

FOREWORD

Thank you for having selected Mitsubishi Diesel Engine for your use.

This manual describes the procedures for proper handling and maintenance of the Engine Models K and KE.

To maintain your engine always in its best operating condition and to enable it to perform best, it is important to handle it properly and carry out complete maintenance according to this manual.

If you have any questions about your engine or in the even of a failure, please contact the nearest Speciality servics station.

We heartily look forward to your continued patronage.

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GENERAL SPECIFICATIONS

		Model						
ENGINE PROPER	Item							
	Type							
	Combustion chamber							
	No. of cylinders	2		3				
	Bore x stroke, mm (in)	65x68 (2.56x2.68)	68x78 (2.68x3.07)	70x78 (2.76x3.07)	68x78 (2.68x3.07)	73x78 (2.87x3.07)		
	Total displacement cc (in³)	451 (27.5)	566 (34.5)	600 (36.6)	849 (51.8)	979 (59.7)		
	Compression ratio	25			23			
	Firing order	1-2		1-3-2				
LUBRICATING SYSTEM	Dry weight kg (lbs)	60(132)	82(181)		125(276)	130(287)		
	Lubricating method				Forced lubrication			
	Oil pump				Trochoid type			
	Oil filter				Paper element type			
FUEL SYSTEM	Oil capacity l (in³) [incl. 0.3 to 0.5 l (18.3 to 30.5 in³) of oil filter]			2.8 (171)				
	Fuel injection pump				Bosch type M			
	Nozzle				Throttle type			
	Fuel injection pressure kg/cm² (psi)	160(1,707)			120(1,707)			
	Fuel to be used							
COOLING SYSTEM	Governor				Centrifugal weight type			
				Oil baty type or paper element type				
	Cooling method							
ELECTRICAL SYSTEM	Water pump				Centrifugal type			
	Water capacity (excluding radiator) l (in³)	1.6 (98)	2.1 (128)		3.0 (183)			
	Starter (V-kW)	(12-0.9)		Solenoid shift starter (12-1.6) or (12-2)				
	Alternator (V-A)	(12-14)						
	Glow plug				Sheathed type			
	Battery (available in the market)	12V, 45 Ah or more		12V, 60 Ah or more				

K3H	K3M	K4C	K4D	K4E	KE75	KE150	KE150-T									
4-cycle, water-cooled, vertical, over-head valve diesel engine																
Swirl chamber type																
3		4		2		4										
78x90 (3.07x3.54)	84x90 (3.31x3.54)	70x78 (2.76x3.07)	73x78 (2.87x3.07)	76x78 (2.99x3.07)	78x80 (3.07x3.15)	78x78 (3.07x3.07)										
1,290 (78.7)	1,496 (91.3)	1,200 (73.2)	1,306 (79.6)	1,415 (86.3)	764 (46.5)	1,490 (90.9)										
23		20		23												
		1-3-4-2		1-2		1-3-4-2										
153(337)	154(339)	140(309)	150(331)	150(331)	105(232)	200(441)	205(452)									
Forced lubrication																
Trochoid type																
Paper element type																
5.0 (305)	4.5 (275)		6.0 (366)	2.9 (177)	5.0 (305)	7.0 (427)										
Bosch type M																
Throttle type																
160 (1,707)	120(1,707)				140(1,992)											
Diesel fuel (Diesel fuel specified for cold weather use at -7°C or below)																
Centrifugal weight type																
Oil baty type or paper element type																
Forced circulation of water																
Centrifugal type																
3.9 (270)	3.5 (214)		2.1 (128)	3.7 (256)												
Solenoid shift starter (12-1.6) or (12-2)		(12-1.2)		(12-1.8)												
(12-15, 12-35 or 12-50) AC generator																
Sheathed type																
12V, 70Ah or more	12V, 60 Ah or more	12V, 70 Ah or more	12V, 45 Ah or more	12V, 70 Ah or more												

CAUTIONS IN OPERATION ENGINE

1. Use proper engine oil and always keep attention to the oil pressure caution lamp during operation.
2. Use clean fuel free from impurities and water.
3. Prevent air and water from intruding into the fuel system.
4. Keep moderate water temperature during engine operation.
5. Pay attention to the color of exhaust fume.
6. Inspect the engine periodically as stated in the periodic maintenance table.

SAFETY PRECAUTIONS

1. Absolutely avoid operating the engine indoors where ventilation is poor.
2. Do not touch moving parts during operation.
3. Do not touch hot parts such as the exhaust pipe and do not place combustible materials there.
4. Be sure to stop the engine whenever inspecting or adjusting engine parts.
5. Be sure to stop the engine whenever checking and correcting engine oil, cooling water and fuel levels.
6. Be sure to wait for water temperature to lower when removing the radiator cap.
7. Perform servicing work safely using tools well matching in size with bolts and nuts to be loosened or tightened.

1. BREAKING IN

Service life of your engine is dependent largely upon how the engine is operated and serviced during the initial 50 hours of operation.

It is essential for high engine performance to break in all moving parts satisfactorily. During breaking-in period give special care to the following:



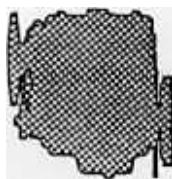
K2



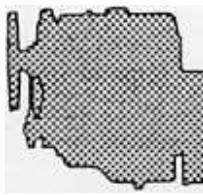
KE75



K3



K4



KE150

CAUTION.

- Keep 5-minute warming-up run after engine start.
- Avoid hasty acceleration.
- Use caution not to overload the engine.
- Carefully observe the inspection and maintenance instructions of this manual.

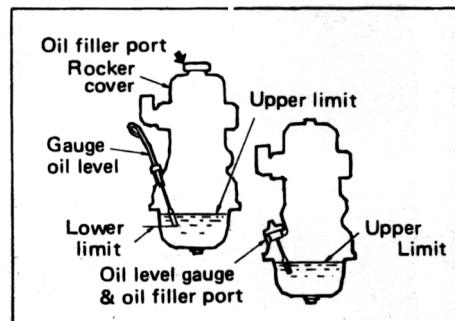
2. PREPARATIONS

Take steps shown below in starting your engine for the first time or after a prolonged shutdown.

(1) Checking and correcting the engine oil level

Check the oil level with the oil level gauge and, if necessary, add oil up to or near the upper limit mark on the gauge.

Thrust in the dipstick type gauge fully or turn in the filler cap with level gauge fully when checking the oil level.



(2) Refilling the air cleaner with oil (only for oil bath type)

Refill the oil bath type cleaner case with engine oil up to the specified oil level.

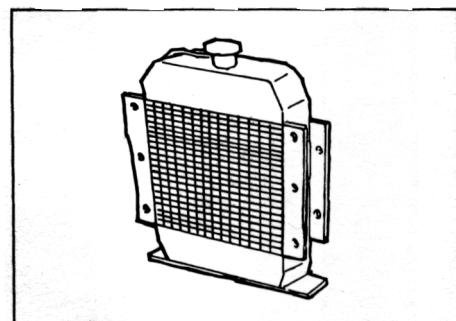


(3) Refilling the radiator with water

Remove the radiator cap and pour clean water into the radiator until water overflows the cap hole.

Use antifreeze in winter.

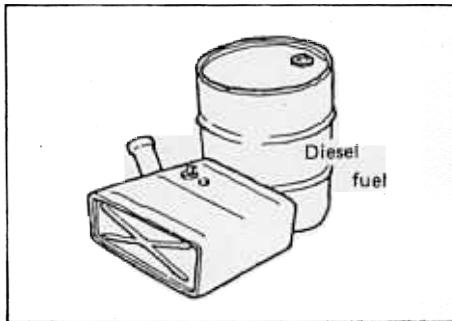
It is recommended to use anti corrosive at all seasons.



2. PREPARATIONS

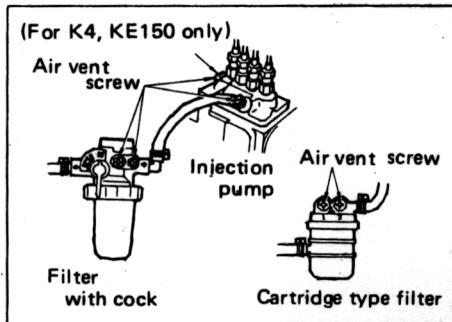
(4) Refueling

Refill the fuel tank with diesel fuel for automobile use. Fuel tank interior should be kept clean to prevent dust and water from mixing with fuel.



(5) Bleeding air from the fuel system

Bleed air by loosening the air vent screws first at the fuel filter and then fuel injection pump.

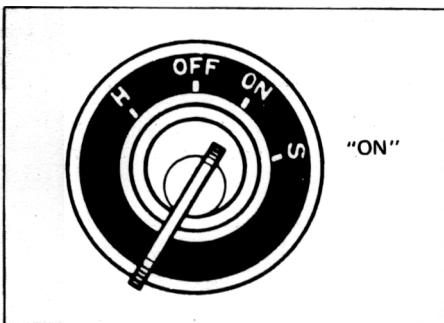


3. STARTING PROCEDURE

(1) Checking the caution lamps

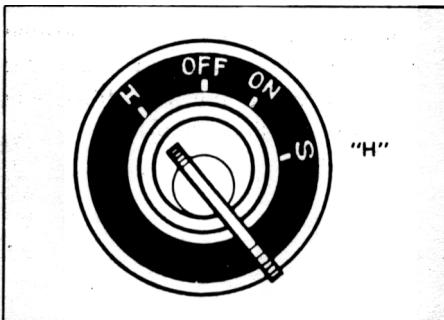
Turn the starter switch to "ON" and check that both the oil pressure lamp and charge lamp go on.

- Oil pressure warning buzzer, if provided, will sound when the starter switch is turned to "ON".



(2) Preheating the glow plug

Turn the starter switch to "H" and maintain there until the glow plug indicator becomes bright.



CAUTION:

- Adequate preheating time is about 20 seconds. The optimum preheating time varies with ambient temperature at which the engine is to be started. The limit of preheating time shown in the table below should not be exceeded to prevent burning out of the glow plug.

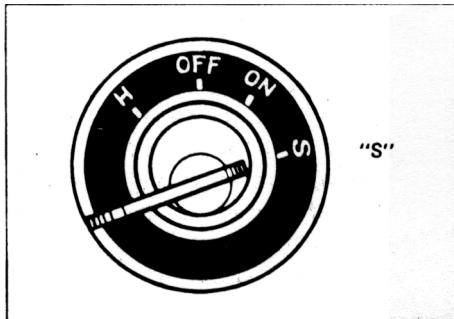
Ambient temperature	Preheating time	
	General type (Y110) (with circular nut)	Quick-heat type (Y114T) (with hex. nut)
+5°C (41°F) or above	Approx. 20 seconds	Approx. 10 seconds
+5°C (41°F) to -5°C (23°F)	Approx. 30 seconds	Approx. 20 seconds
-5°C (23°F) or below	Approx. 60 seconds	Approx. 30 seconds
Limit of continuous use	2 minutes	1 minute

- If the glow plug indicator does not light brightly, contact the nearest Speciality service station.

3. STARTING PROCEDURE

(3) Starting

Confirm that the fuel filter valve is opened. Move the speed control lever to the "full throttle" position (at which surplus fuel is injected). Turn the starter switch to "S", and the starting motor will crank up the engine.

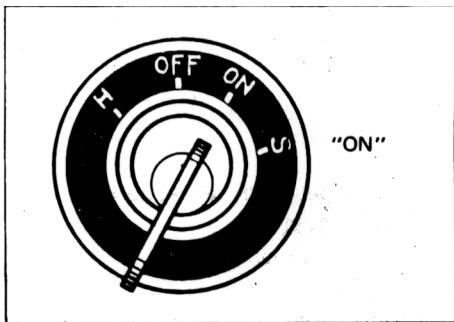


CAUTION:

- If the starter fails to crank up the engine within 10 seconds, release the switch key and wait for the starting motor to come to a complete stop. Then, turn the key to "S" again. Under no circumstances the starting motor should be left to run for more than 30 seconds.

(4) Operation

As soon as the engine starts, release the starter switch key to allow it to return automatically to "ON" position. Leave the key at that position during engine operation. Place the speed control lever in the idling position and continue warm-up running of the engine. After confirming water temperature rises and the oil pressure caution lamp goes off, start operating the engine with load.



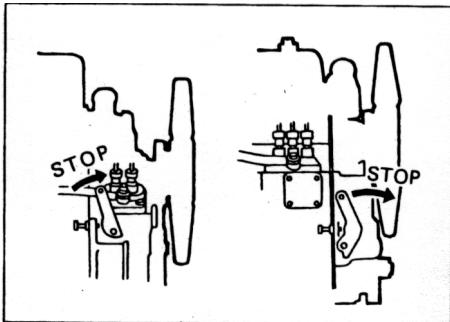
CAUTION:

- During engine operation, do not turn the key to "S" position. Otherwise, the starter may be damaged.

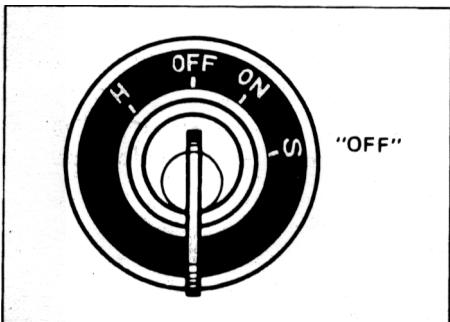
4. STOPPING PROCEDURE

4.1 Standard engine

(1) To stop the engine, push the speed control lever beyond the idling position until the lever comes into contact with the stopper. At that position, fuel injection is stopped. (Hold the lever at that position until the engine comes to a complete stop. Otherwise, the engine may rotate in reverse.)



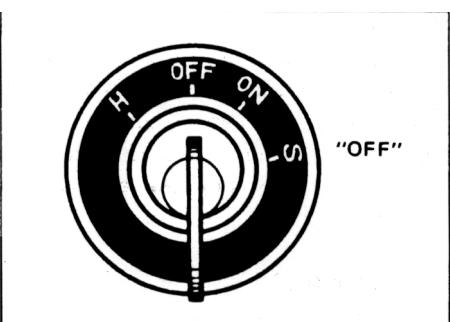
(2) After the engine comes to a stop, return the starter switch to "OFF". If the switch is left at "ON" position even after engine stop, the battery will be discharged. To eliminate the possibility of such a trouble, make it your habit to draw off the starter switch key after the engine stops.



4.2 Engine with emergency stopping system

(1) Normal stopping

Turn the starter switch to OFF, and the engine will come to a stop automatically.

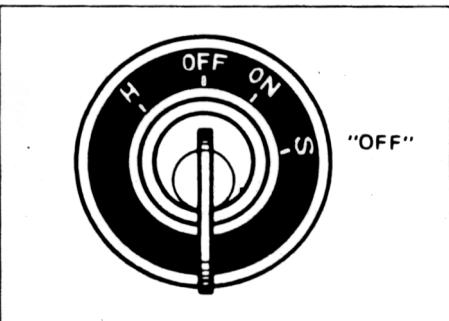


4. STOPPING PROCEDURE

(2) Automatic emergency stop

If engine oil pressure is lowered from the specified value by some reason, the engine will come to a stop automatically.

At the same time, the oil pressure caution lamp will light (and the warning buzzer, if provided, will sound) to call operator's attention. Turn the starter switch to OFF at once.



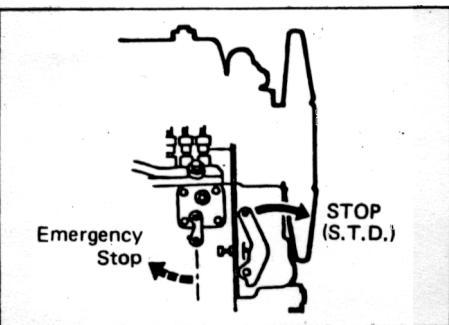
(3) Manual emergency stop

a) Engine without emergency stop knob

If the engine fails to stop when the starter switch is turned to OFF, pull the speed control lever fully until it comes into contact with the stopper.

b) Engine with emergency stop knob

If the engine fails to stop when the starter switch is turned to OFF, pull the emergency stop knob.



CAUTION:

- Whenever the engine comes to a stop automatically, be sure to check and correct the engine oil level and other possible cause of trouble before restarting the engine.

5. CAUTIONS ON STARTING AND OPERATION

5.1 Normal starting

Follow the procedures below for routine starting of the engine.

- (1) Check the oil level in the oil pan.
Add oil if necessary.
- (2) Check the oil bath type air cleaner
(when equipped) for its oil level.
Add oil if necessary.
- (3) Refill the fuel tank with diesel fuel.
- (4) Check the cooling water level.
Add water if necessary. Also, check the cooling fan belt tension.

CAUTION:

- Carefully check for water and oil leakage. Especial care should be taken when evidences of leakage are found on the bottom of the machine.

- (5) Start the engine using the procedure given on the preceding pages.
- (6) Keep the engine in warming-up run until water temperature rises and, then, start operating the engine with load.

5.2 Cold-weather starting

The following four adverse conditions will concur in severely cold weather, causing hard engine start. Take necessary measures shown below for each adverse condition.

- (1) Lubricating oil turns viscous.
 - Pour hot water into the radiator.
 - Make sure that the oil used is suitable for use at low atmospheric temperatures. Check the oil also for deterioration.
- (2) Battery voltage drops.
 - Keep the battery warm by using a suitable cover or other protective method.
 - Confirm that the battery is charged fully.
- (3) Low intake air temperature causes insufficient rise of compressed air temperature.
 - Preheat intake air sufficiently with the glow plug.

5. CAUTIONS ON STARTING AND OPERATION

- (4) Fuel loses its fluidity • Deposition of fuel components at low temperatures affects fluidity of fuel, causing poor combustion. It is necessary, as the case may be, to replace with fuel for severely cold weather use.

5.3 Cautions during operation

- (1) Oil pressure • During normal operation
 - Confirm that the oil pressure caution lamp is going off.
 - At engine start
 - Confirm that the oil pressure caution lamp goes on.
- (2) Exhaust fumes • When engine is cold
 - Whitish smoke
 - When engine is warmed up
 - Almost smokeless
 - When engine is overloaded
 - Some black smoke
- (3) Abnormal sounds • Check for knocking sound, fricative sound, leaking sound, vibrations and blow-back sound.
- (4) Fuel and engine oil • Check for fuel and oil leakage
- (5) Knocking sound • Knocking may be liable to occur when the engine is cold, during quick acceleration and during idling. Confirm that no knocking sound is heard in other cases.
- (6) Safety • Do not touch moving or hot parts.
• Absolutely avoid operating the engine indoors where ventilation is poor. Also, never allow any person to stand near the exhaust pipe or on the leeward of the engine.

6. POINTS OF MAINTENANCE

6.1 Lubrication System

(1) Engine oil

Use diesel engine oil. Recommended API service classification is class CC or higher grade.

CD

Use DC class one for engines with turbo-charger.

the atmospheric temperatures at which the engine is to be operated. It is recommended to use SAE10W-30 oil at all seasons because of its minimum viscosity change under variations of temperature.

(2) Engine oil viscosity

Select oil viscosity most suitable to

Atmospheric temperature	Viscosity
20°C (68°F) or above	SAE30 or SAE10W-30
5°C (41°F) to 20°C (68°F)	SAE20 or SAE10W-30
5°C (41°F) or below	SAE10W-30



(3) Oil pressure

Oil pressure is judged normal if the oil pressure caution lamp (or warning buzzer) goes on or off as follows:

- At engine start (cranking)
The lamp will go on.
- During normal running of engine
The lamp will go off.

If oil pressure drops from the normal range during running of the engine, the lamp will go on (and the engine will be stopped by the function of emergency stop solenoid if equipped). In such a case, have your engine inspected for lubrication trouble by the nearest Speciality service station.

(4) Engine oil change

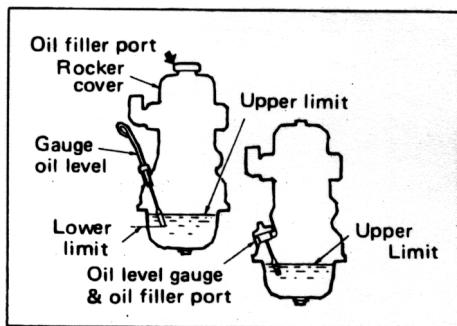
Change engine oil first after 50 hours of initial operation and, thereafter, every 100 hours of operation.

Drain oil after engine stop, while engine oil is still warm, by removing the oil pan drain plug. After draining the oil thoroughly, install and tighten the drain plug. Refill the oil pan up to the specified oil level with fresh engine oil through the oil filter on the rocker cover or at the side of oil filter. Idle the engine for several minutes. Stop the engine and check the oil level in the oil pan again with the oil level gauge.

6. POINTS OF MAINTENANCE

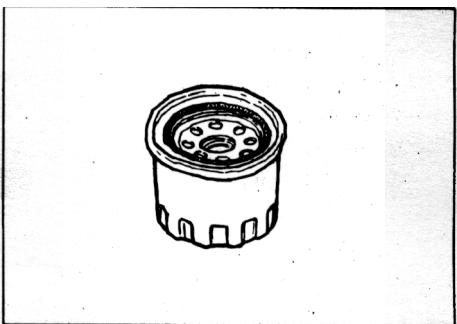
(5) Checking and correcting the oil level

Check the oil level in the oil pan and, if necessary, add the same brand oil as that being used so that oil level is always kept near the upper limit mark of the level gauge. Place the engine horizontally when checking the oil level. When using the oil level gauge, first draw it out, wipe the gauge with clean rag, and dip the stick in the oil pan to check the oil level. In the case of the gauge fitted to the oil filler cap, take out the gauge by loosening the cap, wipe the gauge with clean rag, and reinstall the gauge in the oil pan with the cap tightened securely to check the oil level.



(6) Replacing the oil filter

Replace the oil filter first after 50 hours of initial operation and, thereafter, every 100 hours of operation. The easy-to-handle, cartridge type oil filter requires no cleaning. When installing a new filter, apply thin coat of engine oil to the O-ring and tighten the cartridge securely with hand. After installation, start the engine and confirm that the filter does not leak oil.



6. POINTS OF MAINTENANCE

6.2 Fuel System

(1) Diesel fuel

Use proper diesel fuel. [Use diesel fuel specified for cold weather use at -7°C (19.4°F) or below.] Never use kerosene or heavy oil.

The fuel tank should be refilled early. Especially in winter, keep the fuel tank being topped up to prevent condensation of moisture inside the tank. When refilling the fuel tank, use a proper filtrating method to prevent the fuel from mixing with impurities.

Attention should also be taken to prevent intrusion of dust and water into the fuel tank.

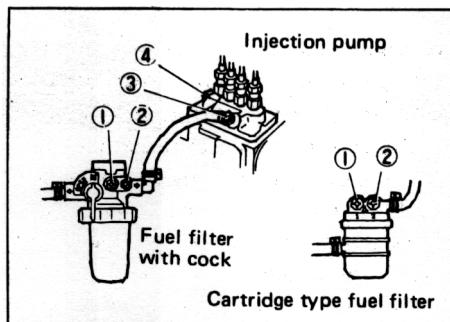
- Filtration of fuel;

Using a centrifugal separator is most desirable to separate dust and water from fuel, although it is costly. For practical purposes, fuel is to be left stood in a drum for several days to deposit impurities off the fuel. Draw the clarified fuel from the drum and feed it to the fuel tank. In this case, using a drum with a tap and setting the drum a little tilted backward will provide a convenient way of drawing clarified fuel.

(2) Air bleeding of fuel system

Air in the fuel system prevents the diesel engine from starting. Air bleeding is necessary to remove air which has intruded into the fuel system during inspection or maintenance of the engine.

To bleed air, first loosen the air vent screw (1) of the fuel filter to allow bubbly fuel to flow out of the vent screw hole. When bubbles no longer come out of the vent hole, tighten the air vent screw. Repeat the same procedure at the air vent screw (2) of the fuel filter and at the air vent screw (3) (two screws (3) and (4) [for K4 and KE150] of the injection pump, in that order. Be



6. POINTS OF MAINTENANCE

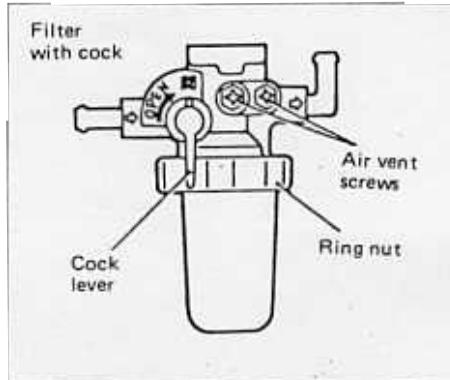
sure to tighten each air vent screw before loosening another vent screw. Then, place the speed control lever in the "full throttle" position and crank the engine several seconds with the starter to expel air from the plungers, fuel injection pipes and nozzles.

CAUTION:

- Be careful not to run the starter for 30 seconds or more continuously.

(3) Cleaning and replacing the fuel filter

Sediment and water accumulated in the fuel filter will cause hard engine operation. Every 100 hours of operation, loosen the filter ring nut and take out the filter element. Rinse out the element in clean diesel fuel. In the case of a cartridge type filter, remove the air vent screws to drain accumulated water and sediment. Replace the fuel filter every 400 hours of operation.



(4) Fuel injection pump and nozzle

The fuel injection pump and nozzles are the most important parts of the diesel engine and thus they call for utmost caution in handling. Any adjustment of pump and nozzles, if necessary, should be entrusted to the nearest Speciality service station since such an adjustment requires the precision pump tester and nozzle tester.

6.3 Intake System

(1) Cleaning the air cleaner

Poor maintenance of the air cleaner causes wear of main moving parts and lowering of engine output. Clean the air cleaner periodically to prolong engine life.

6. POINTS OF MAINTENANCE

a) Paper element type air cleaner

Every 100 hours of operation, take out the air cleaner element and clean it. To clean, apply blast of compressed air from inside to outside of the element or shake off dust in a solution of synthetic detergent and dry it up.

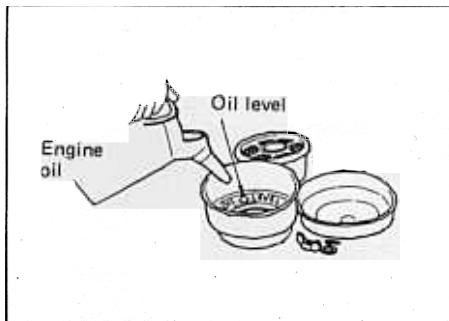
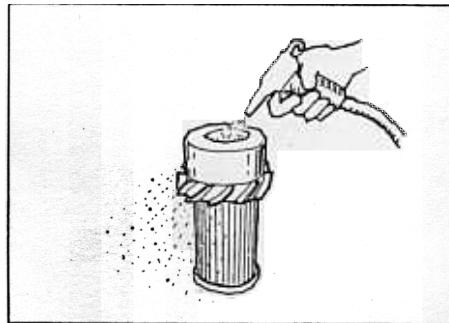
Clean the element early if dusty condition is severe.

Replace the element 400 hours of operation under normal condition. This interval should be reduced if dusty condition is severe.

b) Oil bath type air cleaner

The oil bath type air cleaner encloses a steel wire net element which is either fixed to or separable from the cleaner body.

Clean the element every 100 hours of operation by shaking off dust in oil. Dry the element. Then, dip the element into clean oil, shake off oil thoroughly, and install the element in the cleaner oil bath filled with engine oil up to the specified level.



6.4 Cooling System

(1) Cooling water

Use soft water with least impurities, such as tap water (drinking water) or rainwater. Never use hard water or foul water. Use of hard water or water containing much impurities will lead to deposition of fur in the engine and radiator, thus causing a considerable reduction of cooling effect.

6. POINTS OF MAINTENANCE

(2) Anticorrosive agent

Use anticorrosive agent to prevent resting and corrosion of the cooling system and to prevent lowering of cooling effect resulting from corrosion.

(3) Antifreeze

Be sure to use antifreeze if lowering of atmospheric temperature to the freezing point of water or below is expected. Should water freezes in the cooling system, expansion of its volume would cause cracks and damage to the radiator and cylinder block. Use of a proper concentration

of antifreeze is indispensable.

- Antifreeze of poor quality may cause corrosion of the cooling system. Always use a name brand product and never use a mixture of different brand products.
- Thoroughly clean the engine cooling system before refilling with antifreeze.
- Freezing point of coolant varies with the concentration of antifreeze. The typical relativity is shown in the table below. In individual cases, carefully observe the antifreeze maker's instruction.

Concentration of antifreeze %		13	23	30	35	40	45	50	55	60
Freezing point	°C	-5	-10	-15	-20	-25	-30	-40	-45	-50
	°F	23	14	5	-4	-13	-22	-40	-49	-58

CAUTION:

1. It is advisable that a concentration of antifreeze in the mixture be selected on the basis of a temperature which is about 5°C (41°F) below the expected lowest atmospheric temperature.
2. When preparing a mixture, make a proper estimate of the capacity of radiator and related pipes in addition to the capacity of engine cooling system which is stated in the GENERAL SPECIFICATION table.
3. Unnecessary increase of antifreeze concentration should be avoided to prevent overheating of the engine.

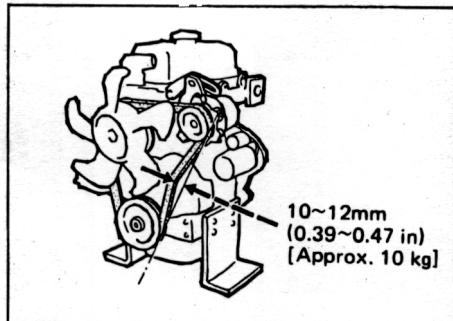
Care on handling of radiator cap and on draining of water:

When removing the radiator cap, stop the engine and wait for hot water to cool down. Also, be careful not to scald yourself when draining hot water.

6. POINTS OF MAINTENANCE

(4) Fan belt tension

Fan belt tension is normal if the belt deflects 10 to 12 mm (0.39 to 0.47 in) when pressed by finger force at the middle of the longest span between pulleys. Excessive tension will cause early wear of the belt, water pump bearing and alternator bearing. While, a slack or greasy belt will slip, causing overheating of the engine or insufficient charging of the battery.



CAUTION:

- Never attempt to adjust the fan belt tension during running of the engine.

6.5 Electrical System:

Water and heat are enemy of the electrical system. Take care to prevent intrusion of water during washing of the engine and to prevent generation of heat due to faulty maintenance.

(1) Cares on handling of electrical system

1. Be careful not to confuse polarity of the battery. Terminal marked (–) must be grounded.
2. Never attempt to measure insulation resistance of the alternator directly with a megger. The alternator should be disassembled to measure its insulation resistance.
3. Never attempt to disconnect the battery cable and to turn off the starter key switch or battery switch

during running of the engine (especially at high engine speed). Otherwise, diodes and coils of the alternator may be damaged.

4. Be sure to tighten grounding joints and wire joints securely. Also, prevent poor conduction due to corrosion.

(2) Wiring diagram

The standard 12-volt electrical system of this engine is diagramed below. Refer to this diagram for proper

6. POINTS OF MAINTENANCE

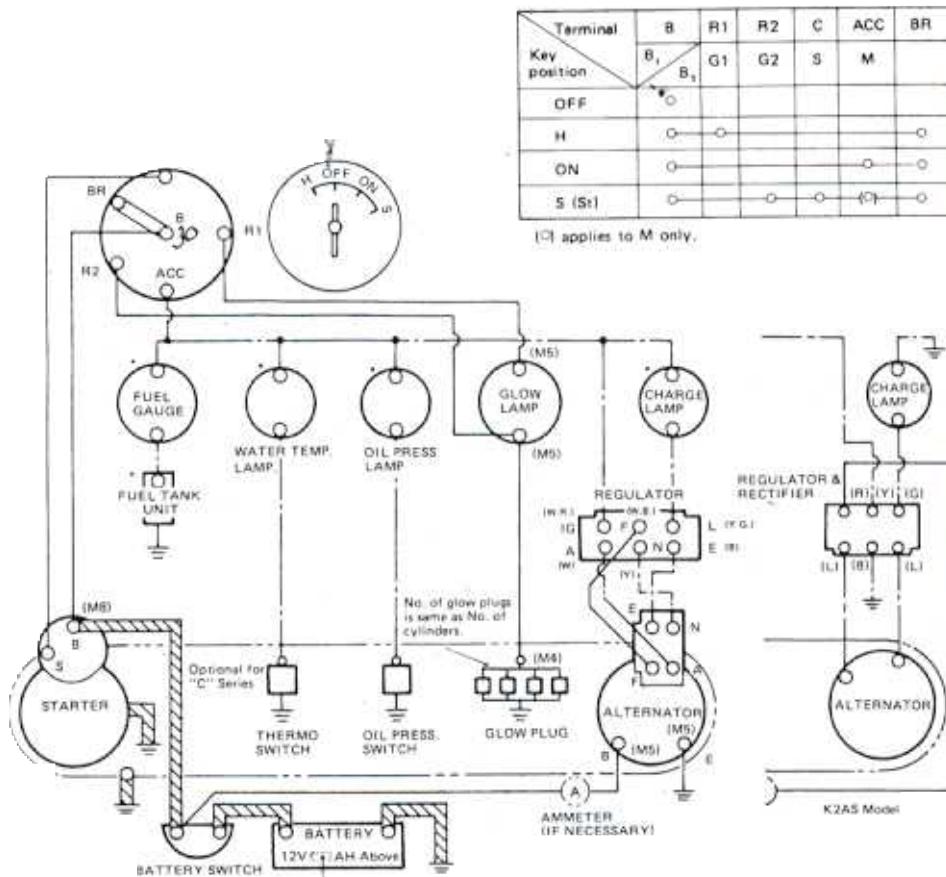
wiring of electrical devices. Also, carefully check for damage to cords and for faulty grounding.

Wiring diagram applicable to the engine with the emergency stopping system using a solenoid is shown on the next page.

2. There are two types of glow plug: General type Y110 (with circular nut) and Quick-heat type Y114T (with hexagonal nut). Be careful to prevent mixed use of them.

Notes: 1. 24-volt electrical system differs from the 12-volt electrical system in specifications of the starter, alternator, regulator, glow plugs, glow plug indicator and battery.

(a) Wiring diagram for standard engine

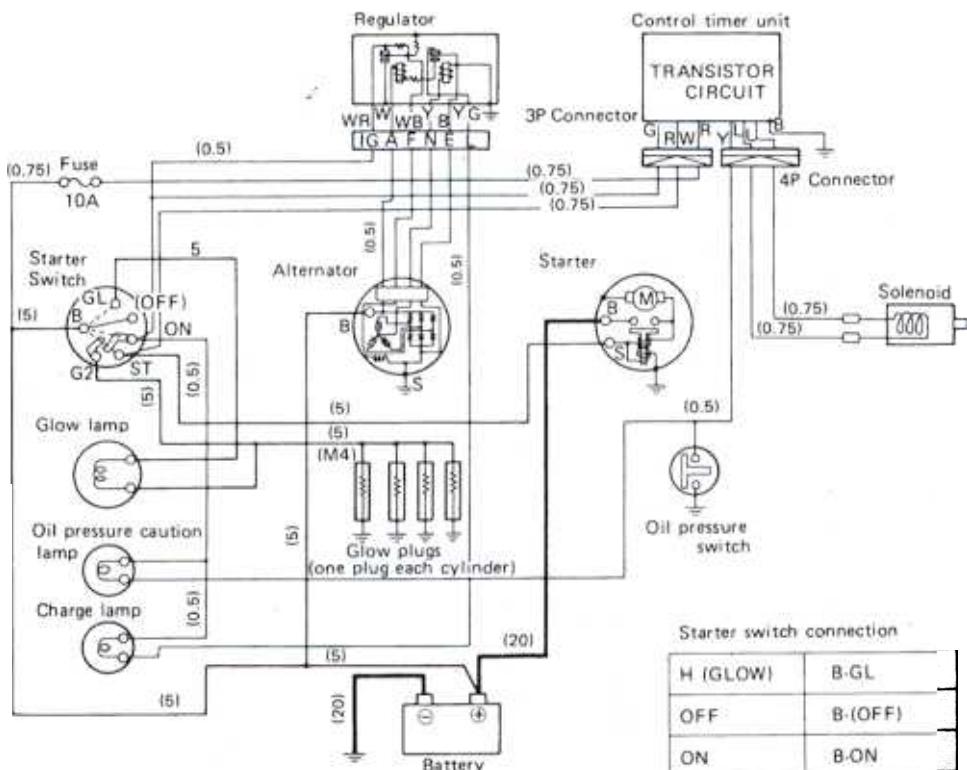


AH	ENGINE
45	K2, KE75
60	K3B, C, D, E; K4C, D
70	K3H, M; K4E; KE150

CORD IDENTIFICATION	ABOVE mm ²
	20
---	5
- - -	0.5

1. The system is changed according to the spec.
2. Numerals in parentheses are screw sizes.
3. Do not connect the terminals of battery opposite.
4. During high-speed operation, do not disconnect the terminals and turn s/w off.
5. Capacity of battery is applied for normal use.

(b) Wiring diagram for engine with emergency stopping system



Notes: 1. Figures in parenthesis denote cord number
(corresponding to cross section
of conductor: mm²).

• Starter switch operation and functioning of associated parts

Switch Operation

Item	Starter Switch	Oil-Pressure Switch	Solenoid	Injection Pump Rack	Operation
Starting	ON	ON	ON	STOP	MS Reset (New device, Injection pump)
	Start	OFF	OFF	MS	Preparation for starting
Running	ON	OFF	OFF	(SS)	Normal running
	ON	ON	ON	STOP	Emergency Stop
	OFF	OFF	ON	STOP	Key-operated stop

7. PERIODIC MAINTENANCE TABLE

○: Inspection, adjustment, refilling
 □: Cleaning ●: Replacement △: Draining

Service item		Intervals		Before engine start	First 50 hrs	Every 100 hrs	Every 400 hrs	Every 800 hrs	After long term storage	Remarks
Engine Proper	Looseness, damage and leakage		○							
	Exhaust fume, abnormal sound and vibration		○							
	Retightening bolts and nuts			○				○		
	Engine valve clearance		○				○			*
	Engine idling condition		○	○						*
	Compression pressure							○		*
Lubrica-tion System	Engine oil		○	●	●					
	Oil filter			●	●					
Fuel System	Fuel		○						△	
	Fuel tank					□			□	
	Fuel filter				□		●			Replacing filter element or filter cartridge
	Injection pump							○		Adjusting injection quantity
	Nozzle					○				
Intake System	Air cleaner	Paper-element type			□		●			Replacing element When operating in dusty areas, replace element earlier.
		Oil-bath type	○		□●					Replacing oil
Cooling System	Water		○	●				●	△	Drain water at the end of daily operation if no anti-freeze is used in cold weather
	Fan belt tension	○								
Electrical System	Indicators	○								Pilot and caution lamps and gauges
	Glow plug						○			
	Starter, alter-nator and regulator						○	○ ¹⁾		1): Adjusting voltage and current

NOTE: See the succeeding pages for inspection procedures. Have the marked * items inspected by the nearest Specialty service station.

8. PERIODIC MAINTENANCE PROCEDURES

Check and service your engine at specified intervals to maintain it in its best conditions and permit as it should. As for the items preceded by mark *, you are suggested to have them inspected or adjusted by the nearest Speciality service station.

Daily inspection before starting the engine

- (1) Check engine oil level. Add oil if necessary to keep the oil level near the upper limit mark on the oil level gauge.
- (2) Check air cleaner (oil bath type). Add oil if necessary to keep the specified oil level.
- (3) Check fuel level.
- (4) Check water level. Top up the radiator until water level is just below the radiator cap.
- (5) Check the pilot and caution lamps for normal indication. After engine start, confirm that the oil pressure, water temperature and charge lamps are going off.
- (6) Check for smoky exhaust, abnormal sounds and vibrations.
- (7) Check for loosening, damage and leakage. To check for loosening of cooling fan belt, depress the middle of longest span between pulleys with thumb. The belt must deflect 10 to 12 mm (0.39 to 0.47 in).

After 50 hours of initial operation

- (1) Change engine oil.
- (2) Replace the oil filter.
- (3) Change cooling water.
- * (4) Adjust valve clearance. Adjust the valve clearance when the engine is cold. Standard for both intake and exhaust valves: 0.25 mm (0.010 in) for K2, K3, K4 and KE150 and 0.35 mm (0.014 in) for KE75.

8. PERIODIC MAINTENANCE PROCEDURES

- *(5) Retighten bolts and nuts.
- *(6) Adjust engine idling condition.

Every 100 hours of operation

- (1) Change engine oil.
- (2) Replace the oil filter.
- (3) Clean the fuel filter.
- (4) Clean the air cleaner. Clean the cleaner case interior and the element. In the case of oil bath type, refill with fresh oil.
- *(5) Adjust engine idling conditions.

Every 400 hours of operation

- (1) Replace the fuel filter.
- (2) Replace the air cleaner element. Paper-element type cleaner only.
- (3) Clean the fuel tank.
- *(4) Adjust valve clearances
- *(5) Adjust engine idling conditions.
- *(6) Check belt tension.
- *(7) Inspect the starter and alternator. Check the brushes for wear and the commutator surface for roughness. Replace brushes if service limit is reached.
- (8) Inspect the glow plugs. Check for disconnection of plugs.
- *(9) Inspect injection nozzles. Check that the injection starting pressure is within the specified value and eliminate undesirable injection conditions including "after-dripping". For specifications of the injection pressure, refer to 10 Service Data.

8. PERIODIC MAINTENANCE PROCEDURES

Every 800 hours of operation

- *(1) Check cylinder compression Check each cylinder with its flow gulg removed using a compression pressure gauge. If measurement of any cylinder is below 30 kg/cm² (427 psi) for K3H and K3M at 280 rpm, and for the rest, 26 kg/cm² (370 psi) at 280 rpm [320 rpm for K2 only] the cylinder must be repaired. Difference in pressure between cylinders must be within 2.5 kg/cm² (35.6 psi).
- *(2) Check fuel injection quantity. If excessive trembling of the engine is found during idling, have the engine checked and adjusted for proper fuel injection by the nearest Speciality service station equipped with the pump tester.
- (3) Flush the cooling system.
- *(4) Inspect the alternator and Check the voltage and current with a circuit regulator.
- *(5) Inspect the starter pinion and File the chamfered portion smooth if excessively damaged. Replace the pinion or ring gear if damage is all over the circumference.
- *(6) Retighten all bolts and nuts.

9. TROUBLESHOOTING

Engine troubles should be detected and corrected early. Use the table below as a guide of troubleshooting. In case a trouble requires skilled hands beyond your ability, have your engine repaired by the nearest Speciality service station.

(1) Engine fails to start

- | | |
|---|---|
| 1. Starter switch is defective | Correct poor connection or contact. |
| 2. Starter is lacking in torque | Check for completely discharged battery, defective starter, and dirty or loose joint of wiring. |
| 3. Improper viscosity of engine oil | Check the viscosity and change oil if necessary. |
| 4. Engine is too cold | Pour hot water into the cooling system. |
| 5. Moving parts are near seizing | Repair. |
| 6. Air in the fuel system | Bleed air completely. |
| 7. Fuel tank is empty | Refuel. |
| 8. Poor quality of fuel | Check the quality and change fuel if necessary. |
| 9. Fuel filter is clogged | Clean or replace filter. |
| 10. Control timer unit is defective | Replace.

(for engine with emergency
stopping system) |

(2) Engine stalls during operation.

- | | |
|-----------------------------------|------------------------------------|
| 1. Fuel tank is empty | Refuel. |
| 2. Fuel filter is clogged | Clean or replace. |
| 3. Fuel line sucks air | Retighten fuel pipe joints. |
| 4. Lowering of oil pressure | Check and repair oil pressure line |

(3) Oil pressure is low.

- | | |
|---|------------------|
| 1. Oil shortage | Refill with oil. |
| 2. Leaky joint | Repair. |
| 3. Oil pressure switch is defective | Replace. |

(4) Engine runs irregularly.

- | | |
|---------------------------------|-----------------------------|
| 1. Fuel filter is clogged | Clean or replace. |
| 2. Fuel line sucks air | Retighten fuel pipe joints. |
| 3. Air cleaner is clogged | Clean or replace. |

9. TROUBLESHOOTING

(5) Engine overheats.

1. Cooling water shortage Refill with water.
2. Water leaks Repair.;
3. Fan belt is slack or smeary Clean or replace.
4. Radiator is defective Repair or replace.
5. Fan is damaged Replace.
6. Concentration of antifreeze is Change.
too large

(6) Battery charge is poor.

1. Improper fan belt tension Correct.
2. Faulty wiring Repair.
3. Charge lamp or ammeter is defective Replace.
4. Battery is defective Replace.
5. Regulator is defective Repair or replace.
6. Alternator is defective Repair or replace.

10. SERVICE DATA

(1) Maintenance standards

Item	Model			
	K2AS	K2B	K2C	KE75
Valve clearance (cold) mm (in)	0.25 (0.010)			0.35 (0.014)
Compression pressure, kg/cm ² (psi)				
Fuel injection order	1 - 2			
Injection timing (BTDC of compression stroke)	Below 2800 rpm	25°	23°	25°
	2800 rpm or more	27°	25°	23°
Injection pressure, kg/cm ² (psi)		160 ⁺¹⁰ ₀ (2276) ⁺¹⁴² ₀	120 ⁺¹⁰ ₀ (1707) ⁺¹⁴² ₀	
Engine oil capacity : standard (incl. coil filter), l (in ³)	2.8 (171)		2.9 (177)	
Cooling water capacity (engine proper only), l (in ³)	1.6 (98)	2.1 (128)		

Item	Model			
	K3H,M	K3B,D,E	K4	KE150
Valve clearance (cold) mm (in)	0.25 (0.010)			
Compression pressure, kg/cm ² (psi)	38 (541)		32 (455) or more at 280 rpm	
Fuel injection order	1-3-2			
Injection timing (BTDC of compression stroke)	2000 rpm or less	17°	19°	17°
	2000 to 3000	21°		
	Others 3000 rpm or more	23°		
Injection pressure, kg/cm ² (psi)		160 ⁺¹⁰ ₀ (2276) ⁺¹⁴² ₀	120 ⁺¹⁰ ₀ (1707) ⁺¹⁴² ₀	
Engine oil capacity : Standard Engine (incl. oil filter), l (in ³)	5 (305)	3.5 (214)	4.5 (275)	5 (305)
Cooling water capacity (engine proper only), l (in ³)	4.0 (244)	3.0 (183)	3.5 (214)	3.7 (226)

10. SERVICE DATA

- (2) Tightening torque kg.m (ft-lbs)
1. Cylinder head bolt (M8) K2AS 3.5–4.0 (23.1–28.7)
 (M10) K3, K4, KE150(T) 7–8 (50.6–50.8)
 (M12) K3B, D, K4C 11–12 (79.5–86.8)
 K2B, C; K3E; 12–13 (86.8–94.9)
 K4D, E
 (M14) KE75; K3H, M 14–15 (101.3–108.5)
 KE150(T) 15–16 (108.5–115.7)
 2. Crankshaft pulley nut K2, KE75 15–20 (108.5–144.7)
 3. Main bearing cap bolt K3, K4, KE150(T) 5–5.5 (36.2–39.8)
 4. Connecting rod cap nut K2, K3, K4 3.2–3.5 (23.1–25.3)
 KE150(T) 4.0–4.3 (28.7–31.1)
 5. Connecting rod cap bolt KE75, KE150 5.5–6 (39.8–43.4)
 6. Flywheel bolt K2AS 6.5–7.0 (47.6–50.6)
 Except K2AS 11.5–12.5 (83.2–90.4)
 7. Oil pan drain plug 5–6 (36.2–43.4)
 8. Oil filter 1.1–1.3 (7.9–9.4)
 9. Delivery valve holder 4–5 (28.7–36.2)
 10. Nozzle holder mounting bolt Except K2AS 1.5–2 (10.8–14.5)
 11. Attaching of nozzle holder K2AS 5.0–6.0 (36.2–43.4)
 12. Nozzle holder body retaining nut K2AS 4–5 (28.9–36.2)
 Except K2AS 6–8 (43.4–57.9)
 13. Glow plug 1.5–2 (10.8–14.5)
 14. General bolts and nuts

Screw dia.	4T material	7T material	10T material
M6	0.3–0.5 (2.2–3.6)	0.8–1.0 (5.8–7.2)	1.0–1.3 (7.2–9.4)
M8	1.0–1.3 (7.2–9.4)	1.5–2.2 (10.8–15.9)	2.5–3.5 (18.1–25.3)
M10	1.8–2.5 (13.0–18.1)	3.0–4.2 (21.7–30.4)	5.0–7.0 (36.2–50.6)
M12	3.0–4.2 (21.7–30.4)	5.5–7.5 (39.8–54.2)	9.5–12.0 (68.7–86.8)
M14	5.0–7.0 (36.2–50.6)	8.0–11.0 (57.9–79.6)	16.0–19.0 (115.7–137.4)