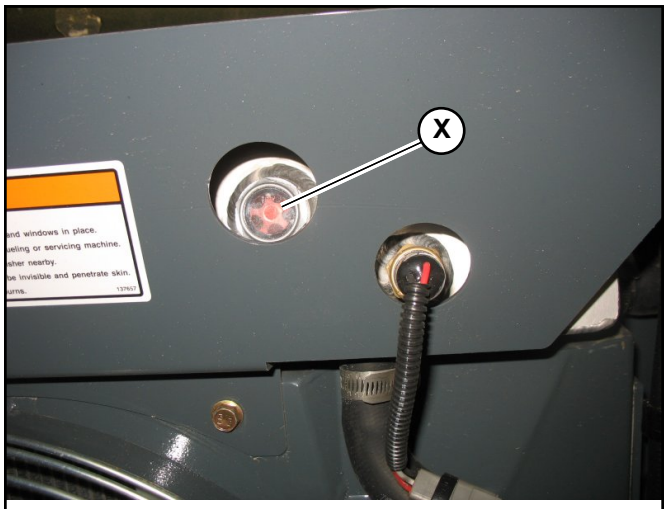


Fig. 192 – Deutz Coolant Level Sight Gauge

6. **Yanmar Engines:** Check the coolant level in the expansion reservoir (R, Fig. 193). The coolant level must be between the full (T) and low (S) marks on the expansion reservoir. Add coolant to the expansion reservoir as required.

IMPORTANT: *The coolant system is specifically designed for coolant level top-off only through the expansion reservoir. Do not add coolant directly to the radiator.*

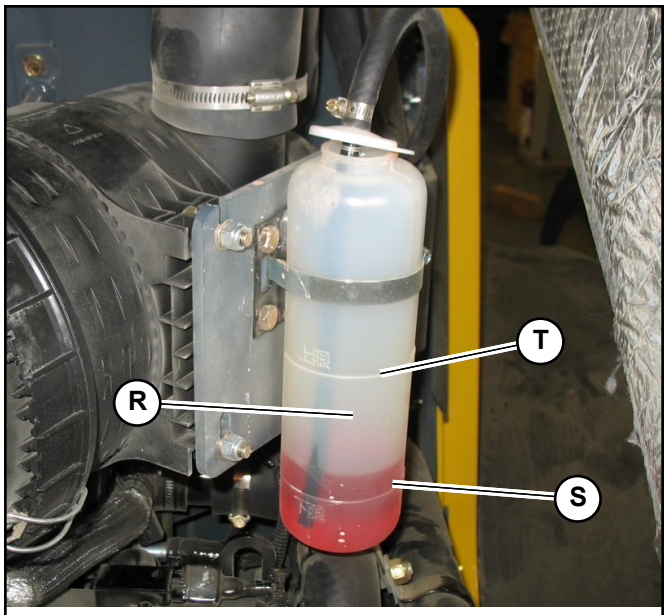


Fig. 193 – Coolant Expansion Reservoir

NOTE: *Use a low-silicate ethylene glycol-based coolant, mixed with quality water and supplemental coolant additives (SCAs) suitable for heavy-duty diesel engines. See "Fluids/Lubricants Types and Capacities" on page 49 and the engine operation manual for additional information.*

Cleaning Radiator Fins

The radiator fins can become blocked during use, which will lead to reduced cooling function and engine overheating. Clean the radiator cooling fins after every 250 hours or 6 months of operation, whichever occurs first. Clean the fins more frequently if operating in excessively dirty/dusty conditions.

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.
3. Open the engine cover.
4. Remove the left and/or the right side panels to access the front of the radiator:
   a. Remove wing nuts (A, Fig. 194) securing side panel (B).
   b. Remove side panel (B).

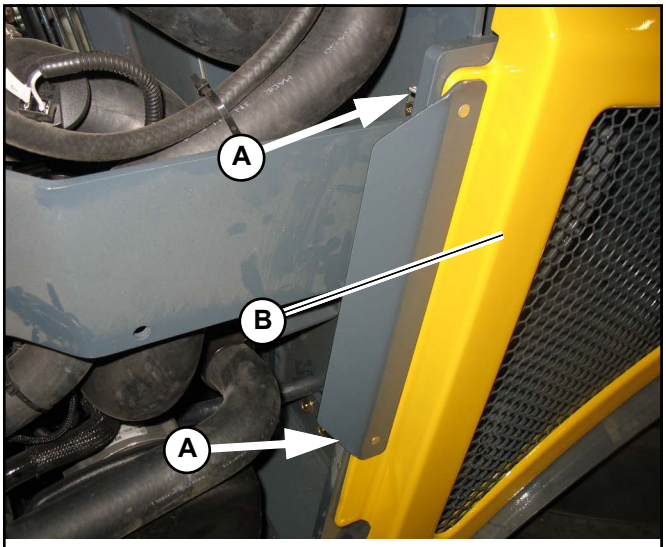


Fig. 194 – Side Panel Removal

NOTE: *Remove either the left, right, or both side panels, as required, to access front of radiator (C, Fig. 195).*

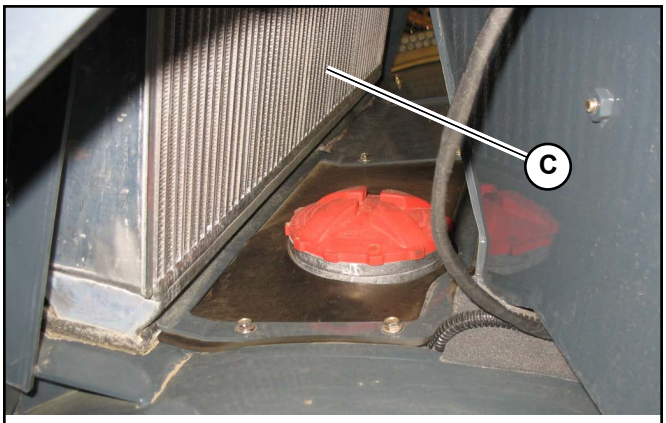


Fig. 195 – Front of Radiator

5. Clean the radiator fins by blowing air/water through the fins.

NOTE: *The cooling fan rotation can temporarily be reversed to help clear particulate matter from the radiator. See "Cooling Fan Rotation Reversing Button" on page 93.*

IMPORTANT: *Use caution! High pressure can damage radiator fins.*

Draining/Refilling Cooling System

1. Park the machine on a level surface.
2. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
3. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.
4. Open the engine cover.

⚠ WARNING

Do not remove radiator cap when the coolant is hot. Serious burns may occur.

5. Slowly loosen radiator cap (P, Fig. 196) and allow pressure to escape. Remove the cap.

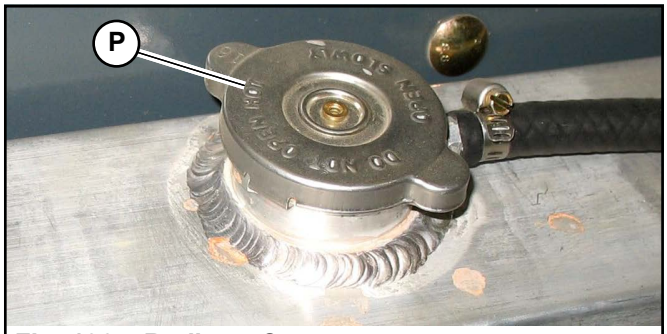


Fig. 196 – Radiator Cap

6. Yanmar engines:

   a. Locate radiator hose (X, Fig. 197) leading from the bottom of the radiator to the right side of the engine.

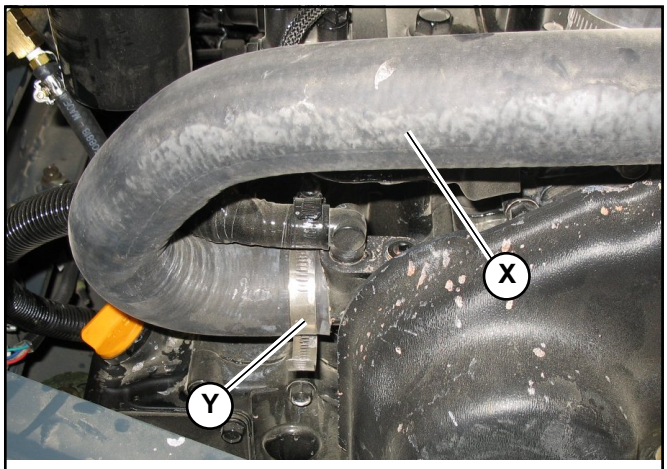


Fig. 197 – Yanmar Engine Radiator Drain

   b. Prepare a suitable collection container, with a minimum capacity of 15 L (4 gals.) to catch coolant as it drains from the radiator.

      IMPORTANT: *Dispose of waste coolant according to environmental laws. DO NOT pour coolant onto the ground or down a drain.*

   c. Loosen hose clamp (Y) and pull hose (X) from the engine. Drain the coolant into the container.

   d. After the coolant has drained from the radiator, replace hose (X) back onto the engine and secure it with hose clamp (Y). Tighten securely.

   e. To drain coolant remaining in the engine water jacket, remove hardware (A, Fig. 198) securing lower engine access panels (B) and remove panels. Loosen hose clamp (C) and pull hose (D) from the engine. Drain the coolant into the container.

   f. After the coolant has drained, replace hose (D) back onto the engine and secure it with hose clamp (C). Tighten securely.

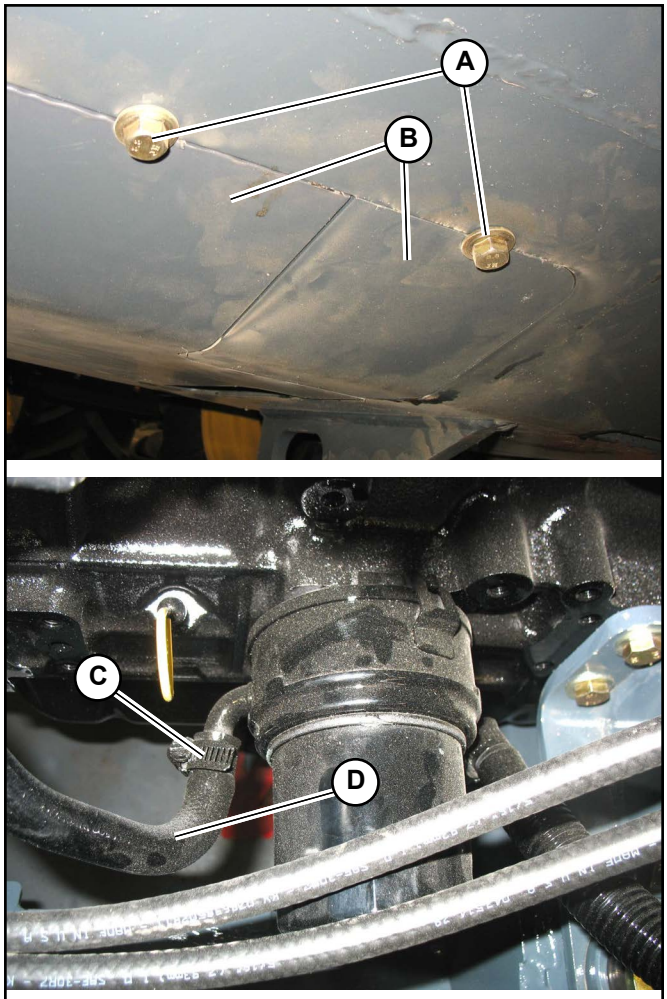


Fig. 198 – Yanmar Engine Coolant Drain

7. Deutz engines:

   a. Remove hardware (A, Fig. 199) securing lower engine access panels (B) and remove panels.

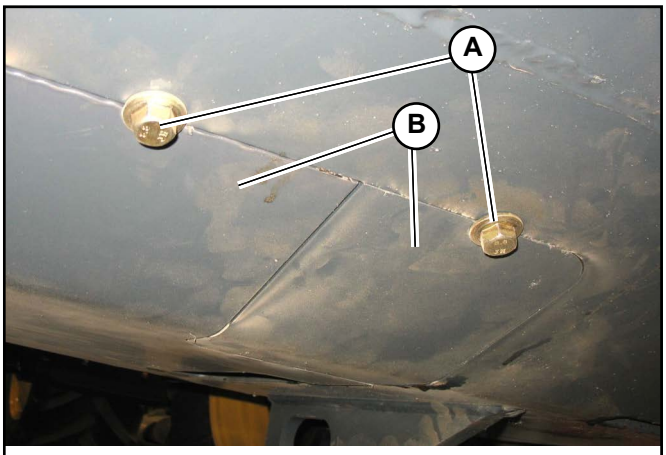


Fig. 199 – Lower Engine Access Panels

   b. Prepare a suitable collection container, with a minimum capacity of 18.5 L (5 gals.) to catch coolant as it drains under the drain plug along the lower coolant hose.

   c. Remove the drain plug (X, Fig. 200) and allow the coolant to drain completely.

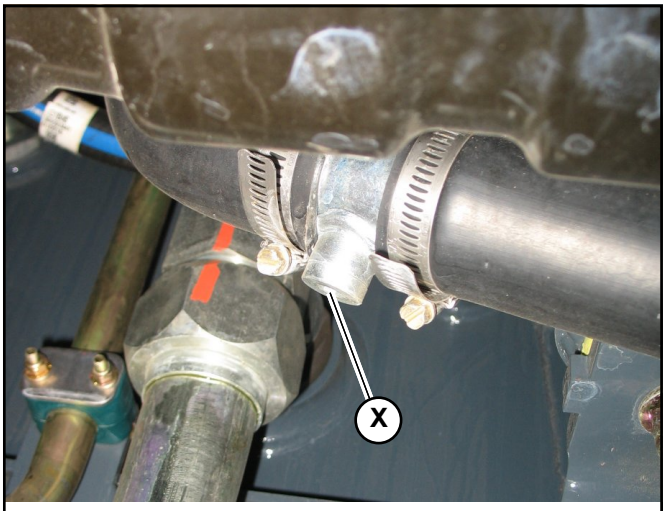


Fig. 200 – Deutz Engine Drain Plug

IMPORTANT: *Dispose of waste coolant according to environmental laws. DO NOT pour coolant onto the ground or down a drain.*

   d. Replace drain plug (X).

8. Fill the radiator with coolant.

   NOTE: *Use a low-silicate ethylene glycol-based coolant, mixed with quality water and supplemental coolant additives (SCAs) suitable for heavy-duty diesel engines. See "Fluids/Lubricants Types and Capacities" on page 49 and the engine operation manual for additional information.*

9. Reinstall the radiator cap and tighten securely.

10. Replace lower engine access panels (B, Fig. 199) secure with hardware (A).

11. Start and run the engine until it reaches operating temperature.

12. Check the coolant level according to "Checking Coolant Level" on page 180.

Belt Maintenance

Check the belt condition monthly or after every 100 hours of use. Replace or adjust it if necessary.

NOTE: *Replace the belt if the deflection exceeds 5/8" (15 mm). Refer to the engine operator's manual for more details.*

Checking and Adjusting Belt Tension

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.

2. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.

3. Open the engine cover.

4. On Yanmar engines:

   a. Remove fasteners (E, Fig. 201) securing belt guard (F) on the right side of the engine. Remove the guard.

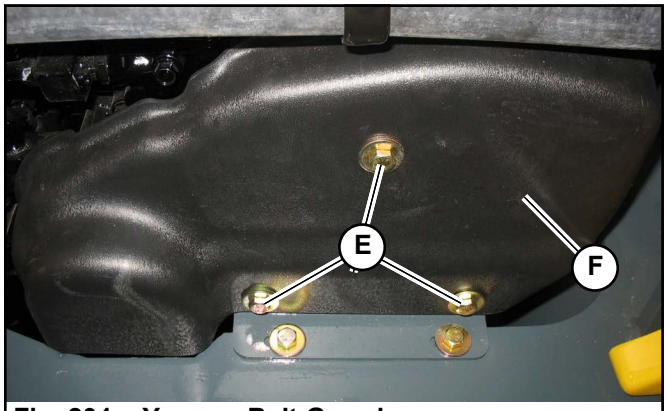


Fig. 201 – Yanmar Belt Guard

   b. Inspect belt (G, Fig. 202) for damage. If it is damaged, have the belt replaced by an authorized repair shop.

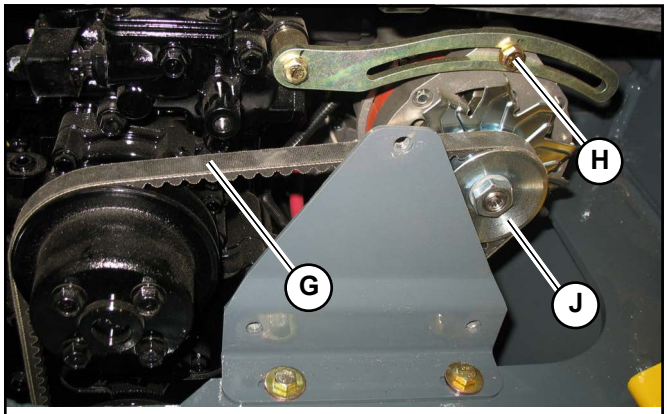


Fig. 202 – Yanmar Belt

   c. Press on belt (G) mid-way between the pulleys to check deflection. The belt should not deflect more than 8 mm (5/16 in.).

   d. If deflection is more than 8 mm (5/16 in.): Loosen adjustment bolt (H) and rotate alternator (J) until the belt tension is correct. Tighten bolt (H) and re-check the belt tension.

5. On Deutz engines:

   a. Remove fasteners (K, Fig. 203) securing belt guard (L) on the right side of the engine. Remove the guard.

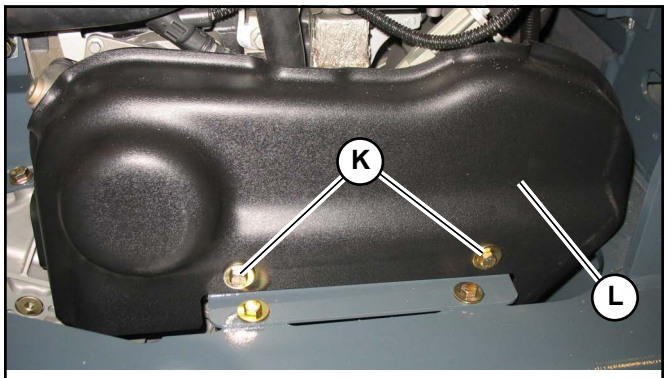


Fig. 203 – Deutz Belt Guard

   b. Inspect belt (M, Fig. 204) for damage. If damaged, have the belt replaced by an authorized repair shop.

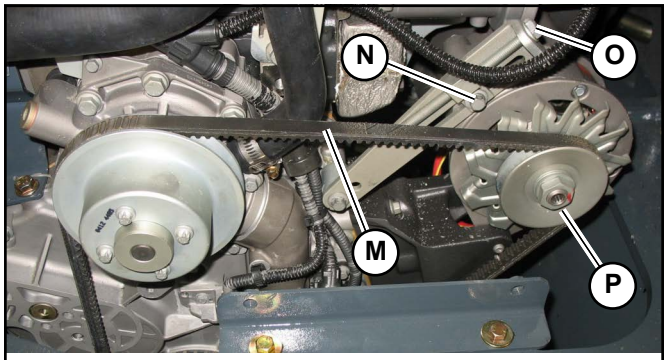


Fig. 204 – Deutz Belt

   c. Press on belt (M) mid-way between the pulleys to check deflection. The belt should not deflect more than 8 mm (5/16 in.).

   d. If deflection is more than 8 mm (5/16 in.): Loosen locking screw (N), and tighten alternator adjustment bolt (O) to rotate alternator (P) until the belt tension is correct. Tighten locking screw (N) and re-check the belt tension.

DPF Service

DPF soot filter replacement is required when the DPF Service screen (Fig. 205) is shown on the multi-purpose display.

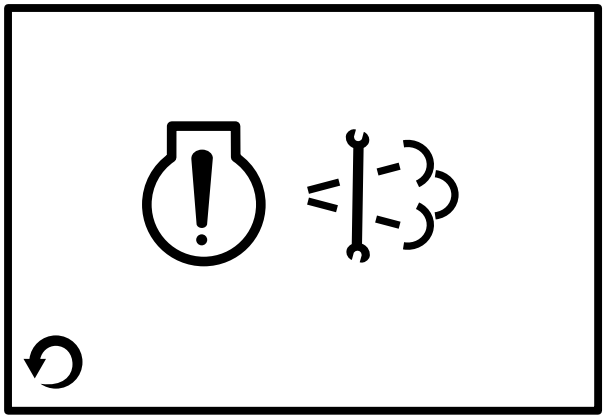


Fig. 205 – DPF Service Screen

NOTE: *Contact an authorized dealer when the DPF Service screen displays.*

Fuel System Maintenance

⚠ WARNING

Diesel fuel is flammable. Keep the machine away from open flames. Do not smoke when refueling or when working on the engine. Stop the engine before fueling.

Wear eye protection. The fuel system is under pressure and fuel could spray out when removing any fuel system component.

Wipe up spills immediately. NEVER use a shop rag to catch draining/leaking fuel. Vapors from the rag are flammable and explosive.

Failure to follow these instructions can cause fire and result in injury or death.

⚠ CAUTION

Use only proper types and grades of diesel fuel (See “Fluids/Lubricants Types and Capacities” on page 49).

NOTICE: *The fuel tank is filled at the factory with United States off-road grade diesel fuel, which is dyed red for identification. It may take several fillings of the fuel tank before the red dye is purged from the fuel system.*

Adding Fuel

⚠ WARNING

Static electricity can produce dangerous sparks at the fuel-filling nozzle. Do not wear polyester, or polyester-blend clothing while fueling. Before fueling, touch the metal surface of the machine away from the fuel fill to dissipate any built-up static electricity. Do not re-enter the machine but stay near the fuel filling point during refueling to minimize the build-up of static electricity. Do not use cell phones while fueling. Make sure the static line is connected from the machine to the fuel truck before fueling begins.

Ultra-Low Sulfur Diesel (ULSD) poses a greater static ignition hazard than higher sulfur content diesel formulations. Avoid death or serious injury from fire or explosion; consult with your fuel supplier to ensure the entire fuel delivery system is in compliance with fueling standards for proper grounding and bonding practices.

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. Use the ignition switch key to unlock and remove fuel cap (F, Fig. 206) from the fuel filler neck.

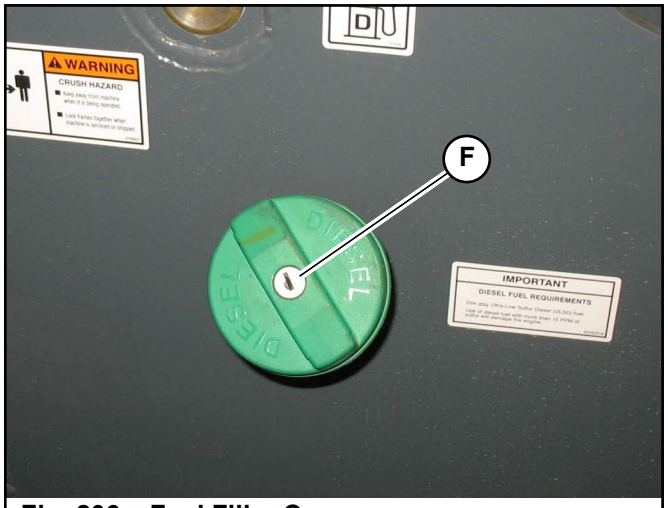


Fig. 206 – Fuel Filler Cap

3. If present, inspect the wire-mesh fuel strainer located in the filler neck opening and remove any accumulated residue. Replace the strainer if damaged.
4. Fill the fuel tank by adding fuel through the fuel filler neck opening.

IMPORTANT: *See "Fluids/Lubricants Types and Capacities" on page 49 and the engine operator's manual for proper fuels. Use of improper fuels can cause engine damage.*

5. When the fuel tank is full, replace, and lock fuel cap (F) in the fuel filler neck opening.

IMPORTANT: *To provide for proper fuel system venting, do not top off the fuel tank.*

Water Separator Inspection/Maintenance

⚠ WARNING

NEVER service the fuel system while smoking, while near an open flame, or if the engine is hot.

IMPORTANT: *Water in the fuel system can cause severe engine damage. Drain water from the fuel filter/water separator anytime water is present.*

Inspect the water separator daily or every time before the machine is used.

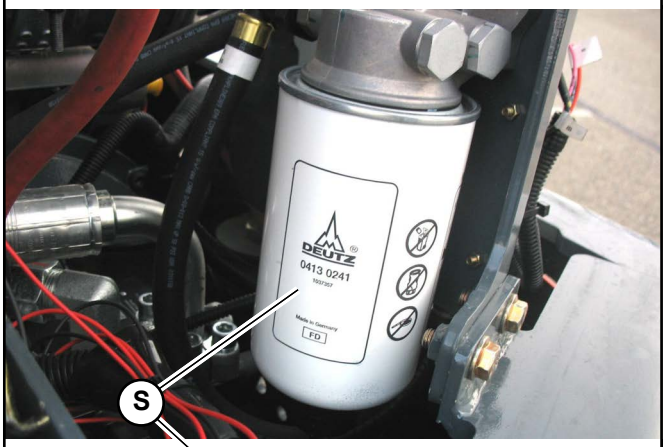
Deutz Engines: An error code is displayed on the multi-purpose display if water is present in the water separator. See "Error Codes" on page 224.

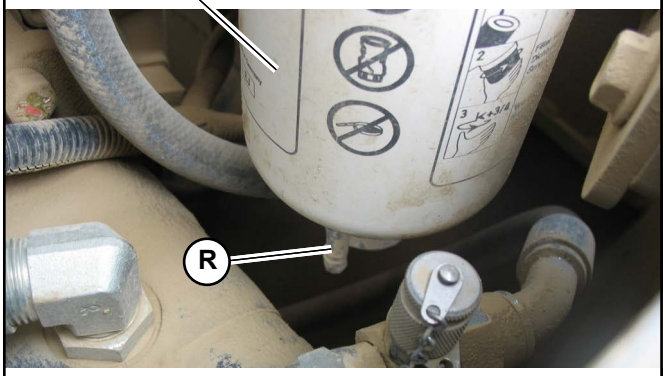
Yanmar Engines: The water separator contains an indicator ring (M, Fig. 207) that floats on top of accumulated water. Under normal conditions, the ring sits at the bottom of the separator cup. If the ring is somewhere between the top and bottom of the cup, water must be drained.

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.

3. Open the engine cover.

Deutz Engines





Yanmar Engines

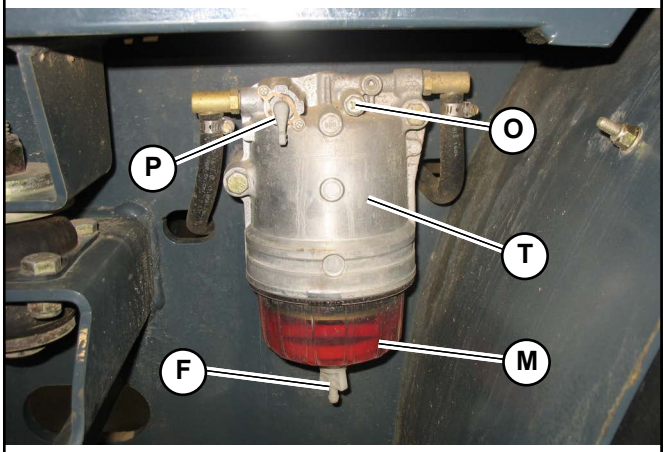


Fig. 207 – Water Separator

4. **Deutz Engines:** Water separator (S, Fig. 207), is located on the left side of the engine compartment:

   a. Position a suitable collection container underneath the water separator drain.

   b. Twist drain fitting (R) at the bottom of the water separator. Allow the water to drain until the flow stops. Twist drain fitting (R) back to it's original position to close.

5. **Yanmar Engines:** Inspect the water separator (T, Fig. 207), located under the left step, for the presence of water:

   - If the indicator ring (M) is at the bottom of the cup, no action is required.
   - If the indicator ring (M) is floating off the bottom of the cup, water is present and needs to be drained.

   a. If water needs to be drained, position a suitable collection container underneath the water separator drain.

   b. Turn the fuel shut-off valve lever (P) on the water separator to the OFF position.

   c. Loosen drain plug (F) at the bottom of the water separator. Allow the water to drain until the indicator ring falls to the bottom of the cup.

   NOTE: *If the water does not drain well, loosen vent plug (O).*

   d. Tighten drain plug (F) and discard the fuel/water according to environmental laws.

IMPORTANT: *Always dispose of fuel according to environmental laws or take it to a recycling center for proper disposal. DO NOT pour onto the ground or down a drain.*

   e. Turn the fuel shut-off valve lever (P) on the water separator to the ON position. Tighten vent plug (O), if it was loosened.

6. **Yanmar Engines:** Prime the fuel system by turning the ignition key switch to the first (ON) position for 30 seconds without starting the engine.

7. **Deutz Engines:** Prime the fuel system:
   a. Turn the ignition key switch to the first (ON) position without starting the engine.
   b. Wait for the fuel supply pump to stop running.
   c. Repeat steps 7-a through 7-b four times.

⚠ CAUTION

Do not use the starter motor to crank the engine to prime the fuel system. Damage to the engine starter motor, coils, pinion/ring gear could result.

IMPORTANT: *Dispose waste fuel according to environmental laws. DO NOT pour fuel onto the ground or down a drain.*

Changing Fuel Filter

⚠ WARNING

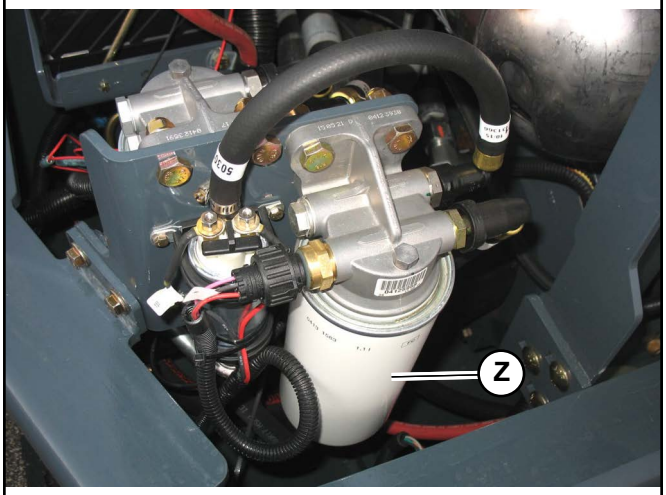
NEVER service the fuel system while smoking, while near an open flame, or if the engine is hot.

Replace the fuel filter annually, or after every 500 hours of use.

IMPORTANT: *The fuel filter change interval should be 250 hours when the available fuel has a sulfur content greater than 15 ppm.*

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.
3. Open the engine cover.
4. On machines equipped with Yanmar engines, turn fuel shut-off valve lever (P, Fig. 207) on the water separator to the OFF position.
5. Remove the fuel filter (Z, Fig. 208), using a filter wrench if necessary. Carefully clean the filter head mounting surface with a clean cloth.
6. Apply a coating of clean diesel fuel on the new fuel filter gasket. Install the filter and tighten 3/4 rotation past the point where the gasket first contacts the filter head.

Deutz Engines



Yanmar Engines

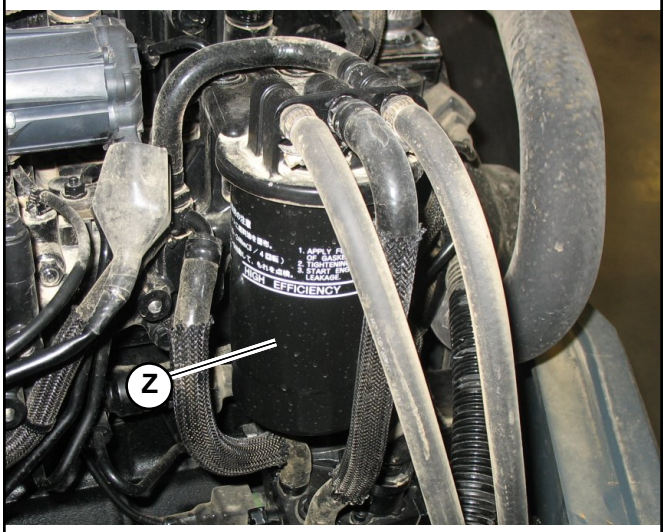


Fig. 208 – Engine Fuel Filter

7. On machines equipped with Yanmar engines, turn shut-off valve on water separator to ON.
8. **Yanmar Engines:** Prime the fuel system by turning the ignition key switch to the first (ON) position for 30 seconds without starting the engine.

9. **Deutz Engines:** Prime the fuel system:
    a. Turn the ignition key switch to the first (ON) position without starting the engine.
    b. Wait for the fuel supply pump to stop running.
    c. Repeat steps 7-a through 7-b four times.

⚠ CAUTION

Do not use the starter motor to crank the engine to prime the fuel system. Damage to the engine starter motor, coils, pinion/ring gear could result.

Hydraulic System Maintenance

⚠ WARNING

Never use your hands to search for hydraulic oil leaks; use a piece of paper or cardboard to find leaks. Escaping fluid under pressure can be invisible and can penetrate the skin, causing serious injury. If any fluid is injected into your skin, see a doctor at once. Injected fluid MUST be surgically removed, or gangrene may result.

Checking Hydraulic Oil Level

Check the hydraulic oil level daily before starting the machine or after every ten hours of use.

1. Park the machine on a level surface. Fully retract all hydraulic cylinders (lift structure down; bucket flat on ground).
2. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
3. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.
4. Open the engine cover. The sight gauge (Z, Fig. 209) for the hydraulic oil level is located near the front of the engine compartment, on the upper left corner of the hydraulic oil tank, just under the DOC/DPF (on Deutz engines) or DPF (on Yanmar engines).

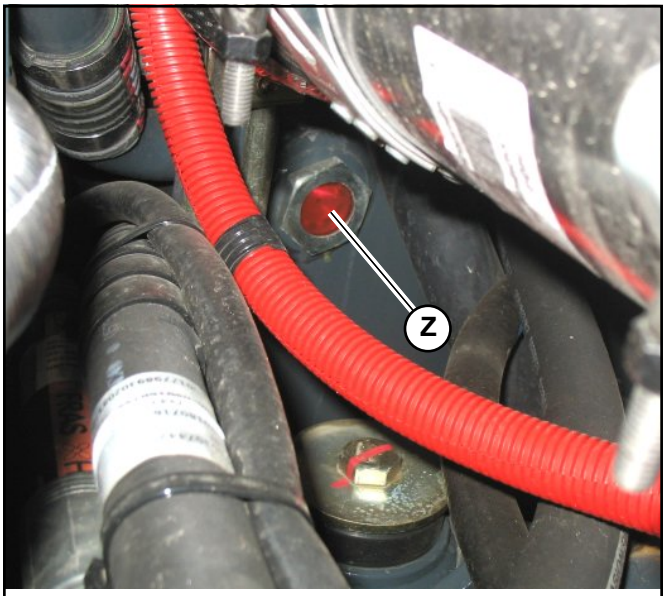


Fig. 209 – Hydraulic Oil Level Sight Gauge

5. Check the level of the hydraulic oil in sight gauge (Z). The oil level should be in the middle of the sight gauge.

6. If the hydraulic oil level is low, remove the hydraulic tank fill cap (P, Fig. 210).

Newer Machines Shown, Older Machines Similar

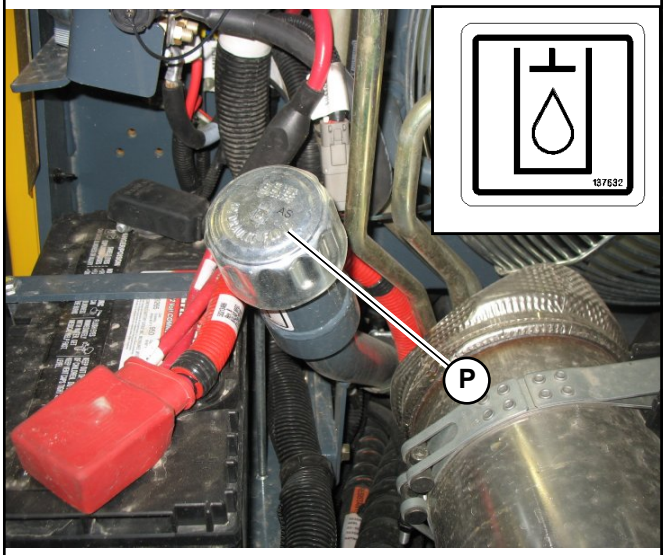


Fig. 210 – Hydraulic Oil Fill

7. Add hydraulic oil until the level is to the middle of sight gauge (Z, Fig. 209). Refer to "Fluids/ Lubricants Types and Capacities" on page 49 for proper hydraulic oil grade and type.

IMPORTANT: *Do not mix different types/grades of hydraulic oil.*

8. Reinstall and tighten oil fill cap (P).

Changing Hydraulic Oil

NOTE: *It is recommended that the hydraulic oil filter is changed whenever the hydraulic oil is changed. The hydraulic oil filter can be changed without changing the hydraulic oil or draining the hydraulic reservoir. See "Changing Hydraulic Filter" on page 191.*

Change the hydraulic oil every 1000 hours or 1 year of use. Change it every 500 hours under extreme conditions.

Also change the hydraulic oil if it becomes contaminated, and/or after major repairs,

Also, change the hydraulic oil and filter if the hydraulic oil filter restriction icon displays on the multi-function display.

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.
3. Position a waste oil collection container with a capacity of at least 75 L (20 gals.) underneath the hydraulic oil reservoir drain plug.

NOTE: *Hydraulic reservoir drain plug (E) is located under the machine directly behind the rear axle.*

4. Remove hydraulic reservoir drain plug (E, Fig. 211) and allow the oil to drain completely.

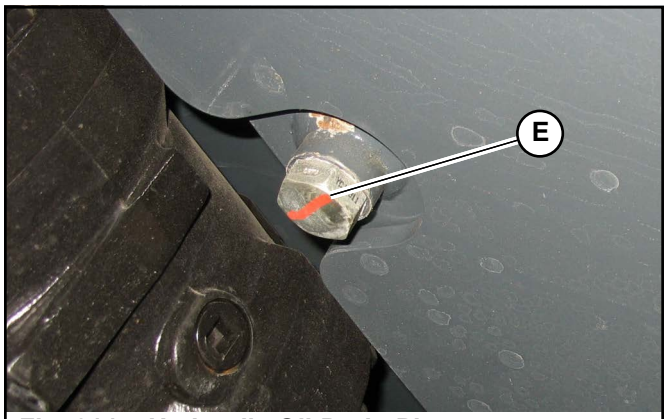


Fig. 211 – Hydraulic Oil Drain Plug

IMPORTANT: *Always dispose of hydraulic oil according to environmental laws or take to a recycling center for proper disposal. DO NOT pour onto the ground or down a drain.*

5. After the hydraulic reservoir has drained, reinstall drain plug (E, Fig. 211).

6. Remove the hydraulic tank fill cap (P, Fig. 212).

Newer Machines Shown, Older Machines Similar

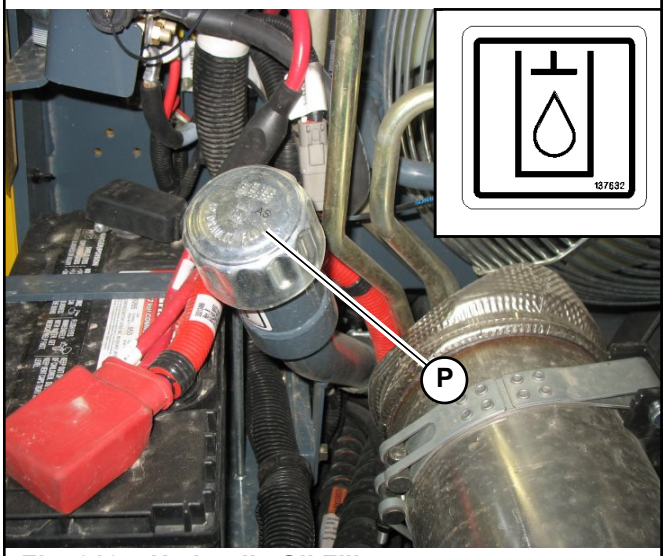


Fig. 212 – Hydraulic Oil Fill

7. Add hydraulic oil until the level is to the middle of sight gauge (Z, Fig. 213).

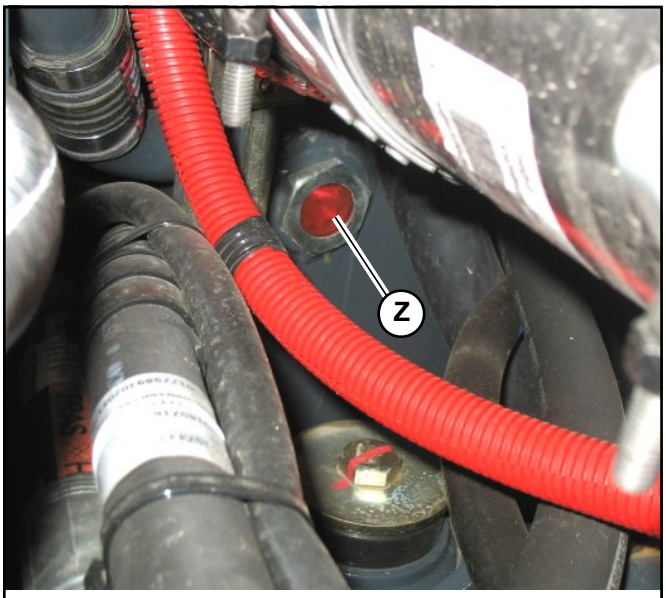


Fig. 213 – Hydraulic Oil Level Sight Gauge

NOTE: *See "Fluids/Lubricants Types and Capacities" on page 49 for proper hydraulic oil grade and type. Hydraulic oil capacity listed is approximate.*

8. Start the machine. Cycle through all hydraulic functions several times to purge air from the hydraulic system. Shut down the machine according to "Mandatory Safety Shutdown Procedure" on page 22.
9. Check the machine for hydraulic oil leaks. Correct any leaks as required.
10. Add oil to the hydraulic system if necessary until the level reaches the middle of sight gauge (Z, Fig. 209). Replace and tighten the hydraulic oil fill cap.

Changing Hydraulic Filter

IMPORTANT: *Hydraulic oil filter wrench [Manitou part # 50313906] is highly recommended for servicing the hydraulic filter.*

NOTE: *The hydraulic oil filter can be changed without changing the hydraulic oil or draining the hydraulic reservoir.*

Change the hydraulic oil filter after the first 50 hours, and after 500 hours or 1 year of use thereafter.

Also, change the hydraulic oil and filter if the hydraulic oil filter restriction icon displays on the multi-function display.

1. Park the machine on a level surface. Fully retract all hydraulic cylinders (lift structure down; bucket flat on ground.
2. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
3. Wait until the engine has cooled. See "Maintenance and Service Safety Practices" on page 32.

4. Remove the right side panel to access the hydraulic oil filter:
   a. Remove wing nuts (A, Fig. 214) securing side panel.
   b. Remove side panel (B).

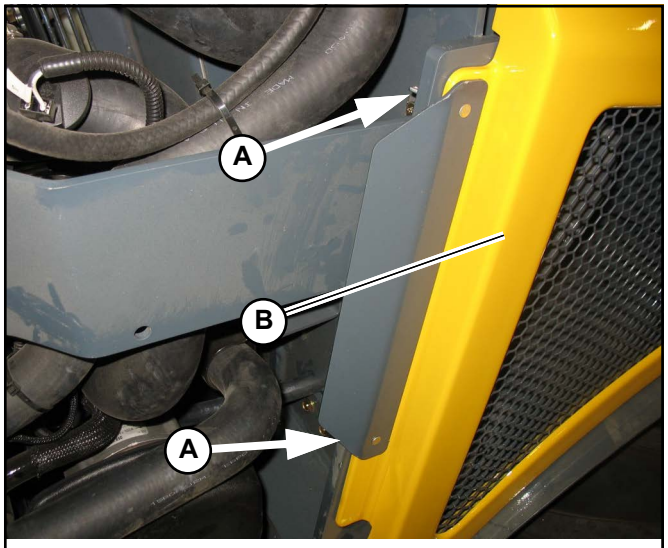


Fig. 214 – Side Panel Removal

5. Remove the old filter element.
6. Put clean oil on the rubber gasket of the new filter element and install the new filter element into the filter housing.
7. Using filter wrench [Manitou part # 50313906], unscrew and remove filter cover (C, Fig. 215).

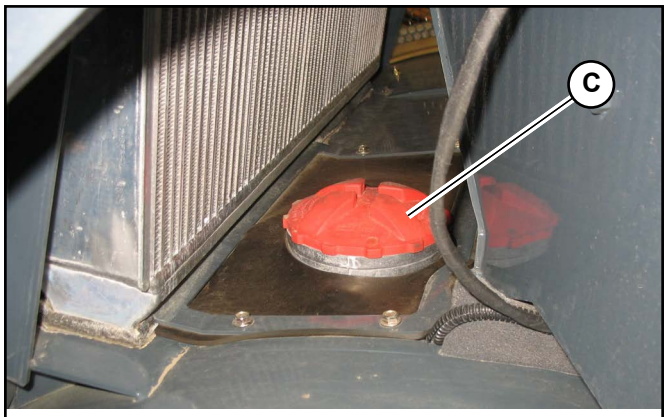


Fig. 215 – Hydraulic System Filter

8. Reinstall filter cover (C).
9. Replace the right side panel (B, Fig. 214) and secure it with wing nuts (A).
10. Start the machine. Cycle through all hydraulic functions several times to purge air from the hydraulic system. Shut down the machine according to “Mandatory Safety Shutdown Procedure” on page 22.
11. Check the machine for hydraulic oil leaks. Correct any leaks as required.
12. Add oil to the hydraulic system if necessary until the level reaches the middle of sight gauge (Z, Fig. 209). Replace and tighten the hydraulic oil fill cap.

Hydraulic Hose Maintenance

⚠ WARNING

Hydraulic hoses and connections must be inspected by a trained technician before the first use of the machine, and at least annually thereafter, for leaks and/or damage.

Leakages and damaged pressure hose/lines must be immediately repaired or replaced by an authorized service center.

Never use your hands to check for suspected hydraulic leaks. Always use a piece of wood or cardboard.

Leaks from hydraulic hoses or pressurized components can be difficult to see, but pressurized oil can have enough force to pierce the skin and cause serious injury.

Obtain immediate medical attention if pressurized oil pierces the skin. Failure to obtain prompt medical assistance could result in gangrene or other serious damage to tissue.

Always relieve hydraulic system pressure before performing any maintenance on the machine. Do not tighten leaking connections when the hydraulic system is under pressure.

⚠ WARNING

Never weld or solder damaged or leaking pressure lines and/or screw connections. Always replace damaged hydraulic components.

Hydraulic hoses must be replaced every six years from the date of manufacture, even if they do not appear damaged. The date of manufacture (month or quarter and year) is indicated on hydraulic hoses. See Fig. 216.

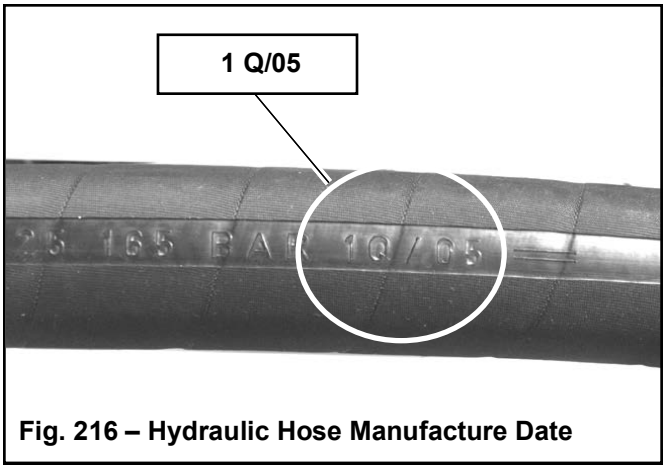


Fig. 216 – Hydraulic Hose Manufacture Date

Planetary Axles

Replace the oil in the axles if it becomes contaminated, after every 1500 hours.

1. Operate the machine until the axles have warmed to operating temperature.
2. Park the machine on a level surface and perform the "Mandatory Safety Shutdown Procedure" on page 22.

Changing Axle Wheel Hub Oil

NOTE: *Removing the wheels and raising the machine on jackstands can make hub oil changing easier.*

3. Rotate the oil drain/fill plug (A, Fig. 217) on the wheel hub so it is positioned at the bottom as shown in the figure.

700 Series Shown—others similar

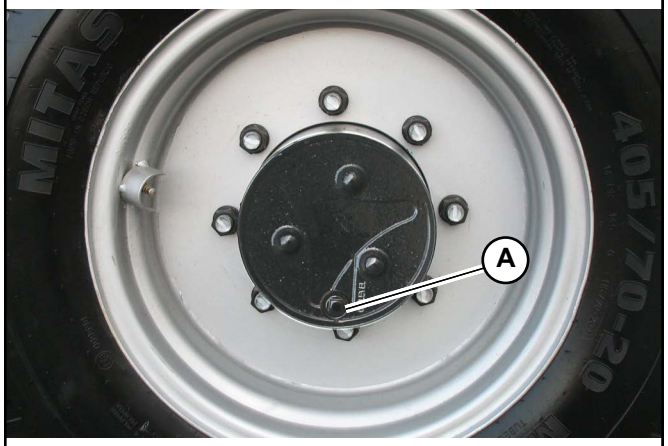


Fig. 217 – Wheel Hub Oil Drain Position

4. Position a waste oil collection container with a capacity of at least 1 liter (1 quart) underneath the wheel hub to catch oil as it drains.

IMPORTANT: *Always dispose of waste oil according to environmental laws or take to a recycling center for proper disposal. DO NOT pour onto the ground or down a drain.*

5. Thoroughly clean the area around the plug (A) to prevent contamination.
6. Slowly loosen and remove the plug and allow the oil to completely drain from the hub.
7. After the oil has drained, rotate the wheel hub so drain hole (A, Fig. 218) is positioned to the side and level line (D) is parallel with the ground as shown in the figure.

700 Series Shown—others similar

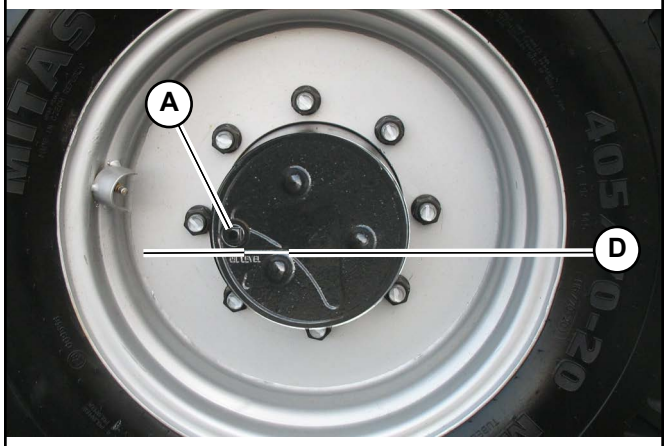


Fig. 218 – Wheel Hub Oil Fill Position

8. Add oil through hole (A) to the level line (D) stamped on the hub.

   NOTE: *See "Fluids/Lubricants Types and Capacities" on page 49 for proper oil grade and type. Oil capacity listed is approximate.*

9. Thoroughly clean the oil drain/fill plug. Replace the plug with a new O-ring and tighten to:
   - 600 Series: 70 Nm (51.6 lbf.-ft.).
   - 700 Series: 100 Nm (73.8 lbf.-ft.).

Changing Axle Center Oil

1. Position waste oil collection containers, with a capacity of at least 4 liters (4 quarts) front and 5 liters (5 quarts) rear, underneath the axle centers to catch oil as it drains.
2. Thoroughly clean the area around the axle center fill plugs (E, Fig. 219). Slowly loosen and remove the plugs.

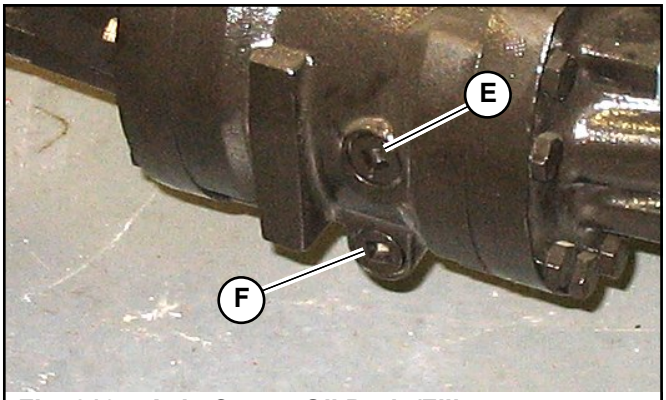


Fig. 219 – Axle Center Oil Drain/Fill

IMPORTANT: *Always dispose of waste oil according to environmental laws or take to a recycling center for proper disposal. DO NOT pour onto the ground or down a drain.*

3. Thoroughly clean the area around the axle center drain plugs (F) and slowly loosen and remove the plugs. Allow the oil to completely drain from the axle centers.
4. Thoroughly clean the axle center oil drain plugs. Replace the plugs with new O-rings and tighten the plugs to 70 Nm (51.6 lbf.-ft.).
5. Add oil through the oil fill holes (E) until it reaches the bottom of the holes.

   NOTE: *See "Fluids/Lubricants Types and Capacities" on page 49 for proper oil grade and type. Oil capacity listed is approximate.*
6. Thoroughly clean the axle center oil fill plugs (E). Replace the plugs with new O-rings and tighten to 70 Nm (51.6 lbf.-ft.).

Brake Fluid Reservoir

Checking/Replenishing Brake Fluid Reservoir Level

1. Park the machine on a level surface and perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. The brake fluid reservoir can be viewed through cutout (Q, Fig. 220) at the front of the cab above the articulation joint.

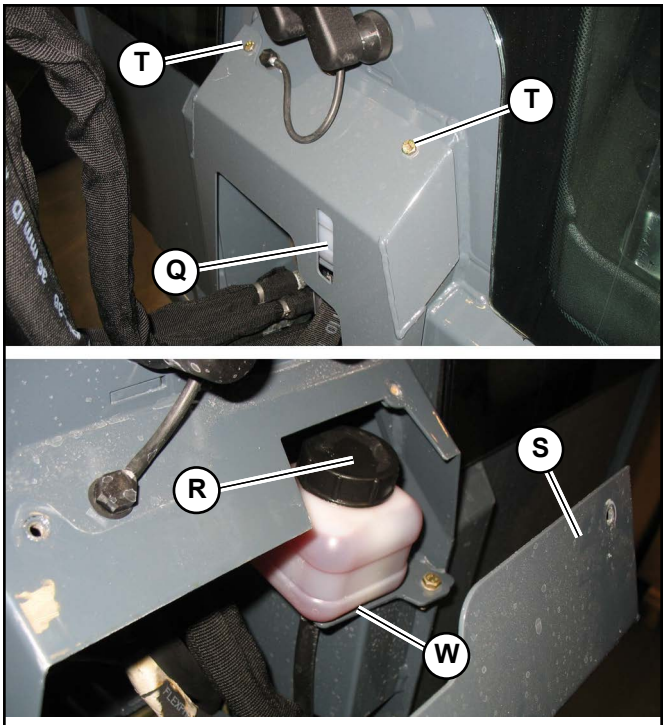


Fig. 220 – Brake Fluid Reservoir

IMPORTANT: *The brake fluid reservoir fluid level should not fall below 1/2 full.*

3. To access the brake fluid fill cap (R), remove fasteners (T) and rotate panel (S) forward.
4. Pivot bracket (W) out to access the reservoir. Carefully remove brake fluid reservoir fill cap (S).
5. Add automatic transmission fluid as required. Be careful not to allow dirt to fall into the reservoir.

Parking Brake Adjustment/Service

Test the parking brake each time before using the machine. Due to cable stretch and brake lining wear, periodic adjustment is required. Adjustment is required if the parking brake doesn't keep the machine from moving when parking brake lever (H, Fig. 221) is pulled up as far as possible.

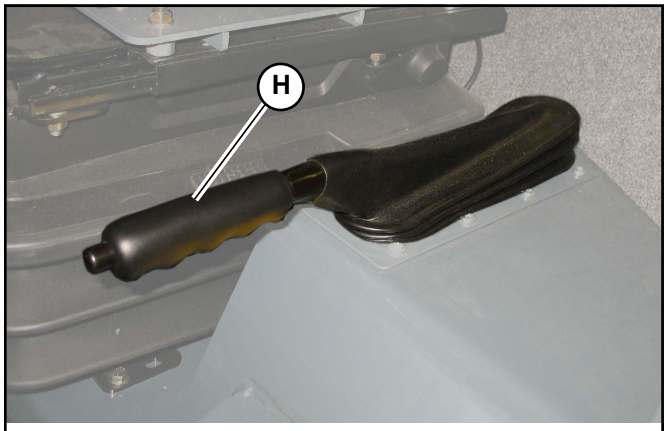


Fig. 221 – Parking Brake Lever

Parking Brake Cable Adjustment

1. Open the engine cover and remove the left side panel to access the underside of parking brake lever (H).
   a. Remove wing nuts (A, Fig. 222) securing left side panel (B).
   b. Remove left side panel (B).

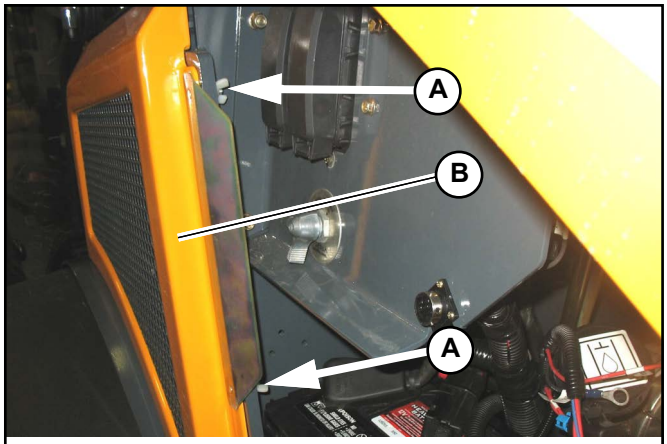


Fig. 222 – Left Side Panel Removal

2. With the parking brake lever in the down position, remove clevis (Q, Fig. 223) from the parking brake lever.
3. Rotate (tighten) clevis (Q) so it moves down the parking brake cable (R).

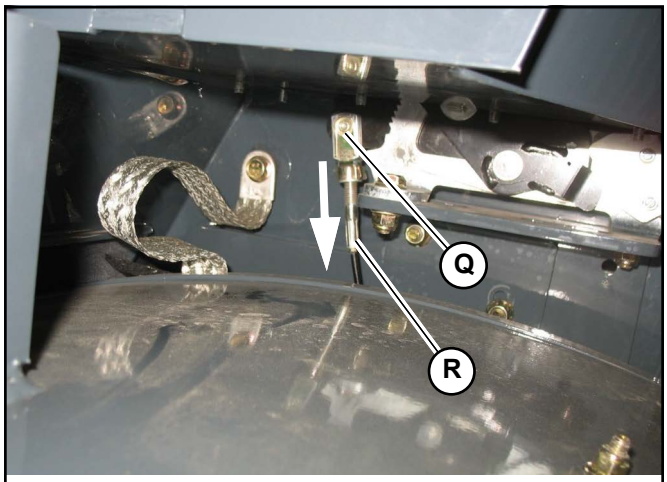


Fig. 223 – Parking Brake Hand Lever Cable Adjustment

4. Test parking brake function. Readjust clevis (Q) as required.

IMPORTANT: *If adjustment does not restore parking brake function, additional service is required. Contact your dealer.*

5. Replace left side panel (B, Fig. 222) and secure with wing nuts (A).

Parking Brake Actuator Bracket Adjustment

As the brake linings wear, the parking brake actuator bracket needs to be relocated to compensate.

1. Perform the "Mandatory Safety Shutdown Procedure" on page 22.
2. Chock the wheels to prevent the machine from rolling when the parking brake is disengaged.
3. Disengage the parking brake.
4. Remove the spring pin (U, Fig. 224) and clevis fastening the parking brake cable to the parking brake lever (Z).

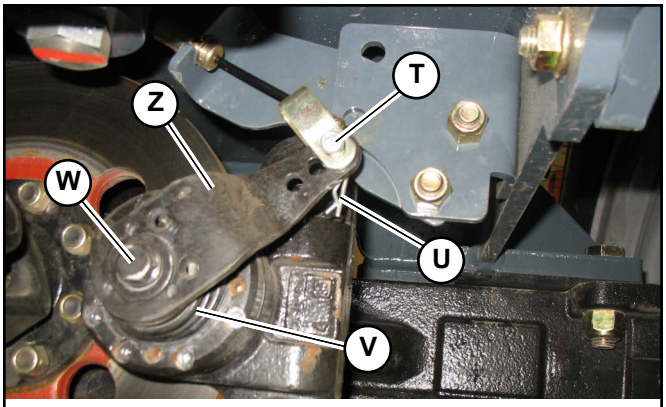


Fig. 224 – Parking Brake Hand Lever Cable Adjustment

5. Remove the fastener (W) securing the parking brake lever (Z) to the splined brake shaft.
6. Rotate the parking brake lever (Z) as required for correct brake lining compensation.

NOTE: *Rotating the parking brake lever (Z) clockwise compensates for brake lining wear.*

7. Replace the re-positioned parking brake lever (Z) onto the splined brake shaft.

NOTE: *Adjust the parking brake lever return spring tension by moving the spring anchor into a different hole.*

8. Fasten the parking brake lever (Z) using the fastener (W). Tighten securely.
9. Replace the parking brake cable back onto the parking brake lever.
10. Anchor the parking brake cable back onto the parking brake cable using the clevis (T) and spring pin (U).
11. Test the parking brake function. Adjust as required.

IMPORTANT: *If adjustment does not restore parking brake function, additional service is required. Contact your dealer.*

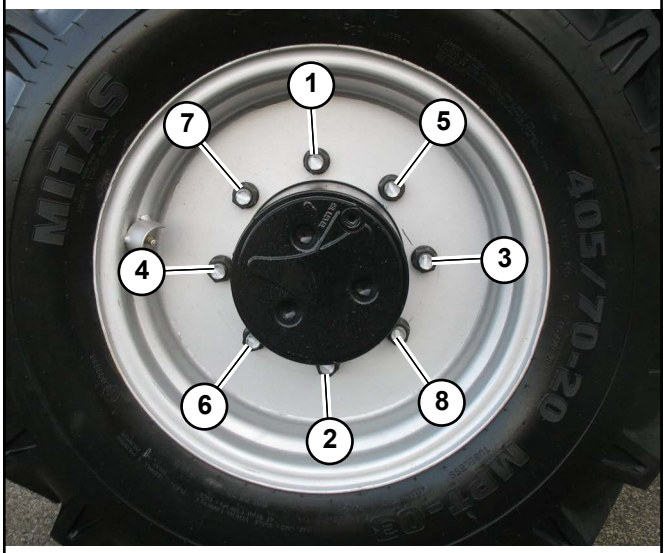
IMPORTANT: *The parking brake actuator bracket must be returned to factory configuration when replacing the parking brake linings.*

Wheels and Tires

Wheel Fasteners

Wheel fastener torque must be checked before initial operation and every two hours or 30 miles (50 km) thereafter until the wheel mounting hardware torque stabilizes. Torque the wheel fasteners in a criss-cross pattern (Fig. 225) to the correct torque. When tires are removed and replaced, this procedure must be repeated. See “Wheels/Tires” on page 60 for wheel fastener torque specifications.

AL 700 Series



AL 600 Series

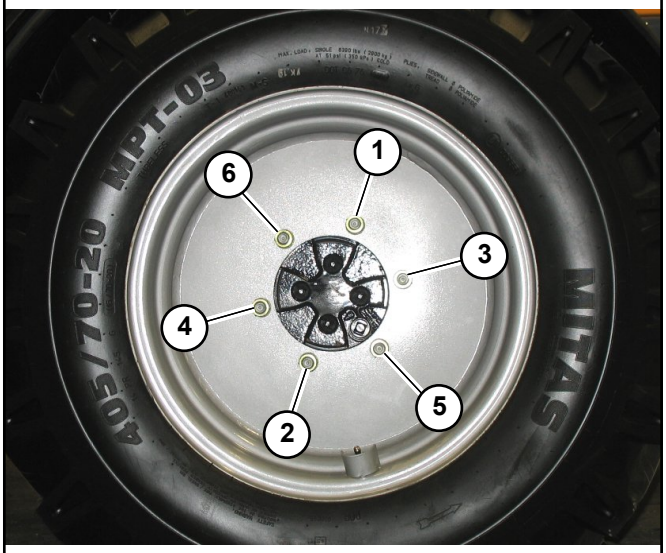


Fig. 225 – Wheel Fasteners

Tires

⚠ WARNING

Inflating or servicing tires can be dangerous. Only trained personnel should service and mount tires.

IMPORTANT: *Keep the same size tire on each side of the loader to prevent excessive wear on tires.*

Tire Rotation

To keep tire wear even, rotate the tires from front to rear and rear to front.

IMPORTANT: *The tread bar of all tires should face the same direction.*

Checking Tire Pressure

Correct tire pressure should be maintained for all tires to enhance operating stability and extend tire life. Use a clip-on tire chuck with remote hose and gauge and stand clear of the tire during inflation.

NOTE: *Refer to the tire manufacturer recommendations for proper tire inflation pressures.*

Travel Motor Lubrication

The hydraulic drive motor is lubricated by hydraulic system oil and does not require separate lubrication maintenance.

Road Lights Adjustment

Adjust headlight aim as follows:

1. Check for proper tire pressure and adjust if necessary. All tires must be inflated to the same pressure.
2. Park the machine on a flat and level surface, free from any source of peripheral light, squarely facing and 25 ft (7.6 m) away from a gray or dull white wall.
3. Turn the starter switch ON to the first position.
4. Twist the end of control lever (S, Fig. 226), and push the control lever downward to activate the road light “high” beams.

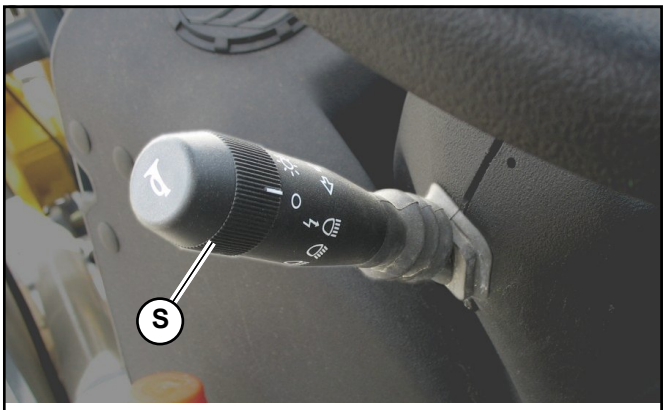


Fig. 226 – Control Lever

5. Loosen nuts (J, Fig. 227), if necessary, to allow for positioning headlights (K).

Fig. 227 – Headlight Adjustment

6. Position the headlights (K) so the high beams shine on the wall exactly straight and level from where the headlights are installed on the machine.
7. Tighten the nuts (J) to secure the headlights (K) in the correct position.

Electrical System

⚠ WARNING

Inspect and check the machine’s electrical equipment at regular intervals. Defects, such as loose connections or scorched cables must be repaired before using the machine.

Only use proper, original equipment fuses with the specified current rating. Turn off the machine immediately if there are any problems with the electrical system.

Work on the machine’s electrical system must be done only by a trained technician.

Battery

⚠ WARNING

Before servicing the battery or electrical system, disconnect the negative cable from the negative battery terminal or turn the battery disconnect switch to the “OFF” position.

Explosive gas is produced while a battery is in use or being charged. Keep flames or sparks away from the battery area. ALWAYS charge the battery in a well-ventilated area.

Do not jump-start a frozen battery, or it may explode. A discharged battery can freeze at 0°C (32°F).

To prevent a short circuit, keep metal parts on your clothing and metal watchbands away from the positive (+) terminal of the battery.

⚠ WARNING

Never lay a metal object on top of a battery because a short circuit can result. Battery acid is harmful to skin and fabrics. If acid spills:

- **If battery acid spills on any clothing, remove it immediately.**
- **If acid contacts skin, rinse the affected area with running water for 10 to 15 minutes.**
- **If acid contacts eyes, flood eyes with running water for 10 to 15 minutes. See a doctor at once. Never use any medication or eye drops unless prescribed by the doctor.**
- **To neutralize acid spilled on the floor, use one of the following mixtures:**
  - **0.5 kg (1 lbs.) of baking soda in 4 L (4.25 qts.) of water.**
  - **0.5 L (0.5 qts.) of household ammonia in 4 L (4.25 qts.) of water.**

Battery (H, Fig. 228) is located on the left, inside the engine compartment.

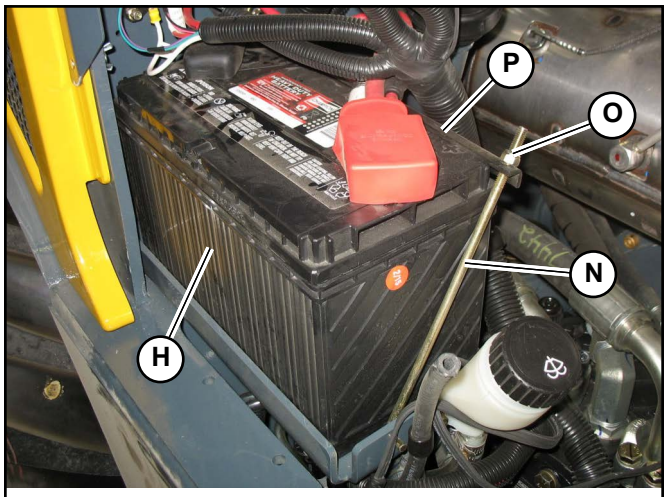


Fig. 228 – Battery (NOTE: Installations may vary)

⚠ WARNING

Check the condition of battery hold-down J-hooks (N), fasteners (O) and clamp (P). Replace parts as necessary. Ensure battery (H) is tightly secured in place.

Using a Booster Battery (Jump-Starting)

Jump-start the machine according to “Jump-Starting” on page 152.

Fuses and Relays

IMPORTANT: *Blown fuses indicate electrical system malfunctions. Determine what caused the fuse to blow and repair the problem before replacing the fuse.*

Fuse Box Fuses

Fig. 229 – Fuse Box Fuses

Table 36: Fuse Box Fuses (Fig. 229)

Fuse	Rated Current (Amps)	Protected Circuit
A	30A	HVAC
B	100A	Glow Plugs
C	60A	Starter (600 Series) (spare on 700 Series)
D	20A	Ignition
E	60A	MCU (Main Control Unit)
F	30A	Wiper Motors/Rear Window Washer
G	15A	Lift Structure Lights (Telescopic Machines Only)
H	5A	LLMI Sensor/Strain Gauge/Extension Indicator (Telescopic Machines Only)
I	30A	Keypad
J	30A	ECU (Engine Control Unit)
K	5A	Intake Breather Heater (600 Series) (spare on 700 Series)
L	10A	Beacon
M	15A	Drive System Controller
N	20A	EGR (Exhaust Gas Recirculation) (600 Series); Fuel Pump (700 Series)
O	20A	Operator's Seat
P	5A	Dome Light/Radio
Q	7.5A	Signal Switches
R	5A	2nd Auxiliary Hydraulics Circuit
S	10A	Hydraglide
T	3A	LCD (Multi-Function Display)
U	5A	Joystick

Fuse Box Relays/Diodes

Fig. 230 – Fuse Box Relays/Diodes

Table 37: Fuse Box Relays/Diodes (Fig. 230)

Relay/ Diode	Rated Current (Amps)	Circuit
V	N/A	EGR (600 Series); Fuel Pump (700 Series) Relay
W	N/A	Front Windshield Washer Relay
X	1.5A	All-Tach Lock Diode
Y	1.5A	All-Tach Unlock Diode
Z	1.5A	Ignition Key Switch Polarity Diode
AA	1.5A	EGR Polarity Diode

Cooling Fan Control Diode

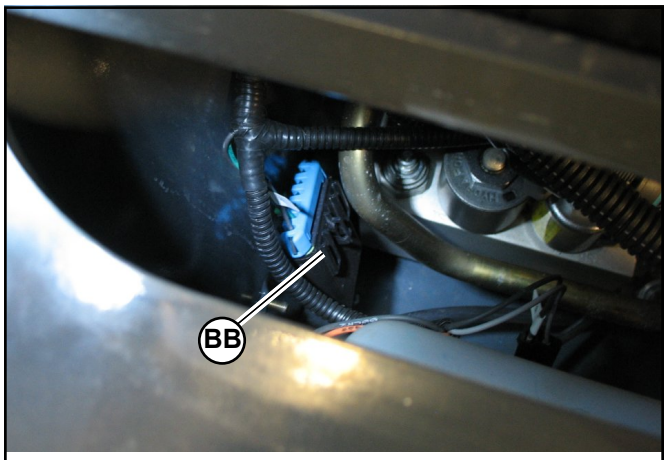


Fig. 231 – Cooling Fan Control Valve Diode (Under Battery Inside Engine Compartment)

Table 38: Cooling Fan Control Diode (Fig. 231)

Diode	Rated Current (Amps)	Circuit
BB	N/A	Fan Control Diode

Front Wiper Relay

Fig. 232 – Front Wiper Relay (Inside HVAC Control Panel)

Table 39: Front Wiper Relay (Fig. 232)

Relay	Circuit
CC	Front Windshield Wiper

Engine Compartment Relays

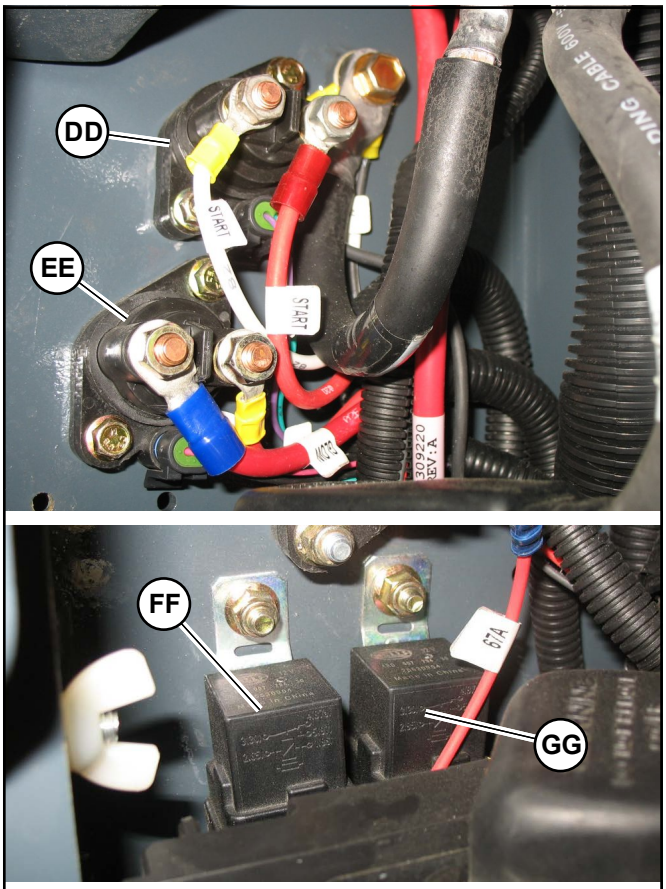


Fig. 233 – Engine Compartment Relays

NOTE: *Caps on relays shown removed in Fig. 233.*

Table 40: Engine Compartment Relays (Fig. 233)

Relay	Circuit
DD	Glow Plugs (600 Series)
EE	Glow Plugs (700 Series); Start (600 Series)
FF	Auxiliary Electrical
GG	Auxiliary Electrical

CAN Resistor

The CAN resistor (A, Fig. 234) is located above the articulation joint in front of the cab.

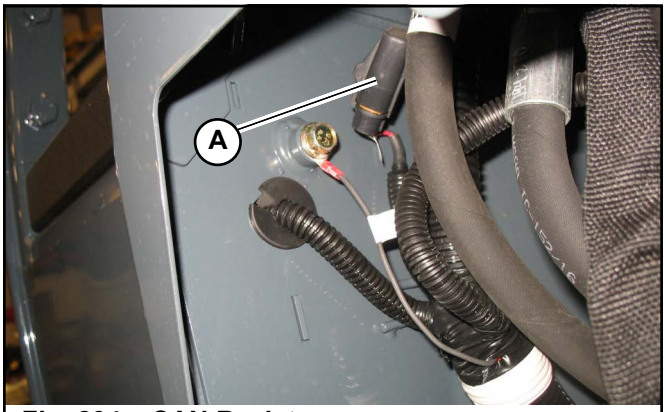


Fig. 234 – CAN Resistor

Chassis Grounds

Front chassis ground (X, Fig. 235) is located under the machine near the front of rear chassis. Rear chassis ground (Z) is located inside the engine compartment, on the left side in the firewall near behind the battery disconnect switch.

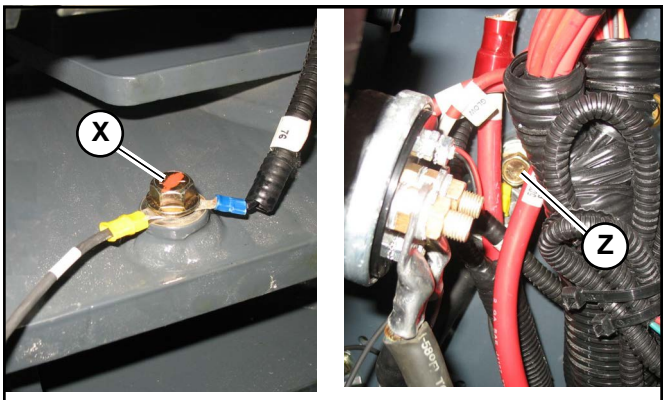


Fig. 235 – Front/Rear Chassis Grounds

Light Bulb Replacement

Work/Telescopic Lift Structure Light Bulb Replacement

⚠ WARNING

BEFORE beginning this service procedure, shut down the machine according to "Mandatory Safety Shutdown Procedure" on page 24.

1. Twist work light bulb (S, Fig. 236) counter-clockwise and pull it out of the work light.

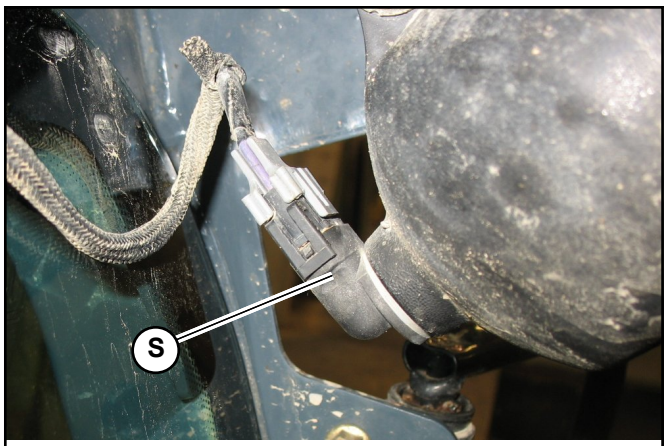


Fig. 236 – Work Light Bulb

2. Remove connector (T, Fig. 236) from bulb (S). Discard the spent bulb.

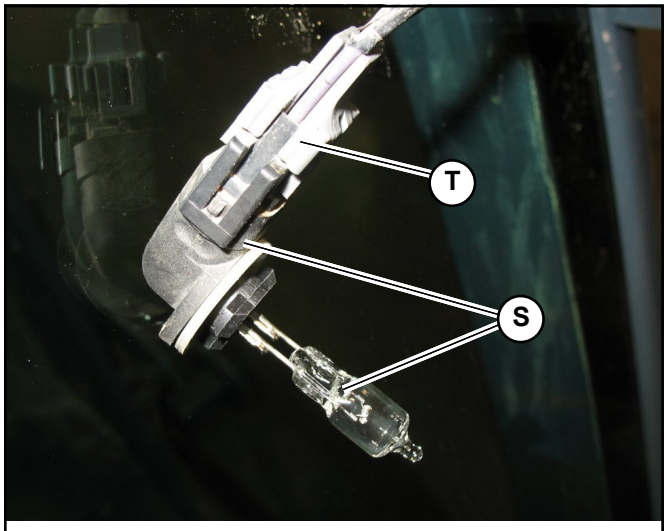


Fig. 237 – Work Light Bulb

IMPORTANT: *Do not touch the new halogen bulb with bare fingers; oils from skin can etch the bulb glass and cause the bulb to fail prematurely. Wear clean gloves or use a clean rag to handle new bulbs.*

3. Plug connector (T) onto new bulb (S). Replacement bulb is GE 862 or equivalent.
4. Install the new bulb into the work light and twist clockwise to lock it in place.

Tail Light Bulb Replacements

⚠ WARNING

BEFORE beginning this service procedure, shut down the machine according to "Mandatory Safety Shutdown Procedure" on page 24.

1. Remove screws (U, Fig. 238) securing tail light lens (W) and remove the lens.

NOTE: *Retain the tail light lens seal (not shown) for re-installation.*

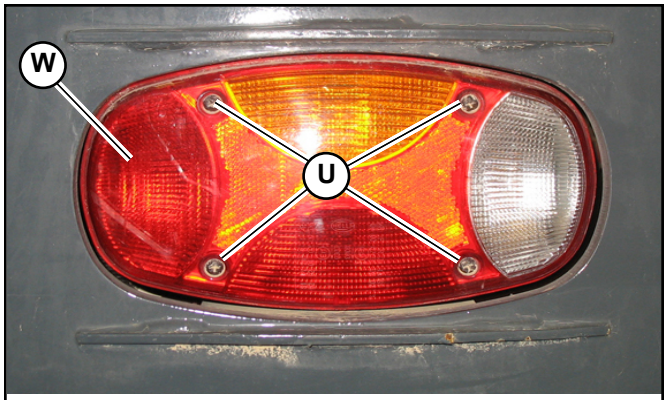


Fig. 238 – Left Tail Light Lens

2. Push in and twist the bulbs to remove. Discard the spent bulbs and replace them with:
   - Brake/backup/marker light replacement bulb: type P21W.
   - Indicator/hazard light replacement bulb: type R10W.

Fig. 239 – Left Tail Light Bulbs

3. Push the replacement bulbs into the sockets and twist to secure in place.
4. Position the tail light lens seal (not shown) onto lens (W). Position and secure tail light lens (W) onto the tail light housing and secure with screws (U).

NOTE: *For proper weatherproofing, make sure the tail light lens seal is properly positioned to seal the edges of lens (W) against the tail light housing.*

Headlight Bulb Replacements

⚠ WARNING

BEFORE beginning this service procedure, shut down the machine according to "Mandatory Safety Shutdown Procedure" on page 24.

1. Remove screws (E, Fig. 240) securing headlight lens bezel (F) and remove lens (D).

NOTE: *Retain the headlight lens seal (not shown) for re-installation.*

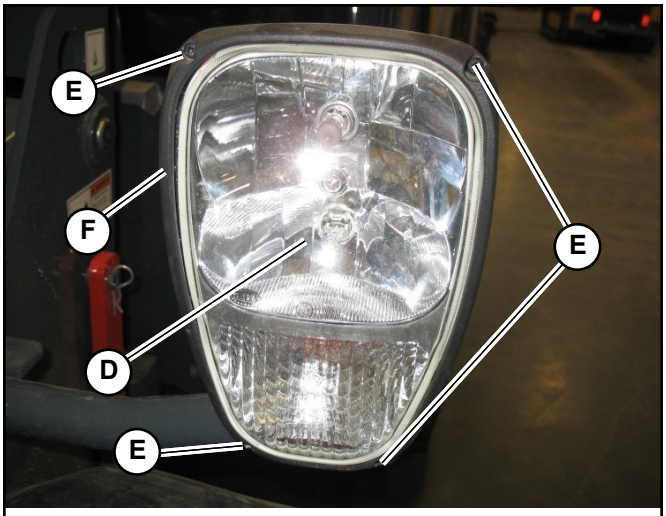


Fig. 240 – Headlight Lens

Refer to the following sections for specific bulb replacements:

- High Beams (A, Fig. 241). See "High Beam Bulb Replacement" on page 206.
- Low Beams (M). See "Low Beam Bulb Replacement" on page 206.
- Marker (C). See "Marker Light Bulb Replacement" on page 207.
- Indicator/Hazard (N). See "Indicator/Hazard Bulb Replacement" on page 207.

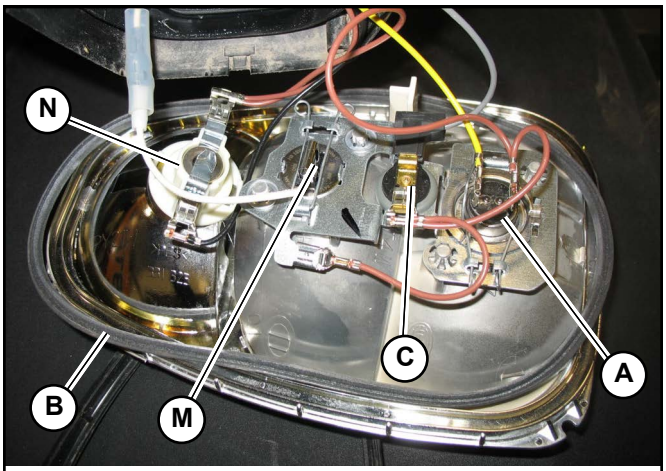


Fig. 241 – Headlight Bulb Locations

2. After completing the bulb replacement(s), position the headlight lens seal (B) onto the headlight lens bezel (F, Fig. 240). Secure headlight lens (D, Fig. 240) onto the headlight housing and secure with bezel (F, Fig. 240) and screws (E, Fig. 240).

NOTE: *For proper weatherproofing, make sure the headlight seal is properly positioned to seal the edges of bezel (F, Fig. 240) against the headlight housing.*

High Beam Bulb Replacement

1. Release bulb retaining clips (J, Fig. 242) and remove the high beam bulb.

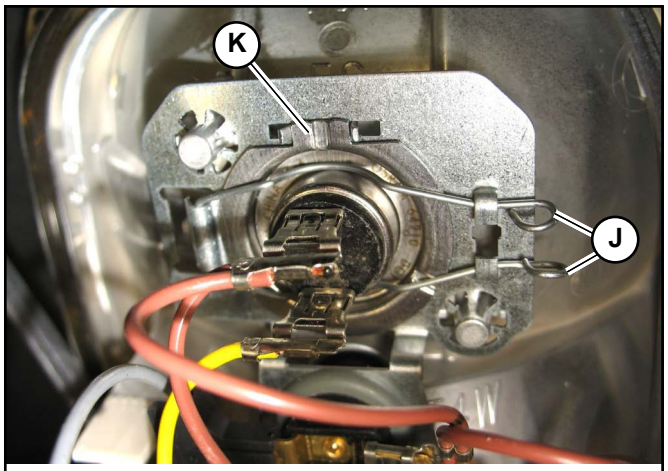


Fig. 242 – High Beam Bulb Mounting

2. Unplug wires (O, Fig. 243) from bulb (L). Discard the spent bulb.

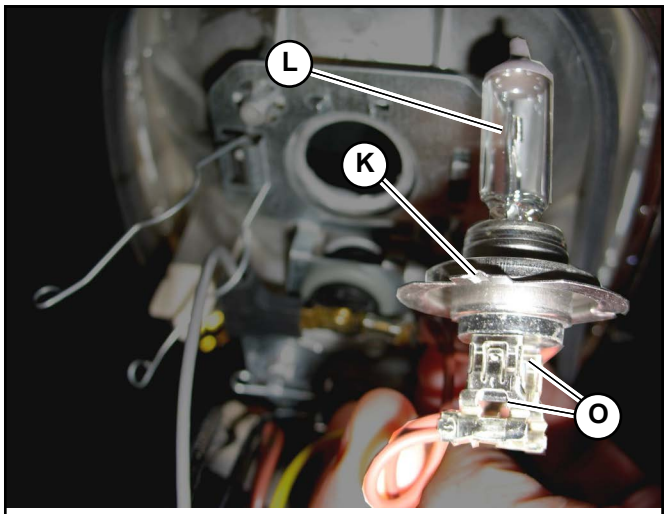


Fig. 243 – High Beam Bulb

IMPORTANT: *Do not touch the new halogen bulb with bare fingers; oils from skin can etch the bulb glass and cause the bulb to fail prematurely. Wear clean gloves or use a clean rag to handle new bulbs.*

3. Plug wires (O) into new bulb (L). Replacement bulb is H7 55W 12V halogen.

   NOTE: *Plug the two-wire connection onto the terminal closest to tab (K).*

4. Secure the new bulb (L) into the headlight housing with retaining clips (J, Fig. 242).

   NOTE: *Orient bulb (L) with tab (K, Fig. 242) at the top.*

Low Beam Bulb Replacement

1. Disconnect low beam bulb wire (O, Fig. 244).

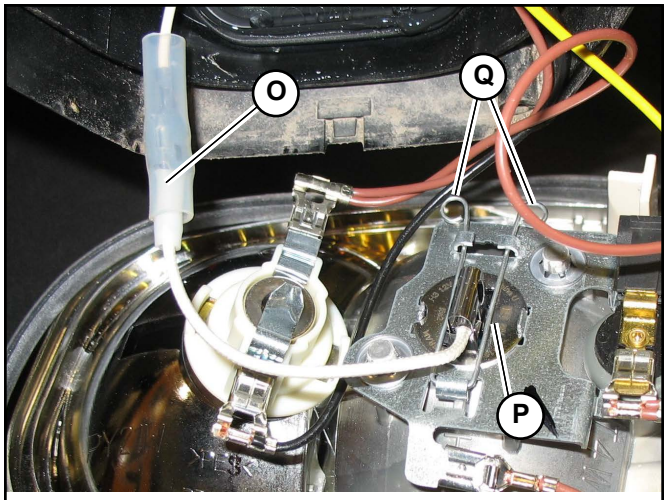


Fig. 244 – Low Beam Bulb

2. Release the bulb retaining clips (Q) and remove bulb (P). Discard the spent bulb.

IMPORTANT: *Do not touch the new halogen bulb with bare fingers; oils from skin can etch the bulb glass and cause the bulb to fail prematurely. Wear clean gloves or use a clean rag to handle new bulbs.*

3. Replacement bulb is H3 55W 12V halogen.
4. Secure the new bulb (P) in the headlight housing with retaining clips (Q).
5. Connect low beam bulb wire (O).

Marker Light Bulb Replacement

1. Pull marker bulb socket (R, Fig. 245) out of the headlight housing.

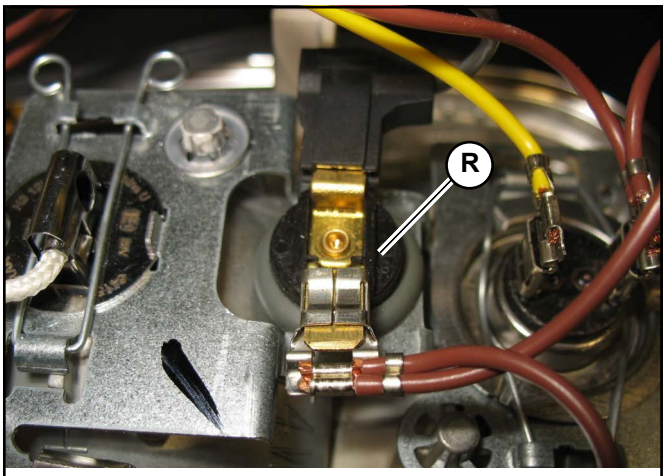


Fig. 245 – Marker Bulb Mounting

2. Push and twist bulb (U, Fig. 246) to remove the bulb from socket (R). Discard the spent bulb.

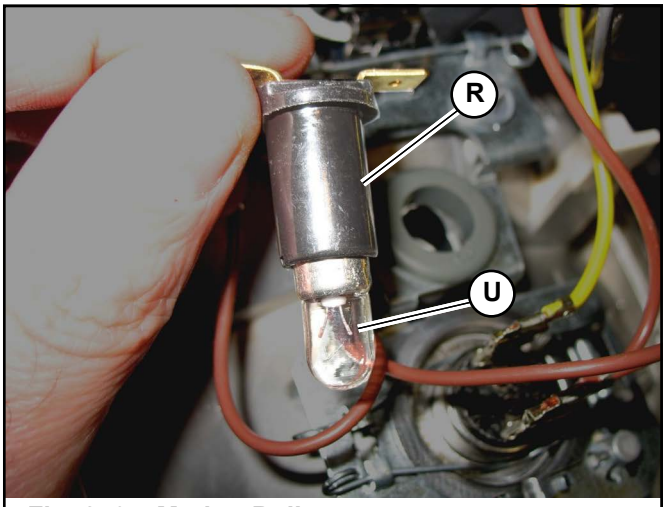


Fig. 246 – Marker Bulb

3. Push replacement bulb (U) into socket (R) and twist to secure it. Replacement bulb is T4W 12V.

4. Push marker bulb socket (R) back into the headlight housing.

Indicator/Hazard Bulb Replacement

1. Twist indicator/hazard bulb socket (L, Fig. 247) counter-clockwise and remove it from the headlight housing.

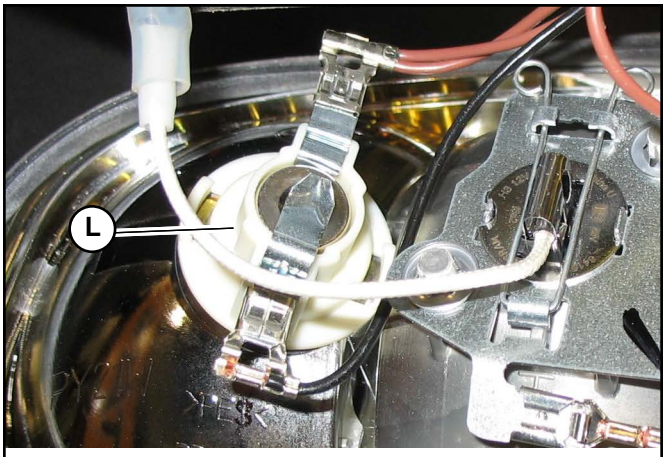


Fig. 247 – Indicator Light Bulb Socket

2. Push and twist bulb (F, Fig. 248) to remove the bulb from socket (L). Discard the spent bulb.

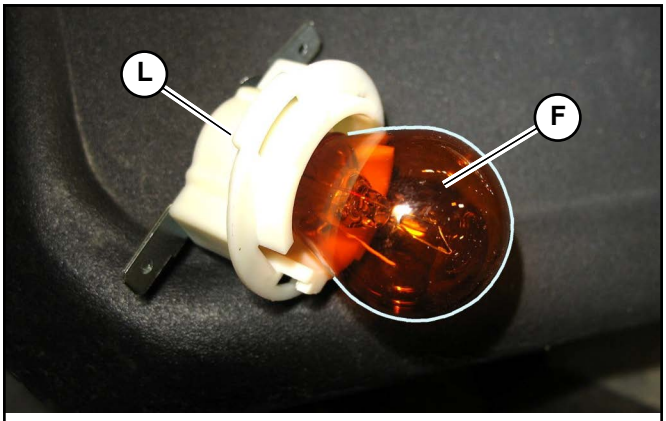


Fig. 248 – Indicator/Hazard Bulb

3. Push replacement bulb (F) into socket (L) and twist to secure it. Replacement bulb is PY 21W 12V.

4. Push indicator/hazard bulb socket (L, Fig. 247) back into the headlight housing and twist clockwise until it snaps into place.

Dome Light Bulb Replacement

⚠ WARNING

BEFORE beginning this service procedure, shut down the machine according to "Mandatory Safety Shutdown Procedure" on page 24.

1. Using a flat-tipped screwdriver, carefully pry the dome light down out of the cab/canopy head-liner.
2. Replace the used bulbs (B, Fig. 249) with new 12V 10W festoon base bulbs (42 mm x 11 mm).
3. Reinstall the dome light up into the headliner. Ensure it snaps securely into place.

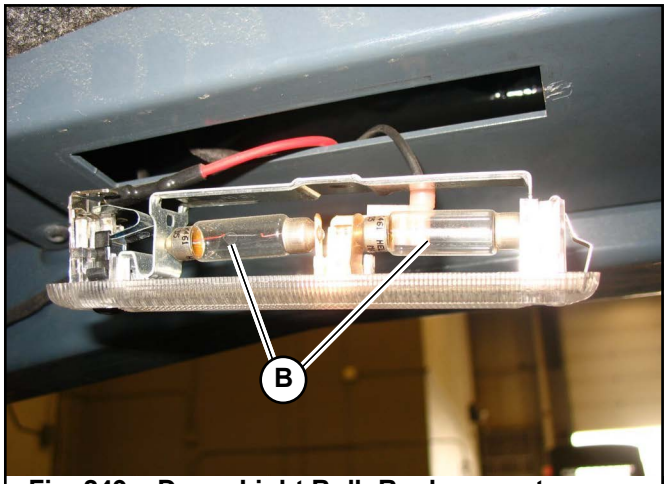


Fig. 249 – Dome Light Bulb Replacement

14-Pin Connector Fuses, Diodes and Relays (Option)

Refer to "14-Pin Connector (Option)" on page 140 for more information.

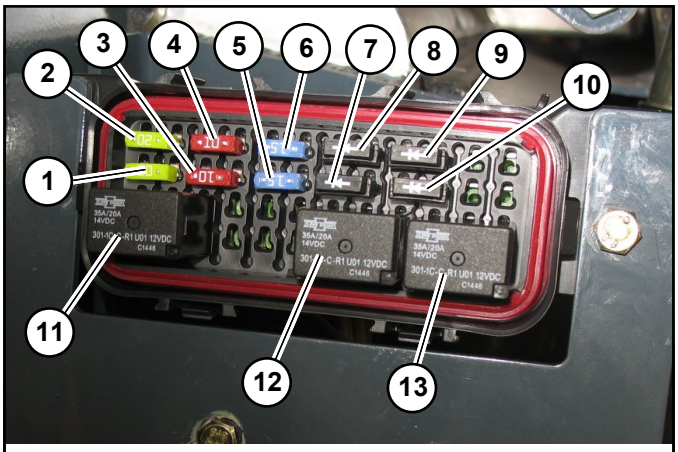


Fig. 250 – Fuses, Diodes, Relays

Fuse	Rated Current	Protected Circuit
1	20A	Main fuse to arming relay
2	20A	Spare fuse
3	10A	Power to joystick switches
4	10A	Spare fuse
5	15A	Power to relays 12, 13 (Power to 14-Pin Connector pins C & D)
6	15A	Spare fuse

Diode	Rated Current / Blocking Voltage	Effected Circuit
7	1A, 400VDC	Parallel to joystick switch 2 down
8	1A, 400VDC	Parallel to joystick switch 2 up
9	1A, 400VDC	Parallel to joystick switch 3 up
10	1A, 400VDC	Parallel to joystick switch 3 down

INSTALL DIODES ORIENTED AS SHOWN

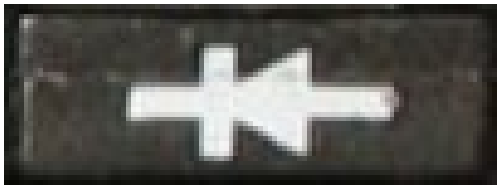


Fig. 251 – Correct Diode Installation Orientation

Back of Relay Shown

Fig. 252 – Correct Relay Installation

Relay	Rated Current N.O. / Rated Current N.C.	Effected Circuit
11	35A/20A	Arms switches and relays
12	35A/20A	Powers 14-Pin Connector pin C
13	35A/20A	Powers 14-Pin Connector pin D

HVAC/Air Conditioning Maintenance

Test cab heating and air conditioning (HVAC) function weekly.

Reduced cab heating could indicate a clogged heater core or malfunctioning thermostat.

IMPORTANT: *The cab heating system should be serviced only by a trained technician.*

Reduced air conditioning function could indicate a low refrigerant level. Low refrigerant or refrigerant leaks can cause air conditioning compressor overheating and failure.

IMPORTANT: *The air conditioning system should be filled only by technicians trained in the air conditioning fill processes.*

HVAC Filters

Check the condition of the HVAC recirculated air and fresh air filters every 250 hours of use and replace if necessary.

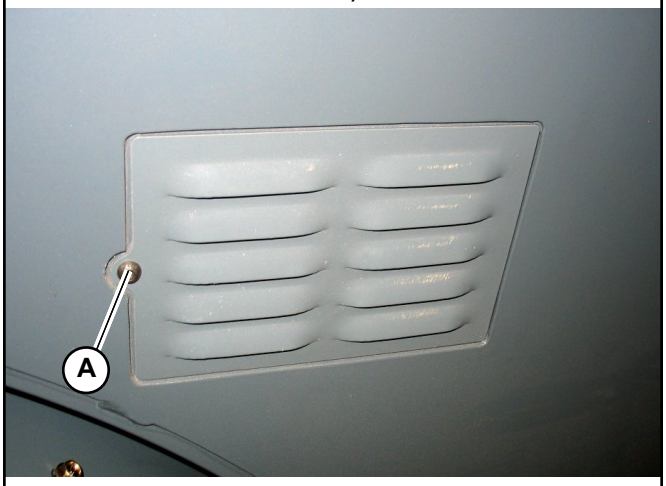
NOTE: *Extreme or dusty/dirty conditions may require more frequent maintenance.*

Cab Air Filters Replacement

The cab air filters are located on the right cab wall. The recirculated air filter is accessed from inside the cab; the fresh air filter is access on the outside of the machine.

1. Remove fasteners (A, Fig. 253) securing the filter grille. Remove and discard the old filter element.

Fresh Air Filter Access (located on the outside right cab wall)



Recirculated Air Filter Access (located on the inside right cab wall)

Fig. 253 – Cab Air Filters

2. Insert new filter element(s). Replace grille and secure it with fastener (A). Make sure filter element(s) is/are completely seated in the opening and grille is firmly and completely seated.

Air Conditioning Compressor Belt

The air conditioning compressor is driven by an elastic stretch belt (T, Fig. 254). Tension is automatic and requires no adjustment.

Remove the left rear access panel (P) and check air conditioning compressor belt condition at regular intervals. Replace if necessary.

NOTE: *Air conditioning belt replacement requires the Stretch Belt Install Tool [Manitou part # 50312475] or an equivalent device.*

⚠ CAUTION

Installation of elastic stretch belts without the proper tools can damage the belt.

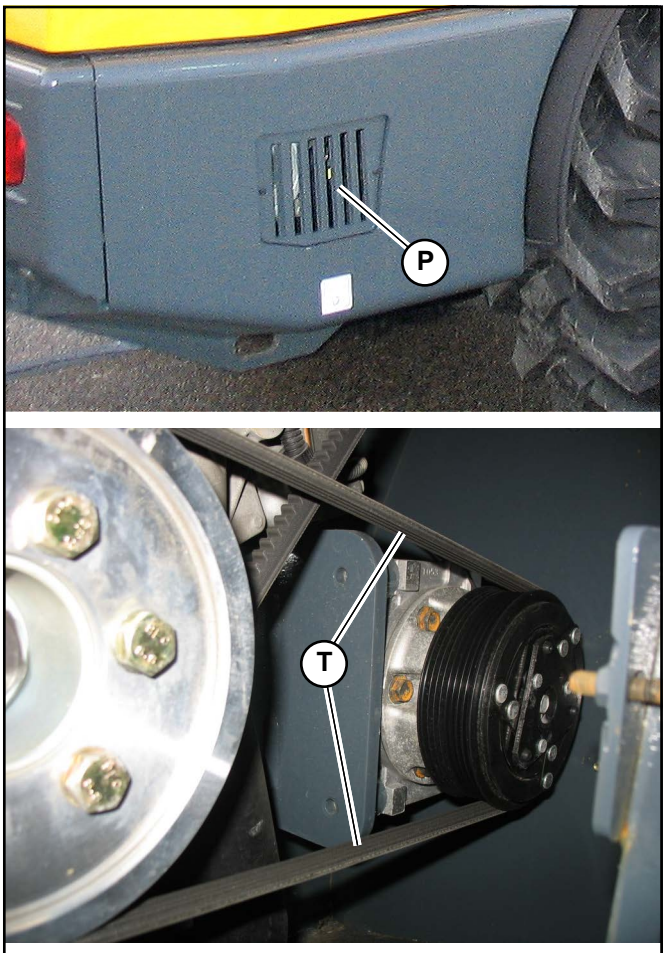


Fig. 254 – Air Conditioning Compressor Belt

Windshield Washer Reservoir

The windshield washer reservoir filler (R, Fig. 255) is located on the left, inside the engine compartment. Check the windshield washer reservoir level daily before starting the machine and fill if necessary.

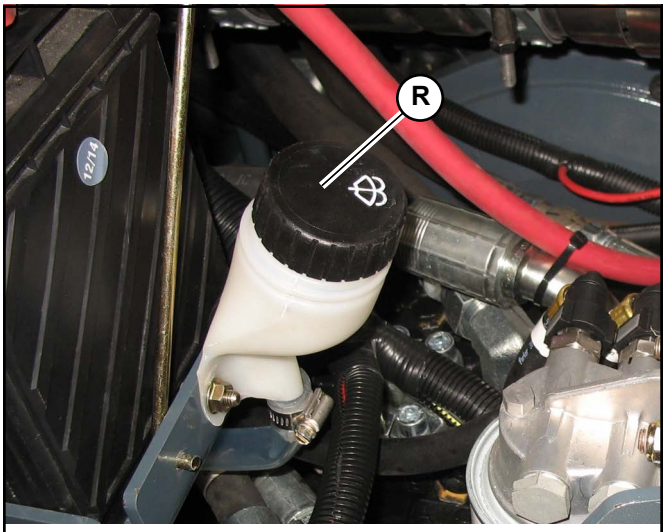


Fig. 255 – Windshield Washer Reservoir

IMPORTANT: *Fill the windshield washer fluid reservoir with a commercial windshield washer fluid or clean tap water only. Add a cleaning agent to the water if required. Add antifreeze to the water in cold weather.*

Long-Term Storage

If storing the machine for a long period (longer than 2 months), perform the procedures in this section.

Before Storage

1. Wash the entire machine. Treat vinyl surfaces in the operator's compartment with a vinyl protectant.
2. Perform all steps for long-term engine storage according to the engine operation manual.
3. Lubricate all grease fittings. See "General Lubrication" on page 167.
4. Check all fluid levels and top-off as necessary.
5. Add a fuel stabilizer to the fuel system according to the fuel supplier's recommendations.
6. Remove and fully charge the battery. Store the battery in a cool, dry location.
7. If the machine will not be operated for a month or longer, apply grease to all exposed hydraulic cylinder rod areas or retract all cylinders so rod exposure is minimized. Apply grease to any remaining rod areas.
8. Protect against extreme weather conditions such as moisture, sunlight, and temperature. Fill the engine coolant system with the proper mix of antifreeze and water as required for expected temperatures according to "Coolant Compound Table" on page 59.

IMPORTANT: *Contact your dealer for additional storage preparation information if the machine will be stored in an environment where temperatures could range below -42°C (-44°F) and/or above 49°C (120°F).*

After Storage

1. Replace and re-connect the battery.
2. Perform all the steps for returning the engine to service according to long-term engine storage section in the engine operation manual.
3. Perform all steps in "Pre-Start Checks" on page 99.
4. Start the engine. Observe all indicators. If all indicators are functioning properly and reading normally, move the machine outside.
5. When outside, park the machine and let the engine idle for at least 5 minutes.
6. Shut off the engine and walk around machine. Make a visual inspection looking for evidence of leaks.

Final Shutdown / Decommissioning

IMPORTANT: *Dispose of all materials properly. Used oils/fluids are environmental contaminants and may only be disposed of at approved collection facilities. Never drain any oils/fluids onto the ground; dispose of in municipal waste collection containers or in metropolitan sewer systems or landfills. Check state and local regulations for other material disposal requirements.*

If the machine will no longer be used as intended, shutdown, decommission, and dispose of it according to the valid regulations.

Before Disposal

1. Prepare the machine for shutdown according to valid regulations regarding proper shutdown.
2. Park the machine on level, dry ground. Ensure the surface can support the weight of the machine. Ensure the location is protected against access by unauthorized persons.
3. Move the throttle to the low-idle position and allow the engine to cool for approximately 2 minutes.
4. Shut off the engine.
5. Move the raise/tilt control(s) to verify that the controls do not cause movement of the lift structure or hitch.
6. Apply the parking brake and lock out the hydraulic controls.
7. Switch off all electrical switches.
8. Unfasten the seat belt and remove the ignition switch key and take it with you.
9. Ensure the machine cannot be operated after shutdown until further disposal.
10. Ensure no environmentally hazardous materials, fluids, and/or fuel can escape the machine. Specifically check for leaks from the engine, the hydraulic system, and the coolant system.
11. Ensure the machine poses no dangers in the place where it is standing.
12. Remove any dirt and/or debris from the engine compartment, the chassis, and the cylinder rod surfaces.
13. Remove the battery
14. Lock the cab door, the storage compartment, the battery, and hydraulic filler compartments and the engine compartment. Remove the key(s) and take it/them with you.

Machine Disposal

Make sure all materials are disposed of in an ecologically sound manner.

Recycle the machine in accordance with the current state of the art at the time of recycling. Observe all accident prevention regulations.

Dispose of all parts at the recycling sites specific to the material of the part. Take care to separate different materials for recycling.

Maintenance Log

Log all maintenance as it is performed in the following table.

Table 41: Maintenance Log

Date	Hours	Maintenance Procedure

Table 41: Maintenance Log

Date	Hours	Maintenance Procedure

Table 41: Maintenance Log

Date	Hours	Maintenance Procedure

Engine Troubleshooting

Table 42: Engine Troubleshooting

Problem	Possible Cause	Corrective Action
Engine does not start.	Operator's seat not occupied.	Occupy operator's seat. Engine will not start with the operator's seat unoccupied.
	Blown fuse.	Check circuit and replace fuse. See "Fuses and Relays" on page 201.
	Dead battery.	Charge or replace battery. See "Jump-Starting" on page 152.
	Malfunctioning seat switch.	Replace seat switch.
	Starter malfunction.	Contact dealer.
	Engine electronics logic error.	Contact dealer.
	Multi-function display not completely initialized.	Wait a few seconds for the multi-function display to start up completely after turning the ignition key switch clockwise to the first detent.
Engine turns over but does not start.	Engine cranking speed too slow.	Check battery and charge/replace as necessary.
		Tighten cables at battery terminals.
	Fuel tank empty.	Fill tank and vent fuel system as necessary.
	Fuel filter plugged or restricted.	Replace fuel filter.
	Paraffin separation during winter.	Use winter grade diesel fuel.
	Fuel line leakage.	Tighten all threaded connections and clamps.
	Pre-heating module malfunction.	Check connection and voltage and charge/replace as necessary.
	Fuel shut-off solenoid not energizing (Yanmar engines only).	Check electrical connections/voltage to shut-off solenoid.
	Fuel pump malfunction.	Contact dealer.
	Fuel shutoff valve on water separator closed (Yanmar engines only).	Open valve.
	Fuel hose restriction.	Check for pinched fuel hose.

Table 42: Engine Troubleshooting

Problem	Possible Cause	Corrective Action
Engine overheating.	Engine oil level incorrect.	Adjust oil level. See “Checking Engine Oil Level” on page 176.
	Cooling air circulation restricted.	Turn engine off and allow it to cool. Remove restriction.
	Fan shroud improperly positioned.	Contact dealer.
	Improper oil grade or oil excessively dirty.	Change engine oil and filter. See “Changing Engine Oil and Filter” on page 177.
	Exhaust restricted.	Turn engine off and allow it to cool. Remove restriction.
	Air filter restricted.	Replace filter(s).
	Low coolant level.	Add coolant. See “Checking Coolant Level” on page 180.
		Check for leaks in coolant system and repair/replace if necessary.
	Malfunctioning fan motor.	Contact dealer.
	Dirty/restricted radiator.	Clean radiator. See “Cleaning Radiator Fins” on page 181.
Engine runs, but travel drive does not operate.	Parking brake applied.	Disengage parking brake.
	Parking brake switch malfunction.	Replace parking brake switch.
	Blown fuse.	Check circuit and replace fuse. See “Fuses and Relays” on page 201.
	Operator not in operator’s seat.	Operator’s seat must be occupied for travel drive to operate.
	Drive system component malfunction.	See “Pump and Drive Motor Error Codes” on page 252.
	Error code present?	See “Error Codes” on page 224.

Indicator Lamp Troubleshooting

Table 43: Indicator Lamp Troubleshooting

Indicator Icon	Indicator Description	Possible Cause	Corrective Action
	Engine oil pressure.	Engine oil pressure too low.	Stop engine immediately. Check oil level and add oil if necessary.
		Engine oil level incorrect.	Adjust oil level. See “Checking Engine Oil Level” on page 176.
		Oil pump malfunction.	Contact dealer.

Table 43: Indicator Lamp Troubleshooting

Indicator Icon	Indicator Description	Possible Cause	Corrective Action
	Hydraulic oil temperature.	Hydraulic oil temperature too hot.	Check cooling system. See “Engine Cooling System” on page 180.
			Check hydraulic oil level.
		Drive system continuously overloaded.	Improve operation procedure.
		Raise/tilt or auxiliary system continuously overloaded.	Improve operation procedure.
		Drive motor(s) or hydrostatic pump(s) internal damage/leakage.	Contact dealer.
		Oil cooler fins restricted.	Clean oil cooler fins. See “Cleaning Radiator Fins” on page 181.
		Hydraulic oil filter restricted.	Replace filter.
	Hydraulic oil filter.	Hydraulic oil filter maintenance required.	Replace hydraulic oil and filter. See “Changing Hydraulic Oil” on page 190. NOTE: During cold start in cold temperatures, this indicator may be activated until hydraulic oil warms to operating temperature.
	Coolant temperature.	Coolant level too low.	Add coolant.
		Air filter plugged.	Replace air filter.
		Coolant leak.	Repair cooling system and top-off coolant.
		Plugged radiator.	Repair/replace radiator.
	Battery voltage.	Alternator not charging properly.	Adjust belt tension.
			Repair/replace alternator.
			Check for loose connections, corroded connections. Replace degraded battery.
	Engine air filter restriction.	Air filter dirty/restricted.	Replace air filter(s).
		Blockage in air filter housing.	Remove blockage.

Seal and Hose Troubleshooting

Table 44: Seal and Hose Troubleshooting

Problem	Possible Cause	Corrective Action
Oil, coolant or fuel leakage.	Loose hose connection(s).	Tighten hose connections.
	Damaged seals or hoses.	Change seals/hoses as necessary.
Hydraulic oil leakage.	Loose fittings.	Tighten hydraulic connections.
	Seals, hoses, or lines damaged.	Change seals, hoses, or lines as necessary.

Hydraulic System Troubleshooting

Table 45: Hydraulic System Troubleshooting

Problem	Possible Cause	Corrective Action
Hydraulics do not work or have poor performance.	Error code present?	See “Error Codes” on page 224.
	Low hydraulic oil level.	Top off hydraulic oil. See “Checking Hydraulic Oil Level” on page 189.
	Hydraulic oil is not at operating temperature.	Allow longer warm-up.
	Engine to pump coupling or hydraulic pump damaged.	Contact dealer.
	Pressure limiting valves set too low or damaged.	Contact dealer.
	Hydraulic cylinder(s) damaged.	Contact dealer.
	Control valve(s) damaged.	Contact dealer.
	Engine speed too low.	Adjust engine speed. See “Throttle Controls” on page 86.
	Dirty/restricted engine air intake filter(s).	Replace filter(s) and/or remove restriction.
	Incorrect fuel type/grade.	Replace fuel with proper type/grade. See “Fluids/Lubricants Types and Capacities” on page 49.
Attachment tilts forward with control in neutral.	Hydraulic oil leaking past cylinder seals (internal and/or external).	Contact dealer.
	Leaking hydraulic system components, such as hoses, tubes, fittings, valves, etc. Leak past spool in control valve.	Repair as necessary.
Lift structure does not raise/lower.	Operator’s seat unoccupied.	Sit in operator’s seat and fasten seatbelt.
	Raise spool in control valve not actuated or leaking.	Contact dealer.
	Hydraulic oil leaking past lift cylinder seals (internal and/or external).	Contact dealer.
	Leaking hydraulic system components, such as hoses, tubes, fittings, valves, etc.	Repair as necessary.
Attachment tilt not working, but lift structure works properly.	Tilt spool in control valve not actuated or leaking.	Contact dealer.
	Hydraulic oil leaking past tilt cylinder seals (internal and/or external).	Contact dealer.
	Leaking hydraulic system components, such as hoses, tubes, fittings, valves, etc.	Repair as necessary.
Attachment tilt auto-level not working properly.	Spool in isolation valve not actuated or leaking.	Contact dealer.
	Hydraulic oil leaking past slave cylinder seals (internal and/or external).	Contact dealer.
	Leaking hydraulic system components, such as hoses, tubes, fittings, valves, etc.	Repair as necessary.

Table 45: Hydraulic System Troubleshooting

Problem	Possible Cause	Corrective Action
Lift structure does not raise but attachment tilt works properly.	Raise spool in control valve not actuated or leaking.	Contact dealer.
	Hydraulic oil leaking past lift cylinder seals (internal and/or external).	Contact dealer.
	Leaking hydraulic system components, such as hoses, tubes, fittings, valves, etc.	Repair as necessary.
Hydraulic system overheating.	Dirty hydraulic oil cooler.	Clean hydraulic oil cooler.
	Low hydraulic oil level.	Top off hydraulic oil. See “Checking Hydraulic Oil Level” on page 189.
	Load too high.	Reduce load.
	Mechanical malfunction (telescopic lift structure binding, bent/damaged pivot points, etc.).	Repair as necessary.
Raise and/or tilt functions inconsistent/ jerky.	Air in hydraulic system.	Cycle lift and tilt cylinders to maximum stroke and maintain for a few seconds to clear air from the hydraulic system.
	Low hydraulic oil level.	Top off hydraulic oil. See “Checking Hydraulic Oil Level” on page 189.
	Cylinder(s) malfunction.	Contact dealer.
Lift structure does not maintain position with control joystick in neutral.	Hydraulic oil leaking past cylinder seals (external leak).	Contact dealer.
	Hydraulic oil leaking past raise spool in control valve.	Contact dealer.
	Leaking hydraulic system components, such as hoses, tubes, fittings, valves, etc.	Contact dealer.
Auxiliary hydraulics not functioning.	Spool in control valve not actuated or leaking.	Contact dealer.
	Hydraulic oil leaking past seals.	Contact dealer.
	Leaking hydraulic system components, such as hoses, tubes, fittings, valves, etc.	Contact dealer.
	Auxiliary hydraulics connected improperly.	Correct hydraulic connections.
Telescopic lift structure not extending/ retracting (telescopic machines only).	Hydraulic oil leaking past extend cylinder seals (external leak).	Contact dealer.
	Hydraulic oil leaking past spool in control valve.	Contact dealer.
	Leaking hydraulic system components, such as hoses, tubes, fittings, valves, etc.	Contact dealer.
	Telescopic lift structure mechanical binding.	Repair as necessary.
	Joystick/electrical malfunction.	Correct electrical fault (joystick switch, electrical connections, etc.).

Hydrostatic Travel Drive System Troubleshooting

Table 46: Hydrostatic Travel Drive System Troubleshooting

Problem	Possible Cause	Corrective Action
Hydrostatic drive and raise/tilt not responsive.	Hydraulic oil viscosity too heavy.	Allow longer warm-up
		Replace hydraulic oil with proper type/ grade. See “Fluids/Lubricants Types and Capacities” on page 49.
	Drive control system malfunction with error code displayed.	See “Error Codes” on page 224.
Drive does not operate in either direction.	Parking brake applied.	Disengage parking brake.
	Low hydraulic oil level.	Top off hydraulic oil. See “Checking Hydraulic Oil Level” on page 189.
	Low or no charge pressure.	Contact dealer.
	Hydrostatic pump(s) relief valves malfunctioning.	Contact dealer.
	Drive control system malfunction with error code displayed.	See “Error Codes” on page 224.
Drive system noisy.	Hydraulic oil viscosity too heavy.	Allow longer warm-up.
		Replace hydraulic oil with proper type/ grade. See “Fluids/Lubricants Types and Capacities” on page 49.
	Low hydraulic oil level.	Top off hydraulic oil. See “Checking Hydraulic Oil Level” on page 189.
	Air in hydraulic system.	Cycle lift and tilt cylinders to maximum stroke and maintain for a few seconds to clear air from the hydraulic system.
	Drive motor(s) / hydrostatic pump(s) / axles internal damage/leakage.	Contact dealer.
Sluggish acceleration.	Low hydraulic oil level.	Top off hydraulic oil. See “Checking Hydraulic Oil Level” on page 189.
	Low hydraulic system charge pressure.	Contact dealer.
	Drive motor(s) or hydrostatic pump(s) internal damage/leakage.	Contact dealer.
	Engine running rough.	Poor fuel quality or incorrect fuel type/ grade. Replace fuel with proper type/ grade. See “Fluids/Lubricants Types and Capacities” on page 49.
		Restricted fuel filter/fuel system. Replace fuel filter; remove restriction. See “Changing Fuel Filter” on page 188.
		Contact dealer.

Electrical Troubleshooting

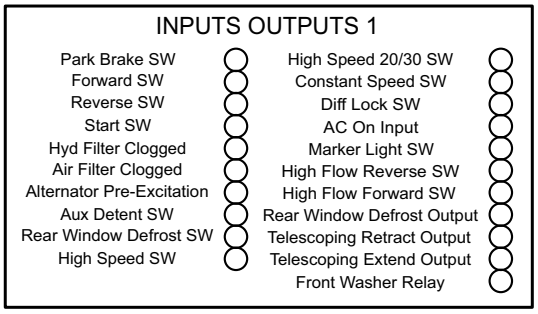
Table 47: Electrical Troubleshooting

Problem	Possible Cause	Corrective Action
Loss of electrical power.	Battery terminals or cables loose or corroded.	Clean battery terminals/cable connections and tighten.
	Battery disconnect switch turned off	Turn the battery disconnect switch on.
	Battery malfunction.	Test battery. Recharge/replace as necessary.
	Blown main fuse.	Correct over-current problem and replace main fuse. See “Fuses and Relays” on page 201.
Instrument display does not activate when ignition key switch is on.	Blown main fuse.	Correct over-current problem and replace main fuse. See “Fuses and Relays” on page 201.
	Battery disconnect switch turned off	Turn the battery disconnect switch on.
	Battery terminals or cables loose or corroded.	Clean battery terminals/cable connections and tighten.
	Ignition key switch malfunction.	Replace switch.
	In very cold weather, display screen slow to display.	Wait a few seconds for display to activate.
Starter does not engage when key switch turned to start position.	Loose/corroded starter electrical connections.	Check/tighten/clean connections.
	Battery terminals or cables loose or corroded.	Clean battery terminals/cable connections and tighten.
	Battery disconnect switch turned off.	Turn the battery disconnect switch on.
	Starter relay malfunction.	Contact dealer.
	Battery malfunction.	Test battery. Recharge/replace as necessary.
	Starter solenoid malfunction.	Contact dealer.
	Starter or pinion malfunctioning.	Repair/replace as needed.
Work/road lights malfunction.	Single light not working; light bulb burned out, faulty wiring.	Check and replace light bulb as needed. Check wiring connections.
	Light switch malfunction.	Replace light switch.
	Poor electrical ground.	Check ground wire connections.
	Blown fuse.	Replace fuse.
LLMI malfunction/Extension Indicator; CAN error displayed “Measuring Device Comm Lost”	Blown fuse.	Replace fuse.
	LLMI sensor malfunction/extension indicator disconnected	Inspect connection and/or harness for wear and/or damage.
		Contact dealer.

Electrical Inputs/Outputs

The inputs/outputs status screens on the multi-purpose display provides real-time electrical component diagnostic information.

Table 48: Electrical Inputs/Outputs Diagnostic Screen

Display	Description
	Displays input/output information from electronic control modules. Refer to “Multi-Function Display” on page 67 for more information. • Green – Active • Blank – Inactive • Yellow – Short or open circuit

Error Codes

The tables in this section describe error codes which may be reported on the multi-function display screen or control module LEDs. More than one error can be reported at one time.

MCU and Keypad CAN Error Codes

Table 49: MCU and Keypad CAN Error Codes

DTC		Error Item	
SPN	FMI	Description	Type
520600	3	Travel Pedal	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520601	31	Forward/Neutral/Revers (FNR) Switch	Malfunctioning or disconnected switch
520602	3	Inching Pedal	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520605	3	Battery (+)	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520606	3	Battery (+)	Voltage above normal or shorted to high source
520608	3	Hand Throttle	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520609	3	Hydraulic Temperature	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520610	3	Boom Telescope Extend/Retract	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520611	3	Auxiliary Hydraulics Forward/Reverse	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520615	3	Fuel	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520620	3	Battery (+)	Voltage above normal or shorted to high source

Table 49: MCU and Keypad CAN Error Codes

DTC		Error Item	
SPN	FMI	Description	Type
520621	3	Battery (+)	Voltage above normal or shorted to high source
520631	3	5V Sensor Power	Voltage above normal or shorted to high source
	4		Voltage below normal or shorted to low source
520632	5	Rear Window Defrost	Current below normal or open circuit
	6		Current above normal or grounded circuit
520635	5	Differential Lock	Current below normal or open circuit
	6		Current above normal or grounded circuit
520636	5	Fan Reverse	Current below normal or open circuit
	6		Current above normal or grounded circuit
520637	5	High Flow Reverse	Current below normal or open circuit
	6		Current above normal or grounded circuit
520638	5	High Flow Forward	Current below normal or open circuit
	6		Current above normal or grounded circuit
520642	5	Front Work Lights	Current below normal or open circuit
	6		Current above normal or grounded circuit
520643	5	Rear Work Lights	Current below normal or open circuit
	6		Current above normal or grounded circuit
520645	5	Brake Lights	Current below normal or open circuit
	6		Current above normal or grounded circuit
520646	5	Raise/Tilt Lock-out	Current below normal or open circuit
	6		Current above normal or grounded circuit
520647	5	Front Wiper Relay	Current below normal or open circuit
	6		Current above normal or grounded circuit
520648	5	Fuel Solenoid	Current below normal or open circuit
	6		Current above normal or grounded circuit
520649	5	Marker Lights	Current below normal or open circuit
	6		Current above normal or grounded circuit
520650	5	Quick Attachment Hitch Lock	Current below normal or open circuit
	6		Current above normal or grounded circuit
520651	5	Quick Attachment Hitch Unlock	Current below normal or open circuit
	6		Current above normal or grounded circuit
520652	5	Start	Current below normal or open circuit
	6		Current above normal or grounded circuit
520654	31	Configurable Memory Error	Computer malfunction

Yanmar Engine Diagnostic Trouble Codes (DTC)

NOTE: *Refer to official Yanmar engine trouble code documentation for the most complete and up-to-date information.*

Table 50: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
28	0	P1126	Acceleration Sensor 3	Sensor failure (throttle in open position)
28	1	P1125	Acceleration Sensor 3	Sensor failure (throttle in closed position)
28	2	P0224	Acceleration Sensor 3	Intermittent fault
28	3	P0223	Acceleration Sensor 2	Acceleration sensor 2 fault (high voltage)
28	4	P0222	Acceleration Sensor 2	Acceleration sensor 2 fault (low voltage)
29	0	P1226	Travel Pedal Position Sensor "B"	Above normal operation range
29	1	P1225	Travel Pedal Position Sensor "B"	Below normal operation range
29	3	P0227	Acceleration Sensor 3	Acceleration sensor 3 fault (high voltage)
29	3	P0228	Acceleration Sensor 3	Acceleration sensor 3 fault (high voltage)
29	8	P1127	Acceleration Sensor 3	Sensor failure (pulse communication)
29	8	P1227	Travel Pedal Position Sensor "B"	Communication fault
29	15	P1228	Travel Pedal Position Sensor "B"	Not available
51	3	P02E9	Intake Throttle Opening Sensor	Intake throttle opening sensor fault (high voltage)
51	4	P02E8	Intake Throttle Opening Sensor	Intake throttle opening sensor fault (low voltage)
91	2	P0124	Acceleration Sensor 1	Intermittent fault
91	3	P0123	Acceleration Sensor 1	Acceleration sensor 1 fault (high voltage)
91	4	P0122	Acceleration Sensor 1	Acceleration sensor 1 fault (low voltage)
100	1	P1198	Oil Pressure Switch	Low oil pressure fault alarm
100	4	P1192	Oil Pressure Switch	Oil pressure switch open circuit
102	3	P0238	EGR Low Pressure Side Sensor	EGR low pressure side sensor fault (high voltage)
102	4	P0237	EGR Low Pressure Side Sensor	EGR low pressure side sensor fault (low voltage)
102	13	P0236	EGR Low Pressure Side Sensor	Abnormal learning value
102	10	P1673	EGR Low Pres. Sensor Malfunction	After-treatment error
105	3	P040D	Intake Air Temperature Sensor	Intake air temperature sensor fault (high voltage)
105	4	P040C	Intake Air Temperature Sensor	Intake air temperature sensor fault (low voltage)
105	10	P1676	Intake Air Temp. Sensor Malfunction	After-treatment error
108	2	P2230	Barometric Pressure Sensor	Intermittent fault
108	3	P2229	Atmospheric Pressure Sensor	Atmospheric pressure sensor fault (high voltage)
108	4	P2228	Atmospheric Pressure Sensor	Atmospheric pressure sensor fault (low voltage)
108	10	P1231	Atmospheric Pressure Sensor	Atmospheric pressure sensor characteristic fault
110	0	P0217	Cooling Water Temperature Sensor	Cooling water temperature sensor temperature abnormally high (overheat)
110	2	P0119	Cooling Water Temperature Sensor	Intermittent fault
110	3	P0118	Cooling Water Temperature Sensor	Cooling water temperature sensor fault (high voltage)
110	4	P0117	Cooling Water Temperature Sensor	Cooling water temperature sensor fault (low voltage)
110	10	P1674	Coolant Temp. Sensor Malfunction	After-treatment error

Table 50: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
157	0	P0088	Abnormal Rail Pressure	Actual rail pressure rise error
157	3	P0193	Rail Pressure Sensor	Rail pressure sensor (high voltage)
157	4	P0192	Rail Pressure Sensor	Rail pressure sensor (low voltage)
157	15	P0093	Abnormal Rail Pressure	Rail pressure deviation error during the actual rail pressure rise
157	16	P000F	PLV (Common Rail Pressure Limit Value)	PLV open valve
157	18	P0094	Abnormal Rail Pressure	Rail pressure deviation error during the actual rail pressure drop
158	0	P0563	System Voltage	Too high
158	1	P0562	System Voltage	Too low
167	1	P1568	Charge Switch	Charge alarm
167	5	P1562	Charge Switch	Charge switch open circuit
172	3	P0113	New Air Temperature Sensor	New air temperature sensor fault (high voltage)
172	4	P0112	New Air Temperature Sensor	New air temperature sensor fault (low voltage)
173	3	P0546	Exhaust Air Temperature Sensor	Exhaust air temperature sensor fault (high voltage)
173	4	P0545	Exhaust Air Temperature Sensor	Exhaust air temperature sensor fault (high voltage)
173	10	P1677	Exhaust Temp. Sensor Malfunction	After-treatment error
174	0	P0168	Fuel Temperature Sensor	Fuel temperature sensor temperature abnormally high
174	3	P0183	Fuel Temperature Sensor	Fuel temperature sensor fault (high voltage)
174	4	P0182	Fuel Temperature Sensor	Fuel temperature sensor fault (low voltage)
190	16	P0219	Over-speed	Over-speed
237	13	U3002	CAN 2	VI (CAN message) reception data fault
237	31	U0168	CAN 2	VI (CAN message) reception time-out error
412	3	P041D	EGR Gas Temperature Sensor	EGR gas temperature sensor fault (high voltage)
412	4	P041C	EGR Gas Temperature Sensor	EGR gas temperature sensor fault (low voltage)
412	10	P1675	EGR Gas Temp Sensor Malfunction	After-treatment error
628	2	P1605	ECU Internal Fault	FlashROM checksum error (data sheet 1)
628		P1606	ECU Internal Fault	FlashROM checksum error (data sheet 2)
628	12	P0605	ECU Internal Malfunction	FlashROM checksum error (main software)
630	2	P1601	ECU Internal Fault	EEPROM error
630	12	P0601	EEPROM	EEPROM memory deletion error
633	3	P0629	SCV (MPROP)	SCV (MPROP) high side VB short-circuit
633	5	P0627	SCV (MPROP)	SCV (MPROP) open circuit
633	6	P1642	SCV (MPROP)	SCV (MPROP) high side GND short-circuit
638	2	P1214	Engine	Malfunction
638	3	P1213	Engine Fuel Rack Position Actuator	Shorted to high source
638	4	P1212	Engine Fuel Rack Position Actuator	Shorted to low source
638	7	P1211	Engine Fuel Rack Position Actuator	Mechanical malfunction
639	12	U0001	High Speed CAN	Communication fault
651	3	P1271	Injector 1 (Cylinder Number 4)	Injector 1 short-circuit

Table 50: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
651	5	P0204	Injector 1 (Cylinder Number 4)	Injector 1 open circuit (inherent location of the injector)
651	6	P0271	Injector 1 (Cylinder Number 4)	Injector 1 coil short-circuit
651	11	P0272	Injector 1 (Cylinder Number 4)	Injector 1 unclassified
652	3	P1262	Injector 1 (Cylinder Number 3)	Injector 1 short-circuit
652		P1268	Injector 4 (Cylinder Number 3)	Injector 4 short-circuit
652	5	P0203	Injector 1 (Cylinder Number 3))	Injector 1 open circuit (inherent location of the Injector)
652		P0203	Injector 4 (Cylinder Number 3)	Injector 4 open circuit (inherent location of the injector)
652	6	P0268	Injector 1 (Cylinder Number 3)	Injector 1 coil short-circuit
652		P0268	Injector 4 (Cylinder Number 3)	Injector 4 coil short-circuit
652	11	P1263	Injector 1 (Cylinder Number 3)	Injector 1 unclassified
652		P1269	Injector 4 (Cylinder Number 3)	Injector 4 unclassified
653	3	P1265	Injector 2 (Cylinder Number 2)	Injector 2 short-circuit
653	5	P0202	Injector 2 (Cylinder Number 2)	Injector 2 open circuit (inherent location of the injector)
653	6	P0265	Injector 2 (Cylinder Number 2)	Injector 2 coil short-circuit
653	11	P1266	Injector 2 (Cylinder Number 2)	Injector 2 unclassified
654	3	P1262	Injector 3 (Cylinder Number 1)	Injector 3 short-circuit
654	5	P0201	Injector 3 (Cylinder Number 1)	Injector 3 open circuit (inherent location of the injector)
654	6	P0262	Injector 3 (Cylinder Number 1)	Injector 3 coil short-circuit
654	11	P1263	Injector 3 (Cylinder Number 1)	Injector 3 unclassified
1078	4	P0340	Fuel Injection Pump Speed Sensor	Shorted to low source
1079	2	P1644	Sensor 5V	Intermittent fault
1079	3	P0643	Sensor 5V	Shorted to high source
1079	4	P0642	Sensor 5V	Shorted to low source
1136	0	P0634	ECU Internal Temperature	Too high
1136	2	P1664	ECU Internal Temperature Sensor	Intermittent fault
1136	3	P0669	ECU Internal Temperature Sensor	Shorted to high source
1136	4	P0668	ECU Internal Temperature Sensor	Shorted to low source
1202	2	U423	Immobilizer	System fault
1209	3	P0473	EGR High Pressure Side Sensor	EGR low pressure side sensor fault (high voltage)
1209	4	P0472	EGR High Pressure Side Sensor	EGR low pressure side sensor fault (low voltage)
1209	13	P0471	EGR High Pressure Side Sensor	Abnormal learning value
1209	10	P1679	EGR High Pres. Sensor Malfunction	After-treatment error
1210	3	P1203	Engine Fuel Rack Position Sensor	Shorted to high source
1210	4	P1202	Engine Fuel Rack Position Sensor	Shorted to low source
1485	2	P068A	Main Relay	Power off without main relay self-holding/main relay early opening
1485	4	P0686	ECU Main Relay	Shorted to low source
1485	7	P068B	Main Relay	Main relay contact stuck

Table 50: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
2791	0	P0404	EGR Valve	EGR over-voltage malfunction
2791	1	P1404	EGR Valve	EGR low voltage malfunction
2791	7	P1409	EGR Valve	EGR feedback malfunction
2791	9	U0401	EGR Valve	EGR ECM data fault
2791	12	P0403	EGR Valve	Open circuit between the EGR motor coils
2797	6	P1146	Injector (Common)	Injector drive circuit (bank 1) short-circuit (common circuit for number 1, number 4)
2798	6	P1149	Injector (Common)	Injector drive circuit (bank 2) short-circuit (common circuit for number 2, number 3)
2950	3	P1658	Intake Throttle Drive Circuit	Power short-circuit of throttle valve drive H bridge output 1
2950	4	P1659	Intake Throttle Drive Circuit	GND short-circuit of throttle valve drive H bridge output 1
2950	5	P0660	Intake Throttle Drive Circuit	No-load of throttle valve drive H bridge circuit
2950	6	P1660	Intake Throttle Drive Circuit	Overload on the drive H bridge circuit of the throttle valve
2951	3	P1661	Intake Throttle Drive Circuit	VB power short-circuit of throttle valve drive H bridge output 2
2951	4	P1662	Intake Throttle Drive Circuit	GND short-circuit of throttle valve drive H bridge output 2
3059	5	P053A	Poor Intake Heater Connection	Intake heater error
3242	0	P1436	DPF Inlet Temperature Sensor	DPF inlet temperature sensor temperature abnormally high
3242	3	P1428	DPF Inlet Temperature Sensor	DPF inlet temperature sensor fault (high voltage)
3242	4	P1427	DPF Inlet Temperature Sensor	DPF inlet temperature sensor fault (low voltage)
3242	10	P167E	DPF Inlet Temp. Sensor Malfunction	After-treatment error
3250	0	P1426	DPF Intermediate Temperature Sensor	DPF intermediate temperature sensor temperature abnormally high (post-injection failure)
3250	1	P0420	DPF Intermediate Temperature Sensor	DPF intermediate temperature sensor temperature abnormally low
3250	3	P1434	DPF Intermediate Temperature Sensor	DPF intermediate temperature sensor fault (high voltage)
3250	4	P1435	DPF Intermediate Temperature Sensor	DPF intermediate temperature sensor fault (low voltage)
3250	10	P167A	DPF Intermediate Temp Sensor Malfunction	After-treatment error
3251	0	P2452	DPF Differential Pressure Sensor	DPF differential pressure sensor differential pressure abnormally high
3251	3	P2455	DPF Differential Pressure Sensor	DPF differential pressure sensor fault (high voltage)
3251	4	P2454	DPF Differential Pressure Sensor	DPF differential pressure sensor fault (low voltage)
3251	13	P2453	DPF Differential Pressure Sensor	Abnormal learning value
3609	3	P1455	DPF High Pressure Sensor	DPF high pressure side sensor fault (high voltage)
3609	4	P1454	DPF High Pressure Sensor	DPF high pressure side sensor fault (low voltage)
3609	10	P167C	DPF High Pres. Sensor Malfunction	After-treatment error

Table 50: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
3719	0	P1424	DPF OP Interface	Backup mode
3719	7	P1446	DPF OP Interface	Recovery regeneration prohibition
3719	9	P1445	DPF OP Interface	Recovery regeneration failure
3719	16	P1421	DPF OP Interface	Stationary regeneration standby
3720	0	P1420	DPF OP Interface	Ash cleaning request 2
3720	16	P242F	DPF OP Interface	Ash cleaning request 1
4257	12	P0611	Injector (Common)	Injector drive IC error
4795	31	P226D	DPF Substrate Removed	After-treatment error
37251	16	P1437	DPF	Maintenance (maintenance not performed for a given period of time)
522241	2	P1224	Engine Fuel Rack Actuator Relay	Intermittent fault
522241	3	P1223	Engine Fuel Rack Actuator Relay	Circuit fault B
522241	4	P1222	Engine Fuel Rack Actuator Relay	Circuit fault A
522241	7	P1221	Reserved	N/A
522242	2	P1244	Cold Start Device	Intermittent fault
522242	3	P1243	Cold Start Device	Circuit fault B
522242	4	P1242	Cold Start Device	Circuit fault A
522243	2	P1234	Air Heater Relay	Intermittent fault
522243	3	P1233	Air Heater Relay	Circuit fault B
522243	4	P1232	Air Heater Relay	Circuit fault A
522243	5	P0543	Start Auxiliary Relay	Start auxiliary relay interrupted
522243	6	P0541	Start Auxiliary Relay	Start auxiliary relay GDN interrupted
522251	3	P1403	EGR Stepping Motor "A"	Circuit fault B
522251	4	P1402	EGR Stepping Motor "A"	Circuit fault A
522252	3	P1413	EGR Stepping Motor "B"	Circuit fault B
522252	4	P1412	EGR Stepping Motor "B"	Circuit fault A
522253	3	P1423	EGR Stepping Motor "C"	Circuit fault B
522253	4	P1422	EGR Stepping Motor "C"	Circuit fault A
522254	3	P1433	EGR Stepping Motor "D"	Circuit fault B
522254	4	P1432	EGR Stepping Motor "D"	Circuit fault A
522314	0	P1217	Engine Coolant Temperature	Abnormal temperature
522323	0	P1101	Air Cleaner Switch	Air cleaner clogged alarm
522329	0	P1151	Oil/Water Separator switch	Oil/water separator alarm
522400	2	P0336	Crank Sensor	Crank signal malfunction
522400	5	P0037	Crank Sensor	No crank signal
522401	2	P0341	Cam Sensor	Cam signal malfunction
522401	5	P0342	Cam Sensor	No cam signal
522401	7	P1341	Cam Sensor	Angle offset failure
522402	4	P1340	Aux Speed Sensor	Shorted to low source
522567	12	U1401	EGR	EGR target value out of range
522571	3	P1641	SCV (MPROP)	SCV (MPROP) low side VB short-circuit
522571	6	P1643	SCV (MPROP)	SCV (MPROP) low side GND short-circuit

Table 50: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
522572	6	P062A	SCV (MPROP)	High-pressure pump drive circuit (drive current [high level])
522572	11	P1645	SCV (MPROP)	High-pressure pump drive circuit (pump overload error)
522573	0	P2463	DPF	Over-accumulation (method C)
522574	0	P1463	DPF	Over-accumulation (method P)
522575	7	P2458	DPF	Regeneration defect (stationary regeneration failure)
522576	12	P160E	EEPROM	EEPROM memory read error
522577	11	P2459	DPF	Regeneration defect (stationary regeneration not performed)
522578	12	P160F	EEPROM	EEPROM memory write error
522579	12	P1405	EGR	Short-circuit between the EGR motor coils
522580	12	P0488	EGR	EGR position sensor malfunction
522581	7	P148A	EGR	EGR stuck open valve malfunction
522582	7	P049D	EGR	EGR initialization malfunction
522583	1	P1410	EGR	EGR high temperature thermistor malfunction
522584	1	P1411	EGR	EGR low temperature thermistor malfunction
522585	12	P1613	ECU Internal Malfunction	CY146 SPE/SPI communication error
522588	12	P1608	ECU Internal Malfunction	Excessive supply 1 voltage error
522589	12	P1617	ECU Internal Malfunction	Dropped/Insufficient supply 1 voltage error
522590	12	P1609	ECU Internal Malfunction	Sensor supply voltage error 1
522591	12	P1618	ECU Internal Malfunction	Sensor supply voltage error 2
522592	12	P1619	ECU Internal Malfunction	Sensor supply voltage error 3
522593	12	P1624	ECU Internal Malfunction	Power for sensor SRC low error
522594	3	P160A	ECU Internal Malfunction	Actuator drive circuit 1 VB short-circuit
522595	3	P1625	ECU Internal Malfunction	Actuator drive circuit 2 VB short-circuit
522596	9	U0292	CAN 2	TSC1 (CAN message) reception time out (SA1)
522597	9	U1301	CAN 2	TSC1 (CAN message) reception time out (SA2)
522598	11	P160B	ECU Internal Malfunction	SW reset (recovery) execution 1
522599	9	U1292	CAN 2	Y_ECR1 (CAN message) reception time out error
522599	11	P1636	ECU Internal Malfunction	SW reset (recovery) execution 2
522600	9	U1293	CAN 2	Y_EC (CAN message) reception time out error
522600	11	P1637	ECU Internal Malfunction	SW reset (recovery) execution 3
522601	9	U1294	CAN 2	Y_RSS (CAN message) reception time out error
522601	12	P160D	ECU Internal Malfunction	WDA/ABE shut off due to dropped voltage
522602	12	P1639	ECU Internal Malfunction	WDA/ABE shut off due to excessive voltage
522603	9	U1296	CAN 2	VH (CAN message) reception time out
522603	12	P1640	ECU Internal Malfunction	WDA/ABE shut off due to unknown cause
522605	9	U1298	CAN 2	Y_ECM3 (CAN message) reception time out
522609	9	U1300	CAN 2	Y_ETCP1 (CAN message) reception time out
522610	9	U101B	CAN 1	CAN1 (for EGR): Reception time out error
522610	19	U040C	EGR	CAN1 (for EGR): Reception data length error

Table 50: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
522611	9	U1107	CAN1/Exhaust Throttle	Exhaust throttle (CAN message from the exhaust throttle time out)
522617	12	U1401	EGR Valve	EGR target value out of range
522618	9	U1302	CAN 2	EBC1 (CAN message) reception time out error
522619	9	U1303	CAN 2	Y_DPFIF (CAN message) reception time out
522623	7	P1647	Acceleration Sensor 1/2	Dual accelerator sensor (open position)
522624	7	P1646	Acceleration Sensor 1/2	Dual accelerator sensor (closed position)
522727	12	P1610	ECU Internal Fault	Sub-CPU error A
522727	12	P1611	ECU Internal Fault	Sub-CPU error B
522727	12	P1612	ECU Internal Fault	Sub-CPU error C
522728	12	P1620	ECU Internal Fault	Engine map data version error
522730	8	U1167	Immobilizer	Pulse communication fault
522730	12	U0167	Immobilizer	Communication fault
522744	4	P1626	ECU Internal Malfunction	Actuator drive circuit 1 GND short-circuit
522746	12	P1438	Exhaust Throttle	Voltage fault
522747	12	P1439	Exhaust Throttle	Motor fault
522748	12	P1440	Exhaust Throttle	Sensor system fault
522749	12	P1441	Exhaust Throttle	MPU fault
522750	12	P1442	Exhaust Throttle	PCB fault
522751	19	P1443	Exhaust Throttle	CAN fault
522994	4	P1633	ECU Internal Malfunction	Actuator drive circuit 2 GND short-circuit
522994	12	P1607	ECU Internal Malfunction	WDA/ABE communication error
522994	12	P1615	ECU Internal Malfunction	CY320 SPI communication error
522994	12	P1616	ECU Internal Malfunction	MSC communication error of R2S2
523249	5	P0008	Cam Sensor	No signal from both sensors
523460	7	P1670	Rail Pressure Control/Sensor	Rail pressure fault (operation time error during RPS limp mode)
523462	13	P1648	Injector (Correction Value)	IQA corrected injection amount for injector 1
523463	13	P1649	Injector (Correction Value)	IQA corrected injection amount for injector 2
523464	13	P1650	Injector (Correction Value)	IQA corrected injection amount for injector 3
523465	13	P1651	Injector (Correction Value)	IQA corrected injection amount for injector 4
523468	9	P1665	PLV (Common Rail Pressure Limit Value); Rail Pressure Sensor	Rail pressure fault (controlled rail pressure error after PLV valve opening)
523469	0	P1666	Rail Pressure Sensor	Rail pressure fault (PLV opening timing error)
523470	0	P1667	Rail Pressure Sensor	Rail pressure fault (PLV opening timing error)
523471	6	P1467	ECU Internal Malfunction	Actuator drive circuit 3 GND short-circuit
523473	12	P1469	ECU Internal Malfunction	AD converter fault 1
523474	12	P1470	ECU Internal Malfunction	AD converter fault 2
523475	12	P1471	ECU Internal Malfunction	External monitoring IC and CPU fault 1
523476	12	P1472	ECU Internal Malfunction	External monitoring IC and CPU fault 2
523477	12	P1473	ECU Internal Malfunction	ROM fault
523478	12	P1474	ECU Internal Malfunction	Shutoff path fault 1
523479	12	P1475	ECU Internal Malfunction	Shutoff path fault 2

Table 50: Yanmar Engine Diagnostic Trouble Codes (DTC)

DTC			Error Item	
SPN	FMI	P-Code	Part	State
523480	12	P1476	ECU Internal Malfunction	Shutoff path fault 3
523481	12	P1477	ECU Internal Malfunction	Shutoff path fault 4
523482	12	P1478	ECU Internal Malfunction	Shutoff path fault 5
523483	12	P1479	ECU Internal Malfunction	Shutoff path fault 6
523484	12	P1480	ECU Internal Malfunction	Shutoff path fault 7
523485	12	P1481	ECU Internal Malfunction	Shutoff path fault 8
523486	12	P1482	ECU Internal Malfunction	Shutoff path fault 9
523487	12	P1483	ECU Internal Malfunction	Shutoff path fault 10
523488	0	P1484	ECU Internal Malfunction	Recognition error of engine speed
523489	0	P1668	PLV (Common Rail Pressure Limit Value); Rail Pressure Sensor	Rail pressure fault (the actual rail pressure is too high during PRV limp mode)
543491	0	P1669	Rail Pressure Control/Sensor	Rail pressure fault (injector B/F temp error during PLV4 limp home)

Deutz Engine Diagnostic Trouble Codes (DTC)

NOTE: *Refer to official Deutz engine trouble code documentation for the most complete and up-to-date information.*

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
29	2	Plausibility Error	Plausibility error between sensor and idle switch; acceleration pedal detection.
29	3	Short-Circuit Error	Hand throttle idle validation switch; short circuit to battery
29	4	Out-Of-Range/Short Circuit Error	Hand throttle; short circuit to ground
51	0	Out-Of-Range Error	Warning threshold for an internal actuator error exceeded, < 4L EGR.actuator und >4L air intake flap
51	1	Out-Of-Range Error	Shut off threshold for an internal actuator error exceeded, < 4L EGR.actuator und >4L air intake flap
51	3	EGR Valve Actuator Error	Actuator of the external EGR valve: the ECU detects a short circuit to battery; short cut to battery on ECU pin A19 or pin A20;
51	4	EGR Valve Actuator Error	Actuator of the external EGR valve: The ECU detects a short circuit to ground; Short cut to ground on ECU pin A19 is detected; measured voltage by ECU is under limit
51	5	EGR Valve Actuator Error	Actuator error EGR Valve: signal range check low, measured current is blow target; open load on ECU output is detected

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
51	6	EGR Valve Actuator Error	Actuator error EGR Valve: signal range check high, measured current by ECU is over target; too high current is going into the actuator, output is switched off; overload by short-circuit
51	7	EGR Valve Actuator Error	Actuator position for EGR Valve is not plausible, internal error, angular misalignment of the flap
51	11	EGR Valve Actuator Error	Actuator EGR valve: temperature limit in powerstage of the actuator is reached due to high current
91	3	Accelerator Pedal Sensor Error	Analog accelerator pedal sensor 1: the voltage measured by ECU is out of the target
91	4	Accelerator Pedal Sensor Error	Analog accelerator pedal sensor 1: the voltage measured by ECU is out of the target
91	11	Accelerator Pedal Sensor Error	Plausibility error between APP1 and idle switch
94	1	Low Fuel Pressure Sensor Error	Low fuel pressure: the low fuel pressure calculated by ECU is underneath the target range; the ECU activates a system reaction
94	3	Low Fuel Pressure Sensor Error	Low fuel pressure: the voltage of sensor measured by ECU is out of the target range, high
94	4	Low Fuel Pressure Sensor Error	Low fuel pressure: the voltage of sensor measured by the ECU is out of the target range, low
97	3	Water in Fuel Sensor Error	Fuel filter water level sensor: the voltage of sensor measured by ECU is out of the target range, high
97	4	Water in Fuel Sensor Error	Fuel filter water level sensor: the voltage of sensor measured by ECU is out of the target range, low
97	12	Water in Fuel Sensor Error	Fuel filter water level sensor: the maximum level is exceeded
100	1	Oil Pressure Sensor Error	Oil pressure is below the target range: warning, power reduction or shutdown threshold
100	3	Oil Pressure Sensor Error	Oil pressure sensor: the voltage of sensor measured by ECU is out of target range, high
100	4	Oil Pressure Sensor Error	Oil pressure sensor: the voltage of sensor measured by ECU is out of target range, low
102	1	Change Air Pressure Out-Of-Range	Pressure downstream charge air cooler, pressure below lower physical threshold
102	2	Charge Air Pressure Sensor Error	Charge air pressure measured by sensor is above the warning threshold or shutdown threshold

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
102	3	Charge Air Pressure Sensor Error	Charge air pressure sensor: the measured voltage of sensor by ECU is out of the target range, high
102	4	Charge Air Pressure Sensor Error	Charge air pressure sensor: the measured voltage of sensor by ECU is out of the target range, low
105	0	Charge Air Temperature Sensor Error	Charge air temperature downstream calculated by ECU is above the target range: the ECU activates a warning threshold or shutdown threshold
105	3	Charge Air Temperature Sensor Error	Charge air temperature sensor: the voltage of sensor measured by ECU is out of target range, high
105	4	Charge Air Temperature Sensor Error	Charge air temperature sensor: the voltage of sensor measured by ECU is out of target range, low
107	0	Air Filter Differential Pressure Sensor Error	Air filter differential pressure: the pressure difference of the intake air between the filter inlet and outlet calculated by ECU is above the target range and the ECU activates a warning threshold
110	0	Coolant Temperature Sensor Error	Coolant temperature: the coolant temperature calculated by ECU is above the target range; the ECU activates a warning power reduction or a shutdown threshold
110	1	Coolant Temperature Out-Of-Range	Physical range check low for coolant temperature
110	3	Coolant Temperature Sensor Error	Coolant Temperature sensor: the voltage of the sensor measured by ECU is out of the target range, high
110	4	Coolant Temperature Sensor Error	Coolant Temperature sensor: the voltage of the sensor measured by ECU is out of the target range, low
111	1	Coolant Level	Coolant Level: the coolant level calculated by the ECU is underneath the allowed minimum
157	3	Rail Pressure Sensor Error	Rail Pressure Sensor: the voltage of sensor measured by ECU is out of target range, high
157	4	Rail Pressure Sensor Error	Rail Pressure Sensor: the voltage of sensor measured by ECU is out of target range, low
164	2	Rail Pressure Sensor Error	Physical range check low for coolant temperature
168	0	Battery Voltage Sensor Error	Battery Voltage: the voltage measured by ECU is out of the target range, high

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
168	1	Battery Voltage Sensor Error	Battery Voltage: the voltage measured by ECU is out of the target range, low
168	2	Battery Voltage Sensor Error	Battery Voltage: the voltage measured by ECU is out of the target range, battery voltage above warning threshold
168	3	Battery Voltage Sensor Error	Battery Voltage: the voltage measured by ECU is out of the target range, battery voltage above warning threshold, short cut to battery
168	4	Battery Voltage Sensor Error	Battery Voltage: the voltage measured by ECU is out of the target range, battery voltage above warning threshold, short cut to ground
171	3	SCR Sensor Error	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check high
171	4	SCR Sensor Error	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check low
190	0	Engine Speed	Maximum engine speed exceeded
190	2	Engine Speed	ECU measures a offset angle between crankshaft and camshaft sensor is too large
190	8	Engine Speed	Camshaft Speed Sensor: ECU receives no signal, uses crankshaft sensor to calculate engine speed. Crankshaft Speed Sensor: disturbed signal
190	11	Engine Speed	Engine Speed: the engine speed calculated by ECU is above the target range, the ECU activates a warning threshold
190	12	Engine Speed	Crankshaft Speed Sensor Unavailable: ECU uses camshaft speed sensor. Speed detection; out of range, signal disrupted, erratic signal
190	14	Engine Speed	Engine Speed: the engine speed calculated by ECU is above the target range, the ECU activates a engine speed warning threshold
411	3	EGR Sensor Error	Sensor error differential pressure venturi unit (EGR), signal range check low
411	4	EGR Sensor Error	Physical range check low for EGR differential pressure Sensor error differential pressure venturi unit (EGR), signal range check high
412	3	EGR Electrical Error	Electrical error EGR cooler downstream temperature. Signal range check high
412	4	EGR Electrical Error	Electrical error EGR cooler downstream temperature. Signal range check low.

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
520	9	CAN Timeout Error	Timeout Error of CAN-Receive-Frame TSC1TR; control signal
630	12	EEPROM Error	The ECU finds an error during the access to its EEPROM memory or works with an alternative value
639	14	CAN-Bus error	CAN-Bus “BusOff-Status”
651	3	Electrical Error	Injector Cyl. 1: the current drop measure by ECU is above the target range, short circuit to injector 1
651	5	Electrical Error	Injector Cyl. 1: interruption of electrical connection
652	3	Electrical Error	Injector Cyl. 3: the current drop measure by ECU is above the target range, short circuit to injector 1
652	5	Electrical Error	Injector Cyl. 3: interruption of electrical connection
653	3	Electrical Error	Injector Cyl. 4: the current drop measure by ECU is above the target range, short circuit to injector 1
653	5	Electrical Error	Injector Cyl. 4: interruption of electrical connection
654	3	Electrical Error	Injector Cyl. 2: the current drop measure by ECU is above the target range, short circuit to injector 1
654	5	Electrical Error	Injector Cyl. 2: interruption of electrical connection
655	3	Short-Circuit Error	Injector 5 (in firing order); short circuit
655	5	Electrical Error	Injector 5 (in firing order); interruption of electric connection
656	3	Short-Circuit Error	Injector 6 (in firing order); short circuit
656	5	Electrical Error	Injector 6 (in firing order); interruption of electric connection
676	11	Cold Start Device Error	Cold start device relay error; cold start aid relay open load
677	3	Starter Relay Error	Starter Relay (high side power stage): The current drop measured by ECU is above the target range; starter relay high side short circuit to battery. Starter Relay (high side power stage): The current drain measured by ECU is above the target range; starter relay low side, short circuit to battery

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
677	4	Starter Relay Error	Starter Relay (high side power stage): The current drop measured by ECU is above the target range; starter relay low side short circuit to ground. Starter Relay (high side power stage): The current drain measured by ECU is above the target range; starter relay high side, short circuit to ground
677	5	Starter Relay Error	Starter Relay (low side power stage): the current drop measured by ECU is above the target range; open circuit/disconnection LowSide-Output
677	12	Starter Relay Error	Starter Relay (low side power stage): the current drop measured by ECU is above the target range; starter relay powerstage over temperature
729	3	Short-Circuit Error	Intake Air Heater Device; short-circuit to battery
729	4	Short-Circuit Error	Air intake heater; Short circuit to ground error for powerstage on CJ945
729	5	Cold Start Error	Cold start aid relay open load
898	9	Timeout Error	Timeout error: limp mode activated
1079	13	(ECU) Error	Internal Hardware Monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 1
1080	13	(ECU) Error	Internal Hardware Monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 2
1109	2	Engine Shut-off Error	Operator ignores the engine shut off request within an allowed period.
1136	0	ECU Temperature Range Check Error	Physical range check high for ECU temperature
1176	0	Turbine Pressure Sensor Out-Of-Range Error	Pressure sensor upstream turbine, physical range check high
1176	3	Turbine Pressure Sensor Out-Of-Range Error	Pressure sensor upstream turbine, signal range check (SRC) high
1176	4	Turbine Pressure Sensor Out-Of-Range Error	Pressure sensor upstream turbine, signal range check (SRC) low
1231	14	CAN BusOff Error	CAN Bus 1: the ECU is not allowed to send messages, because the status “BusOff” is detected
1235	14	CAN Bus Error	CAN-Bus 2 = engine bus BusOff-Status
1237	2	Override Switch Error	Override Switch: the ECU receives a permanent signal, plausibility error

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
1761	2	DEF Tank Error	DEF tank level plausibility error
1761	14	DEF Tank Error	DEF level below first warning threshold
2791	0	EGR Temperature Error	EGR actuator, temperature critically high
2791	2	EGR CAN error	EGR actuator, CAN error
2791	3	EGR Electrical Error	EGR actuator supply voltage above the maximum threshold
2791	4	EGR Electrical Error	EGR actuator supply voltage below minimum threshold
2791	6	EGR Electrical Error	EGR actuator current above maximum threshold
2791	7	EGR Error	EGR actuator blocked; EGR actuator, broken spring detected
2791	12	EGR Electrical Error	EGR actuator, internal electrical fault
2791	13	EGR Error	EGR actuator, EOL calibration error; EGR actuator, learning process aborted; EGR actuator, learning process out-of-range
2791	16	EGR Error	EGR actuator, temperature high
2797	4	Timeout Error	Timeout of short-circuit ground diagnosis cyl. bank 0;_IVDiaShCirGndToutBnk_0
2798	4	Short-Circuit Error	Injector diagnostic; Short circuit to ground cylinder bank 0 Injector diagnostic; Short circuit to ground cylinder bank 1
3031	0	DEF Tank Error	DEF temperature in DEF tank too high
3031	1	DEF Tank Error	DEF temperature below lower physical threshold
3224	9	CAN timeout Error	Timeout Error of CAN-Receive-Frame AT1IG1Vol; NOX sensor
3234	2	CAN Error	DLC Error of CAN-Receive-Frame AT1O1Vol NOX
3234	9	CAN Error	Timeout Error of CAN-Receive-Frame AT1OG1Vo
3251	0	DPF Error	Differential pressure DPF maximum value is exceeded Differential pressure sensor across DPF exceeds warning high limit
3251	1	DPF Error	Differential pressure DPF, pressure below lower shutoff threshold Differential pressure DPF, pressure below lower warning threshold.
3253	2	DPF Error	Differential pressure DPF, plausibility error

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
3253	3	Electrical Error	Electrical error differential pressure B58 (DPF); (signal range check high)
3253	4	Electrical Error	Electrical error differential pressure (DPF); signal range check low
3361	3	Short-Circuit Error (DEF)	DEF dosing valve; short circuit to battery on low side DEF dosing valve; short circuit to battery or open load on high side
3361	4	Short-Circuit Error (DEF)	Urea dosing valve; short circuit to ground or open load on low side DEF dosing valve; short circuit on high side
3361	6	DEF Error	DEF dosing valve; power at the end of injection too high
3519	3	DEF Error	DEF quality sensor, internal temperature sensor short circuit to battery or open load
3519	4	DEF Error	DEF quality sensor, internal temperature sensor short circuit to ground
3519	12	DEF Error	DEF tank temperature, temperature too high
3519	13	Invalid UQS Temperature	Temperature at UQS out of range the specified thresholds; invalid temperature quality
3520	1	DEF Error	Bad DEF quality
3520	2	DEF Error	DEF quality sensor, bad DEF quality detected or no DEF measuring possible
3520	3	DEF Error	DEF quality sensor, short circuit to battery or open load
3520	4	Short-Circuit Error (DEF)	DEF quality sensor, short circuit to ground
3520	8	DEF Error	DEF quality sensor, measurement conditions not fulfilled
3520	13	Invalid UQS Urea Quality	Urea quality at UQS out of range the specified thresholds; invalid quality of the urea qualiy
3532	3	DEF Error	Sensor error DEF tank level; signal range check high The DEF Level at UQS out of max. physical range
3532	4	DEF Error	Sensor error DEF tank level; signal range check low Quality at UQS out of min. physical range
3532	13	DEF Error	DEF quality sensor, tank level; DEF level out of physical range
3711	12	Standstill Error	Temperature during standstill main phase too low or too high

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
3936	14	Standstill Error	Standstill request ignored too long Standstill time based escalation requests Inducement step 2
4171	2	SCR Error	Dynamic check of temperature before SCR
4334	0	DEF Error	Supply module DEF, DEF pressure above upper physical threshold
4334	2	DEF Error	DEF supply module pressure, plausibility error
4341	3	Short-Circuit Error (DEF)	SCR-heater DEF supply line; short circuit to battery
4341	4	Short-Circuit Error (DEF)	SCR-heater DEF supply-line; short circuit to ground
4341	5	DEF Error	SCR heater relay DEF supply line primary side; open load
4343	3	DEF Error	SCR heater DEF pressure line; short circuit to battery
4343	4	DEF Error	SCR heater DEF pressure line; short circuit to ground
4343	5	DEF Error	SCR heater relay DEF pressure line primary side; open load
4345	3	DEF Error	SCR heater DEF return line; short circuit to battery
4345	4	DEF Error	SCR heater DEF return line; short circuit to ground
4345	5	DEF Error	SCR heater relay DEF return line primary side; open load
4360	0	SCR-Cat Over-Temperature	Exhaust temperature upstream SCR-Cat, temperature above upper physical threshold; The filtered DEF cat upstream temperature is greater than an applicable maximum temperature threshold

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
4360	2	SCR-Cat Temperature Plausibility Error	Error at static plausibility check: absolute temperature difference of sensed temperature upstream SCR catalyst and ambient temperature > as static plausibility limit at engine cold start (engine was off for at least 8 h), temperature upstream of SCR catalyst is expected to be identical to ambient temperature => Error at dynamic plausibility check: temperature difference of sensed temperature upstream SCR catalyst and ambient temperature < as dynamic plausibility limit dynamic check is blocked if static plausibility check is already faulty => Temperature upstream SCR catalyst must be by 40°C higher than ambient temperature if engine runs and a certain delay time has expired
4361	3	DEF Error	DEF catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range
4361	4	DEF Error	DEF catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range
4365	3	Urea Tank/DEF Error	Urea tank temperature sensor: the current drain measured by ECU is above the target range; DEF quality sensor, tank temperature short circuit to battery or open load
4365	4	Urea Tank/DEF Error	Sensor error urea tank temperature; short circuit to ground; DEF quality sensor, tank temperature; short circuit to ground
4365	12	Urea Tank Error	Urea tank temperature above the warning threshold
4365	13	Urea Tank/DEF Error	DEF quality sensor, tank temperature; temperature out of physical range
4366	4	Short-Circuit Error (SCR)	SCR Tank heating valve; short circuit to ground
4366	5	SCR Error	SCR tank heating valve primary side; open load
4375	3	Short-Circuit Error (SCR)	Urea pump motor; short circuit to battery
4375	4	Short-Circuit Error (SCR)	Urea pump motor; short circuit to ground
4375	5	SCR Error	Urea pump motor; open load
4376	3	Short-Circuit Error (SCR)	SCR reversal valve; short circuit to battery
4376	4	Short-Circuit Error (SCR)	SCR reversing valve; short circuit to ground
4376	5	SCR Error	SCR reversal valve; open load

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
4765	0	Exhaust Temperature Error	Temperature upstream DOC, temperature above upper shutoff threshold; temperature above upper warning threshold
4766	0	Exhaust Temperature Error	Temperature downstream DOC, temperature above upper shutoff threshold; temperature above upper warning threshold
4768	2	Exhaust Temperature Error	Temperature upstream DOC, plausibility error; Exhaust gas temperature sensors up- and downstream DOC are physically swapped
4768	3	Exhaust Temperature Error	Electrical error exhaust gas temperature upstream (DOC); signal range check high
4768	4	Exhaust Temperature Error	Electrical error exhaust gas temperature upstream (DOC); signal range check low
4769	2	Exhaust Temperature Error	Temperature downstream DOC, plausibility error
4769	3	Exhaust Temperature Error	Sensor error exhaust gas temperature downstream (DOC); signal range check high
4769	4	Exhaust Temperature Error	Sensor error exhaust gas temperature downstream (DOC); signal range check low
520521	5	Actuator Error (EGR)	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); signal range check low
523009	9	Pressure Relief Valve Error	Rail Pressure Relief Valve: reached maximum allowed opening count
523009	10	Pressure Relief Valve Error	Rail Pressure Relief Valve: reached maximum allowed opening time
523211	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame EBC1
523212	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection
523240	9	Timeout Error (CAN)	Timeout CAN-message FunModCtl; Function Mode Control
523350	4	Injector Short Circuit Error	Injector Cylinder - Bank 1: short circuit
523352	4	Injector Short Circuit Error	Injector Cylinder - Bank 2: short circuit
523354	12	Injector Error	ECU detects an error of its injector high current output; injector powerstage output defect
523470	2	Pressure Relief Valve (PRV) Error	PRV will be forced to open; performed by pressure increase. PRV: is open, will be forced to open, the forced open failed; performed by pressure shock
523470	7	Pressure Relief Valve (PRV) Error	Rail pressure is out of the expected range; Maximum rail pressure in limp home mode exceeded, monitoring for maximum rail pressure in limp home mode with PRV

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
523470	11	Pressure Relief Valve (PRV) Error	Rail pressure relief valve can't be opened due to rail pressure; PRV error; rail pressure out of tolerance range; average rail pressure is outside the expected tolerance range
523470	12	Pressure Relief Valve (PRV) Error	Rail pressure relief valve open; PRV forced to open; system reaction initiated, fault path indicating shutoff condition in case of open PRV; power reduction may result
523470	14	Pressure Relief Valve (PRV) Error	Rail pressure relief valve open;PRV is open; PRV in rail is open; power reduction may result
523550	12	T50 Start Switch Error	Terminal 50: ECU receives a permanent signal; T50 start switch active for too long; start information to starter T50 Switch erratic/defect
523601	13	Sensor Supply Voltage Monitor 3 Error	Internal Hardware Monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 3
523605	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame TSC1AE; Traction Control
523606	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame TSC1AR; Retarder
523612	3	Electrical Error	Reported supply over-voltage
523612	4	Electrical Error	Reported supply under-voltage
523612	12	Software Error	ECU Internal software error; power reduction may result. Internal ECU monitoring detection reported error
523612	14	Software Error	Internal Hardware Monitoring: ECU CPU reset and cause is logged internally; no item created in error memory; software reset CPU, software visibility resets in DSM
523613	0	Rail Pressure Error	Rail Pressure: fuel pressure in rail below target range dependent on engine speed; rail pressure disrupted, positive governor deviation; maximum positive rail pressure deviation exceeded concerning set fuel flow; power reduction may result
523613	1	Rail Pressure Error	Rail Pressure: fuel pressure in rail exceeds target range dependent on engine speed; rail pressure disrupted, maximum negative rail pressure deviation with metering unit on lower limit is exceeded

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
523613	2	Metering Unit Error	Rail Pressure: fuel pressure in rail exceeds target rage dependant on engine speed; rail pressure disrupted, leakage detected based on fuel quantity balance; power reduction may result
523615	3	Metering Unit Error	Rail Pressure: fuel pressure in rail exceeds target range dependent on engine speed; rail pressure disrupted, maximum rail pressure exceeded
523615	4	Metering Unit Error	Rail Pressure: fuel pressure in rail calculated by ECU is below the target range which is dependant on engine speed; minimum rail pressure exceeded
523615	5	Fuel System Error	Fuel metering unit: the ECU detects no load or temperature excess of the ECU component for power supply of the valve; Metering unit (Fuel-System); open load; power reduction may result
523632	3	Sensor Error	Sensor error urea pump pressure; signal range check high
523632	4	Sensor Error	Sensor error urea pump pressure; signal range check low
523632	11	Electrical Error	Pump motor not available for actuation
523698	11	SCR Error	Rail Pressure: fuel pressure in rail calculated by ECU is below the target range which is dependent on engine speed; setpoint of metering unit in over-run mode not plausible
523718	3	Short-Circuit Error (SCR)	SCR main relay (primary side); short circuit to battery
523718	4	Short-Circuit Error (SCR)	SCR main relay (primary side); short circuit to ground
523718	5	Electrical Error	Tank heating valve; open load
523719	3	Short-Circuit Error (SCR)	SCR heater DEF supply module; short circuit to battery
523719	4	Short-Circuit Error (SCR)	SCR heater DEF supply module; short circuit to ground
523719	5	Electrical Error (SCR)	SCR heater relay DEF supply module primary side; open load
523720	8	Temperature Error (DEF)	DEF supply module heater temperature; duty cycle in failure range; duty cycle in invalid range
523721	8	Temperature Error	DEF supply module temperature; duty cycle in failure range; Urea supply module temperature; duty cycle in invalid range.
523721	11	Temperature Error	Urea supply module temperature measurement not available

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
523722	8	PWM Signal Error (DEF)	DEF supply module PWM signal; period outside valid range; Detect faulty PWM signal from supply module
523741	14	CAN Error	Engine shutoff request through CAN
523766	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame Active TSC1AE
523767	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame Passive TSC1AE
523768	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame Active TSC1AR
523769	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame Passive TSC1AR
523776	9	Timeout Error	Fuel Metering Unit: current drain measured by ECU is above the target range; short circuit to battery high side; short circuit to battery low side
523777	9	Passive Timeout Error	Fuel Metering Unit: current drain measured by ECU is above the target range; short circuit to ground high side; short circuit to ground low side
523778	9	Timeout Error (CAN)	Timeout Error of CAN-Receive-Frame TSC1TR
523779	9	Timeout Error (CAN)	Passive Timeout Error of CAN-Receive-Frame TSC1TR
523895	13	Injector Adjustment Error	Engine Shut Off request from supervisory monitoring function
523896	13	Injector Adjustment Error	Timeout Error; limp mode activated
523897	13	Injector Adjustment Error	Passive Timeout Error; limp mode activated
523898	13	Injector Adjustment Error	Missing or wrong injector adjustment value programming (IMA) injector 1
523900	13	Fuel Injector Error	Check of missing injector adjustment value programming (IMA) injector 6 (in firing order)
523906	3	Fuel Pump Error	ECU detects short cut to battery in fuel feed pump circuit; electric fuel pre-supply pump short circuit to battery
523906	4	Fuel Pump Error	ECU detects short cut to ground in fuel feed pump circuit; electric fuel pre-supply pump short circuit to ground
523906	5	Fuel Pump Error	ECU detect open load on the electric fuel feed pump output: electric fuel pre-supply pump open load, cable break
523906	12	Fuel Pump Error	ECU detects to high temperature in powerstage of fuel pump circuit; electric fuel pre-supply pump powerstage over temperature

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
523912	4	Electrical/CAN Error	@ engines < 4l: Throttle valve error, open load or short cut to battery, blocked valve or wrong control signal for valve. @ engines with burner T4i: Pressure sensor error after valve (DV2), lower limit reached
523924	4	Short-Circuit Error	UB2; short-circuit to ground of actuator relay 2
523925	3	Short-Circuit Error	UB3: short-circuit to battery of actuator relay 3
523925	4	Short-Circuit Error	UB3; short circuit to ground of actuator relay 3
523926	4	Short-Circuit Error	UB4; short-circuit to ground of actuator relay 4
523927	3	Short-Circuit Error	UB5; short-circuit to battery of actuator relay 5
523935	12	Timeout Error (CAN)	Timeout Error of CAN-Transmit-Frame EEC3VOL1; engine send messages
523936	12	Timeout Error (CAN)	Timeout Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages
523942	9	Calibration Error	Calibration message 1 of the after-catalyst NOx sensor has failed
523960	0	Temperature Error (EGR)	Physical range check high for EGR cooler downstream temperature
523982	0	Powerstage Diagnosis Disabled	Powerstage Diagnosis Disabled; high battery voltage
523982	1	Powerstage Diagnosis Disabled	Powerstage Diagnosis Disabled; low battery voltage
523984	3	Short-Circuit Error	UB7; short-circuit to battery error of actuator relay 7
523986	4	Short-Circuit Error	UB6; short-circuit to ground actuator relay 6
523987	4	Short-Circuit Error	UB7; short-circuit to ground actuator relay 7
524025	8	Timeout Error	Maximum launch time for standstill exceeded (60min)
524057	2	Fuel Pressure Error	Electric Fuel Pump; fuel pressure build up error
524063	3	Short-Circuit Error (SCR)	SCR heater main relay; short-circuit to battery
524063	4	Short-Circuit Error (SCR)	SCR heater main relay load side (K31) on heating valve (Y31), short-circuit to ground

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
524063	5	Electrical Error	Urea backflow line heater: broken wiring detected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2 SCR main relay not connected; SCR heater pressure line; open load; Relay Urea suction line: broken wiring detected (open load) -- SCR suction line (K28) SCR heater supply module; open load SCR heater tank; open load
524063	12	Timeout Error	DEF tank, time for defrosting too long
524065	0	Over-Pressure Error	Pressure sensor upstream SCR-CAT, pressure above upper physical threshold
524065	1	Under-Pressure Error	Pressure sensor upstream SCR-CAT, pressure below lower physical threshold
524065	2	Plausibility Error	Pressure sensor upstream SCR-CAT, plausibility error
524065	3	Electrical Error	Pressure sensor upstream SCR-CAT; short circuit battery or open load
524065	4	Short-Circuit Error	Pressure sensor upstream SCR-CAT; short circuit ground
524067	0	Over-Temperature Error	DEF supply module, heater temperature above upper physical threshold
524067	1	Under-Temperature Error	DEF supply module, heater temperature below lower physical threshold
524067	2	Plausibility Error	Supply module heater temperature, plausibility error
524074	9	Electrical Error	NOx sensor downstream SCR-CAT, sensor internally open load
524075	11	Short-Circuit Error	NOx sensor downstream SCR-CAT, sensor internally short circuit
524076	9	Electrical Error	NOx sensor upstream SCR-CAT, sensor internal open line
524077	11	Short-Circuit Error	NOx sensor upstream SCR-CAT, sensor internal short-circuit
524078	9	Plausibility Error	NOx sensor downstream SCR-CAT, lambda value above upper physical threshold
524079	9	Plausibility Error	NOx sensor downstream SCR-CAT, lambda value below lower physical threshold
524080	9	Plausibility Error	NOx sensor upstream SCR-CAT, lambda value above upper physical threshold

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
524081	9	Plausibility Error	NOx sensor upstream SCR-CAT, lambda value below lower physical threshold
524108	9	Timeout Error	Missing CAN message of EGR throttle valve; Timeout Error of CAN-Transmit-Frame ComEGRTVActr, Missing CAN Bus message
524109	9	Timeout Error	Missing message of EGR throttle valve; Timeout error of CAN-Receive-Frame ComRxEGRTVActr, Missing CAN Bus message
524133	2	Electrical Error	State of digital input standstill release switch
524134	0	Threshold Error	DPF ash load exceeds the shutoff threshold
524135	0	Threshold Error	DPF ash load exceeds the warning threshold; DPF soot load exceeds the shutoff threshold
524135	14	Threshold Error	DPF soot load exceeds the service request threshold
524147	7	SCR System Error	SCR system reverting valve blocked
524147	13	Plausibility Error	SCR system pressure build-up not possible Set together with DFC_SCRCoBldUpLoPres. DFC_SCRCoBldUpLoPresRst is only used for inducement purposes. It ensures that legal inducement is working correctly
524152	2	Timeout Error (CAN)	Urea quality sensor; Timeout CAN message
524153	2	Timeout Error (CAN)	Urea tank level and urea tank temperature via CAN bus, timeout of CAN message
524175	0	Threshold Error	SCR-CAT NOx emissions above maximum threshold
524178	7	Out-of-Range Error (CAN)	SCR system DEF pressure out-of-range
524190	14	DEF Error	Inducement level 1 active; Not enough urea in tank, low urea quality, hardware tampering failure is detected, or hardware failure is detected
524191	14	DEF Error	Inducement level 2 active; Low DEF tank level, a low DEF quality is detected, hardware tampering (system components are pinched off) or hardware failures as shortcut to battery, shortcut to ground etc. are detected
524193	8	Timeout Error	Standstill regeneration mode time exceeds long-limit threshold; machine too long or too often in standstill mode
524194	8	Timeout Error	Standstill regeneration mode time exceeds short-limit; Machine too long or too often within a short time in standstill mode
524195	14	Timeout Error	Standstill request due to crystallization ignored too long

Table 51: Deutz Engine Diagnostic Trouble Codes (DTC)

DTC			
SPN	FMI	Trouble Code Type	Error Description
524267	14	2nd Level Inducement Error	General inducement error. Refer to official Deutz engine error code documentation for more information

Travel Drive Control Module Error Codes

Certain types of drive errors will cause restricted modes. The errors are listed in the following table.

In less severe (LIMITED-Mode) error cases, the travel drive operates, but pump power is reduced by 50% and the drive motor operates in full displacement, causing the machine to move slowly.

When a “LIMITED-Mode” error occurs, the travel direction switch on the joystick must be switched to “Neutral” (N) and then moved into either “Forward” (F) or “Reverse” (R) before the travel drive will operate.

NOTE: *Due to the reduced pump power and drive motor displacement, the travel drive pedal must be displaced further than normal, or the travel drive control module will not detect the speed signal and the travel drive will not operate.*

In severe (SAFE-Mode) error cases, the travel drive is disabled. The error can only be cleared by turning the power off.

If several errors occur at once, the errors are prioritized. The error with the lowest numeric Error Flash Code will display.

Table 52: Travel Drive Control Module Error Codes

Error Flash Code	Description	Action
13	Watchdog Ready Error	SAFE-Mode
15	Battery Voltage or Sensor Voltage Error	SAFE-Mode
19	Pump Current Forward Error	SAFE-Mode
23	Pump Current Reverse Error	SAFE-Mode
27	Motor Current Error	SAFE-Mode
31	Engine Speed RPM Error	LIMITED-Mode
35	FNR Shortcut Error	SAFE-Mode
39	Inching Error	LIMITED-Mode
43	Driving Pedal Error	LIMITED-Mode
47	Mode Switch-2 Error	LIMITED-Mode
55	Break Pressure Defeat Error (or Parking Brake Error or Brake Light Error)	SAFE-Mode
59	Motor RPM and Direction Error	LIMITED-Mode
70	General CAN Receive Error	LIMITED-Mode

Error Flash Codes (Blinkcode) are displayed via the blinking red LED light next to 12-pin connector (X, Fig. 256) on the bottom of travel drive control module (Z), which is located inside the panel at right rear corner inside the cab/canopy.

NOTE: *Hold a piece of paper under travel drive control module to reflect the LED flashes/blinks.*

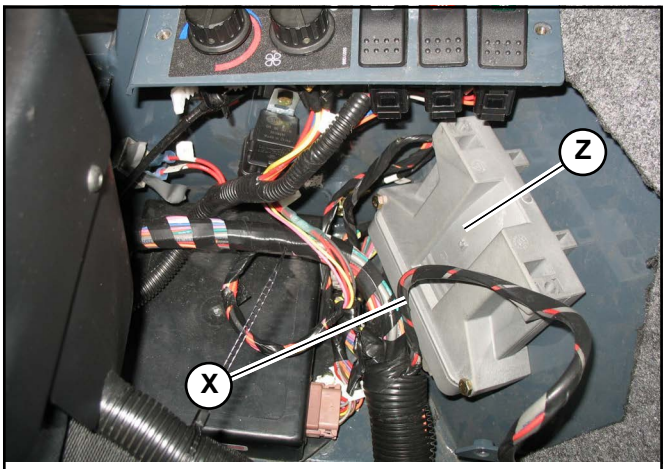


Fig. 256 – Travel Drive Control Module

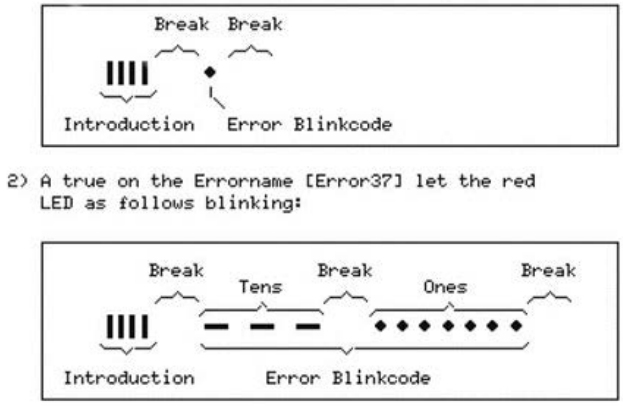


Fig. 257 – Travel Drive Control Module Error Flash Code (Blinkcode) Interpretation

Pump and Drive Motor Error Codes

Table 53: Pump and Drive Motor Error Codes

SPN	FMI	Description
168	-	Battery power fault
	0	Battery power fault: High: Data valid but above normal operational range
	1	Battery power fault: Low: Data valid but below normal operational range
3509	-	Sensor Power fault
	0	Sensor Power fault: High: Data valid but above normal operational range
	1	Sensor Power fault: Low: Data valid but below normal operational range
1083	-	CAN1 node error
	9	CAN1 node error: Time out/over-run/bus-off/driver error: Abnormal update rate
741	-	Pump valve fwd.: Transmission forward solenoid valve
	5	Pump valve fwd.: Transmission forward solenoid valve: Open circuit: Current below normal or open circuit
	6	Pump valve fwd.: Transmission forward solenoid valve: Short circuit: Current above normal or grounded circuit
	13	Pump valve fwd.: Transmission forward solenoid valve: Out of calibration
4216	-	Pump valve rev.: Transmission reverse solenoid valve
	5	Pump valve rev.: Transmission reverse solenoid valve: Open circuit: Current below normal or open circuit
	6	Pump valve rev.: Transmission reverse solenoid valve: Short circuit: Current above normal or grounded circuit
	13	Pump valve rev.: Transmission reverse solenoid valve: Out of calibration
1614	-	Motor rpm: Vehicle over-speed
	0	Motor rpm: Vehicle overspeed: Value too high: Data valid but above normal operational range
4217	-	Motor proportional solenoid: Transmission shift modulation solenoid valve
	5	Motor proportional solenoid: Transmission shift modulation solenoid valve: Open circuit: Current below normal or open circuit
	6	Motor proportional solenoid: Transmission shift modulation solenoid valve: Short circuit: Current above normal or grounded circuit
1594	-	Motor PPU wiring
	3	Motor PPU wiring: Short to battery: Voltage above normal or shorted high
	4	Motor PPU wiring: Short to ground: Voltage below normal or shorted low
	5	Motor PPU wiring: Open circuit: Current below normal or open circuit

CE

SAMPLE DOC

EC Declaration of Conformity

1. Manufacturer: **Manitou Equipment America LLC**
2. Address **One Gehl Way**
   West Bend, WI 53095 U.S.A.

3. Technical Construction File Location: **Manitou Interface and Logistics Europe**

4. Authorized Representative **Manitou Interface and Logistics Europe**
5. Address: **Rue DesAndains 2**
   Perwez, 1360
   Belgium

6. We hereby declare that the machines listed below conform to EC Directives: 2004/30/ UE (EMC), 2006/42/EC (Machinery) and 2000/14/EC (Noise Emission), as amended by EU/2024/1208.

7. In accordance with EN/ISO Standards: **EN 474-1:2022 and EN 474-3:2022**
8. Designation: **EARTH-MOVING MACHINERY/LOADERS/ COMPACT**
9. Model: **AL608, AL708, AL708T, MLA-T 516-75 H**
10. Serial Number:
11. Net Installed Power **kW**
12. Sound Power Levels – (measured): **dB(A)**
    (guaranteed): **dB(A)**
13. Directive/Conformity Assessment Procedure/Notified Body:

2000/14/EC	**Annex VI (Procedure 1)**	**TÜV Industrie Service GmbH – TÜV SÜD Group Westendst. 199, D-80686 München GERMANY**

14. Name:
15. Position/Title:
16. (Signature)
17. Place:
18. Date:

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Torque Specifications

Note: Use these torque values when tightening hardware (excluding: locknuts and self-tapping, thread forming and sheet metal screws) unless specified otherwise.

Hydraulic fittings with various seals (light application). All torque values are in Nm (lb.-ft.) unless marked otherwise.

Thread	Straight pipe fitting with thread and screwed plug (GE)			Non-return valve with elastic seal	Identification aid outside Ø
	Sealing washer	Elastic seal	O-ring		
M10X1.0	9 (7)	18 (13)	15 (11)	18 (13)	10 mm (0.4 in.)
M12X1.5	20 (15)	25 (18)	25 (18)	25 (18)	12 mm (0.5 in.)
M14X1.5	35 (26)	45 (33)	26 (35)	35 (26)	14 mm (0.6 in.)
M16X1.5	45 (33)	55 (41)	40 (30)	50 (37)	16 mm (0.6 in.)
M18X1.5	55 (41)	70 (52)	45 (33)	70 (52)	18 mm (0.7 in.)
M22X1.5	65 (48)	125 (92)	60 (44)	125 (92)	22 mm (0.9 in.)
M27X2.0	90 (66)	180 (133)	100 (74)	145 (107)	27 mm (1.0 in.)
M33X2.0	150 (111)	310 (229)	160 (118)	210 (155)	33 mm (1.3 in.)
M42X2.0	240 (177)	450 (332)	210 (155)	360 (266)	42 mm (1.7 in.)
M48X2.0	290 (214)	540 (398)	260 (192)	540 (398)	48 mm (1.9 in.)
G1/8A	9 (7)	13 (18)	15 (11)	18 (13)	9.73 mm (0.4 in.)
G1/4A	35 (26)	35 (26)	30 (22)	35 (26)	13.16 mm (0.5 in.)
G3/8A	45 (33)	70 (52)	45 (33)	50 (37)	16.66 mm (0.7 in.)
G1/2A	65 (48)	90 (66)	55 (41)	65 (48)	20.96 mm (0.8 in.)
G3/4A	90 (66)	180 (133)	100 (74)	140 (103)	26.44 mm (1.0 in.)
G1A	150 (111)	310 (229)	160 (118)	190 (140)	33.25 mm (1.3 in.)
G1 1/4A	240 (177)	450 (332)	210 (155)	360 (266)	41.91 mm (1.7 in.)
G1 1/2A	290 (214)	540 (398)	260 (192)	540 (398)	47.80 mm (1.9 in.)

Hydraulic fittings with various seals (heavy application). All torque values are in Nm (lb.-ft.) unless marked otherwise.

Thread	Straight pipe fitting with thread and screwed plug (GE)			Non-return valve with elastic seal	Identification aid outside Ø
	Sealing washer	Elastic seal	O-ring		
M12X1.5	20 (15)	35 (26)	35 (26)	35 (26)	12 mm (0.5 in.)
M14X1.5	35 (26)	55 (41)	45 (33)	45 (33)	14 mm (0.6 in.)
M16X1.5	45 (33)	70 (52)	55 (41)	55 (41)	16 mm (0.6 in.)
M18X1.5	55 (41)	90 (66)	70 (52)	70 (52)	18 mm (0.7 in.)
M20X1.5	55 (41)	125 (92)	80 (59)	100 (74)	20 mm (0.8 in.)
M22X1.5	65 (48)	135 (100)	100 (74)	125 (92)	22 mm (0.9 in.)
M27X2.0	90 (66)	180 (133)	170 (125)	135 (100)	27 mm (1.0 in.)
M33X2.0	150 (111)	310 (229)	310 (229)	210 (155)	33 mm (1.3 in.)
M42X2.0	240 (177)	450 (332)	330 (243)	360 (266)	42 mm (1.7 in.)
M48X2.0	290 (214)	540 (398)	420 (310)	540 (398)	48 mm (1.9 in.)
G1/8A	35 (26)	55 (41)	45 (33)	45 (33)	13.16 mm (0.5 in.)
G1/4A	45 (33)	80 (59)	60 (44)	60 (44)	16.66 mm (0.7 in.)
G3/8A	65 (48)	115 (85)	75 (55)	100 (74)	20.96 mm (0.8 in.)
G1/2A	90 (66)	180 (133)	170 (125)	145 (107)	26.44 mm (1.0 in.)
G3/4A	150 (111)	310 (229)	310 (229)	260 (192)	33.25 mm (1.3 in.)
G1A	240 (177)	450 (332)	330 (243)	360 (266)	41.91 mm (1.7 in.)
G1 1/4A	290 (214)	540 (398)	420 (310)	540 (398)	47.80 mm (1.9 in.)

With coarse-pitch thread. All torque values are in Nm (lb.-ft.) unless marked otherwise.					
Thread	Threads according to DIN 912, DIN 931, DIN 933, etc.			Threads according to DIN 7984	
	8.8	10.9	12.9	8.8	10.9
M5	5.5 (4.1)	8 (6)	10 (7)	5 (4)	7 (5)
M6	10 (7)	14 (10)	17 (13)	8.5 (6.3)	12 (9)
M8	25 (18)	35 (26)	42 (31)	20 (15)	30 (22)
M10	45 (33)	65 (48)	80 (59)	40 (30)	59 (44)
M12	87 (64)	110 (81)	147 (108)	69 (51)	100 (74)
M14	135 (100)	180 (133)	230 (170)	110 (81)	160 (118)
M16	210 (155)	275 (203)	350 (258)	170 (125)	250 (184)
M18	280 (207)	410 (302)	480 (354)	245 (181)	345 (254)
M20	410 (302)	570 (420)	690 (509)	340 (251)	490 (361)
M22	550 (406)	780 (575)	930 (686)	460 (339)	660 (487)
M24	710 (524)	1000 (738)	1190 (878)	590 (435)	840 (620)
M27	1040 (767)	1480 (1092)	1770 (1305)	870 (642)	1250 (922)
M30	1420 (1047)	2010 (1482)	2400 (1770)	1200 (885)	1700 (1254)

With fine-pitch thread. All torque values are in Nm (lb.-ft.) unless marked otherwise.					
Thread	Threads according to DIN 912, DIN 931, DIN 933, etc.			Threads according to DIN 7984	
	8.8	10.9	12.9	8.8	10.9
M8X1.0	25 (18)	37 (27)	32 (43)	22 (16)	32 (24)
M10X1.0	50 (37)	75 (55)	88 (65)	43 (32)	65 (48)
M10X1.25	49 (36)	71 (52)	83 (61)	42 (31)	62 (46)
M12X1.25	87 (64)	130 (96)	150 (111)	75 (55)	110 (81)
M12X1.5	83 (61)	125 (92)	145 (107)	72 (53)	105 (77)
M14X1.5	135 (100)	200 (148)	173 (235)	120 (89)	175 (129)
M16X1.5	210 (155)	310 (229)	360 (266)	180 (133)	265 (195)
M18X1.5	315 (232)	450 (332)	530 (391)	270 (199)	385 (284)
M20X1.5	440 (325)	630 (465)	730 (538)	375 (277)	530 (391)
M22X1.5	590 (435)	840 (620)	980 (723)	500 (369)	710 (524)
M24X2.0	740 (546)	1070 (789)	1250 (922)	630 (465)	900 (664)
M27X2.0	1100 (811)	1550 (1143)	1800 (1328)	920 (679)	1300 (959)
M30X2.0	1500 (1106)	2150 (1586)	2500 (1844)	1300 (959)	1850 (1364)

SAE Torque Values

NOTE: *Torque values are lb.-ft. unless marked with an *, which are lb.-in.*

UNIFIED NATIONAL THREAD	GRADE 2		GRADE 5		GRADE 8	
	DRY	LUBED	DRY	LUBED	DRY	LUBED
8-32	19*	14*	30*	22*	41*	31*
8-36	20*	15*	31*	23*	43*	32*
10-24	27*	21*	43*	32*	60*	45*
10-32	31*	23*	49*	36*	68*	51*
1/4-20	66*	50*	9	75*	12	9
1/4-28	76*	56*	10	86*	14	10
5/16-18	11	9	17	13	25	18
5/16-24	12	9	19	14	25	20
3/8-16	20	15	30	23	45	35
3/8-24	23	17	35	25	50	35
7/16-14	32	24	50	35	70	55
7/16-20	36	27	55	40	80	60
1/2-13	50	35	75	55	110	80
1/2-20	55	40	90	65	120	90
9/16-12	70	55	110	80	150	110
9/16-18	80	60	120	90	170	130
5/8-11	100	75	150	110	220	170
5/8-18	110	85	180	130	240	180
3/4-10	175	130	260	200	380	280
3/4-16	200	150	300	220	420	320
7/8-9	170	125	430	320	600	460
7/8-14	180	140	470	360	660	500
1-8	250	190	640	480	900	680
1-12	270	210	710	530	1000	740

WARNING

THIS OPERATOR'S MANUAL IS PROVIDED FOR OPERATOR USE

DO NOT REMOVE FROM THIS MACHINE

Do not start, operate or work on the machine until you carefully read and thoroughly understand the contents of this Operator's Manual.

Failure to follow safety, operating and maintenance instructions can result in serious injury to the operator or bystanders, poor operation, and costly breakdowns.

If you have any questions on proper operation, adjustment or maintenance of the machine, contact your dealer or the Manitou Group Service Department before starting or continuing operation.

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For Support and Service, Contact Your Dealer

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