

Portable Power

50 Hz: G265 - G300 - G G400 - G435 - G500 - G550XW/XF 60 Hz: G300 - G335 - G430 - G470 - G530 - G635XW/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 <i>GENERAL INFORMATION</i> 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					

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GENERAL DATA

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GENERAL DATA (CONFIGURATION 1)

UNIT MODEL 50HZ	G265XW/XF	G300XW/XF	G400XW/XF	G435XW/XF	G500XW/XF	G550XW/XF
Engine Speed - RPM	1500	1500	1500	1500	1500	1500
UNIT MODEL 60HZ	G300XW/XF	G335XW/XF	G430XW/XF	G470XW/XF	G530XW/XF	G635XW/XF
Engine Speed - RPM	1800	1800	1800	1800	1800	1800
Engine Fuel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Manufacturer	Doosan	Doosan	Doosan	Doosan	Doosan	Doosan
Model	P126TI	P126TI-II	P158LE	DP158LC	P180LE	DP180LA
Number of cylinders / Displacement (litres)	6 / 11	6 / 11	V8 / 15	V8 / 15	V10 / 18	V10 / 18
FLUID CAPACITIES						
Engine Crankcase Lubricant (litres)	Max. 23 Min. 20	Max. 23 Min. 20	Max. 21 Min. 17	Max. 21 Min. 17	Max. 35 Min. 28	Max. 35 Min. 28
Fuel Tank (litres)	TBA	TBA	TBA	TBA	TBA	TBA
Radiator & Engine Coolant (litres)	51	51	80	80	81	81
Electrical System	24VDC	24VDC	24VDC	24VDC	24VDC	24VDC
UNIT MEASUREMENTS / WEI	GHTS (XW)					
Overall length (mm)	4400	4400	5260	5260	5260	5260
Overall width (mm)	1370	1370	2000	2000	2000	2000
Overall height (mm)	2100	2100	2130	2130	2130	2130
Weight (with fuel) (kg)	TBA	TBA	TBA	TBA	TBA	TBA
Weight (without fuel) (kg)	3970	3970	5200	5200	5200	5450

ELECTRICAL DATA (CONFIGURATION 1)

UNIT MODEL	G265XW/XF	G300XW/XF	G400XW/XF	G435XW/XF	G500XW/XF	G550XW/XF
Prime Power Rating	385A	424 A	576 A	628 A	722 A	833 A
@ 400V-3Ø, 0.8PF, 50Hz	267,00 KVA	294,00 kVA	399,00 kVA	435,00 kVA	500,00 kVA	577,00 KVA
	213,60 KW	235,20 KW	319,20 KW	348,00 KW	400,00 KW	461,60 KW
Standby Power Rating	436 A	472 A	661 A	693 A	794 A	919 A
@ 400V-3Ø, 0.8PF, 50Hz	302,00 kVA	327,00 kVA	458,00 kVA	480,00 kVA	550,00 kVA	637,00 kVA
	241,60 kW	261,60 kW	366,40 kW	384,00 kW	440,00 kW	509,60 kW
Rated Voltage (V)	400,220/380/	400,220/380/	400,220/380/	400,220/380/	400,220/380/	400,220/380/
	480-3Ø	480-3Ø	480-3Ø	480-3Ø	480-3Ø	480-3Ø
Rated Frequency (Hz)	50	50	50	50	50	50
Rated Power Factor	0.8	0.8	0.8	0.8	0.8	0.8

UNIT MODEL	G300XW/XF	G335XW/XF	G430XW/XF	G470XW/XF	G530XW/XF	G635XW/XF
Prime Power Rating	361 A	401 A	517 A	559 A	638 A	764 A
@ 480V-3Ø, 0.8PF, 60HZ	240,00 kW	266,40 kW	430,00 kVA 344,00 kW	465,00 kVA 372,00 kW	530,00 kVA 424,00 kW	508,00 kW
Standby Power Rating @ 480V-3Ø, 0.8PF, 60Hz	389 A 323,00 kVA 258,40 kW	432 A 359,00 kVA 287,20 kW	571 A 475,00 kVA 380,00 kW	593 A 493,00 kVA 394,40 kW	704 A 585,00 kVA 468,00 kW	840 A 698,00 kVA 558,40 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	400,220/380/ 480-3Ø
Rated Frequency (Hz)	60	60	60	60	60	60
Rated Power Factor	0.8	0.8	0.8	0.8	0.8	0.8

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GENERAL DATA (CONFIGURATION 2)

UNIT MODEL 50HZ	G265XW/XF	G300XW/XF	G400XW/XF	G435XW/XF	G500XW/XF	G550XW/XF
Engine Speed - RPM	1500	1500	1500	1500	1500	1500
UNIT MODEL 60HZ	G300XW/XF	G335XW/XF	G430XW/XF	G470XW/XF	G530XW/XF	G635XW/XF
Engine Speed - RPM	1800	1800	1800	1800	1800	1800
Engine Fuel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Manufacturer	Doosan	Doosan	Doosan	Doosan	Doosan	Doosan
Model	P126TI	P126TI-II	P158LE	DP158LC	P180LE	DP180LA
Number of cylinders / Displacement (litres)	6 / 11	6 / 11	V8 / 15	V8 / 15	V8 / 15	V10 / 18
FLUID CAPACITIES						
Engine Crankcase Lubricant (litres)	Max. 23 Min. 20	Max. 23 Min. 20	Max. 21 Min. 17	Max. 21 Min. 17	Max. 21 Min. 17	Max. 35 Min. 28
Fuel Tank (litres)	TBA	TBA	TBA	TBA	TBA	TBA
Radiator & Engine Coolant (litres)	51	51	80	80	80	81
Electrical System	24VDC	24VDC	24VDC	24VDC	24VDC	24VDC
UNIT MEASUREMENTS / WEIG	GHTS (XW)					
Overall length (mm)	4400	4400	5260	5260	5260	5260
Overall width (mm)	1370	1370	2000	2000	2000	2000
Overall height (mm)	2100	2100	2130	2130	2130	2130
Weight (with fuel) (kg)	TBA	TBA	TBA	TBA	TBA	TBA
Weight (without fuel) (kg)	3970	3970	5200	5200	5200	5450

ELECTRICAL DATA (CONFIGURATION 2)

UNIT MODEL	G265XW/XF	G300XW/XF	G400XW/XF	G435XW/XF	G500XW/XF	G550XW/XF
Prime Power Rating @ 400V-3Ø, 0.8PF, 50Hz	385A 267,00 kVA 213,60 kW	424 A 294,00 kVA 235,20 kW	576 A 399,00 kVA 319,20 kW	628 A 435,00 kVA 348,00 kW	722 A 500,00 kVA 400,00 kW	833 A 577,00 kVA 461,60 kW
Standby Power Rating @ 400V-3Ø, 0.8PF, 50Hz	436 A 302,00 kVA 241,60 kW	472 A 327,00 kVA 261,60 kW	661 A 458,00 kVA 366,40 kW	693 A 480,00 kVA 384,00 kW	794 A 550,00 kVA 440,00 kW	919 A 637,00 kVA 509,60 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	400,220/380/ 480-3Ø
Rated Frequency (Hz)	50	50	50	50	50	50
Rated Power Factor	0.8	0.8	0.8	0.8	0.8	0.8

UNIT MODEL	G300XW/XF	G335XW/XF	G430XW/XF	G470XW/XF	G530XW/XF	G635XW/XF
Prime Power Rating @ 480V-3Ø, 0.8PF, 60Hz	361 A 300,00 kVA 240,00 kW	401 A 333,00 kVA 266,40 kW	517 A 430,00 kVA 344,00 kW	559 A 465,00 kVA 372,00 kW	638 A 530,00 kVA 424,00 kW	764 A 635,00 kVA 508,00 kW
Standby Power Rating @ 480V-3Ø, 0.8PF, 60Hz	389 A 323,00 kVA 258,40 kW	432 A 359,00 kVA 287,20 kW	571 A 475,00 kVA 380,00 kW	593 A 493,00 kVA 394,40 kW	704 A 585,00 kVA 468,00 kW	840 A 698,00 kVA 558,40 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	400,220/380/ 480-3Ø
Rated Frequency (Hz)	60	60	60	60	60	60
Rated Power Factor	0.8	0.8	0.8	0.8	0.8	0.8

OPERATION & MAINTENANCE MANUAL

SAFETY

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SAFETY DECALS

GRAPHIC FORM AND MEANING OF ISO SYMBOLS

		Δ
PROHIBITION / MANDATORY	INFORMATION / INSTRUCTIONS	WARNING
WARNING: Electrical shock risk	WARNING - Pressurised component	WARNING - Hot surface.
	or system.	
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	Do not operate with the doors or	Do not use fork lift truck from this side.
other parts of the pressure system.	enclosure open.	-
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.

К Х,Хьк WARNING - Maintain correct tyre	WARNING - Before connecting the tow	WARNING - For operating temperature
pressure.	bar or commencing to tow consult the Operation & Maintenance manual.	below 0 ℃ (32 ℉), consult the Operation & Maintenance manual.
Image: Non-Aligned stateImage: Non-Aligned stateImage	WARNING - Consult the Operation & Maintenance manual before commencing any maintenance.	Do not breathe the compressed air from this machine.
km/h		
Do not exceed the trailer speed limit.	No naked lights.	Do not open the service valve before the airhose is attached.
	\bigcirc	8
Use fork lift truck from this side only.	Emergency stop.	Tie down point

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Fill with fuel before start-up



This machine is not designed for operating lifesustaining 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.



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.

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.



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.

ACAUTION

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.

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.

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.

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.

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.



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.



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 mm², shall be used for the external earth conductor, when earthing is required.

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

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.

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.

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.

A 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.

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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.

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.

Call a qualified person to make electrical repairs.

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.

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.



POWER is present upon cranking the engine.



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



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



NOTE: For further details, see the section entitled 'OPERATION' 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 9 button.

The *Stop/Reset* ⁽⁰⁾ icon is displayed to indicate *Stop/Reset Mode* operations.

In Stop/Reset Mode (9), 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* 9 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.

> Power Save Mode in the **DSE** Configuration Suite Power Save Mode Enable Software

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

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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 (1) button.

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

In *Manual Mode* (1), the set does not start automatically.

To begin the starting sequence, press the *Start* U 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* (1), 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* **O** 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* (1) 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*.

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TEST MODE

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

Test Mode is activated by pressing the Test Mode (1980) button.

The *Test Mode* (1) icon is displayed to indicate *Test Mode* (1) operations.

In *Test Mode* (19), the set does not start automatically.

To begin the starting sequence, press the *Start* U 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* $\overset{1}{\otimes}$ icon is displayed.

In *Test Mode* (19), 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* O 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* (19) the set continues to run until either:

- The *Stop/Reset Mode* ¹ 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 E button.

The *Auto Mode* ^{CD} icon is displayed to indicate *Auto Mode* ^{CD} operations.

Auto Mode ellows 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 OPERATION AND MAINTENANCE

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ENGINE SPECIFICATION

ENGINE SPECIFICATION

Iter	ns	DE	12T	P12	26TI	P126TI-1	P120	6TI-II	PU126TI
Engine type		Water-cool in-line ty chai	ed, 4 cycle pe Turbo rged	Water-cooled, 4 cycle in-line type Turbo charged & intercooled				ercooled	
Combustion type	chamber		Direct injection type						
Cylinder liner	r type		Replaceable dry liner						
Timing gear s	system				Gear dri	ven type			
No. of piston	ring			Co	mpression r	ring 2, oil rin	g 1		
No. of cylinde stroke (mm)	er - bore x				6 - 123	3 x 155			
Total piston displacement	t (cc)				11,	051			
Compression	n ratio				17.	1:1			
Engine dimer (length x wide height)(mm)	nsion th x	1,365.5 x 8	365.5 x 870 x 1,046 1,383 x 870 x 1,207						
Engine weigh	nt (kg)	93	30			9	10		
Rotation (fror	m flywheel)				Counter	clockwise			
Fuel injection	n order				1 - 5 - 3	- 6 - 2 - 4			
Fuel injectior (B.T.D.C stat	timing ic)	1:	2°	16° 12° 16° 14°			14°		
Injection pur	np type				Zexel in-li	ne "P" type			
Governor typ	e	Mechanical governor type (RSV) Electric gov			governor ty	vpe (Ghana	Control)		
Injection noz	zle type	Multi-ho (5 h	ole type ole)			Multi-hole t	ype (5 hole)		
Fuel injection (kg/cm ²)	n pressure	22	20			1st : 1 60	, 2nd : 220		
Compression (kg/cm ²)	n pressure			28 (at 200 rpm)					
	Condition	50Hz (1,500rpm)	60Hz (1,800rpm)	50Hz (1,500rpm)	60Hz (1,800rpm)	60Hz (1,800rpm)	60Hz (1,800rpm)	50Hz (1,500rpm)	2,100rpm
Power (ISO 3046)	Prime	205PS (151kW)	245PS (180kW)	328PS (241kW)	378PS (278kW)	356PS (262kW)	418PS (307kW)	360PS (265kW)	400PS
	Standby	226PS (166kW)	270PS (199kW)	370PS (272kW)	405PS (298kW)	392PS (288kW)	465PS (342kW)	400PS (294kW)	(294kW)
Intake and exhaust valve clearance (at cold)(mm) 0.3									

ENGINE SPECIFICATION (CONT'D)

Iten	าร	DE12T	P126TI	P126TI-1	P126TI-II	PU126TI		
Intelie velve	Open at	18° (B.T.D.C.)						
intake valve	Close at	34° (A.B.D.C.)						
Exhaust valve	Open at	46° (B.B.D.C.)						
	Close at	14° (A.T.D.C.)						
Lubrication metho	bd		Full forced pre	ssure feed ty	rpe			
Oil pump type			Gear type driv	en by camsh	aft			
Oil filter type		Full-flow, cartridge type						
Lubricating oil	Max.		2	23				
capacity (litres)	Min.	20						
Oil cooler type		Water cooled						
Water pump		Gear driven impeller type						
Cooling Method		Pressurized circulation						
Cooling water cap (engine only)(litre	oacity es)	19						
Thermostat type		Wax pallet type (95 ℃)Wax pallet type (85 ℃)						
Alternator voltage (V - A)	e - capacity	24 - 45						
Starting motor vo (V - kW)	ltage - output	24 - 6.0						

SPECIFICATION FOR GENERATOR ENGINE

Items		P158LE series	P180LE series	P222LE series		
Engine type		Water-cooled, 4 cycle Vee type Turbo charged & intercooled				
Combustion chamber t	ype	Direct injection type				
Cylinder liner type		Wet t	ype, chromated or castin	g liner		
Timing gear system			Gear driven type			
No. of piston ring		Co	ompression ring 2, oil ring	g 1		
No. of cylinder-bore ×	stroke (mm)	8 – 128 × 142	10 – 128 × 142	12 – 128 × 142		
Total piston displacement	ent (cc)	14,618 18,273 21,92				
Compression ratio		P158LE/-1/-2, P180LE/-1, P222LE/-1 => 15.0 : 1 P158LE-S/-III, P180LE-S/-II, P222LE-S/-II => 14.6 : 1 P222LE-II(EAYQD) => 14.0 : 1				
Engine dimension (length × width × heigh	it)(mm)	1,484 × 1,389 × 1,161.5	1,557 × 1,389 × 1,248	1,717 × 1,389 × 1,288		
Engine dry weight (kg)		P158LE/-1/-2 : 950 P158LE-S/-III : 961	P180LE/-1 : 1,175 P180LE-S/-II : 1,188	P222LE/-1 : 1,575 P222LE-S/-II : 1,591		
Fuel injection order		1-5-7-2-6-3-4-8	1-6-5-10-2-7-3-8-4-9	1-12-5-8-3-10-6-7-2- 11-4-9		
Injection pump type			Bosch in-line P type			
Governor type		Electrical type				
Injection nozzle type		Multi-hole type				
Fuel injection pressure (kg/cm ²)		285				
Compression pressure (kg/cm ²)		28 (at 200 rpm)				
Intake and exhaust val (at cold)(mm)	ve clearance	0.25 / 0.35				
Intake valve	Open at	24° (B.T.D.C)				
	Close at		36° (A.B.D.C)			
Exhaust valve	Open at	63° (B.B.D.C)				
	Close at	27°(A.T.D.C)				
Lubrication method		Fully forced pressure feed type				
Oil pump type		Gear type				
Oil filter type		Full-flow, cartridge type				
Lubricating oil capacity	(max./min.)(litres)	21 / 17	35 / 28	40 / 33		
Oil cooler type		Water cooled				
Water pump		Centrifugal type driven by belt				
Cooling Method		Pressurized circulation				
Cooling water capacity (engine only)(lites)		20 21 23				
Thermostat type		Wax pallet type (71 ~ 85 °C)				
Alternator voltage – capacity (V – A)		24 – 45				
Starting Motor voltage	– output (V – kW)	24 – 7.0				
Battery capacity (V – A	NH)	24 – 200				

ENGINE SPECIFICATIONS AND PERFORMANCE

ENGINE SPECIFICATIONS

nem		DP158LCS	DP158LCF	DP158LDS	DP158LDF10	Remarks
General Informa	tion		I	l		
Engine types		Water-coole				
Cylinder liner typ	be		Wet ty	pe liner		
No. of cylinder - (mm)	bore x stroke		8 - 128	3 X 142		
Total displaceme	ent (cc)		14,	618		
Compression ra	tio		15	: 1		
Rotation		Co	ounter clockwise v	viewed from flywh	ieel	
Firing order			1-5-7-2	-6-3-4-8		
Injection timing	(°)(BTDC)	23°±1°	18°±1°	23°±1°	18°±1°	
Dry weight (kg)			1,-	155		With fan
Dimension (L x	W x H)(mm)		1,274 X 1, ⁻	138 X 1,207		With fan
Flywheel housin	g		SAE	NO.1M		
Flywheel						
No. of teeth on f	lywheel					
Cooling System						
Cooling method						
Coolant	Engine only					
capacity (litres)	With radiator	Approx				
Coolant flow rate	e (litres /min)	660	550	660	550	
Pressure cap (k	Pa)					
WaterMax. for standby and prime(°C)Before start of full load						
		40				
Water pump						
Туре						
Thermostat	Opening temp. (℃)					
	Full open temp. (℃)					
	Туре		Blow	Туре		
Cooling fan Diameter - blades		915mm - 7 blades				
Item		DP158L				Pomarka
-------------------------------	---------------------------	---------------------------------	--------------------	--------------------	------------	---------
		DP158LCS	DP158LCF	DP158LDS	DP158LDF10	nemarks
Lubrication Syste	em					
Lubrication meth	od	Fully forced pressure feed type				
Oil aurea	Туре	Gear type				
Oli pump	Driving type		Driven by cra	ankshaft gear		
Oil filter			Full flow, Ca	artridge type		
Oil capacity	Max.		2	22		
(litres)	Min.		1	3		
	Idle speed		Min	. 100		
Dressure (kPa)	Governed		Min	250		
	speed		IVIII I.	. 230		
Max. oil tempera	ture (°)		1:	20		
Oil specification	Oil class		Above	API CD		
On speemeation	SAE		15V	V/40		
Fuel System	·				·	
Injection pump			Bosch in-li	ne "P" type		
Governor			Electr	ic type		
	Туре		Mechanical type	e injection pump		
Fuel feed pump	Capacity (litres/hr)	315				
	Туре	Multi hole type				
Injection nozzle	Opening	28				
	pressure (MPa)		2	-0		
Fuel filter		Full fle	ow, Cartridge type	e with water drain	valve	
Fuel used			Diese	l fuel oil		
Intake/Exhaust S	System					
Max. back press	ure (kPa)		5	.9		
Max. intake air	With clean filter element	2.16 6.23				
restriction (kPa)	With dirty filter element					
Cylinder block/he	ead					
Valve system typ	e		Overhead	valve type		
No. of valve	Intake			1		
(per cylinder)	Exhaust			1		
Valve lashes	Intake		0.	25		
(at cold)(mm)	Exhaust		0.	35		
	Opening		24° (E	BTDC)		
Intake valve (°)	Close		36°(A	ABDC)		
Exhaust valve	Opening	63°(BBDC)				
(°)	Close	27° (ATDC)				
Electrical System						
Alternator voltag	e - capacity	27.5 - 45				
Voltage regulato	r		Built-in type	IC regulator		
Starting motor vo (V - kW)	oltage - capacity		24 -	- 7.0		
Battery capacity			2-200Ah (re	commended)		

Itom		DP180L			Domorko	
	em	DP180LBS	DP180LBF	DP180LAS	DP180LAF	Remarks
General Information			I			•
Engine types		Water-cooled, 4cycle, V-type, Turbo charger & inter cooled (air to air)				
Cylinder liner typ	ре		Wet ty	pe liner		
No. of cylinder - (mm)	bore x stroke		10 - 12	8 X 142		
Total displaceme	ent (cc)		18,	273		
Compression ra	tio		15	:1		
Rotation		Со	unter clockwise v	viewed from flywh	eel	
Firing order			1-6-5-10-2	2-7-3-8-4-9		
Injection timing	(°)(BTDC)	21°±1°	19 <i>°</i> ±1 <i>°</i>	21 °±1 °	19°±1°	
Dry weight (kg)			1,2	250		With fan
Dimension (L x	W x H)(mm)		1,592 x 1,3	389 x 1,223		With fan
Flywheel housin	g	SAE NO.1M				
Flywheel		Clutch NO.14M				
No. of teeth on flywheel		160				
Cooling System						
Cooling method			Fresh water fo	rced circulation		
Coolant	Engine only		Appro	ox. 21		
capacity (litres)	With radiator	Approx.	79 (Air on 43°C)	/ Approx 90 (Air o	on 52℃)	
Coolant flow rate	e (litres /min)	660	550	660	550	
Pressure cap (k	Pa)	Max. 49				
Water temperature	Max. for standby and prime	103				
(°C)	Before start of full load	40				
Water pump		Centrifugal type driven by belt				
	Type Wax-pellet		llet type			
Thermostat	Opening temp. (℃)	71				
	Full open temp. (℃)	85				
	Туре		Blow	Туре		
Cooling fan	Diameter - blades	915mm - 7 blades				

Item		DP180L				Pomarka
		DP180LBS	DP180LBF	DP180LAS	DP180LAF	nemarks
Lubrication Syste	em					
Lubrication meth	od		Fully forced pressure feed type			
Oil aurea	Туре	Gear type				
Oli pump	Driving type		Driven by cra	ankshaft gear		
Oil filter			Full flow, Ca	artridge type		
Oil capacity	Max.		3	34		
(litres)	Min.		2	23		
	Idle speed		Min	. 100		
pressure (kPa)	Governed		Min	250		
procedie (in a)	speed		IVIIII	. 200		
Max. oil tempera	ture (°)		1:	20		
Oil specification	Oil class		Above	API CD		
	SAE		15V	V/40		
Fuel System						
Injection pump			Bosch in-li	ne "P" type		
Governor			Electr	ic type		
	Туре		Mechanical type	e injection pump		
Fuel feed pump	Capacity (litres/hr)	630				
	Туре	Multi hole type (4 hole)				
Injection nozzle	Opening	28				
pressure (MPa)						
Fuel filter		Full flo	ow, Cartridge typ	e with water drain	valve	
Fuel used			Diese	l fuel oil		
Intake/Exhaust S	System					
Max. back press	ure (kPa)		5	.9		
Max. intake air	With clean filter element	2.16 6.23				
restriction (kPa)	With dirty filter element					
Cylinder block/he	ead					
Valve system typ)e		Overhead	valve type		
No. of valve	Intake			1		
(per cylinder)	Exhaust			1		
Valve lashes	Intake		0.	25		
(at cold)(mm)	Exhaust		0.	35		
Intako valvo (%	Opening		24°(E	BTDC)		
Intake valve ()	Close		36°(A	ABDC)		
Exhaust valve	Opening	63° (BBDC)				
(°)	Close	27° (ATDC)				
Electrical System	n					
Alternator voltag (V - A)	e - capacity	27.5 - 45				
Voltage regulato	r		Built-in type	IC regulator		
Starting motor vo (V - kW)	oltage - capacity		24	- 7.0		
Battery capacity			2-200Ah (re	commended)		

TECHNICAL INFORMATION

ENGINE MODEL AND SERIAL NUMBER

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



EI6OM011

DOOSAN	Doosan Infracore
MODEL	BORE mm
SPEED rpm :	STROKE mm
STAND-BY PS(kW)	DISPL. liters
PRIME PS(kW)	DATE
	CORE Co. Ltd

EI6OM012





Engine serial No. (example 3 : PU126TI) EDIPA900001



MAINTENANCE AND CARE (P126TI AND P126TI-II ENGINES)

PERIODICAL INSPECTION AND MAINTENANCE

In order to insure maximum, trouble-free engine performance at all times, regular inspection, adjustment and maintenance are vital.

- Daily inspections should be checked every day.
- The maintenance should be executed thoroughly at regular intervals. (Refer to "Periodic Inspection Cycle")

LUBRICATION SYSTEM

Exchanging of lubrication oil

Engine oil and the oil filter are important factors affecting engine life. They affect ease of starting, fuel economy, combustion chamber deposits and engine wear. Refill and drain oil pan every 50 hours of operation or 6 months whichever occurs first. At the end of the break-in period (50 hours), change the oil sump oil and replace the oil filter.

Oil level

Check the oil level in the engine sump daily with a dipstick.



- The notches on the dipstick must indicate the oil level between the max. and the min. permissible.
- The oil level should be checked with the engine horizontal and only after it has been shut down for approximately 5 minutes.
- Examine the viscosity and contamination of the oil smeared on the dipstick and replace the engine oil if necessary.



Do not add so much engine oil that the oil level rises above the max. marking on the dipstick. Over filling will result in damage to the engine.

Oil exchange procedure

While the oil is still hot, exchange oil as follows:

- Take out the dipstick.
- Remove the drain valve from oil pan and the drain plug from the oil filter head, then drain out the engine oil into a container.



• Reassemble the drain valve with the oil pan and the drain plug with the oil filter head after draining out the engine oil.



- Refill with new engine oil at the oil filler neck on the head cover and the lubricating oil through the oil filler in accordance with the oil capacity of the engine. Be careful not to allow contaminants to enter during re-filling of oil. Confirm that the oil level gauge shows the oil level is near to maximum.
- For a few minutes, operate the engine at idle speed in order to circulate oil through lubrication system.

• Shut down the engine. After waiting for approximately 10 minutes measure the quantity of oil and refill the additional oil if necessary.



Recommended lubricating oil

Initial factory filling is high quality break-in oil (API Service CH-4 grade). During the break-in period (50 hours), check the oil level frequently. Somewhat higher oil consumption is normal until piston rings are seated. The oil level should be maintained in the safe range between Min. and Max. mark on the dipstick. To obtain the best engine performance and engine life, Engine oil is specified by API Service, lettered designations and SAE viscosity numbers. If the specified engine oil is not available, use a reputable brand of engine oil labeled for API Service CH-4 and SAE viscosity 15W40 or 10W40. Refer to oil identification symbol on the container.



Replacement of oil filter cartridge

During an oil change, replace the oil filter cartridge.

• Drain engine oil by loosening the drain plug on the filter head.

Tighten the drain plug after draining engine oil.



- Loosen the oil filter by turning it counter- clockwise with a filter wrench.
- Wipe clean the fitting face of the filter body and the oil filter body with a rag so that the new oil filter cartridge can be seated properly.
- Lightly oil the O-ring and turn the oil filter until sealing face is fitted against the O-ring. Turn 1-1/4 turns further with the filter wrench.
- **NOTE:** It is strongly advisable to use DOOSAN genuine oil filter cartridge for replacement.

COOLING SYSTEM

The coolant must be changed at intervals of 1,200 hours operation or six months whichever comes first. If the coolant is contaminated, it will cause the engine to overheat or coolant to leak from the expansion tank.

Coolant draining



- 1. Remove the pressure cap.
- 2. Open the drain valve located at the bottom of the radiator to drain the coolant.



3. Loosen the coolant drain plug of the cylinder block.

CAUTION

When removing the pressure filler cap while the engine is still hot, cover the cap with a rag, then turn it slowly to release the internal steam pressure. This will prevent a person from scalding with hot steam spouted out from the filler port.

Cleaning of the cooling system inside circuit (by authorized specialist personnel)

When the cooling system circuits are contaminated with water scales or sludge particles, the cooling efficiency will be lowered.

Investigations have shown that in many cases the poor condition of the coolant and /or the cooling system accounts for damage to the water pump mechanical seal. The poor condition of the cooling system is normally due to use of unsuitable or no anti-freezing agents and corrosion inhibitor. Failure to replace filler neck cover and working valves often enough can also cause damage.

If the engine water pump develops leaks or the coolant is heavily contaminated (dull, brown, mechanically contaminated, gray or black signs of a leakage on the water pump casing) more than once over a short period of time, clean the cooling system prior to removing the water pump as follows:

- 1. Drain coolant.
- 2. Remove thermostats to ensure that the cooling system is thoroughly cleaned.
- 3. Fill the cooling system with a mixture of potable water and 1.5% by volume of cleaner. (Henkel P3T5175)
- 4. Warm up engine under load. After a temperature of 60 °C is reached, run engine for a further 15 minutes.
- 5. Drain cleaning fluid.
- 6. Repeat steps 3) and 4).
- 7. Flush cooling system.
- 8. Replace drain plug by drain plug with a bore of 8 mm diameter.
- 9. Fill cooling system with hot water.
- 10. Run engine at idle for 30 minutes. At the same time continuously replenish the water leaking from the bore in drain plug by adding fresh water.

Periodically clean the circuit interior with a cleaner. The cooling system should be cleaned every 1,200 hours.

Intercooler

The intercooler is air to air type and has a large cooling fan capacity. The intercooler life and performance depends greatly on the intake air condition. Contaminated air pollutes and clogs the air fins of the intercooler. As a result of this, the engine output is decreased and engine malfunction will occur. Always check whether the intake air systems such as the air filter element are worn or polluted. Cleaning

In order to maintain the heat transfer efficiency of the intercooler, it is necessary to clean it at regular intervals.



NOTE: Cleaning of intercooler fins: Every 600 hours.

AIR INTAKE SYSTEM

Maintenance (only when engine is switched off)



Empty the dust bowl regularly. The bowl should never be filled more than halfway with dust.

After removing the two clamps, the dust bowl can be removed. Take off the cover of the dust bowl and empty.

Be careful to assemble cover and bowl correctly. There is a recess in the cover rim and a lug on the collector which should align. Where the filter is installed horizontally, ensure the cleaner bowl is oriented correctly by referring to the "top" mark.

Changing filter element



Do not allow dirt to get into the clean air end.

On removing the hexagon nut, take out the dirty cartridge and replace or clean.

Wipe the cleaner housing with a damp cloth, in particular the sealing surface for the element.

NOTE: Unless the maximum number of cleanings (up to 5 x) have been done, the filter cartridge should be renewed every two years or 4,000 hours of operation.

Cleaning filter elements



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

By compressed air

The air gun should be fitted with a nozzle extension which is bent 90° at the discharge end and is long enough to reach the bottom of the element. Moving the air gun up and down, blow out the element from the inside (maximum 500 kPa - 5 bar) until no more dust comes out of the filter pleats.



By washing

Before washing, the element should be precleaned by means of compressed air, as described above. Then allow the element to soak in lukewarm washing solvent for 10 minutes, and then move it back and forth in the solvent for approximately 5 minutes. Rinse thoroughly in clean water, shake out and allow drying at room temperature. The cartridge must be dry before it is reinstalled. Never use steam sprayers, petrol (gasoline), alkalis or hot liquids etc. to clean the filter elements. Knocking out dirt by hand In emergencies, when no compressed air or cleaning agent is available, it is possible to clean the filter cartridge provisionally by hitting the end disk of the cartridge with the ball of one's thumb.

Under no circumstances should the element be hit with a hard object or knocked against a hard surface to loosen dirt deposits.



• Checking the filter cartridge Before reinstalling the cartridge, it must be checked for damage e.g. to the paper pleats and rubber gaskets, or for bulges and dents etc. in the metal casket.

Cracks and holes in the paper pleating can be established by inspecting the cartridge with a flashlight. Damaged cartridges should not be reused under any circumstances. In cases of doubt, discard the cartridge and install a new one.

FUEL SYSTEM

Fuel filter



- After every 200 hour of operation, drain the water and sediment from the fuel-water separator.
- Shut off the engine. Use your hand to open the drain valve (6).
- Turn the valve counter clockwise approximately 2 ~ 3 turns until draining occurs. Drain the filter sump of water until clean fuel is visible.

• Turn the valve clockwise to close the drain valve. Do not over tighten the valve, overtightening can damage the threads.

Replacement of fuel filter



- Clean the area around the fuel filter head (3).
- Remove the fuel filter (2) by turning it counter-clockwise with a filter wrench. (Discard the used filter.)
- Remove the fuel filter thread adapter seal ring (4).
- Use a clean lint free cloth to clean the gasket surface of the fuel filter head (3).
- Install the new thread adapter seal ring (4) supplied with the new filter.
- Use clean oil to lubricate the filter seal (5), and fill the new filter with clean fuel.
- Install the filter on the filter head (3).
- Tighten the filter until the gasket contacts the filter head surface.
- Tighten the filter an additional one-half to three-quarters of a turn with the filter wrench, or as specified by the filter manufacturer.
- **NOTE:** Mechanical over tightening of the filter can distort the thread or damage the filter element seal.

Fuel system checks

Fill the tank with the recommended fuel. Keeping the tanks full reduces water condensation and helps keep fuel cool, which is important to engine performance.

Make sure fuel supply valves (if used) are open.

To insure prompt starting and even running, the fuel system must be primed with the fuel feed pump manually before starting the engine the first time, or after a fuel filter change.

Refill at the end of each day's operation to prevent condensation from contaminating the fuel.

Condensation formed in a partially filled tank promotes the growth of microbial organisms that can clog fuel filters and restrict fuel flow.

If the engine is equipped with a fuel water separator, drain off any water that has accumulated.

Water in fuel can seriously affect engine performance and may cause engine damage. DOOSAN recommends installation of a fuel water separator on generator units.

Air removal of fuel system

The suction room of fuel injection pump has the function of air removal continuously during the operation through a relief valve.

In case the suction room lacks fuel, such as when a new injection pump has been installed, after loosening the air removing screws of cartridge filter respectively, remove the air by operating the manual pump of the fuel supply pump until the bubbles disappear.

• Fuel supply pump Whenever the engine oil is replaced, the fuel strainer installed at the fuel supply pump should be removed and cleaned.

Fuel Contamination and water trap

In the generator environment, the most likely fuel contaminants are water and microbial growth (black "slime"). Generally, this type of contamination is the result of poor fuel handling practices.

Black "slime" requires water in the fuel to form and grow, so the best prevention is to keep water content to a minimum in storage tanks.

If diesel fuel which contains moisture is used the injection system and the cylinder liners / pistons will be damaged. This can be prevented to some extent by filling the tank as soon as the engine is switched off while the fuel tank is still warm (formation of condensation is prevented).

Drain moisture from storage tanks regularly. Installation of a water trap upstream of the fuel filter is also advisable.

NOTE: A galvanized steel tank should never be used for fuel storage, because the fuel oil reacts chemically with the zinc coating to form powdery flakes which can quickly clog the fuel filters and damage the fuel pump and injection nozzles.

Priming pump strainer cleaning



Clean the priming pump strainer every 200 operation hours.

The strainer is incorporated in the priming pump inlet side joint bolt.

Clean the strainer with compressed air and rinse it in the fuel oil.

Bleeding the fuel system



Whenever fuel filter is changed or the engine is stopped due to lack of fuel, the air in the fuel line must be removed as follows.

Bleed the fuel by manually operating the priming pump with fuel filter outlet joint bolt and injection pump bleeder screw loosened.

- Press the feed pump cap repeatedly until fuel without bubbles overflows from the bleeding plug screw.
- Once all the air has been removed, close the plug screws of the filter and the pump.
- Confirm the resistance of fuel delivery by repeated pressing of the feed pump cap, Pressure and turn the priming pump cap simultaneously to close it.

Injection pump

- Check the fuel injection pump housing for cracks or breaks, and replace if damaged.
- Check and see if the lead seal for idling control and speed control levers have not been removed.
- No alterations must be made to the injection pump. If the lead seal is damaged the warranty on the engine will become null and void.
- We strongly recommended that any faults developing in the injection pump should be taken care of by authorized specialist personnel.

INJECTION NOZZLE MAINTENANCE (BY AUTHORIZED SPECIALIST PERSONNEL)



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.

A copper seal fitted to the injector ensures gas-tight seating and good heat dissipation.

The opening pressure of the nozzle is adjusted by means of shims at the compression spring.



- Install a nozzle to a nozzle tester.
- Check injection pressure, and adjust the nozzle using the adjusting shim if the pressure does not meet the specified limit.
- Check nozzle spray patterns and replace if damaged.

	DE12T	P126TI / P126TI-1 / P126TI-II / PU126TI
Opening pressure	220kg/cm ²	1st: 160kg/cm ² 2nd: 220kg/cm ²

- **NOTE:** A galvanized steel tank should never be used for fuel storage, because the fuel oil reacts chemically with the zinc coating to form powdery flakes which can quickly clog the fuel filters and damage the fuel pump and injection nozzles.
- When mounting the pipes to the engine ensure they are properly fitted.
- Do not bend pipes when replacing the nozzles.
- Do not mount any misshapen pipes.
- Avoid bending pipe ends by more than 2 to 3 degrees.

In case of faults in the injection system which might have resulted in excessive operating pressures, replace both the failed part and the injection line.

TURBOCHARGER

Maintenance (by authorized specialist personnel)

The turbochargers do not call for any specific maintenance.

The only points to be observed are the oil pipes which should be checked at every oil change for leakage and restrictions. The air cleaners should be carefully serviced.

Furthermore, a regular check should be kept on charge air exhaust gas pipes. Any leakages should be attended to at once because they are liable to cause overheating of the engine.

When operating in highly dust or oil-laden atmospheres, cleaning of the air impeller may be necessary from time to time. To this end, remove compressor casing (Caution : Do not skew it!) and clean in a non-acid solvent, if necessary using a plastic scraper.

If the air compressor should be badly contaminated, it is recommended that the wheel be allowed to soak in a vessel with solvent and then cleaned with a stiff brush. When doing so, take care to see that only the compressor wheel is immersed and that the turbocharger is supported on the bearing casing and not on the wheel.

Special hints

It is recommended that the radial and axial clearances of

the rotor be checked after every 3,000 hours operation.

This precaution will enable any wear of the Measuring of axial clearance bearings to be detected in good time before serious damage is caused to the rotor and bearings.



Measuring rotor axial clearance

0.2 mm

Measuring radial clearance

Axial clearance

Radial clearance

0.65 mm



CHECKING AND SETTING

ADJUSTMENT OF VALVE CLEARANCE

General information

The valve clearances are to be adjusted at the following times:

- After initial 50 hours of operation.
- When the engine is overhauled and the cylinder heads are disassembled.
- When severe noise comes from valve train.

• When the engine is not normally operated, even though there is no problem with the fuel system.

Adjusting order of the valve clearance

• Cylinder No. 1 begins from the rear side where the flywheel is mounted. Cylinder No. 6 begins from the front side of the engine.



Step 1 :

 Move cylinder No.6 to the overlap TDC position by turning the crankshaft. Then adjust the valves corresponding to " 1 of the above figure. At this time cylinder No. 1 should be at the ignition TDC position (O.T).

Step 2 :



After adjusting the upper valves turn the crank pulley 360° to adjust the other valve clearance until cylinder No. 1 comes to overlap TDC position. At this time cylinder No. 6 should be at the ignition

TDC position (O.T).

After reconfirming the valve clearances, retighten it if necessary.



Loosen the lock nuts of the rocker arm adjusting screws, push the specified feeler gauge and adjust the valve clearance with adjusting screw respectively.

Model	Intake Valve	Exhaust Valve
DE12T / P126TI / P126TI-1 / P126TI-II / PU126TI	0.3 mm	0.3 mm

Method of adjusting the valve clearance



- 1. Loosen the lock-nuts (1) using a ring spanner.
- 2. Insert a thickness gauge of 0.3mm between valve stem (2) and rocker arm (3).
- 3. Turn the adjusting bolts (4) using a screw driver until the gauge can be pulled out with some restriction.
- 4. After the adjustment fix the adjusting bolt taking care not to rotate and tighten the locknut at the same time.
- 5. Measure the clearance one more time and if necessary adjust again.

ADJUSTMENT OF INJECTION TIMING

Method of adjusting injection timing



• Turn the flywheel until No. 1 piston is placed in the "OT" position of notch marks on the flywheel, and then turn the flywheel clockwise again until showing the notch mark of the above figure corresponding to the injection timing is aligned with the pointer on the flywheel housing.

	DE12T / P126TI-1	P126TI / P126TI-II	PU126TI
Fuel injection timing (B.T.D.C. static)	12°	16°	14°



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



• Tighten the coupling fixing bolts and nuts to specified torque.

Torque	6.0 kg•m

• Tighten the drive shaft connecting flange fixing bolts to specified torque.

Torque	7.5 ~ 8.5 kg•m
--------	----------------

• Install the oil delivery pipe and return pipe.

CYLINDER COMPRESSION PRESSURE



1. Stop the engine after warming it up, then remove the nozzle assemblies.



- 2. Install a special tool (gauge adapter) in nozzle holder hole and connect the compression pressure gauge to the adapter.
- 3. Cut off fuel circulation, rotate the starter, then measure compression pressure of each cylinder.

Standard value	25 ~ 28 kg/cm ²
Limit	24 kg/cm ² or less
Difference between each cylinder	Within ± 10%

Testing conditions: at water temperature of 20° C and speed of 200 rpm (10 turns).

V-BELTS

The tension of the V-belts should be checked after every 2,000 hours of operation.

1. Change the V-belts

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

2. Checking condition

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



3. Testing by hand

The tension is correct if the V-belts can be pressed in by about the thickness of the V-belt. (there should be no more than 10-15 mm deflection when tested at the centre point in between the pulleys.)

A more precise check of the V-belt tension is possible using a V-belt tension guage.

4. Measuring tension

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



- Apply tester to belt at a point midway between two pulleys so that edge of contact surface (2) is flush with the V- belt.
- Slowly depress pad (3) until the spring can be heard to disengage. This will cause the indicator to move upwards.

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

5. Reading of tension.



- Read the tension value at the point where the top surface of the indicator arm (1) intersects with the scale.
- Before taking readings, ensure that the indicator arm remains in its position.

		Tensioning forces on the tester			
	Drive helt	New installation		When	
Туре	width	Installation	After 10 min. running time	servicing after long running time	
Α	11.8 mm	55 kg	50 kg	45 kg	

* V-belt of raw edge cogged type

Туре	New installation	When servicing after long running time
3V	45 kgf	41 kg



6. Tensioning and changing V-belt



- Remove fixing bolts (1).
- Remove lock nut (2).
- Adjust nut (3) until V-belts have correct tensions.
- Retighten lock nut and fixing bolts.

OPERATING GUIDE

PERIODIC INSPECTION CYCLE

(o :Check & adjust • : Replace)

Increation		Daily	Inspection interval (Hours)					Pomark
	inspection	Daily	50	200	400	600	1,200	nemark
	Check for leakage (hoses, clamp)	0						
	Check the coolant water level	0						
Cooling system	Change the coolant water						•	
	Adjust the V-belt tension	0						Every 2,000hrs
	Clean the radiator						0	
	Check for leakage	0						
Lubrication	Check the oil level gauge	0						
system	Change the lubricating oil			₊a	•			
	Replace the oil filter cartridge			₀a	•			
	Check the fuel line for leakage	0						
	Clean the fuel strainer of fuel feed pump						0	
	Remove sediment from fuel tank						0	
Fuel system	Drain the water in separator			0				
1 doi bybloini	Replace the fuel filter element				•			
	Check fuel injection timing			0				When necessary
	Check the injection nozzles			0				When necessary
	Check the intercooler for leakage (hoses, clamp)	0						
Intake / Exhaust	Clean and change the air cleaner element			o ^b	•			
system	Clean the intercooler air fins				0			
	Clean the turbocharger							Every 2,000hrs
	Check the state of exhaust gas	0						
	Check the battery charging	0						
Engine adjust	Check the compression pressure						0	When necessary
	Adjust Intake/Exhaust valve clearance		o ^a					When necessary

a. First 50hr

b. Clean

TROUBLE SHOOTING

Engine starting impossible





Output insufficient









Engine knocking





CAUSES AND REMEDIES

Condition	Causes	Remedies		
1) Starting difficult	Valve is not fully closed, stem distortion	Repair or replace		
(1) Compression pressure	Valve spring damage	Replace valve spring		
	 Cylinder head gasket leaks 	Replace gasket		
	Worn piston ring or liner	Adjust		
2) Idle operation abnormal	Injection timing incorrect	Adjust		
	 Air mixing at injection pump 	Remove air		
3) Engine output insufficient	Valve clearance incorrect	Adjust		
insufficient	Valve tightness poor	Repair		
	Cylinder head gasket leaks	Replace gasket		
	 Worn, sticking or damaged piston ring 	Replace piston ring		
	 Injection timing incorrect 	Adjust		
	 Fuel injection amount insufficient 	Adjust injection pump		
	Nozzle injection pressure improper or stuck	Adjust or replace		
	 Supply pump's function lowered 	Repair or replace		
	Fuel pipe system clogged	Repair		
	 Air suction amount insufficient 	Clean or replace air cleaner		
	Supercharger poor	Repair or replace		
(2) Output insufficient when in	Compression pressure insufficient	Disassemble engine		
	 Injection timing incorrect 	Adjust		
	 Fuel injection amount insufficient 	Adjust injection pump		
	 Injection pump timer's function insufficient 	Repair or replace		
	 Nozzle injection pressure, injection angle improper 	Repair, replace		
	 Supply pump's function lowered 	Repair or replace		
	Air intake provides insufficient clean air	Clean or replace air cleaner		
4) Overheating	Engine oil insufficient or poor	Replenish or replace		
	Cooling water insufficient	Replenish or replace		
	 Fan belt loosened, worn, damaged 	Adjust or replace		
	 Cooling water pump's function lowered 	Repair or replace		
	Water temp. regulator's operation poor	Replace		
	Valve clearance incorrect	Adjust		
	Exhaust system's resistance increased	Clean or replace		

Condition	Causes	Remedies
5) Engine noisy	For noises caused by rotating parts, lapping parts etc., It is necessary to determine the cause of noises accurately.	
(1) Crankshaft	• As the wear of bearing or crankshaft progresses, the oil clearances increases.	Replace bearing & grind crankshaft
	 Uneven wear of crankshaft 	Grind or replace
	 Oil supply insufficient due to oil passage clogging 	Clean oil passage
	Stuck bearing	Replace bearing & Grind
(2) Con rod and Con rod	Uneven wear of con rod bearing	Replace bearing
beamig	 Uneven wear of crank pin 	Grind crankshaft
	Connecting rod distortion	Repair or replace
	Stuck bearing	Replace & grind crankshaft
	 Oil supply insufficiency as clogging at oil passage progresses 	Clean oil passage
(3) Piston, piston pin & piston ring	Piston clearance increase as the wear of piston and piston ring progresses	Replace piston & piston ring
	 Wear of piston or piston pin 	Replace
	Piston stuck	Replace piston
	Piston insertion poor	Replace piston
	Piston ring damaged	Replace piston
(4) Others	Wear of crankshaft, thrust bearing bearing	Replace thrust
	Camshaft end play increased	Replace thrust plate
	 Idle gear end play increased 	Replace thrust washer
	Timing gear backlash excessive	Repair or replace
	Vale clearance excessive	Adjust valve clearance
	 Abnormal wear of tappet, cam 	Replace tappet, cam
	Supercharger inner part damaged	Repair or replace
6) Fuel Consumption Excessive	Injection timing incorrect	Adjust
	 Fuel injection amount excessive 	Adjust injection pump

Condition	Causes	Remedies		
7) Oil Consumption Excessive	Clearance between cylinder liner & piston	Replace		
	Wear of piston ring, ring groove	Replace piston, piston ring		
	Damaged, sticking or worn piston ring	Replace piston ring		
	Piston ring opening's disposition improper	Correct position		
	Piston skirt part damaged or abnormal wear	Replace piston		
	Oil ring's oil return hole clogged	Replace piston ring		
	Oil ring's contact poor	Replace piston ring		
(2) Oil level lowered	Loose of valve stem & guide	Replace in set		
	Wear of valve stem seal	Replace seal		
	Cylinder head gasket leaks	Replace gasket		
(3) Oil leak	Looseness of connection parts	Replace gasket, repair		
	 Various part's packing poor 	Replace packing		
	Oil seal poor	Replace oil seal		

ENGINE REGULAR INSPECTION

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GENERAL INFORMATION -(DP158 AND DP180 ENGINES)

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.



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.

Incorrect inspection methods may cause of 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 coloured 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)

		Inspection interval (Hours)								
Check Points	Daily	First 50	200	400	800	1,600	3,200	1 Year	2 Year	Remark
Coolant system		I.	1	4			1		1 1	
Check of coolant level	0									
V-belt tension, adjusting if necessary	0									
Check of coolant hose & clamp	0									
Concentration of antifreeze solution			0							
Replace V-belt						•			•	
Cleaning of water jacket and radiator								0		
Change of coolant								•		
Replace of coolant hose & clamp									•	
Lubrication system	1	1	I	1			l		1 1	
Check of engine oil level	0									
Engine exterior for loss of oil	0									
Oil Separator for oil leaks	0									
Change of Engine oil ^a		•	•					•		
Change of Oil Filter ^a		•	•					•		
Replace Oil Hoses, Clamps									•	
Intake/Exhaust system		I	I				I		11	
Check of exhaust gas colour	0									
Check of air or gas leak	0									
Check of air cleaner indicator	0									
Clean of air filter element			0							
Replace air filter element				•						
Replace Air hoses, Clamps									•	

(o :Inspection and Adjustment, • : Replacement)

				Inspe	ction in	terval (H				
Check Points	Daily	First 50	200	400	800	1,600	3,200	1 Year	2 Year	Remark
Fuel System		L				1				
Fuel lines for leaks	0									
Drain Fuel filter / Water separator	0									
Check of fuel stop lever	0									
Engine Clean fuel pre-filter		0		0						
Replace Fuel filter		•		•						
Replace Water separator filter		•		•						
Drain Water & Sediment from fuel tank				0						
Check of Injectors, replace if						•				
necessary ^a						0				
Replace Fuel Hoses, Clamps									•	
Electrical system									I.	
Engine alarms	0									
Check of battery charging	0									
Magnetic pick up and adjust								0		
Cylinder head	I	1		4		-1		1	I	
Cylinder head valve and valve seats							0			
Check of valve clearance										If necessary

a. If the sulfur content of fuel is > 0.02wt%, the changer or check intervals should be halved.

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

CAPACITY OF COOLANT

Engino Modo	Coolant capacity (litres)						
	Inside engine	With radiator					
DP 158	Approx 20	Approx. 79 (Air on 43℃)					
DI 130E	Αρριολ. 20	Approx. 90 (Air on 52℃)					
DP180I	Approx 21	Approx. 91 (Air on 43℃)					
51 1002		Approx. 114 (Air on 43℃)					
DP 2221	Approx 23	Approx. 114 (Air on 43℃)					
	, ippiox. 20	Approx. 125(Air on 52 <i>°</i> C)					

CHECKING THE COOLANT

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.

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. If managed improperly, it can have a fatal impact on the coolant pump and cylinder liner.

- 4. The engine cylinder liner is of a wet type which specially requires good coolant flow.
- 5. Check the concentration of antifreeze and corrosion inhibitor using the coolant test sheet.

50 Hz: G265 - G300 - G400 - G435 - G500 - G550XW/XF 60 Hz: G300 - G335 - G430 - G470 - G530 - G635XW/XF
MEASUREMENT OF COOLANT CONCENTRATION

Special Tools

Figure	Product Number/Name
C) B) A)	60.99901-0038 CC2602M Coolant test sheet

The coolant concentration can be measured as follows:

1. If the engine coolant temperature is within a range of $10 \sim 55 \,^{\circ}$ C, drain the coolant and fill half a plastic cup with it.

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.

- 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.



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

4. Check the colour on test sheet.



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

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

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

5. Compare and confirm the parts with identical colours on the test sheet and the standard colour table.



a) Compare the changed pink colour part A of the test sheet with the GLYOOL/FREEZEPOINT (End pad) of the standard colour table on top of the container and confirm the concentration. The concentration indication has to be within the colour scope of $33{\sim}50\%$

b) The state of additives for anticorrosion is shown on the point where the colour of MOLYBDATE (Middle pad) on the standard colour table (which is identical with the Middle (B) of the test sheet) is crossed with the colour of NITRITE on the standard colour table (which is identical with the (C) of the test sheet). It should be maintained at the optimum range, in the green section between 0.3 to 0.8.

c) If the measurement result is below 0.3, replenish anticorrosion additives (DCA4). If it is above 0.8 or, drain a little coolant and then add clean tap water to adjust the concentration.



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



1) Loosen the drain plug (A) of the oil cooler cover and then drain cooling water.

CHARGING THE COOLANT

- 1. Ensure that the engine is cool.
- 2. Open the radiator cap.

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 the coolant in slowly.

A CAUTION

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

- 4. Be sure that the air is gone out from cooling system.
- 5. After checking the coolant level when the engine is warmed up, replenish coolant if necessary.

WARNING

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.

Do not mix antifreezes from different manufacturers.

Do not mix the coolant with different concentrations.

Do not add antirust which is not recommended by us.

As insufficient coolant concentration may cause corrosion or freezing, on the other hand, an excessive concentration may degrade the cooling performance. Mix coolant with 40% antifreeze and $3\sim5\%$ additives (DCA4) 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 of 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 colour becomes a discoloured 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. If you want 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.

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.



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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 $5 \sim 10$ 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 and 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.



Engine Model and Product Code	SAE Classification	Oil Class
DP158L	SAE 15W40	API CD or above
DP180L	SAE 15W40	API CD or above
DP222L	SAE 15W40	API CD or 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	Engine oil capacity (litres)				
	Max.	Min.			
DP158L	22	13			
DP180L	34	23			
DP222L	40	27			

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.

A CAUTION

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



 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.



a) Check the oil level every day using the oil level gauge.

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

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

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

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 th 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.



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.

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.

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.

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 fi	Iter clogging point	(°°)	< -12	-18
Colour (ASTM)			< 2.5	0.7
Carbon Residue (1 (wt)	0%) Distillation residue	(%)	< 0.15	0.08
Total acid value		(mg KOH/g)	< 0.40	0.03
Copper corrosion (100 <i>°</i> C, 3 hrs)		< 1	1 - a
Ash content (wt)		(%)	< 0.01	0.001
Moisture and Preci	pitate	(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

REPLACING 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.



- Turn the drain plug (A) 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.

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

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

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

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.



- 1. Clean the area around the fuel filter head (3).
- 2. Disassemble the cartridge (2) by turning it counterclockwise with a fuel filter wrench.

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. Apply thin coat of clean oil to the O-ring (5) area of the cartridge, and fill the cartridge with fuel.
- 7. Screw the cartridge to the fuel filter head.
- 8. Tighten the cartridge by hand until the O-ring contacts the fuel filter head surface.

9. Turn by an additional 3/4 to 1 turn with a fuel filter wrench.



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 abnormal, authorized personnel should handle it.
- If the fuel injection pump is found to be damaged, it should only be repaired by authorised personnel.

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.

CLEANING THE FUEL PRE-FILTER

The fuel pre-filter should be cleaned periodically through disassembly. The fuel pre-filter is mounted individually for easy maintenance. Open the cover of the pre-filter and clean the element with compressed air first, and then rinse it with diesel fuel to remove foreign substances.



AIR BLEEDING IN THE FUEL CIRCUIT

When the engine stops due to replacement of fuel filter, fuel injection pump or insufficient fuel, perform air bleeding.



- 1. Loosen the air bleeding plug (B) on the fuel filter.
- 2. Operate the priming pump by hand to bleed air inside the fuel circuit.

3. Operate the priming pump until the air is discharged completely.



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.

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.

INJECTOR MAINTENANCE

- 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.
- A copper gasket fitted to the injector ensures gas-tight seating and good heat dissipation.
- The opening pressure of the nozzle is adjusted by means of shims at the compression spring.



- 1. Rod type filter
- 7. Connect hole for fuel delivery

8. Nozzle holder

overflow

9. Connect tube for

2. Cap nut

6. Nozzle

- 3. Compression spring
- 4. Compression pin 10. Shim
- 5. Cap nut for fixed nozzle 11. Pin
 - 12. Nozzle bush

FUEL INJECTION NOZZLE

1. Install a nozzle to the nozzle tester.



- 2. Check the fuel injection pressure. If the pressure does not satisfy the reference value, adjust the injection pressure of the nozzle using an adjustment shim.
- 3. Check the nozzle spray status. If it is defective, replace the nozzle.

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.



Engine	Nozzle injection pressure (Mpa)	
	DP158LCS	28
	DP158LCF	28
DF136L	DP158LDS	28
	DP158LDF	28
	DP180LBS	28
	DP180LBF	28
	DP180LAS	28
	DP180LAF	28
	DP222LAS	28
	DP222LBS	28
DP222L	DP222LBF	28
	DP222LCS	28
	DP222LCF	28

REMOVAL OF NOZZLE

- 1. Remove fuel injection pipe between nozzle holder and injection pump.
- 2. Remove fuel return pipe.
- 3. Loosen the Union screw (A) of nozzle holder with Nozzle plug socket (EI.03004-0225).
- 4. Remove nozzle holder with sealing from the cylinder head.



INSTALLATION NOZZLE

- 1. Clean seat in cylinder head.
- 2. Insert nozzle holder with new gasket.
- 3. Tighten union nut with 12 kgf•m.

Torque	12 kgf•m
	e e

4. Install injection lines free of constraint. Install leak fuel lines, screw delivery pipe at nozzle holder and at the injection pump.

The injection lines are designed for high operating pressure and should be handled with particular care.

When mounting the pipes to the engine ensure they are properly fitted.

Do not bend pipes when replacing the nozzles.

Do not mount any misshapen pipes.

Avoid bending pipe ends by more than 2 to 3 degrees.

In case of faults in the injection system which might have resulted in excessive operating pressures, replace both the failed part and the injection line.

NOTE FOR CLEANING NOZZLE

- Clean nozzle body externally from 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 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.

CHECKING THE INJECTION TIMING

- 1. Remove the plug screw on the flywheel housing cover.
- **NOTE:** In some cases it is necessary to remove the cover assembly.
- 2. Turn the crank pulley so that the mark on pointer provided on the injection pump coincides with matching mark (FB) on the flange surface of the drive gear.



 To check the injection timing degree, ensure the V-type edge of the flywheel housing sight hole coincides with the engine injection timing degree marked on the flywheel corresponding to the fuel delivery position.



Engir	Injection Timing (°)	
	DP158LCS	23°±1°
	DP158LCF	18°±1°
DI 130L	DP158LDS	23°±1°
	DP158LDF	18°±1°
	DP180LBS	21°±1°
	DP180LBF	19°±1 °
DI TOOL	DP180LAS	21°±1°
	DP180LAF	19°±1 °
	DP222LAS	21°±1°
	DP222LBS	21°±1°
DP222L	DP222LBF	19°±1 °
	DP222LCS	21°±1°
	DP222LCF	19°±1°

ADJUSTING INJECTION TIMING

If upper pre-checked injection timing degree is wrong, follow the procedure below.

1. Loosen the fixing bolts (M8) of the injection pump driving gear in order to adjust the injection timing slightly.



- 2. Turn the crank pulley clockwise until V-groove of the flywheel housing sight hole is aligned with the injection timing degree of the engine.
- 3. Ensure the mark on pointer provided in the injection pump corresponds with the matching mark (FB) on the flange surface of the drive gear by turning the flange in the oblong holes of the drive gear.
- 4. Tighten the bolt (M8) to specified torque, (2.2 kgf⋅m) being careful not to move the drive gear.
- 5. Once the fastening bolts are completely tightened check the start point (injection timing degree) of fuel delivery setting. Correct again using the above procedure if necessary.

INTAKE/EXHAUST SYSTEM

DISASSEMBLY OF AIR FILTER

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.



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.

DANGER

Allowed only when the engine is stopped.

- 1. Empty the dust bucket periodically. The dust should not exceed the half of the dust bucket capacity.
- 2. Disassemble the dust bucket by removing 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 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.
- 2. Air cleaner element

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.



a) To clean, use an air gun at a 90 $^{\circ}$ angle from the inside of the element.

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

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



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.



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.



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.



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.



- **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 any 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.



- 2. Clea or replace with new element.
- 3. Clean the inside of the filter housing with a damp cloth.
- 4. Replace end cap.



Do not let dust enter the end of air filter.

TURBOCHARGER

The Turbocharger does not need a specific maintenance. When replacing the engine oil, check 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.

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, 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

Remove the turbocharger 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.

ADJUSTING THE VALVE CLEARANCE



• 8 Cylinder engine



• 10 Cylinder engine



• 12 Cylinder engine



- 1. Rotate the crankshaft so that #1. cylinder may be positioned at the compression TDC (Top Dead Centre).
- **NOTE:** #1. Cylinder is located at the side near the cooling water pump.
- **NOTE:** In case of 8/12 cylinder engine, #6. cylinder is positioned at the valve overlap when #1. cylinder is positioned at the compression TDC (Top Dead Centre).
- **NOTE:** In case of 10 cylinder engine, #7. cylinder is positioned at the valve overlap when #1. cylinder is positoned at the compression TDC (Top Dead Centre).
- 2. Loosen the lock nut of the #1. cylinder rocker arm.
- 3. Push the feeler gauge between a rocker arm and a valve stem.
- 4. Adjust the clearance screw respectively and then tighten with the lock nut.
- 5. Only adjust the valve clearance when the engine is cold.

Engin	e Model	In. valve	Ex. valve
	DP158LCS	0.25mm	0.35mm
	DP158LCF	0.25mm	0.35mm
DI 130E	DP158LDS	0.25mm	0.35mm
	DP158LDF	0.25mm	0.35mm
	DP180LBS	0.25mm	0.35mm
	DP180LBF	0.25mm	0.35mm
DI 100L	DP180LAS	0.25mm	0.35mm
	DP180LAF	0.25mm	0.35mm
	DP222LAS	0.25mm	0.35mm
	DP222LBS	0.25mm	0.35mm
DP222L	DP222LBF	0.25mm	0.35mm
	DP222LCS	0.25mm	0.35mm
	DP222LCF	0.25mm	0.35mm

- 6. Rotate the crankshaft. When a cylinder reaches the compression TDC (Top Dead Centre), adjust the valve clearance of the cylinder.
- When a cylinder is at the vavle overlap, adjust the valve clearance cylinder of the compression TDC (Top Dead Centre), as follows.
- 8 cylinder engine (DP158L)

Valve overlap cylinder No.							
1	5	7	2	6	3	4	8
6	3	4	8	1	5	7	2
Adjusting valve cylinder No. (In./Ex. Valve)							

• 10 cylinder engine (DP180L)

Valve overlap cylinder No.									
1	6	5	10	2	7	3	8	4	9
7	7 3 8 4 9 1 6 5 10 2								
Adjusting valve cylinder No. (In./Ex. Valve)									

• 12 cyliner engine (DP222L)

Valve overlap cylinder No.											
1	12	5	8	3	10	6	7	2	11	4	9
6	7	2	11	4	9	1	12	5	8	3	10
Adjusting valve cylinder No. (In./Ex. Valve)											

TIGHTENING CYLINDER HEAD BOLT

1. Retightening cylinder head bolt on new engine.



1) The cylinder heads are mounted with cylinder head bolts which are tightened by the angle of rotation method.

2) On new engines the cylinder head bolts are tightened up for the first time at the factory after the engine has been broken in.

3) After the first 400 hours of operation retighten cylinder head bolts 1 to 4 in the order shown in the figure above by a further 90° (1/4 revolution).

The two outer screws (intake and exhaust sides) must not be retightened.

The cylinder head bolts to be retightened must not be loosened first, but simply tightened by a further $90^{\circ}(1/4 \text{ revolution})$ from their actual position.

2. Tightening cylinder head bolts after a repair. (Engine cold).



- 1. Tighten temporarily 1~2 threads by hands.
- 2. 1st step: Tighten to approximately 8kgf•m with a wrench.
- 3. 2nd step: Tighten to approximately 15kgf•m with a wrench.
- 4. 3rd step: Rotate 90° with a wrench.
- 5. Final step: Rotate 90° with a wrench.

Excessive torque may damage the cylinder head gasket, cylinder liner flange and cylinder head bolt. Ensure to use the specified torque settings.

When tightening cylinder head bolts after a repair, always adjust the valve clearance.

6. After the first 10 to 20 hours of operation after a repair turn the cylinder head bolts by a further 90° (1/4 revolution).

A CAUTION

Do not loosen cylinder head bolts before re-tightening. Tighten them by turning by a further $90^{\circ}(1/4 \text{ revolution})$ from their actual position.

 After 400 hours of operation turn the cylinder head bolts by a further 90° (1/4 revolution).

The two outside screws (intake and exhaust side) must not be retightened.

Do not loosen cylinder head bolts before re-tightening. Tighten them by turning by a further $90^{\circ}(1/4 \text{ revolution})$ from their actual position.

When a cylinder head has been removed the cylinder head gasket must always be changed.

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 (EU.2-0532), in the fuel injection nozzle holder hole.



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%

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.



Starter should be protected from humidity at all times.

Before working on the electrical 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.

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

2. Checking condition.

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

3. Testing by hand.



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

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

- 4. Tension measurement.
 - 1) Lower indicator arm (1) into the scale.



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



- 3) 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.
 - 4) Read the tension value at the point that the top surface of indicator arm (1) intersects with the scale.

5) 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.

		Tension from a Tension Meter		
-	Belt	New belt (kg)		
(mm)		Upon installatio n	After 10 minutes	Replacement required
М	8.5	50	45	40
Α	11.8	55	50	45
В	15.5	75	70	60
С	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.



- 1) Loosen the fixing bolt (1).
- 2) Loosen the lock nut (2).
- 3) Adjust the bolt (3) until belt have correct tension.
- 4) Tighten the fixing bolt (1) and nut (2).

5) To replace the V-belt, loosen the fixing bolts (1) and the lock nut (2) and push the tension pulley inwards by turning the adjusting bolt (3) counter clockwise.



- 6) Loosen the mounting bolts (B).
- 7) Loosen the lock nut (A).

8) Adjust the nut (C) until the belt tension has correct tensions.

9) Retighten the lock nut (A) and the mounting bolt (B).

10) To replace the belt, loosen the lock nut and push the alternator inwards.

ALTERNATOR INSTALLATION AND MAINTENANCE

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LSA 46.2 - 4 POLES ALTERNATORS

THIS SECTION CONCERNS THE ALTERNATOR WHICH YOU HAVE JUST PURCHASED.

We wish to draw your attention to the contents of this section.

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various operations described in this manual are accompanied by recommendations or symbols to alert the user to the potential risk of accidents. It is vital that you understand and take notice of the different warning symbols used.

- 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 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.

We wish to draw your attention to the following 2 safety measures which must be complied with:

a) During operation, do not allow anyone to stand in front of the air outlet guards, in case anything is ejected from them.

b) Do not allow children younger than 14 to go near the air outlet guards.

A set of self-adhesive stickers depicting the various warning symbols is included with this maintenance manual. They should be positioned as shown in the drawing below once the machine has been fully installed.

The alternators must not be put into service until the machines in which they are to be incorporated have been declared compliant with Directives EC and plus any other directives that may be applicable.

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RECEIPT

STANDARDS AND SAFETY MEASURES

Our alternators comply with most international standards.

See the EC Declaration of Incorporation on the last page.

INSPECTION

On receipt of your alternator, check that it has not suffered any damage in transit. If there are obvious signs of knocks, contact the transporter (you may be able to claim on their insurance) and after a visual check, turn the machine by hand to detect any malfunction.

IDENTIFICATION

The alternator is identified by means of a nameplate fixed on the machine (see drawing).

Make sure that the nameplate on the machine conforms to your order.

So that you can identify your alternator quickly and accurately, we suggest you fill in its specifications on the nameplate below.

Prior to commissioning, machines should be stored: - away from humidity (< 90%); after a long period of storage, check the machine insulation. To prevent the bearings from becoming marked, do not store in an environment with significant vibration.

APPLICATION

STORAGE

These alternators are mainly designed to produce electricity in the context of applications involving the use of generators.

CONTRAINDICATIONS TO USE

Use of the machine is restricted to operating conditions (environment, speed, voltage, power, etc) compatible with the characteristics indicated on the nameplate.

	RATINGS
N°· Date ·	
r n m Hz Weight : kg	Phase
P.F. : Th.class. Altitude : m	Conn.
A.V.R. Excit.	Contin.
Excit. values full load : V / A	B.R
at no load : A	40°C.
D.E. bearing	Std by
N.D.E. bearing	
	27°C

TECHNICAL CHARACTERISTICS

ELECTRICAL CHARACTERISTICS

The LSA 46.2 alternator is a machine without sliprings or revolving armature brushes, wound as "2/3 pitch", 6 or 12-wire, with class H insulation and a field excitation system available in either SHUNT, AREP or «PMG» version (see diagrams and AVR manuals).

Electrical options

- Stator temperature detection sensors
- Bearing sensors (PTC, PT100, etc)
- Space heater

Interference suppression conforms to standard EN 55011, group 1, class B (Europe).

MECHANICAL CHARACTERISTICS

- Steel frame
- Cast iron end shields
- Protected ball bearings, greased for life
- Mounting arrangements:

IM 1201 (MD 35) foot and flange mounted, single-bearing with SAE coupling disc.

IM 1001 (B 34) double-bearing with SAE flange and standard cylindrical shaft extension.

- Drip-proof machine, self-cooled
- Degree of protection: IP 23

Mechanical options

- Air inlet filter
- Regreasable ball bearings
- IP 44 protection



INSTALLATION

Personnel undertaking the various operations indicated in this section must wear personal protective equipment appropriate for mechanical and electrical hazards.

ASSEMBLY



All mechanical handling operations must be undertaken using suitable equipment and the machine must be horizontal. Check how much the machine weighs before choosing the lifting tool.

During this operation, do not allow anyone to stand under the load.

Handling

The generously-sized lifting rings are for handling the alternator alone. They must not be used to lift the genset. The choice of lifting hooks or handles should be determined by the shape of these rings. Choose a lifting system which respects the integrity and the environment of the machine.

During this operation, do not allow anyone to stand under the load.



Single-bearing coupling

Before coupling the machines, check that they are compatible by:

- undertaking a torsional analysis of the transmission,

- checking the dimensions of the flywheel and its housing, the flange, coupling discs and offset.

When coupling the alternator to the prime mover, do not use the fan to turn the alternator or rotor.

The holes of the coupling discs should be aligned with the flywheel holes by cranking the engine.

Make sure the machine is securely bedded in position during coupling.

Check that there is lateral play on the crankshaft.

Double-bearing coupling

- Semi-flexible coupling

Careful alignment of the machines is recommended, checking that the lack of concentricity and parallelism of both parts of the coupling do not exceed 0.1 mm. **This alternator has been balanced with a 1/2 key.**

Location

The room where the alternator is placed must be ventilated to ensure that the ambient temperature cannot exceed the data on the nameplate.

CHECKS PRIOR TO FIRST USE

Electrical checks



Under no circumstances should an alternator, new or otherwise, be operated if the insulation is less than 1 megohm for the stator and 100,000 ohms for the other windings.

There are 2 possible methods for restoring the above minimum values.

a) Dry out the machine for 24 hours in a drying oven at a temperature of 110 $^{\circ}$ C (without the regulator).

b) Blow hot air into the air intake, having made sure that the machine is rotating with the exciter field disconnected.

NOTE: Prolonged standstill

In order to avoid these problems, we recommend the use of space heaters, as well as turning over the machine from time to time. Space heaters are only really effective if they are working continuously while the machine is stopped.

Ensure that the alternator has the degree of protection matching the defined environmental conditions.

Mechanical checks

Before starting the machine for the first time, check that:

- all fixing bolts and screws are tight,
- the cooling air is drawn in freely,
- the protective grilles and housing are correctly in place,
- the standard direction of rotation is clockwise as seen from the shaft end (phase rotation in order 1 2 3).

For anti-clockwise rotation, swap 2 and 3.

- the winding connection corresponds to the site operating voltage (See later in this manual).

TERMINAL CONNECTION DIAGRAMS

To modify the connection, change the position of the stator cables on the terminals.

The winding code is specified on the nameplate.



Any intervention on the alternator terminals during reconnection or checks should be performed with the machine stopped.







Option connection diagram

R791T interference suppression kit (standard for CE marking)	Remote voltage potentiometer
Connections \bigcirc \bigcirc \bigcirc Black \neg \neg \neg \neg Black \neg \neg \neg \neg Black \neg \neg \neg \neg Black \neg \neg \neg Black \neg \neg \neg Black \neg	ST4 Voltage adjustment via remote potentiometer

Current transformer connection (optional) Coupling D & A- PH 1 Coupling D- PH 1 = T4 = T10 P2 P2 In - Secondary 1 A In - Secondary 1A (coupl. D) 6-wire 12-wire **P1** Neutral Neutral link link Anti condensation heater Thermistor (PTC) temperature 103 130 C blue wire Ph1 250W - 220 V 101 150 C black wire Ph2 102 Ph3 180 C red/white wire 104

COMMISSIONING

Electrical installations must comply with the current legislation in force in the country of use.

Check that:

- The residual circuit-breaker conforms to legislation on protection of personnel, in force in the country of use, and has been correctly installed on the alternator power output as close as possible to the alternator. (In this case, disconnect the wire of the interference suppression module linking the neutral).

- Any protection devices in place have not been tripped.

- If there is an external AVR, the connections between the alternator and the cabinet are made in accordance with the connection diagram.

- There is no short-circuit phase-phase or phase-neutral between the alternator output terminals and the generator set control cabinet (part of the circuit not protected by circuitbreakers or relays in the cabinet).

- The machine should be connected with the busbar separating the terminals as shown in the terminal connection diagram.



- The alternator earth terminal inside the terminal box is connected to the electrical earth circuit.

- The earth terminal (ref 28) is connected to the frame. The connections inside the terminal box must never be subjected to stress due to cables connected by the user.



CAUTION

The machine can only be started up and used if the installation is in accordance with the regulations and instructions defined in this manual.

The machine is tested and set up at the factory. When first used with no load, make sure that the drive speed is correct and stable (see the nameplate). With the regreasable bearing option, we recommend greasing the bearings at the time of commissioning (See later in this manual).

On application of the load, the machine should achieve its rated speed and voltage; however, in the event of abnormal operation, the machine setting can be altered (follow the adjustment procedure later in this manual). If the machine still operates incorrectly, the cause of the malfunction must be located (See later in this manual).

SETTING UP



The various adjustments during tests must be made by a qualified engineer.

Ensure that the drive speed specified on the nameplate is reached before commencing adjustment.

After operational testing, replace all access panels or covers.

The AVR is used to make any adjustments to the machine.

SERVICING - MAINTENANCE

SAFETY MEASURES

Servicing or troubleshooting must be carried out strictly in accordance with instructions so as to avoid the risk of accidents and to maintain the machine in its original state.



All such operations performed on the alternator should be undertaken by personnel trained in the commissioning, servicing and maintenance of electrical and mechanical components, who must wear personal protective equipment appropriate for mechanical and electrical hazards.

Before any intervention on the machine, ensure that it cannot be started by a manual or automatic system and that you have understood the operating principles of the system.





During and after running, the alternator will reach temperatures hot enough to cause injury, such as burns.

ROUTINE MAINTENANCE

Checks after start-up

After approximately 20 hours of operation, check that all fixing screws on the machine are still tight, plus the general state of the machine and the various electrical connections in the installation.

Electrical servicing

Commercially-available volatile degreasing agents can be used.



Do not use: trichlorethylene, perchlorethylene, trichloroethane or any alkaline products.

These operations must be performed at a cleaning station, equipped with a vacuum system that collects and flushes out the products used.

The insulating components and the impregnation system are not at risk of damage from solvents. Avoid letting the cleaning product run into the slots.

Apply the product with a brush, sponging frequently to avoid accumulation in the housing. Dry the winding with a dry cloth. Let any traces evaporate before reassembling the machine.

Mechanical servicing



Cleaning the machine using water or a high pressure washer is strictly prohibited. Any problems arising from such treatment are not covered by our warranty.

Degreasing: Use a brush and detergent (suitable for paintwork).

Dusting: Use an air gun.

If the machine is fitted with air inlet and outlet filters, the maintenance personnel should clean them routinely at regular intervals. In the case of dry dust, the filter can be cleaned using compressed air and/or replaced if it is clogged.

After cleaning the alternator, it is essential to check the winding insulation (See later in this manual).

BEARINGS

Approximate life of the grease (depending on use) = 20,000 hours or 3 years.
Regreasing interval: 4000 hrs of operation DE bearing: Amount of grease: 33 gr NDE bearing: Amount of grease: 30 gr
LITHIUM - standard - NLGI 3
ESSO - Unirex N3



It is imperative to lubricate the alternator during operation and on first use. Before using another grease, check for compatibility with the original one.

MECHANICAL DEFECTS

Fault		Action	
Bearing	Excessive overheating of one or both bearings (bearing temperature 80 °C above the ambient temperature)(With or without abnormal bearing noise).	 If the bearing has turned blue or if the grease has turned black, change the bearing. Bearing not fully locked (abnormal play in the bearing cage). End shields incorrectly aligned. 	
Abnormal temperature	Excessive overheating of alternator frame (more than 40 °C above the ambient temperature).	 Air flow (inlet-outlet) partially clogged or hot air is being recycled from the alternator or engine. Alternator operating at too high a voltage (>105% of Un on load). Alternator overloaded. 	
Vibrations	Too much vibration.	 Misalignment (coupling). Defective mounting or play in coupling. Rotor balancing fault (Engine - Alternator). 	
	Excessive vibration and humming noise coming from the machine.	- Phase imbalance. - Stator short-circuit.	
Abnormal noise	Alternator damaged by a significant impact, followed by humming and vibration.	 System short-circuit. Misparalleling. Possible consequences. Broken or damaged coupling. Broken or bent shaft end. Shifting and short-circuit of main field. Fan fractured or coming loose on shaft. Irreparable damage to rotating diodes/AVR, surge suppressor. 	
Fault	Action	Effect	Check/Cause
---	---	--	--
	Connect a new battery of 4 to 12 volts to terminals E- and E+, respecting the polarity, for 2 to 3 seconds.	The alternator builds up and its voltage is still correct when the battery is removed.	- Lack of residual magnetism.
No voltage at no load on start-up		The alternator builds up but its voltage does not reach the rated value when the battery is removed.	 Check the connection of the voltage reference to the AVR. Faulty diodes. Armature short-circuit.
		The alternator builds up but its voltage disappears when the battery is removed.	 Faulty AVR. Field windings open circuit (check winding). Revolving field coil open circuit (check the resistance).
Voltage too low	Check the drive speed.	Correct speed.	Check the AVR connections (AVR may be faulty). - Field windings short-circuited. - Rotating diodes burnt out. - Revolving field coil short-circuited. - Check the resistance.
		Speed too low.	Increase the drive speed (do not touch the AVR voltage pot. (P2) before running at the correct speed).
Voltage too high.	Adjust AVR voltage potentiometer.	Adjustment ineffective.	Faulty AVR.
Voltage oscillations.	Adjust the AVR stability potentiometer.	If no effect: try normal or fast stability modes (ST2).	 Check the speed: possibility of cyclic irregularity. Loose connections. Faulty AVR. Speed too low when on load (or AVR LAM set too high).
Voltage	Run at no load and	Voltage between E+ and E- (DC) SHUNT / AREP / PMG < 10V.	- Check the speed (or AVR LAM set too high).
correct at no load and too low when on load.	check the voltage between E+ and E- on the AVR.	Voltage between E+ and E SHUNT/ AREP / PMG > 15V.	 Faulty rotating diodes. Short-circuit in the revolving field coil. Check the resistance. Faulty exciter armature. Check the resistance.
Voltage disappears during operation.	Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components.	The voltage does not return to the rated value.	 Exciter winding open circuit. Faulty exciter armature. Faulty AVR. Revolving field coil open circuit or shortcircuited.

Checking the winding

You can check the winding insulation by performing a high voltage test. In this case, you must disconnect all AVR wires.



Damage caused to the AVR in such conditions is not covered by our warranty.

CHECKING THE DIODE BRIDGE

A diode in good working order should allow the current to flow only in the anode-tocathode direction.



Checking the windings and rotating diodes using separate excitation



During this procedure, make sure that the alternator is disconnected from any external load and inspect the terminal box to check that the connections are fully tightened.

- 1. Stop the unit, disconnect and isolate the AVR wires.
- 2. There are two ways of creating an assembly with separate excitation.

Assembly A:

Connect a 12 V battery in series with a rheostat of approximately 50 ohms - 300 W and a diode on both exciter field wires (5+) and (6-).



Assembly B:

Connect a "Variac" variable power supply and a diode bridge on both exciter field wires (5+) and (6-).

Both these systems should have characteristics which are compatible with the field excitation power of the machine (see the nameplate).

- 3. Run the unit at its rated speed.
- 4. Gradually increase the exciter field current by adjusting the rheostat or the variac and measure the output voltages on L1 L2 L3, checking the excitation voltage and current at no load (see the machine nameplate or ask for the factory test report). When the output voltage is at its rated value and balanced within 1% for the rated excitation level, the machine is in good working order. The fault therefore comes from the AVR or its associated wiring (ie. detection, auxiliary windings).

ASSEMBLY B



During the warranty period, this operation should only be carried out in an approved workshop or in our factory, otherwise the warranty may be invalidated.

Whilst being handled, the machine should remain horizontal (rotor not locked in position). Check how much the machine weighs before choosing the lifting method.



Tools required

To fully dismantle the machine, we recommend using the tools listed below:

- 1 ratchet spanner + extension
- 1 torque wrench
- 1 set of flat spanners: 8 mm, 10 mm, 18 mm
- 1 socket set: 8, 10, 13, 16, 18, 21, 24, 30 mm
- 1 socket with male ferrule: 5 mm- 1 puller

Screw tightening torque

See later in this manual.

Access to diodes

- Open the air intake grille (51).

- Disconnect the diodes.

- Check the 6 diodes, change the diode bridges if necessary.

Access to connections and the regulation system

Access directly by removing the top of the cover (48) or the AVR access door (466).

Replacing the NDE bearing

- Remove the box lid (48) and the NDE panel (365) and remove the 2 screws from the part (122).
- Disconnect the stator outputs (T1 to T12).
- Disconnect the auxiliary winding wires AREP (X1,X2,Z1,Z2).
- Disconnect the exciter wires (5+,6-).
- Remove the air inlet louvre (51).

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Remove the bearing (78) thrust screws (72).
- Remove all 4 screws (37).
- Remove the shield (36).
- Take out the antifriction bearing (70) using a puller with
- a central screw (see drawing below).



- Fit the new antifriction bearing onto the shaft after heating it by induction to approximately 80 °C.

- Mount the new preloading (wavy) washer (79) + the new "O" ring seal (349) in the shield (36) and coat the bearing seat with adhesive paste (see After Sales Service)

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Screw a threaded rod into the thrust bearing (78).

- Refit the end shield on the machine using a dowel and nut in the shaft extension (see drawing).

- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).



- Fit the thrust bearing screws (78), remove the threaded rod, fit the other screw and tighten up the assembly.

- Tighten the 4 bearing screws (37).
- Reconnect wires.
- Fit the 2 support screws (122).
- Fit the air inlet louvre (51).
- Replace the cover.

CAUTION

When dismantling the shields, you will need to change the antifriction bearings, the "O" ring seal, the preloading (wavy) washer and adhesive paste.

Replacing the DE bearing

- Remove the air outlet grille (33).

- Remove the 6 screws (31) from the DE shield and the 3 screws (62) from the inner bearing retainer.

- Remove the shield (30).

- Take out the ball bearing (60) using a puller with a central screw.

- Fit the new bearing, after heating it by induction to approximately 80 °C.

- Screw a threaded rod into the thrust bearing (68).
- Refit the shield (30) on the machine.

- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).

- Tighten the bottom thrust bearing screws (78), remove the threaded rod and fit the other screws.

- Tighten the 6 shield screws (31).

- Refit the air outlet grille (33).

Dismantling the rotor assembly

- Remove the NDE shield (36) as described later in this manual.

- Remove the DE shield (30) as described in this manual if it is a double-bearing machine.

- Support the DE rotor (4) with a strap or with a support constructed in accordance with the following drawing.

- Move the strap as the rotor moves in order to distribute the weight over it.

- After extracting the rotor, be careful not to damage the fan and place the revolving field on special V-blocks.



A CAUTION

When dismantling the rotor involves changing parts or rewinding, the rotor must be rebalanced.

Reassembling the machine

- Mount the rotor (4) in the stator (1) (see drawing above) taking care not to knock the windings.

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Mount the new preloading (wavy) washer (79) + the new "O" ring seal (349) in the shield (36).

- Screw a threaded rod into the thrust bearing (78).
- Refit the shield (36) on the machine using a dowel and nut in the shaft extension (see diagram).

- Slide the threaded rod into the shield hole to make it easier to assemble (see diagram).

- Fit the thrust bearing screws (78), remove the threaded rod, fit the other screw and tighten up the assembly.

- Tighten the 4 bearing screws (37).
- Reconnect exciter wires E+, E-.
- Finish reassembling the cover.
- Refit the flange (30) on the stator (1).
- Tighten the screws (31).

If using a double-bearing machine:

- Mount the new preloading (wavy) washer (79) + the new "O" ring seal (349) in the shield (36).

- Refit the shield (36) on the machine using a dowel and nut in the shaft extension (see diagram).

- Tighten the 4 shield screws (37).
- Reconnect exciter wires E+, E-.
- Finish reassembling the cover.
- Screw a threaded rod into the thrust bearing (68).
- Refit the shield (30) on the machine.

- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).

- Fit the thrust bearing screws (68), remove the threaded rod, fit the other screw and tighten up the assembly.

- Tighten the 6 shield screws (31).
- Refit the air outlet grille (33).

- Check that the machine assembly is correctly mounted and that all screws are tightened.

Dismantling and reassembly of the filters

- Remove the grille (417) then take out the filter (418). Change the filter if necessary; please see later in this manual for cleaning the filter.

To replace, follow the instructions in reverse order.

51 418 417

INSTALLATION AND MAINTENANCE OF THE PMG

For the LSA 46.2, the PMG reference is: PMG 2. See the PMG manual ref : 4211.

TABLE OF CHARACTERISTICS

Table of average values

Alternator - 4 poles - 50 Hz - Standard winding No. 6.

(400V for the excitation values)

The voltage and current values are given for no-load operation and operation at rated load with separate field excitation.

All values are given to within \pm 10% and may be changed without prior notification (for exact values, consult the test report).

LSA46.2 average values Resistances at 20 °C (Ohms)

LSA 46.2	Stator L/N	Rotor	Exciter armature
VL12	0.0085	0.343	0.037

Field excitation current i exc (A)

Symbols : "i exc": excitation current of the exciter field.

LSA 46.2	No load	At rated load
VL12	1.1	3.5

For 60 Hz machines, the "i exc" values are approximately 5 to 10 % lower.

Table of weights (values given for information only)

LSA 46.2	Total weight (kg)	Rotor (kg)
VL12	1000	380



After operational testing, it is essential to replace all access panels or covers.

SPARE PARTS

FIRST MAINTENANCE PARTS

Emergency repair kits are available as an option. They contain the following items:

Emergency kit SHUNT	ALT 472 KS 001
AVR R 250	-
Diode bridge assembly	-
Surge suppressor	-

Single-bearing kit	ALT 471 KB 002
Non drive end bearing	-
«O» ring	-
Preloading (wavy) washer	-

TECHNICAL SUPPORT SERVICE

Our technical support service will be pleased to provide any additional information you may require.

When ordering spare parts, you should indicate the complete machine type, its serial number and the information given on the nameplate.

Address your enquiry to your usual contact.

Part numbers should be identified from the exploded views and their description from the parts list. Our extensive network of service centres can dispatch the necessary parts without delay.

To ensure correct operation and the safety of our machines, we recommend the use of original manufacturer spare parts.

In the event of failure to comply with this advice, the manufacturer cannot be held responsible for any damage.



After operational testing, it is essential to replace all access panels or covers.

ACCESSORIES

Space heater for use when stopped

The space heater must run as soon as the alternator stops. It is installed at the rear of the machine. Its standard power is 250W with 220V or 250W with 110V on request.

The power supply is present when the machine has stopped.

Temperature sensors with thermistors (PTC)

These are thermistor triplets with a positive temperature coefficient installed in the stator winding (1 per phase). There can be a maximum of 2 triplets in the winding (at 2 levels: warning and trip) and 1 or 2 thermistors in the shields.

These sensors must be linked to adapted detection relays (supplied optionally).

Cold resistance of cold thermistor sensors: 100 to 250 Ohms per sensor.

Connection accessories

- 6-wire machines : coupling (F).
- 12-wire machines : coupling (A), (F .F), (F).

EXPLODED VIEW, PARTS LIST AND TIGHTENING TORQUE

LSA 46.2 SINGLE-BEARING



Ref.	Qty	Description	Screw	Torque
			Ø	N.m
1	1	Stator assembly	-	-
4	1	Rotor assembly	-	-
15	1	Fan	-	-
21	1	Lifting ring	-	-
22	1	Shaft extension key	-	-
28	1	Earth terminal	M10	20
30	1	Drive end shield	-	-
31	6 or 4	Fixing screws	M14	80(*)
33	1	Protective grille	-	-
34	2	Fixing screws	M6	5
36	1	Exciter end shield	-	-
37	4	Fixing screws	M12	50
41	1	Cover front panel	-	-
48	1	Cover top panel	-	-
49	-	Cover screws	M6	5
51	1	Air intake grille	-	-
53	1	Plug	-	-
60	1	Drive end bearing	-	-
62	3 or 4	Fixing screws	M8	20
68	1	Inner bearing retainer	-	-
70	1	Non drive end bearing	-	-
71	1	Cover	-	-
72	2	Fixing screws	M8	20
78	1	Inner bearing retainer	-	-
79	1	Preloading (wavy) washer	-	-

Ref.	Qty	Description	Screw Ø	Torque N.m
90	1	Exciter field	-	-
91	4	Fixing screws	M6	10
100	1	Exciter armature	-	-
120	1	Terminal plate support		
122	1	Plate support	-	-
124	1	Terminal plate	M12	35
177	2	AVR support bracket	-	-
198	1	Voltage regulator (AVR)	-	-
284	1	Circlips	-	-
320	1	Coupling sleeve	-	-
321	1	Sleeve key	-	-
322	3	Coupling disc	-	-
323	6	Fixing screw	M16	170
325	-	Spacer shim	-	-
343	1	Diode bridge assembly	M6	4
347	1	Protection varistor (+ PCB)	-	-
349	1	"O" ring	-	-
364	1	AVR support	-	-
365	1	Cover rear panel	-	-
367	2	Side panel	-	-
371	4	Damper	-	-
416	1	Filter	-	-
417	1	Filter support	-	-
466	2	AVR inspection door	-	-

(*) 80 N.m in M / 190 N.m in L, VL

OPERATION & MAINTENANCE MANUAL

LSA 47.2 - 4 POLES ALTERNATORS

This section concerns the alternator which you have just purchased.

We wish to draw your attention to the contents of this maintenance manual.

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various operations described in this manual are accompanied by recommendations or symbols to alert the user to the potential risk of accidents. It is vital that you understand and take notice of the different warning symbols used.

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.

WARNING SYMBOLS

We wish to draw your attention to the following 2 safety measures which must be complied with:

a) During operation, do not allow anyone to stand in front of the air outlet guards, in case anything is ejected from them.

b) Do not allow children younger than 14 to go near the air outlet guards.

A set of self-adhesive stickers depicting the various warning symbols is included with this maintenance manual. They should be positioned as shown in the drawing below once the machine has been fully installed.

A WARNING

The alternators must not be put into service until the machines in which they are to be incorporated have been declared compliant with Directives EC and plus any other directives that may be applicable.

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RECEIPT

STANDARDS AND SAFETY MEASURES

Our alternators comply with most international standards.

See the EC Declaration of Incorporation on the last page.

INSPECTION

On receipt of your alternator, check that it has not suffered any damage in transit. If there are obvious signs of knocks, contact the transporter (you may be able to claim on their insurance) and after a visual check, turn the machine by hand to detect any malfunction.

IDENTIFICATION

The alternator is identified by means of a nameplate fixed on the machine (see drawing).

Make sure that the nameplate on the machine conforms to your order.

So that you can identify your alternator quickly and accurately, we suggest you fill in its specifications on the nameplate below.

Prior to commissioning, machines should be stored: - away from humidity (< 90%); after a long period of storage, check the machine insulation. To prevent the bearings from becoming marked, do not store in an environment with significant vibration.

APPLICATION

STORAGE

These alternators are mainly designed to produce electricity in the context of applications involving the use of generators.

CONTRAINDICATIONS TO USE

Use of the machine is restricted to operating conditions (environment, speed, voltage, power, etc) compatible with the characteristics indicated on the nameplate.

	IP		RATINGS	
N°: Date :		Voltage		Πv
r.p.m. Hz Weight	: kg	Phase		=
P.F. : Th.class. Altitude	e: m	Conn.		
A.V.R. Excit.		Contin.		 □ kVA
Excit. values full load : V /	A	B.R.		
at no load :	A	40°C.		A
D.E. bearing		Std by		
N.D.E. bearing		P.R.		
S ₽°	((27°C.		
c Us		150 8528-3	Made in	

TECHNICAL CHARACTERISTICS

ELECTRICAL CHARACTERISTICS

The LSA 47.2 alternator is a machine without sliprings or revolving armature brushes, wound as "2/3 pitch", 6 or 12-wire, with class H insulation and a field excitation system available in either SHUNT, AREP or «PMG» version (see diagrams and AVR manuals).

Electrical options

- Stator temperature detection sensors
- Bearing sensors (PTC, PT100, etc)
- Space heater

Interference suppression conforms to standard EN 55011, group 1, class B (Europe).

MECHANICAL CHARACTERISTICS

- Steel frame
 - Cast iron end shields
 - Protected ball bearings, greased for life
 - Mounting arrangements:

IM 1201 (MD 35) foot and flange mounted, singlebearing with SAE coupling disc. IM 1001 (B 34) double-bearing with SAE flange and

standard cylindrical shaft extension.

- Drip-proof machine, self-cooled
- Degree of protection: IP 23

Mechanical options

- Air inlet filter
- Regreasable ball bearings
- IP 44 protection



INSTALLATION

Personnel undertaking the various operations indicated in this section must wear personal protective equipment appropriate for mechanical and electrical hazards.

ASSEMBLY



All mechanical handling operations must be undertaken using suitable equipment and the machine must be horizontal. Check how much the machine weighs before choosing the lifting tool.

During this operation, do not allow anyone to stand under the load.

Handling

The generously-sized lifting rings are for handling the alternator alone. They must not be used to lift the genset. The choice of lifting hooks or handles should be determined by the shape of these rings. Choose a lifting system which respects the integrity and the environment of the machine.

During this operation, do not allow anyone to stand under the load.



Single-bearing coupling

Before coupling the machines, check that they are compatible by:

- undertaking a torsional analysis of the transmission,

- checking the dimensions of the flywheel and its housing, the flange, coupling discs and offset.

When coupling the alternator to the prime mover, do not use the fan to turn the alternator or rotor.

The holes of the coupling discs should be aligned with the flywheel holes by cranking the engine.

Make sure the machine is securely bedded in position during coupling.

Check that there is lateral play on the crankshaft.

Double-bearing coupling

- Semi-flexible coupling

Careful alignment of the machines is recommended, checking that the lack of concentricity and parallelism of both parts of the coupling do not exceed 0.1 mm. **This alternator has been balanced with a 1/2 key.**

Location

The room where the alternator is placed must be ventilated to ensure that the ambient temperature cannot exceed the data on the nameplate.

CHECKS PRIOR TO FIRST USE

Electrical checks



Under no circumstances should an alternator, new or otherwise, be operated if the insulation is less than 1 megohm for the stator and 100,000 ohms for the other windings.

There are 2 possible methods for restoring the above minimum values.

a) Dry out the machine for 24 hours in a drying oven at a temperature of 110 $^{\circ}$ C (without the regulator).

b) Blow hot air into the air intake, having made sure that the machine is rotating with the exciter field disconnected.

NOTE: Prolonged standstill

In order to avoid these problems, we recommend the use of space heaters, as well as turning over the machine from time to time. Space heaters are only really effective if they are working continuously while the machine is stopped.

A CAUTION

Ensure that the alternator has the degree of protection matching the defined environmental conditions.

Mechanical checks

Before starting the machine for the first time, check that:

- all fixing bolts and screws are tight,
- the cooling air is drawn in freely,
- the protective grilles and housing are correctly in place,
- the standard direction of rotation is clockwise as seen from the shaft end (phase rotation in order 1 2 3).

For anti-clockwise rotation, swap 2 and 3.

- the winding connection corresponds to the site operating voltage (See later in this manual).

TERMINAL CONNECTION DIAGRAMS

To modify the connection, change the position of the stator cables on the terminals.

The winding code is specified on the nameplate.



Any intervention on the alternator terminals during reconnection or checks should be performed with the machine stopped.





Option connection diagram

R791T interference suppression kit (standard for CE marking)	Remote voltage potentiometer
Connections \bigcirc \bigcirc \bigcirc Black \top \top \top \top Hue \blacksquare \blacksquare \blacksquare	ST4 Voltage adjustment via remote potentiometer

Current transformer connection (optional) Coupling D- PH 1 Coupling D & A- PH 1 Τ4 = T10 In - Secondary 1 A In - Secondary 1A (coupl. D) D1 P1 12-wire 6-wire Neutral Neutral link link Anti condensation heater Thermistor (PTC) temperature 103 Ph1 130 C blue wire 250W - 220 V 101 150 C black wire Ph2 102 180 C red/white wire Ph3 104

OPERATION & MAINTENANCE MANUAL

COMMISSIONING



Electrical installations must comply with the current legislation in force in the country of use.

Check that:

- The residual circuit-breaker conforms to legislation on protection of personnel, in force in the country of use, and has been correctly installed on the alternator power output as close as possible to the alternator. (In this case, disconnect the wire of the interference suppression module linking the neutral).

- Any protection devices in place have not been tripped.

- If there is an external AVR, the connections between the alternator and the cabinet are made in accordance with the connection diagram.

- There is no short-circuit phase-phase or phase-neutral between the alternator output terminals and the generator set control cabinet (part of the circuit not protected by circuitbreakers or relays in the cabinet).

- The machine should be connected with the busbar separating the terminals as shown in the terminal connection diagram.



- The alternator earth terminal inside the terminal box is connected to the electrical earth circuit.

- The earth terminal (ref 28) is connected to the frame. The connections inside the terminal box must never be subjected to stress due to cables connected by the user.



The machine can only be started up and used if the installation is in accordance with the regulations and instructions defined in this manual.

The machine is tested and set up at the factory. When first used with no load, make sure that the drive speed is correct and stable (see the nameplate). With the regreasable bearing option, we recommend greasing the bearings at the time of commissioning (See later in this manual).

On application of the load, the machine should achieve its rated speed and voltage; however, in the event of abnormal operation, the machine setting can be altered (follow the adjustment procedure later in this manual). If the machine still operates incorrectly, the cause of the malfunction must be located. (See later in this manual)

SETTING UP



The various adjustments during tests must be made by a qualified engineer.

Ensure that the drive speed specified on the nameplate is reached before commencing adjustment.

After operational testing, replace all access panels or covers.

The AVR is used to make any adjustments to the machine.

SERVICING - MAINTENANCE

SAFETY MEASURES

Servicing or troubleshooting must be carried out strictly in accordance with instructions so as to avoid the risk of accidents and to maintain the machine in its original state.



All such operations performed on the alternator should be undertaken by personnel trained in the commissioning, servicing and maintenance of electrical and mechanical components, who must wear personal protective equipment appropriate for mechanical and electrical hazards.

Before any intervention on the machine, ensure that it cannot be started by a manual or automatic system and that you have understood the operating principles of the system.





During and after running, the alternator will reach temperatures hot enough to cause injury, such as burns.

ROUTINE MAINTENANCE

Checks after start-up

After approximately 20 hours of operation, check that all fixing screws on the machine are still tight, plus the general state of the machine and the various electrical connections in the installation.

Electrical servicing

Commercially-available volatile degreasing agents can be used.



Do not use: trichlorethylene, perchlorethylene, trichloroethane or any alkaline products.

These operations must be performed at a cleaning station, equipped with a vacuum system that collects and flushes out the products used.

The insulating components and the impregnation system are not at risk of damage from solvents. Avoid letting the cleaning product run into the slots.

Apply the product with a brush, sponging frequently to avoid accumulation in the housing. Dry the winding with a dry cloth. Let any traces evaporate before reassembling the machine.

Mechanical servicing



Cleaning the machine using water or a high pressure washer is strictly prohibited. Any problems arising from such treatment are not covered by our warranty.

Degreasing: Use a brush and detergent (suitable for paintwork).

Dusting: Use an air gun.

If the machine is fitted with air inlet and outlet filters, the maintenance personnel should clean them routinely at regular intervals. In the case of dry dust, the filter can be cleaned using compressed air and/or replaced if it is clogged.

After cleaning the alternator, it is essential to check the winding insulation (See later in this manual).

BEARINGS

The bearings are permanently greased	Approximate life of the grease (depending on use) = 20,000 hours or 3 years.
As an option, the bearings are regreasable	Regreasing interval: 3500 hrs of operation DE bearing: Amount of grease: 41 gr NDE bearing: Amount of grease: 30 gr
Standard grease	LITHIUM - standard - NLGI 3
Grease used in the factory	ESSO - Unirex N3



It is imperative to lubricate the alternator during operation and on first use. Before using another grease, check for compatibility with the original one.

MECHANICAL DEFECTS

Fault		Action
Bearing	Excessive overheating of one or both bearings (bearing temperature 80 ℃ above the ambient temperature)(With or without abnormal bearing noise).	 If the bearing has turned blue or if the grease has turned black, change the bearing. Bearing not fully locked (abnormal play in the bearing cage). End shields incorrectly aligned.
Abnormal temperature	Excessive overheating of alternator frame (more than 40 °C above the ambient temperature).	 Air flow (inlet-outlet) partially clogged or hot air is being recycled from the alternator or engine. Alternator operating at too high a voltage (>105% of Un on load). Alternator overloaded.
Vibrations	Too much vibration.	 Misalignment (coupling). Defective mounting or play in coupling. Rotor balancing fault (Engine - Alternator).
	Excessive vibration and humming noise coming from the machine.	Phase imbalance.Stator short-circuit.
Abnormal noise	Alternator damaged by a significant impact, followed by humming and vibration.	 System short-circuit. Misparalleling. Possible consequences. Broken or damaged coupling. Broken or bent shaft end. Shifting and short-circuit of main field. Fan fractured or coming loose on shaft. Irreparable damage to rotating diodes/AVR, surge suppressor.

ELECTRICAL FAULTS

Fault	Action	Effect	Check/Cause
		The alternator builds up and its voltage is still correct when the battery is removed.	- Lack of residual magnetism.
No voltage at no load on	Connect a new battery of 4 to 12 volts to terminals E- and E+, respecting the polarity for 2 to 3	The alternator builds up but its voltage does not reach the rated value when the battery is removed.	 Check the connection of the voltage reference to the AVR. Faulty diodes. Armature short-circuit.
	seconds.	The alternator builds up but its voltage disappears when the battery is removed.	 Faulty AVR. Field windings open circuit (check winding). Revolving field coil open circuit (check the resistance).
Voltage too low	Check the drive speed.	Correct speed.	Check the AVR connections (AVR may be faulty). - Field windings short-circuited. - Rotating diodes burnt out. - Revolving field coil short-circuited. - Check the resistance.
		Speed too low.	Increase the drive speed (do not touch the AVR voltage pot. (P2) before running at the correct speed).
Voltage too high.	Adjust AVR voltage potentiometer.	Adjustment ineffective.	Faulty AVR.
Voltage oscillations.	Adjust the AVR stability potentiometer.	If no effect: try normal or fast stability modes (ST2).	 Check the speed: possibility of cyclic irregularity. Loose connections. Faulty AVR. Speed too low when on load (or AVR LAM set too high).
Voltage	Run at no load and	Voltage between E+ and E- (DC) SHUNT / AREP / PMG < 10V.	- Check the speed (or AVR LAM set too high).
correct at no load and too low when on load.	check the voltage between E+ and E- on the AVR.	Voltage between E+ and E SHUNT/ AREP / PMG > 15V.	 Faulty rotating diodes. Short-circuit in the revolving field coil. Check the resistance. Faulty exciter armature. Check the resistance.
Voltage disappears during operation.	Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components.	The voltage does not return to the rated value.	 Exciter winding open circuit. Faulty exciter armature. Faulty AVR. Revolving field coil open circuit or shortcircuited.

Checking the winding

You can check the winding insulation by performing a high voltage test. In this case, you must disconnect all AVR wires.



Damage caused to the AVR in such conditions is not covered by our warranty.

CHECKING THE DIODE BRIDGE

A diode in good working order should allow the current to flow only in the anode-tocathode direction.



Checking the windings and rotating diodes using separate excitation



During this procedure, make sure that the alternator is disconnected from any external load and inspect the terminal box to check that the connections are fully tightened.

- 1. Stop the unit, disconnect and isolate the AVR wires.
- 2. There are two ways of creating an assembly with separate excitation.

Assembly A:

Connect a 12 V battery in series with a rheostat of approximately 50 ohms - 300 W and a diode on both exciter field wires (5+) and (6-).



Assembly B:

Connect a "Variac" variable power supply and a diode bridge on both exciter field wires (5+) and (6-).

Both these systems should have characteristics which are compatible with the field excitation power of the machine (see the nameplate).

- 3. Run the unit at its rated speed.
- 4. Gradually increase the exciter field current by adjusting the rheostat or the variac and measure the output voltages on L1 L2 L3, checking the excitation voltage and current at no load (see the machine nameplate or ask for the factory test report). When the output voltage is at its rated value and balanced within 1% for the rated excitation level, the machine is in good working order. The fault therefore comes from the AVR or its associated wiring (ie. detection, auxiliary windings).

ASSEMBLY B



During the warranty period, this operation should only be carried out in an approved workshop or in our factory, otherwise the warranty may be invalidated.

Whilst being handled, the machine should remain horizontal (rotor not locked in position). Check how much the machine weighs before choosing the lifting method.



Tools required

To fully dismantle the machine, we recommend using the tools listed below:

- 1 ratchet spanner + extension
- 1 torque wrench
- 1 set of flat spanners: 8 mm, 10 mm, 18 mm
- 1 socket set: 8, 10, 13, 16, 18, 21, 24, 30 mm
- 1 puller (U35) / (U32/350)

Screw tightening torque

See later in this manual.

Access to diodes

- Open the air intake grille (51).
- Disconnect the diodes.

- Check the 6 diodes using an ohmmeter or a battery lamp (See later in this manual).

If the diodes are faulty,

- Remove the surge suppressor (347).
- Remove the 6 «H» nuts for mounting the diode bridges on the support.
- Change the crescents, respecting the polarity.

Access to connections and the regulation system

Access directly by removing the top of the cover (48) or the AVR access door (466).

Replacing the NDE bearing

- Remove the air intake grille (51).

- Remove the lid of the protective cover (48) and the side panels (366) and (367).

- Remove the hook (21) and the cover rear panel (365).
- Replace the hook (21) in order to manipulate the flange.
- Disconnect the exciter wires (5+,6-).

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Remove the bearing thrust screws (78).
- Remove all 5 screws (37).
- Remove the shield (36).

- Take out the antifriction bearing (70) using a puller with a central screw (see drawing below).



- Fit the new antifriction bearing onto the shaft after heating it by induction to approximately 80° C.

- Mount the new preloading (wavy) washer (79) + the new "O" ring seal (349) in the shield (36).

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Screw a threaded rod into the thrust bearing (78).

- Refit the end shield on the machine using a dowel and nut in the shaft extension (see drawing).

- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).



- Fit the thrust bearing screws (78), remove the threaded rod, fit the other screw and tighten up the assembly.

- Tighten the 5 bearing screws (37).
- Reconnect exciter wires E+, E-.
- Finish reassembling the cover.

When dismantling the shields, change the antifriction bearings, the "O" ring seal, the preloading (wavy) washer and adhesive paste.

Replacing the DE bearing

- Remove the air outlet grille (33).

- Remove the 6 screws (31) from the DE shield and the 4 screws (62) from the inner bearing retainer.

- Remove the shield (30).

- Take out the ball bearing (60) using a puller with a central screw (See later in this manual.

- Fit the new bearing, after heating it by induction to approximately 80 °C.

- Screw a threaded rod into the thrust bearing (68).
- Refit the shield (30) on the machine.

- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).

- Tighten the bottom thrust bearing screws (68), remove the threaded rod and fit the other screws.

- Tighten the 6 shield screws (31).
- Refit the air outlet grille (33).

Dismantling the rotor assembly

- Remove the NDE shield (36) as described later in this manual.

- Remove the DE shield (30) as described in this manual if it is a double-bearing machine.

- Support the DE rotor (4) with a strap or with a support constructed in accordance with the following drawing.

- Move the strap as the rotor moves in order to distribute the weight over it.

- After extracting the rotor, be careful not to damage the fan and place the revolving field on special V-blocks.



When dismantling the rotor involves changing parts or rewinding, the rotor must be rebalanced.

Reassembling the machine

- Mount the rotor (4) in the stator (1) (see drawing above) taking care not to knock the windings.

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Mount the new preloading (wavy) washer (79) + the new "O" ring seal (349) in the shield (36).

- Screw a threaded rod into the thrust bearing (78).

- Refit the shield (36) on the machine using a dowel and nut in the shaft extension (see diagram).

- Slide the threaded rod into the shield hole to make it easier to assemble (see diagram).

- Fit the thrust bearing screws (78), remove the threaded rod, fit the other screw and tighten up the assembly.

- Tighten the 5 bearing screws (37).
- Reconnect exciter wires E+, E-.
- Finish reassembling the cover.

- Screw a threaded rod into the thrust bearing (68).
- Refit the shield (30) on the machine.

- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).

- Fit the thrust bearing screws (68), remove the threaded rod, fit the other screw and tighten up the assembly.
- Tighten the 6 shield screws (31).
- Refit the air outlet grille (33).

- Check that the machine assembly is correctly mounted and that all screws are tightened.

Dismantling and reassembly of the filters

- Remove the grille (417) then take out the filter (418). Change the filter if necessary; please see later in this manual for cleaning the filter.

To replace, follow the instructions in reverse order.

INSTALLATION AND MAINTENANCE OF THE PMG

For the LSA 47.2, the PMG reference is: PMG 3. See the PMG manual ref : 4211.

TABLE OF CHARACTERISTICS

Table of average values

Alternator - 4 poles - 50 Hz - Standard winding No. 6. (400V for the excitation values)

The voltage and current values are given for no-load operation and operation at rated load with separate field excitation.

All values are given to within \pm 10% and may be changed without prior notification (for exact values, consult the test report).

LSA47.2 average values Resistances at 20 °C (Ohms)

LSA 47.2	Stator L/N	Rotor	Exciter armature
S4	0,0063	0,88	0,128
S5	0,0063	0,88	0,128
L9 (6 & 12 fils)	0,0039	1,1	0,128

Field excitation current i exc (A)

Symbols : "i exc": excitation current of the exciter field.

LSA 47.2	No load	At rated load
S4	0.9	3.4
S5	0.9	3.8
L9	0.95	3.75
L9 (6 wires)	0.95	3.7

For 60 Hz machines, the "i exc" values are approximately 5 to 10 % lower.

Table of weights (values given for information only)

LSA 47.2	Total weight (kg)	Rotor (kg)
S4	1130	445
S5	1130	445
L9	1400	550



After operational testing, it is essential to replace all access panels or covers.

SPARE PARTS

FIRST MAINTENANCE PARTS

Emergency repair kits are available as an option. They contain the following items:

Emergency kit SHUNT	ALT 472 KS 001
AVR R 250	-
Diode bridge assembly	-
Surge suppressor	-

Single-bearing kit	ALT 471 KB 002
Non drive end bearing	-
«O» ring	-
Preloading (wavy) washer	-

TECHNICAL SUPPORT SERVICE

Our technical support service will be pleased to provide any additional information you may require.

When ordering spare parts, you should indicate the complete machine type, its serial number and the information given on the nameplate.

Address your enquiry to your usual contact.

Part numbers should be identified from the exploded views and their description from the parts list. Our extensive network of service centres can dispatch the necessary parts without delay.

To ensure correct operation and the safety of our machines, we recommend the use of original manufacturer spare parts.

In the event of failure to comply with this advice, the manufacturer cannot be held responsible for any damage.



After operational testing, it is essential to replace all access panels or covers.

ACCESSORIES

Space heater for use when stopped

The space heater must run as soon as the alternator stops. It is installed at the rear of the machine. Its standard power is 250W with 220V or 250W with 110V on request.

A WARNING

The power supply is present when the machine has stopped.

Temperature sensors with thermistors (PTC)

These are thermistor triplets with a positive temperature coefficient installed in the stator winding (1 per phase). There can be a maximum of 2 triplets in the winding (at 2 levels: warning and trip) and 1 or 2 thermistors in the shields.

These sensors must be linked to adapted detection relays (supplied optionally).

Cold resistance of cold thermistor sensors: 100 to 250 Ohms per sensor.

Connection accessories

- 6-wire machines : coupling (F).
- 3 flexible SHUNTS
- 12-wire machines : coupling (A), (F .F), (F).
- 3 flexible SHUNTS

EXPLODED VIEW, PARTS LIST AND TIGHTENING TORQUE

LSA 47.2 SINGLE-BEARING



Ref.	Qty	Description	Screw	Torque
			Ø	N.m
1	1	Stator assembly	-	-
4	1	Rotor assembly	-	-
15	1	Fan	-	-
21	1	Lifting ring	-	-
22	1	Shaft extension key	-	-
28	1	Earth terminal	M10	20
30	1	Drive end shield	-	-
31	6 or 4	Fixing screws	M12	69
33	1	Protective grille	-	-
34	2	Fixing screws	M6	5
36	1	Exciter end shield	-	-
37	4	Fixing screws	M12	69
41	1	Cover front panel	-	-
48	1	Cover top panel	-	-
49	-	Cover screws	M6	5
51	1	Air intake grille	-	-
53	1	Plug	-	-
60	1	Drive end bearing	-	-
62	3 or 4	Fixing screws	M8	20
68	1	Inner bearing retainer	-	-
70	1	Non drive end bearing	-	-
71	1	Cover	-	-
72	2	Fixing screws	M8	20
78	1	Inner bearing retainer	-	-

Ref.	Qty	Description	Screw	Torque
			Ø	N.m
79	1	Preloading (wavy)	-	-
		washer		
90	1	Exciter field	-	-
91	4	Fixing screws	M6	10
100	1	Exciter armature	-	-
124	1	Terminal plate	M12	35
128	3	Starting range	-	-
130	1	Neutral link	-	-
131	9	Terminal block terminal	-	-
		screws		
177	2	AVR support bracket	-	-
198	1	Voltage regulator (AVR)	-	-
284	1	Circlips	-	-
322	3	Coupling disc	-	-
323	6	Fixing screw	M16	170
325	-	Spacer shim	-	-
343	1	Diode bridge assembly	M6	4
347	1	Protection varistor	-	-
		(+ PCB)		
349	1	"O" ring	-	-
365	1	Cover rear panel	-	-
366	1	Side panel	-	-
367	1	Side panel with	-	-
		inspection door		
466	1	AVR inspection door	-	-

OPERATION & MAINTENANCE MANUAL

MAIN BREAKER OPERATION

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Operation	Operation effort
○ (OFF)⇒ (ON)	140N
(ON)⇒ ○ (OFF)	140N
TRIP⇒ ○ (OFF)	170N

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OVER-CURRENT RELEASES SETTING PROCEDURE S1000-CE

ELECTRONIC TYPE



TIME / CURRENT CHARACTERISTIC CURVES

Under bar is default setting. Electronic Type





Operation	Operation effort
○ (OFF)⇒ (ON)	157N
(ON)⇒ ○ (OFF)	294N
TRIP⇒ ○ (OFF)	343N

OVER-CURRENT RELEASES SETTING PROCEDURE S1250 - S1600-NE



TIME / CURRENT CHARACTERISTIC CURVES

Under bar is default setting. Electronic Type



WIRING DIAGRAMS



OPERATION & MAINTENANCE MANUAL

50 Hz: G265 - G300 - G400 - G435 - G500 - G550XW/XF 60 Hz: G300 - G335 - G430 - G470 - G530 - G635XW/XF

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 enduser / 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.

BENELUX SA DOOSAN 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 PURPOSE. CORRECTIONS PARTICULAR BY DOOSAN BENELUX SA OF NONCONFORMITIES WHETHER PATENT OR LATENT, IN THE MANNER AND FOR THE TIME PERIOD PROVIDED ABOVE, CONSTITUTE FULFILLMENT OF SHALL 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 INCLUDING ANY HOLDING, SUBSIDIARY, SA ASSOCIATED OR AFFILIATED COMPANY OR DISTRIBUTOR WITH RESPECT TO THIS SALE OR THE PRODUCT AND SERVICE FURNISHED HEREUNDER CONNECTION WITH IN THF PERFORMANCE OR BREACH THEREOF, OR FROM DELIVERY, INSTALLATION, REPAIR OR TECHNICAL DIRECTION COVERED BY OR FURNISHED UNDER THIS SALE, WHETHER BASED ON CONTRACT, TORT, NEGLIGENCE, WARRANTY, 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.