DOOSAN

Portable Power

50 Hz: G60 - G80 - G115 - G150 - G200XW/XF
60 Hz: G65 - G100 - G135 - G170 - G225XW/XF
OPERATION & MAINTENANCE MANUAL

Original Instruction

This manual contains important safety information and must be made available to personnel who operate and maintain this machine.

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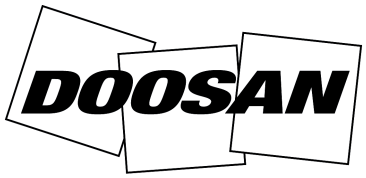

Portable Power

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REFERENCE INFORMATION

Write the correct information for YOUR DIPP generator in the spaces below. Always use these numbers when referring to your DIPP generator.

Generator Serial Number _____

Engine Serial Number _____

NOTES:

_____

_____

_____

_____

YOUR DIPP DEALER:

_____

ADDRESS:

_____

PHONE:

_____

CE

Doosan Benelux SA
Drève Richelle 167
B-1410 Waterloo
BELGIUM

Portable Power

FOREWORD

The contents of this manual are considered to be proprietary and confidential to and should not be reproduced without the prior written permission of the company.

Nothing contained in this document is intended to extend any promise, warranty or representation, expressed or implied, regarding the products described herein. Any such warranties or other terms and conditions of sale of products shall be in accordance with the standard terms and conditions of sale for such products, which are available upon request.

This manual contains instructions and technical data to cover all routine operation and scheduled maintenance tasks by operation & maintenance staff. Major overhauls are outside the scope of this manual and should be referred to an authorised service department.

The use of repair parts / lubricants / fluids other than those included within the approved parts list may create hazardous conditions over which the company has no control. Therefore the company cannot be held responsible for equipment in which non-approved repair parts are installed.

The company reserves the right to make changes and improvements to products without notice and without incurring any obligation to make such changes or add such improvements to products sold previously.

The intended uses of this machine are outlined below and examples of unapproved usage are also given, however the company cannot anticipate every application or work situation that may arise.

IF IN DOUBT CONSULT SUPERVISION.

This machine has been designed and supplied for use only in the following specified conditions and applications:

- Operation within the ambient temperature range specified in the *GENERAL INFORMATION* section of this manual.

The use of the machine in any of the situation types listed in table 1:

a) Is not approved,

b) May impair the safety of users and other persons, and

c) May prejudice any claims made against the company.

TABLE 1
Use of the machine outside the ambient temperature range specified in the *GENERAL INFORMATION SECTION* of this manual.
This machine is not intended and must not be used in potentially explosive atmospheres, including situations where flammable gases or vapours may be present.
Use of the machine fitted with non approved components / lubricants / fluids.
Use of the machine with safety or control components missing or disabled.
Use of the machine for storage or transportation of materials inside or on the enclosure except when contained within the toolbox.
GENERATOR
Use of the generator to supply load(s) greater than those specified.
Use of unsafe or unserviceable electrical equipment connected to the generator.
Use of electrical equipment: (a) Having incorrect voltage and / or frequency ratings. (b) Containing computer equipment and / or similar electronics.

The company accepts no responsibility for errors in translation of this manual from the original English version.

Portable Power

GENERAL DATA

CONTENTS

GENERAL DATA (CONFIGURATION 1)

UNIT MODEL 50HZ	G60XW/XF	G80XW/XF	G115XW/XF	G150XW/XF	G200XW/XF
Engine Speed - RPM	1500	1500	1500	1500	1500
UNIT MODEL 60HZ	**G65XW/XF**	**G100XW/XF**	**G135XW/XF**	**G170XW/XF**	**G225XW/XF**
Engine Speed - RPM	1800	1800	1800	1800	1800
Engine Fuel	Diesel	Diesel	Diesel	Diesel	Diesel
Manufacturer	Doosan	Doosan	Doosan	Doosan	Doosan
Model	DB58	D1146	D1146T	DP086TA	P086TI
Number of cylinders / Displacement (litres)	6 / 5,8	6 / 8	6 / 8	6 / 8	6 / 8
FLUID CAPACITIES					
Engine Crankcase Lubricant (litres)	Max. 19 Min.16	Max. 15,5 Min.12	Max. 15,5 Min.12	Max. 15,5 Min.12	Max. 15,5 Min.12
Fuel Tank (litres)	TBA	TBA	TBA	TBA	TBA
Radiator & Engine Coolant (litres)	43	48	48	48	48
Electrical System	24VDC	24VDC	24VDC	24VDC	24VDC
UNIT MEASUREMENTS / WEIGHTS (XW)					
Overall length (mm)	3200	3200	3200	4400	3940
Overall width (mm)	1100	1100	1100	1370	1370
Overall height (mm)	1850	1850	1850	2100	2100
Weight (with fuel) (kg)	TBA	TBA	TBA	TBA	TBA
Weight (without fuel) (kg)	1920	2190	2350	2800	2800

ELECTRICAL DATA (CONFIGURATION 1)

UNIT MODEL	G60XW/XF	G80XW/XF	G115XW/XF	G150XW/XF	G200XW/XF
Prime Power Rating @ 400V-3Ø, 0.8PF, 50Hz	84 A 58,00 kVA 46,40 kW	118 A 82,00 kVA 65,60 kW	166 A 115,00 kVA 92,00 kW	211 A 146,00 kVA 116,80 kW	284 A 197,00 kVA 157,60 kW
Standby Power Rating @ 400V-3Ø, 0.8PF, 50Hz	91 A 63,00 kVA 50,40 kW	131 A 91,00 kVA 72,80 kW	180 A 125,00 kVA 100,00 kW	235 A 163,00 kVA 130,40 kW	320 A 222,00 kVA 177,60 kW
Rated Voltage (V)	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø
Rated Frequency (Hz)	50	50	50	50	50
Rated Power Factor	0.8	0.8	0.8	0.8	0.8

UNIT MODEL	G65XW/XF	G100XW/XF	G135XW/XF	G170XW/XF	G225XW/XF
Prime Power Rating @ 480V-3Ø, 0.8PF, 60Hz	76 A 63,00 kVA 54,40 kW	117 A 97,00 kVA 77,60 kW	158 A 131,00 kVA 104,80 kW	204 A 170,00 kVA 136,00 kW	268 A 223,00 kVA 178,40 kW
Standby Power Rating @ 480V-3Ø, 0.8PF, 60Hz	81 A 67,00 kVA 53,60 kW	126 A 105,00 kVA 84,00 kW	174 A 145,00 kVA 116,00 kW	223 A 185,00 kVA 148,00 kW	292 A 243,00 kVA 194,40 kW
Rated Voltage (V)	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø
Rated Frequency (Hz)	60	60	60	60	60
Rated Power Factor	0.8	0.8	0.8	0.8	0.8

GENERAL DATA (CONFIGURATION 2)

UNIT MODEL 50HZ	G60XW/XF	G80XW/XF	G115XW/XF	G150XW/XF	G200XW/XF
Engine Speed - RPM	1500	1500	1500	1500	1500
UNIT MODEL 60HZ	**G65XW/XF**	**G100XW/XF**	**G135XW/XF**	**G170XW/XF**	**G225XW/XF**
Engine Speed - RPM	1800	1800	1800	1800	1800
Engine Fuel	Diesel	Diesel	Diesel	Diesel	Diesel
Manufacturer	Doosan	Doosan	Doosan	Doosan	Doosan
Model	DB58	DP066TA	DP066LA	DP086TA	P086TI
Number of cylinders / Displacement (litres)	6 / 5,8	6 / 8	6 / 8	6 / 8	6 / 8
FLUID CAPACITIES					
Engine Crankcase Lubricant (litres)	Max. 19 Min.16	Max. 15,5 Min.12	Max. 15,5 Min.12	Max. 15,5 Min.12	Max. 15,5 Min.12
Fuel Tank (litres)	TBA	TBA	TBA	TBA	TBA
Radiator & Engine Coolant (litres)	43	48	48	48	48
Electrical System	24VDC	24VDC	24VDC	24VDC	24VDC
UNIT MEASUREMENTS / WEIGHTS (XW)					
Overall length (mm)	3200	3200	3200	4400	4400
Overall width (mm)	1100	1100	1100	1370	1370
Overall height (mm)	1850	1850	1850	2100	2100
Weight (with fuel) (kg)	TBA	TBA	TBA	TBA	TBA
Weight (without fuel) (kg)	1920	2190	2350	2800	2800

ELECTRICAL DATA (CONFIGURATION 2)

UNIT MODEL	G60XW/XF	G80XW/XF	G115XW/XF	G150XW/XF	G200XW/XF
Prime Power Rating @ 400V-3Ø, 0.8PF, 50Hz	84 A 58,00 kVA 46,40 kW	118 A 82,00 kVA 65,60 kW	166 A 115,00 kVA 92,00 kW	211 A 146,00 kVA 116,80 kW	284 A 197,00 kVA 157,60 kW
Standby Power Rating @ 400V-3Ø, 0.8PF, 50Hz	91 A 63,00 kVA 50,40 kW	131 A 91,00 kVA 72,80 kW	180 A 125,00 kVA 100,00 kW	235 A 163,00 kVA 130,40 kW	320 A 222,00 kVA 177,60 kW
Rated Voltage (V)	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø
Rated Frequency (Hz)	50	50	50	50	50
Rated Power Factor	0.8	0.8	0.8	0.8	0.8

UNIT MODEL	G65XW/XF	G100XW/XF	G135XW/XF	G170XW/XF	G225XW/XF
Prime Power Rating @ 480V-3Ø, 0.8PF, 60Hz	76 A 63,00 kVA 54,40 kW	117 A 97,00 kVA 77,60 kW	158 A 131,00 kVA 104,80 kW	204 A 170,00 kVA 136,00 kW	268 A 223,00 kVA 178,40 kW
Standby Power Rating @ 480V-3Ø, 0.8PF, 60Hz	81 A 67,00 kVA 53,60 kW	126 A 105,00 kVA 84,00 kW	174 A 145,00 kVA 116,00 kW	223 A 185,00 kVA 148,00 kW	292 A 243,00 kVA 194,40 kW
Rated Voltage (V)	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø	400,220/380/ 480-3Ø
Rated Frequency (Hz)	60	60	60	60	60
Rated Power Factor	0.8	0.8	0.8	0.8	0.8

Portable Power

SAFETY

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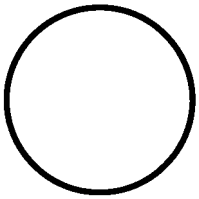
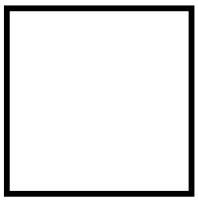
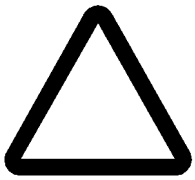
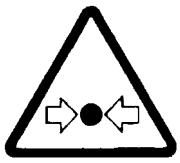
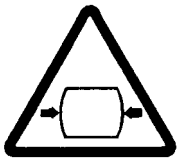
SAFETY DECALS

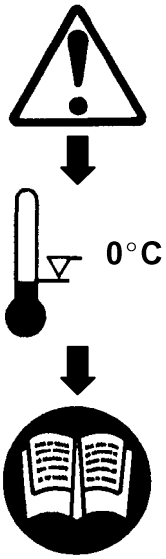
GRAPHIC FORM AND MEANING OF ISO SYMBOLS

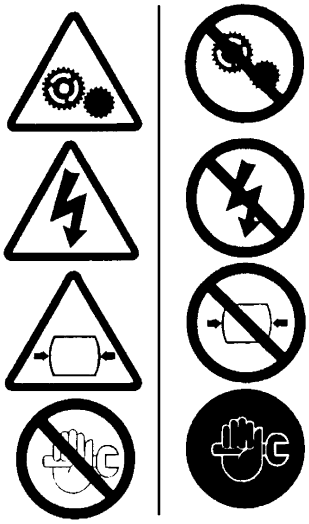
PROHIBITION / MANDATORY	INFORMATION / INSTRUCTIONS	WARNING
 WARNING: Electrical shock risk	 WARNING - Pressurised component or system.	 WARNING - Hot surface.
 WARNING - Pressure control.	 WARNING - Corrosion risk.	 WARNING - Air/gas flow or Air discharge.
 WARNING - Pressurised vessel.	 WARNING - Hot and harmful exhaust gas.	 WARNING - Flammable liquid.
 Do not stand on any service valve or other parts of the pressure system.	  Do not operate with the doors or enclosure open.	 Do not use fork lift truck from this side.
 Do not remove the Operating and Maintenance manual and manual holder from this machine.	 Do not stack.	 Do not operate the machine without the guard being fitted.

WARNING - Maintain correct tyre pressure.

WARNING - Before connecting the tow bar or commencing to tow consult the Operation & Maintenance manual.



WARNING - For operating temperature below 0°C (32°F), consult the Operation & Maintenance manual.



WARNING - Do not undertake any maintenance on this machine until the electrical supply is disconnected and the air pressure is totally relieved.

WARNING - Consult the Operation & Maintenance manual before commencing any maintenance.

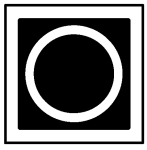
Do not breathe the compressed air from this machine.

Do not exceed the trailer speed limit.

No naked lights.

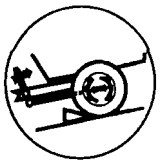
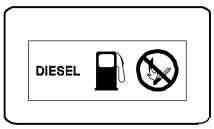
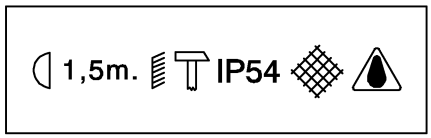
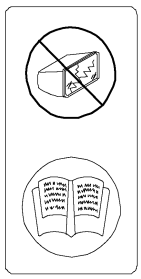
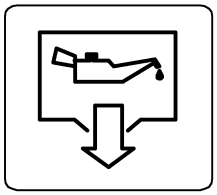
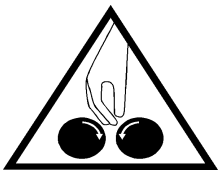
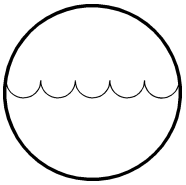
Do not open the service valve before the airhose is attached.

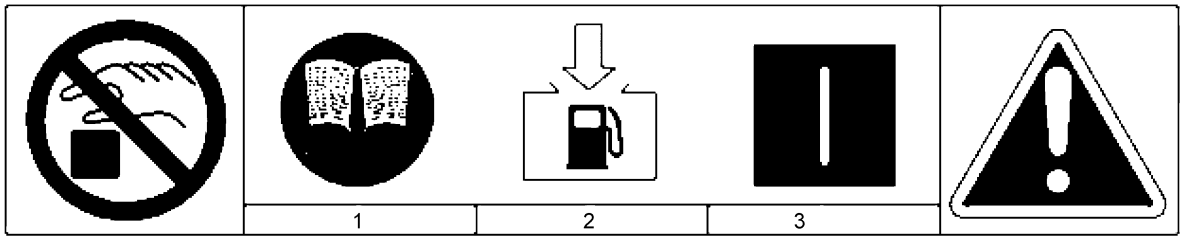
Use fork lift truck from this side only.



Emergency stop.

Tie down point

 Lifting point.	 On (power).	 Off (power).
 Read the Operation & Maintenance manual before operation or maintenance of this machine is undertaken.	 When parking use prop stand, handbrake and wheel chocks.	 Compressor oil filling
 Diesel fuel No open flame.	 Parking brake.	 Rough Service Designation. Wet Location Operation.
 Replace any cracked protective shield.	 Oil drain.	 Crush Warning
 No Water	 Coolant Fill	 No Flame



Fill with fuel before start-up

⚠ DANGER

This machine is not designed for operating life-sustaining equipment. It is equipped with a safety shutdown system that will cause the machine to stop operating whenever a shutdown condition is present.

Never operate the machine inside a building without adequate ventilation. Avoid breathing exhaust fumes when working on or near the machine.

⚠ WARNING

A battery contains sulfuric acid and can give off gases which are corrosive and potentially explosive. Avoid contact with skin, eyes, and clothing. In case of contact, flush area immediately with water.

⚠ WARNING

Improper operation of this equipment can cause severe injury or death. Read the Operation & Maintenance manual supplied with this machine before operation or service.

Modification or alteration of this machine CAN result in severe injury or death. Do not alter or modify this machine without the express written consent of the manufacturer.

⚠ WARNING

This machine is equipped with an Auto Start System, which can cause the machine to start at any time. Follow all safety recommendations outlined in this manual to avoid injury to personnel. DISCONNECT BATTERY BEFORE SERVICING.

⚠ CAUTION

Exercise extreme caution when using booster battery. To jump battery, connect ends of one booster cable to the positive (+) terminal of each battery. Connect one end of other cable to the negative (-) terminal of the booster battery and other end to a earth connection away from dead battery (to avoid a spark occurring near any explosive gases that may be present). After starting unit, always disconnect cables in reverse order.

⚠ WARNING

Never inspect or service unit without first disconnecting battery cable(s) to prevent accidental starting.

Wear eye protection while cleaning unit with compressed air, to prevent debris from injuring eyes.

⚠ WARNING

HOT PRESSURISED FLUID - Remove cap slowly to relieve PRESSURE from HOT radiator. Protect skin and eyes. HOT water or steam and chemical additives can cause serious personal injury.

⚠ WARNING

Flammable Fuels - Do not fill tank when engine is running.

Do not smoke or use an open flame in the vicinity of the generator set or fuel tank. Do not permit smoking, open flame, or sparks to occur near the battery, fuel, cleaning solvents or other flammable substances and explosive gases.

Do not operate Genset if fuel has been spilled inside or near the unit.

⚠ WARNING

Electrical Shock -

Do not operate electrical equipment while standing in water, on wet earth or with wet hands or shoes.

Use extreme caution when working on electrical components. Battery voltage (12V / 24V DC) is present unless the battery cables have been disconnected. Higher voltage (potentially 480V) is possibly present at all times.

⚠ WARNING

Always treat electrical circuits as if they were energised.

Disable Start Control before attempting any repair service, disconnect all leads to electrical power requirements and disconnect battery to prevent start up.

EARTHING

Comply with applicable electrical codes.

⚠ WARNING

The Generator Set can produce high voltages, which can cause severe injury or death to personnel and damage to equipment. The Generator Set should have proper internal and external earth when required by IEC 364-4-41.

The Generator Set is internally earthed neutral to the frame of the Generator Set. This internal earth connection is essential for proper Generator Set performance and personal protection.

External earthing consists of connecting the generator neutral to a solid earth, and is the responsibility of the operator, when earthing is required by IEC 364-4-41 Protection Against Electric Shock, and other local codes as applicable.

Several methods are employed to externally earth portable generator sets, depending on the intended use and code requirements. In all cases, a continuous length of splice-free copper cable, no smaller than 10 mm^2, shall be used for the external earth conductor, when earthing is required.

A qualified, licensed electrical contractor, knowledgeable in local codes, should be consulted.

⚠ WARNING

Failure to properly earth the Generator Set can result in severe injury or death.

IF USED AS ALTERNATE POWER SUPPLY

Connect only after the main service entrance switch has been DISCONNECTED and LOCKED OPEN. In addition, circuit overload protection must be provided in accordance with National Electrical Codes and local regulations.

⚠ CAUTION

Welding -

Prior to any welding, disconnect alternator relays, diagnostic circuit board, voltage regulator circuit board, meters, circuit breakers and battery cables. Open all circuit breakers, and remove any external connections (except earthing rod). Connect the welding earth as close as possible to the area being welded.

⚠ WARNING

Electrical Loading -

Never make electrical connections with the unit running.

Before placing the unit in operation, verify the electrical rating of the Generator Set and do not exceed generator set ratings.

HAZARDOUS SUBSTANCE PRECAUTION

⚠ CAUTION

Use extreme care to avoid contacting hot surfaces (engine exhaust manifold and piping).

Ensure that adequate ventilation of the cooling system and exhaust gases is maintained at all times.
The following substances are used in the manufacture of this machine and may be hazardous to health if used incorrectly.

- anti-freeze
- engine lubricant
- preservative grease
- rust preventative
- diesel fuel
- battery electrolyte

Avoid ingestion, skin contact and breathing fumes for the following substances: Antifreeze, Engine Lubricating Oil, Preservative Grease, Rust Preventative, Diesel Fuel and Battery Electrolyte.
The following substances may be produced during the operation of this machine and may be hazardous to health:

- Avoid build-up of engine exhaust fumes in confined spaces.
- Avoid breathing exhaust fumes.
- Avoid breathing brake lining dust during maintenance.
- **Always operate in a well ventilated area.**

WARNINGS

Warnings call attention to instructions which must be followed precisely to avoid injury or death.

CAUTIONS

Cautions call attention to instructions which must be followed precisely to avoid damaging the product, process or its surroundings.

NOTES

Notes are used for supplementary information.

GENERAL INFORMATION

Ensure that the operator reads and understands the decals and consults the manuals before maintenance or operation.

Ensure that the Operation & Maintenance manual, and the manual holder, are not removed permanently from the machine.

Ensure that maintenance personnel are adequately trained, competent and have read the Maintenance Manuals.

Make sure that all protective covers are in place and that the canopy / doors are closed during operation.

The specification of this machine is such that the machine is not suitable for use in flammable gas risk areas. If such an application is required then all local regulations, codes of practice and site rules must be observed. To ensure that the machine can operate in a safe and reliable manner, additional equipment such as gas detection, exhaust spark arresters, and intake (shut-off) valves may be required, dependant on local regulations or the degree of risk involved.

A weekly visual check must be made on all fasteners / fixing screws securing mechanical parts. In particular, safety-related parts such as coupling hitch, drawbar components, road-wheels, and lifting bail should be checked for total security.

All components which are loose, damaged or unserviceable, must be rectified without delay.

Electricity

The human body has a low tolerance for electricity and is a very good conductor. Exposure to electrical shock can results in an interruption of normal heart activity, thermal burns, severe muscle contractions and even death.

Never operate the generator without all protections in place. Controller and busbar doors must be closed at any time during operation.

If live testing is necessary, it should only be performed by properly trained people.

While testing on live electrical equipment, rubber sole shoes and adequate rubber gloves must be worn, and all local regulations must be respected.

Materials

The following substances may be produced during the operation of this machine:

- engine exhaust fumes

AVOID INHALATION.

Ensure that adequate ventilation of the cooling system and exhaust gases is maintained at all times.

The following substances are used in the manufacture of this machine and may be hazardous to health if used incorrectly:

- anti-freeze
- engine lubricant
- preservative grease
- rust preventative
- diesel fuel
- battery electrolyte

AVOID INGESTION, SKIN CONTACT AND INHALATION OF FUMES.

Should engine lubricants or fuel come into contact with the eyes, then irrigate with water for at least 5 minutes.

Should engine lubricants or fuel come into contact with the skin, then wash off immediately.

Consult a doctor if large amounts of engine lubricants or fuel are ingested.

Consult a doctor if engine lubricants or fuel are inhaled.

Never give fluids or induce vomiting if the patient is unconscious or having convulsions.

Safety data sheets for engine lubricants and fuel should be obtained from the lubricant supplier.

Battery

Batteries contain corrosive liquid and produce explosive gas. Do not expose to naked lights. Always wear personal protective clothing when handling. When starting the machine from a slave battery ensure that the correct polarity is observed and that connections are secure.

DO NOT ATTEMPT TO SLAVE START A FROZEN BATTERY SINCE THIS MAY CAUSE IT TO EXPLODE.

Radiator

Hot engine coolant and steam can cause injury. Ensure that the radiator filler cap is removed with due care and attention.

Transport

When loading or transporting machines ensure that the specified lifting and tie down points are used.

OPERATING INSTRUCTIONS

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OPERATING INSTRUCTIONS

Never operate unit without first observing all safety warnings and carefully reading the operation & maintenance manual shipped from the factory with this machine.

COMMISSIONING

Upon receipt of the unit, and prior to putting it into service, it is important to adhere strictly to the instructions given below in *PRIOR TO STARTING*.

Ensure that the operator reads and *understands* the decals and consults the manuals before maintenance or operation.

Ensure that the position of the *emergency stop* device is known and recognised by its markings. Ensure that it is functioning correctly and that the method of operation is known.

Attach the battery cables to the battery(s) ensuring that they are tightened securely. Attach the negative cable before attaching the positive cable.

The operating controls and instruments are arranged on the control panel as shown. A description of each panel device is as follows:

Ensure that all transport and packing materials are discarded.

Ensure that the correct fork lift truck slots or marked lifting / tie down points are used whenever the machine is lifted or transported.

When operating the machine ensure that there is sufficient clearance for ventilation and exhaust requirements, observing any specified minimum dimensions (to walls, floors etc.).

Adequate clearance needs to be allowed around and above the machine to permit safe access for specified maintenance tasks.

Ensure that the machine is positioned securely and on a stable foundation. Any risk of movement should be removed by suitable means, especially to avoid strain on any rigid discharge piping.

CONNECTING THE LOAD

Make sure the wires are not cracked or damaged in any way.

Connect the proper phase wire to its corresponding bar L1–L2–L3. Mixing phases connections can result in equipment damage, accidents causing injuries or even death.

Make sure your installation is in compliance with local regulations.

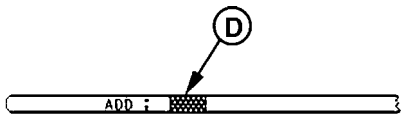
PRIOR TO STARTING

Before starting the engine, carry out the following checks:

1. Engine oil level: Add as required.

⚠ CAUTION

DO NOT fill above the top mark on the dipstick. Oil levels anywhere within crosshatch (D) are considered in the acceptable operating range.



2. Engine coolant level: Add as required.
3. Fuel filter: Drain any accumulation of water. Clean or replace element as required.
4. Air cleaner service indicator (if equipped): Service immediately if showing "red" when the engine is running.
5. Fuel level in tank: Fill, using CLEAN DIESEL fuel, at the end of the day to minimise condensation.
6. Battery: Keep terminals clean and lightly greased.
7. Engine belts and hoses: Check for proper fit and / or damage. Service as required.
8. Air Vents / Grilles: Both engine radiator and generator cooling air. Check for obstructions (leaves, paper, etc.).
9. Visual inspection: Check for excessive fluid leaks, evidence of arcing around control panel, loose wire-routing clamps, etc.

⚠ CAUTION

Call a qualified person to make electrical repairs.

⚠ WARNING

Do not remove the cap from a HOT engine radiator. The sudden release of pressure from a heated cooling system can cause severe injury or death.

STARTING

⚠ CAUTION

Use the EMERGENCY STOP button ONLY in the event of an emergency.

NEVER use it for normal shut-down.

Verify the following:

1. All external electrical power loads are turned “OFF”.
2. Main Breaker is “OFF”.
3. Battery Disconnected Switch is “ON”.
4. Reset (pull to unlatch) Emergency Stop Button.
5. Push the controller “START” Button.

⚠ DANGER

POWER is present upon cranking the engine.

⚠ CAUTION

Allow starter to cool for one minute between start attempts.

If engine shuts down, diagnostic lamps will indicate the problem. Correct the problem before continuing.

6. Allow the engine to warm-up for 3 to 5 minutes.
7. Check the CONTROL Panel for proper voltages. No RED diagnostic lamps should be glowing.
8. With main breaker “ON” power is present and available for use.
9. Close side doors for optimum cooling of the unit while running.

STOPPING

1. Turn off all external electrical power loads.
2. Turn Main Breaker “OFF”.
3. Allow 5 minute cool down.
4. Push controller “STOP” Button.
5. Wait at least 15 seconds before restarting.
6. Fill fuel tank at end of working day to prevent condensate.

CONTROLLER

NOTE: The following descriptions detail the sequences followed by a module containing the standard 'factory configuration'. Always refer to your configuration source for the exact sequences and timers observed by any particular module in the field.

QUICKSTART GUIDE

This section provides a quick start guide to the module's operation.

STARTING THE ENGINE

NOTE: For further details, see the section entitled 'OPERATING INSTRUCTIONS' elsewhere in this manual.

STOPPING THE ENGINE

NOTE: For further details, see the section entitled ‘OPERATING INSTRUCTIONS’ elsewhere in this manual.

STOP / RESET MODE

NOTE: If a digital input configured to *panel lock* is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Stop/Reset Mode is activated by pressing the ***Stop/Reset Mode*** button.

The *Stop/Reset* icon is displayed to indicate ***Stop/Reset Mode*** operations.

In ***Stop/Reset Mode***, the module removes the generator from load (if necessary) before stopping the engine if it is already running.

If the engine does not stop when requested, the FAIL TO STOP alarm is activated (subject to the setting of the *Fail to Stop* timer). To detect the engine at rest the following must occur :

- Engine speed is zero as detected by the CANbus ECU.
- Generator AC Voltage and Frequency must be zero.
- Engine Charge Alternator Voltage must be zero.
- Oil pressure sensor must indicate low oil pressure.

When the engine has stopped, it is possible to send configuration files to the module from DSE Configuration Suite PC software and to enter the Front Panel Editor to change parameters.

Any latched alarms that have been cleared are reset when ***Stop/Reset Mode*** is entered.

The engine is not started when in ***Stop/Reset Mode***. If remote start signals are given, the input is ignored until ***Auto Mode*** is entered.

When left in ***Stop/Reset Mode*** with no presses of the fascia buttons and configured for *Power Save Mode,* the module enters *Power Save Mode*. To 'wake' the module, press any fascia control buttons.

NOTE: For further details of module configuration, refer to DSE Publication: *057-185 DSE71xx MKII Configuration Software Manual.*

MANUAL MODE

NOTE: If a digital input configured to panel lock is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Manual Mode is activated by pressing the ***Manual Mode*** button.

The ***Manual Mode*** icon is displayed to indicate ***Manual Mode*** operations.

In ***Manual Mode***, the set does not start automatically.

To begin the starting sequence, press the ***Start*** button.

STARTING SEQUENCE

NOTE: There is no *start delay* in this mode of operation.

The fuel relay is energised and the engine is cranked.

NOTE: If the unit has been configured for CAN, compatible ECUs receives the start command via CAN.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start sequence is terminated and the display shows ***Fail to Start.***

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CANbus link to the engine ECU depending on module configuration.

NOTE: For further details of module configuration, refer to DSE Publication: *057-185 DSE71xx MKII Configuration Software Manual.*

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

After the starter motor has disengaged, the *Safety On Delay* timer activates, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

ENGINE RUNNING

Once the engine is running and all starting timers have expired, the animated *Engine Running* icon is displayed.

In ***Manual Mode***, the load is not transferred to the generator unless a 'loading request' is made.
A loading request can come from a number of sources.

- Press the *Transfer to Generator* button.
- Failure of mains supply (DSE7120 MKII only).
- Activation of an auxiliary input that has been configured to *Remote Start On Load or Auxiliary Mains Fail (DSE7120 MKII Only).*
- Activation of the inbuilt exercise scheduler if configured for 'on load' runs.

NOTE: The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

Once the generator has been placed on load, it is not automatically removed. To manually remove the load either:

- Press the *Open Generator* (DSE7110 MKII Only) or *Transfer to Mains* (DSE7120 MKII Only) button.
- Press the ***Auto Mode*** button to return to automatic mode. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the *Auto Mode Stopping Sequence.*
- Press the ***Stop/Reset Mode*** button to remove load and stop the generator.
- Activation of an auxiliary input that has been configured to *Generator Load Inhibit.*

STOPPING SEQUENCE

In ***Manual Mode*** the set continues to run until either:

- The ***Stop/Reset Mode*** button is pressed – The delayed load outputs are de-activated immediately and the set immediately stops.
- The ***Auto Mode*** button is pressed. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the *Auto Mode Stopping Sequence*.

TEST MODE

NOTE: If a digital input configured to panel lock is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Test Mode is activated by pressing the ***Test Mode*** button.

The *Test Mode* icon is displayed to indicate ***Test Mode*** operations.

In ***Test Mode***, the set does not start automatically.

To begin the starting sequence, press the ***Start*** button.

STARTING SEQUENCE

NOTE: There is no start delay in this mode of operation.

The fuel relay is energised and the engine is cranked.

NOTE: If the unit has been configured for CAN, compatible ECUs receives the start command via CAN.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start sequence is terminated and the display shows ***Fail to Start.***

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CANbus link to the engine ECU depending on module configuration.

NOTE: For further details of module configuration, refer to DSE Publication: *057-185 DSE71xx MKII Configuration Software Manual.*

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

After the starter motor has disengaged, the *Safety On Delay* timer activates, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

ENGINE RUNNING

Once the engine is running and all starting timers have expired, the animated *Engine Running* icon is displayed.

In ***Test Mode***, the load is automatically transferred to the generator.

NOTE: The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

Once the generator has been placed on load, it is not automatically removed. To manually remove the load either:

- Press the ***Manual Mode*** button followed by the *Open Generator* (DSE7110 MKII Only) or *Transfer to Mains* (DSE7120 MKII Only) button.
- Press the ***Auto Mode*** button to return to automatic mode. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the *Auto Mode Stopping Sequence*.
- Press the ***Stop/Reset Mode*** button to remove load and stop the generator.
- Activation of an auxiliary input that has been configured to Generator Load Inhibit.

STOPPING SEQUENCE

In ***Test Mode*** the set continues to run until either:

- The ***Stop/Reset Mode*** button is pressed – The delayed load outputs are de-activated immediately and the set immediately stops.
- The ***Auto Mode*** button is pressed. The set observes all ***Auto Mode*** start requests and stopping timers before beginning the Auto Mode Stopping Sequence.

AUTOMATIC MODE

NOTE: If a digital input configured to external panel lock is active, changing module modes is not possible. Viewing the instruments and event logs is NOT affected by panel lock.

Auto Mode is activated by pressing the ***Auto Mode*** button.

The *Auto Mode* icon is displayed to indicate ***Auto Mode*** operations.

Auto Mode allows the generator to operate fully automatically, starting and stopping as required with no user intervention.

WAITING IN AUTO MODE

If a starting request is made, the starting sequence begins.

Starting requests can be from the following sources:

- Failure of mains supply (DSE7120 MKII only).
- Activation of an auxiliary input that has been configured to Remote Start or Auxiliary Mains Fail (DSE7120 MKII Only).
- Activation of the inbuilt exercise scheduler.

STARTING SEQUENCE

To allow for 'false' start requests, the *start delay* timer begins.

Should all start requests be removed during the *start delay* timer, the unit returns to a stand-by state.

If a start request is still present at the end of the *start delay* timer, the fuel relay is energised and the engine is cranked.

NOTE: If the unit has been configured for CAN, compatible ECU's receive the start command via CAN and transmit the engine speed to the DSE controller.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start sequence is terminated and the display shows ***Fail to Start.***

The starter motor is disengaged when the engine fires. Speed detection is factory configured to be derived from the AC alternator output frequency, but can additionally be measured from a Magnetic Pickup mounted on the flywheel or from the CANbus link to the engine ECU depending on module configuration.

NOTE: For further details of module configuration, refer to DSE Publication: 057-185 DSE71xx MKII Configuration Software Manual.

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or over-speed).

After the starter motor has disengaged, the *Safety On Delay* timer activates, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

ENGINE RUNNING

Once the engine is running and all starting timers have expired, the animated *Engine Running*  icon is displayed.

The generator is placed on load if configured to do so.

NOTE: The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

If all start requests are removed, the *stopping sequence* begins.

STOPPING SEQUENCE

The *Return Delay* timer operates to ensure that the starting request has been permanently removed and isn't just a short term removal. Should another start request be made during the cooling down period, the set returns on load.

If there are no starting requests at the end of the *Return Delay* timer, the load is removed from the generator to the mains supply and the *cooling* timer is initiated.

The *Cooling Down* timer allows the set to run off load and cool sufficiently before being stopped. This is particularly important where turbo chargers are fitted to the engine.

After the *Cooling Down* timer has expired, the set is stopped.

ENGINE GENERAL INTRODUCTION

CONTENTS

GENERAL INFORMATION

This Operation and Maintenance Manual provides the most efficient methods for engine maintenance as well as quick, efficient methods to determine the cause of engine faults to ensure that any actions taken by authorized skilled technicians are done in the most efficient and efficient way possible. If maintenance is performed by unskilled technicians, or maintenance without the specified tools and facilities, serious bodily injury or critical faults in engine performance may occur.

Regular inspection and maintenance are required to maintain long-term optimal engine conditions and best performance. In the event that a part must be replaced, only genuine parts as defined by the parts list (PARTS BOOK) should be used. Doosan shall not be held liable for any critical damage or faults which may be caused by the use of unauthorized or remanufactured parts.

The maintenance methods stated in this Operation and Maintenance Manual are the most efficient and safest work procedures. Some work procedures require special tools.

For questions about genuine parts and special tools, please contact us.

This Operation and Maintenance Manual includes 'Danger,' 'Warning,' and 'Caution' in order to reduce possible injuries and engine faults which may occur while performing maintenance. If workers do not follow the instructions, critical faults in engine performance and operation or serious bodily injury may occurred. 'Danger,' 'Warning,' and 'Caution' instructions must be followed. However, we inform you that it is not possible to describe all possible and unexpected dangers which may arise while performing engine maintenance.

DANGER, WARNING, CAUTION AND NOTE

GENERAL INFORMATION

This Operation & Maintenance manual divides maintenance operations such as performing engine checks, troubleshooting, or diagnosing faults into three categories, "Danger," "Warning," and "Caution." In addition, Note) is used to provide additional descriptions and information required for maintenance technicians to successfully operate Doosan engines.
The recommended repair methods and 'Danger,' 'Warning,' and 'Caution' can enhance the degree of completion of engine maintenance and prevent bodily injury which may occur to workers. However, this manual cannot predict all possible risks.

⚠ DANGER

Operators must observe instructions, otherwise fatal or serious injuries to operators and other persons may occur.

⚠ WARNING

Operators must follow this instruction as failing to do so may result in the death or serious bodily harm of operators or others.

⚠ CAUTION

Operators must observe this instruction since failing to do so may cause critical faults which can have impact on the engine performance and operation.

NOTE: Indicates additional description, information, and references for operators' easy understanding.

GENERAL INSTRUCTIONS

1. In order to maintain the best long term performance and safety, please read and understand this manual and execute routine inspections and regular inspections.

2. We have divided the content of this manual into causes of bodily injury and damage to assets and causes of pollution.

⚠ WARNING

If skin contact with corrosive acids, fuel or hot oil occurs seek immediate medical attention.

⚠ WARNING

If fuel or antifreeze comes into contact with eyes seek immediate medical attention.

⚠ WARNING

During operation of the engine, be careful not to touch the cooling fan safety guard as the rotating fan may cause serious injury.

⚠ WARNING

During operation of the engine, be careful not to touch the v-belt safety guard as the rotating belt may cause serious injury.

⚠ WARNING

The v-belt safety guard is an optional item for customers. In order to prevent accidents while the engine is running you should install a v-belt safety guard. If a v-belt safety guard is not installed, you should not access the engine while running. The engine manufacturer will not be responsible for accidents or injury arising without the installation of a v-belt safety guard.

⚠ WARNING

Do not touch the turbocharger when engine is running, or immediately after it has stopped. The turbocharger will be hot and can cause severe burns. Always allow the turbocharger to cool before carrying out any maintenance.

⚠ DANGER

Do not touch the exhaust manifold or heat screen when engine is running, or immediately after it has stopped. The exhaust manifold and heat screen will be hot and can cause severe burns. Always allow the exhaust manifold and heat screen to cool before carrying out any maintenance. Pay particular attention to the heat screen as this will be extremely hot.

⚠ WARNING

If you need to perform an emergency stop of the engine, use the electronic emergency stop device installed on the generator before attempting a mechanical emergency stop. It is difficult to operate the mechanical emergency stop device which is mounted on a fuel pump. Serious burns can occur if the operator comes into contact with the exhaust manifold. The operator is required to install a separate cable for operating the mechanical emergency stop. The engine manufacturer will not be responsible for accidents or injury arising without the installation of separate auxiliary cable.

PRECAUTIONS IN STARTING THE ENGINE

1. Before starting the engine, please read this manual carefully and fully understand 'Danger,' 'Warning,' and 'Caution'. If you cannot fully understand it or have any question, please contact us.

2. For safety reasons, attach "Warning" signs around engines in operation to keep people other than workers from accessing the engines. Let engine operators know that they are responsible for the safety of the engine room.

3. Only authorized people may start and operate engines. Unauthorized people should not be allowed to handle engines.

4. Do not get close to moving or rotating parts while the engine is in operation.

5. Do not touch the hot engine during operation.

6. Exhaust gas is poisonous. Fully ventilate before starting engine. If the space is enclosed, ensure that it is well ventilated.

7. Keep vicinity of engine, ladders and stairways free of oil and grease. Accidents caused by slipping can have serious consequences.

CAUTIONS FOR INSPECTION AND REPAIR

1. Inspection and repair of engine should be performed only when the engine is stopped.

2. If it is inevitable to perform inspection or repair on the operating engine, do not get close to the rotating parts.

⚠ WARNING

When accessories such as necklaces, rings, watches, or gloves become stuck in rotating parts while the engine is running, serious bodily injury may occur.

⚠ WARNING

Do not exchange or disassemble a pipe or hose (from the engine fuel circuit, engine oil circuit, coolant circuit, or compressed air circuit) while the engine is running. The leaked liquid may cause bodily injuries.

3. Use an engine oil drain container that is large enough to prevent the overflow of engine oil while draining.

4. Open the engine coolant cap after fully cooling the engine to exchange or replenish coolant.

⚠ WARNING

If the coolant cap is opened while the engine is still hot, hot water will spurt out and may cause burns. Open the engine coolant cap after fully cooling the engine.

5. Fuel is highly flammable. Smoking, sparks or naked flames around an engine may cause fire.

⚠ WARNING

Only refuel when the engine is stopped.

6. Mark and separately manage the containers for storing coolant from beverage bottle for avoiding confusion. See a doctor immediately in case of drinking coolant.

7. Follow the instructions provided by the battery manufacturer when checking or handling batteries.

⚠ WARNING

Battery fluid is corrosive and dangerous because of its explosiveness and toxicity. Therefore, it should only be handled by a skilled technician who specializes in battery fluid.

8. Only authorized skilled technicians should repair and maintain engines.

9. Only appropriate tools should be used. If the jaws of a wrench are worn out, the wrench might slip during use, causing accidents or injury.

10. Do not allow other persons to stay or pass under an engine when lifting the engine with a crane. Before lifting the engine, ensure that there is no one around the engine and to ensure enough safe space.

11. Before inspecting or replacing the electrical apparatus, disconnect the battery ground wire first. Connect the battery ground wire after completing all required work for checking or replacing the electrical apparatus in order to prevent a short circuit.

12. Before performing electric welding work, turn off engine, block the power supply to the engine, and remove the wire harness connector.

13. Do NOT give any electric or mechanical shocks or perform welding works on the electrical apparatus or the ECU.

GENERAL REPAIR

1. Wait until the engine is properly cooled down before starting work, as the engine will be hot and may cause serious burns.

2. Disconnect the battery ground wire from to prevent damage of wires and sensors caused by a short circuit.

3. Engine oil and coolant may damage paint and should be stored in a separate container and marked for safe management.

4. Store the disassembled parts in a specified space to avoid damage or pollution.

5. Use specified and special tools for efficient and safe repair.

6. If parts need to be replaced, use only genuine parts for replacement. Using unauthorized or remanufactured parts may cause critical damage and faults in engine performance.

7. Replace parts such as cotter pins, gaskets, O-rings, seal rings, oil seals, and washers with new ones during repairs. Reuse of parts may be the cause of engine faults and engine may not operate properly.

8. Group and store disassembled parts in disassembling order. As bolts and nuts vary in strength, shape and torque according to their assembly position, divide and store them accordingly to these characteristics.

9. Clean disassembled parts to remove foreign substances before inspecting or reassembling parts. Use compressed air to clean the oil galleries.

10. Thinly spread oil or grease on rotating parts or parts requiring lubrication, before assembling them.

11. If required, use a specified adhesive to assemble gaskets to prevent water or oil from leaking.

12. Assemble bolts and nuts with the specified tightening torque.

13. After completing repairs, conduct a final inspection and perform a test operation to check if all works have been successfully completed.

OTHER SAFETY INSTRUCTIONS AND ENVIRONMENTAL POLLUTION

Observe the following instructions to protect workers from danger and to prevent the environmental pollution while performing engine repairs.

1. Good ventilation and low humidity should be maintained in the work space.

2. The workspace should be clean, in good order and free of flammables.

3. Smoking is strictly forbidden in the workshop.

4. Workers should wear working clothes, protective goggles, and safety shoes.

5. Workers are not allowed to wear accessories such as necklaces, rings, watches, and earrings.

6. Start the engine in a well-ventilated space and fully ventilate the space before starting engine to prevent carbon monoxide poisoning.

7. Wait until the engine is properly cooled down before starting work, since you may get burned by the heated engine.

8. Do NOT work on rotating or running parts once the engine has been started.

9. Discard oil according to the regulations set forth by the relevant authorities.

10. If engine oil or fuel leaks on the floor or is improperly drained, serious environmental pollution of sea, river or underground water may occur.

11. Discard the undiluted anticorrosive agent, antifreeze, filter elements, and cartridges as special wastes.

12. Discard coolant and special waste according to the regulations of the appropriate authorities.

⚠ WARNING

Failure to observe the regulations of the relevant authorities violates environmental pollution regulations and may be subject to legal penalties.

USE OF GENUINE PARTS

An engine consists of many parts which are mechanically harmonized. To prevent engine faults in advance and use engines with best performance for a long period, maintenance and replacement of expendable parts should be conducted regularly.

Use of genuine parts is recommended. Using unauthorized or remanufactured parts may cause critical damage and faults to engine for which Doosan shall not be held liable.

ENGINE MAINTENANCE

PREVENTION OF DAMAGE AND ABRASION

Using an engine for any purposes other than the designed purpose may cause critical faults to the engine for which Doosan shall not be held liable. For details concerning the usage and purpose of the engine, please direct questions to Doosan Sales Team. Do NOT adjust, convert, or change the ECU without Doosan authorization.

If a problem is found in an engine, figure out and solve the cause to prevent the critical faults in advance. Use of genuine parts is recommended. Using unauthorized or remanufactured parts may cause critical damage and faults to engine for which Doosan shall not be held liable.

Consider the following while managing engines:

1. Use clean, specified, and qualified fuel only. Use fuel recommended in this Operation and Maintenance Manual.

⚠ CAUTION

Using inappropriate or unspecified fuel may cause critical damage and faults in engine performance.

2. Do not operate an engine without lubrication oil or coolant. Use only the products (engine oil, cooling water, anticorrosive agent, and etc) recommended by Doosan.

3. Always keep surroundings of the engine clean.

4. Use fuel recommended in this Operation & Maintenance manual.

5. Conduct inspections and exchanges regularly according to the regular inspection table.

6. If the engine is overheated, do not stop it immediately, but operate it at idle status for five minutes or more to lower the engine temperature to the proper level.

⚠ WARNING

If the radiator cap is opened while the engine is still hot, hot water will spurt out and may cause burns.

7. Check the engine oil level on a flat surface. Do not exceed the maximum of the oil level gauge.

⚠ CAUTION

Immediately replenish engine oil when the engine oil level is below the lower limit of the engine oil gauge.

8. If there are gauges for battery, oil pressure, coolant and temperature, check if they indicate a normal status.

9. Do not operate engine without coolant.

⚠ CAUTION

Always use coolant mixed with antifreeze. If coolant without antifreeze is used, the coolant may freeze causing the coolant passage in the cylinder block to freeze and damage the engine.

PREVENTION OF POLLUTION

Consider the following to manage engine without causing environmental pollution.

1. Drain oil and coolant using collection containers.

2. Discard oil and coolant according to the regulations of the relevant authorities.

3. Be careful not to let drained oil and cooling water flow into the ground or the sewer. Otherwise, serious pollution of the drinking water source may occur.

4. Classify the oil, filters, and filter cartridges as environmental pollution wastes and discards them according to regulations.

5. Classify the antifreeze, cooling water, and anticorrosive agent as hazardous wastes and discards them by observing the regulations.

HANDLING OF ENGINE OIL

Prolonged and repeated contact of skin with engine oil may cause skin to dry out and contract, causing dermatitis. Engine oil includes substances toxic to the human body. Handle engine oil by observing the following safety rules:

1. Do not expose skin to used engine oil for a long time.

2. Always wear working clothes and gloves.

3. If skin comes in contact with engine oil, immediately wipe it off with water, soap or hand cleaners.

4. Do not clean skin with gasoline, fuel, thinner, or solvent.

5. Apply a skin care cream after cleaning from oil.

6. Do not put oil-stained gloves or cloth in ones pocket.

⚠ WARNING

Discard oil according to the regulations set forth by the relevant authorities. Disposing of drained oil into the ground, sewers, drains, rivers, or the sea will cause serious environmental pollution. Violation of regulations regarding discard of engine oil without observing the handling regulations, will be punished.

Portable Power

OPERATION AND MAINTENANCE

CONTENTS

STARTING AND STOPPING OF THE ENGINE

PREPARING FOR START

Check the following before starting the engine for the first time after purchase.

1. Before starting an engine, check the levels of fuel, coolant, and oil and replenish those fluids if required.

2. Check if engine oil level is between the upper and lower limit of the oil level gauge. The upper and lower limit of the oil level gauge indicate the maximum and minimum of the engine oil level.

⚠ CAUTION

When replenishing engine oil, do not exceed the maximum on the oil level gauge. Too much oil may cause damage to the engine.

The oil required to fill the oil filters and pipes depends upon the engine equipment and use and must be determined individually at the time of initial commissioning. Make a note of the determined quantity.

3. Be careful not to mix foreign substances in fuel, engine oil, or coolant while adding the fluid, and keep the fluid clean while it is not in use. Use fuel, oil, and coolant recommended by Doosan. Otherwise, critical damage to the engine may occur.

STARTING THE ENGINE

Observe the following when starting the engine.

1. Insert key in start switch.

2. Move control lever to idle speed.

3. Turn key switch clockwise.

4. Do not operate for longer than 10 seconds at a time.

5. When engine starts release the key switch.

6. Adjust control lever for desired speed.

7. If engine fails to start, release the key, wait approximately 1 minute, then operate starter again.

8. Avoid running the cold engine idle for any length of time as this may cause increased wear due to corrosion. Prolonged idling is harmful to the environment.

⚠ CAUTION

On initial start of an overhauled engine or after long periods without use, press shutdown lever in “stop” position and operate starter motor for a few seconds (max. 10) until oil pressure is indicated.

Ensure that the engine can not be started by unauthorized persons.

RUNNING IN

It is recommended that new or overhauled engines should not be operated at a load higher than approximately 75% of the maximum load during the first few hours of operation. Initial run-in should be at varying speeds or load. After this initial run-in, the engine should be brought up to fuel output gradually.

DURING OPERATION

⚠ CAUTION

Do not overload the engine. Do not exceed the maximum permissible engine tilt. If faults occur, find their cause immediately and have them eliminated in order to prevent more serious damage.

1. Oil pressure.
   During operation the oil pressure in the engine lubrication system must be monitored. if the monitoring devices register a drop in the lube oil pressure, switch off the engine immediately.

2. Coolant temperature.
   Operating an engine with too low coolant temperature increases fuel consumption, abrasion of the cylinder liner, and shortens the engine's life span.

3. Alternator.
   In order to avoid damage to the alternator, observe the following instructions while the engine is running.
   1) Do not switch off the main battery.
   2) Do not disconnect the battery or pole terminals or the cables.
   3) If during operation the battery charge lamp suddenly lights up, stop the engine immediately and remedy the fault in the electrical system.
   4) Do not short-circuit the connections of the alternator with those of the regulator or said connection with ground, not even by briefly bringing the connections into contact.
   5) Do not operate the alternator without battery connection of the alternator with those of the regulator or said connections with ground, not even by briefly bringing the connections into contact.
   6) Do not operate the alternator without battery connection.

STOPPING THE ENGINE

Cut off the main circuit breaker of the generator control panel but do not stop the engine immediately. Keep running the engine at idle speed for approximately 5 minutes before stopping the engine.

BREAK-IN PERIOD OF THE ENGINE

GENERAL INFORMATION

Doosan engines are subjected to a final approval test to ensure the provision of high quality engines before being shipped. However, engines are not operated for a long period of time in this test. Therefore, new engines require a break-in period during the initial 50 hours after delivery. By properly breaking-in an engine, the highest levels of engine performance can be maintained long-term.

BREAK-IN PERIOD OF A NEW ENGINE

If the engine's bearings are not properly broken in, they may be easily damaged and the lifetime of the engine may be shortened by overloading or high speeds. In order to prevent this, follow the guidelines below for the initial 50 hours after delivery of new engine.

1. Fully warm up the engine until the engine temperature reaches the normal operation condition, before starting normal operation of the engine.

2. Do not overload the engine or operate it at too high RPM.

3. Do not operate the engine with high speed at idle.

4. Do not rapidly start up or stop the engine.

5. Operate the engine with less than 70 % of the engine load.

6. Inspection, check, and repair of engines should be managed by officially-certified technicians at certified service centers in compliance with corresponding rules.

CHECK POINTS

Check the following during the break-in period of a new engine.

1. Periodically check if the engine oil level is between the minimum and maximum limit of the oil level gauge.

⚠ CAUTION

If the oil level cannot be accurately checked through the oil level gauge, rotate the oil level gauge to 180 degrees, insert in the guide tube, and then withdraw to check.

2. If the oil indicator lamp on the apparatus is turned on or blinks, the oil pressure may be insufficient. In this case, check the oil level and replenish oil if required. When replenishing engine oil, do not exceed the maximum on the oil level gauge. If the oil level is normal, check other related parts such as the oil pressure sensor, oil pump, or oil line.

⚠ CAUTION

The oil pressure may increase with high rpm and decrease with low rpm. In addition, the pressure of cold oil may be higher at a specific rpm than that of warm oil. This condition may occur when the engine operates properly.

3. Check the coolant level to check if the coolant circulates properly. If there is insufficient coolant in the radiator, the coolant level indicated may not be accurate.

4. Exchange engine oil and oil filter after the break-in period.

⚠ CAUTION

If engine oil and oil filter need to be replaced, use only genuine engine oil and parts recommended by Doosan.

COLD START OPERATION

Slowly warm up the engine in case of starting up in cold weather or in areas with cold climate. Do not rapidly raise the rpm or load before the engine has been warmed up. The engine may consume oil until its piston ring is in position. Check the engine oil level frequently for the initial 50 hours of the break-in period.

INSPECTION AFTER STARTING THE ENGINE

Check the pressure of the engine lubrication system by using the engine oil pressure gauge mounted on the apparatus while the engine is in operation. If pressure decreases on oil pressure gauge, immediately stop the engine. In addition, make sure that the recharge alarm indicator lamp of the alternator is turned off while the engine is operating.

1. Tightly connect the +/- terminals to prevent gaps between them. The sheath of battery connection cables should not be damaged or broken.

2. If the recharge alarm indicator lamp suddenly turns on or blinks during engine operation and the engine stops, fix the fault of the electric apparatus.

3. If color or odor of exhaust gas is unusual during operation, stop the engine, diagnose the cause and fix the fault.

4. Check the engine status through the alarm indicator lamp and gauges mounted on the apparatus during operation.

OPERATION IN WINTER

COLD START

Periodically check and inspect freezing of coolant and viscosity of lubrication oil.

PREVENTING COOLANT FROM FREEZING

When only water is used as coolant, without mixing with antifreeze, corrosion in the engine, degradation of cooling efficiency, and freezing of the engine in winter may occur. If the engine is not operated for a long period during cold weather or in areas with cold climate, fully drain the coolant from the engine. Freezing of coolant leads to critical damage to the engine. Use a mixture of coolant with antifreeze at revised ratio when replacing or replenishing the coolant. The antifreeze prevents coolant from freezing.

PREVENTING OVERCOOLING OF THE ENGINE

When the engine is cooled below the normal operating temperature, thermal efficiency is lowered and fuel consumption as well as abrasion of the cylinder liner may increase. Therefore, the engine should be operated within the normal operating temperature. If the engine has been sufficiently operated, but the temperature of coolant remains below the normal operating temperature, check the water temperature controller or other parts related to the cooler.

ENGINE OIL

When viscosity of engine oil increases due to its low temperature during cold weather or in areas with cold climate, the rpm may not be stable after starting the engine. To prevent this, replace oil with engine oil for cold weather or areas with cold climate. When replacing engine oil, use of Doosan genuine engine oil is recommended.

INSPECTION AND REPAIR OF THE ENGINE

CHECKING ENGINE PARTS AFTER PROLONGED OPERATION

Wear, corrosion, or degradation of engine elements and assemblies may occur, causing lowered performance of engine parts. To maintain high engine performance, check the engine after prolonged operation to enhance durability of the engine.

Unexpected faults may occur in some weak engine parts after normal operation of the engine, when operation time is prolonged. In this case, it is difficult to maintain high engine performance by simply repairing some parts. It is recommended to replace or repair the entire related parts in order to diagnose the causes more accurately and maintain high engine performance.

To prevent engine failure in advance and use the engine safely for a long period, perform periodic replacements and inspections.

It is recommended to perform engine adjustments and preventive inspections during spring after the engine was exposed to winter or cold weather. This allows economic, long-term use of the engine without faults.

As the following parts affect the engine output and performance, they should be regularly checked and inspected.

1. Parts affecting intake and exhaust:
   - Air filter
   - Inter cooler
   - Turbocharger, Silencer
   - Other parts

2. Parts affecting lubrication and cooling:
   - Air filter
   - Oil filter
   - Antifreeze
   - Other parts

INSPECTION AND REPAIR OF TURBOCHARGER

As performance of the turbocharger significantly affects the engine performance, regular inspection and repair should be made and inspection and maintenance regulations should be observed.

INTAKE SYSTEM

Be careful to handle the air filter carefully. In regards to the dry air filter, intake resistance should be small to ensure a smooth intake of air.

EXHAUST SYSTEM

If exhaust gas is leaked from the connections in the exhaust pipe, the turbocharger efficiency is lowered, causing degraded engine output and seizure of related parts in the worst case. As parts related to exhaust and turbocharger are used at high temperature, be careful not to mix the bolts and nuts with other parts when performing repair.

LUBRICATION SYSTEM

Inspection and exchange of oil and oil filter should be performed while considering their exchange cycle. Overheated engine oil significantly affects the engine performance as well as the engine itself.

PERFORMANCE AND SPECIFICATIONS

CONTENTS

ENGINE SPECIFICATIONS AND PERFORMANCE

ENGINE SPECIFICATION

Items		D1146/ PU086	D1146T/ PU086T	P086TI	P086T (Power Up)	P086TI (Power Up)	Remarks
Engine type		4stroke, in-line, water-cooled type, naturally aspirated	4stroke, in-line, water-cooled type, turbo charged	4stroke, in-line, water-cooled type, turbo charged inter cooled			
Combustion chamber type		Direct injection type					
Cylinder liner type		Replaceable dry liner					
Timing gear system		Gear driven type					
No. of piston ring		Compression ring 2, oil ring 1					
No. of cylinder - bore x stroke (mm)		6 - 111 × 139					
Total piston displacement (cc)		8,071					
Compression ratio		17.6 : 1	16.8 : 1	16.7 : 1			
Engine dimension (length x width x height)(mm)		1,224 x 830 x 974	1,224 x 830 x 1,082	1,248 x 918 x 1,102	1,242 x 746 x 1,113	1,242 x 1,122 x 1,113	
Engine weight (kg)		720 / 780	780 / 780	790			
Rotation		Counter clockwise					Viewed from flywheel
Fuel injection order		1 - 5 - 3 - 6 - 2 - 4					
Fuel injection timing		18°	18° / 12°	12°	19°	14°	BTDC static
Injection pump type		Zexel in - line " AD" type		Zexel in-line "P" type	Weifu in-line "P" type		
Governor type		Mechanical governor type (RSV)		Electrical governor type (GAC)	Electrical governor type (FUCHANG)		
Injection nozzle type		Multi-hole type (5 hole)					
Fuel injection pressure (kg/cm^2)		214					at 200rpm
Compression pressure (kg/cm^2)		28					
Valve clearance (mm)	Intake	0.3					at cold
	Exhaust	0.3					at cold

ENGINE SPECIFICATION (CONT'D)

Items		D1146/ PU086	D1146T/ PU086T	P086TI	P086T (Power Up)	P086TI (Power Up)	Remarks
Intake valve	Open at	16°					BTDC
	Close at	36°					ABDC
Exhaust valve	Open at	46°					BBDC
	Close at	14°					ATDC
Lubrication method		Full forced pressure feed type					
Oil pump type		Gear type driven by camshaft					
Oil filter type		Full-flow, cartridge type					
Lubricating oil capacity (litres)	Max.	15.5					
	Min.	12					
Oil specification	Oil class (API)	Above API CD or CE					
	SAE	15W40					
Oil cooler type		Water cooled					
Water pump		Centrifugal type driven by belt					
Cooling Method		Fresh water forced circulation					
Cooling water capacity (litres)		14 / 11					engine only
Thermostat type		Wax pallet type					
Alternator voltage - capacity (V - A)		24 - 45					
Starting motor voltage - output (V - kW)		24 - 4.5		24 - 6.0			

ENGINE OUTPUT

(Production tolerance: ±5%)

Generating-Set Engines			Condition			Remarks
			Continuous	Prime	Stand by	
D1146	Standard	50Hz (1,500 rpm)	-	105PS (77kW)	116PS (85kW)	
		60Hz (1,800 rpm)	-	130PS (96kW)	143PS (105kW)	
D1146T	Standard	50Hz (1,500 rpm)	-	145PS (107kW)	160PS (118kW)	
		60Hz (1,800 rpm)	-	170PS (125kW)	187PS (138kW)	
P086T	P086T Power Up	50Hz (1,500 rpm)	-	186PS (137kW)	207PS (152kW)	
		60Hz (1,800 rpm)	-	228PS (168kW)	254PS (187kW)	
P086TI	Standard	50Hz (1,500 rpm)	205PS (151kW)	240PS (177kW)	270PS (199kW)	
		60Hz (1,800 rpm)	253PS (186kW)	279PS (205kW)	303PS (223kW)	
	P086TI-1	50Hz (1,500 rpm)	-	203PS (149kW)	223PS (164kW)	
		60Hz (1,800 rpm)	-	237PS (174kW)	260PS (164kW)	
	P086TI Power Up	50Hz (1,500 rpm)	-	273PS (201kW)	305PS (224kW)	
		60Hz (1,800 rpm)	-	310PS (228kW)	344PS (253kW)	

NOTE: All data is based on operation without cooling fan at ISO 3046. (Production tolerance: ±5%)

ENGINE SPECIFICATIONS

Item		Engine model DP066TA	Engine model DP066LA
Engine type		4-stroke, in-line, water-cooled, turbocharged	4-stroke, in-line, water-cooled, turbocharged and air-cooled
Combustion chamber type		Direct injection	
Cylinder liner type		Dry liner	
Timing gear system		Gear driven type	
No. of piston rings		2 compression rings and 1 oil ring	
Number of cylinders - bore x stroke (mm)		6 - Ø102 × 118	
Total displacement (cc)		5,785	
Compression ratio		18.5 : 1	
Engine dimensions (length × width × height)(mm)		1,166 x 749 x 995	116 x 836 x 976
Engine weight (kg)		493	502
Rotating direction (when seeing from flywheel side)		Counterclockwise	
Ignition order		1 - 5 - 3 - 6 - 2 - 4	
Fuel injection timing		13° (BTDC)	
Fuel injection pump type		Wafer style in-line	
Governor type		Electric	
Fuel injection nozzle type		Multi-hole type (6 holes)	
Fuel injection pressure (kg/cm^2)		195	
Compression pressure (kg/cm^2)		20.4 @ 200rpm	
Intake and exhaust valve clearance (cold)(mm)		0.4	
Intake valve	Opening	28° (BTDC)	
	Closing	62° (ABDC)	
Exhaust valve	Opening	70° (BBDC)	
	Closing	28° (ATDC)	
Lubrication method		Forced lubrication	
Oil pump type		Gear driven type	
Oil filter type		Cartridge	
Lubricant capacity (max./min.)(litres)		19 / 16	
Oil cooler type		Water-cooled layered	
Water pump		Belt driven impeller type	
Cooling method		Forced circulation	
Coolant capacity (in engine)(litres)		14	
Thermostat type		Wax pellet (71 ~ 85° or 82 ~ 95°)	
Start motor (voltage - power)(V - kW)		24 - 4.5	
Alternator (V - A)		24 - 45	
Battery capacity (V - AH)		24 - 120	

ENGINE POWER

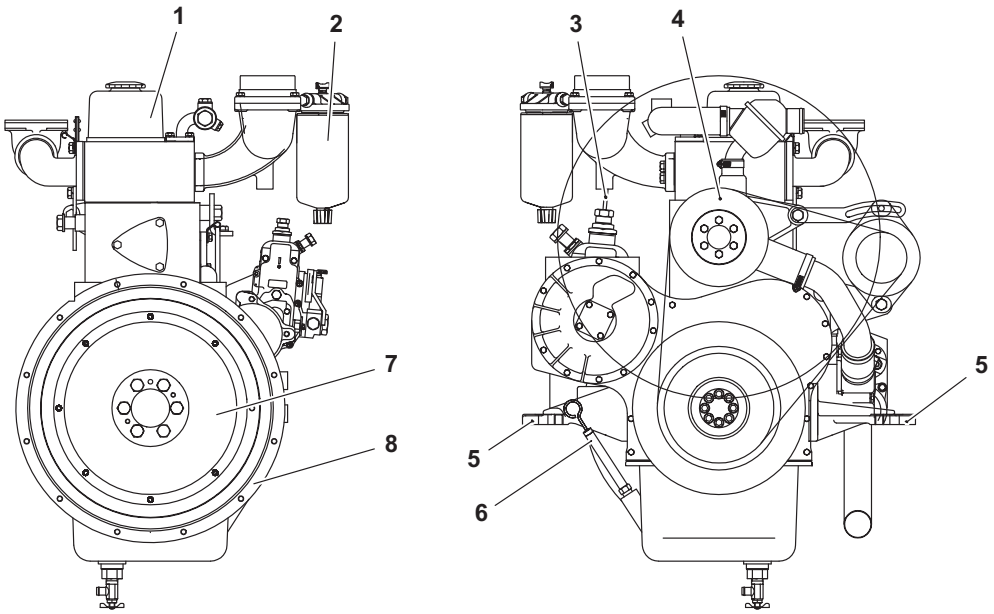
(Tolerance: ±5%)

Engine model		Performance			Remarks
Model	**Code (Suffix)**	**Injection timing (BTDC°)**	**Power (kW / rpm)**	**Torque (kg·m / rpm)**	
DP066TA	00G03	13 (BTDC)	135 / 1,800 (stand-by) 122 / 1,800 (prime)	-	
	00G04		115 / 1,500 (stand-by) 105 / 1,500 (prime)	-	
DP066LA	00G05		120 / 1,800 (stand-by) 109 / 1,800 (prime)	-	
	00G06		85 / 1,500 (stand-by) 77 / 1,500 (prime)	-	

NOTE: All performance data was measured without the cooling fan during the test (KS- R0071).

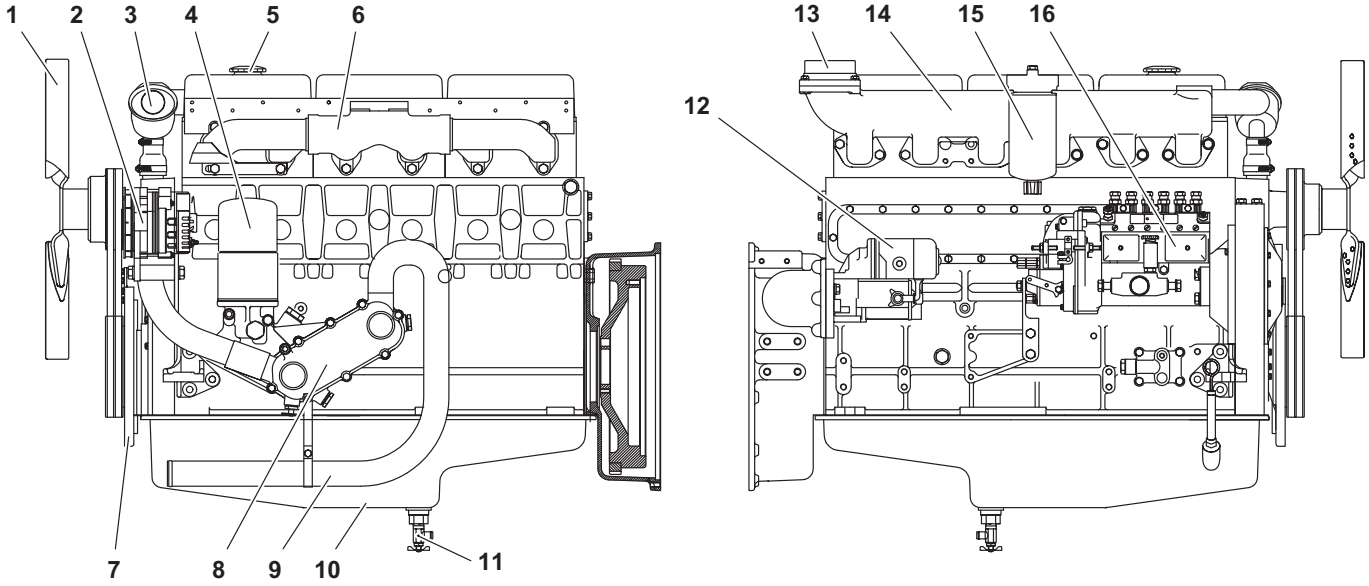
EXTERIOR VIEW DRAWING OF THE ENGINE (D1146/PU086)

FRONT/REAR (D1146/PU086)



1. Cylinder head cover
2. Cooling water pipe
3. Fuel injection pipe
4. Water pump
5. Mounting bracket
6. Oil level gauge
7. Flywheel
8. Flywheel housing

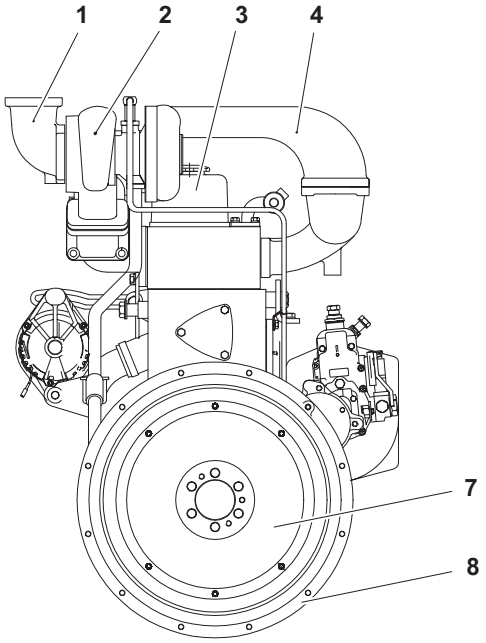
LEFT/RIGHT (D1146/PU086)

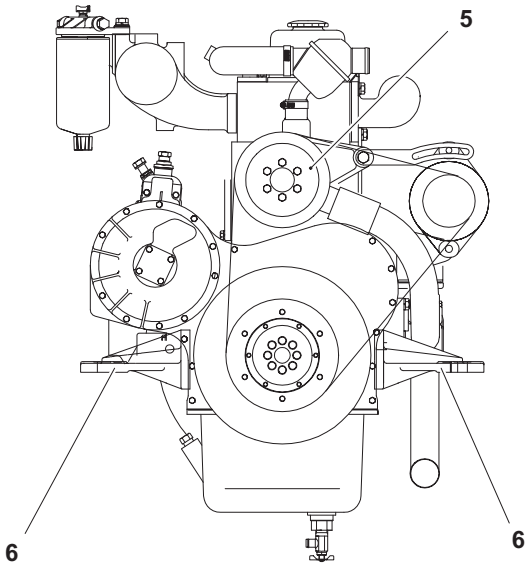


1. Cooling fan
2. Alternator
3. Thermostat
4. Oil filter
5. Oil filler cap
6. Exhaust manifold
7. Vibration damper
8. Oil cooler
9. Cooling water pipe
10. Oil pan
11. Oil drain valve
12. Starter
13. Intake stake
14. Intake manifold
15. Fuel filter
16. Fuel injection pump

EXTERIOR VIEW DRAWING OF THE ENGINE (D1146T/PU086T)

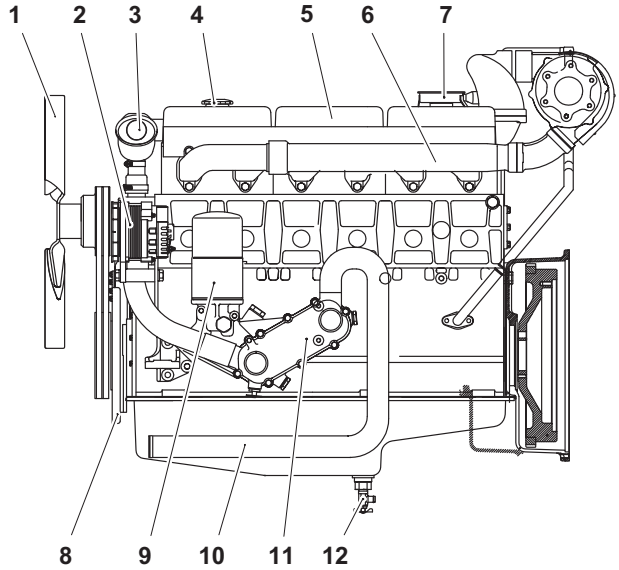
FRONT/REAR (D1146T/PU086T)

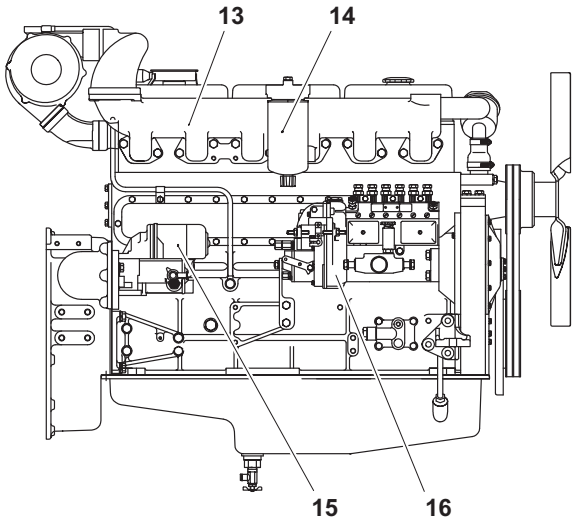




1. Exhaust elbow
2. Turbocharger
3. Cylinder head cover
4. Air pipe
5. Water pump
6. Mounting bracket
7. Flywheel
8. Flywheel housing

LEFT/RIGHT (D1146T/PU086T))

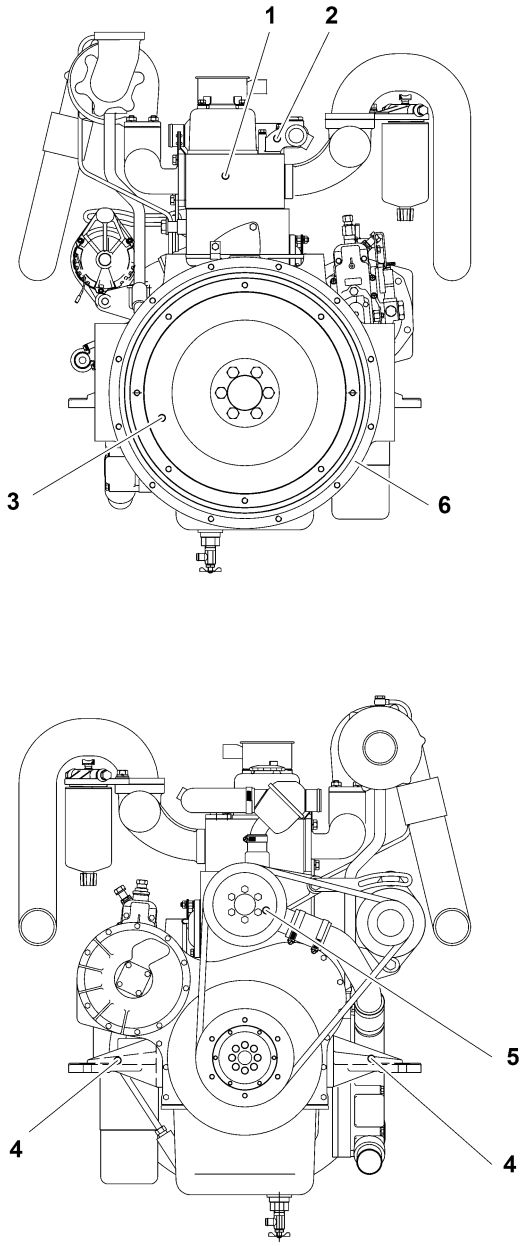




1. Cooling fan
2. Alternator
3. Thermostat
4. Oil filler cap
5. Cylinder head cover
6. Exhaust manifold
7. Breather
8. Vibration damper
9. Oil filter
10. Cooling water pipe
11. Oil cooler
12. Oil drain valve
13. Intake manifold
14. Fuel filter
15. Starter
16. Fuel injection pump

EXTERIOR VIEW DRAWING OF THE ENGINE (P086TI)

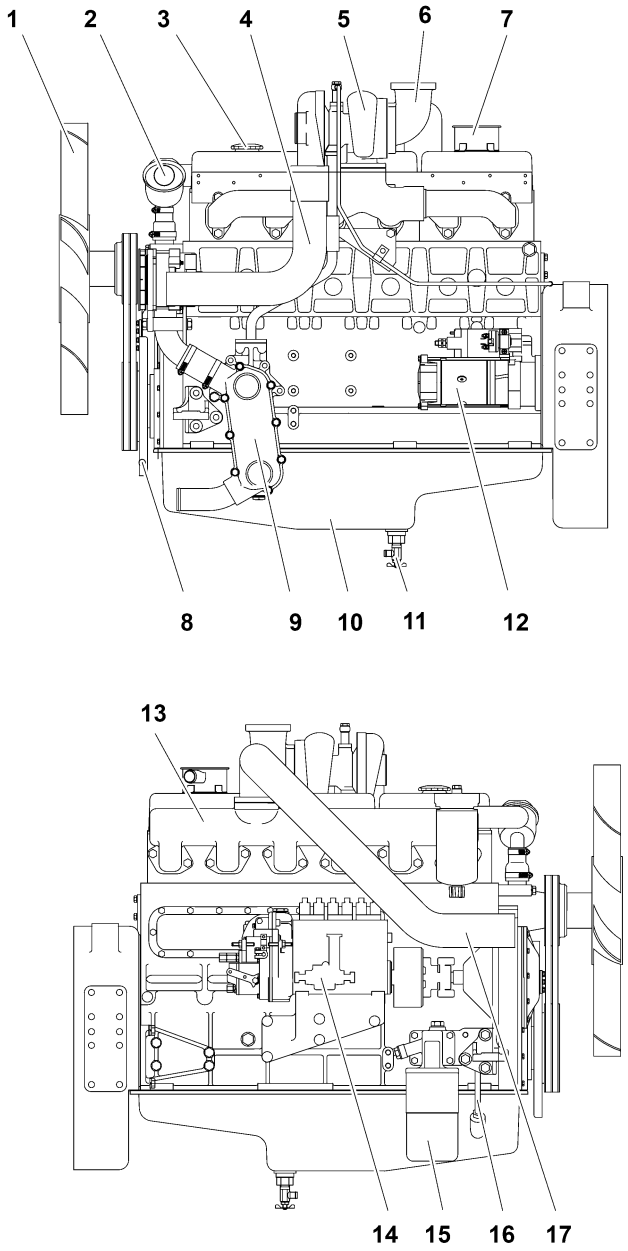
FRONT/REAR (P086TI)



EA9O1005_1

1. Cylinder head
2. Cooling water pipe
3. Flywheel
4. Mounting bracket
5. Water pump
6. Flywheel housing

LEFT/RIGHT (P086TI)

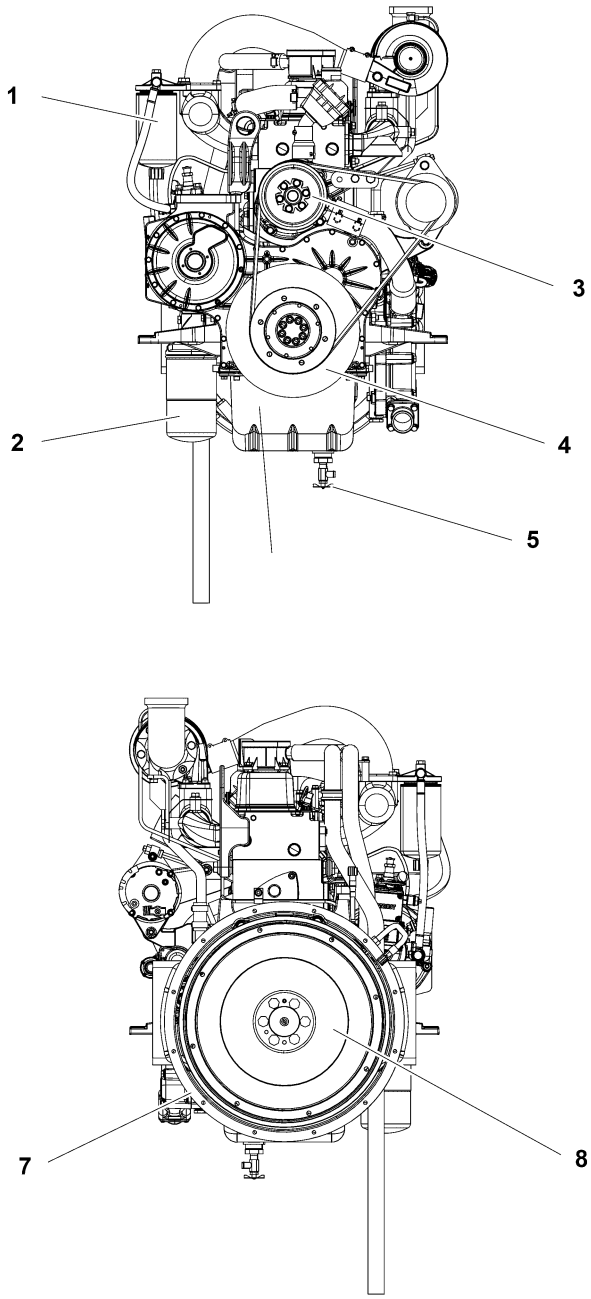


EA9O1005_2

1. Cooling fan
2. Thermostat
3. Oil filler cap
4. Air pipe
5. Turbocharger
6. Exhaust elbow
7. Breather
8. Vibration damper
9. Oil cooler
10. Oil pan
11. Oil drain valve
12. Starter
13. Intake manifold
14. Fuel injection pump
15. Oil filter
16. Oil level gauge
17. Air pipe

EXTERIOR VIEW DRAWING OF THE ENGINE (P086T POWER UP)

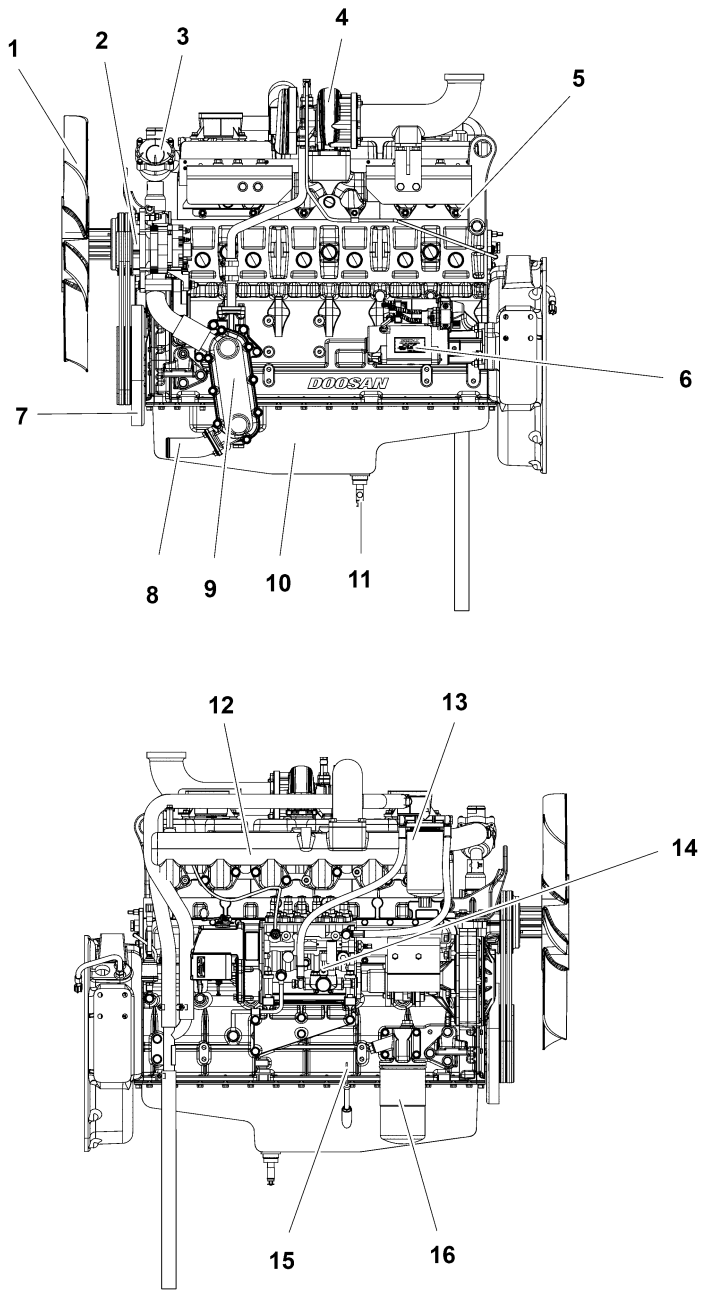
FRONT/REAR (P086T POWER UP)



EK00345A

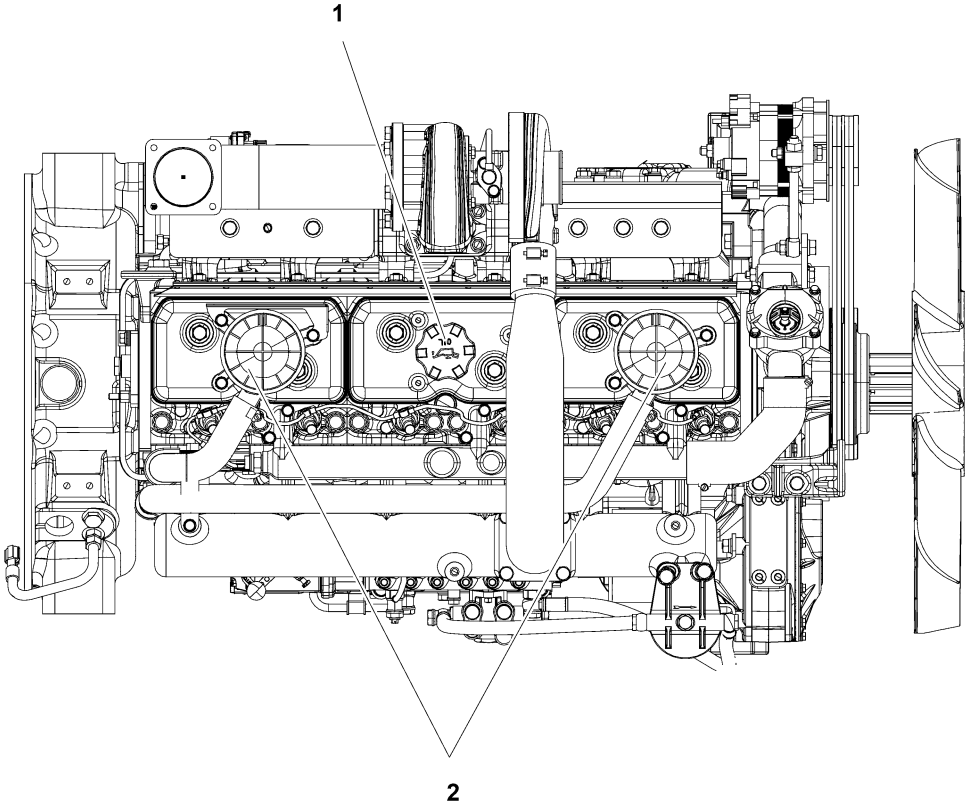
1. Fuel filter
2. Oil filter
3. Cooling fan pulley
4. Crankshaft pulley
5. Oil drain plug
6. Oil pan
7. Flywheel housing
8. Flywheel

LEFT/RIGHT (P086T POWER UP)



EK00346A

1. Cooling pan
2. Alternator
3. Thermostat
4. Turbocharger
5. Exhaust manifold
6. Starter
7. Vibration damper
8. Cooling water pipe
9. Oil cooler
10. Oil pan
11. Oil drain valve
12. Intake manifold
13. Fuel filter
14. Fuel injection pump
15. Oil level gauge
16. Oil filter

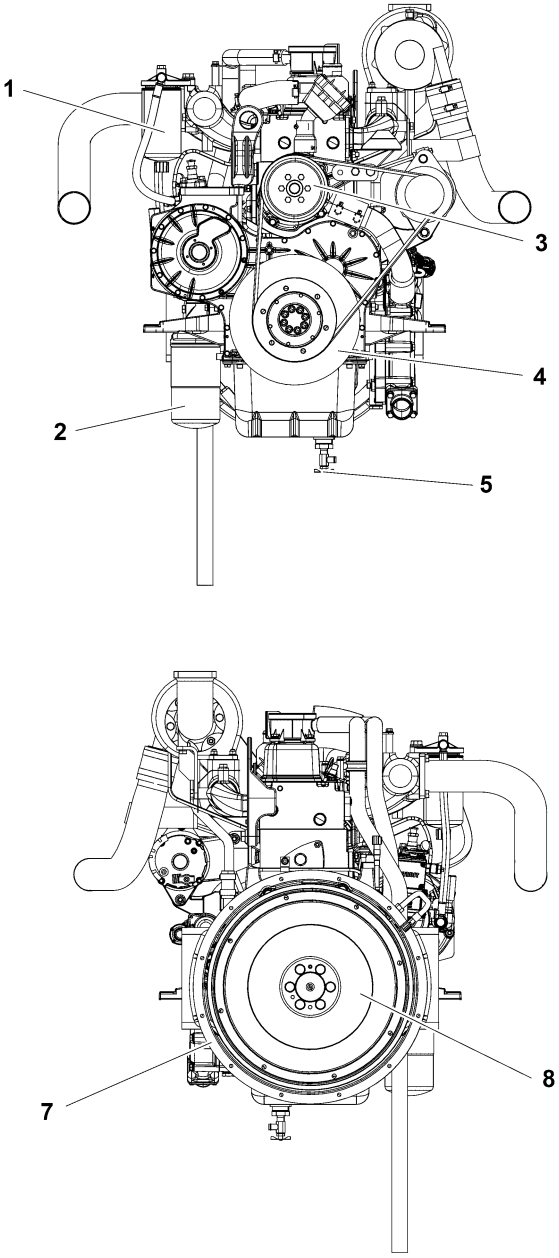


EK00347A

1. Oil cap
2. Breather

EXTERIOR VIEW DRAWING OF THE ENGINE (P086TI POWER UP)

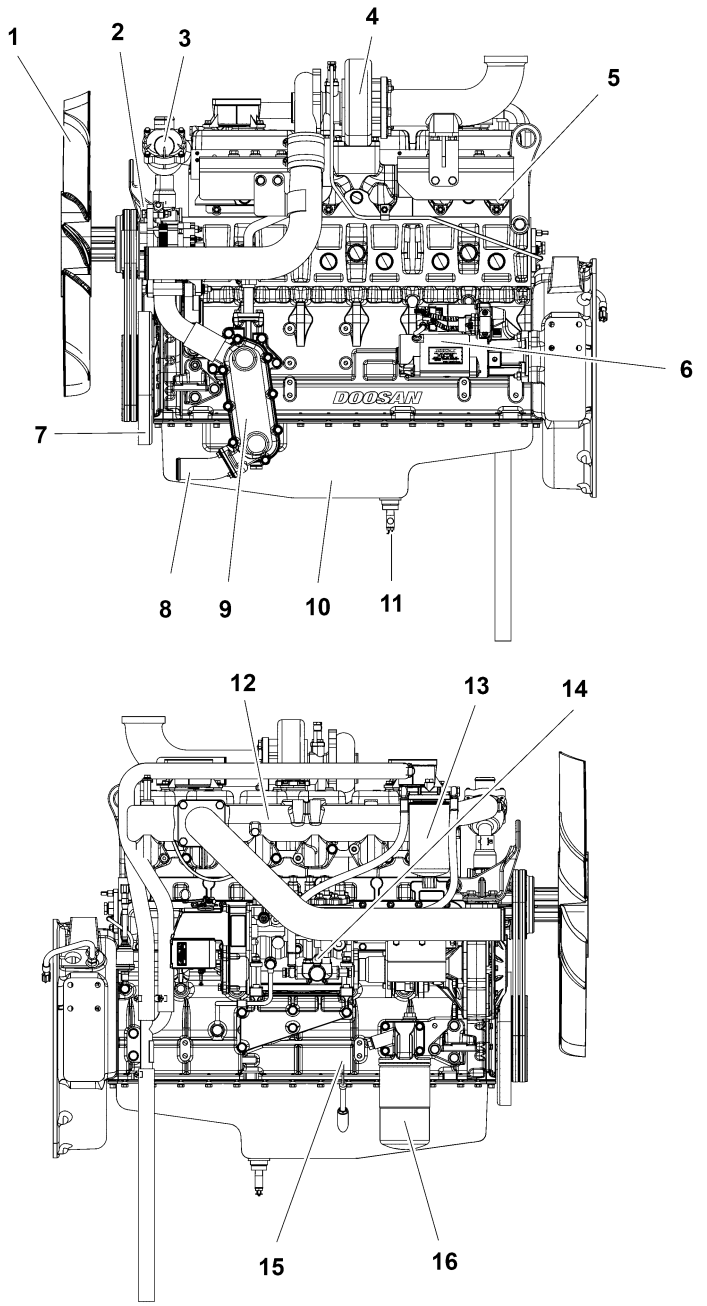
FRONT/REAR (P086TI POWER UP)



EK00348A

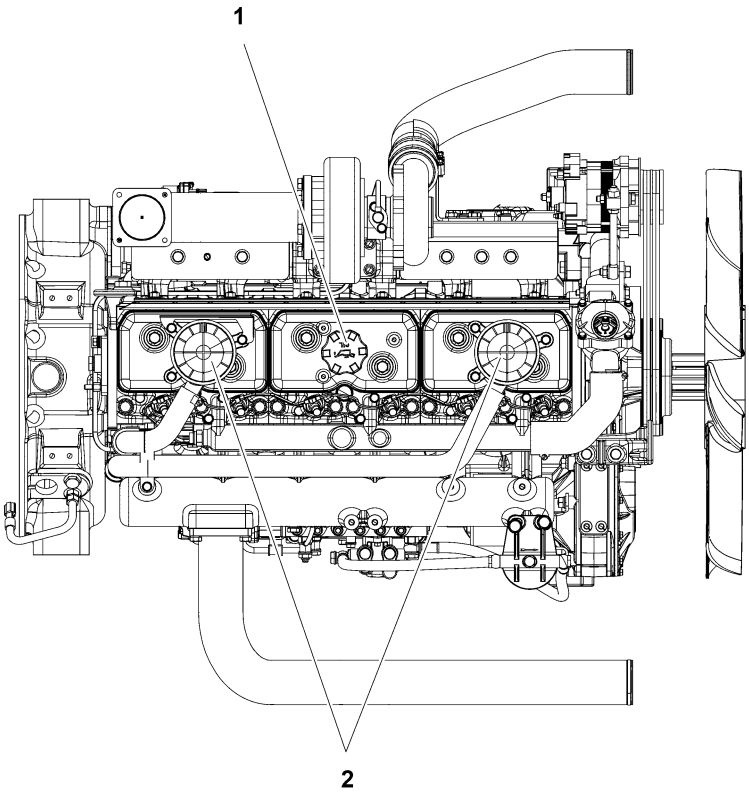
1. Fuel filter
2. Oil filter
3. Oil pan pulley
4. Crankshaft pulley
5. Oil drain plug
6. Oil pan
7. Flywheel housing
8. Flywheel

LEFT/RIGHT (P086TI POWER UP)



EK00349A

1. Cooling pan
2. Alternator
3. Thermostat
4. Turbocharger
5. Exhaust manifold
6. Starter
7. Vibration damper
8. Cooling water pipe
9. Oil cooler
10. Oil pan
11. Oil drain valve
12. Intake manifold
13. Fuel filter
14. Fuel injection pump
15. Oil level gauge
16. Oil filter



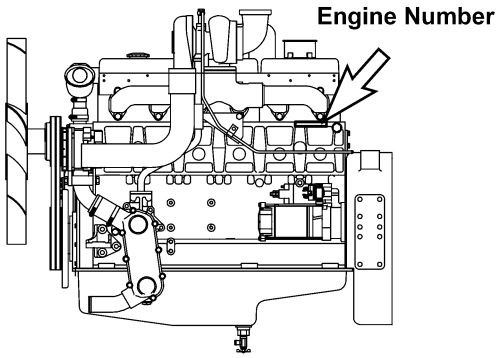
EK00350A

1. Oil cap
2. Breather

ENGINE IDENTIFICATION NUMBER

ENGINE CODE AND MANUFACTURING NUMBER

The engine model and serial number are located on the engine as illustrated. These numbers are required when requesting warranty and ordering parts.



EA9O2001

ENGINE NUMBER ENGRAVING

- **Type 1**

□□□□□ □ □□□□□
(A) (B) (C)

A Engine Model SUFFIX (5 digits)
B Production Year (1 digit)
C Serial Number (5 digits)

- **Type 2**

□□□□□□□ □ □□□□□ □□
(A) (B) (C) (D)

A Sales Model name (4-7 digits)
B Production Year (1 digit)
C Serial Number (5 digits)
D After engine model SUFFIX (2 digits)

- **Type 3**

□□□□□ □□□ □ □□□□□ □□
(A) (B) (C) (D) (E)

A Sales Model name (5 digits)
B Engine output (3 digits)
C Production Year (1 digit)
D Serial Number (5 digits)
E After engine model SUFFIX (2 digits)

- **Type 4**

□□□□□□□□□ □ □□□□□
(A) (B) (C)

A New representative specification (9 digits)
B Production Year (1 digit)
D Serial Number (5 digits)

- **Type 5**

□□□□□□□ □ □□□□□ □□□
(A) (B) (C) (D)

A Sales Model name (4-7 digits)
B Production Year (1 digit)
C Serial Number (5 digits)
D After new representative specification (3 digits)

- **Type 6**

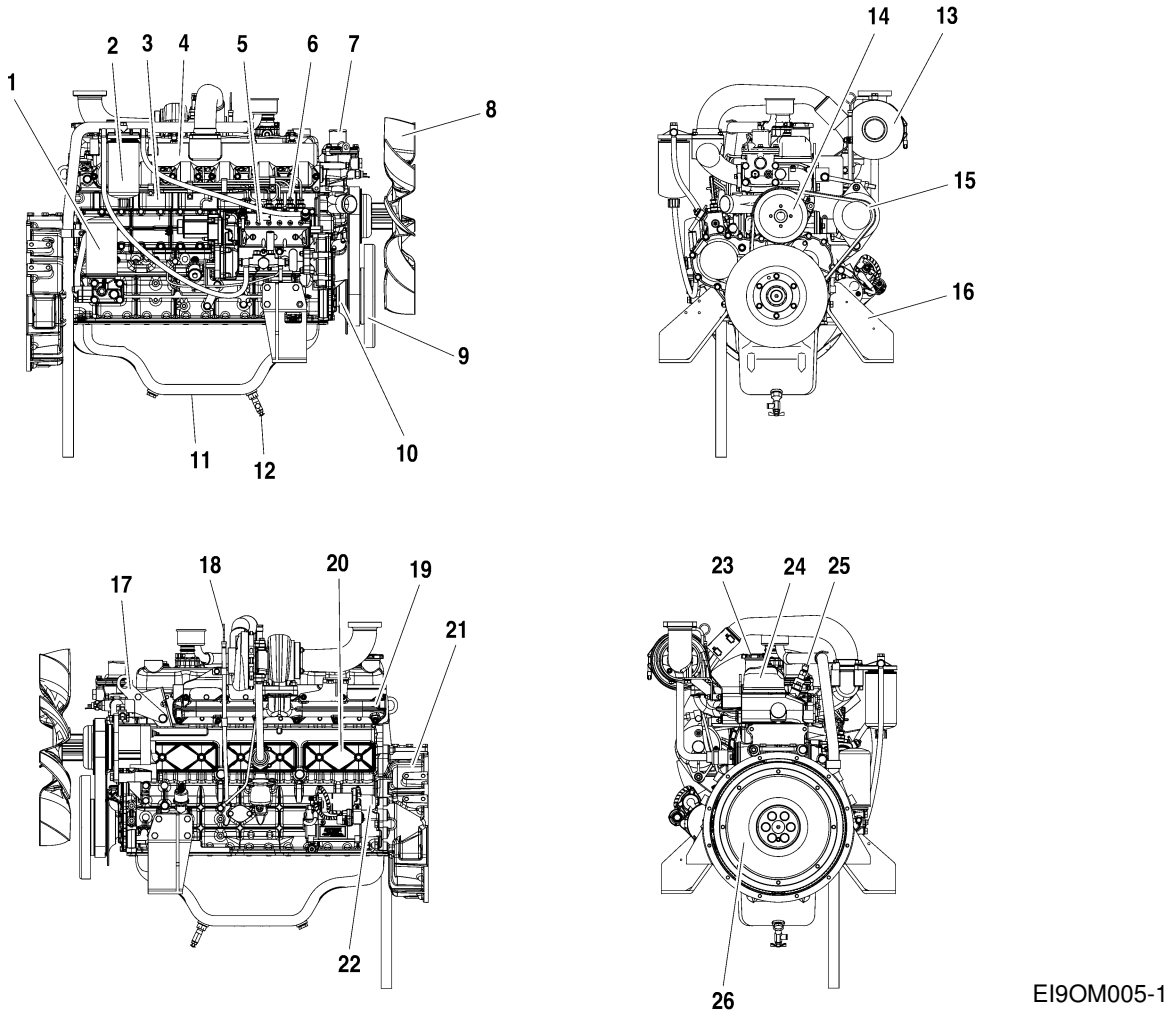
□□□□□ □□□ □ □□□□□ □□□
(A) (B) (C) (D) (E)

A Sales Model name (5 digits)
B Engine output (3 digits)
C Production Year (1 digit)
D Serial Number (5 digits)
E After new representative specification (3 digits)

ENGINE ASSEMBLY DIAGRAM

EXTERNAL VIEW OF ENGINE

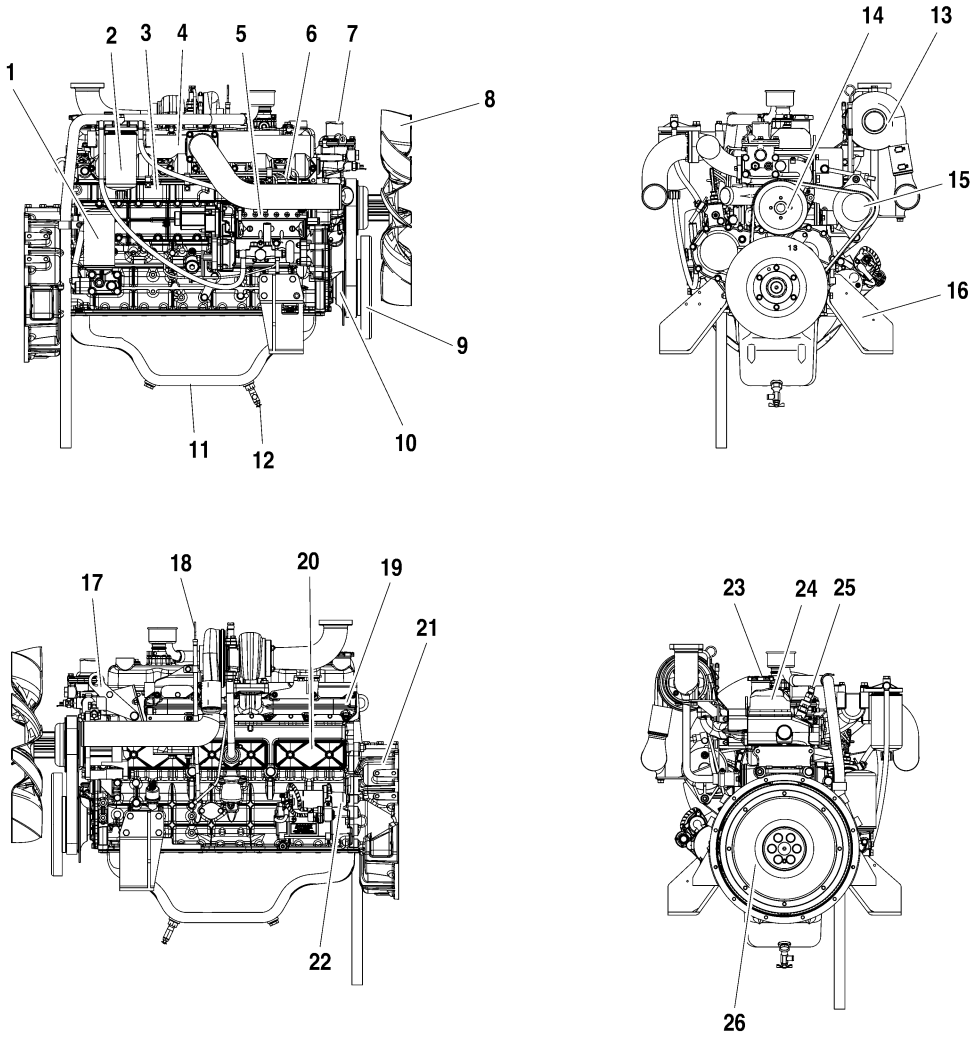
1) DP066LA



EI9OM005-1

1. Oil filter
2. Fuel filter
3. Oil Cooler
4. Intake manifold
5. Fuel injection pump
6. Fuel injection nozzle
7. Coolant outlet
8. Cooling fan
9. Absorber damper
10. Crankshaft pulley
11. Oil pan
12. Oil drain plug
13. Turbocharger
14. Coolant pump
15. Alternator
16. Engine mounting bracket
17. Engine lift hook
18. Dipstick
19. Exhaust manifold
20. Push rod chamber
21. Flywheel housing
22. Start motor
23. Oil filler cap
24. Cylinder head cover
25. Fuel injection nozzle
26. Flywheel

2) DP066TA



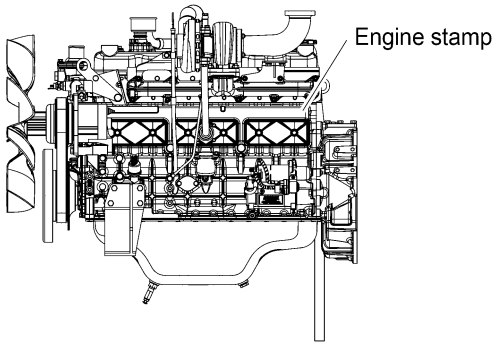
EI9OM005-2

1. Oil filter
2. Fuel filter
3. Oil Cooler
4. Intake manifold
5. Fuel injection pump
6. Fuel injection nozzle
7. Coolant outlet
8. Cooling fan
9. Absorber damper
10. Crankshaft pulley
11. Oil pan
12. Oil drain plug
13. Turbocharger
14. Coolant pump
15. Alternator
16. Engine mounting bracket
17. Engine lift hook
18. Dipstick
19. Exhaust manifold
20. Push rod chamber
21. Flywheel housing
22. Start motor
23. Oil filler cap
24. Cylinder head cover
25. Fuel injection nozzle
26. Flywheel

TECHNICAL INFORMATION

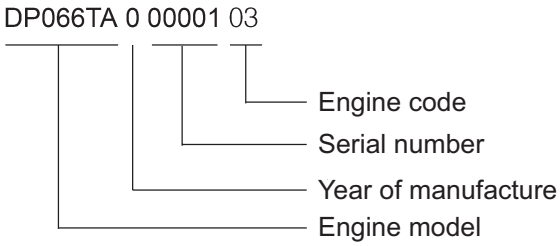
NUMBER STAMP ON ENGINE

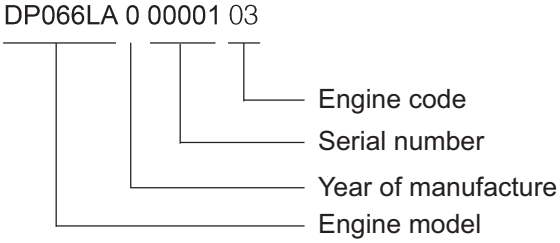
- The engine code and manufacturing number are marked on the specified location as shown in the figure. This number is required for a warranty claim and part order.



EI9OM006-1

- **Engine number stamp**





REGULAR INSPECTION

CONTENTS

CONTENTS (CONT'D)

GENERAL INFORMATION

GENERAL INFORMATION

After purchasing an engine over time, each of the engine's parts will age and the initial engine performance cannot be maintained.

Regular inspection and replacement of components according to the recommended regular inspection table allows you to maintain an engine with the optimum conditions and best performance for a long period and prevent unexpected accidents in advance.

Users are responsible for the proper operation and maintenance of engines. Engines should be inspected and replaced by officially-certified technicians in a workspace with the specified tools and facilities. Observe the following instructions to perform inspections.

1. Perform inspections on a flat floor without a slope.
2. Excluding extreme circumstances, only perform inspection while the engine is stopped.
3. Disconnect the '-' terminal of the battery before performing an inspection.
4. Perform inspection in a well ventilated space.
5. Use a wooden prop or lift when working under the engine.

⚠ DANGER

Wait until the engine is sufficiently cooled before starting inspection after operating the engine. Failure to observe this may result in serious burns.

You may be poisoned by the emissions when starting an engine in a closed space. Perform inspection in a well-ventilate space.

unless it is absolutely necessary, do not perform inspection under an engine.

When carrying out engine inspection or maintenance, ensure there are no naked flames within the vicinity of the machine. Fuel, oil, or batteries may generate gas, causing fire.

If inspecting the engine while it is running, do not wear accessories such as necklaces, rings, watches or gloves. Such accessories may become stuck in rotating parts while the engine is running and may cause serious bodily injury.

⚠ CAUTION

Incorrect inspection methods may cause engine faults.

Cleaning an engine with liquids such as water or wax may cause breakdown of electrical parts.

Be careful when handling batteries, cables, and electrical wirings because current flows through those parts.

Do not put heavy things or apply excessive force or impact on the fuel-related units.

Ensure that the battery terminals ('+' and '-') are connected to the correct terminal. Connecting the '+' and '-' terminals to the wrong terminal may cause damage to the electrical unit parts and fire.

ROUTINE INSPECTION

Routine inspection is an inspection performed by an engine operator before operating the engine. It should be performed to protect operator's safety, as well as the engine.

The following is a minimal check list.

1. Check whether the engine smoothly starts and the levels of fuel, oil, and coolant are within the normal range.
2. Check if any discharged emissions are colored and if the exhaust contains toxic gas elements.
3. Check whether abnormal noise occurs after starting an engine or not.
4. Check whether oil or water is leaking.

REGULAR INSPECTION TABLE

GENERAL CONDITIONS

Regular inspection and replacement according to the recommended regular inspection table allows you to maintain the engine with optimum conditions and best performance for a long period and prevent unexpected accidents in advance.

(o : Inspection and Adjustment • : Replacement)

Check Points		Daily	Inspection interval (Hours)					Remarks
			First 50	200	400	600	1,200	
Cooling system	Check for leakage(hoses, clamp)	o						
	Check the coolant water level	o						
	Change the coolant water						•	
	Adjust the V-belt tension	o						Every 2,000hrs
	Clean the radiator						o	
Lubrication system	Check for leakage	o						
	Check the oil level gauge	o						
	Change the lubricating oil			•[a]	•			
	Replace the oil filter cartridge			•[a]	•			
Fuel system	Check the fuel line for leakage	o						
	Clean the fuel strainer of fuel feed pump			o				
	Remove sediment from fuel tank						o	
	Drain the water in separator			o				
	Replace the fuel filter element				•			
	Check fuel Injection timing			o				When necessary
	Check the injection nozzles			o				When necessary
Intake / Exhaust system	Check the intercooler for leakage (hoses, clamp)	o						
	Clean and change the air cleaner element			o[b]	•			
	Clean the inter-cooler air fins					o		
	Clean the turbocharger							Every 2,000hrs
Engine adjust	Check the state of exhaust gas	o						
	Check the battery charge	o						
	Check the compression pressure						o	When necessary
	Adjust Intake/Exhaust valve clearance		o[a]					When necessary

a. First 50hr
b. Clean

USE OF GENUINE PARTS

An engine consists of many parts which are mechanically harmonized. To prevent engine faults in advance and use engines with best performance for a long period, maintenance and replacement of expendable parts should be conducted regularly.

Use of genuine parts is recommended. Using unauthorized or remanufactured parts may cause critical damage and faults to engine for which Doosan shall not be held liable.

COOLING SYSTEM

GENERAL INFORMATION

The coolant should be replaced according to the cycle specified in the inspection interval table. If the coolant gets dirty, the engine is overheated, and the coolant overflows in the thermal expansion tank.

COOLANT STANDARDS

It is recommended that the antifreeze is added in a concentration of approximately 40~50% of the entire coolant. The antifreeze prevents the freezing and corrosion of the system, and increases the boiling point of coolant. In winter, the amount of antifreeze may need to be changed to suit the ambient temperature as shown in the table below. The freezing point per antifreeze ratio shown in the table may differ slightly depending on the antifreeze type. For more information, see the specifications provided by the manufacturer. Whenever coolant (water) is added to replenish the amount reduced by engine operation, the antifreeze portion is decreased. Therefore, the antifreeze level must be increased to the proper level after replenishing the coolant.

- concentration of antifreeze during winter

Ambient temperature (℃)	Coolant (℃)	Antifreeze (%)
Antifreeze (%)	85	15
-10	80	20
-15	73	27
-20	67	33
-25	60	40
-30	56	44
-40	50	50

CAPACITY OF COOLANT

Engine Mode	Coolant capacity (litres)
D1146	14/11
D1146T	
P086T Power Up	
P086TI	
P086TI Power Up	
PU086	
PU086T	

CHECKING THE COOLANT

⚠ DANGER

If the radiator cap is opened to exchange or replenish coolant while the engine is overheated, hot water will spurt out and may cause serious burns. If it is absolutely necessary to open the radiator cap while the engine is overheated, wrap the radiator cap with a cloth and slowly open the cap in two steps until the steam pressure has been released from the inside. After the steam pressure has been completely released, remove the radiator cap.

1. Use clean tap water for the engine coolant.
2. Add 40% of antifreeze to the coolant to prevent corrosion and freezing.
3. Periodically check coolant to maintain the concentration of antifreeze and additives.

⚠ CAUTION

If the antifreeze and corrosion inhibitor is kept at the proper level, corrosion of the engine will be prevented effectively and engine quality will be maintained. Be careful that, if managed improperly, it can give a fatal impact on the coolant pump and cylinder liner.

4. Check the concentration of antifreeze and corrosion inhibitor using the coolant test sheet.

MEASUREMENT OF COOLANT CONCENTRATION

- Special Tools

Figure	Product Number/Name
	60.99901-0038 COOLANT TEST SHEET

The coolant concentration can be measured as follows:

1. If the engine coolant temperature is within a range of 10 ~ 55℃, drain the coolant and fill half a plastic cup with it.

⚠ CAUTION

When taking out a sample of coolant from the supplementary tank, it is difficult to measure the precise concentration. Always take out sample by opening the drain plug of coolant.

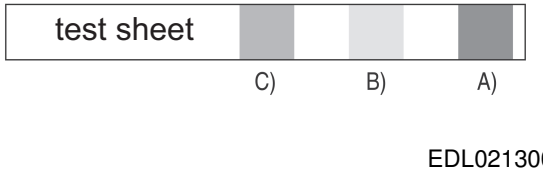
2. Soak the test sheet in the coolant and take it out after 3 ~ 5 seconds. Shake the sheet to remove the remaining coolant.

3. Wait for approximately 45 seconds until the test sheet changes its colour.

⚠ CAUTION

Measurement time should not exceed 75 seconds. The color changes as time passes.

4. Check the color on test sheet.



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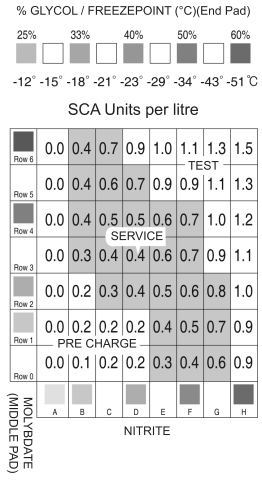
1) Compare the color of part (A) on the test sheet to the color of GLYCOL/FREEZEPOINT (End pad) of the standard color table.

2) Compare the color of the test sheet (B) to the color of MOLYBDATE (Middle pad) of the standard color table.

3) Compare the color of the test sheet (C) to the color of NITRITE of the standard color table.

5. Compare and confirm the parts with identical colors on the test sheet and the standard color table.



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1) Compare the changed pink color part A of the test sheet with the GLYOOL/FREEZEPOINT (End pad) of the standard color table on top of the container and confirm the concentration. The concentration indication has to be within the color scope of 33~50%

2) It should be maintained at the optimum range, in the green section between 0.3 to 0.8 where the color of MOLYBDATE (Middle pad) on the standard color table (which is identical with the Middle (B) of the test sheet) is crossed with the color of NITRITE on the standard color table (which is identical with the (C) of the test sheet).

3) If it is above 0.8, drain a little coolant and then add clean tap water to adjust the concentration.

⚠ CAUTION

If the color on the test sheet does not match the color of the standard color table, find a middle color on the standard color table. For example, if the color of (C) of the test sheet matches D and F on the NITRITE of the standard color table, select E.

To prevent corrosion inside of the engine cooling unit, drain the coolant and replace it with new coolant once a year.

DISCHARGING THE COOLANT

The coolant can be drained as follows:

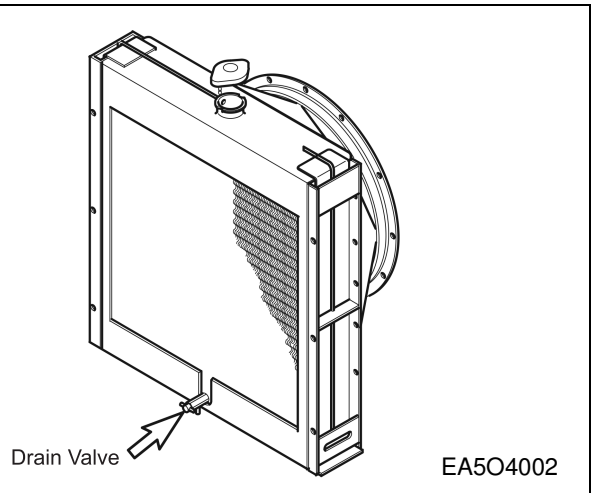
1. Ensure that the engine and radiator are cooled.
2. Open the radiator cap.

⚠ WARNING

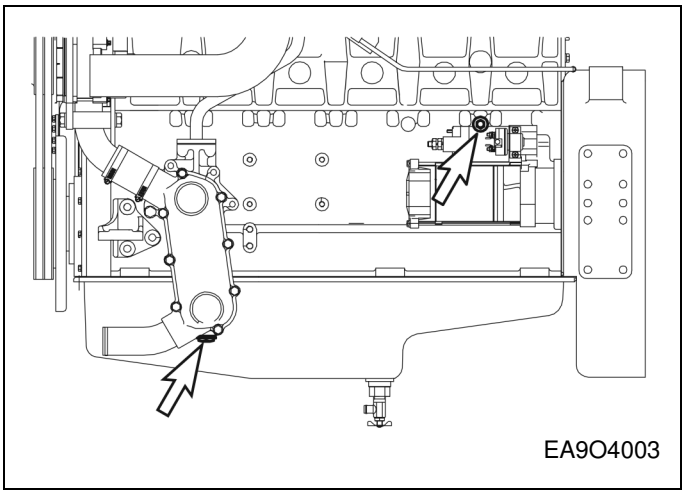
Never open the radiator cap while the engine is overheated. If the radiator cap is opened while the engine is overheated, hot water will spurt out and may cause serious burns. Open the radiator cap after ensuring that the engine has been cooled sufficiently.

Mark and separately manage the containers for storing coolant from beverage containers to avoid confusion. If coolant is ingested, see a doctor immediately.

3. Loosen the drain valve located under the radiator to drain the coolant.



4. Disassemble the coolant drain plug of the cylinder block, and drain it to a container.



5. Drain cooling water in the oil cooler.

CHARGING THE COOLANT

1. Ensure that the engine is cooled.
2. Open the radiator cap.

⚠ DANGER

Never open the radiator cap while the engine is overheated. If the radiator cap is opened while the engine is overheated, hot water will spurt out and may cause serious burns. Open the radiator cap after ensuring that the engine has been cooled sufficiently.

Mark and separately manage the containers for storing coolant from beverage containers to avoid confusion. If coolant is ingested, see a doctor immediately.

3. Pour in the coolant in slowly.

⚠ CAUTION

Be careful not to let foreign substances flow into the engine when replenishing coolant.

4. Ensure that there is no air in the cooling system.
5. After checking the coolant level when the engine is warmed up, replenish coolant if necessary.

⚠ DANGER

If the engine is hot, wrap the coolant pressure cap with a cloth upon opening it so that the steam may be discharged. This can prevent burning from the hot steam coming out of the cap inlet.

⚠ CAUTION

Do not mix antifreezes from different manufacturers.

Do not mix the coolant with different concentrations.

Do not add antirust which is not recommended by Doosan.

As insufficient coolant concentration may cause corrosion or freezing, alternatively, an excessive concentration may degrade the cooling performance. Mix coolant with 40% antifreeze to prevent corrosion.

⚠ WARNING

Discard exchanged coolant according to the regulations set forth by the relevant authorities. Disposing of exchanged coolant into the ground, sewers, drains, rivers, or the sea will cause serious environmental pollution. Violation of regulations regarding discard of coolant without observing the handling regulations, will be punished.

CLEANING THE COOLING CIRCUIT

If the internal coolant circuit is contaminated by corrosion or foreign substances, the cooling effect is reduced. The resistance in the coolant circuit may damage the mechanical seal of the coolant pump.

The reduced performance in the cooling circuit may be caused by use of incorrect type or quantity of antifreeze or corrosion inhibitor, or by use of coolant without such ingredients. If the coolant pump leaks or the coolant is severely contaminated within the first 6 months of operation (e.g., the coolant color becomes discolored - brown, grey or black depending on the degree of contamination), clean the cooling system in the following way before removing the cooling pump.

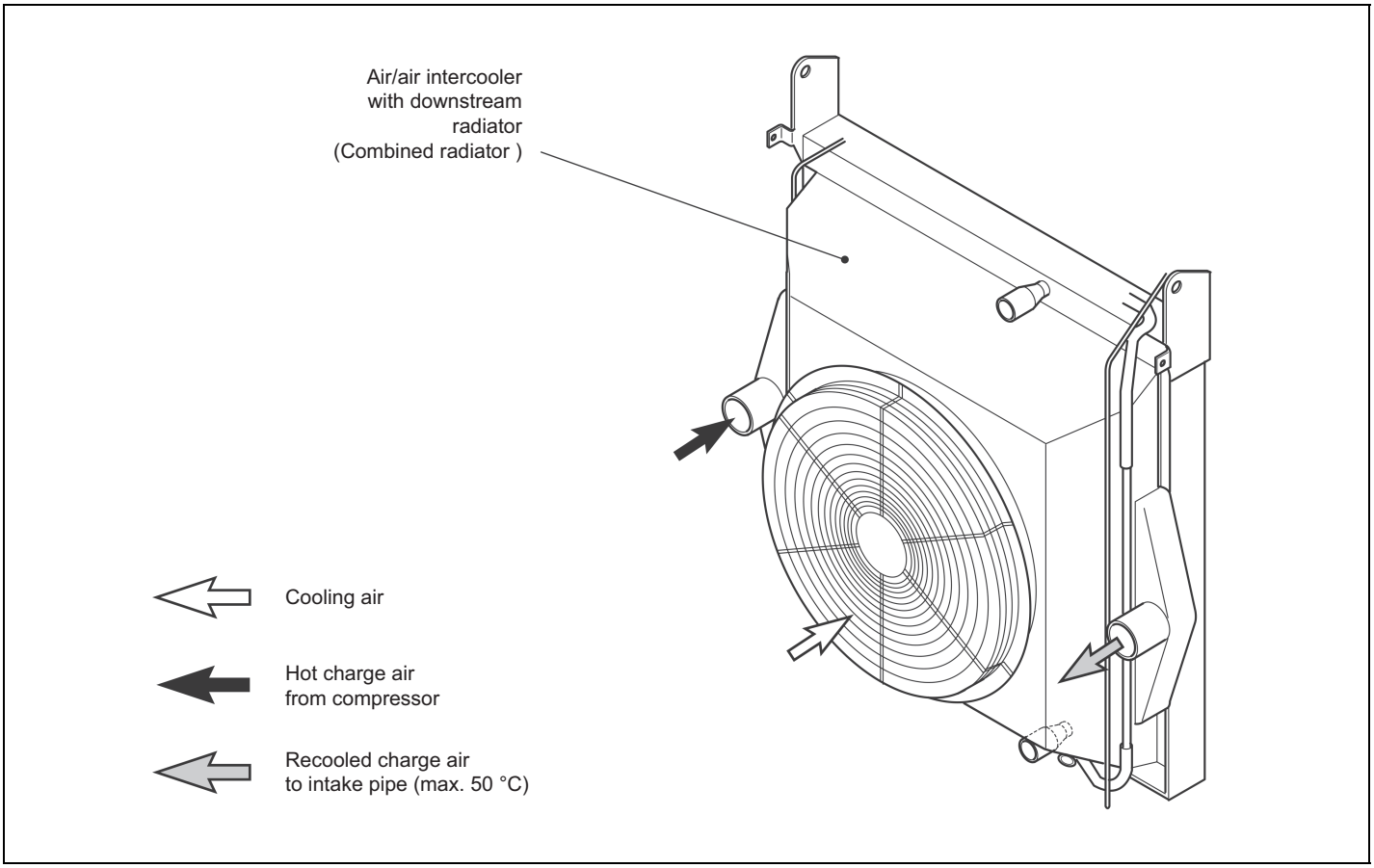
1. Drain the coolant.
2. To clean the cooling circuit swiftly, remove the thermostat.
3. Mix water and 1.5% of cleaning solution and fill the cooling circuit with this liquid.
4. Load the engine. When the coolant temperature reaches 60℃, run the engine for approximately 15 minutes.
5. Drain the cleansing solution.
6. Repeat step 3 and 4 above.
7. Fill the cooling circuit with hot water.
8. While running the engine at idle speed for 30 minutes, check if there is any leakage in the drain plug and coolant line. If the coolant is insufficient, replenish it.

⚠ CAUTION

Clean the cooling circuit regularly with cleansing solution.

INTER COOLER

The air cooler adopts an air cooling fan, which has sufficient cooling capacity. The life and performance of an air cooler greatly depends on the intake air conditions. Dirty air may contaminate and clog the cooling pins. This results in reduced engine power or engine failure. Always check the intake system for air leaks, damage or contamination of the air filter.



⚠ CAUTION

To keep the optimum performance of the air cooler, clean it regularly.

LUBRICATION SYSTEM

GENERAL INFORMATION

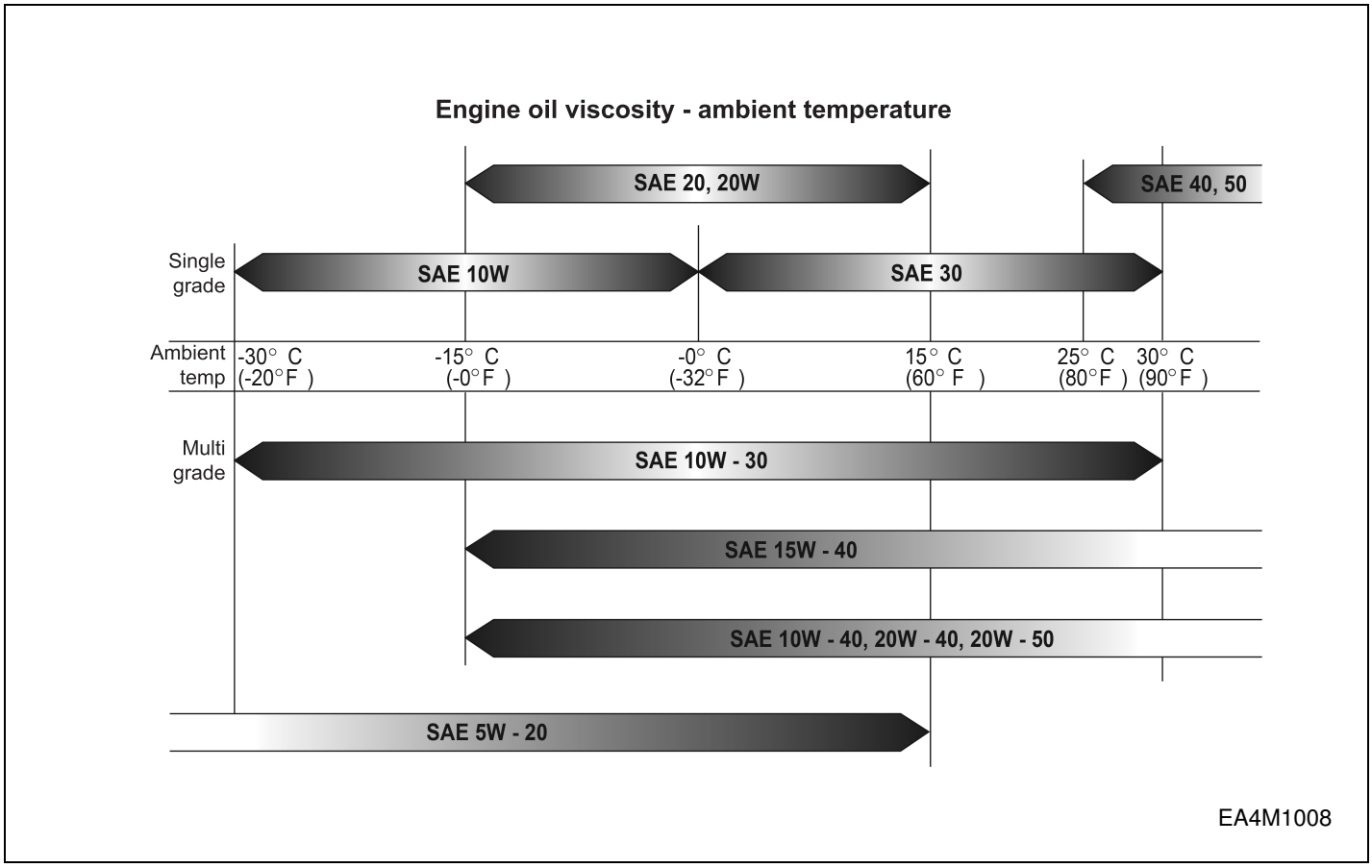
Engine oil lubricates, cools, seals, prevents corrosion, and cleans engines, enhancing engine performance and extending the engine's lifetime. If a vehicle is continuously driven while engine oil is insufficient, the moving parts of the engine may get stuck, causing engine faults.

Engine oil should be checked through the oil level gauge and replenished if required. Oil level should be checked while the engine is stopped. To check the oil level, turn off the engine while it is running and wait for 5 ~10 minutes to allow the engine oil to flow back into the oil pan. The engine oil level should indicate between the upper limit and the lower limit of the oil level gauge.

Engine oil should be periodically replaced based on the regular inspection table. The oil filter and the cartridge should be replaced as the engine oil is replaced.

ENGINE OIL STANDARDS

Use the specified engine oil suitable for the environment and conditions of the site where the engine will be used.



Use the engine oil which satisfies the following recommended specifications.

Engine Model and Product Code	SAE Classification	Oil Class
D1146	SAE 15W40	API CD OR CE ABOVE
D1146T	SAE 15W40	API CD OR CE ABOVE
P086TI	SAE 15W40	API CD OR CE ABOVE
P086T Power Up	SAE 15W40	API CD OR CE ABOVE
P086TI Power Up	SAE 15W40	API CD OR CE ABOVE
PU086	SAE 15W40	API CD OR CE ABOVE
PU086T	SAE 15W40	API CD OR CE ABOVE

NOTE: Use of Doosan genuine engine oil is recommended.

ENGINE OIL CAPACITY

Replenish the engine oil based on the following recommended oil amount.

Engine Model and Product Code	Engine oil capacity (litres)	
	Engine only	
	Max.	Min.
D1146	15.5	12
D1146T	15.5	12
P086TI	15.5	12
P086T Power Up	15.5	12
P086TI Power Up	15.5	12
PU086	15.5	12
PU086T	15.5	12

CHECKING THE ENGINE OIL

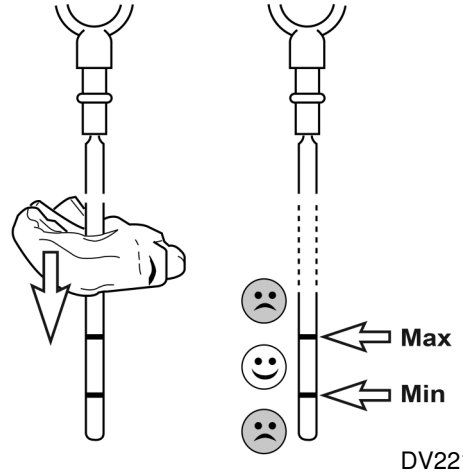
Check the oil level every day using an oil level gauge.

1. The oil level should be checked when the engine is stopped and on an even level. If the engine has been running prior to checking, wait for 5~10 minutes to allow the engine oil to flow back into the oil pan.

2. Pull out the oil level gauge, and clean the indication line of the oil level gauge with a clean cloth.

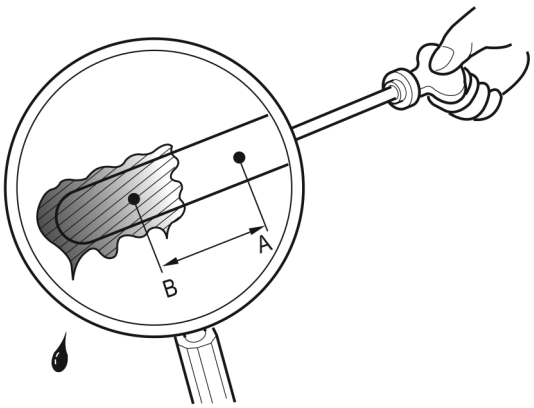
⚠ CAUTION

Cleaning the indication line of the oil level gauge with a dirty cloth allows foreign substances to get into the engine, causing damage to the engine.



DV2213163A

3. Insert the oil level gauge, and then remove it to check the engine oil level, viscosity, and contamination. Replenish or replace the engine oil if required.



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1) Check the oil level everyday using the oil level gauge.

2) Check if the oil level is between the upper limit (A) and the lower limit (B) of the oil level gauge.

3) If engine oil level is below the lower limit (B) or not on the gauge at all, replenish engine oil.

4) Check condition of engine oil. If it is polluted, replace it with new oil.

⚠ CAUTION

Do not fill the engine oil above the upper limit. Exceeding the upper limit may damage the engine.

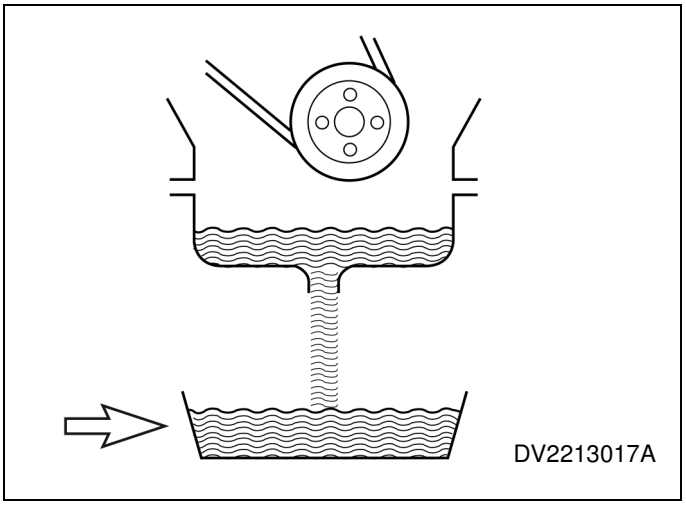
Be careful not to let foreign substances flow into the engine when replenishing engine oil.

REPLACEMENT OF ENGINE OIL

Check the oil level using the oil level gauge and replenish it if required. Replace the engine oil in the following steps when the engine is warm after running.

1. Pull out the oil level gauge.

2. Open the drain plug of the oil pan to drain the engine oil from the container.



3. After draining the engine oil, replace the drain plug of the oil pan.

4. Fill the engine oil into the cartridge of the oil filter.

5. Fill the engine oil through the oil filler cap.

6. Run the engine at idle speed for several minutes so the oil can circulate through the lubrication system.

7. Stop the engine and wait for approximately 10 minutes. Check the oil level and fill the oil if required.

⚠ DANGER

Prolonged and repeated contact of skin with engine oil may lead to shrinking, dryness of skin and even cause dermatitis.

Do not expose skin with exchanged engine oil for a long period.

Always wear work clothes and gloves.

When skin is stained with engine oil, immediately wash it with water, soap or hand cleaners.

Do not clean skin with gasoline, fuel, thinner, or solvent.

Apply a skin protective cream after cleaning from oil.

Do not put oil-stained gloves or cloth in pockets.

⚠ WARNING

Discard exchanged oil according to the regulations set forth by the relevant authorities. Disposing of discharged oil into the ground, sewers, drains, rivers, or the sea will cause serious environmental pollution. Violation of regulations regarding discard of engine oil without observing the handling regulations, will be punished.

REPLACEMENT OF ENGINE FILTER

Check the oil pressure and leakage, and replace the oil filter if required. Whenever replacing the oil, the oil filter cartridge should also be replaced.

1. Using an oil filter wrench, loosen the cartridge by turning it counterclockwise.

2. Wipe the oil filter head and cartridge contact thoroughly, and make sure that the oil filter cartridge is positioned properly.

3. Apply a small amount of oil to the O-ring area of the cartridge. Screw the cartridge on until the O-ring surface makes contact, and turn it 3/4 to 1 turn using a wrench until sealed.

⚠ CAUTION

When replacing the oil filter cartridge, be sure to use the genuine Doosan part.

FUEL SYSTEM

GENERAL INFORMATION

The fuel injection pump and nozzle are composed of very sophisticated components with high precision. If fuel is mixed with foreign substance, it may block the nozzle or the fuel injection pump components may become seized. Ensure the fuel system is clean at all times.

⚠ CAUTION

Use clean, certified and qualified fuel only. Using irregular or unspecified fuel may cause critical damage and faults to the engine.

Replenish fuel while the engine is stopped.

FUEL STANDARDS

The quality of fuel is very important to satisfy the engine performance, extension of engine life and the allowable exhaust gas level. Doosan engines are designed to use diesel fuel available in the local market. If the optimum engine performance is required, select the proper fuel by referring to the fuel selection table below.

- Low Sulfur Diesel

Fuel Ingredients		Unit	Standard	Product
Specific Gravity		(kg/litres)	**-**	**0.83**
Flash Point		(℃)	> 40	**47.8**
Viscosity (40℃)		(cSt)	**1.955**	**2.459**
Sulfur content		(wt%)	< 0.05	0.038
Cloud point		(℃)	**-**	**-3**
Pour Point		(℃)	< -17.5	-27.2
Low temperature filter clogging point		(℃)	< -12	-18
Colour (ASTM)			< 2.5	0.7
Carbon Residue (10%) Distillation residue (wt)		(%)	< 0.15	0.08
Total acid value		(mg KOH/g)	< 0.40	0.03
Copper corrosion (100℃, 3 hrs)			< 1	1 - a
Ash content (wt)		(%)	< 0.01	0.001
Moisture and Precipitate		(vol. %)	< 0.01	0.005
Cetane Index			> 45	**52**
Distillation test temperature	50% Distillation Point	(℃)	**-**	264.4
	90% Distillation Point	(℃)	< 360	344.3

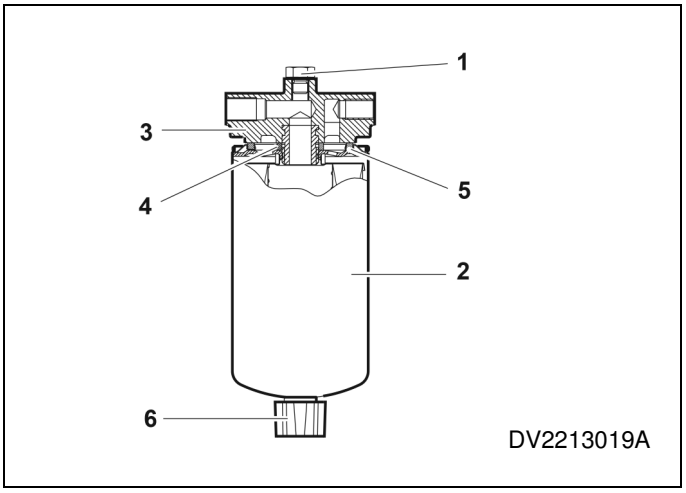
NOTE: High sulphur content in diesel fuel - Doosan diesel fuel engines can be operated with fuels whose sulphur content is max. 0.05wt%. Fuels with a sulphur content of > 0.05wt% are not permitted as they result in increased corrosion and greatly reduce the service life of engines. The oil change intervals must be halved if the sulphur content is > 0.02wt%.

WATER DRAINING FROM FUEL FILTER

An oil filter has two functions: oil filtering and water separation.

1. The water separation function of the fuel filter drains water and sediment from the water separator.

2. Stop the engine, and loosen the drain plug for water separation manually.



3. Turn the drain plug (6) for water separation counterclockwise 2~3 times until water is drained. Drain the water in the cartridge until fuel is discharged.

4. Tighten the drain plug for water separation by turning it clockwise.

⚠ DANGER

Fuel may be drained when water is drained from the fuel filter. Fuel is highly inflammable. Fire may occur if there are naked flames or sparks near the engine when draining water from the fuel filter.

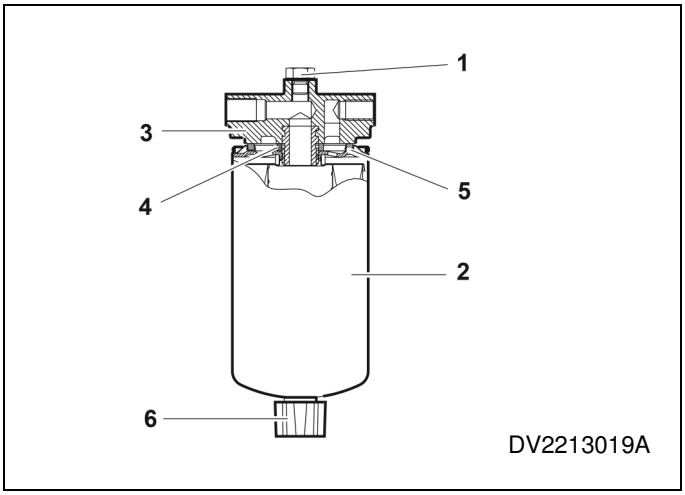
⚠ CAUTION

Do not tighten the plug excessively because it may damage the screw.

Check the fuel filter regularly and drain the water in the fuel filter. If water enters the fuel system it will cause serious failure and may damage the fuel filter or reduce performance. Water in the fuel system may stop the engine.

Use approved fuel only. Use of non approved fuel may result in increased water in the fuel filter.

REPLACING FUEL FILTER



1. Clean the area around the fuel filter head (3).

2. Disassemble the cartridge (2) by turning it counterclockwise with a fuel filter wrench.

⚠ CAUTION

Do not reuse the cartridge; replace them with new ones.

3. Remove the fuel filter screw adapter seal ring (4).

4. Clean the gasket contact of the fuel filter head (3).

5. Check the position of the new cartridge adapter seal ring (4).

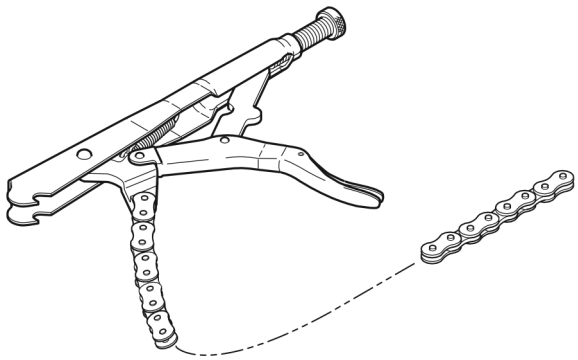
6. Screw the cartridge to the fuel filter head.

⚠ CAUTION

Assemble the new fuel filter without fuel. Do not inject fuel into the new fuel filter. After replacing the fuel filter, do air bleeding in the fuel circuit.

7. Tighten the cartridge by hand until the O-ring contacts the fuel filter head surface.

8. Tighten it by 3/4 to 1 turn with a fuel filter wrench.



DV2213020A

⚠ CAUTION

If the cartridge is tightened excessively, the screw may be distorted or the O-ring damaged.

PREVENTING FUEL CONTAMINATION

Most of the fuel contaminations encountered while using the alternator engine are caused by water and propagation of microbes.

Improper handling of fuel can lead to contamination. Propagation of microbes requires water contained in the fuel. To prevent propagation of microbes, keep the water level as low as possible in the storage tank.

FUEL INJECTION PUMP

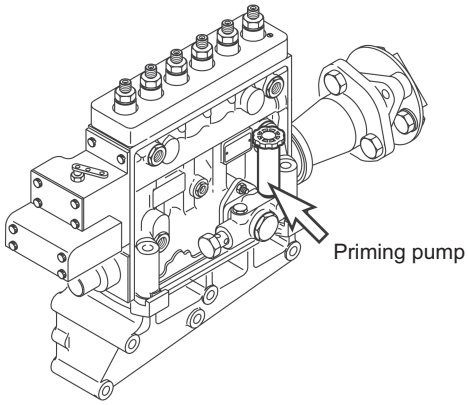
- If the fuel injection pump housing is cracked or damaged, replace it.
- Ensure the idle operaion and speed control lever's sealing device was not removed.
- Ensure the idling or speed control lever's sealing line is not damaged.
- Do not modify the fuel injection pump if the sealing line is damaged, such modifications will void the warranty.
- If the fuel injection pump is found to be damaged, it should only be repaired by authorised personnel.
- The adjustment and test of the fuel injection pump must be conducted using an appropriate tester.

⚠ CAUTION

If any parts that contain a seal ring (copper seal ring, rubber coating seal ring, etc.) are disassembled, then replace the seal ring with a new one. Failure to do so may cause leakage in the fuel filter connections preventing normal functioning.

AIR BLEEDING IN THE FUEL CIRCUIT

Air must be bled from the fuel system when the fuel filter or injection pump are replaced, or air has entered the fuel system due to insufficient fuel.



EA9O4005

1. Turn the priming pump cap.
2. Bleed the fuel by manually operating the priming pump with fuel filter outlet joint bolt and injection pump bleeder screw loosened.
3. Press the feed pump cap repeatedly until fuel without bubbles overflows from the bleeding plug screw.
4. After the air is removed, close the plug screws of the filter and the pump.
5. Confirm the resistance of fuel delivery by repeatedly pressing the feed pump cap. Apply pressure to the priming pump cap and turn.

⚠ DANGER

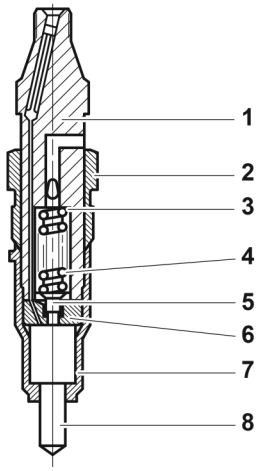
Fuel is highly inflammable. Fire may occur if there are naked flames or sparks near the engine when air is bleeding into the fuel circuit from the priming pump.

⚠ CAUTION

If any parts that contain a seal ring (copper seal ring, rubber coating seal ring, etc.) are disassembled, then replace the seal ring with a new one. Failure to do so may cause leakage in the fuel filter connections preventing normal functioning.

FUEL INJECTION NOZZLE

- The injectors are designed to spray the fuel delivered by the injection pump directly into the spherical combustion chamber in the piston crown.
- The injector consists of the nozzle and the nozzle holder.

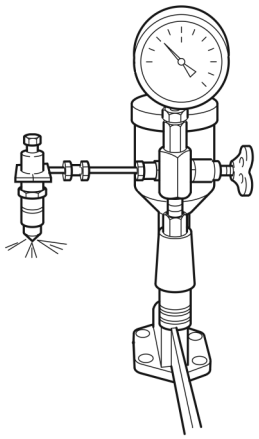


EFM2054I

1. Nozzle holder
2. Union nut
3. Shim
4. Coil spring
5. Guide bush
6. Washer
7. Cap nut
8. Nozzle

CHECK FUEL INJECTION NOZZLE PRESSURE

1. Install a nozzle to the nozzle tester.

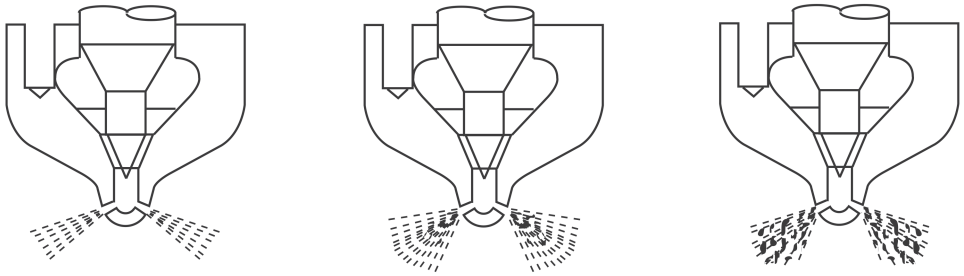

DV2213023A

2. Check injection pressure by cranking to meet the correct pressure.
3. Check the nozzle spray status. If it is defective, replace the nozzle.

⚠ CAUTION

As the injection nozzle is designed to operate under high pressure, it should be handled with care.

Always keep hands away from the fuel jet, as there is a risk of injury. Do not inhale the atomized fuel oil. If possible, work under an extraction system.



DV2213024A

Engine Model	Opening pressure (kg/cm^2)	Remarks
D1146	214	at 200 rpm
D1146T	214	at 200 rpm
P086TI	214	at 200 rpm
P086T Power Up	214	at 200 rpm
P086TI Power Up	214	at 200 rpm
PU086	214	at 200 rpm
PU086T	214	at 200 rpm

REMOVAL OF NOZZLE

1. Assemble the cap nut and nozzle to the nozzle tester.
2. Remove the nozzle nut and components inside.

INSTALLATION NOZZLE

1. After removing carbon deposit, submerge the nozzle in diesel oil and clean it.
2. Replace all the gaskets with new ones.
3. Assemble the parts and tighten them to specified torque.

ADJUSTMENT NOZZLE

1. The cap nut and assemble a nozzle to a nozzle tester.
2. With the adjusting screw loosened, operate the nozzle 2 ~ 3 times to bleed it.
3. Operate the nozzle tester lever at the specified rate.
4. Adjust the injection pressure to the standard pressure using the adjusting screw.
5. After adjusting the injection pressure, tighten the cap nut to the specified torque.
6. Re-check the injection pressure and ensure the spray pattern is normal. the spray pattern should be uniform and free of spattering.

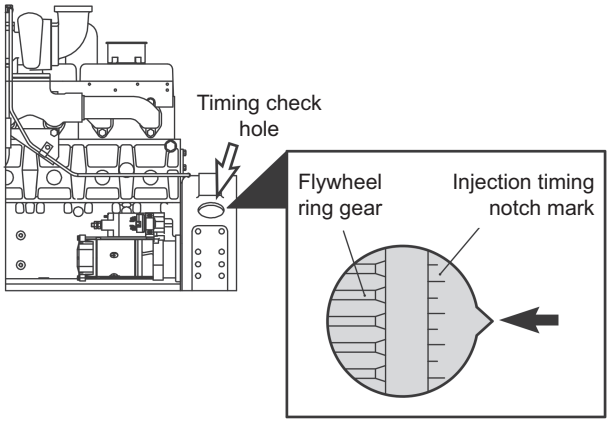
NOTE FOR CLEANING NOZZLE

- Clean nozzle body externally of soot and carbon. When cleaning several nozzles at the same time, make sure nozzle bodies and needles are not mixed up. Visually inspect needle and body.
- Do not clean the nozzle if the seat of the needle is indented or the pintle is damaged. If this occurs the nozzle should be replaced.
- Clean annular groove with scraper over full circumference. Wash out dislodged carbon deposits and dirt.
- Scrape needle seat with cleaning cutter. Dip cutter in test oil before use. The cutter can also be clamped in a lathe.
- Polish needle seat with wooden cleaning tool by chucking the needle in a lathe at the pintle end.
- Clean the spray holes of nozzles by chucking a cleaning needle of suitable diameter in the collet. If the carbon deposits in the spray holes cannot be removed by rotating and pressing, have the needle project only slightly from the collet and drive out the carbon by lightly tapping on the tool.
- Before reassembly thoroughly wash nozzle body and needle in clean test oil.
- Hold the needle at the pintle end only; to avoid corrosion do not touch the lapped surfaces of the needle with your fingers.
- Thoroughly clean all other parts of the nozzle holder with clean fuel.
- Check nozzle discharge pressure in the nozzle tester. The edge-type filter should not be pressed into the nozzle holder by more than approximately 5mm. If this depth is exceeded the injector must be replaced.

ADJUSTING INJECTION TIMING

1. Bring the piston of #1 cylinder to the compression TDC (OT) by turning the crankshaft. Again, turn 60° in the reverse direction of engine rotation.
2. Disassemble the fuel injection pipe that connects the fuel injection pump and #1 injection nozzle.
3. Disassemble the fuel injection pump delivery valve holder. After removing the valve and valve spring, assemble the valve holder. Finally, assemble the "U" shaped pipe.
4. Operating the priming pump of supply pump, turn the crankshaft slowly in the direction of engine rotation until the fuel drops at the rate of one drop every 6 ~8 sec.

5. Ensure the indication point at the flywheel housing inspection hole coincides with the specified injection angle. If the injection timing is not correct, adjust as follows.



EA9O5001

a) As shown in the above method, ensure the indication point at the flywheel housing's inspection hole and the flywheel's inspection angle coinside.

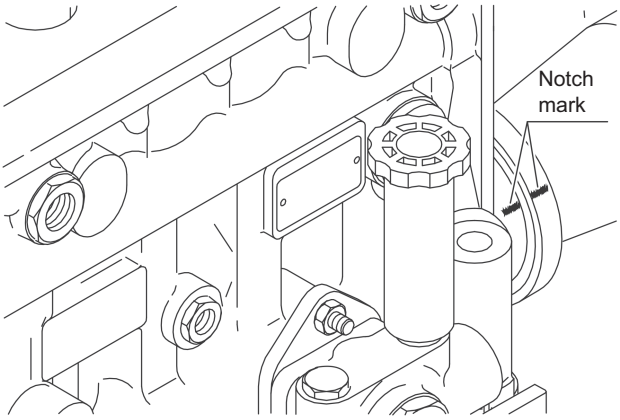
Engine Model	Injection timing	Remarks
D1146	18°	BTDC
D1146T	18°/12°	BTDC
P086TI	12°	BTDC
P086T Power Up	19°	BTDC
P086TI Power Up	14°	BTDC
PU086	18°	BTDC
PU086T	18°/12°	BTDC

b) Slightly loosen the drive gear fixing bolt of injection pump.

c) Slowly turn the coupling of the injection pump until the fuel drops from #1 plunger at the rate of one drop every 6 ~ 8 sec. Tighten the driving gear fixing bolt of the fuel pump.

6. After adjusting the injection timing, disassemble the "U" shape pipe and readjust the delivery valve and the valve spring.

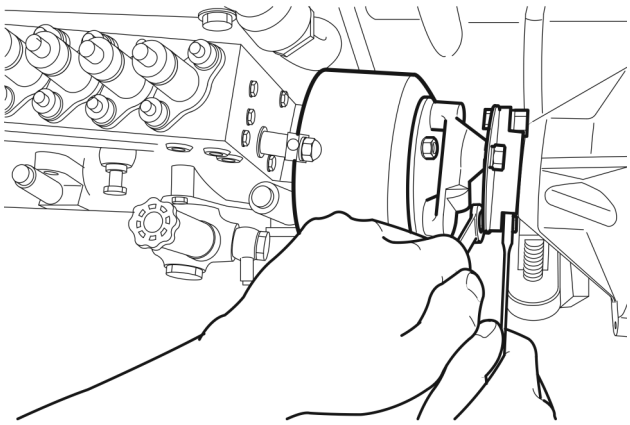
7. Turn the coupling until the notch mark of the indicator plate attached to the fuel injection pump is aligned with the notch mark of the coupling.



EA9O5002

8. Tighten the Coupling fixing bolts and nuts to the specified torque.

Torque	6.0 ~ 6.5 kgf·m

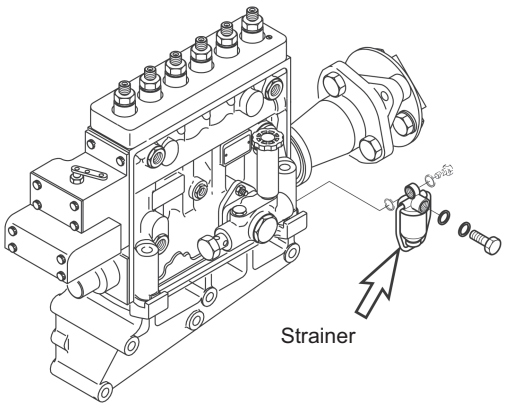

EAMD021I

9. Install the oil delivery pipe and return pipe.

PRIMING PUMP STRAINER CLEANING

1. Clean the priming pump strainer filter frequently.

2. The strainer filter is incorporated in the priming pump inlet side.



EA9O4004

INTAKE/EXHAUST SYSTEM

GENERAL INFORMATION

The air filter purifies dust and foreign substances included in the air and supplies clean air into the engine. The air filter is directly related to engine lifetime, emissions, and engine output. Periodically check, clean, and replace the air filter.

⚠ CAUTION

Do not operate the engine without the air filter.

Use specified air filters only. Using unauthorized or remanufactured air filters may result in critical faults.

Foreign substances in the engine may cause abrasion inside the engine.

Immediately exchange a damaged air filter with a new one.

Be careful not to let foreign substances flow into engine or damage the air filter related electric apparatus when replacing an air filter.

Be careful not to let dust inside when assembling the air filter.

AIR FILTER

- Air cleaner is mounted on the engine to purify the air for combustion.
- The intervals at which the air cleaner requires servicing depend on the specific operating conditions encountered.
- Clogged air filters may cause black smoke and reduce power.
- A check should be made from time to time to see that the fastening elements securing the air cleaner to the intake manifold seal the connection tightly.
- Any ingress of unfiltered air is liable to cause a high rate of cylinder and piston wear.

DISASSEMBLY OF AIR FILTER

⚠ DANGER

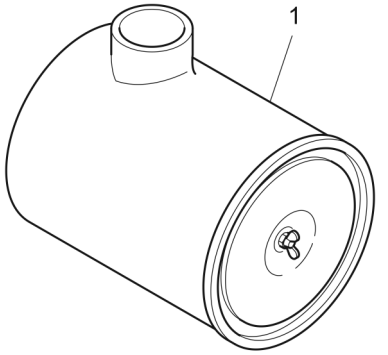
Only disassemble the air filter when the engine is stopped.

1. Empty the dust bucket periodically. The dust should not exceed half of the dust bucket capacity.

2. Disassemble the dust bucket by removing the two clamps. Remove the dust bucket cover and empty the dust inside.

3. Assemble the cover and dust bucket accurately with care.

4. For easy alignment, the cover has a dent and the dust collector has a protrusion. Here is the position where a filter is mounted horizontally, check the “TOP” mark on the air filter canister.



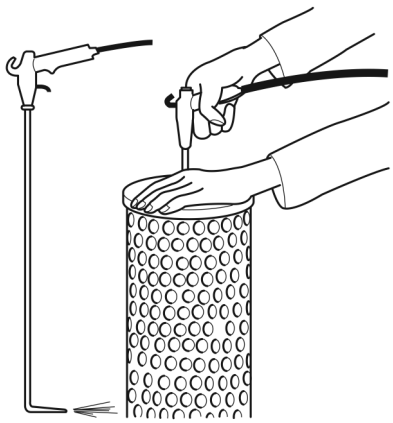
DV2213029A

1. Air cleaner assembly.

CLEANING OF THE AIR FILTER ELEMENT

Clean the air filter element by using the most suitable method for the work environment among the three methods stated below.

1. Use compressed air to clean the air filter element.



EDL022155A

a) Use an air gun at a 90° angle from the inside of the element.

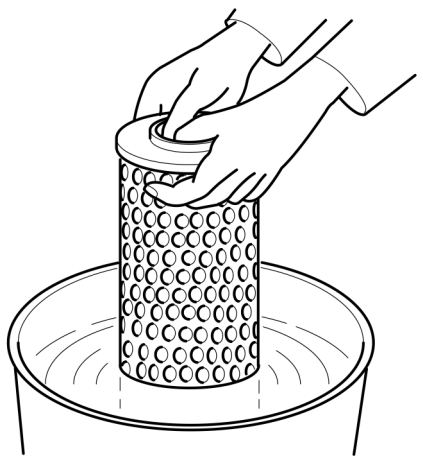
b) Move air gun up and down the element to blow air out through the element until there is no more dust in the element.

c) Do not use compressed air with pressure exceeding 5 bars.

⚠ DANGER

Always wear protective goggles before starting work in order to prevent injury from dust or foreign substances in the element.

2. Clean the element by washing it.



EDL022156A

a) Before washing the element, clean the element by using compressed air as described above.

b) Soak the element in the warm cleaning solvent for 10 minutes and then shake it back and forth for approximately 5 minutes.

c) Rinse the element with clean water, drain the water, and then dry it at room temperature. Fully dry the element before reassembling.

⚠ CAUTION

Never use steam spray, gasoline, alkali or hot cleansing solution to clean the element.

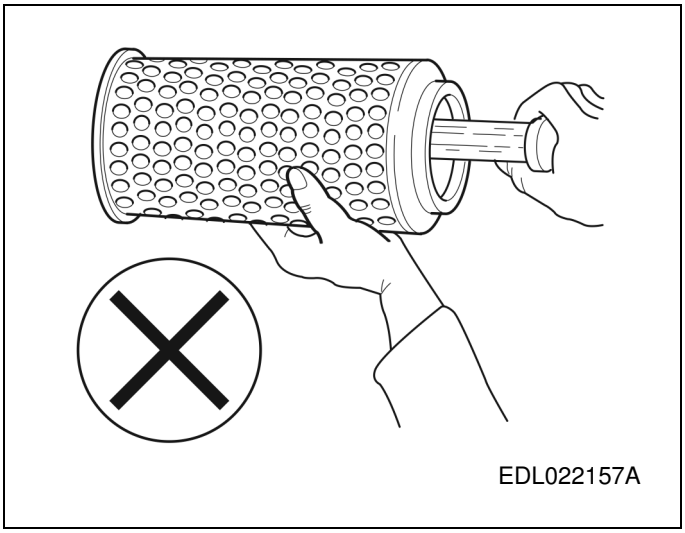
3. In an emergency, temporarily clean the element by using the following method.

a) Tap the end plate of the element to clean it temporarily.

⚠ CAUTION

This method should only be used in an emergency when cleaning of element is necessary and no compressed air or cleansing solution is available.

Under no circumstances should the surface of the element be hit or beaten with a hard object to shake the dust off.



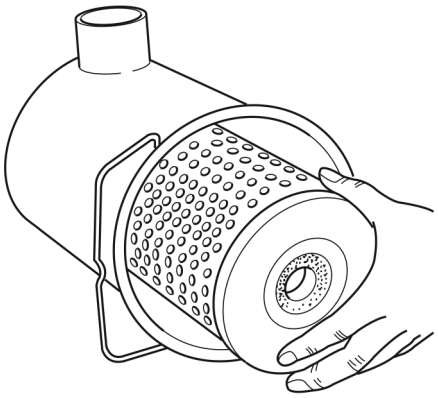
EDL022157A

NOTE: Before reassembling the element, make sure that the filter paper is not wrinkled, the state of rubber sealing is good, and the element is not deformed.

NOTE: Do not reuse damaged elements under and circumstances. When in doubt, replace the element with a new one.

CHANGING THE AIR FILTER ELEMENT

1. Remove the hex nut, remove the dirty element.



DV2213030A

2. Clean or replace with new element.

3. Clean the inside of the filter housing with a damp cloth.

4. Replace end cap.

⚠ DANGER

Do not let dust enter the end of air filter.

TURBOCHARGER

The Turbocharger does not need specific maintenance. When replacing the engine oil, check the oil pipe for leakage or clogging.

- Handle the air filter with special care to prevent foreign substances from getting in.

- The turbocharged compressed air and exhaust gas pipe should be checked periodically for air leakage. Any air leakage can cause the engine to overheat.

⚠ CAUTION

Be careful not to bend the turbocharged compressed air and exhaust gas pipe.

- If the impeller is severely contaminated, soak only the wheel in a solvent and clean it thoroughly with a rigid brush. Be sure to soak only impeller. The turbocharger should be supported by a bearing housing and not by an impeller.

ROUTINE CHECK AND SERVING THE TURBOCHARGER

The turbocharger performance is affected by the maintenance state of the engine. Regularly perform inspection and maintenance as specified in order to maintain turbocharger performance.

1. Intake system
   The air filter should be carefully managed. For a wet type air filter, the intake resistance should be as small as possible.

2. Exhaust system
   When exhaust gas leaks from the exhaust pipe or turbocharger joint, supercharging efficiency is lowered. Ensure there is no gas leakage as this can cause serious burns. Heat resistant nuts are used for parts which become hot during operation, such as the turbine seal. These nuts must not be mixed with other nuts. The screw burn prevention paint should be applied to the assembly nuts at the specified positions.

3. Fuel system
   If the spray status of the fuel injection nozzle is not good, or the injection timing is not correct, the exhaust gas temperature increases to give a negative impact on the turbocharger. Ensure that the nozzle is tested.

4. Lubrication system
   Ensure that the correct grade of oil is used and the oil filter cartridge is replaced according to the maintenance schedule. Degradation of engine oil has a negative effect on the turbocharger, as well as the engine body.

DISASSEMBLY AND CLEANING A TURBOCHARGER

The turbocharger can be removed from the engine to clean or inspect it. Be sure to seal the oil inlet and outlet with tape, etc.

CYLINDER BLOCK/HEAD

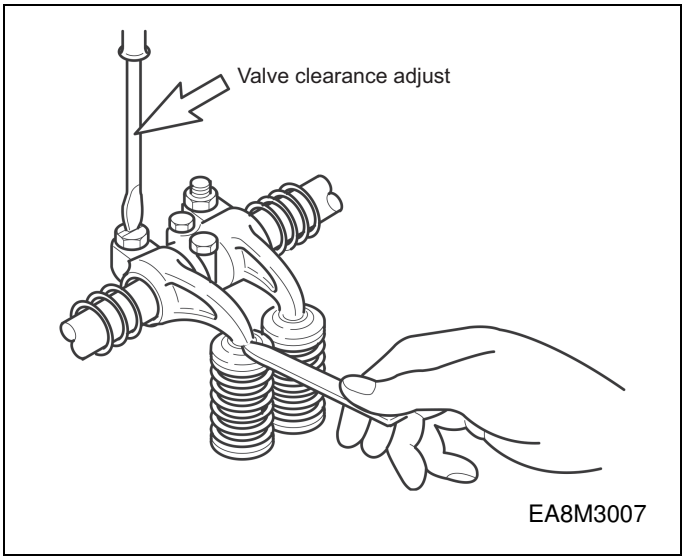
VALVE CLEARANCE

Adjust the valve clearance.

- When disassembling the engine or cylinder head.
- When there is excessive noise in the valve connection.
- When the engine runs abnormally even if the fuel injection system is normal.

HOW TO ADJUST THE VALVE CLEARANCE

1. Loosen the lock nuts of rocker arm adjusting screws.
2. Push the feeler gauge of specified value between a rocker arm and a valve stem (to measure the clearance of the valve and rocker arm contacting part).
3. Adjust the clearance with adjusting screw respectively and then tighten with the lock nut.

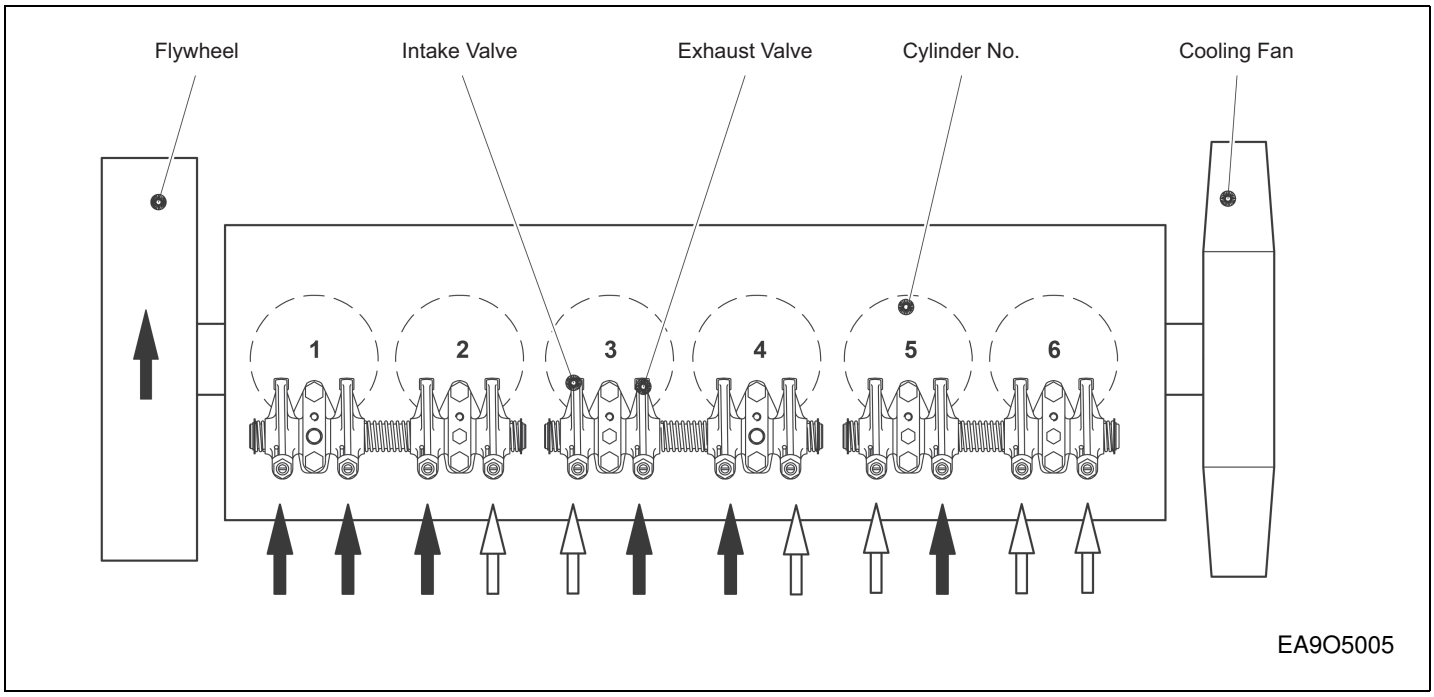


4. Adjust valve clearance with a feeler gauge and tighten the fixing nuts to the specified torque.

Torque	5.0 kgf·m

ADJUSTING THE VALVE CLEARANCE

Guide for valve clearance adjustment



1. Rotate the crankshaft so that #1. cylinder may be positioned at the compression TDC (Top Dead Center). Then adjust the valves corresponding to mark " • " in the below table.

NOTE: #1. cylinder is located at the side near the flywheel.

NOTE: #6. cylinder is positioned at the valve overlap when #1. cylinder is positioned at the compression TDC (Top Dead Center).

2. Rotate the crankshaft one rotation (360°) so that #6. cylinder may be positioned at the compression TDC (Top Dead Center). Then adjust the valves corresponding to mark " o " in the below table.

NOTE: #6. cylinder is located at the side near the cooling fan.

NOTE: #1. cylinder is positioned at the valve overlap when #6. cylinder is positioned at the compression TDC (Top Dead Center).

(I: Intake, E: Exhaust)

Cylinder No.	#1		#2		#3		#4		#5		#6	
	I	E	I	E	I	E	I	E	I	E	I	E
#1 TDC	•	•	•			•	•			•		
#6 TDC				o	o			o	o		o	o

3. Only adjust the valve clearance when the engine is cold.

Engine Model	Intake Valve (mm)	Exhaust Valve (mm)
D1146	0.3	0.3
D1146T	0.3	0.3
P086TI	0.3	0.3
P086T Power Up	0.3	0.3
P086TI Power Up	0.3	0.3
PU086	0.3	0.3
PU086T	0.3	0.3

⚠ CAUTION

Crankshaft revolution is done by hand without using a starting motor.

Turn it to the direction of engine rotation, but do not use the installing bolts at the turn.

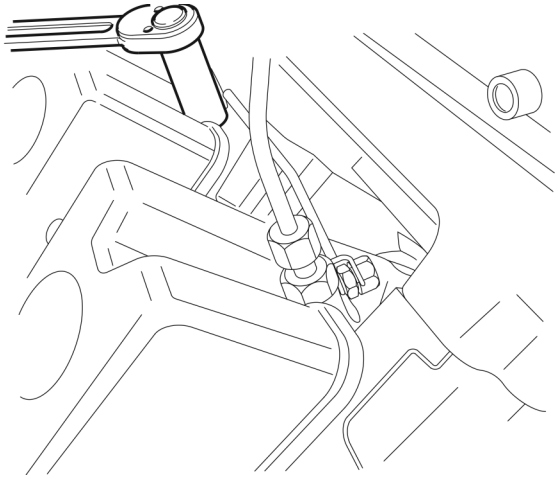
The cylinder no. and the order of intake and exhaust can be determined from the flywheel housing.

CYLINDER COMPRESSION PRESSURE

1. Start and warm up the engine.

2. Stop the engine and disassemble the fuel injection nozzle holder assembly.

3. Install a special tool, compression pressure gauge adapter in the fuel injection nozzle holder hole.

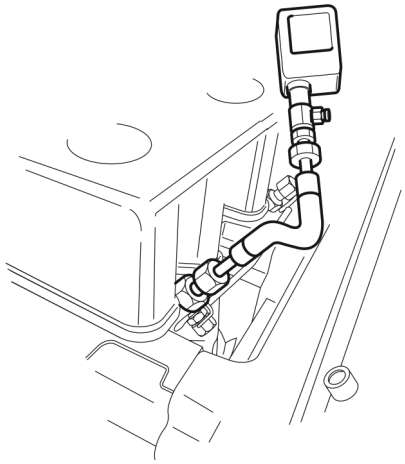


DV2213046A

4. Connect the compression pressure gauge to the adapter.

Standard	Above 28kg/cm^2
Tolerance limit	24kg/cm^2
Difference between each cylinder	Within ±10%

NOTE: Testing conditions: at water temperature of 20℃ and speed of 200 rpm (10 turns)



EA9O5004

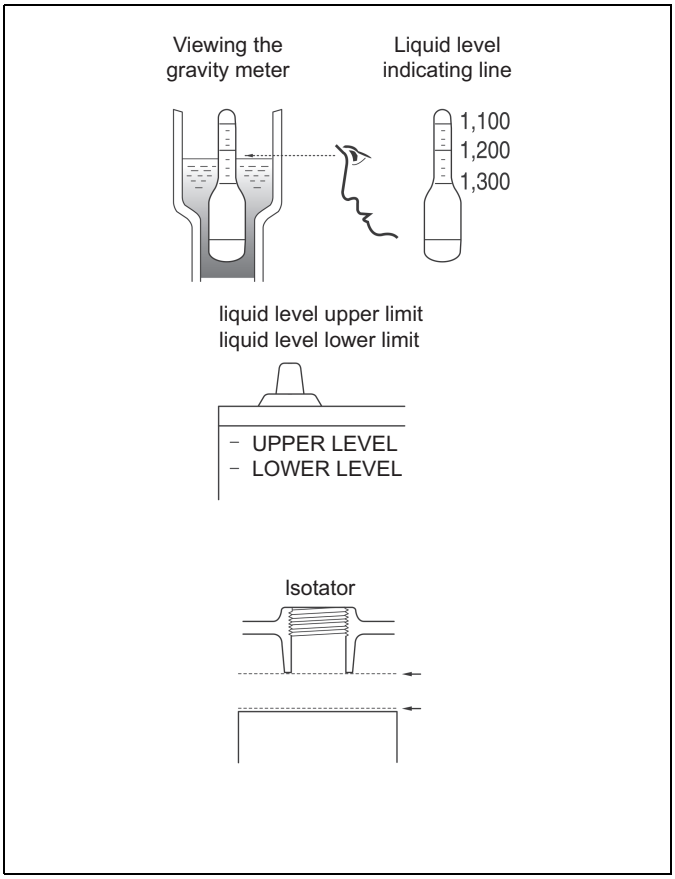
ELECTRICAL SYSTEM

BATTERY

- Check the battery for cracks and ensure there is no electrolyte leakage. Replace the battery if defective.

- Check the amount of electrolyte, and replenish distilled water if insufficient.

- Check the specific gravity of electrolyte. If it is below the specified value (1.12 ~ 1.28), replenish it.



STARTER

When servicing the engine, immerse the starter motor's pinion gear and ring gear in the fuel, wash them completely, and apply grease again. When cleaning the surrounding of engine, ensure that no water enters the starter.

⚠ CAUTION

Starter should be protected from humidity at all times.

Before working on the electric system, be sure to disconnect the ground wire ("-" minus wire) of the battery. Short circuit may occur while working on the electrical system. Reconnect the ground wire last after completing all of work.

OTHERS/DRIVING SYSTEM

V-BELT

The tension of the V-belts should be checked daily.

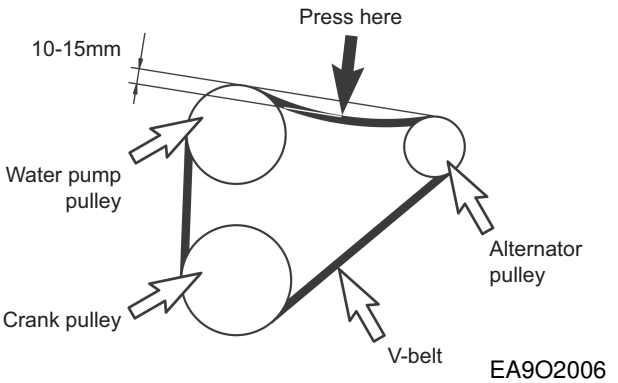
1. Change the V-belts if necessary.

   a) If wear or differing tensions are found in a multiple V-belt drive, always replace the complete set of V-belts.

2. Checking condition.

   a) Check V-belts for cracks, oil, overheating and wear.

3. Testing by hand.

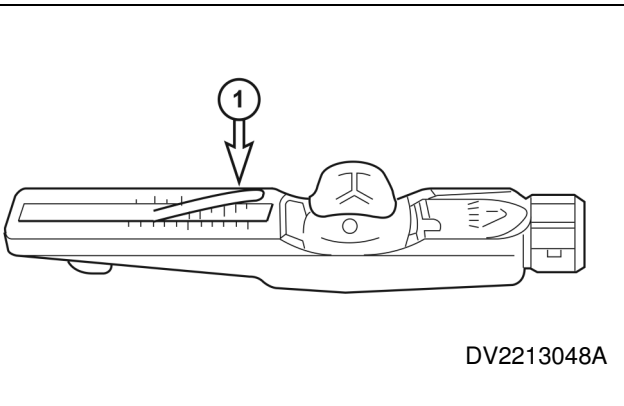


   a) Test the V-belt tension by pressing the V-belt in the centre between pulleys. 10~15mm deflection is normal.

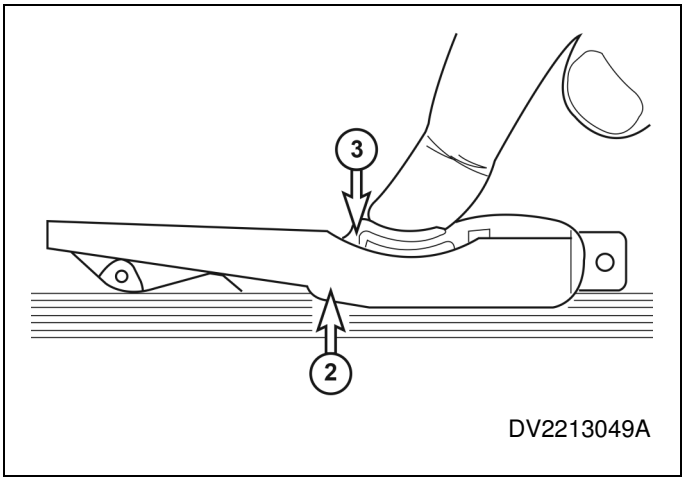
   b) To check the V-belt tension more accurately, use a V-belt tension gauge.

4. Tension measurement.

   a) Lower indicator arm (1) into the scale.



   b) Apply tester to belt at a point midway between two pulleys so that edge of contact surface (2) is flush with the V-belt.



   c) Slowly depress pad (3) until the spring can be heard to disengage. This will cause the indicator (1) to move upwards.

NOTE: If pressure is maintained after the spring has disengaged a false reading will be obtained.

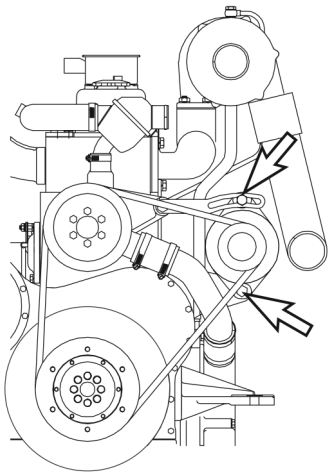
   d) Read the tension value at the point that the top surface of indicator arm(1) intersects with the scale.

   e) Before taking readings, ensure that the indicator arm remains in its position.

NOTE: If the value measured deviates from the setting value specified, the V-belt tension must be corrected according to the following table.

Type	Belt width (mm)	Tension from a Tension Meter		
		New belt (kg)		Replacement required
		Upon installation	After 10 minutes	
M	8.5	50	45	40
A	11.8	55	50	45
B	15.5	75	70	60
C	20.2	75	70	60
3V-2	18.8	90~100	70~80	60
3V-4	39.4	180~200	140~160	120
3V-6	60.0	270~300	210~240	180

5. Tension adjustment and V-belt replacement.



EA9O2007

a) Loosen fixing bolts and nuts.

b) Adjust the alternator until V-belts have correct tensions.

c) Tighten fixing bolts and nuts.

d) To change the V-belts loosen fixing bolts and nuts. Then push the alternator toward water pump pulley by hand.

ALTERNATOR INSTALLATION AND MAINTENANCE

CONTENTS

GENERAL SAFETY WARNING

The generators which are the subject of these “instructions” are components designed for use in industrial areas (machines/plants) and therefore cannot be treated as retail goods.

This documentation consequently contains information that is only suitable for use by qualified personnel. It must be used in compliance with the regulations, laws and technical Standards in force and cannot under any circumstances take the place of plant standards or additional prescriptions, including any which are not legally enforceable, which have been issued for the purpose of ensuring safety.

Machines built to customer specifications or with constructional differences may differ in detail from the generators described herein. If you encounter any difficulties please do not hesitate to contact Marelli Motori, specifying:

- The type of machine.
- The full code number of the generator.
- The serial number.

Some operations described in this manual are preceded with symbols that are added to alert for the possible risk of accidents. It is important to understand the following symbols.

Warning symbol for an operation capable of damaging or destroying the machine or surrounding equipment.

Warning symbol for general danger to personnel.

Warning symbol for electrical danger to personnel.

Electric rotating machines have dangerous parts: when operating they have live and rotating components.

Therefore:
- **improper use**
- **the removal of protective covers**
- **the disconnection of protection devices**
- **inadequate inspection and maintenance**

can result in severe personal injury or property damage.

The person responsible for safety must therefore ensure that the machine is transported, installed, operated, maintained and repaired by qualified personnel only, that must have:

- Specific training and experience.
- Knowledge of applicable standards and laws.
- Knowledge of the general safety regulations, national and local codes and plant requirements.
- The skill to recognise and avoid possible danger.

All maintenance and inspection operations must be carried out only with the authorisation of the person responsible for safety, with the machine at a standstill, disconnected from the supply (including the auxiliary circuits such as the anticondensation heaters).

As the electric machine is a product to be installed in industrial areas, **additional protective measures must be taken and assured by the person responsible for the installation, if stricter protection conditions are required.**

As the electric generator is a component to be coupled to another machine, it is the responsibility of the installing engineer to ensure, during operation, proper protection against the risk of contact with bare rotating parts and to prevent people or things from approaching the machine.

If the machine shows deviations from the normal performance (excessive or too low voltage, increase in temperature, noise and vibrations) promptly advise the personnel responsible for maintenance.

⚠ WARNING

Here enclosed with this "instructions manual" there are self-adhesive leaflets which are reporting symbols for security: the self-adhesive leaflets are to be applied to the generator surface, at the customer's charge, according the instructions presented on the sheet of the self-adhesive.

DESCRIPTION

These instructions refer to three-phase synchronous generators series MJB. Technical data and constructive details are given in the catalogue.

In order to obtain the proper working of the generator it is necessary to read carefully all included instructions.

The generators MJB are synchronous generators, brushless type, self-excited and self-regulated, manufactured according to the standards indicated on the name plate (IEC 34-1).

DEGREE OF PROTECTION - CHARACTERISTICS

The protection degree of the generators and the rated data are shown on the name plate. All necessary operations and interventions on this machine must be performed by a qualified technician.

FREQUENCY

⚠ WARNING

The generators are suitable for operation at 50 and 60 Hz, according to the data reported on the name-plate: for correct operation for 50 or for 60 Hz, it is necessary to verify that the settings of the voltage regulator are proper for the required operation and that the use of the generator is in accordance with the values on the name-plate.

ACCESSORIES

According to the customer's order the generators can be equipped with accessories, such as anti condensation heaters, thermistors, etc.

TRANSPORT AND STORAGE

The generator is shipped ready for installation. It should be carefully inspected on arrival in order to verify if damage has occurred during transport; if any, they should be referred directly to the haulier (writing one note on the document of transport) and to Marelli Motori if possible with photographic documentation.

⚠ WARNING

For lifting and handling the purpose made eyebolts must be used.
The lifting eyes are designed to support only the weight of the generator and they are not to be used for lifting the complete gen-set that incorporates the generator. Check that the lifting means available are suitable for the movement of all parts which have to be handled. Check also that all the working conditions are suitable to operate without dangers for safety of personnel.

The eyebolts on the end - shield are to the alignment of the generator during the phase of coupling to the engine.

Following are the weight of the generators:

Average weight of the generators (kg)						
Size	Pack length					
	SA4	SB4	SC4	MA4	MB4	LA4
MJB 160	120	130	140	165	175	~
MJB 200	205	215	~	260	300	~
MJB 225	305	335	~	370	~	405

If the generator is not put into operation immediately, it should be stored in a covered area or in a clean, dry and vibration-free place.

⚠ WARNING

For periods of inactivity of longer than three months, perform the tasks for "prolonged periods of storage" (available on request).

If it is stored in a damp environment, the windings should be dried before using it.

The rolling contact bearings do not require maintenance during storage; periodic rotation of the shaft will help to prevent contact corrosion and hardening of the grease.

INSTALLATION AND COMMISSIONING

CHECK BEFORE INSTALLATION

⚠ WARNING

Before installing the generator
- Make sure that name plate data corresponds to the power supply and operating conditions and that the installation complies with the manufacturer's recommendations.
- Clean any protecting varnish from all connecting surfaces (such as surface of couplings, flanges and shaft extension for two-bearing generators).

The single support generators come supplied with a bracket that holds together the coupling flange and the adapter flange or with a bolt that blocks the rotor to the non drive side endshield. Before installation, remove the bracket and/or the bolt.

Install the generator in a ventilated room. If installed in closed areas the alternators should have a possibility to exchange the cooling air directly with atmosphere. Air outlet and inlet openings should not be obstructed: provisions should be taken to prevent obstacles from obstructing ventilation openings. The inlet of warm air should be avoided.

Provision should be taken to make inspection and maintenance easy when the generator is installed or during operation.

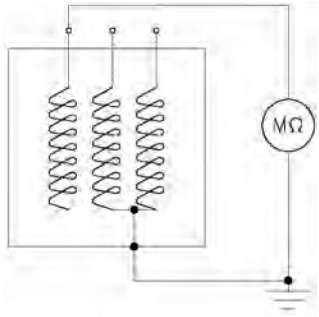
INSULATION TEST

On the premises of the constructor of the group, if the alternator has remained inactive for a long period of time (more than one month) it is opportune to execute an insulation test towards ground of the windings of the main stator, before putting it into service. Before executing this test, it is necessary to disconnect the connections leading to the regulation devices (Voltage regulator or other devices).

The insulation resistance of windings to heart should be measured using a suitable DC instrument ("Megger" instrument or a similar one), which output voltage (test voltage) is equal to 500 V for low voltage generators and not less than 1000 V for medium voltage generators. Reading of insulation resistance will be done after having applied Megger output for 1 minute to winding. For a new generator, the stator winding insulation resistance larger of 100 M Ohm represent one of the essential safety requirements.

⚠ DANGER

Do not touch power terminals during and immediately after the insulation resistance check because the winding is in voltage.



To measure the insulation resistance, proceed in the following way:

Concerning the windings of the **main stator (see diagram)**, the insulation resistance measurement must be conducted taking care to detach the connections leading to the regulation devices (voltage regulator or other devices) or to any other group devices. The measurement is taken between one phase and ground with the remaining two phases also connected to ground (the operation must be conducted on all three phases).

Concerning the **exciter-stator**, detach the + and – cables from the regulator and measure the insulation resistance between one of these two terminals of the winding and ground.

Concerning the **rotor windings**, measure the insulation resistance between one terminal of the winding of the main rotor on the rectifier bridge and the rotor ground (shaft).

The values measured are recorded. If in doubt, also measure the **polarisation index. (§ 4.8)**

In order to prevent risks of electric shock, connect the windings briefly to the ground immediately after measurement.

In order to be able to make a correct comparison of the measured insulation resistance values, they are referred to 20°C.

A correction coefficient is applied for different temperatures:

$$(R_{isol})_{20°C} = K_{c_{mis}} \left(\square^{T}_{R} \right)$$

Twinding (°C)	T	15	20	25	30	35	40
K correction	Kc	0.69	1	1.42	2	2.82	4

Example: Rmis = 50 M Ohms at the winding temperature of 30°C;
$(R_{isol})_{20°C} = K_c \cdot (R_{mis})_{30°C} = 2 \cdot 50 = 100$ M Ohms

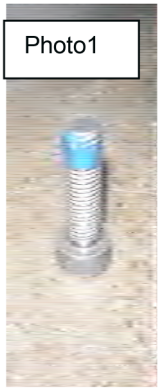
BALANCING

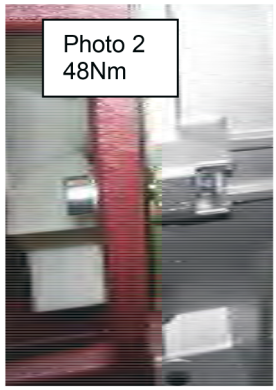
Unless otherwise indicated the rotor is balanced dynamically with a half-key fitted on the shaft extension, in compliance with IEC 34-14.

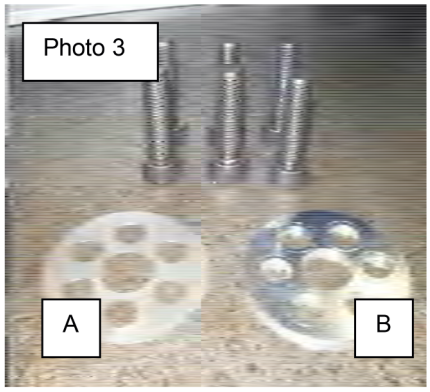
ASSEMBLY OF ADAPTORS AND DISCS FOR MJB 160

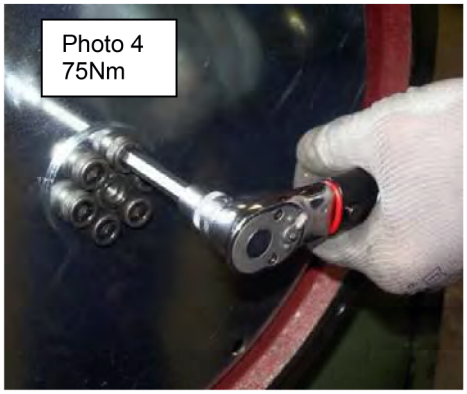
For the MJB 160 type only, in case the assembly of adaptors and discs is carried out directly on the shaft-end, proceed as follows:

- Deeply clean the machined surfaces for the coupling of the adaptor and frame, and make sure that they are not damaged.
- Fit the adaptor up on the frame with n°6 screws M 10X50 (cl 8.8), washers and nuts. Put on the screws some drops of LOCTITE® 243 (Photo 1), and cross tighten them through a 48Nm torque wrench (Photo 2).
- Deeply clean the shaft-end by means of a detergent.
- Make sure that the disc's contact surface is not damaged.
- Insert the spacer "A" in the shaft, the coupling disc and the washer "B". Tighten the parts with n°6 screws M10 class 12,9 supplied in the kit (picture 3), put on the screws some drops of LOCTITE® 243 (Photo 1), and cross-tighten them through a 75Nm torque wrench (Photo 4).









ALIGNMENT

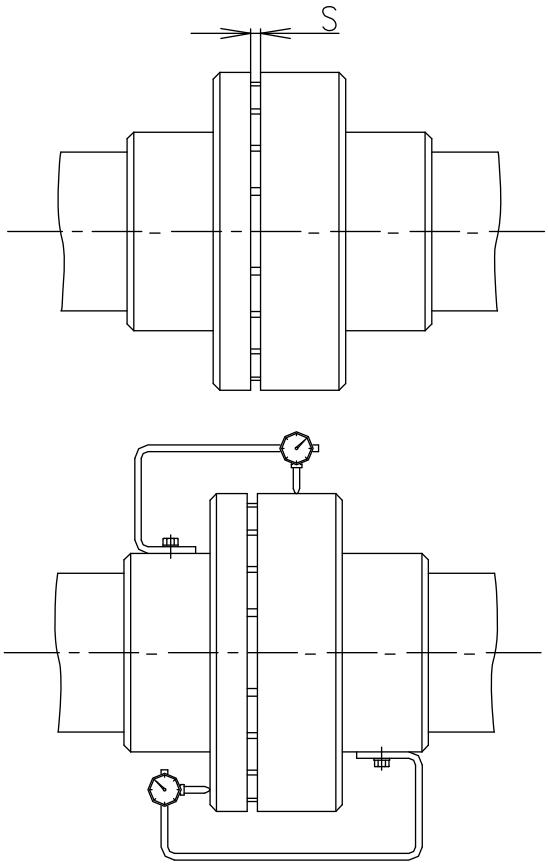
⚠ WARNING

Carefully align the generator and the driving machine. Inaccurate alignment may lead to vibrations and damage of the bearings.

It is also necessary to verify that the torsional characteristics of generator and driving machine are compatible. In order to allow torsional analysis calculation (at customer's charge); MarelliMotori can provide rotor drawings for torsional analysis purposes.

For single bearing generators it is further necessary to verify all dimensions of the flywheel and flywheel housing. Furthermore it is necessary to check the dimensions of the coupling and of the flange on the generator.

For double bearings generators, to check the alignment is necessary to verify with a thickness caliper that the distance “S” between the half-couplings is the same all the way around and check with a comparator or a rule that the external surface of the half-couplings are coaxial.



The check must be performed in 4 diametrically opposite points, the alignment errors should be in the limits stated by the coupling manufacturer and corrected by side displacement or using shims placed between the feet and the base. Always double-check alignment after tightening fixing bolts.

Perform the control of the vibrations of the generator installed in the group, with this latter operating both with and without a load.

ELECTRICAL CONNECTION

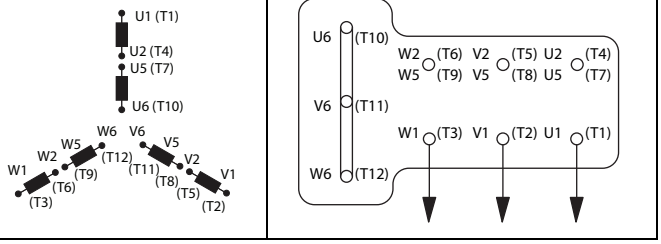
Standard generators are supplied with 12 leads (9 terminals).

The entry of the terminal cables in the terminal box is on the right (see to drive end). Entry on the left is possible after having moved the voltage regulator to the right.

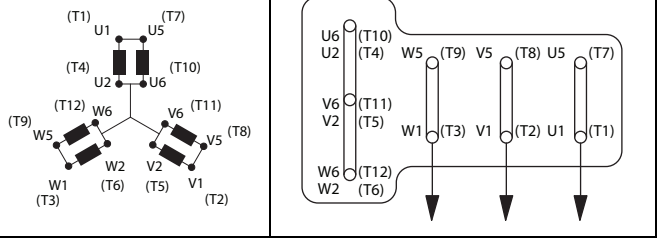
Terminals arrangement permits star series and star parallel connection: it is anyway necessary, when changing the connection from star series to star parallel, to check and modify the connection to the voltage regulator, according applicable diagrams.

Wiring diagram for standard generators

Star connection

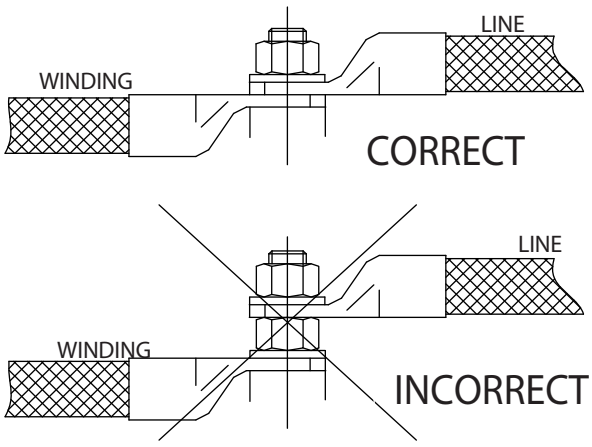


Star parallel connection



Internal connection diagrams are shown last pages for standard generators (12 leads, with AVR only).

The output cables have to be fixed to the terminal board as indicated in the following figure.



Direction of rotation

Generators are normally supplied to operate correctly when rotating clockwise (looking from shaft end side).

Grounding

DANGER

Inside the terminal box there is a terminal for grounding, and a second terminal is on a foot of the generator. Grounding has to be carried out using a copper wire of suitable size, in compliance with applicable standards.

SINGLE PHASE LOADS

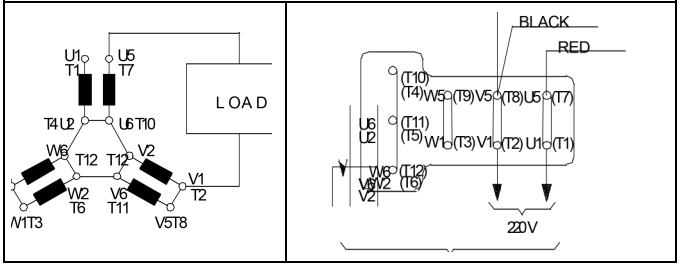
The standard three phase generators of this series can be used as single phase if the following instructions are followed:

The generator should be used for a maximum power equivalent to 0,6 times the power indicated on the nameplate for three phase load.

DANGER

The generator can be connected to star parallel (voltage of 220 Volt 50Hz or 220 – 240 Volt at 60 Hz) and single phase load should be connected to terminals U1/T1 and V1/T2.

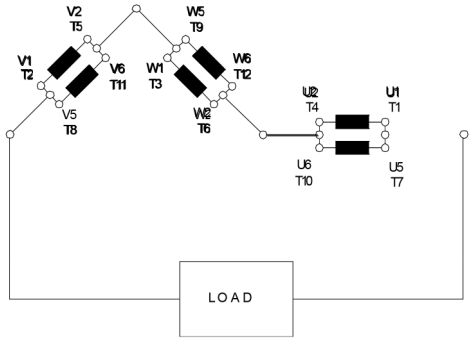
Star parallel connection

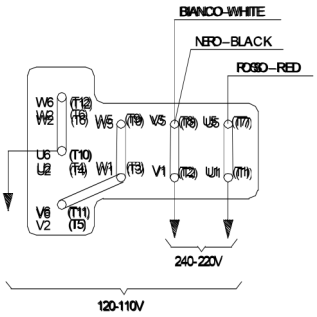


DANGER

The generator can also be connected to zig zag (voltage of 220 – 240 Volt 50Hz or 220 – 240 Volt at 60 Hz) and single phase load should be connected to terminals U1/T1 and V1/T2.

Connection zig–zag





Supply of leading loads only

It is possible to supply symmetrical leading three phase loads for a maximum (in KVAR) equivalent to 0,25 times the power (in KVA) indicated on the nameplate.

COMMISSIONING

Before putting into service it is necessary to check the insulation with a Megger at 500 Vdc after 1 minute of the application of the test voltage.

For a new generator, <u>the stator winding insulation resistance larger of 100 M Ohms</u> represent one of essential safety requirements.

DANGER

ALREADY OPERATING GENERATORS OR AFTER PROLONGED PERIODS OF INACTIVITY THE MACHINE MUST NOT BE OPERATED IF THE INSULATION RESISTANCE IS LESS THAN 30 M OHMS AT THE TEMPERATURE OF 20°. In this case, it is suggested to dry the winding previously to the generator star-up.

THE MACHINE MUST NOT BE OPERATED IF THE POLARISATION INDEX IS LESS THAN 1,5. (§ 4.8)
In order to prevent risks of electric shock, connect the windings briefly to the ground immediately after measurement.

BEFORE INITIAL START-UP, MAKE THE FOLLOWING CHECKS:

Mechanical checks - Verify that:

- Fixing bolts are securely fixed.
- The alignment and coupling is correct.
- The ventilation air is sufficient and that no impurities are drawn in.
- The protection grids are in place.
- For single bearing generators, the bolts of the disks are fixed with the correct torque.

Electrical checks - Verify that:

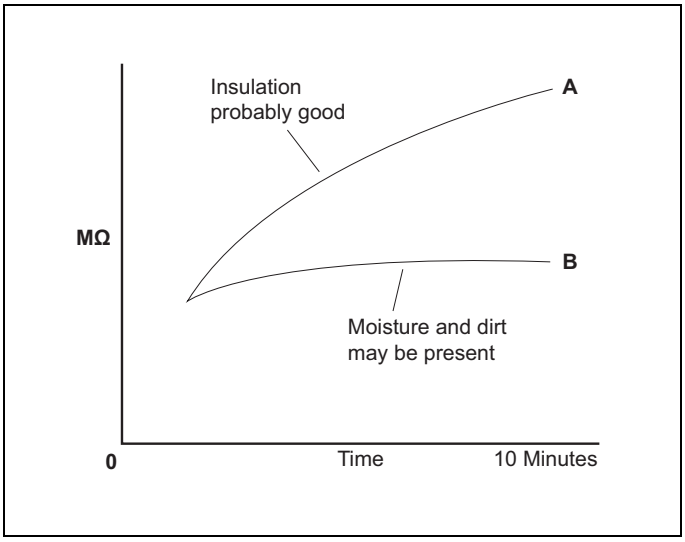
- The plant is provided with the correct electrical protection devices, according to applicable standards.
- That the connection to the terminal block is correctly performed (bolts of terminals properly tightened).
- That no misconnection or short-circuits are present between generator and external breakers: the generator is normally not protected against short circuits on the connection between generator and external breaker.

⚠ CAUTION

In order to avoid any damage to current transformers and to the generator, all current transformers installed on the generator have to be connected to proper loads: in case the current transformers were not used, they must be shortcircuited.

STATOR WINDING INSULATION CHECK THROUGH POLARIZATION INDEX

Qualitative insulation resistance versus time curves:



It is possible to check the generator insulation condition by measuring the polarization index, according to IEEE 43.

Execute the insulation resistance measure and insulation resistance registration at ambient temperature and in different times: T1', T2', …, T10'. Space the measures at regular time intervals (one minute for example).

Insulation resistances have to be measured leaving the 500V DC of "Megger" instrument applied for the full duration of 10 minutes.

The comparison between 10 minutes insulation resistance ($R_{isol20°C\ T10'}$) and 1 minute insulation resistance ($R_{isol20°C\ T1'}$) may be used to evaluate the condition of the machine winding insulation.

The ratio between those insulation resistances is called polarisation index (PI):

POLARISATION INDEX	INSULATION LEVEL	
$PI = \frac{R_{isol\ 20°c\ T10'}}{R_{isol\ 20°c\ T1'}}$	PI =1	Bad
	PI <1,5	Dangerous
	1,5 < PI < 2	Uncertain
	2 < PI < 3	Good
	PI > 3	Very good

The slope in insulation resistance versus time curve indicates the dryness and cleanliness of a winding.

Winding insulation could be considered GOOD if the diagram obtained is similar to the curve A.

Winding insulation could be considered UNSATISFACTORY if the diagram obtained is similar to the curve B. In that case insulation is affected by moisture or dirt and should be dried-out and cleaned.

REMOVAL OF MOISTURE FROM WINDINGS

An increase of insulation resistance between phase and earth is normally obtained by removing the moisture.

Several methods can be followed for this scope:

- **Stator winding drying by internal heat source.**

Heaters have to be distributed below the generator main winding stator.

- **Stator winding drying-out by self heating method.**

The stator can be heated with the circulation of low voltage DC current (i.e. obtained by an industrial welding set) through the windings.

A current of approximately 25% of the full load current, as marked on the generator rating plate, should be used.

If both phase terminals are available, generator winding can be re-connected to adjust its internal resistance, in order to suit the direct current supply available. A thermometer should be placed inside the stator windings.

Temperature should not be allowed to exceed **80°C**.

It may be useful to cover the machine to conserve the heat.

If possible, ensure that all openings on the frame are open. Openings if positioned on the top of the generator (i.e. removing terminal box cover or removing end shields for vertical constructions) can improve moisture escape.

- **Drying of stator with oven heating.**

Bring the oven to 110 – 150°C maximum. The drying of windings for generators **MJB 160 – 200 – 225** may take 2 - 4 hours depending on the starting condition insulation resistance.

If the insulation resistance doesn't reach at least the recommended value, it's possible that the cause is a solid contamination.

In this case, it will be necessary to clear the winding once more and then repeat the drying process.

MAINTENANCE

⚠ DANGER

For safety purposes it is necessary that any testing or maintenance carried out on electrical machine are performed by qualified and authorised personnel, and all operation must be performed when the machine is stopped, at ambient temperature and disconnected from any supply source (including the auxiliary circuits such as the anti-condensation heaters). Furthermore all measures must be taken to avoid restarting of gen-set during maintenance.

The environment in which the generator is put to work must be clean and dry.

In order to block the screws use Loctite® 243 thread-lock, ensuring that they are not dirty with oil/grease (if necessary use Loctite® 7063 or equivalent solvent).

⚠ CAUTION

In the case of electrical connections, the Loctite® must not cover the electrical contact surfaces!

INSPECTION AND MAINTENANCE INTERVALS

Inspection and maintenance should take into account the importance of the plant ambient conditions (dust etc.) and operating conditions.

As a general rule, the machine should be subjected to a first inspection after approx. 100 operating hours (in any case not more than 1 year) and subsequent inspections when performing maintenance on prime mover.

When performing inspection check that:

- The generator operates smoothly, without noise or irregular vibrations due to bearing deterioration.
- The operating data complies with that detailed on the rating plate.
- The air inlet openings are not obstructed.
- The supply cables show no signs of deterioration and connections are firmly tight.
- The electrical connections are in perfect condition (undamaged).
- Screws and nuts are firmly tightened.

For the above inspections it is not necessary to dismantle the generator, dismantling is only necessary when the bearings are cleaned or replaced and in that occasion the following additional checks are required:

- Alignment.
- Insulation resistance.
- Tightening of all fixing bolts, screws and nuts.

Particular inspections should be carried out at given time steps.

Operation and tasks	Daily	Every 2 Months 1000 hours	Every 4 Months 2000 hours	Every 12 Months 4500 hours	Check dedicated sections
Noise level	X				
Ventilation	X				
Vibrations		X			
Fastening of screw elements		X			
Terminals connections (terminal block,TA,TV,AVR)		X			
General clearness			X		
Full inspection				X	
Insulating resistance				X	
Bearing lubrication					X
Bearing replace					X

⚠ CAUTION

Any deviations or changes found during inspection must be corrected immediately.

MAINTENANCE OF BEARINGS

The lifetime of bearings is determined by multiple factors and specifically by:

- The lifetime of the grease.
- The environmental conditions and working temperature.
- The external loads and vibrations.

The bearings (D.E. and N.D.E. side) are prelubricated sealed type (life lubrication), with sufficient grease quantity for a long operating time.

The expected life time is, in case of normal operating condition, of approximately 30.000 hours for all bearings.

In case of complete overhaul of genset, the bearing of the generator should be changed.

DISMANTLING OPERATIONS

⚠ DANGER

Before dismantling the machine, examine the views in cross-section.

Check that the lifting means available are suitable for the movement of all parts which have to be handled.

Check also that all the working conditions are suitable to operate without dangers for safety of personnel.

On disassembly, mark the components if believed necessary, in order to identify their correct positions during successive assembly.

Then uncouple the generator from the prime mover, removing the bolts securing the flange and feet; remove the bolts fixing the coupling and disconnect the terminals of the power leads on the terminal board.

Next, remove the generator from the prime mover.

Disconnect the leads whites (+) and (-) connecting the exciter stator to the voltage regulator, and take the clamps off.

For two bearing generators:

- Remove the half coupling from shaft extension and remove the key (223).
- Remove the bolts fixing the shields (4-5) to the frame.
- Then remove the shields taking care to support the rotor in order that it will not fall heavily on the stator.
- Using proper lifting apparatus, remove the rotor (3) from the main stator, through the D.E. side, taking special care to avoid any damage to the windings.

FOR SINGLE BEARING GENERATORS:

For single bearing generators:

- Remove the bolts fixing the N.D.E. shield to the frame.
- Remove the shields taking care to support the rotor in order that it will not fall heavily on the stator. The rotor can be extracted from the stator, from D.E. side.

⚠ CAUTION

It should be remembered that the exciter stator is fixed to the N.D.E. shield: special care should be taken to avoid any damage to its windings when removing the N.D.E. shield; furthermore be sure the connections or the exciter stator are free to slide out from terminal box.

If a bearing needs to be replaced, remove it with a suitable puller or on the inner cover of the bearing (where present).

REASSEMBLY OPERATIONS

Carry out the operations described above for dismantling in reverse order.

- Place the pre-loading spring on the N.D.E. shield and apply grease.
- The fixing screws have to be fixed with LOCTITE type 243 (on the threaded surface).
- If a bearing was removed, always install a new one.
- To make assembly easier, the bearings should be heated to approximately 80 - 90°C.

⚠ CAUTION

Bearings should be assembled with the utmost care in order not to damage them.
If a locking element has to be replaced, make sure that the new one is of the same type and same resistance class of the original.

The following table indicates the tightening torques valid for locking screws and nuts:

Tightening torques in Nm					
Application	**Thread diameter**				
	M6	**M8**	**M10 (cl.8.8)**	**M10 (cl.12.9)**	**M12**
Fixing of electrical connections.	10	22	~	~	~
Fixing of screws in low strength material components (aluminium).	5	12	~	~	~
Fixing of components (shields, bearing caps, etc). Fixing of feet or flange.	11	26	48	~	85
Assembly of discs is carried out directly on the shaft-end (on MJB 160 only).	~	~	~	75	~

VOLTAGE REGULATORS

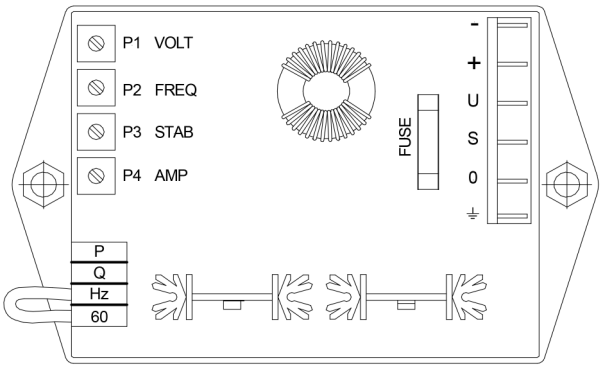
VOLTAGE REGULATOR "MARK V" (M16FA655A)

The generators are equipped with an automatic voltage regulator (AVR) MARK V.

The AVR is equipped with potentiometers to adapt the characteristics of the AVR to different operating conditions.

The AVR is equipped with adjustable stability circuitry to allow operations in a wide range of applications.

The AVR is equipped with a protecting circuit allowing the generator to operate underspeed if not loaded.



DANGER

It is not advisable to have the generator operating loaded when the frequency (speed) is below the rated value: this kind of operation is an overload for the whole generator excitation system.

Connection of AVR

The AVR is connected to the terminals of the generator and to exciter FAST-ON terminals.

Use of potentiometers

P1/VOLT- Potentiometer for adjusting the output voltage of the generator; it allows a wide range of voltage setting (i.e. between 350 and 470 V; or between 170 and 260 V depending on winding connections)). When resetting the potentiometer, the voltage has to be set in the range +5%,-5% around the rated voltage of the machine. In order to obtain a finer regulation, or to adjust the voltage from control panel or to limit the voltage range, it is possible to insert an external potentiometer.

⇒ increase voltage	⇒ decrease voltage

P2/FREQ - Potentiometer for changing the low speed protection. Usually it is set in order to reduce the excitation when the speed is 10 % below the rated value at 50 Hz. By removing the bridge which is normally shorting the auxilary terminals 60-Hz of the regulator, the low speed protection acts properly for 60 Hz.

⇒ increase frequency of intervention	⇒ decrease frequency of intervention

P3/STAB - Potentiometer for stability adjust. By rotating it clockwise the stability of the regulator increases,but the response time becomes longer.

⇒ increase response time, increase stability	⇒ decrease response time, decrease stability

P4/AMP - Potentiometer for chancing the overexcitation limit device. The overexcitation limit device helps to protect the excitation system. This device is delayed to avoid transitory conditions (in case of overexcitation).

⇒ increase response time, increase stability	⇒ decrease response time, decrease stability

CAUTION

In the workshop the potentiometer is set in the way the said limitation comes into operation only under extreme overexcitation.

Radio interference suppressor

The voltage regulator is internally provided with radio interference suppressor, in order to limit the radio interference from the generators MJB among levels stated by C.E. standards for industrial areas.

DANGER

Fuse - On the AVR there is a protecting fuse. Should it be necessary to replace it, high speed fuses should be used; in addition they should have high breaking resistance with a rated voltage of 500V, and rated current of 5A.

VOLTAGE REGULATOR "MARK I" (M40FA640A/A)

The instructions contained in the paragraph are refereed to the synchronous generators MJB supplied from the automatic voltage regulator (AVR) type "MARK I" (M40FA640A/A) rather than the regulator "MARK V" (M16FA655A). The voltage regulator MARK I is supplied ready for use with generators in parallel, functionality with the mains in parallel and when a three-phase reference when required.

The AVR is provided with potentiometers to adapt the characteristics of the AVR to the different operating conditions.

The AVR is provided with adjustable stability circuitry to allow operations in a wide range of applications.

The AVR is equipped also with protecting circuit allowing the generator to operate underspeed if not loaded.

DANGER

It is not advisable to have the generator operating loaded when the frequency (speed) is below the rated value: this kind of operation is an overload for the whole excitation system of the generator.

Radio interference suppressor

The voltage regulator is internally provided with radio interference suppressor, in order to limit the radio interference from the generators MJB to within levels stated by C.E. standards for industrial areas.

DANGER

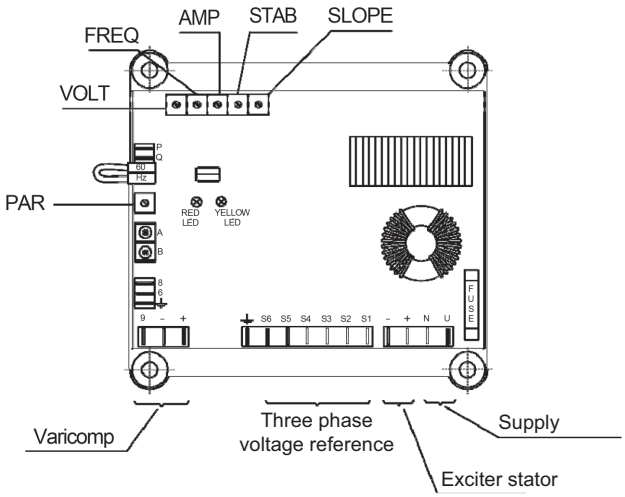
Fuse - On the AVR there is a protecting fuse. In case it should be necessary to replace it, high speed fuses should be used; in addition they should have high breaking resistance with a rated voltage of 500V, and rated current of 10A.

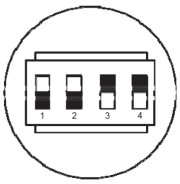
Connection of AVR

The AVR is connected to the terminals of the generator and to exciter using FAST-ON terminals.

DANGER

When changing generator wiring diagram, it is advisable to pay attention to connection of AVR, in order to avoid AVR damages.





mini switches 1-4

Use of potentiometers

VOLT - Potentiometer for adjusting the output voltage of the generator. It allows a wide range of voltage setting. In case of resetting this potentiometer the voltage has to be set within 5% of the rated voltage of the machine. It is possible to fit an external potentiometer in order to obtain finer regulation, adjust the voltage from the control panel or to limit the voltage range.

⇒ increase voltage	⇒ decrease voltage

FREQ - Potentiometer for changing the low speed protection. Usually it is set in order to reduce the excitation when the speed is 10 % below the rated value at 50 Hz. By removing the bridge which is normally shorting terminals “60-Hz”, the low speed protection acts properly for 60 Hz. In case of intervention, red led switch on.

⇒ decrease frequency of intervention	⇒ increase frequency of intervention

AMP - Potentiometer for chancing the over excitation limit device. This function is to limit the over-excitation due to particular load conditions that could cause the generator damage. As soon as the excitation voltage rises over a certain threshold, set by means of the potentiometer AMP, for a time larger than the limiter time delay, the over-excitation limiter steps-down the excitation voltage to the threshold value. Limiter time delay depends on the amount of the over-load; the limiter takes action more quickly when the overload is higher. Limiting the excitation voltage, the generator voltage decreases, either partially or fully, depending on the over-load. In case voltage shutdown is due to the limiter, it could not be maintained.

⚠ WARNING

Even if correctly set, this device does not substitute external systems protections, it is only an additional protective device.

⇒ increase the over excitation threshold	⇒ decrease the over excitation threshold

For a limiter setting, it is possible to momentarily disable the time delay, by means of the micro-switch 3 (see also the next paragraphs).

In order to properly set the limiter, apply the following procedure:

- When the generator is running at the rated speed, apply the maximum desired load;
- Select the OFF position for the micro-switch 3;
- Carefully rotate the potentiometer AMP counter-clockwise, until the yellow LED lights up and the generator voltage decreases to a stable value, lower than the rated voltage;
- Carefully rotate the AMP clockwise until the yellow LED switches-off; the generator voltage must recover the rated value.
- Select the ON position for the micro-switch 3.

If the procedure is properly carried out, the excitation voltage threshold is set to a value 15-20% higher than the excitation voltage at the maximum desired load, previously applied.

Time delay depends on the amount of the over-load occured; it can range from a minimum of 10s to a maximum of several minutes.

⚠ CAUTION

In the workshop the potentiometer is set in the way the said limitation comes into operation only under extreme overexcitation.

STAB - Potentiometer for stability adjustment. By rotating it clockwise stability increases, but response time becomes larger.

⇒ increase response time, increase stability	⇒ decrease response time, decrease stability

USE OF MICRO SWITCHES

To change the stability characteristics of the regulator, it is possible to use the microswitches. In such a way it is possible to insert capacitors on electronic stability circuit, then obtaining step changes in the transient response of the regulator.

dip 1

pos.ON ⇒	transient response becomes faster

dip 2

pos.ON ⇒	transient response becomes faster

dip 3

pos.ON ⇒	Proper setting of the excitation limiter IT MUST ALWAYS BE KEPT IN ON POSITION
pos.OFF ⇒	Only for setting of the excitation limiter: it permits to disable the normal limiter time delay

dip 4

pos.ON ⇒	standard low speed protection
pos.OFF ⇒	proportional low speed protection V/f (see “SLOPE” potentiometer

SLOPE - Potentiometer for changing the slow speed protection characteristic slope. This potentiometer can increase or decrease the under speed ramp slope, and set the voltage droop for a fixed reduced speed. Setting with SLOPE is possible only with dip 4 OFF.

⇒ increase voltage	⇒ decrease voltage

PAR - Potentiometer for changing the droop in order to obtain a correct sharing of reactive power, when two or more generators are required to operate in parallel, it is necessary to verify that the no load voltage is the same, that the bridge between “A-B” is open and the voltage droop is the same for all generators when loaded. When this unit is inserted the output voltage should show a 4% voltage droop when passing from no load to full load 0.8 p.f. If the voltage is increasing as the load increases, it is necessary to reverse the leads of the current transformer at the terminals “A-B”. If necessary, the voltage droop can be reset by acting on the internal potentiometer. In single operation the terminals A and B have to be shorted.

⇒ increase droop	⇒ decrease droop

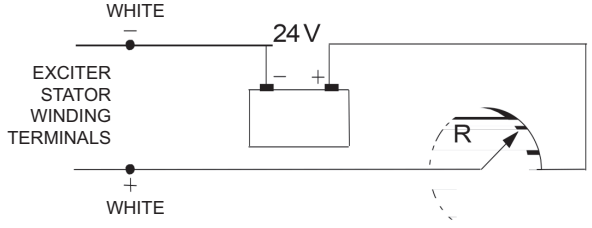
RHEOSTAT FOR REMOTE VOLTAGE SETTING

For all generators, that rheostat can be inserted between the auxiliary terminals P and Q (FAST-ON terminals). The external rheostat has to be inserted with its wiper in intermediate position and then the internal potentiometer of AVR (P1) has to be reset to obtain the nominal voltage. Rheostat features must be minimum rating 0,5 W, resistance approximately 100 k Ohm.

INSTRUCTIONS FOR MANUAL CONTROL OF GENERATORS

WARNING

If the voltage regulator (AVR) breaks down, a manual control system can be used, when a 24 V D.C. power supply is available.



This source could consist of a bank of batteries or of a voltage transformer and a rectifier unit connected at the alternator output.

- Disconnect the two exciter stator terminals (whites wire + and -) from AVR;
- Apply the D.C. power supply to these two wires;
- Set the rheostat R to adjust the alternator output voltage.

CAUTION

Compensate by manually increasing excitation as the load increases. Before removing the load, reduce the excitation current.

Use the following table to select the rheostat:

Generator	I max [A]	Max. resistance of rheostat [Ohms]
MJB 160 – 200 – 225	5	80

TROUBLE SHOOTING AND REPAIRS

ELECTRICAL ANOMALY

TROUBLE	POSSIBLE CAUSE	REMEDY DANGER (always to be done with the machine switched off - SAFETY HAZARD)
The alternator will not energise (no load voltage below 10% of rated voltage).	a) Loose connections. b) Rotating diodes or surge suppressor broken. c) Excitation circuit shorted or interrupted. d) Insufficient residual voltage.	a) Check and repair. b) Check the diodes and change in case they are open or short circuited. c) Check the continuity and repair. d) Apply for a while a 12 Volt battery voltage connecting the – terminal to – of AVR and + terminal to + of AVR by means of a diode.
The alternator will not energise (no load voltage 20-30% of rated voltage). Voltage insensitive to AVR potentiometer's rotation.	a) Fuse (on AVR's supply line) blown. b) Connection's cut on the exciter stator. c) Incorrect connections of exciter stator.	a) Replace the fuse with the spare. If the fuse blows again check if the exciter stator is short circuited. If everything is correct, change the AVR. b) Check the continuity and repair. c) Reverse the two wires from the exciter stator.
Voltage lower than rated (output voltage between 50 and 70%).	a) Speed less than rated. b) Voltage potentiometer unset. c) Fuse blown. d) Faulty regulator. e) Overexcitation limitation intervention.	a) Check rpm (frequency). b) Rotate the potentiometer until the voltage reaches the rated value. c) Replace the fuse with spare. d) Disconnect AVR and replace it. e) Re-set the potentiometer for excitation limitation (AMP).
Voltage too high.	a) Voltage potentiometer unset. b) Faulty regulator.	a) Rotate the potentiometer until the voltage reaches the rated value. b) Replace AVR.
Unstable voltage.	a) Diesel engine rpm variations. b) Stability potentiometer unset. c) Faulty regulator.	a) Check rpm uniformity. Check the diesel engine governor. b) Act on AVR's stability potentiometer. c) Replace AVR.

MECHANICAL ANOMALY

TROUBLE	POSSIBLE CAUSE	REMEDY **DANGER** **(always to be done with the machine switched off - SAFETY HAZARD)**
Winding temperature raised. Air cooling temperature raised.	a) High ambient temperature.	a) Ventilate in order to reduce the ambient temperature.
	b) Hot air reflow.	b) Create sufficient free space around to the machine.
	c) Source of heat in the proximity.	c) Remove the heat sources.
	d) Plant of defective cooling.	d) Inspect conditions system and correct assembly.
	e) Loopholes of the air obstructed.	e) Clean up the loopholes from eventual detritus.
	f) Air filter very dirty.	f) Clear or substitute the filter.
	g) Reduced air flow.	g) Remove the obstacles and assure that the air flow is enough.
	h) Speed less than rated.	h) Check rpm (frequency).
	i) Defective of measurement system.	i) Check the thermodetectors.
	j) Overload.	j) Eliminate the overload to cool the genset before restarting it.
	k) Load with cosfì below to 0,8.	k) Verify the values of the load, cosfì must be 0,8 or to reduce the load.
Noise, high vibrations.	a) Insufficient base structure or not suitable antivibration, incorrect fixing to the basement.	a) Strengthen the base, replace the antivibration, cross the screw again on the base.
	b) Defective coupling.	b) Review the alignment, the fixing of the disc on they fly motor and of the D-end shield on the first motor.
	c) Defective cooling fan, unbalanced rotor.	c) Check and repair the cooling fan, clean the rotor and rebalancing.
	d) Excess of unbalanced load, Single phase loads.	d) Check that the load is conforming to the requisite.
	e) Malfunctioning bearing.	e) Replace bearing.
Bearings temperature raised.	a) Malfunctioning bearing.	a) Replace bearing.
	b) Axial or radial load too high.	b) Check the alignment and check the coupling of the genset.

SPARE PARTS – NOMENCLATURE

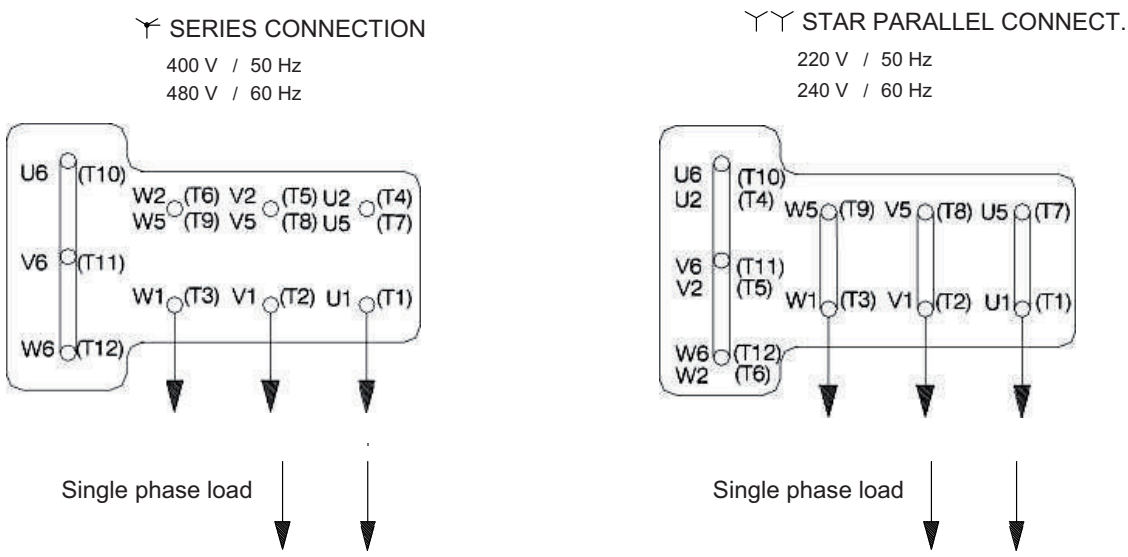
Pos.	Part name	Type / Code		
		MJB 160	**MJB 200**	**MJB 225**
201	D side (D:E) bearing	6310 2RS C3 / 346245050	6313 2RS C3 / 346245065	6215 2RS C3 / 346242075
202	N side (N.D.E.) bearing	6309 2RS C3 / 346245045		6311 2RS C3 / 346240055
6	Voltage regulator	MARK V M16FA655A		
7	Fuse (6.3x32 5A – 500V)	963823065		
309	Kit rotating diode (direct)	M16FA646A		M22FA703A
310	Kit rotating diode (inverse)	M16FA647A		M22FA704A
311	Surge suppressor	M16FA864A		
119	Complete rotating rectifier	M16FA648B		M22FA500B

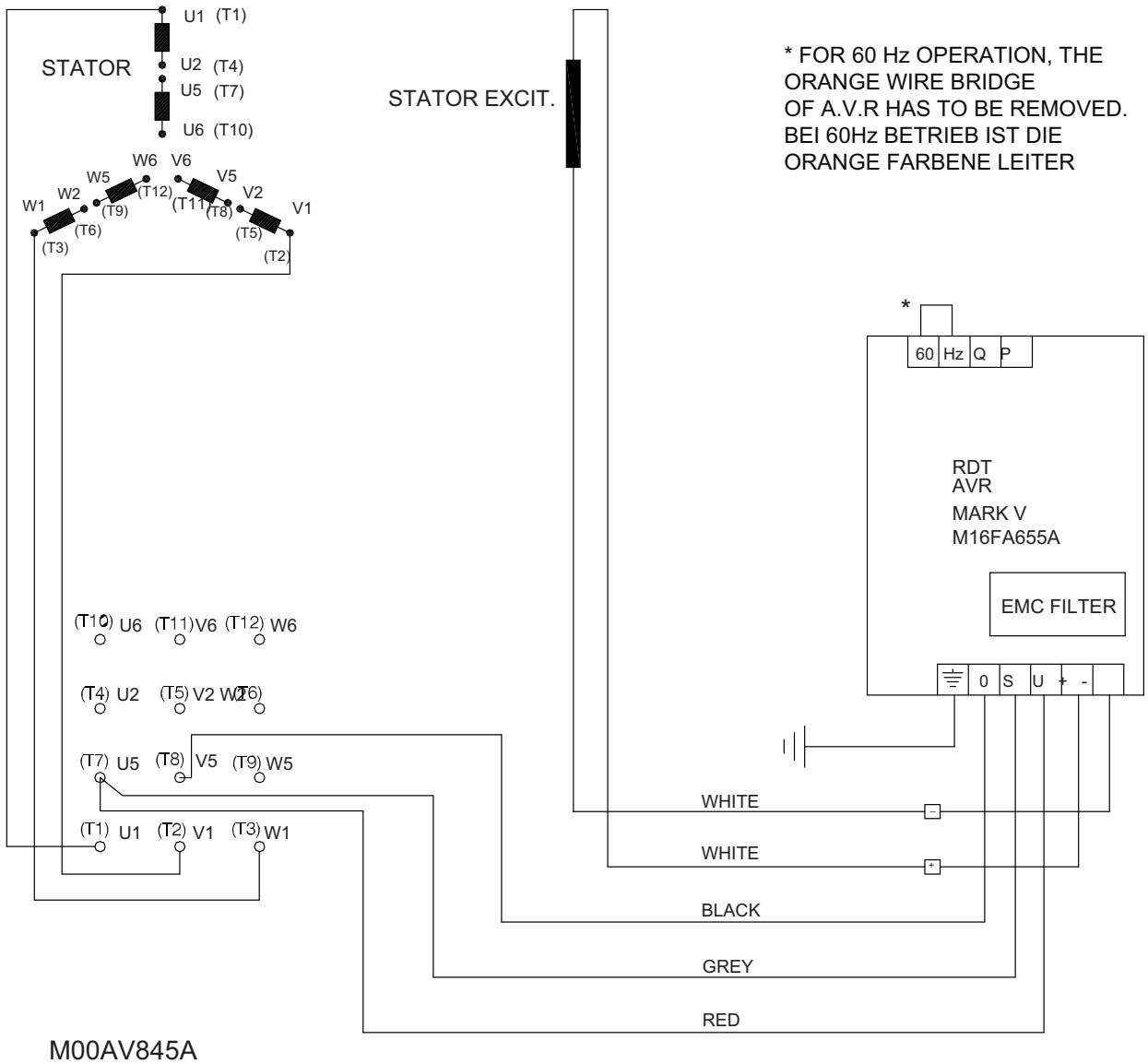
DISPOSAL

Packaging - All packaging materials are ecological and recyclable and must be treated in accordance with the regulations in force.

Generator to be scrapped - The generator is made of quality recyclabe materials. The municipal administration or the appropriate agency will supply addresses of the centers for the salvaging of the materials to be scrapped and instructions for the correct procedure.

WIRING DIAGRAM FOR 12 TERMINALS GENERATORS WITH AVR MARK V WITHOUT AUXILIARY WINDING.





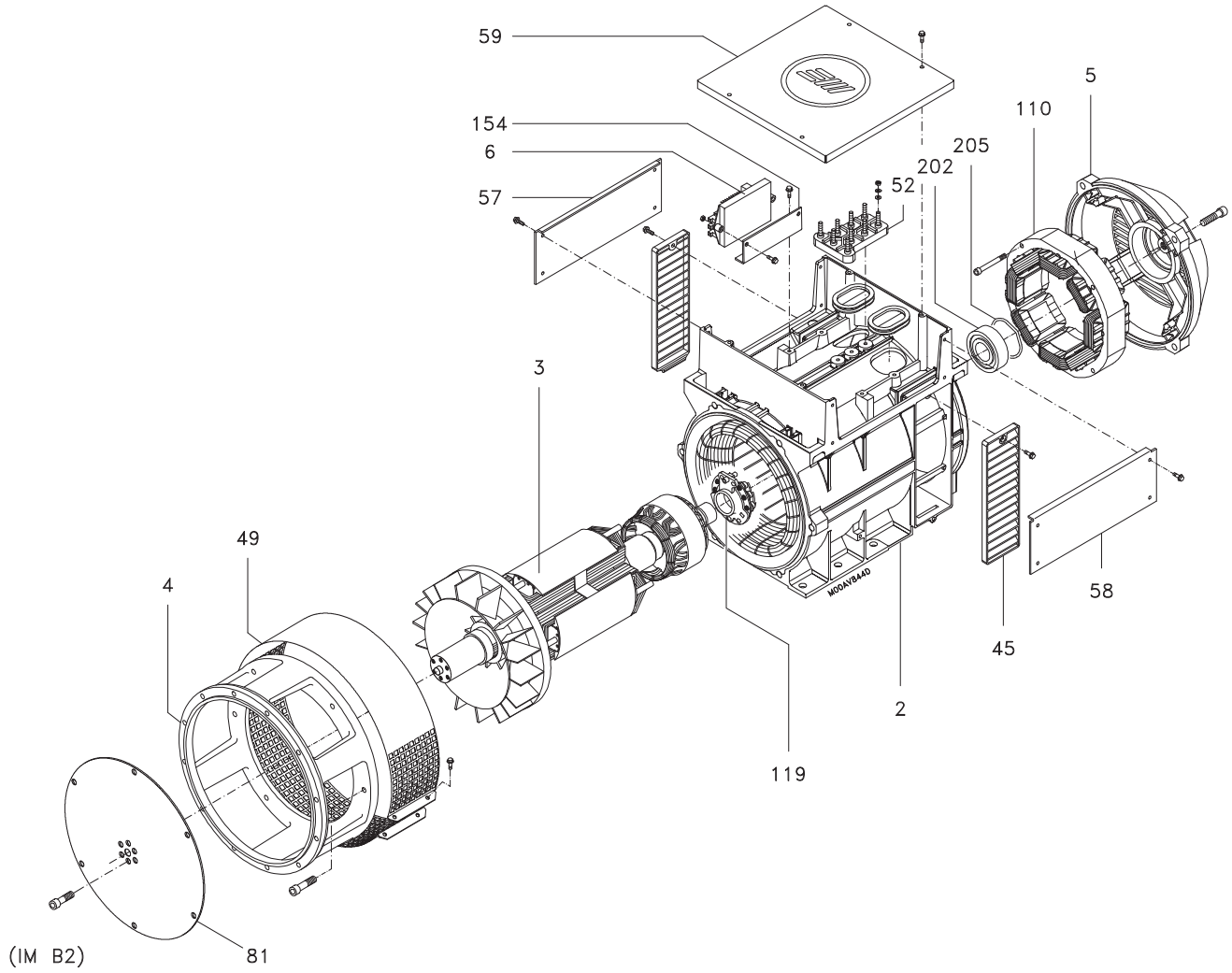
M00AV845A

ALTERNATORS COMPONENTS

CONTENTS

MJB 160 COMPACT

STANDARD CONFIGURATION



Delivered generators may differ in details from that illustrated.

COMMON COMPONENTS

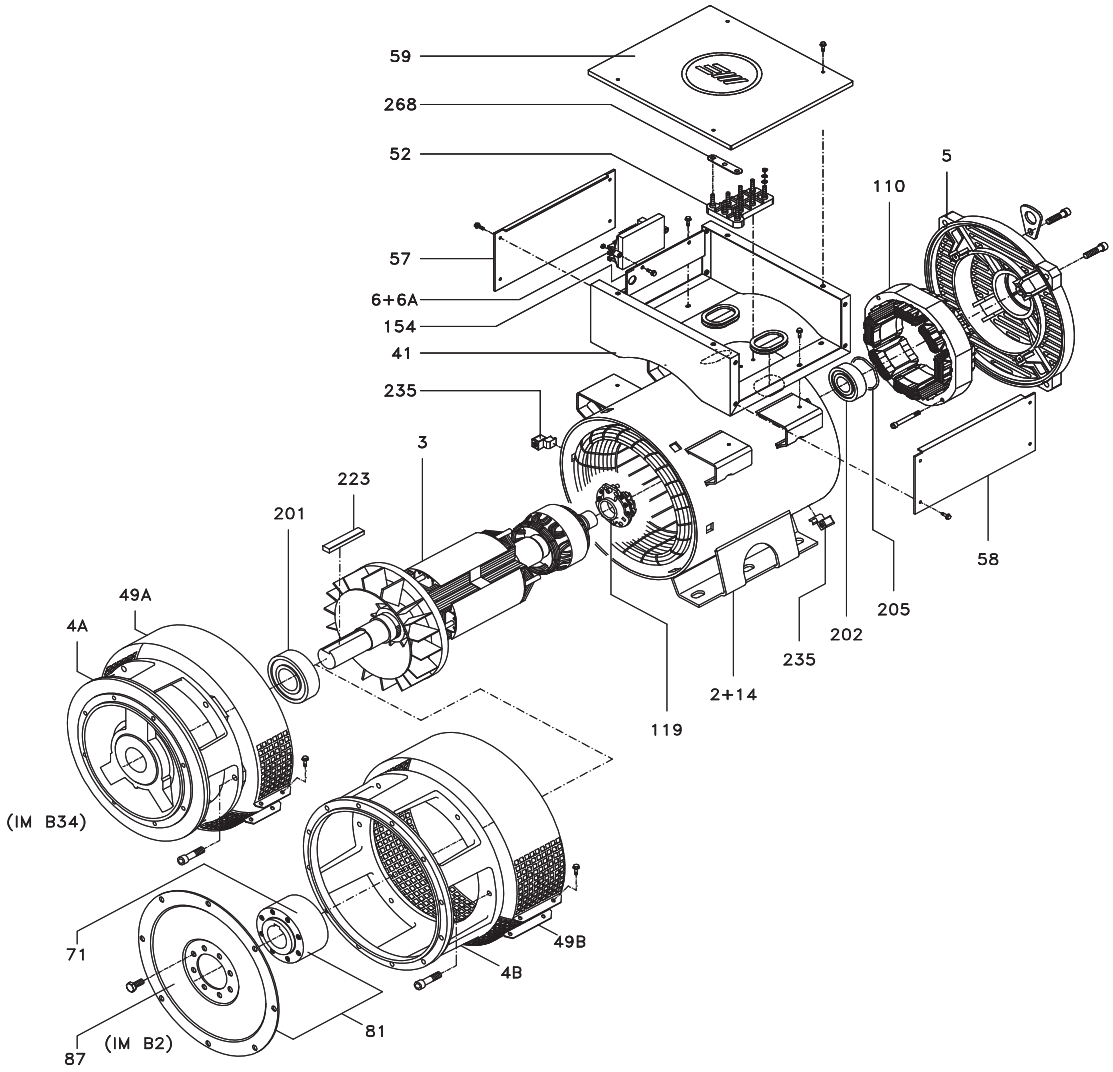
Item	Description
2	Housing with stator
3	Complete rotor
5	N.D.E. endshield
6	AVR
6A	Fuse
45	N.D.E. protective louvre
52	Terminal block
57	Side panel
58	Side panel
59	Terminal box cover
110	Exciter stator
119	Rotating rectifier
154	AVR bracket
202	N.D.E. bearing
205	N.D.E. preloading spring
268	Connection bridge
470	AVR connection cable kit

COMPONENTS FOR SINGLE BEARING COMPACT CONSTRUCTION

Item	Description
4	SAE adaptor
49	D.E. protective screen
81	Disc

D.E. = Drive end
N.D.E. = Non-drive end
AVR = Automatic Voltage Regulator

STANDARD CONFIGURATION



Delivered generators may differ in details from that illustrated.

COMMON COMPONENTS

Item	Description
2 + 14	Housing with stator
3	Complete rotor
5	N.D.E. endshield
6	AVR
6A	Fuse
41	Terminal box
52	Terminal block
57	Side panel
58	Side panel
59	Terminal box cover
110	Exciter stator
119	Rotating rectifier
154	AVR bracket
202	N.D.E. bearing
205	N.D.E. preloading spring
223	Key
235	Clamping block
268	Connection bridge
470	AVR connection cable kit

COMPONENTS FOR SINGLE BEARING COMPACT CONSTRUCTION

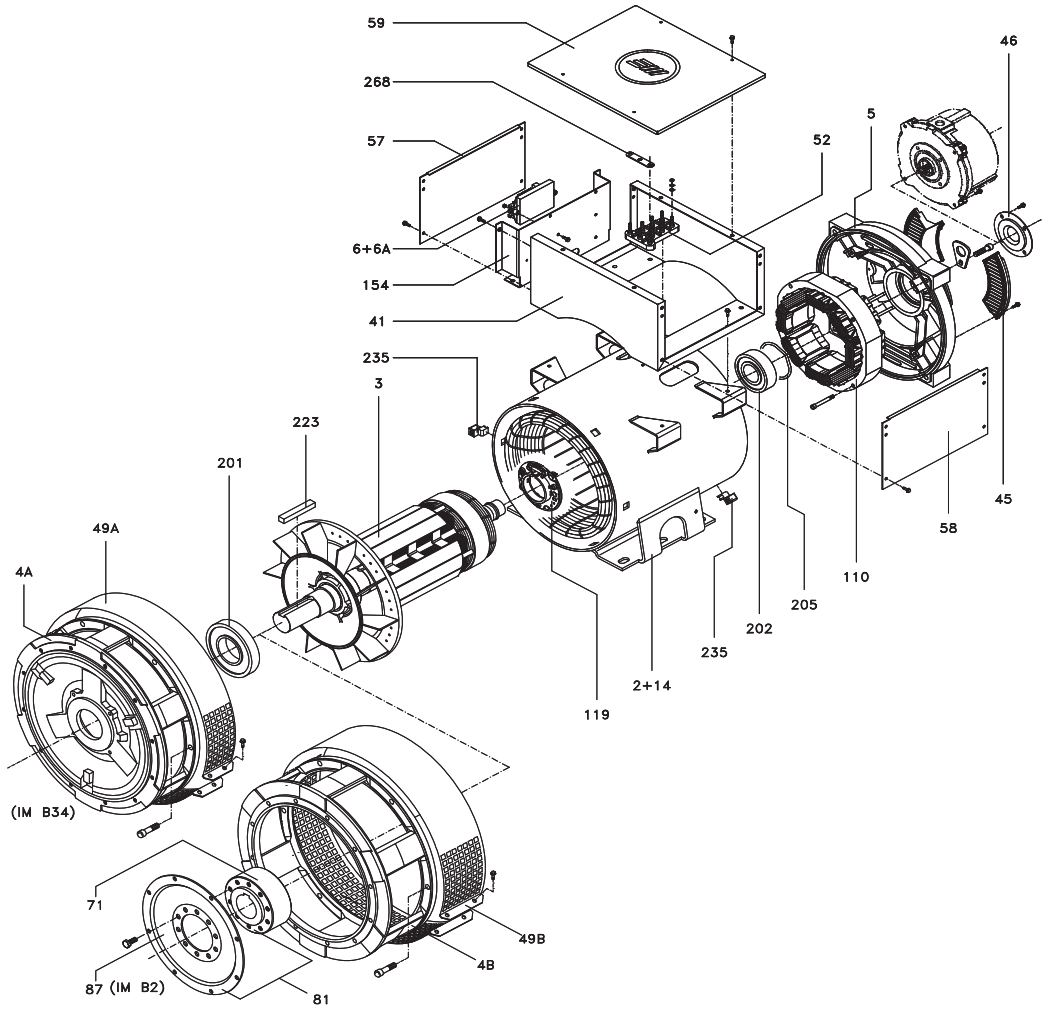
Item	Description
4B	SAE adaptor
49B	D.E. protective screen
71	Hub
81	Complete flexplate coupling (71 + 87)
87	Disc

COMPONENTS FOR DOUBLE BEARING CONSTRUCTION

Item	Description
4A	D.E. endshield
49A	D.E. protective screen
201	D.E. bearing

D.E. = Drive end
N.D.E. = Non-drive end
AVR = Automatic Voltage Regulator

STANDARD CONFIGURATION



Delivered generators may differ in details from that illustrated.

COMMON COMPONENTS

Item	Description
2 + 14	Housing with stator
3	Complete rotor
5	N.D.E. endshield
6	AVR
6A	Fuse
41	Terminal box
45	N.D.E. protective louvre
46	N.D.E. shaft cover
52	Terminal block
57	Side panel
58	Side panel
59	Terminal box cover
110	Exciter stator
119	Rotating rectifier
154	AVR bracket
202	N.D.E. bearing
205	N.D.E. preloading spring
223	Key
235	Clamping block
268	Connection bridge
470	AVR connection cable kit

COMPONENTS FOR SINGLE BEARING COMPACT CONSTRUCTION

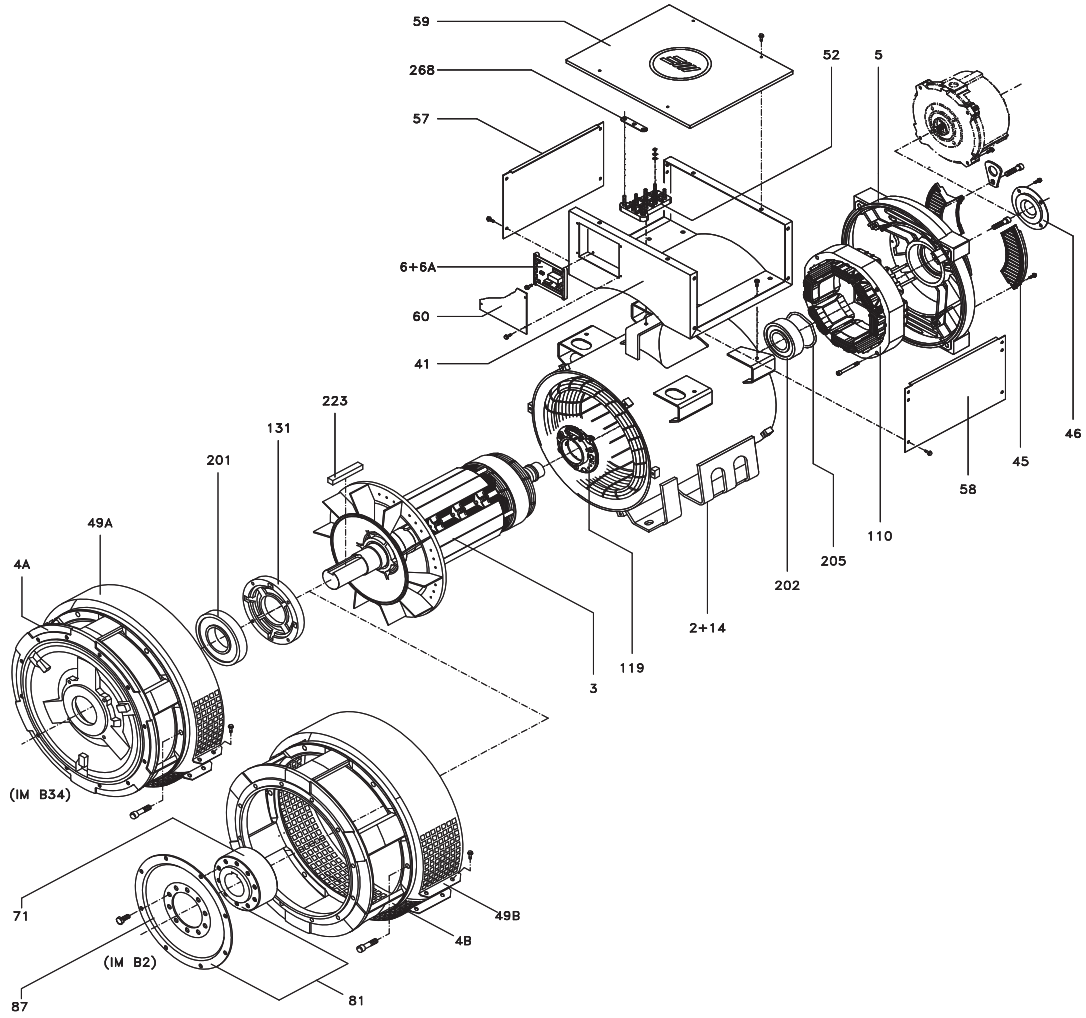
Item	Description
4B	SAE adaptor
49B	D.E. protective screen
71	Hub
81	Complete flexplate coupling (71 + 87)
87	Disc

COMPONENTS FOR DOUBLE BEARING CONSTRUCTION

Item	Description
4A	D.E. endshield
49A	D.E. protective screen
201	D.E. bearing

D.E. = Drive end
N.D.E. = Non-drive end
AVR = Automatic Voltage Regulator

STANDARD CONFIGURATION



Delivered generators may differ in details from that illustrated.

COMMON COMPONENTS

Item	Description
2 + 14	Housing with stator
3	Complete rotor
5	N.D.E. endshield
6	AVR
6A	Fuse
7	AVR connection cable kit
41	Terminal box
45	N.D.E. protective louvre
46	N.D.E. shaft cover
52	Terminal block
57	Side panel
58	Side panel
59	Terminal box cover
60	Regulation panel cover
61	Gasket for regulation panel cover
110	Exciter stator
119	Rotating rectifier
202	N.D.E. bearing
205	N.D.E. preloading spring
223	Key
268	Connection bridge

COMPONENTS FOR SINGLE BEARING COMPACT CONSTRUCTION

Item	Description
4B	SAE adaptor
49B	D.E. protective screen
71	Hub
81	Complete flexplate coupling (71 + 87)
87	Disc

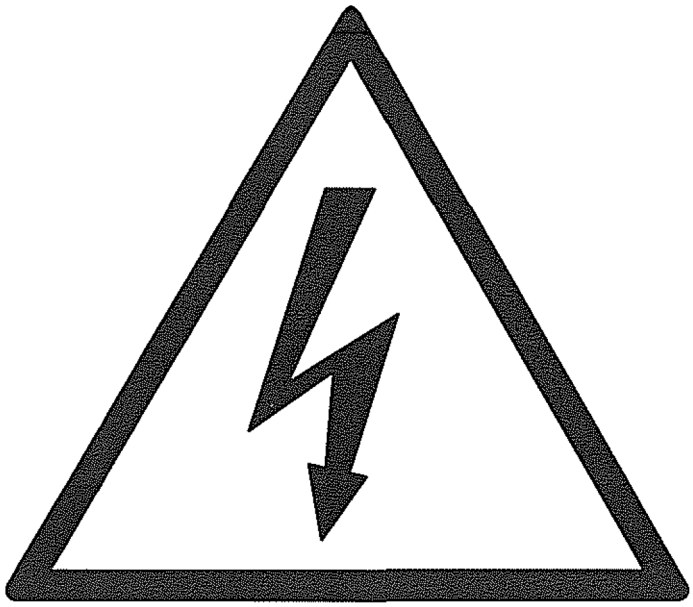
COMPONENTS FOR DOUBLE BEARING CONSTRUCTION

Item	Description
4A	D.E. endshield
49A	D.E. protective screen
131	D.E. inner bearing cap
201	D.E. bearing

D.E. = Drive end
N.D.E. = Non-drive end
AVR = Automatic Voltage Regulator

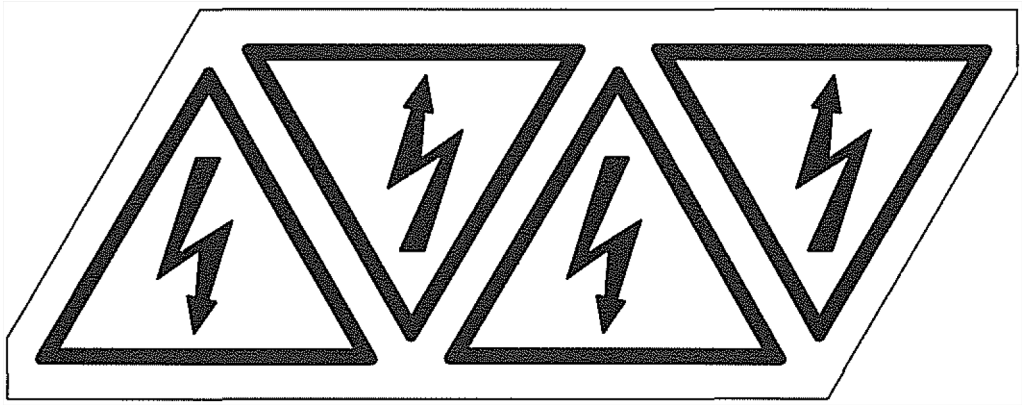
SELF-ADHESIVE WARNING LABELS

LABEL N°1

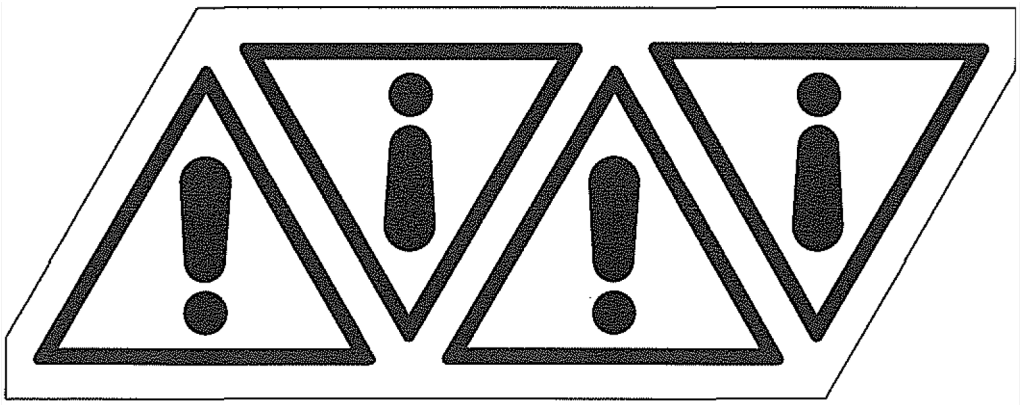


REFER TO INSTRUCTION MANUAL BEFORE REMOVING COVERS.

LABEL N°2

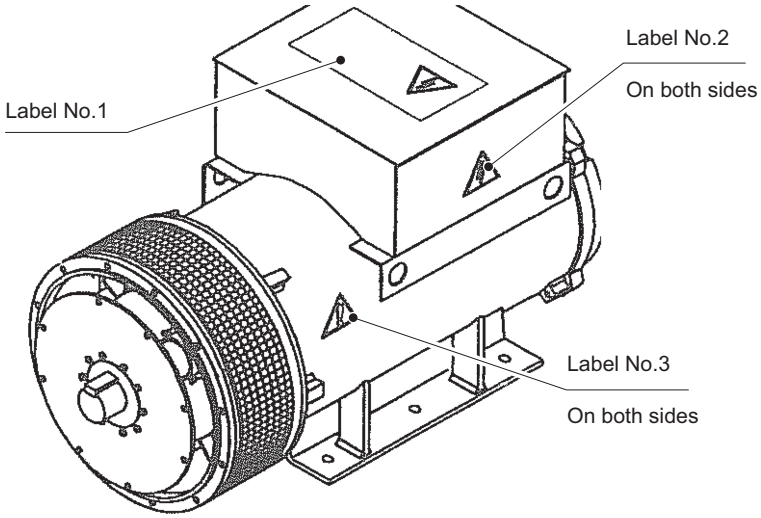


LABEL N°3

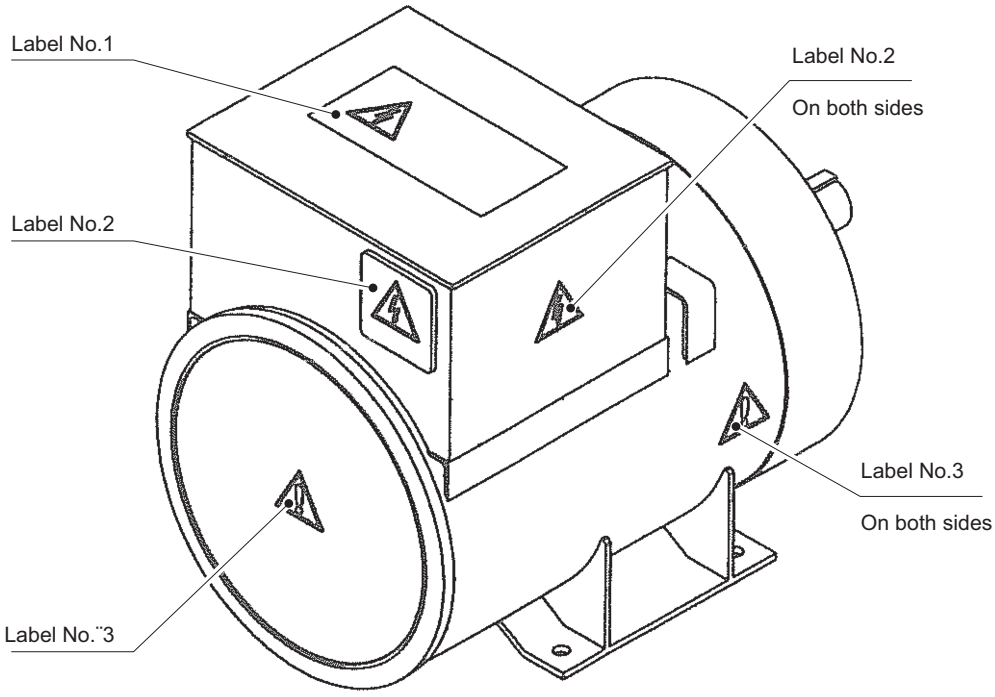


It is the responsibility of the set assembler to ensure that the self-adhesive warning labels provided are fitted to the generator, as follows.

FRAME SIZE 160 - 200



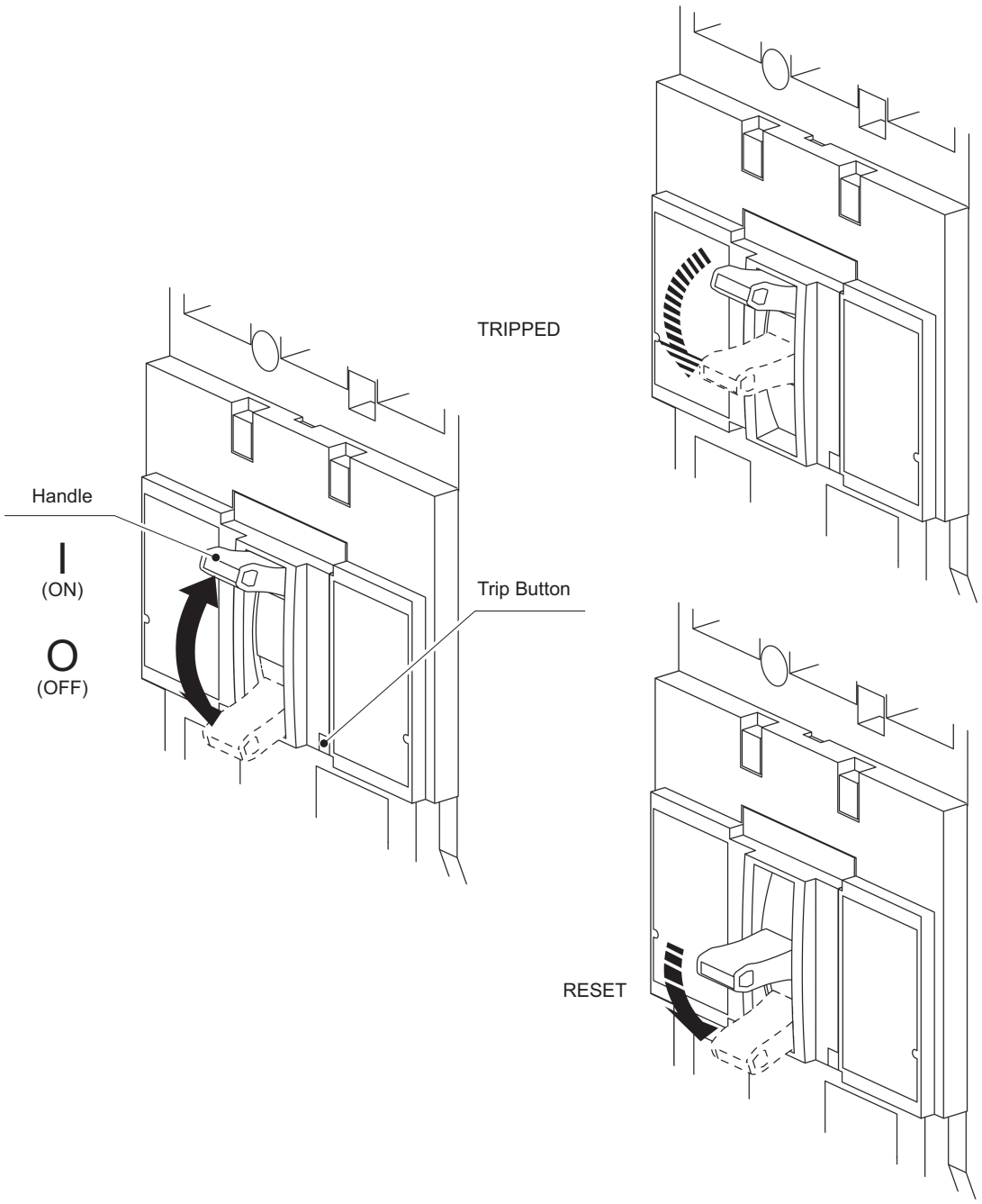
FRAME SIZE 250 - 315 - 400



Portable Power

MAIN BREAKER OPERATION

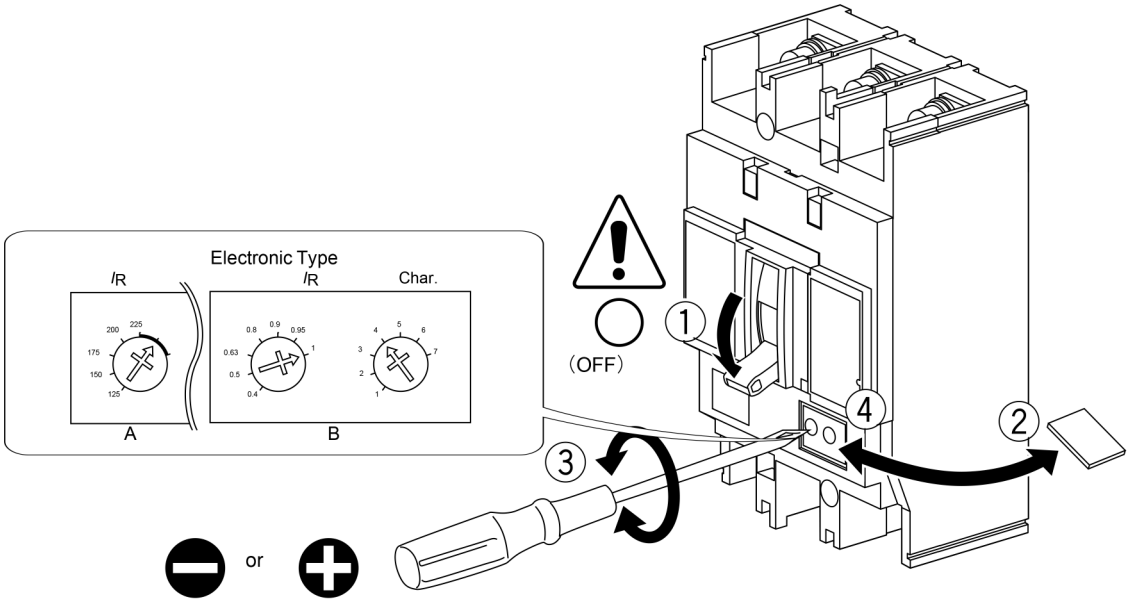
CONTENTS



	Operation	Operation effort
S160 - S250	○ (OFF)⇒ | (ON)	22N
	| (ON)⇒ ○ (OFF)	110N
	TRIP⇒ ○ (OFF)	28N
S400	○ (OFF)⇒ | (ON)	68N
	| (ON)⇒ ○ (OFF)	115N
	TRIP⇒ ○ (OFF)	125N

BREAKER ADJUSTING INSTRUCTIONS

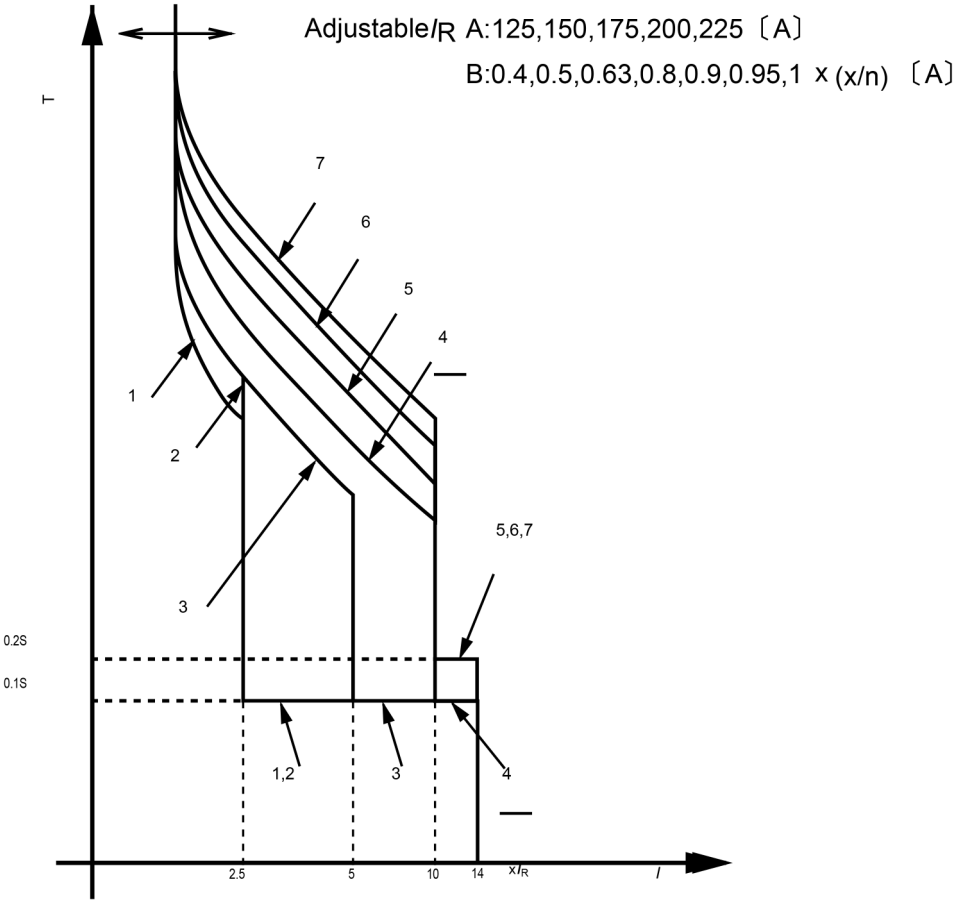
ELECTRONIC TYPE: S150 TO S250 SERIES



TIME / CURRENT CHARACTERISTIC CURVES

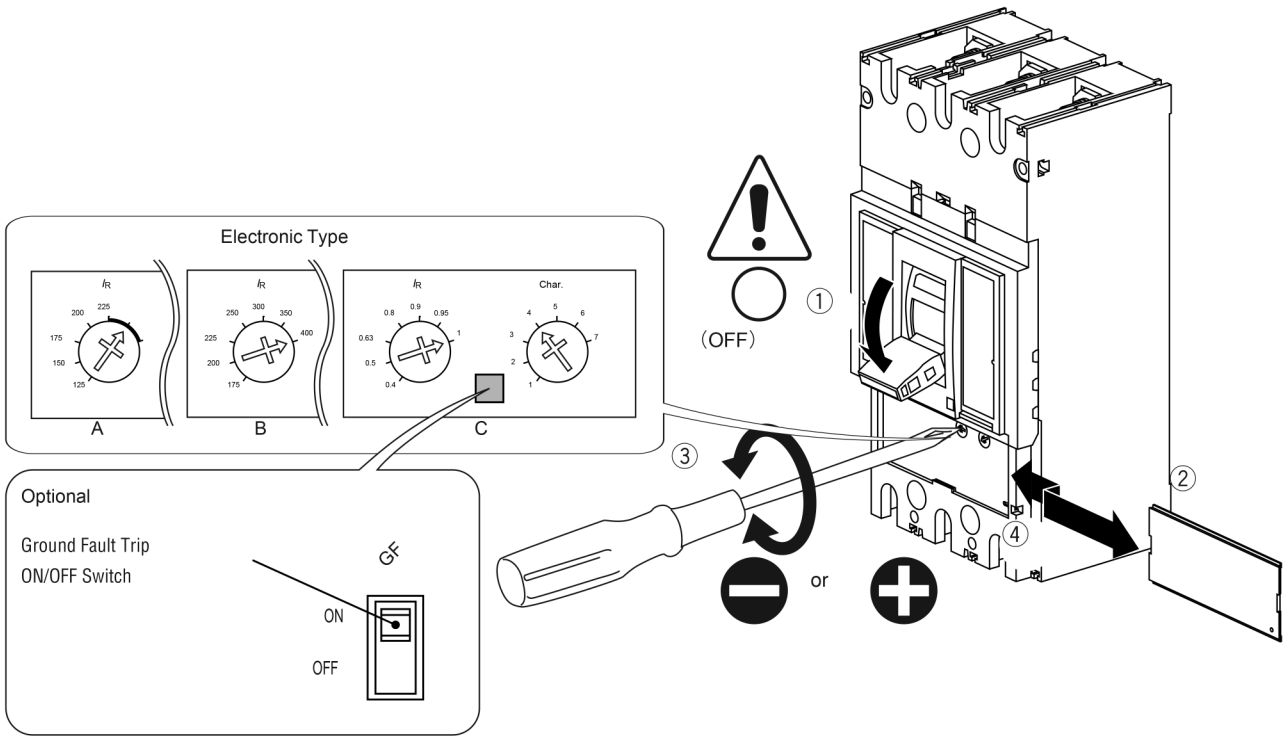
Under bar is default setting.

Electronic Type



BREAKER ADJUSTING INSTRUCTIONS

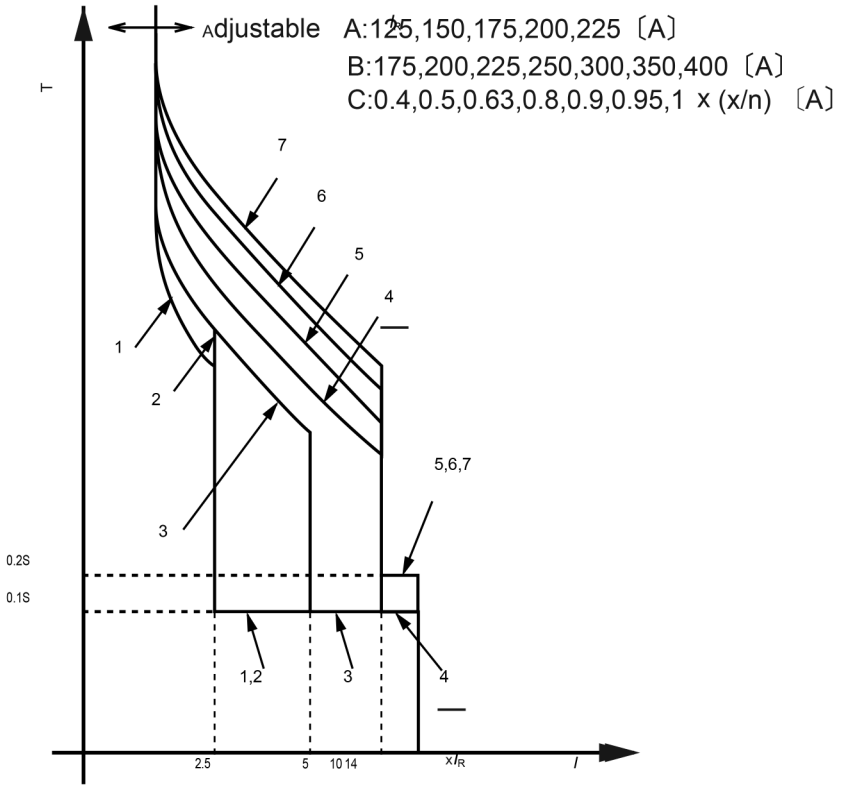
ELECTRONIC TYPE: S400 AND S600 SERIES

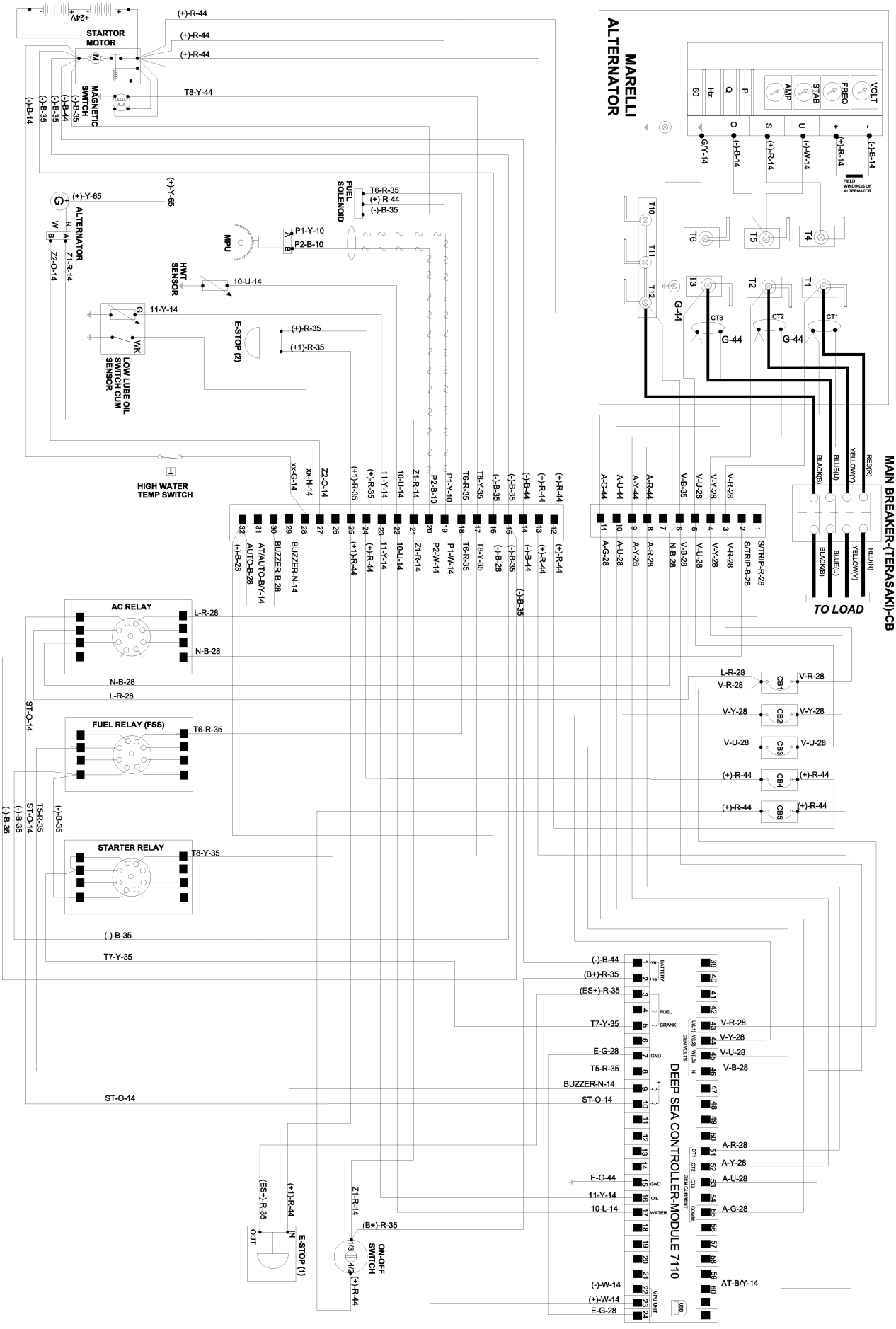


TIME / CURRENT CHARACTERISTIC CURVES

Under bar is default setting.

Electronic Type




MARELLI ALTERNATOR
MAIN BREAKER-(TERASAKI)-CB
TO LOAD
STARTOR MOTOR
MAGNETIC SWITCH
ALTERNATOR
FUEL SOLENOID
MPU
HWT. SENSOR
LOW LUBE OIL SWITCH CUM SENSOR
E-STOP (2)
HIGH WATER TEMP SWITCH
AC RELAY
FUEL RELAY (FSS)
STARTER RELAY
E-STOP (1)
ON-OFF SWITCH
DEEP SEA CONTROLLER-MODULE 7110

Portable Power

WARRANTY CONDITIONS

GLOBAL EXPORT GENERATORS

Doosan Benelux SA warrants to its authorized dealers who in turn warrant to the end-user / owner that each new Doosan Global Export Generator will be free from defects in material and workmanship for twelve (12) months from the date of delivery to the end user / owner or 2000 hours of machine usage, whichever occurs first. During the warranty period, the authorized Doosan dealer shall repair or replace, at Doosan Benelux SA's option, without charge for parts, labour and travel of technicians, any part of the Doosan product which fails because of defects in material or workmanship. The end-user / owner shall provide the authorized Doosan dealer with prompt written notice of the defect and allow reasonable time for replacement or repair. Doosan Benelux SA may, at its option, request failed parts to be returned to the factory or to any other designated location. Transportation of the Doosan Benelux SA product to the authorized Doosan dealer for warranty work is the responsibility of the end-user / owner. Service schedules must be adhered to, documented and genuine parts / lubricants must be used. Coverage for batteries and engine fuel system parts (glow plugs, fuel injection pumps, injectors) is reduced as failures generally originate from factors not under Doosan's control such as, but not limited to, prolonged storage, abuse or fuel quality. Reduced coverage is, depending on the component, limited from 50 to 500 operating hours and 6 months after delivery to the end customer.

The warranty does not cover:
Oils and lubricants, coolant fluids, filter elements, brake linings, tune-up parts, bulbs, fuses, alternator fan belts, drive belts, pins, bushings and other high-wear items, damages resulting from abuse, accidents, alterations not approved by Doosan Benelux SA, air flow obstructions, failure to maintain or use the Doosan product according to the instructions applicable to it, fuel system cleaning, engine tune-up, adjustments or slight defects which generally do not affect the reliability of the machine.

DOOSAN BENELUX SA EXCLUDES OTHER CONDITIONS, WARRANTIES OR REPRESENTATIONS OF ALL KINDS, EXPRESSED OR IMPLIED, STATUTORY OR OTHERWISE (EXCEPT THAT OF TITLE) INCLUDING ALL IMPLIED WARRANTIES AND CONDITIONS RELATING TO MERCHANTABILITY, SATISFACTORY QUALITY AND FITNESS FOR A PARTICULAR PURPOSE. CORRECTIONS BY DOOSAN BENELUX SA OF NONCONFORMITIES WHETHER PATENT OR LATENT, IN THE MANNER AND FOR THE TIME PERIOD PROVIDED ABOVE, SHALL CONSTITUTE FULFILLMENT OF ALL LIABILITIES OF DOOSAN BENELUX SA FOR SUCH NONCONFORMITIES, WHETHER BASED ON CONTRACT, WARRANTY, TORT, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE WITH RESPECT TO OR ARISING OUT OF SUCH PRODUCT. THE REMEDIES OF THE END-USER / OWNER SET FORTH UNDER THE PROVISIONS OF THE WARRANTY OUTLINED ABOVE ARE EXCLUSIVE AND THE TOTAL LIABILITY OF DOOSAN BENELUX SA INCLUDING ANY HOLDING, SUBSIDIARY, ASSOCIATED OR AFFILIATED COMPANY OR DISTRIBUTOR WITH RESPECT TO THIS SALE OR THE PRODUCT AND SERVICE FURNISHED HEREUNDER IN CONNECTION WITH THE PERFORMANCE OR BREACH THEREOF, OR FROM DELIVERY, INSTALLATION, REPAIR OR TECHNICAL DIRECTION COVERED BY OR FURNISHED UNDER THIS SALE, WHETHER BASED ON CONTRACT, WARRANTY, TORT, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE SHALL NOT EXCEED THE PURCHASE PRICE OF THE PRODUCT UPON WHICH SUCH LIABILITY IS BASED. DOOSAN BENELUX SA INCLUDING ANY HOLDING, SUBSIDIARY, ASSOCIATED OR AFFILIATED COMPANY AND DISTRIBUTOR SHALL IN NO EVENT BE LIABLE TO THE END-USER / OWNER, ANY SUCCESSORS IN INTEREST OR ANY BENEFICIARY OR ASSIGNEE RELATING TO THIS SALE FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES ARISING OUT OF THIS SALE OR BY ANY BREACH THEREOF, OR ANY DEFECT IN, OR FAILURE OF, OR MALFUNCTION OF THE PRODUCT UNDER THIS SALE, WHETHER BASED UPON LOSS OF USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL, WORK STOPPAGE, IMPAIRMENT OF OTHER GOODS, LOSS BY REASON OF SHUTDOWN OR NON-OPERATION, INCREASED EXPENSES OF OPERATION OR CLAIMS OF USER OR CUSTOMERS OF THE USER FOR SERVICE INTERRUPTION WHETHER OR NOT SUCH LOSS OR DAMAGE IS BASED ON CONTRACT, WARRANTY, TORT, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE.

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