1221F
Tier 4
Wheel Loader

SERVICE MANUAL

Part number 47544213
1st edition English
August 2013

CASE CONSTRUCTION

1. STRUCTURE

This service manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.
This service manual mainly contains the necessary technical information for operations performed in a service workshop.
For ease of understanding, the manual is divided into the following sections.

Structure and function

This group explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

Operational checks and troubleshooting

This group explains the system operational checks and troubleshooting charts correlating problem to remedy.

Tests and adjustments

This group explains checks to be amide before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs.

Disassembly and assembly

This section explains the order to be followed when removing, installing, disassembling or assembling each component, as well as precautions to be taken for these operations.

The specifications contained in this shop manual are subject to change at any time and without any advance notice. Contact your Case distributor for the latest information.

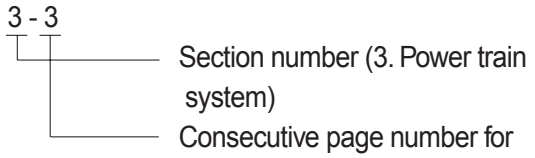
2. HOW TO READ THE SERVICE MANUAL

Distribution and updating

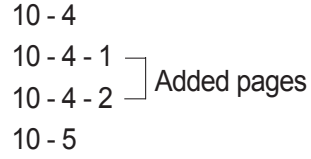
Any additions, amendments or other changes will be sent to Case distributors.
Get the most up-to-date information before you start any work.

Filing method

1. See the page number on the bottom of the page.
   File the pages in correct order.
2. Following examples shows how to read the page number.
   Example 1



3. Additional pages : Additional pages are indicated by a hyphen(-) and number after the page number. File as in the example.



Revised edition mark (①②③…)

When a manual is revised, an edition mark is recorded on the bottom outside corner of the pages.

Revisions

Revised pages are shown at the list of revised pages on the between the contents page and section 1 page.

Symbols

So that the shop manual can be of ample practical use, important places for safety and quality are marked with the following symbols.

Symbol	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work.
		Extra special safety precautions are necessary when performing the work because it is under internal pressure.
※	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.

CONTENTS

SECTION 7 ELECTRICAL SYSTEM

SECTION 1 GENERAL

Foreword - Ecology and the environment

Soil, air, and water are vital factors of agriculture and life in general. When legislation does not yet rule the treatment of some of the substances required by advanced technology, sound judgment should govern the use and disposal of products of a chemical and petrochemical nature.

NOTE: *The following are recommendations that may be of assistance:*

- Become acquainted with and ensure that you understand the relative legislation applicable to your country.
- Where no legislation exists, obtain information from suppliers of oils, filters, batteries, fuels, antifreeze, cleaning agents, etc., with regard to their effect on man and nature and how to safely store, use, and dispose of these substances.
- Agricultural consultants will, in many cases, be able to help you as well.

Helpful hints

- Avoid filling tanks using cans or inappropriate pressurized fuel delivery systems that may cause considerable spillage.
- In general, avoid skin contact with all fuels, oils, acids, solvents, etc. Most of them contain substances that may be harmful to your health.
- Modern oils contain additives. Do not burn contaminated fuels and or waste oils in ordinary heating systems.
- Avoid spillage when draining off used engine coolant mixtures, engine, gearbox and hydraulic oils, brake fluids, etc. Do not mix drained brake fluids or fuels with lubricants. Store them safely until they can be disposed of in a proper way to comply with local legislation and available resources.
- Modern coolant mixtures, i.e. antifreeze and other additives, should be replaced every two years. They should not be allowed to get into the soil, but should be collected and disposed of properly.
- Do not open the air-conditioning system yourself. It contains gases that should not be released into the atmosphere. Your [Brand] dealer or air conditioning specialist has a special extractor for this purpose and will have to recharge the system properly.
- Repair any leaks or defects in the engine cooling or hydraulic system immediately.
- Do not increase the pressure in a pressurized circuit as this may lead to a component failure.
- Protect hoses during welding as penetrating weld splatter may burn a hole or weaken them, allowing the loss of oils, coolant, etc.

Personal safety

Most accidents involving machine operation and maintenance can be avoided by following basic safety rules and precautions. Read and understand all the safety messages in this manual, the safety manual and the safety signs on the machine before you operate or service the machine. See your dealer if you have any questions.

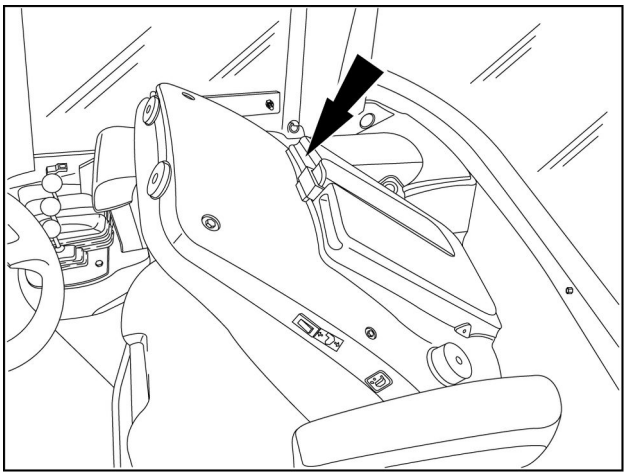
READ THIS MANUAL COMPLETELY and make sure you understand the controls. All equipment has a limit. Make sure you understand the speed, brakes, steering, stability, and load characteristics of the machine before you start to operate this machine.

DO NOT remove this manual or the safety manual from the machine. See your dealer for additional manuals. Also see the manual information on the Title pages (first and second pages in front of the Table of Contents) of this manual.

The safety information given in this manual does not replace safety codes, insurance needs, federal, state, or local laws. Make sure that your machine has the correct equipment according to these rules or laws.

Additional safety messages are used in the text of the manual to show specific safety hazards.

NOTICE: *The safety messages in this chapter point out conditions which can happen during the normal operation and maintenance of your machine. These safety messages also give possible ways of dealing with these conditions.*



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Safety rules – California Proposition 65 Warning

CALIFORNIA

Proposition 65 Warning

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

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

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California Proposition 65 Warning

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Safety rules

⚠ General Safety Rules ⚠

Use caution when operating the machine on slopes. Raised equipment, full tanks and other loads will change the center of gravity of the machine. The machine can tip or roll over when near ditches and embankments or uneven surfaces.

Never permit anyone other than the operator to ride on the machine.

Never operate the machine under the influence of alcohol, drugs, or while otherwise impaired.

Never allow riders on the machine.

When digging or using ground engaging attachments, be aware of buried cables. Contact local utilities to determine the locations of services.

Pay attention to overhead power lines and hanging obstacles. High voltage lines may require significant clearance for safety.

Hydraulic oil or diesel fuel leaking under pressure can penetrate the skin, causing serious injury or infection.

- DO NOT use your hand to check for leaks. Use a piece of cardboard or paper.
- Before connecting or disconnecting fluid lines, always stop the engine, remove the key, and relieve the fluid line pressure.
- Ensure all components are in good condition. Tighten all connections before starting the engine or pressurizing the system.
- If the hydraulic fluid or diesel fuel penetrates the skin, seek medical attention immediately.
- Continuous long term contact with hydraulic fluid may cause skin cancer. Avoid long term contact and promptly wash the skin with soap and water.

Keep clear of moving parts. Loose clothing, jewelry, watches, long hair, and other loose or hanging items can become entangled in moving parts.

Wear protective equipment when appropriate.

DO NOT attempt to remove material from any part of the machine while it is being operated or components are in motion.

Ensure all guards and shields are in good condition and properly installed before operating the machine. Never operate the machine with shields removed. Always close access doors or panels before operating the machine.

Dirty or slippery steps, ladders, walkways, and platforms can cause falls. Ensure these surfaces remain clean and clear of debris.

A person or pet within the operating area of a machine can be struck or crushed by the machine or its equipment. DO NOT allow anyone to enter the work area.

Raised equipment and/or loads can fall unexpectedly and crush persons underneath. Never allow anyone to enter the area underneath raised equipment during operation.

Never operate the engine in enclosed spaces, as harmful exhaust gases may build up.

Before starting the machine, ensure that all controls are in neutral or park lock position.

Start the engine only from the operator's seat. If the safety start switch is bypassed, the engine can start with the transmission in gear. DO NOT connect or short across terminals on the starter solenoid. Attach jumper cables as described in the manual. Starting in gear may cause death or serious injury.

Always keep windows, mirrors, all lighting, and the Slow Moving Vehicle (SMV) emblem clean to provide the best possible visibility while operating the machine.

Operate controls only when seated in the operator's seat, except for those controls expressly intended for use from other locations.

⚠ Parking the Machine⚠

Before leaving the machine, do the following:

1. Park the machine on a firm, level surface.
2. Put all controls in the neutral or park lock position.
3. Engage the park brake. Use wheel chocks, if required.
4. Lower all of the hydraulic equipment.
5. Turn the engine OFF. Remove the key.

If required to keep the engine running, do the following:

1. Bring the engine to low idle speed.
2. Disengage all the drive systems.
3. Shift the transmission into neutral.
4. Apply the parking brake.

⚠ General Maintenance Safety ⚠

Keep the area used for servicing the machine clean and dry. Clean up spilled fluids.

Service the machine on a firm, level surface.

DO NOT attempt repairs unless trained. Refer to manuals and experienced personnel for help.

If you doubt your ability to complete maintenance procedures correctly, contact your authorized dealer.

Observe proper maintenance intervals and procedures. Pay close attention to all safety messages.

Install guards and shields after servicing the machine.

Close all access doors and install all panels after servicing the machine.

Do not attempt to clean, lubricate, clear obstructions, or make adjustments to the machine while it is in motion or while the engine is running.

Always ensure the working area is clear of tools, parts, other persons and pets before you start operating the machine.

Unsupported hydraulic cylinders can lose pressure and drop the equipment causing a crushing hazard. DO NOT leave equipment in a raised position while parked or during service, unless securely supported.

Jack or lift the machine only at jack or lift points indicated in this manual.

Incorrect towing procedures can cause accidents. When towing a disabled machine follow the procedure in Operator's Manual. Use only rigid tow bars.

Towing the machine is not recommended. When absolutely necessary to tow, DO NOT exceed the recommended towing speed. Ensure the towing machine has sufficient braking capacity to stop the towed load. If the towed machine cannot be braked, a tow bar must be used. Do not use chains to tow a machine without braking ability.

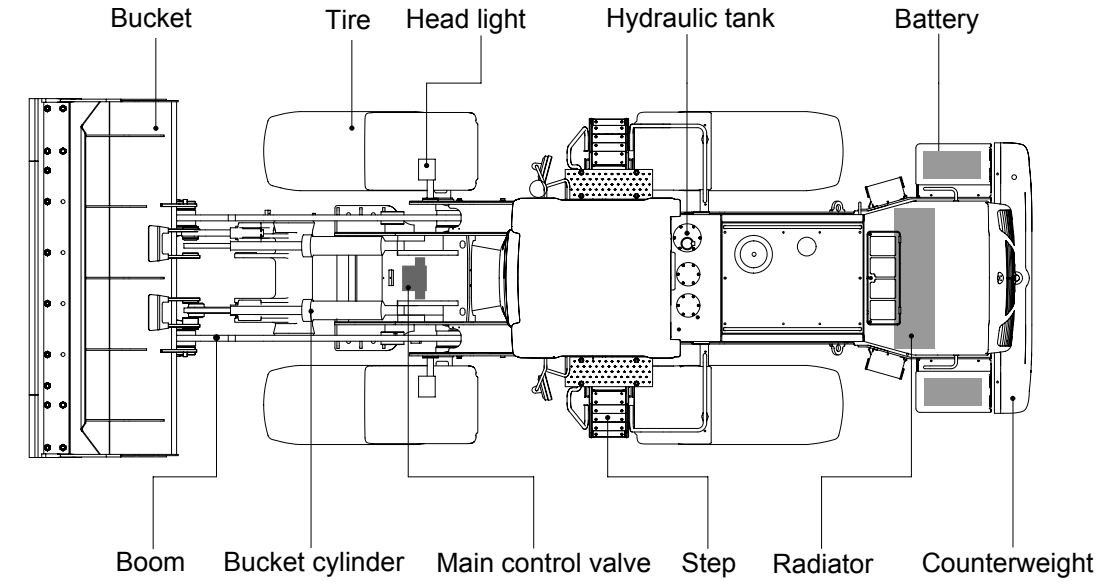
Before disconnecting or connecting fluid lines, always stop the engine, remove key, and relieve fluid line pressure.

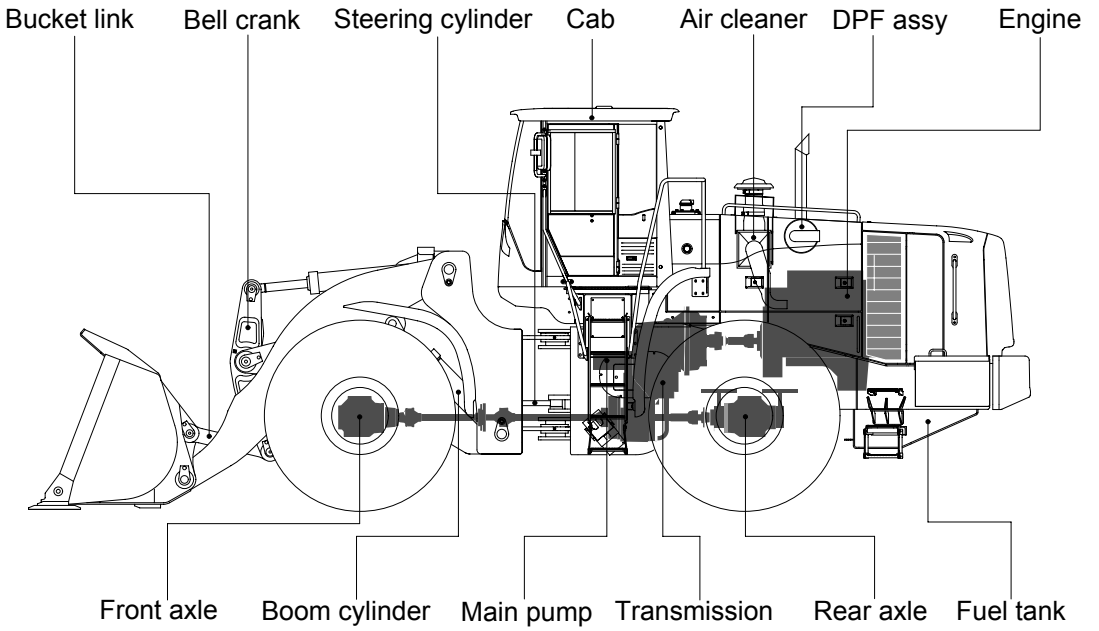
Release all pressure before working on systems with an accumulator. It is your responsibility know the quantity of accumulators and their locations on the machine.

Before disconnecting or connecting electrical connections, stop the engine and remove key.

GROUP 2 SPECIFICATION

1. MAJOR COMPONENT

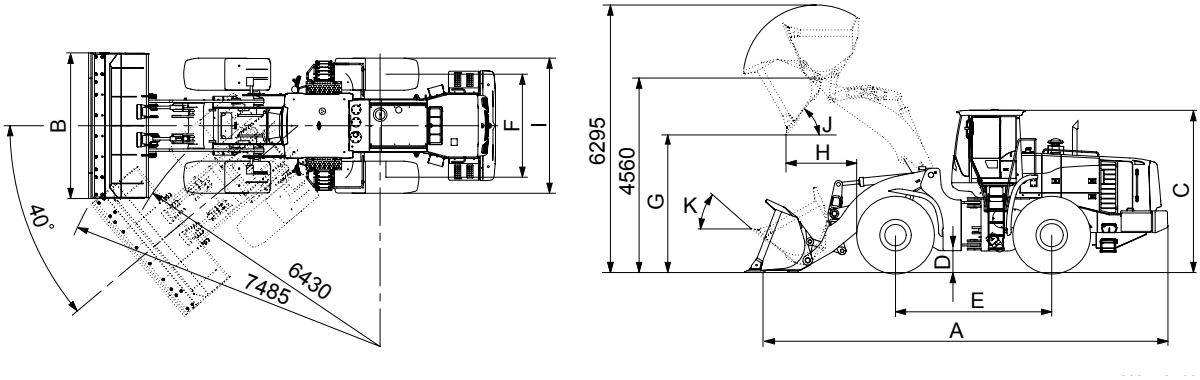




1221F

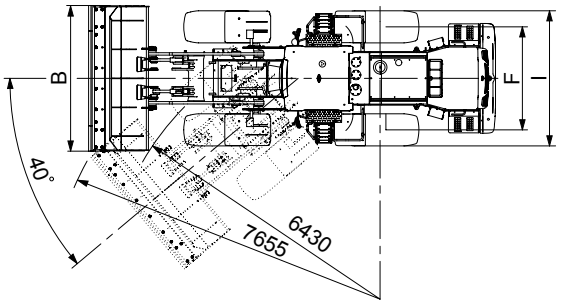
2. SPECIFICATIONS

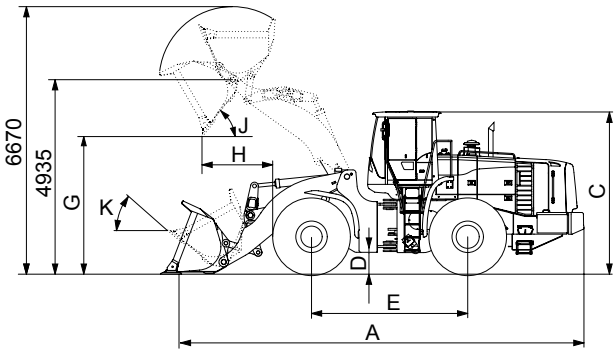
1) 1) WITH BOLT-ON CUTTING EDGE TYPE BUCKET (1221F)



Description			Unit	Specification
Operating weight			kg (lb)	30300 (66800)
Bucket capacity		Struck	m^3 (yd^3)	4.6 (6.0)
		Heaped		5.4 (7.1)
Overall length		A	mm (ft-in)	9630 (31' 7")
Overall width		B		3450 (11' 4")
Overall height		C		3865 (12' 8")
Ground clearance		D		495 (1' 7")
Wheelbase		E		3700 (12' 2")
Tread		F		2440 (8' 0")
Dump clearance at 45°		G		3300 (10' 10")
Dump reach (full lift)		H		1430 (4' 8")
Width over tires		I		3220 (10' 7")
Dump angle		J	degree (°)	47
Roll back angle (carry position)		K		48
Cycle time		Lift (with load)	sec	6.1
		Dump (with load)		1.4
		Lower (empty)		4.1
Maximum travel speed			km/hr (mph)	36.0 (22.4)
Braking distance			m (ft-in)	12 (39' 4")
Minimum turning radius (center of outside tire)				6.43 (21' 1")
Gradeability			degree (°)	30
Breakout force			kg (lb)	23750 (52360)
Travel speed	Forward	First gear	km/hr (mph)	6.1 (3.8)
		Second gear		11.4 (7.1)
		Third gear		17.9 (11.1)
		Fourth gear		36.0 (22.4)
	Reverse	First gear		6.1 (3.8)
		Second gear		11.4 (7.1)
		Third gear		24.8 (15.4)

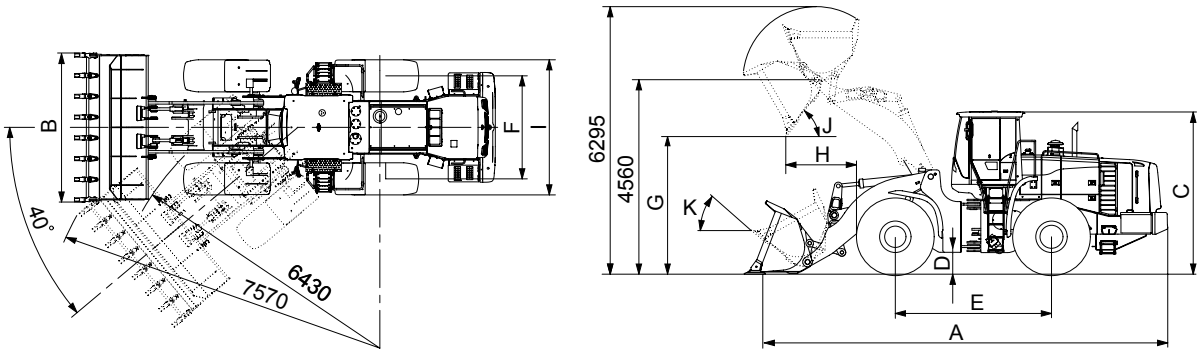
WITH BOLT-ON CUTTING EDGE TYPE BUCKET (1221F XR)





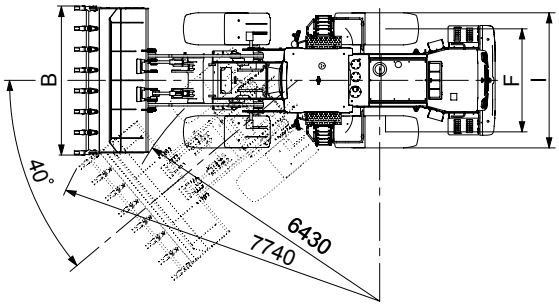
Description			Unit	Specification
Operating weight			kg (lb)	31100 (68560)
Bucket capacity		Struck	m^3 (yd^3)	4.6 (6.0)
		Heaped		5.4 (7.1)
Overall length		A	mm (ft-in)	10060 (33' 0")
Overall width		B		3450 (11' 4")
Overall height		C		3865 (12' 8")
Ground clearance		D		485 (1' 7")
Wheelbase		E		3700 (12' 2")
Tread		F		2440 (8' 0")
Dump clearance at 45°		G		3670 (12' 0")
Dump reach (full lift)		H		1480 (4' 10")
Width over tires		I		3220 (10' 7")
Dump angle		J	degree (°)	47
Roll back angle (carry position)		K		49
Cycle time		Lift (with load)	sec	6.1
		Dump (with load)		1.4
		Lower (empty)		4.1
Maximum travel speed			km/hr (mph)	36.0 (22.4)
Braking distance			m (ft-in)	12 (39' 4")
Minimum turning radius (center of outside tire)				6.43 (21' 1")
Gradeability			degree (°)	30
Breakout force			kg (lb)	23130 (50990)
Travel speed	Forward	First gear	km/hr (mph)	6.1 (3.8)
		Second gear		11.4 (7.1)
		Third gear		17.9 (11.1)
		Fourth gear		36.0 (22.4)
	Reverse	First gear		6.1 (3.8)
		Second gear		11.4 (7.1)
		Third gear		24.8 (15.4)

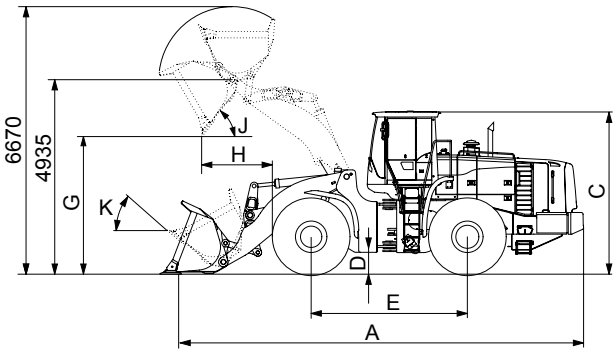
2) 2) WITH TOOTH TYPE BUCKET (1221F)



Description		Unit	Specification
Operating weight		kg (lb)	30300 (66800)
Bucket capacity	Struck	m^3 (yd^3)	4.4 (5.8)
	Heaped		5.2 (6.8)
Overall length	A	mm (ft-in)	9820 (32' 3")
Overall width	B		3500 (11' 6")
Overall height	C		3865 (12' 8")
Ground clearance	D		495 (1' 7")
Wheelbase	E		3700 (12' 2")
Tread	F		2440 (8' 0")
Dump clearance at 45°	G		3145 (10' 4")
Dump reach (full lift)	H		1560 (5' 1")
Width over tires	I		3220 (10' 7")
Dump angle	J	degree (°)	47
Roll back angle (carry position)	K		48
Cycle time	Lift (with load)	sec	6.1
	Dump (with load)		1.4
	Lower (empty)		4.1
Maximum travel speed		km/hr (mph)	36.0 (22.4)
Braking distance		m (ft-in)	12 (39' 4")
Minimum turning radius (center of outside tire)			6.43 (21' 1")
Gradeability		degree (°)	30
Breakout force		kg (lb)	25280 (55730)
Travel speed	Forward	km/hr (mph)	First gear	6.1 (3.8)
			Second gear	11.4 (7.1)
			Third gear	17.9 (11.1)
			Fourth gear	36.0 (22.4)
	Reverse		First gear	6.1 (3.8)
			Second gear	11.4 (7.1)
			Third gear	24.8 (15.4)

WITH TOOTH TYPE BUCKET (1221F XR)





Description			Unit	Specification
Operating weight			kg (lb)	31100 (68560)
Bucket capacity		Struck	m^3 (yd^3)	4.4 (5.8)
		Heaped		5.2 (6.8)
Overall length		A	mm (ft-in)	10250 (33' 8")
Overall width		B		3500 (11' 6")
Overall height		C		3865 (12' 8")
Ground clearance		D		495 (1' 7")
Wheelbase		E		3700 (12' 2")
Tread		F		2440 (8' 0")
Dump clearance at 45°		G		3520 (11' 7")
Dump reach (full lift)		H		1600 (5' 3")
Width over tires		I		3220 (10' 7")
Dump angle		J	degree (°)	47
Roll back angle (carry position)		K		49
Cycle time		Lift (with load)	sec	6.1
		Dump (with load)		1.4
		Lower (empty)		4.1
Maximum travel speed			km/hr (mph)	36.0 (22.4)
Braking distance			m (ft-in)	12 (39' 4")
Minimum turning radius (center of outside tire)				6.43 (21' 1")
Gradeability			degree (°)	30
Breakout force			kg (lb)	24630 (54300)
Travel speed	Forward	First gear	km/hr (mph)	6.1 (3.8)
		Second gear		11.4 (7.1)
		Third gear		17.9 (11.1)
		Fourth gear		36.0 (22.4)
	Reverse	First gear		6.1 (3.8)
		Second gear		11.4 (7.1)
		Third gear		24.8 (15.4)

3. WEIGHT

Item		kg	lb
Front frame assembly		2695	5940
Rear frame assembly		3282	7240
Front fender (LH & RH)		48	106
Counterweight (1221F)		1200	2650
Additional counterweight (3EA, 1221F XR)		550	1210
Cab assembly		1050	2320
Engine assembly		1269	2800
Transmission assembly		835	1840
Drive shaft (front)		25	55
Drive shaft (center)		62	137
Drive shaft (rear)		30	66
Drive shaft (upper)		13	29
Front axle (include differential)		1814	4000
Rear axle (include differential)		1820	4010
Tire (29.5-25, 22PR, L3)		430	948
Hydraulic tank assembly		280	617
Fuel tank assembly		485	1070
Main pump		45	99
Steering pump		45	99
Fan & brake pump assembly		12	26
Main control valve (2/3 spool)		88/104	194/229
Flow amplifier		29	64
Boom assembly	1221F	2050	4520
	1221F XR	2260	4980
Bell crank assembly		282	620
Bucket link		60	132
5.4 m^3 bucket, with bolt on cutting edge		2750	6060
5.2 m^3 bucket, with tooth		2585	2430
Boom cylinder assembly (2EA)		290	639
Bucket cylinder assembly (2EA)		130	287
Steering cylinder assembly (2EA)		60	132
Seat		40	88
Battery		55	121

4. SPECIFICATION FOR MAJOR COMPONENTS

1) ENGINE

Item	Specification
Model	Cummins QSX 11.9
Type	4-cycle turbocharged, charge air cooled diesel engine
Control type	Electronic control
Cooling method	Water cooling
Number of cylinders and arrangement	6 cylinders, in-line
Firing order	1-5-3-6-2-4
Combustion chamber type	Direct injection type
Cylinder bore × stroke	130 × 150 mm (5.12" × 5.91")
Piston displacement	11900 cc (726 cu in)
Compression ratio	16.6
Rated gross horse power	360 ps at 2000 rpm
Maximum gross torque at 1400 rpm	173 kgf · m (1250 lbf · ft)
Engine oil quantity	43 ℓ (11.4 U.S. gal)
Wet weight	1269 kg (2797 lb)
High idling speed	2130 ± 50 rpm
Low idling speed	800 ± 25 rpm
Rated fuel consumption	162 g/ps·hr
Starting motor	Delco Remy 39MT HO (24 V-7.5 W)
Alternator	Delco Remy 28SI (24 V - 80 Amp)
Battery	2 × 12V × 220Ah

2) STEERING PUMP / MAIN PUMP

Item	Specification	
	Steering pump	Main pump
Type	Variable piston pump	
Capacity	110 cc/rev	100 cc/rev
Maximum operating pressure	280 kgf/cm^2 (3980 psi)	
Rated oil quantity	220 ℓ /min (58.1 U.S.gpm)	200 ℓ /min (52.8 U.S.gpm)
Rated speed	2000 rpm	

3) FAN & BRAKE PUMP

Item	Specification
Type	Piston pump
Capacity	45 cc/rev
Maximum operating pressure	250 kgf/cm^2 (3560 psi)
Rated oil quantity	90 ℓ /min (23.8 U.S.gpm)
Rated speed	2000 rpm

4) MAIN CONTROL VALVE

Item	Specification
Type	2 spool
Operating method	Hydraulic pilot assist
Main relief valve pressure	280 kgf/cm^2 (3980 psi)
Overload relief valve pressure	340 kgf/cm^2 (4840 psi)
Overload relief valve pressure (dump)	310 kgf/cm^2 (4410 psi)

5) REMOTE CONTROL VALVE

Item		Specification
Type		Pressure reducing type
Operating	Minimum	5 kgf/cm^2 (71 psi)
	Maximum	30 kgf/cm^2 (427 psi)
Single operation angle	degree	17

6) CYLINDER

Item			Specification
Boom cylinder		Bore dia × Rod dia × Stroke	ø 180 × ø 105 × 863 mm
Bucket cylinder	1221F	Bore dia × Rod dia × Stroke	ø 140 × ø 75 × 575 mm
	1221F XR		ø 140 × ø 75 × 570 mm
Steering cylinder		Bore dia × Rod dia × Stroke	ø 105 × ø 55 × 480 mm

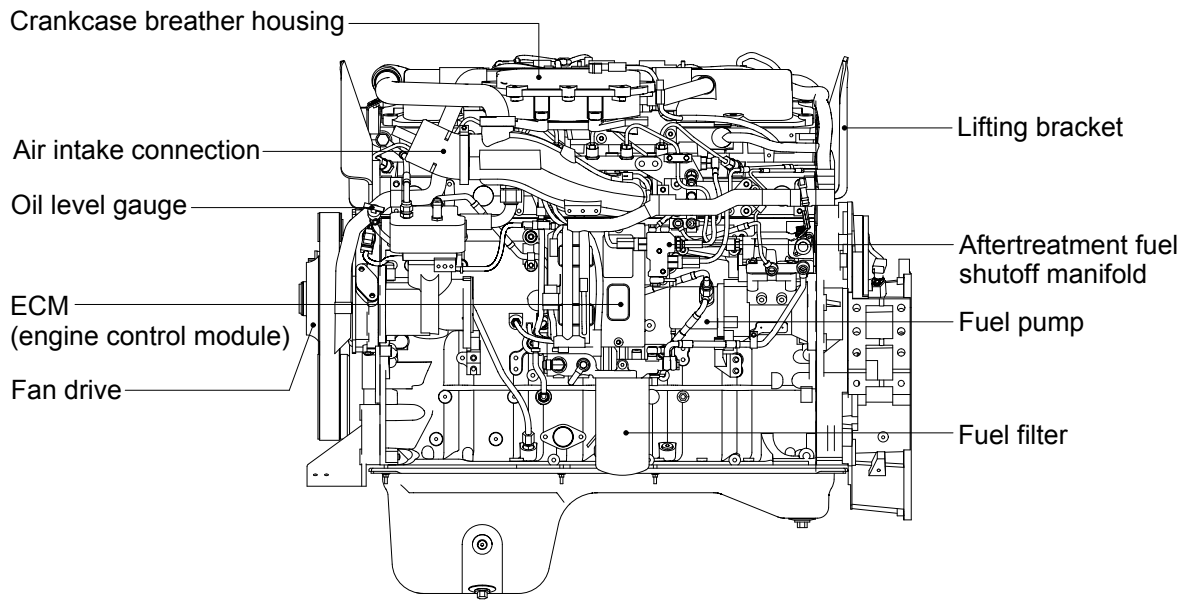
7) DYNAMIC POWER TRANSMISSION DEVICES

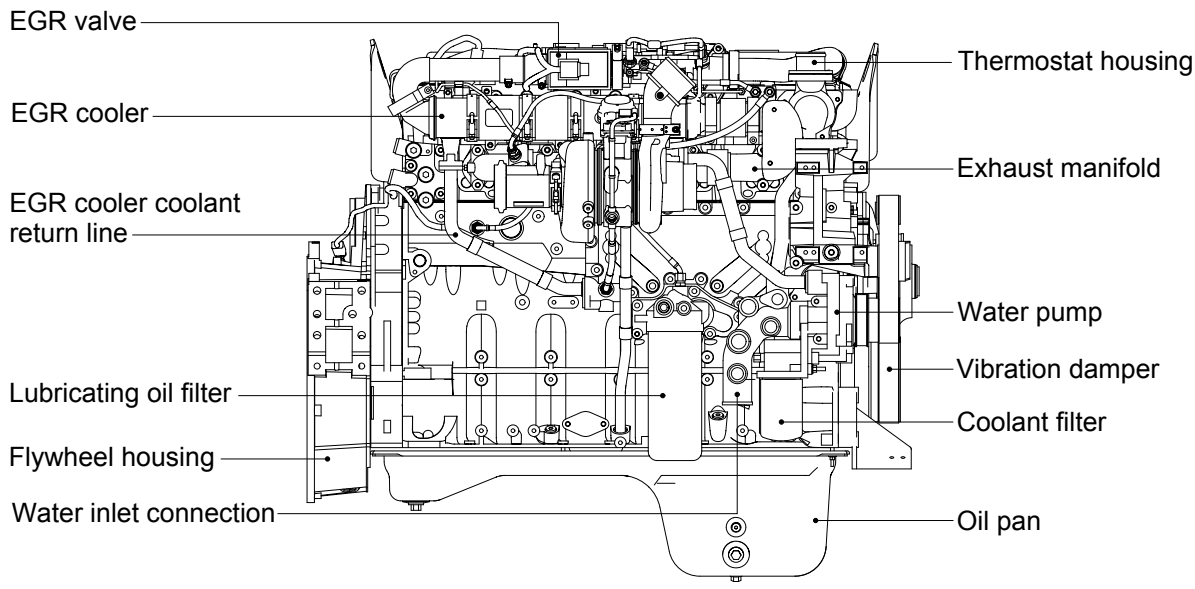
Item			Specification
4-speed transmission (std)	Model		ZF 4WG 310
	Type	Converter	Single-stage, double-phase
		Transmission	Full-automatic power shift
	Converter stall ratio		2.51 : 1
	Gear shift		Forward fourth gear, reverse third gear
	Control		Electrical single lever type, kick-down system Automatic kick down from 2nd to 1st gear FNR switch on joystick lever (option)
	Pump rated f ow		135 ℓ /min (35.7 U.S.gpm) at 2000 rpm
	Travel speed		See the page 2-2.
5-speed transmission (opt)	Model		ZF 5WG 310
	Type	Converter	Single-stage, double-phase (with lock up clutch)
		Transmission	Full-automatic power shift
	Converter stall ratio		2.51 : 1
	Gear shift		Forward fifth gear, reverse third gear
	Control		Electrical single lever type, kick-down system Automatic kick down from 2nd to 1st gear FNR switch on joystick lever (option)
	Pump rated f ow		135 ℓ /min (35.7 U.S.gpm) at 2000 rpm
	Travel speed	Forward 1/2/3/4/5	6.1 / 11.8 / 18.3 / 26.6 / 41.0 km/hr
		Reverse 1/2/3	6.1 / 11.8 / 26.6 km/hr
Axle	Drive devices		4-wheel drive
	Front		Front fixed location
	Rear		Oscillation ±13° of center pin-loaded
Wheels	Tires		29.5-25, 22PR (L3)
Brakes	Travel		Four-wheel, wet-disc type, full hydraulic
	Parking		Spring applied, hydraulic released brake on T/M
Steering	Type		Full hydraulic, articulated
	Steering angle		40° to both right and left angle, respectively

SECTION 2 ENGINE

GROUP 1 STRUCTURE AND FUNCTION

1. STRUCTURE



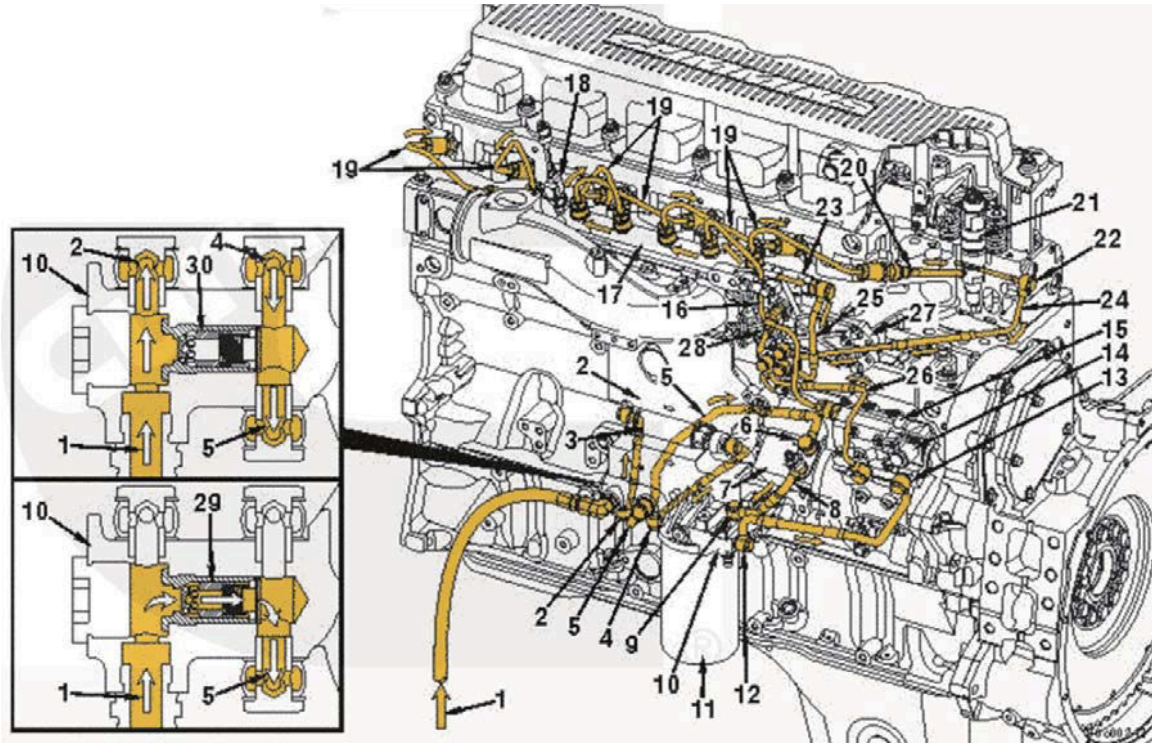


· Direct 4-stroke, 6-cylinders, water-cooling and charge air cooled diesel engine in installed, cylinder block and cylinder head are made of case iron and turbocharger is attached.

2. SYSTEM DIAGRAMS

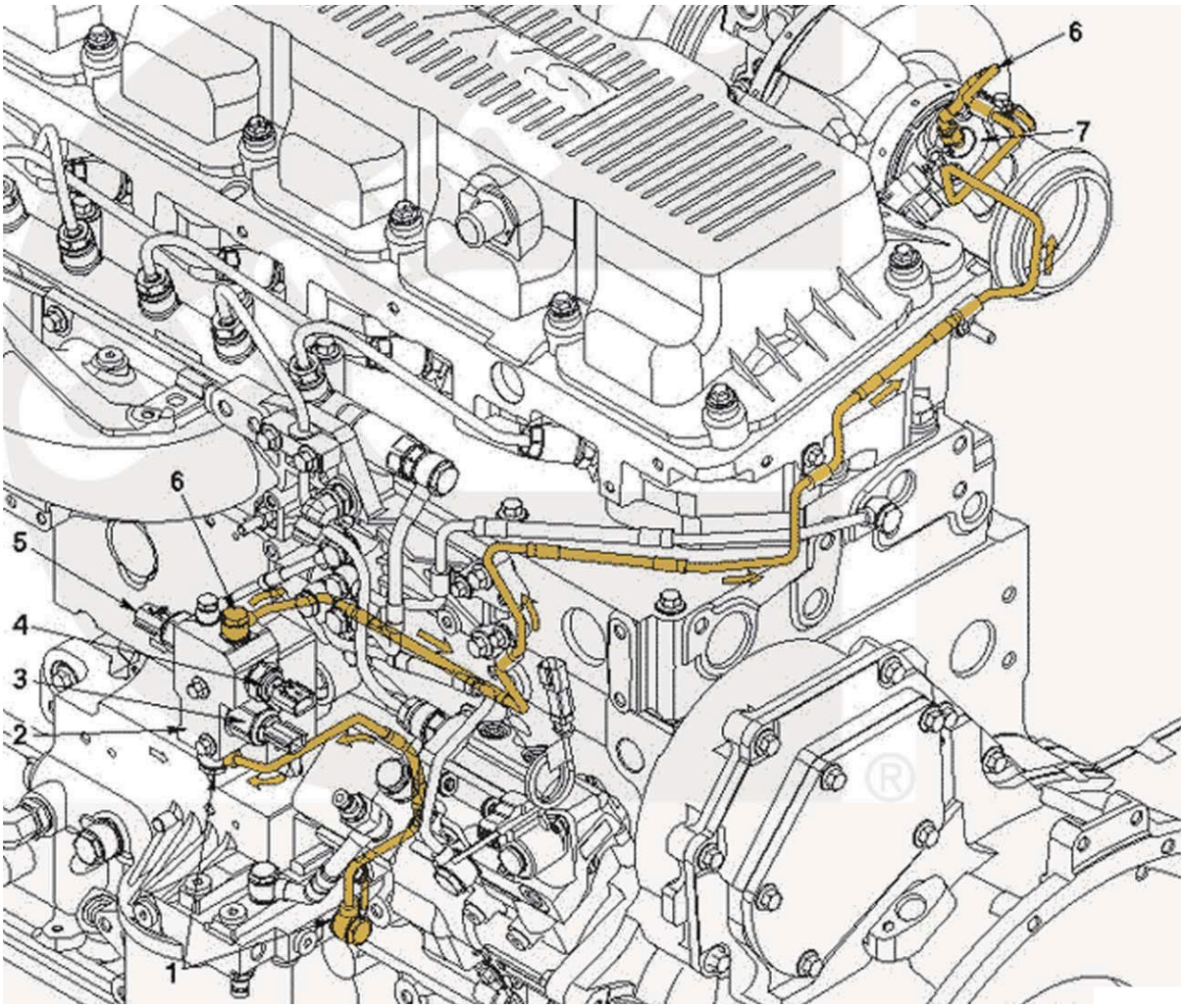
The following drawings show the flow through the engine systems.

1) FUEL SYSTEM



1	Fuel supply connection	16	Fuel rail supply line
2	Fuel lift pump supply line	17	Fuel rail
3	Fuel lift pump	18	Fuel pressure sensor
4	Fuel lift pump line	19	High-pressure injector supply lines
5	Fuel pump gear pump supply lines	20	High-pressure fuel connector
6	Fuel pump gear pump inlet	21	Fuel injector
7	Fuel pump gear pump	22	Fuel injector drain check valve (banjo type)
8	Fuel pump gear pump outlet	23	High-pressure relief valve
9	Pressure side fuel filter inlet	24	Injector drain line
10	Fuel filter head	25	High-pressure relief valve drain line
11	Pressure side fuel filter	26	Fuel pump drain line
12	Pressure side fuel filter outlet	27	Fuel drain manifold
13	High-pressure fuel pump inlet	28	OEM fuel return connection
14	Fuel pump actuator	29	Lift pump OFF (check valve open)
15	High-pressure fuel pump	30	Lift pump ON (check valve closed)

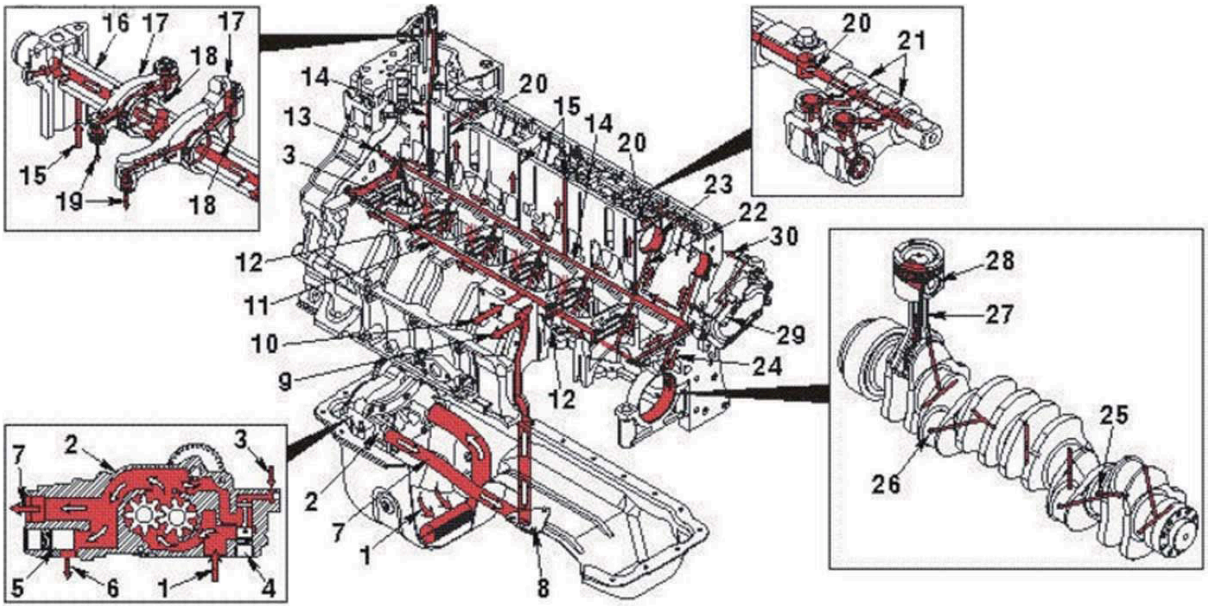
FUEL SYSTEM



1 Fuel supply from fuel filter head to the aftertreatment fuel injector fuel manifold
2 Aftertreatment fuel injector fuel manifold
3 Fuel shutoff valve
4 Fuel pressure sensor
5 Fuel drain valve
6 Fuel supply to aftertreatment fuel injector
7 Aftertreatment fuel injector

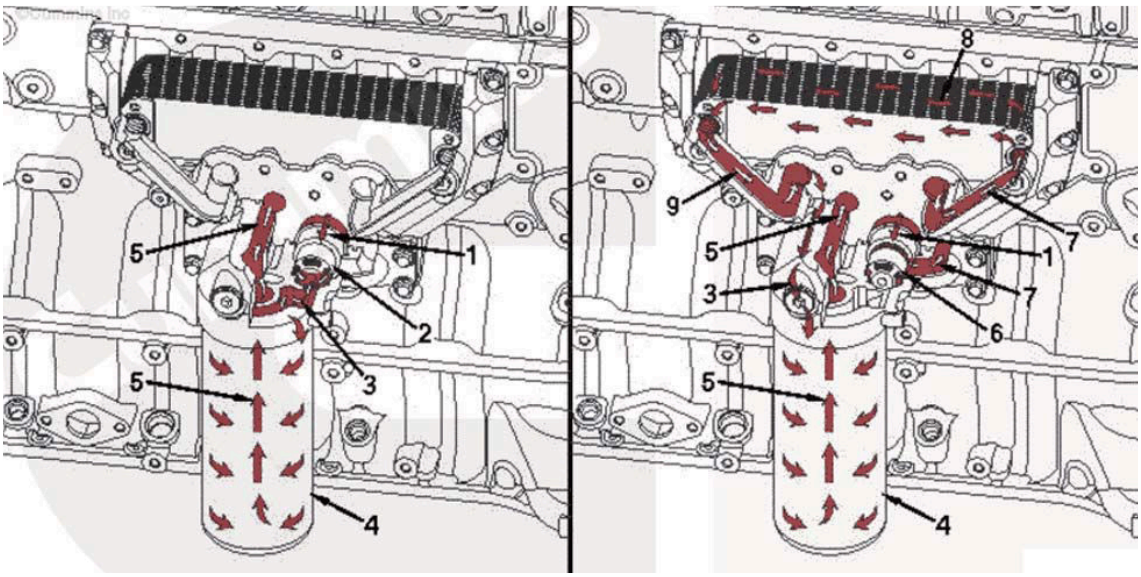
2) LUBRICATING OIL SYSTEM

LUBRICATING OIL SYSTEM



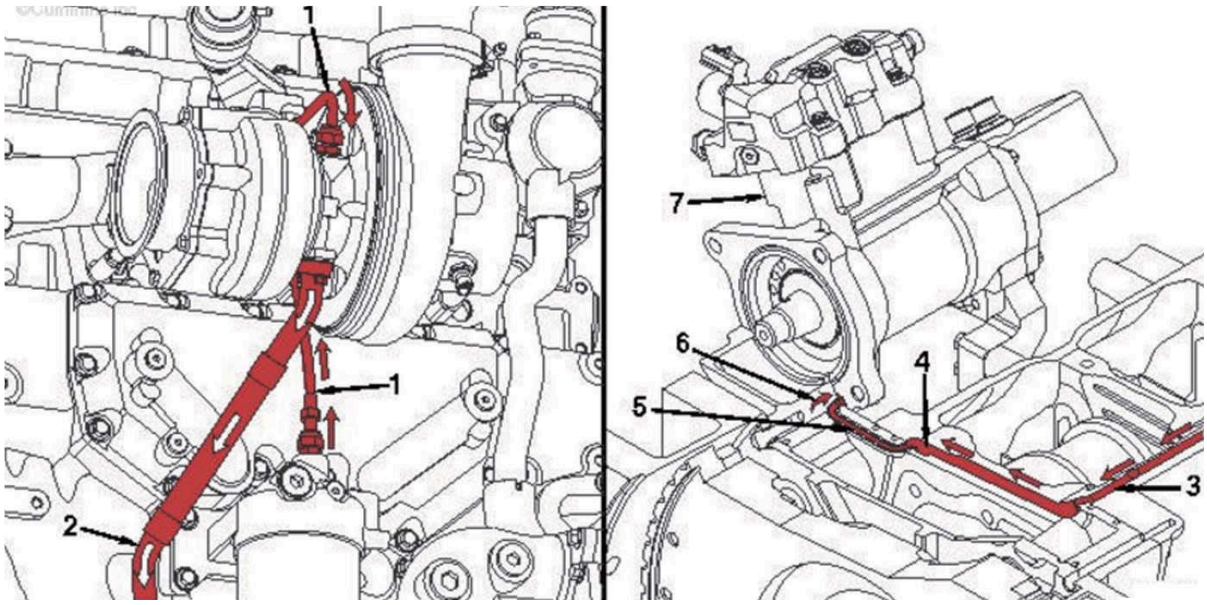
1 Lubricating oil supply from the lubricating oil pan
2 Lubricating oil pump
3 Lubricating oil pressure sensing line from the main oil rifle
4 Lubricating oil pressure regulator
5 High pressure relief valve
6 Oil return to the lubricating oil pan
7 Lubricating oil transfer tube
8 Lubricating oil transfer connection
9 Oil flow through the cylinder block to the lubricating oil filter head
10 Oil flow from the filter head to the main oil rifle
11 Right oil rifle
12 Oil flow to the rear idler gear
13 Left oil rifle
14 Oil flow to the overhead
15 Oil flow to rocker lever shaft
16 Rocker lever shaft
17 Rocker levers
18 Lubricating oil flow to the push tubes
19 Oil supply to crosshead
20 Lubricating oil supply to the cam followers
21 Cam followers
22 Lubricating oil flow to the camshaft
23 Lubricating oil flow around the camshaft
24 Lubricating oil flow to the main bearings
25 Crankshaft main bearing journal
26 Crankshaft connecting rod journal
27 Connecting rod
28 Lubricating oil flow around the piston pin
29 Front gear housing
30 Lubricating oil flow to the air compressor

LUBRICATING OIL SYSTEM

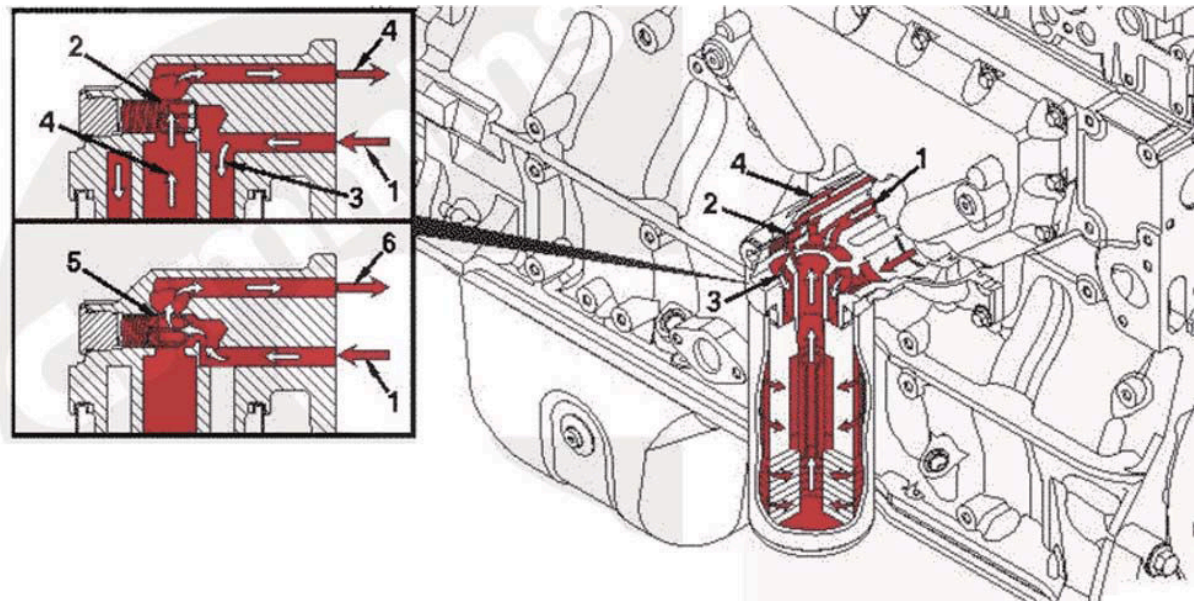


1 Lubricating oil flow from the lubricating oil pump
2 Lubricating oil thermostat closed
3 Lubricating oil through the oil filter head to the oil filter
4 Lubricating oil filter
5 Lubricating oil flow to the main oil rifle
6 Lubricating oil thermostat open
7 Lubricating oil flow to the lubricating oil cooler
8 Lubricating oil flow through the lubricating oil cooler core
9 Lubricating oil flow to the lubricating oil filter head

LUBRICATING OIL SYSTEM

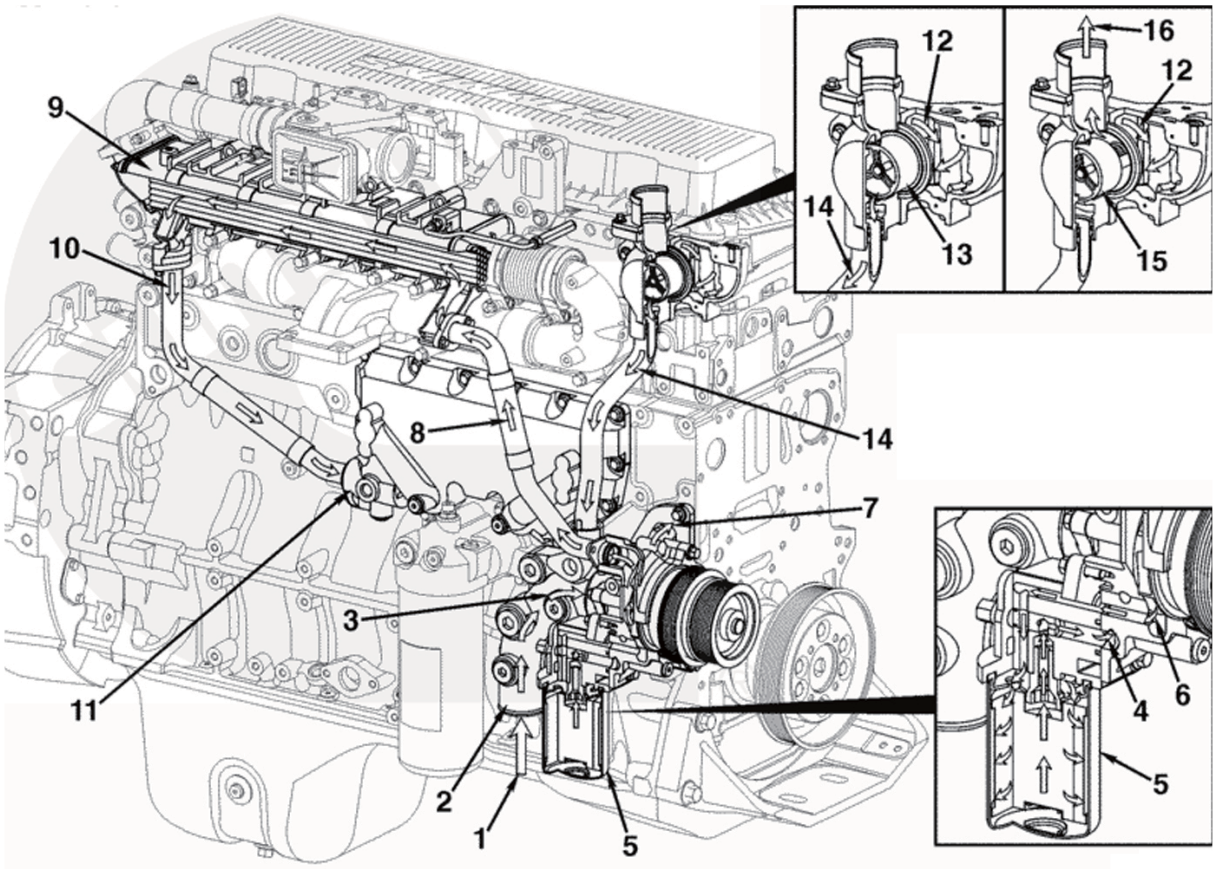


1 Lubricating oil supply to the turbocharger bearing housing
2 Lubricating oil return to the lubricating oil pan
3 Lubricating oil main rifle
4 Lubricating oil passage from the cylinder block to the rear gear housing
5 Lubricating oil flow through the rear gear housing
6 Lubricating oil supply to the fuel pump
7 Fuel pump



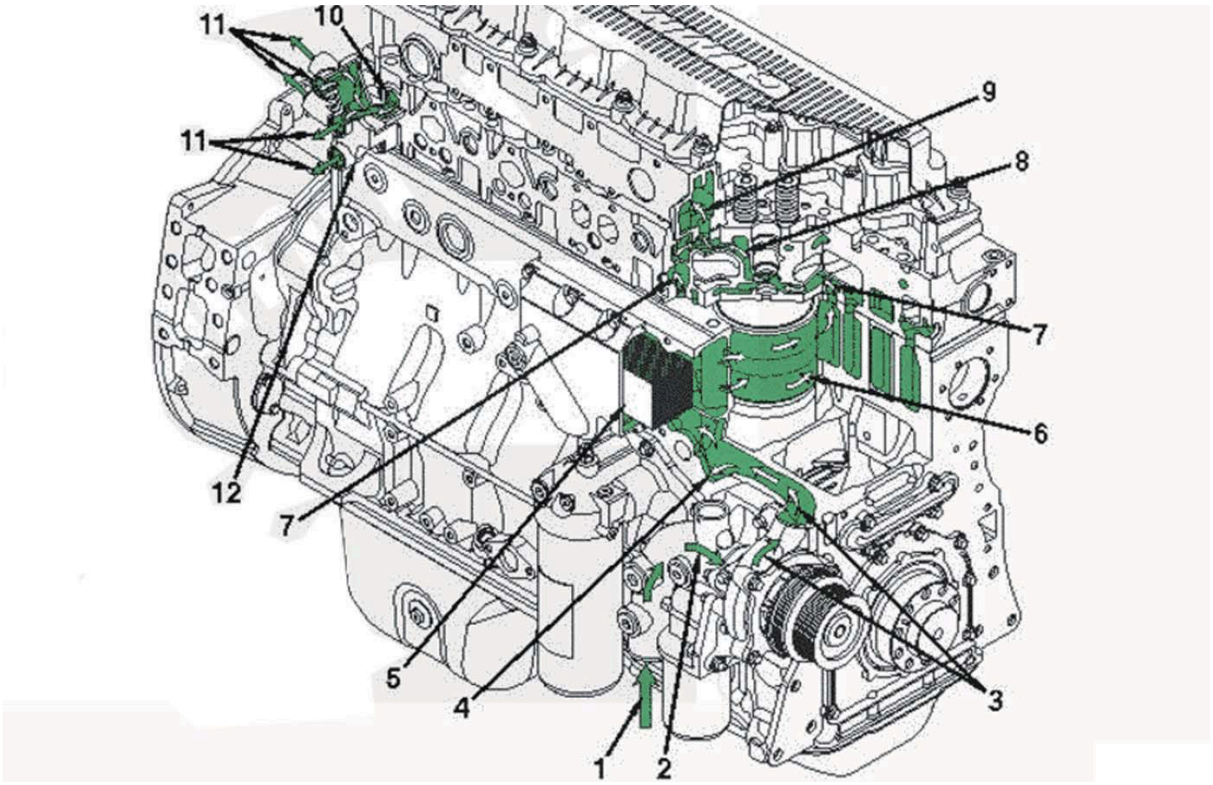
1 Lubricating oil supply from the lubricating oil cooler
2 Lubricating oil filter bypass valve closed
3 Lubricating oil flow to the lubricating oil filter
4 Filtered lubricating oil flow to the main oil rifle
5 Lubricating oil filter bypass valve open
6 Unfiltered lubricating oil flow to the main oil rifle

3) COOLING SYSTEM



1 Coolant inlet flow from radiator
2 Coolant inlet connection
3 Coolant from inlet to water pump
4 Coolant from coolant filter to water pump
5 Coolant filter
6 Coolant from water pump to coolant filter
7 Coolant from water pump to cylinder block inlet
8 Coolant from water pump to exhaust gas recirculation (EGR) cooler
9 EGR cooler
10 Coolant from EGR cooler to lubricating oil cooler
11 Lubricating oil cooler
12 Coolant from rocker lever housing
13 Thermostat closed
14 Coolant through bypass tube to coolant connection
15 Thermostat open
16 Coolant to radiator

COOLING SYSTEM



1 Coolant inlet from radiator
2 Coolant inlet to water pump
3 Coolant from water pump to cylinder block
4 Coolant to lubricating oil cooler
5 Lubricating oil cooler
6 Coolant flow around cylinder liners
7 Coolant to lower cylinder head
8 Coolant to upper cylinder head
9 Coolant to rocker lever housing
10 Coolant from cylinder head to coolant manifold
11 Coolant manifold supply
12 Coolant manifold

Suggest:

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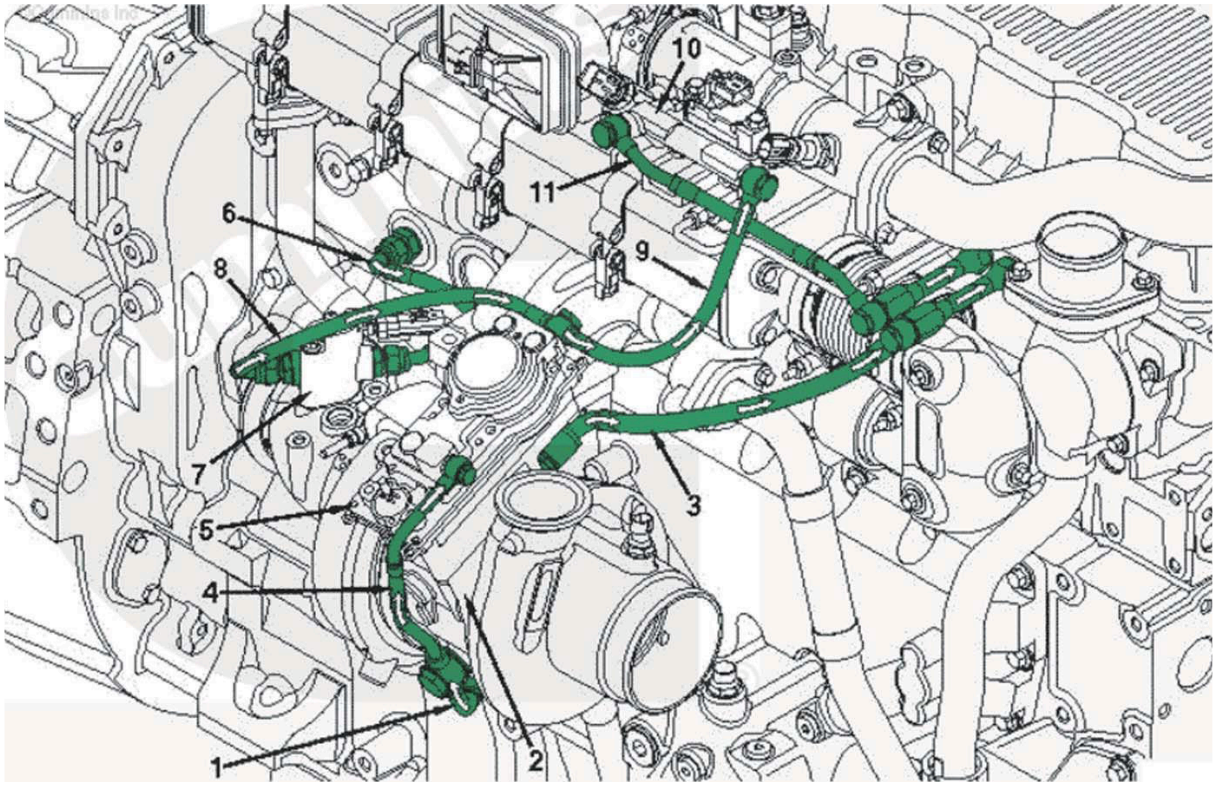
COOLING SYSTEM



1 Coolant from lubricating oil cooler to turbocharger bearing housing
2 Turbocharger bearing housing
3 Coolant from turbocharger bearing housing to rocker lever housing
4 Coolant from turbocharger bearing housing to turbocharger actuator
5 Turbocharger actuator
6 Coolant from cylinder block to aftertreatment fuel injector
7 Aftertreatment fuel injector
8 Coolant from aftertreatment fuel injector to turbocharger actuator outlet
9 Coolant from turbocharger actuator outlet to EGR mass measurement flow assembly
10 EGR mass measurement flow assembly
11 Coolant from EGR mass measurement flow assembly to rocker lever housing