

SHOP MANUAL KOMATSU WA250-1LC WHEEL LOADER

MACHINE MODEL

SERIAL NUMBERS

WA250-1LC

A65001 and up

It is our policy to improve our products whenever it is possible and practical to do so. We reserve the right to make changes or add improvements at any time without incurring any obligation to install such changes on products sold previously.

Due to this continuous program of research and development, periodic revisions may be made to this publication. It is recommended that customers contact their distributor for information on the latest revision.

FEB 92

PRODUCT PUBLICATIONS INFORMATION

VARIOUS PRODUCT PARTS & SERVICE PUBLICATIONS ARE AVAILABLE TO ALL KOMATSU CONSTRUCTION EQUIPMENT OWNERS, INCLUDING OPERATION & MAINTENANCE MANUALS, PARTS BOOKS AND SHOP MANUALS.

SPECIAL PUBLICATIONS SUCH AS SERVICE TOOL, AIR CONDITIONING, AND TURBOCHARGER SHOP MANUALS ARE ALSO AVAILABLE AS WELL AS SELECTED OPERATION & MAINTENANCE AND SHOP MANUALS IN FOREIGN LANGUAGES.

THE PUBLICATIONS LISTED BELOW ARE AVAILABLE FOR THIS PARTICULAR MACHINE(S).

DESCRIPTION	FORM NUMBER
PARTS BOOK - PAPER:	
Engine and Chassis	BEPBW18021
PARTS BOOK - MICROFICHE:	
Engine and Chassis	BEPMW18021
OPERATION & MAINTENANCE MANUAL:	
Chassis	CEAMW18020
SHOP MANUAL:	
Chassis	CEBMW18020
Engine:	
Shop Manual	CEBM610SM0
Specification Manual	CEBM610AR0
SAFETY MANUAL	1085 883 R3

PARTS AND SERVICE PUBLICATIONS CAN ONLY BE ACQUIRED BY AN AUTHORIZED KOMATSU DISTRIBUTOR, USING THE "REQUEST FOR LITERATURE" FORM KDC-EPS-05 SHOWN ON THE REVERSE SIDE OF THIS PAGE.

PLEASE TEAR OUT THIS PAGE AND FILL IN ALL THE INFORMATION REQUESTED ON THE ORDER FORM!

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WARNING! IMPORTANT SAFETY NOTICE

Proper service and repair is extremely important for the safe operation of your machine. The service and repair techniques recommended and described in this manual are both effective and safe methods of operation. Some of these operations require the use of tools specially designed for the purpose.

To prevent injury to workers, the symbol shown is used to mark safety precautions in this manual. The cautions accompanying these symbols should always be followed carefully. If any dangerous situation arises or may possibly arise, first consider safety, and take the necessary actions to deal with the situation.



SAFETY

GENERAL PRECAUTIONS

Mistakes in operation are extremely dangerous. Read the Operation and Maintenance Manual carefully **BEFORE** operating the machine.

1. Before carrying out any greasing or repairs, read all the precautions given on the decals which are fixed to the machine.
2. When carrying out any operation, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
-Always wear safety glasses when hitting parts with a hammer.
-Always wear safety glasses when grinding parts with a grinder, etc.
3. If welding repairs are needed, always have a trained, experienced welder carry out the work. When carrying out welding work, always wear welding gloves, apron, glasses, cap and other clothes suited for welding work.
4. When carrying out any operation with two or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the operation. Before starting work, hang **UNDER REPAIR** signs on the controls in the operator's compartment.
5. Keep all tools in good condition and learn the correct way to use them.
6. Decide a place in the repair workshop to keep tools and removed parts. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dirt or oil on the floor. Smoke only in the areas provided for smoking. Never smoke while working.

PREPARATIONS FOR WORK

7. Before adding oil or making repairs, park the machine on hard, level ground, and block the wheels or tracks to prevent the machine from moving.
8. Before starting work, lower blade, ripper, bucket or any other work equipment to the ground. If this is not possible, insert the safety pin or use blocks to prevent the work equipment from falling. In addition, be sure to lock all the control levers and hang warning signs on them.
9. When disassembling or assembling, support the machine with blocks, jacks or stands before starting work.
10. Remove all mud and oil from the steps or other places used to get on and off the machine. Always use the handrails, ladders or steps when getting on or off the machine. Never jump on or off the machine. If it is impossible to use the handrails, ladders or steps, use a stand to provide safe footing.

PRECAUTIONS DURING WORK

11. When removing the oil filler cap, drain plug or hydraulic pressure measuring plugs, loosen them slowly to prevent the oil from spurting out. Before disconnecting or removing components of the oil, water or air circuits, first remove the pressure completely from the circuit.
12. The water and oil in the circuits are hot when the engine is stopped, so be careful not to get burned. Wait for the oil and water to cool before carrying out any work on the oil or water circuits.

SAFETY

13. Before starting work, remove the leads from the battery. Always remove the lead from the negative (-) terminal first.
14. When raising heavy components, use a hoist or crane.
Check that the wire rope, chains and hooks are free from damage.
Always use lifting equipment which has ample capacity.
Install the lifting equipment at the correct places.
Use a hoist or crane and operate slowly to prevent the component from hitting any other part. Do not work with any part still raised by the hoist or crane.
15. When removing covers which are under internal pressure or under pressure from a spring, always leave two bolts in position on opposite sides. Slowly release the pressure, then slowly loosen the bolts to remove.
16. When removing components, be careful not to break or damage the wiring. Damaged wiring may cause electrical fires.
17. When removing piping, stop the fuel or oil from spilling out. If any fuel or oil drips on to the floor, wipe it up immediately. Fuel or oil on the floor can cause you to slip, or can even start fires.
18. As a general rule, do not use gasoline to wash parts. In particular, use only the minimum of gasoline when washing electrical parts.
19. Be sure to assemble all parts again in their original places.
Replace any damaged part with new parts.
 - When installing hoses and wires, be sure that they will not be damaged by contact with other parts when the machine is being operated.
20. When installing high pressure hoses, make sure that they are not twisted. Damaged tubes are dangerous, so be extremely careful when installing tubes for high pressure circuits. Also check that connecting parts are correctly installed.
21. When assembling or installing parts, always use the specified tightening torques. When installing protective parts such as guards, or parts which vibrate violently or rotate at high speed, be particularly careful to check that they are installed correctly.
22. When aligning two holes, never insert your fingers or hand. Be careful not to get your fingers caught in a hole.
23. When measuring hydraulic pressure, check that the measuring tool is correctly assembled before taking any measurements.
24. Take care when removing or installing the tracks of track-type machines.
When removing the track, the track separates suddenly, so never let anyone stand at either end of the track.

FOREWORD

This shop 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 shop manual mainly contains the necessary technical information for operations performed in a service workshop.

For ease of understanding, the manual is divided into chapters for each main group of components; these chapters are further divided into the following sections.

STRUCTURE AND FUNCTION

This section 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.

TESTING AND ADJUSTING

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

Troubleshooting charts correlating "Problems" to "Causes" are also included in this section.

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.

MAINTENANCE STANDARD

This section gives the judgement standards when inspecting disassembled parts.

NOTICE

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

HOW TO READ THE SERVICE MANUAL

VOLUMES

Service manuals are issued as a guide to carrying out repairs. They are two manuals for each machine, **Chassis volume** and **Engine volume**.

These volumes are designed to avoid duplication of information. Therefore to deal with all repairs for any model, both chassis and engine volumes are needed.

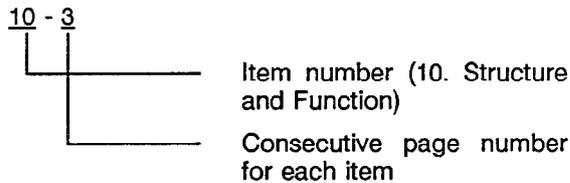
DISTRIBUTION AND UPDATING

Any additions, amendments or other changes will be sent to your 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 show how to read the page number:

Example 1 (Chassis volume):



Example 2 (Engine volume):
Refer to the pertinent engine manual.

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

Example:

21-4
21-4-1 Added pages
21-4-2
21-5

REVISED EDITION MARK ([1] [2] [3])

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

REVISIONS

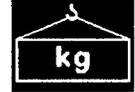
Revised pages are shown at the LIST OF REVISED PAGES on the between the title page and SAFETY page.

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.
	Weight	Weight of parts or systems. Caution necessary when selecting hoisting wire or when working posture is important, etc.
	Tightening torque	Places that require special attention for tightening torque during assembly.
	Coat	Places to be coated with adhesives and lubricants etc.
	Oil, water	Places where oil, water or fuel water must be added, and the capacity.
	Drain	Places where oil or water must be drained, and quantity to be drained.

HOISTING INSTRUCTIONS



Heavy parts (25 kg or more) must be lifted with a hoist etc. In the **Disassembly and Assembly** section, every part weighing 25 kg or more is indicated clearly with the symbol

1. If a part cannot be smoothly removed from the machine by hoisting, the following checks should be made:
 - Check for removal of all bolts fastening the part to the relative parts.
 - Check for existence of another part causing interface with the part to be removed.

2. Wire ropes

- 1) Use adequate ropes depending on the weight of parts to be hoisted, referring to the table below:

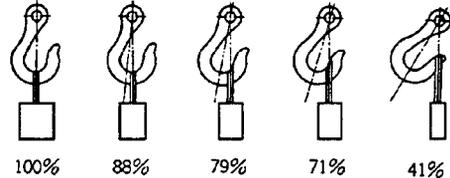
Wire ropes (Standard "Z" or "S" twist ropes without galvanizing)	
Rope diameter (mm)	Allowable load (tons)
10.0	1.0
11.2	1.4
12.5	1.6
14.0	2.2
16.0	2.8
18.0	3.6
20.0	4.4
22.4	5.6
30.0	10.0
40.0	18.0
50.0	28.0
60.0	40.0

The allowable load value is estimated to be one-sixth or one-seventh of the breaking strength of the rope used.

- 2) Sling wire ropes from the middle portion of the hook.

Slinging near the edge of the hook may cause the rope to slip off the hook during hoisting, and a serious accident can result.

Hooks have maximum strength at the middle portion.



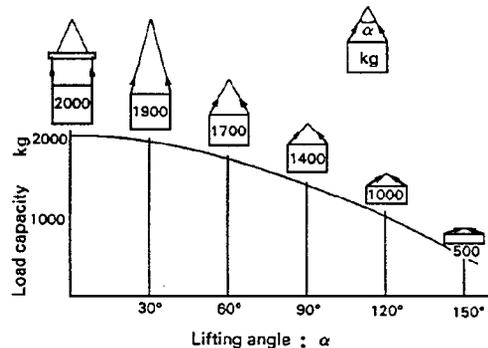
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- 3) Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound on to the load.



Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original winding position on the load, which can result in a dangerous accident.

- 4) Do not sling a heavy load with ropes forming a wide hanging angle from the hook. When hoisting a load with two or more ropes, the force subjected to each rope will increase with the hanging angles. The table below shows the variation of allowable load (kg) when hoisting is made with two ropes, each of which is allowed to sling up to 1000 kg vertically, at various hanging angles. When two ropes sling a load vertically, up to 2000 kg of total weight can be suspended. This weight becomes 1000 kg when two ropes make a 120° hanging angle. On the other hand, two ropes are subject to an excessive force as large as 4000 kg if they sling a 2000 kg load at a lifting angle of 150°.



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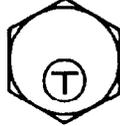
STANDARD TIGHTENING TORQUE



STANDARD TIGHTENING TORQUE

1. STANDARD TIGHTENING TORQUE OF BOLTS AND NUTS

The following charts give the standard tightening torques of bolts and nuts. Exceptions are given in sections of "Disassembly and Assembly".

Thread diameter of bolt (mm)	Width across flat (mm)		
		kgm	Nm
6	10	1.35±0.15	13.2±1.4
8	13	3.2±0.3	31.4±2.9
10	17	6.7±0.7	65.7±6.8
12	19	11.5±1.0	112±9.8
14	22	18.0±2.0	177±19
16	24	28.5±3	279±29
18	27	39±4	383±39
20	30	56±6	549±58
22	32	76±8	745±78
24	36	94.5±10	927±98
27	41	135±15	1320±140
30	46	175±20	1720±190
33	50	225±25	2210±240
36	55	280±30	2750±290
39	60	335±35	3280±340

This torque table does not apply to the bolts with which nylon packings or other non-ferrous metal washers are to be used, or which require tightening to otherwise specified torque.

★ Nm (newton meter): 1Nm ≈ 0.1 kgm

2. TIGHTENING TORQUE OF SPLIT FLANGE BOLTS

Use these torques for split flange bolts.

Thread diameter of bolt (mm)	Width across flats (mm)	Tightening torque	
		kgm	Nm
10	14	6.7±0.7	65.7±6.8
12	17	11.5±1	112±9.8
16	22	28.5±3	279±29

STANDARD TIGHTENING TORQUE

3. TIGHTENING TORQUE FOR NUTS OF FLARED FITTINGS

Use these torques for nut part of flared.



Thread diameter of nut part (mm)	Width across flats of nut part (mm)	Tightening torque	
		kgm	Nm
14	19	2.5±0.5	24.5±4.9
18	24	5±2	49±19.6
22	27	8±2	78.5±19.6
24	32	14±3	137.3±29.4
30	36	18±3	176.5±29.4
33	41	20±5	196.1±49
36	46	25±5	245.2±49
42	55	30±5	294.2±49

COATING MATERIALS



The recommended coating materials prescribed in the shop manuals are listed below.

Nomenclature	Code	Applications
Adhesives	LT-1A	Used to apply rubber pads, rubber gaskets, and cork plugs.
	LT-1B	Used to apply resin, rubber, metallic and non-metallic parts when a fast, strong seal is needed.
	LT-2*	Preventing bolts, nuts, and plugs from loosening and leaking oil.
	LT-3	Provides an airtight, electrically insulating seal. Used for aluminum surfaces.
Liquid gasket	LG-1	Used with gaskets and packings to increase sealing effect.
	LG-3	Heat-resistant gasket for precombustion chambers and exhaust piping.
	LG-4	Used by itself on mounting surfaces on the final drive and transmission cases. (Thickness after tightening: 0.07 - 0.08 mm).
	LG-5	Used by itself to seal grease fittings, tapered screw fittings and tapered screw fittings in hydraulic circuits of less than 50 mm in diameter.
Antifriction compound (Lubricant including molybdenum disulfide)	LM-P	Applied to bearings and taper shafts to facilitate press-fitting and to prevent sticking, burning or rusting.
Grease (Lithium grease)	G2-LI	Applied to bearings, sliding parts and oils seals for lubrication, rust prevention and facilitation of assembling work.
Vaseline	---	Used for protecting battery electrode terminals from corrosion.

*LT-2 is also called **LOCTITE** in the shop manuals.



ELECTRIC WIRE CODE

In the wiring diagrams, various colors and symbols are employed to indicate the thickness of wires. This wire code table will help you understand WIRING DIAGRAMS.

Example: 05WB indicates a cable having a nominal number 05 and white coating with black stripe.

CLASSIFICATION BY THICKNESS

Nominal number	Copper wire			Cable O.D. (mm)	Current rating (A)	Applicable circuit
	Number strands	Dia. of strands (mm)	Cross section (mm ²)			
0.85 (01)*	11	0.32	0.88	2.4	12	Starting, lighting, signal etc.
2 (02)*	26	0.32	2.09	3.1	20	Lighting, signal etc.
5 (05)*	65	0.32	5.23	4.6	37	Charging and signal
15	84	0.45	13.36	7.0	59	Starting (Glow plug)
40	85	0.80	42.73	11.4	135	Starting
60	127	0.80	63.84	13.6	178	Starting
100	217	0.80	109.1	17.6	230	Starting

* Old numbers

CLASSIFICATION BY COLOR AND CODE

Priority	Classification	Circuits	Starting	Charging	Lighting	Signal	Instrument	Other
1	Primary	Code	B	W	R	G	Y	L
		Color	Black	White	Red	Green	Yellow	Blue
2	Auxiliary	Code	BW	WR	RW	GW	YR	LW
		Color	Black & White	White & Red	Red & White	Green & White	Yellow & Red	Blue & White
3	Auxiliary	Code	BY	WB	RB	GR	YB	LR
		Color	Black & Yellow	White & Black	Red & Black	Green & Red	Yellow & Black	Blue & Red
4	Auxiliary	Code	BR	WL	RY	GY	YG	LY
		Color	Black & Red	White & Blue	Red & Yellow	Green & Yellow	Yellow & Green	Blue & Yellow
5	Auxiliary	Code	--	WY	RG	GB	YL	LB
		Color	--	White & Yellow	Red & Green	Green & Black	Yellow & Blue	Blue & Black
6	Auxiliary	Code	--	WG	RL	GL	YW	
		Color	--	White & Green	Red & Blue	Green & Blue	Yellow & White	

WEIGHT TABLE



This weight table is a guide for use when transporting or handling components.

Unit: kg

Engine assembly	465
Radiator assembly	130
Torque converter assembly	40
Transmission with torque converter	510
Front axle assembly (dry)	480
Rear axle assembly (dry)	95
Rear axle pivot	95
Wheel (1 piece) (14.00 X 25)	85
Wheel (1 piece) (17.00 X 25)	117
Tire (1 piece) (17.5 X 25 - 12 PR)	105
Tire (1 piece) (20.5 X 25 - 12 PR)	147
Hydraulic tank (dry)	160
Lift cylinder (1 piece)	105
Dump cylinder	110
Engine hood	28
Front frame (without accessories)	920
Rear frame (without accessories)	740
Tilt lever	195
Lift arm (with bushing)	735
Bucket (with edges)	835
Counterweight	1,020
Fuel tank (empty)	105
Battery (1 piece) (wet)	40
Floor board	105
ROPS cab	500

LUBRICANTS, FUEL AND COOLANT

PROPER SELECTION TABLE

RESERVOIR	FLUID TYPE	AMBIENT TEMPERATURE (Top line °F, Bottom line °C)	CAPACITY	
			Specified	Refill
Engine with filter	Engine oil See NOTE 1	SAE 20W-40 or 20W-50	22.4 ℓ	18.9 ℓ
		SAE 15W-40, 15W-50		
		SAE 10W-30		
		Synthetic SAE 5W-20 or 5W-30		
Torque converter Transmission & Service brakes	Engine oil See NOTE 2	SAE 30W	55 ℓ	53 ℓ
		SAE 10W		
Hydraulic system		SAE 10W	140 ℓ	114 ℓ
Drive axles - Front & rear	Axle oil	See NOTE 3	48 ℓ each	48 ℓ each
All lubrication fittings	Grease	See NOTE 4	Fill as in- structed	--
Fuel tank	Diesel fuel	See NOTE 5	260 ℓ	--
Cooling system	Coolant	See NOTE 6	48 ℓ	--

Specified capacity: Total amount of oil including oil for components and oil in piping.

Refill capacity: Amount of oil needed to refill system during normal inspection and maintenance.

API: American Petroleum Institute

ASTM: American Society of Testing and Material

SAE: Society of Automotive Engineers

NOTES:

1. ENGINE OIL

Normal Operation

Oil performance recommendations are as follows:

The use of a quality engine lubricating oil combined with appropriate oil and filter change intervals are critical factors in maintaining engine performance and durability.

SAE 15W-40 multi-viscosity oil meeting the American Petroleum Institute (API) Classification of CE/SF is recommended. CD/SF oil may be used in areas where CE/SF oil is not available.

A sulfated ash limit of 1.0 mass percent is suggested for optimum valve and piston deposit and oil consumption control. The sulfated ash **must not** exceed 1.85 mass percent. The sulfated ash limit of 1.85 mass percent has been placed on all engine lubricating oils recommended for use in the engine. Higher ash oils can cause valve and/or piston damage and lead to excessive oil consumption.

GENERAL

The API service symbol displays the following information. The upper half of the symbol displays the appropriate oil categories; the lower half may contain words to describe oil energy conserving features. The center section identifies the SAE oil viscosity grade.

Oil viscosity recommendations are as follows:

The use of a multi-graded lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures.

While SAE 15W-40 multi-viscosity oil is recommended for most operating climates, refer to the previous chart for oil viscosity recommendations for extreme climates.

Limited use of low viscosity oils, such as SAE 10W-30 may be used for easier starting and providing sufficient oil flow at ambient temperatures below +23°F (-5°C). However, continuous use of low viscosity oils can decrease engine life due to wear.

Do not use special "break-in" lubricating oils for a new or rebuilt engine. Use the same type of oil during the "break-in" as specified for normal operation.

Arctic Operation

If an engine is operated in ambient temperatures consistently below -10°F (-23°C) and there are no provisions to keep the engine warm when it is **not** in operation, use a synthetic CE/SF or CD/SF engine oil with adequate low temperature properties such as SAE 5W-20 or 5W-30.

The oil supplier **must** be responsible for meeting the performance service specifications.

IMPORTANT: The use of a synthetic base oil does not justify extended oil change intervals. Extended oil change intervals can decrease engine life due to factors such as; corrosion, deposits and wear.

Additional information regarding lubricating oil availability throughout the world is available in the "E.M.A. Lubricating Oils Data Book for Heavy Duty Automotive and Industrial Engines." The data book may be ordered from the Engine Manufacturers Association, One Illinois Center, 111 East Wacker Drive, Chicago, IL U.S.A. 60601. The telephone number is (312) 644-6610.

2. ENGINE OIL

Use API classification CE engine oil. If API classification CD is used, reduce the oil change interval to half.

3. AXLE OIL

For axle oil, use only the recommended oil as follows:

SHELL: DONAX TT or TD
CALTEX: RPM TRACTOR HYDRAULIC FLUID
CHEVRON: TRACTOR HYDRAULIC FLUID
TEXACO: TDH OIL
MOBIL: MOBIL AND SUPER UNIVERSAL

* It is possible to substitute engine oil SAE 30W API classification CD for axle oil. If noise comes from the brake, it is no problem of durability.

4. GREASE

The recommended lubricating grease is No. 2 multi-purpose lithium grease with 3% molybdenum disulfide.

5. DIESEL FUEL



WARNING! Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.

IMPORTANT: Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the injection pump and nozzles.

The use of ASTM No. 2-D diesel fuel with a minimum Cetane number of 40 is recommended. The use of No. 2-D diesel fuel will result in optimum engine performance under most operating conditions. Fuels with Cetane numbers higher than 40 may be needed in high altitudes or extremely low ambient temperatures to prevent misfires and excessive smoke.

At operating temperatures below +32°F (0°C), acceptable performance can be obtained by using a blend of No. 2-D and No. 1-D fuels. The use of lighter fuels can reduce fuel economy.

Use a low sulfur content fuel having a cloud point that is at least 10 degrees below the lowest expected fuel temperature. Cloud point is the temperature at which crystals begin to form in the fuel.

The viscosity of the fuel **must** be kept above 1.3 cSt to provide adequate fuel system lubrication.

GENERAL

6. COOLANT

Heavy duty diesel engines require a balanced coolant mixture of water, antifreeze, and supplemental coolant additives. Supplemental coolant additive recommendations are included in the section entitled "CHANGE THE COOLANT AND FLUSH THE COOLING SYSTEM". The coolant should be changed at the specified service interval shown in the "MAINTENANCE TABLE".

DCA4 is recommended to inhibit corrosion in the cooling system.

In climates where the temperature is above -34°F (-37°C), use a coolant mixture that contains 50 percent antifreeze. **Antifreeze is essential in any climate.** It broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point. Do **not** use more than 50 percent antifreeze in the mixture unless additional freeze protection is required. **Never** use more than 68 percent antifreeze under any condition.

Low silicate ethylene glycol antifreeze is recommended. The antifreeze should contain no more than 0.1% anhydrous alkali metasilicate. Low silicate antifreeze is recommended to avoid the formation of silica-gel (hydro-gel). This gel formation can occur when the cooling system contains an over concentration of high silicate antifreeze and/or supplemental coolant additive. **DO NOT** use methanol or alcohol as an antifreeze because of its low boiling point.

Antifreeze may retain its freeze protection for more than one season but coolant conditioners must be added to maintain corrosion protection.

Antifreeze formulated with methoxy propanol, or propylene glycol, is not recommended for this system.

NOTE: *Do not mix types of antifreeze solutions. Mixed solutions make it impossible to determine the protection against freezing. Antifreeze containing sealer or anti-leak additives should NOT be used in this system. Sealer or anti-leak additives will cause plugging problems in the cooling system.*

Check the solution periodically and at normal operating temperature, to be sure the cooling system has sufficient protection against freezing.

Use water which has a low mineral content. Water used in conjunction with antifreeze, coolant filters and inhibited water must meet the following standards:

Total Hardness - Not to exceed 170 parts per million (10 grains/gallon maximum) to prevent scale deposits. Water containing dissolved magnesium and calcium (the usual reason for water hardness) above the specified amount will cause scale deposits to develop in the engine.

Chlorides - Not to exceed 40 parts per million (2.5 grains/gallon maximum) to prevent corrosion.

Sulfites - Not to exceed 100 parts per million (5.8 grains/gallon maximum) to prevent corrosion.

Dissolved Solids - Not to exceed 340 parts per million (20 grains/gallon maximum) to minimize sludge deposits, scale deposits, corrosion or a combination of these.

If any of the above requirements cannot be met, use distilled, de-ionized, or de-mineralized water. To determine if local water supplies meet these standards, water samples can be tested by water treatment laboratories. "Softened" water that is prepared using common salt (sodium chloride) contains excessive amounts of chlorides and should not be used.

NOTE: *Never use water alone in the cooling system because corrosion will occur.*

Maintain supplemental coolant additive levels at 1 unit DCA4 per 1 U.S. gal (3.8 liters) of coolant.

Use antifreeze during all seasons to protect the cooling system from corrosion as well as freezing damage.

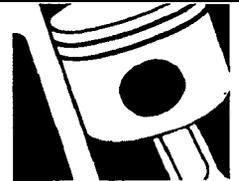
A mixture of 50% water and 50% ethylene glycol base antifreeze is required for operation of the engine in temperature environments above -34.6°F (-37°C). A mixture of 40% water and 60% antifreeze is recommended for temperatures below -34.6°F (-37°C).

In tropical climates where antifreeze availability may be limited, use a corrosion inhibitor (Cummins liquid DCA), or an equivalent to protect the engine cooling system.

Do not operate the engine without a thermostat.

ENGINE

12 TESTING AND ADJUSTING



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★ The following precautions are necessary when using the Standard Value Tables to make judgements during troubleshooting or during testing and adjusting.

1. The values in these tables are based on the values for new machines leaving the plant, so they should be used as target values when repairing or when estimating wear after a period of use.
2. The standard values in these tables for judgement when troubleshooting are estimated values based on the standard values for the machine when shipped from the plant, and on the results of various tests. Therefore, they should be used as reference in combination with repair and operating records when making judgements.
3. These standard value tables must not be used for standard values when judging claims. In addition, do not use these values alone to make simple judgements.

TESTING AND ADJUSTING



When carrying out testing, adjusting or troubleshooting, stop the machine on level ground, install the safety bar on the frame, lower the bucket to the ground, and stop the engine. Then apply the parking brake and block the tires.



Do not allow unauthorized persons near the machine.



When measuring the engine speed, one worker should measure the engine speed while the another person sits in the operator's seat to operate the controls. Always check that the operation is safe, and use agreed upon signals.



Be careful not to get caught in rotating parts.



When installing or removing gauges, loosen the oil filler cap slowly to release the pressure inside the hydraulic tank. Then operate the control levers several times to release the remaining pressure in the hydraulic piping.



When taking measurements, do not allow unauthorized persons near the machine.



The oil in the circuit is hot, so be careful not to get burnt.