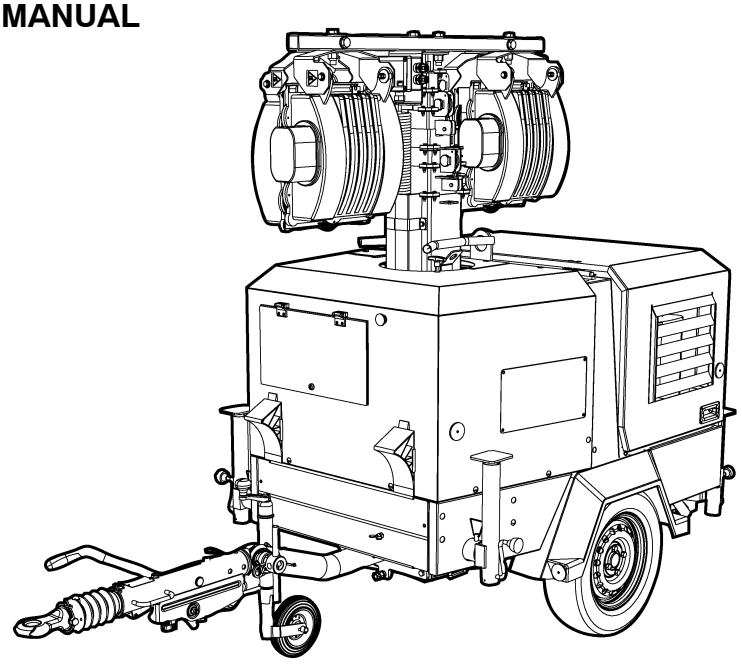
Doosan Infracore
Portable Power

LIGHTSOURCE V9

OPERATION AND MAINTENANCE MANUAL
Original Instruction



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

SERIAL No : 368000 –>

46500039_en_C_11/11

Machine models represented in this manual may be used in various locations world−wide. Machines sold and shipped into European Union Territories require that the machine display the CE Mark and conform to various directives. In such cases, the design specification of this machine has been certified as complying with EC directives. Any modification to any part is absolutely prohibited and would result in the CE Certification and marking being rendered invalid. A declaration of that conformity follows:

CE

DOOSAN

[1] **EC Declaration of Conformity**

[2] Original declaration

[3] **We:**
Doosan International USA, Inc
1293 Glenway Drive
Statesville
North Carolina 28625-9218
USA

[4] **Represented in EC by:**
Doosan Trading Limited
Block B, Swords Business Campus
Swords
Co. Dublin
Ireland

[5] **Hereby declare that, under our sole responsibility the product(s)**

[6] Machine description: Portable Light Tower
[7] Machine Model: LT6K
Lightsource V9
[8] Commercial name: LT6K
Lightsource V9
[9] VIN / Serial number:

[10] **is (are) in conformity with the relevant provisions of the following EC Directive(s)**

[11] 2006/42/EC The Machinery Directive
[12] 2004/108/EC The Electromagnetic Compatibility Directive
[13] 2000/14/EC The Noise Emission Directive
[16] 97/68/EC The emission of engines for no-road mobile machinery
[17] and their amendments

[18] **Conformity with the Noise Emission Directive 2000/14/EC**

[19] Directive 2000/14/EC, Annex VI, Part I
[20] Notified body: AV Technology, Stockport, UK. Nr 1067

[21]Machine		[23]Measured sound power level	[24]Guaranteed sound power level
[22]Type	kW		
LT6K	8,4	**87L$_{WA}$**	**88L$_{WA}$**
Lightsource V9	8,4	**85L$_{WA}$**	**86L$_{WA}$**

Jan Moravec
[27] Engineering Manager
[28] Issued at Dobris, Czech Republic

[29] Date

[30] **The technical documentation for the machinery is available from:**
Doosan Infracore Portable Power EMEA, Dreve Richelle 167, B-1410 Waterloo, Belgium

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ABBREVIATIONS & SYMBOLS

####	Contact the company for serial number
–>####	Up to Serial No.
####–>	From Serial No.
*	Not illustrated
†	Option
AR	As required
HA	High ambient machine
F.H.R.G.	Fixed height running gear
V.H.R.G.	Variable height running gear
bg	Bulgarian
cs	Czech
da	Danish
de	German
el	Greek
en	English
es	Spanish
et	Estonian
fi	Finnish
fr	French
hu	Hungarian
it	Italian
lt	Lithuanian
lv	Latvian, Lettish
mt	Maltese
nl	Dutch
no	Norwegian
pl	Polish
pt	Portuguese
ro	Romanian
ru	Russian
sk	Slovak
sl	Slovenian
sv	Swedish
zh	Chinese

The contents of this manual are considered to be proprietary and confidential 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 and maintenance staff. Major overhauls are outside the scope of this manual and should be referred to an authorised service department.

The design specification of this machine has been certified as complying with EC directives. As a result:

(a) Any machine modifications are strictly prohibited, and will invalidate EC certification.

(b) A unique specification for USA/Canada is adopted and tailored to the territory.

All components, accessories, pipes and connectors added to the compressed air system should be:
. of good quality, procured from a reputable manufacturer and, wherever possible, be of a type approved by the company.
. accompanied with instructions for safe installation, operation and maintenance.

Details of approved equipment are available from the company service departments.

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.

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.

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

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

The company, through its distributor, warrants that each item of equipment manufactured by it and delivered hereunder to the initial user will be free of defects in material and workmanship for a period of three (3) months from initial operation or six (6) months from the date of shipment to the initial user, whichever occurs first.

With respect to the following types of equipment, the warranty period enumerated below will apply in lieu of the foregoing warranty period.

A. **Aftercoolers** – The earlier of nine (9) months from date of shipment to or six (6) months from start up by initial user.

B. **Portable Light Towers** – The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of service by the initial user.

The company will provide a new part or repaired part, at it's sole discretion, in place of any part which is found to be defective in material or workmanship during the period described above. Labor cost to replace the part is the responsibility of the initial user.

C. **Portable Light Tower Alternator** – The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of operation by the initial user. Light Source model only, the earlier of twenty–four (24) months from shipment to or the accumulation of 4,000 hours of operation by the initial user.

D. **Spare Parts** – Six (6) months from date of shipment to the initial user.

The company will provide a new part or repaired part, at its sole discretion, in place of any part that is found to be defective in material and workmanship during the period described above. Such parts will be repaired or replaced without charge to the initial user during normal working hours at the place of business of a distributor authorized to sell the type of equipment involved or other establishment authorized. User must present proof of purchase at the time of exercising warranty.

The above warranties do not apply to failures occurring as a result of abuse; misuse, negligent repairs, corrosion, erosion and normal wear and tear, alterations or modifications made to the product without express written consent; or failure to follow the recommended operating practices and maintenance procedures as provided in the product's operating and maintenance publications.

Accessories or equipment furnished by the company, but manufactured by others, including, but not limited to, engines, tires, batteries, engine electrical equipment, hydraulic transmissions, carriers, shall carry only the manufacturers warranty, which the company can lawfully assign to the initial user.

THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, (EXCEPT THAT OF TITLE), AND THERE ARE NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

GENERAL WARRANTY INFORMATION – ESA

			COMMENTS
LIGHT TOWER	PACKAGE	12 MONTHS / 2,000 HOURS	COVERS CONTROLS, SWITCHES, SHEET METAL, ELECTRICAL CIRCUIT ETC.
	ALTERNATOR	12 MONTHS / 2,000 HOURS	EXTENDED WARRANTY OF 24 MONTHS / 4,000 HRS. FOR LIGHTSOURCE INTRODUCED 8/16/99.
	ENGINE	SEE BELOW	

ENGINES			
	MONTHS	**HOURS**	**COMMENTS**
KUBOTA (7/20)	24	4,000	EXTENDED WARRANTY OF 60 MONTHS / 10,000 HRS. WHEN USING GENUINE DOOSAN FLUIDS AND PARTS ON MAJOR COMPONENTS.

PARTS			
	MONTHS	**HOURS**	**COMMENTS**
DOOSAN	6	UNLIMITED	PARTS ONLY AVAILABLE FROM THE COMPANY NETWORK.

NOTE: Actual warranty times may change.
Consult the Manufacturer's warranty policy as shipped with each new product.

WARRANTY REGISTRATION

FOR UNITS SOURCED FROM DUBLIN, IRELAND

Complete Machine Registration

To initiate the machine warranty, fill out the ”Warranty Registration” form 83242 11/99 supplied as part of the machine documentation, keep a copy for your records and mail the original to:

Doosan Warranty Team
Doosan BENELUX S.A.
Drève Richelle 167
1410 Waterloo – Belgium

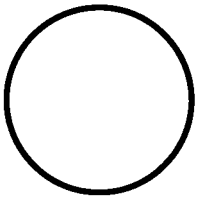
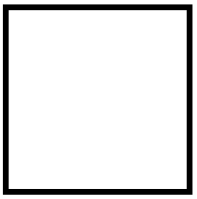
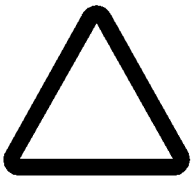
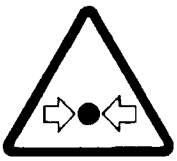
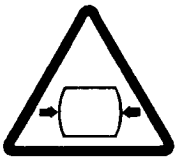
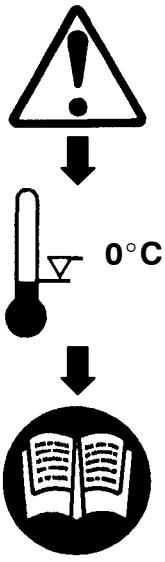
Fax: +32 2 371 69 15
Email: doosanwarranty@dii.doosan.com

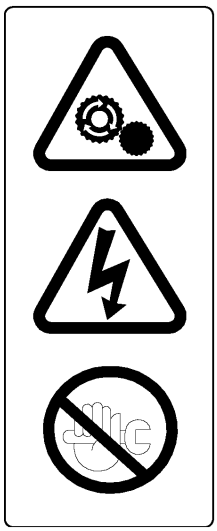
Note: Completion of this form validates the warranty.

Engine Registration:

You MUST provide proof of the “in–service” date when requesting engine warranty repairs.

GRAPHIC FORM AND MEANING OF ISO SYMBOLS

		
Prohibition / Mandatory	**Information / Instructions**	**Warning**
		
WARNING: Electrical shock risk.	**WARNING – Pressurised component or system.**	**WARNING – Hot surface.**
		
WARNING – Pressure control.	**WARNING – Corrosion risk.**	**WARNING – Air/gas flow or Air discharge.**
		
WARNING – Pressurised vessel.	**WARNING – Hot and harmful exhaust gas.**	**WARNING – Flammable liquid.**
		
WARNING – Maintain correct tyre pressure. (Refer to the **GENERAL INFORMATION** section of this manual).	**WARNING – Before connecting the tow bar or commencing to tow consult the operation and maintenance manual.**	**WARNING – For operating temperature below 0°C, consult the operation and maintenance manual.**



WARNING – Do not undertake any maintenance on this machine until the electrical supply is disconnected.

WARNING – Consult the operation and maintenance manual before commencing any maintenance.

WARNING – Corrosion risk.

Do not remove the Operating and Maintenance manual and manual holder from this machine.

Do not stack.

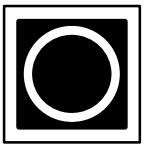
Do not operate the machine without the guard being fitted.

Do not exceed the trailer speed limit.

Do not operate with the doors or enclosure open.

Do not use fork lift truck from this side.

Use fork lift truck from this side only.

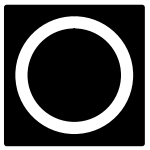


Emergency stop.

Tie down point

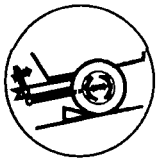
Lifting point.

On (power).



Off (power).

Read the Operation and Maintenance manual before operation or maintenance of this machine is undertaken.

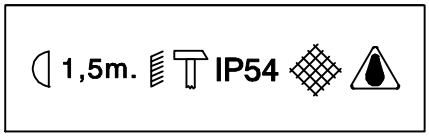


When parking use prop stand, handbrake and wheel chocks.

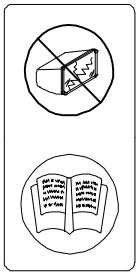
No naked lights.

Diesel fuel
No open flame.

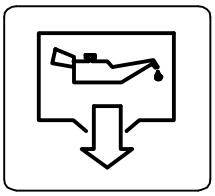
Parking brake.



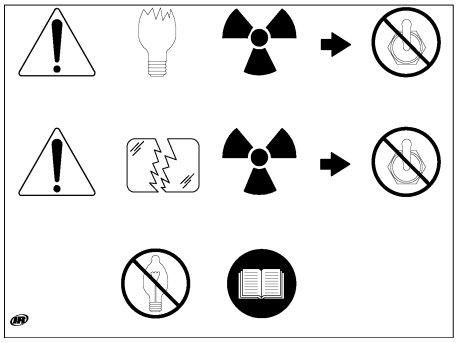
Rough Service Designation.
Wet Location Operation.



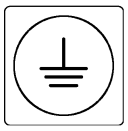
Replace any cracked protective shield.



Oil drain.



Warning: Ultra violet radiation.
Can cause serious skin burn and eye inflammation.
Do not operate lights with missing or broken lens.
Do not operate if glass bulb is broken or punctured.



Electrical ground/earth

FREE SAFETY DECALS!

Safety Decals are available **free** of charge.

Decal part numbers are on the bottom of each decal and are also listed in the parts manual of the machine. Submit orders for Safety Decals to the **Doosan Portable Power EMEA Aftermarket Department**. The no charge order should contain only Safety Decals. Help promote product safety! Assure that decals are present on the machines. Replace decals that are not readable.

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

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

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

Ensure that the Operation and 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.

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

Hazards may exist on the jobsite should this unit shutdown automatically and all lamps be extinguised. Personnel should be advised of this and have additional lighting.

Hot Pressurized 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.

Electrical shock hazard will cause severe injury or death. Do NOT position light tower under electric power lines.

Improper operation of this machine can result in severe injury or death.

Hazardous Voltage can cause serious injury or death.

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.

Do not enter ballast box while engine is running. Do not steam clean ballast box. Capacitor/Ballast can cause severe injury.

Do not operate lights with broken or missing lens or broken glass bulb. Ultra violet radiation can cause serious skin burn and eye inflamation.

Do not place hand in tower recess while tower is being lowered or raised. Pinch point can cause severe injury.

Ground equipment in accordance with applicable codes. (Consult local electrician).

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

Use extreme caution when working on electrical components. Battery voltage (12V) is present unless the battery cables have been disconnected. Higher voltage (potentially 500 volts) is present at all times when the engine is running.

Always treat electrical circuits as if they were energized.

Before attempting any repair service, disconnect all leads to electrical power loads.

Do NOT connect or disconnect lamps while engine is running.

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 arrestors, 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.

This machine produces loud noise with the doors open or service valve vented. Extended exposure to loud noise can cause hearing loss. Always wear hearing protection when doors are open or service valve is vented.

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

Do not use petroleum products (solvents or fuels) under high pressure as this can penetrate the skin and result in serious illness. wear eye protection while cleaning unit with compressed air to prevent debris from injuring eye(s).

Rotating fan blade can cause serious injury. Do not operate without guard in place.

Use care to avoid contacting hot surfaces (engine exhaust manifold and piping, air receiver and air discharge piping, etc.).

WARNING: Under no circumstances should volatile liquids such as Ether be used for starting this machine.

Never operate unit with guards, covers or screens removed. Keep hands, hair, clothing, tools, blow gun tips, etc. well away from moving parts.

Do not alter or modify this machine.

Materials

The following substances *may* be produced during the operation of this machine:
. brake lining dust
. 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:

. engine lubricant
. preservative grease
. rust preventative
. diesel fuel
. battery electrolyte

AVOID INGESTION, SKIN CONTACT AND INHALATION OF FUMES

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

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

This machine may include such materials as oil, diesel fuel, antifreeze, brake fluid, oil/air filters and batteries which may require proper disposal when performing maintenance and service tasks. Contact local authorities for proper disposal of these materials.

When recycling or disposing of any electrical components, light bulbs etc., do not mix with general waste.

There is a separate collection system for used electronic products in accordance with legislation that requires proper treatment, recovery and recycling.

Please contact your local authorities for the correct method of disposal or recycling.

Battery

A battery contains sulphuric 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.

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

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 ground 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.

Radiator

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

Do not remove the pressure cap from a HOT radiator. Allow radiator to cool down before removing pressure cap.

Generator sets

The generator set is designed for safety in use. However, the responsibility for safe operation rests with those who install, use and maintain it. The following safety precautions are offered as a guide, which, if conscientiously followed, will minimise the possibility of accidents throughout the useful life of this equipment.

Emergency Stop Controls

Important Note:– In addition to the key operated emergency stop control on the main control panel, a second control is provided at the socket control panel in the event of electrical hazards associated with generator operation. Use this second control to immediately isolate all electrical power to all sockets, then use the key control to stop the engine.

Operation of the generator must be in accordance with recognised electrical codes and local health and safety codes.

The generator set should be operated by those who have been trained in its use and delegated to do so, and who have read and understand the operator's manual. *Failure to follow the instructions, procedures and safety precautions in the manual may increase the possibility of accidents and injuries.*

Do not start the generator set unless it is safe to do so. Do not attempt to operate the generator set with a known unsafe condition. Fit a danger notice to the generator set and render it inoperative by disconnecting the battery and disconnecting all ungrounded conductors so others who may not know of the unsafe condition will not attempt to operate it until the condition is corrected.

An earth point is provided beneath the socket outlets.

The generator set should only be used with the earth point connected directly to the general earth/ground mass. An earth spike kit is available as an optional extra for this purpose (refer to the *parts catalogue*).

WARNING: DO NOT OPERATE THE MACHINE UNLESS IT HAS BEEN SUITABLY EARTHED.

Generator sets must be connected to the load only by trained and qualified electricians who have been delegated to do so, and when required by applicable regulations, their work should be inspected, and accepted by the inspection agency having authority, prior to attempting to operate the generator set.

Do not make contact with electrically energised parts of the generator set and/or interconnecting cables or conductors with any part of the body or with any non–insulated conductive object.

Make sure the generator set is effectively grounded in accordance with all applicable Regulations prior to attempting to make or break load connections and prior to attempting operation.

Prior to attempting to make or break electrical connections at the generator set, stop the engine, disconnect the battery and disconnect and lock out the ungrounded conductors at the load end.

Keep all parts of the body and any hand–held tools or other conductive objects, away from exposed live parts of the generator set engine electrical system. Maintain dry footing, stand on insulating surfaces and do not contact any other portion of the generator set when making adjustments or repairs to exposed live parts of the generator set engine electrical system.

Replace the generator set terminal compartment cover as soon as connections have been made or broken. Do not operate the generator set without the terminal cover secured firmly in place.

Close and lock all access doors when the generator set is left unattended.

Do not use extinguishers intended for Class A or Class B fires on electrical fires. Use only extinguishers suitable for class *BC* or class *ABC* fires.

Keep the towing vehicle or equipment carrier, generator set, connecting cables, tools and all personnel at least 3 metres from all power lines and buried power cables, other than those connected to the generator set.

Attempt repairs only in clean, dry, well lighted and ventilated areas.

Connect the generator set only to loads and/or electrical systems that are compatible with its electrical characteristics and that are within it's rated capacity.

Transport

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

When loading or transporting machines ensure that the towing vehicle, its size, weight, towing hitch and electrical supply are all suitable to provide safe and stable towing at speeds either, up to the legal maximum for the country in which it is being towed or, as specified for the machine model if lower than the legal maximum.

Ensure that the maximum trailer weight does not exceed the maximum gross weight of the machine (by limiting the equipment load), limited by the capacity of the running gear.

Note:
Gross mass (on data plate) is for the basic machine and fuel only, excluding any fitted options, tools, equipment and foreign materials.

Before towing the machine, ensure that:–

. the tyres and towing hitch are in a serviceable condition.
. the canopy is secure.
. all ancillary equipment is stored in a safe and secure manner.
. the brakes and lights are functioning correctly and meet necessary road traffic requirements.
. break-away cables/safety chains are connected to the towing vehicle.

The machine must be towed in a level attitude (the maximum permissible drawbar angle is between 0° and +5° from horizontal) in order to maintain correct handling, braking and lighting functions. This can be achieved by correct selection and adjustment of the vehicle towing hitch and, on variable height running gear, adjustment of the drawbar.

To ensure full braking efficiency, the front (towing eye) section must always be set level.

When adjusting variable height running gear:–

Ensure front (towing eye) section is set level

When raising towing eye, set rear joint first, then front joint.

When lowering towing eye, set front joint first, then rear joint.

After setting, fully tighten each joint by hand and then tighten further to the next pin. Refit the pin.

When parking always use the handbrake and, if necessary, suitable wheel chocks.

Make sure wheels, tyres and tow bar connectors are in safe operating condition and tow bar is properly connected before towing.

Do not store or transport hazardous or combustible materials in or on this unit.

Do not suspend this machine with other equipment hanging from the running gear.

Safety chains / connections and their adjustment

The legal requirements for the joint operation of the breakaway cable and safety chains are as yet unidentified by 71/320/EEC or UK regulations. Consequently we offer the following advice / instructions.

Where brakes only are fitted:

a) Ensure that the breakaway cable is securely coupled to the handbrake lever and also to a substantial point on the towing vehicle.

b) Ensure that the effective cable length is as short as possible, whilst still allowing enough slackness for the trailer to articulate without the handbrake being applied.

Where brakes and safety chains are fitted:

a) Loop the chains onto the towing vehicle using the towing vehicle hitch as an anchorage point, or any other point of similar strength.

b) Ensure that the effective chain length is as short as possible whilst still allowing normal articulation of the trailer and effective operation of the breakaway cable.

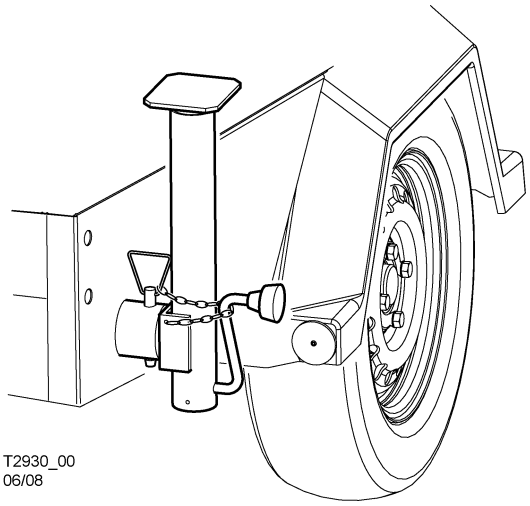
Where safety chains only are fitted:

a) Loop the chains onto the towing vehicle using the towing vehicle hitch as an anchorage point, or any other point of similar strength.

b) When adjusting the safety chains there should be sufficient free length in the chains to allow normal articulation, whilst also being short enough to prevent the towbar from touching the ground in the event of an accidental separation of the towing vehicle from the trailer.

Before towing

Make sure wheels, tires and tow bar connectors are in safe operating condition and tow bar is properly connected before towing.



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Store the front outriggers and all jacks. To secure each jack handle, wrap the jack positioning pin chain around the handle to keep it from being damaged during towing.

Towing

CAUTION: *Do not tow or move with mast extended.*

Do not tow this unit with a vehicle whose towing capacity is less than the unit gross weight shown in General Data.

Do not exceed maximum speed of 80km/h (or local legal maximum, if lower) when towing unit.

Welding

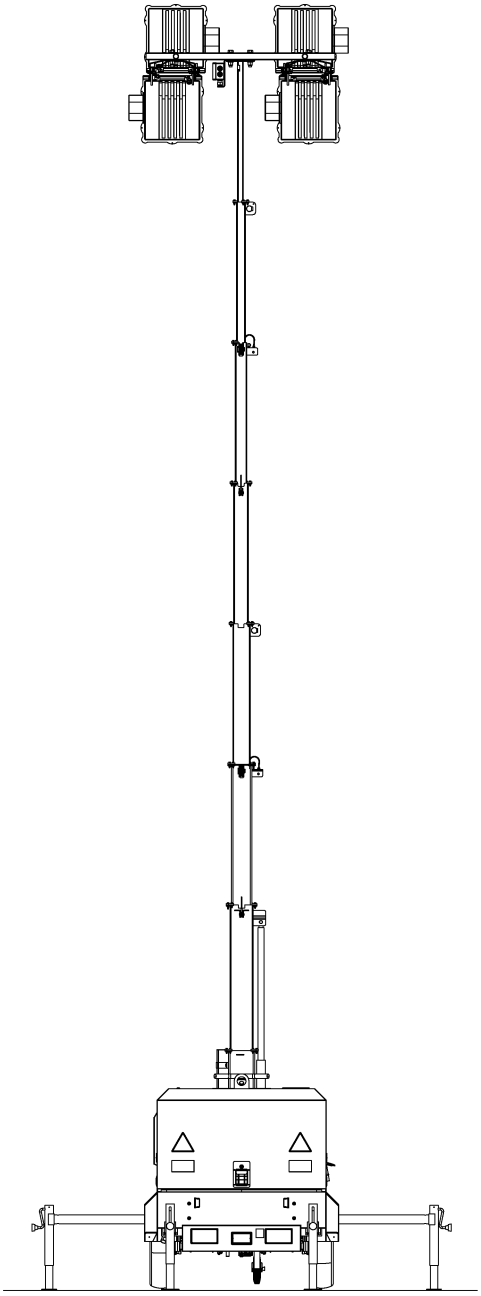
Prior to any welding, disconnect alternator relays, voltage regulator, meters, circuit breakers and battery cables. Open all circuit breakers, and remove any external connections. Connect the welding ground as close as possible to the area being welded.

Mast Operation

Before and during all mast operation, ensure that the area is clear of persons and obstructions over a 2m radius. When the mast has completed its normal travel, or is prevented from travelling, immediately release the control switch, to ensure that no cable overtension occurs.

Check that no person is behind the machine (within 10m) while the tower is raised or lowered.

The unit must have all outriggers extended and be level before raising mast.



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DO NOT climb on tower. Perform repairs and adjustments with the tower in the down (transport) position.

Damaged cables may break during tower operation allowing the tower to fall. Do not operate tower with damaged cables. Replace damaged cables.

Lamps

Inspect lamps and replace broken or missing lamp lens or punctured glass bulbs. Do NOT operate lights with broken or missing lens or broken glass bulb.

Flammable fuels

Do not fill the fuel tank when the engine is running.

Do not smoke or use an open flame in the vicinity of the light tower or fuel tank.

Do not permit smoking, or open flame, or sparks to occur near the battery, fuel, cleaning solvents or other flammable substances and explosive gases.

BUNDED BASE

This machine can be fitted with bund equipment to contain leakages and spillages, which occur within the machine enclosure.

The bund will contain all fluids normally installed in the machine, plus an additional 10%.

When fitted with bund, the machine must only be operated when levelled.

Drains for engine water, engine oil and fuel tank are located at the rear right corner of the machine.

Draining of contaminated fluids

Contaminated fluid must be removed by authorized personnel only.

Captured fluids can be drained from the bund by removal of the plug at the rear base of the frame. This plug must be replaced after draining.

Drainage of machine fluids

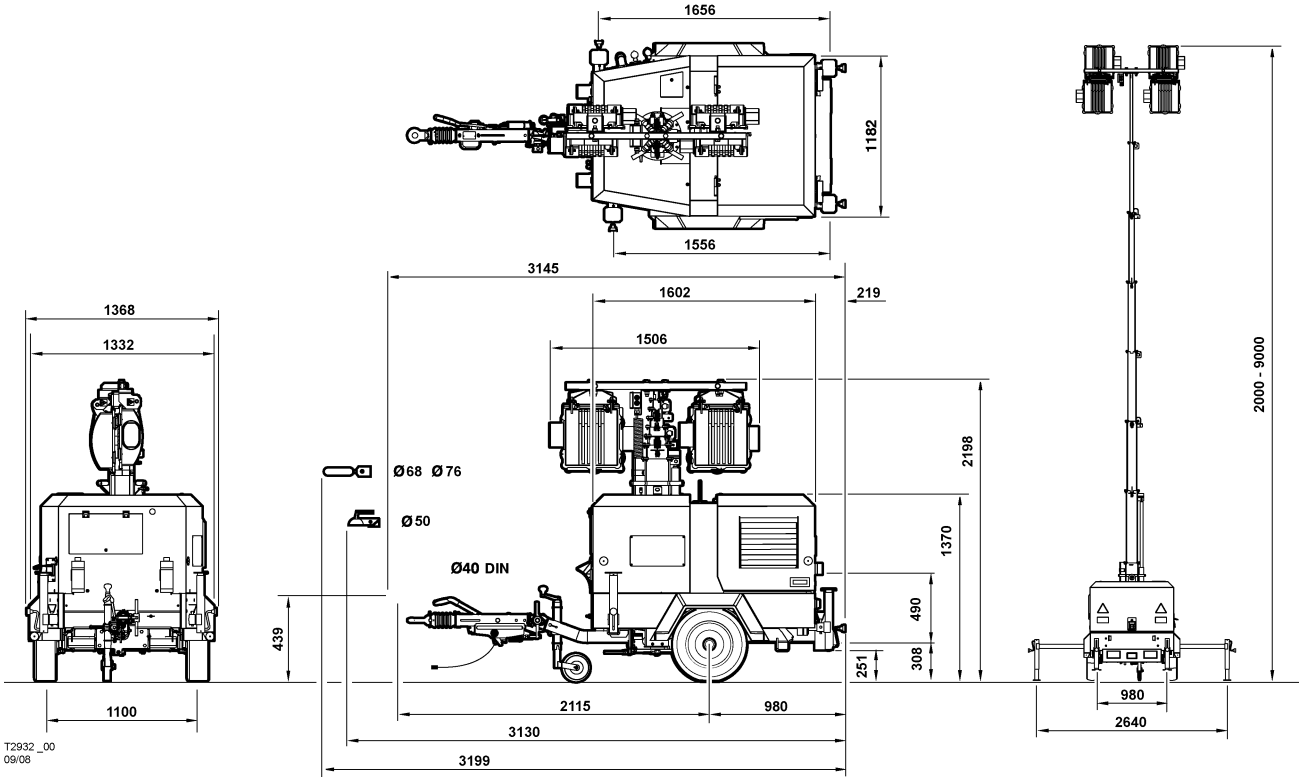
During maintenance operations, drain machine fluids using the drain ports indicated.

WARNING: Major leakages or spillages must be drained before the machine is towed.

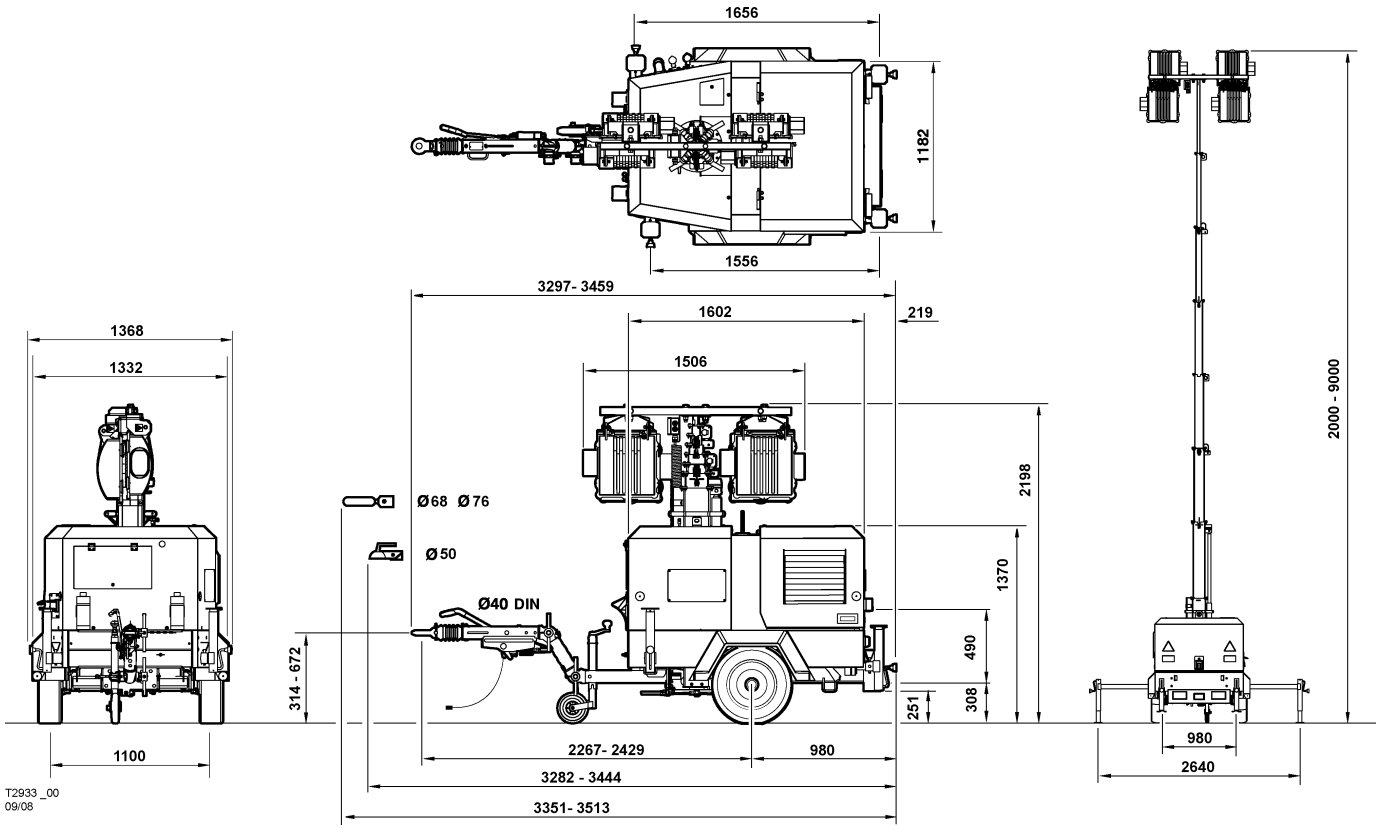
Disposal of contaminated fluids from bund

Contaminated fluids removed from bund, must be disposed of to designated containers only.

FIXED HEIGHT RUNNING GEAR



VARIABLE HEIGHT RUNNING GEAR



LIGHT TOWER

Rated Power Output–kilowatts	6 kVA
Number of Lamps	4
Type of Lamps	Metal–halide 1000 W
Overall Length – Fixed Height RG	3135 mm
Overall Length – Variable Height RG	3297 – 3459 mm
Overall Height	2198 mm
Overall Width – Transporting	1368 mm
Overall Width – Operating	2875 mm
Maximum Tower Height (operating position)	9 m
Maximum wind speed rating	105 km/h (65mph)

HYDRAULIC DATA

Maximum working pressure	125 bar
Hydraulic oil capacity	3,0 litres
Pump operating voltage	12 VDC

ENGINE

Model	KUBOTA D1105
Type	Diesel water cooled
Number of cylinders.	3
Speed at full load.	1500 revs min^{-1}
Speed at idle.	1500 revs min^{-1}
Power available at 1500 revs min^{-1}	8,4kW (11,3 HP)
Fuel tank capacity	130 litres
Oil specification	Refer to engine section
Oil capacity.	5,1 litres
Coolant capacity	4 litres (1,06 US GAL)
Electrical system.	12V negative earth
Alternator	30 amps @ 12 Volts

GENERATOR

Type	Mecc Alte LT3–130/4
Voltage	230 V
Frequency	50 Hz
Power	6 kVA
Voltage stability	+/– 6%

Standard socket outlet – 2 x 16 Amps/Max. total 26 Amps @ 230 Volts

INFORMATION ON AIRBORNE NOISE (CE regions)

– The A–weighted emission sound pressure level

. 70 dB(A), uncertainty 1 dB(A)

– The A–weighted emission sound power level

. 86 dB(A), uncertainty 1 dB(A)

The operating conditions of the machinery are in compliance with ISO 3744:1995 and EN ISO 2151:2004

FIXED HEIGHT RUNNING GEAR
Braked version (KNOTT)

Shipping weight.	1160 kg
Maximum weight.	1300 kg (2866 lbs)
Maximum horizontal towing force.	1300 kgf (2866 lbs)
Maximum vertical coupling load (nose weight).	75 kgf (165 lbs)

VARIABLE HEIGHT RUNNING GEAR
Braked version (KNOTT)

Shipping weight.	1175 kg
Maximum weight.	1300 kg (2866 lbs)
Maximum horizontal towing force.	1300 kgf (2866 lbs)
Maximum vertical coupling load (nose weight).	75 kgf (165 lbs)

WHEELS AND TYRES (KNOTT)

Number of wheels.	2 x 13 x 5J
Tyre size.	165 R13C 94N
Tyre pressure.	3,5 bar (50 PSI)

Further information may be obtained by request through the customer services department.

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.

Running gear drawbar – Machines are shipped to some areas with the drawbar removed. Fitting involves four nuts / bolts to secure the drawbar to the axle and two bolts to fit the drawbar to the front of the machine with the saddle and spacer block.

Support the front of the machine, fit the wheel chocks to stop the machine moving and attach the drawbar. Refer to the torque value table in the *MAINTENANCE* section of this manual for the correct torque values.

CAUTION:
This is a safety critical procedure. Double check the torque settings after assembly

Fit the propstand and coupling. Remove the supports and set the machine level.

Before towing the unit, ensure that the tyre pressures are correct (refer to the *GENERAL INFORMATION* section of this manual) and that the handbrake is functioning correctly (refer to the *MAINTENANCE* section of this manual). Before towing the unit during the hours of darkness, ensure that the lights are functioning correctly (where fitted).

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 selecting the working position of 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.

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

SET–UP (PRIOR TO RAISING TOWER)

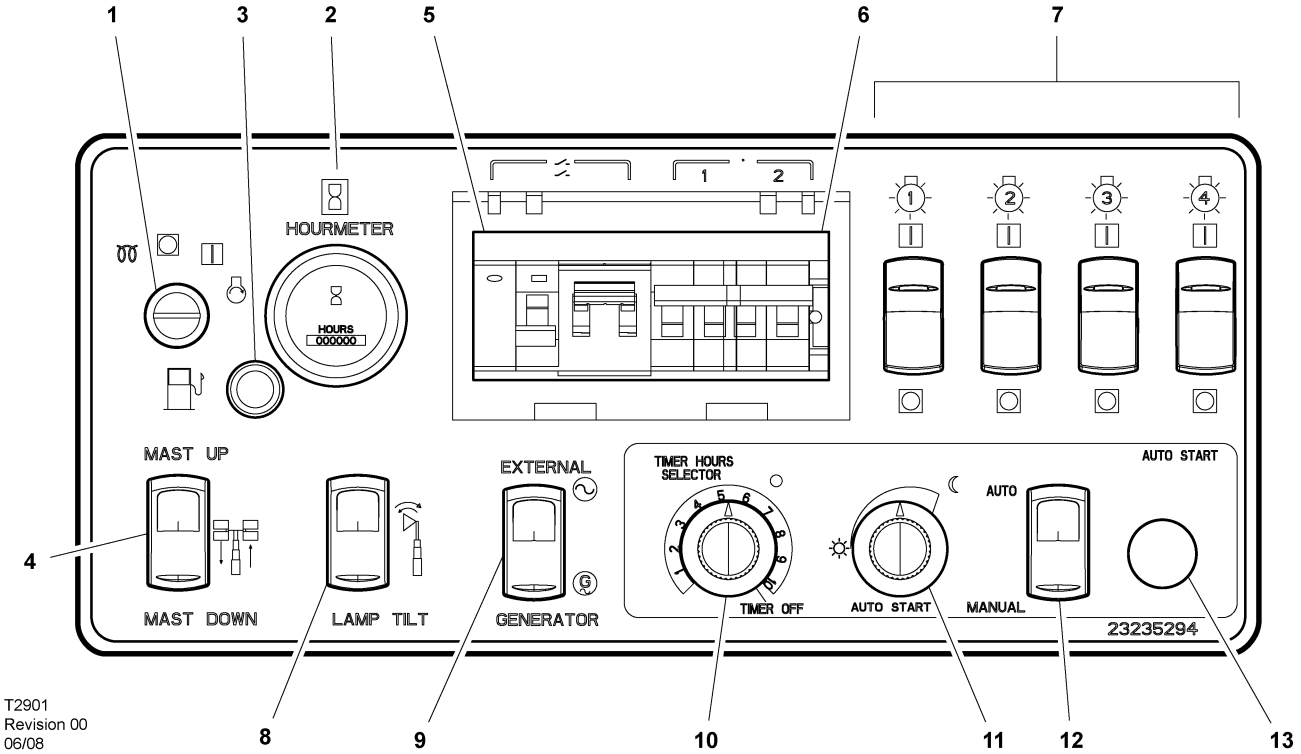
1. Make sure unit is detached from towing vehicle.
2. Make sure parking brake is correctly engaged.
3. Inspect cables. Cables should not be frayed, cut, abraded, or otherwise damaged. Replace damaged cables.
4. Check hydraulic oil level. Fill if necessary / as required.
5. Ensure no obstruction is overhaed within 15 meters.
6. Be sure lamps are secure on cross bar and aim as desired.
7. Extend all outriggers fully and insert locking pins fully. Ensure drawbar jack and all outrigger and/or jacks are firmly in contact with ground.
8. Level unit using jacks and bubble level indicator.
9. Jacks must support entire unit weight (tyres off the ground).

BEFORE STARTING THE ENGINE

Before starting the engine, carry out the following checks:

1. Engine oil level: Add as required.
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 when showing “red”.
5. Fuel level in tank: Fill, using CLEAN DIESEL fuel, at the end of the day to minimize condensation.
6. Battery: Keep terminals clean and lightly greased.
7. Engine belts and hoses: Check for proper fit and/or damage. Service as required.
8. Air Vents/Grilles: Both engine radiator and generator cooling air. Check for obstructions (leaves, paper, etc.).
9. Visual inspection: Check for excessive fluid leaks, evidence of arcing around control panel, loose wire–routing clamps, etc.

CAUTION: *Call a qualified person to make electrical repairs*.



Reference	Description	Function
1	**OFF**	Stops the engine.
	RUN	Normal engine operating position.
	START	Energises engine cranking motor.
	PREHEAT	Turn rotary switch to PREHEAT position for 5 seconds and then to START.
2	**Hour meter**	Records engine operating hours for maintenance purposes.
3	**Low fuel lamp**	
4	**Mast control unit**	Operates the mast to raise and lower the lamps.
5	**Main circuit breaker**	Protects all lamp circuits.
6	**Socket circuit breaker.**	
7	**Lamp switch**	Controls individual lamps.

Reference	Description	Function
*8	**Lamp tilt switch**	Tilts lamp head to required angle.
*9	**Aux/Generator switch**	Switches between generator and auxiliary power.
*10	**Auto start timer**	Selects time period for auto start feature.
*11	**Photo cell**	Sensitivity adjusment.
*12	**Auto/Manual**	Selects mode of operation.
*13	**Auto start warning lamp**	Horn sounds when lamp is lit.

*** Optional**

STARTING THE ENGINE

1. The Main Circuit Breaker and Lamp switches should be “OFF”.
2. Turn the Ignition Switch to “PREHEAT“ for 5 seconds prior to starting.

NOTE: In extreme cold temperatures, this may take up to 10 seconds.

WARNING: Electrical power is present upon cranking engine.

3. Immediately turn the Ignition Switch to “START”.

NOTE: DO NOT crank for more than 15 seconds without allowing the starter to cool for 30 seconds. If the engine does not start after a few attempts, refer to “Fault finding”.

4. Release the Ignition Switch to “ON“ as soon as the engine continues to run.
5. Allow the engine to warm up for 3 to 5 minutes.
6. Turn on the main circuit breaker.
7. The Lamp Switches may now be used.

WARNING: Keep side doors closed for optimum cooling and safety of unit while running.

NOTE: The engine in this unit is protected with sensors for high coolant temperature and low oil pressure. Should either of these conditions occur, the engine will automatically stop causing a loss of power to all lamps. Before restarting the unit, check the fuel level and engine/radiator thoroughly and correct the problem. The lamps should not be restarted for 15 minutes.

SOCKET OUTLETS

With engine running:

1. Turn on the socket breakers.
2. Plug the equiptment in to the sockets.

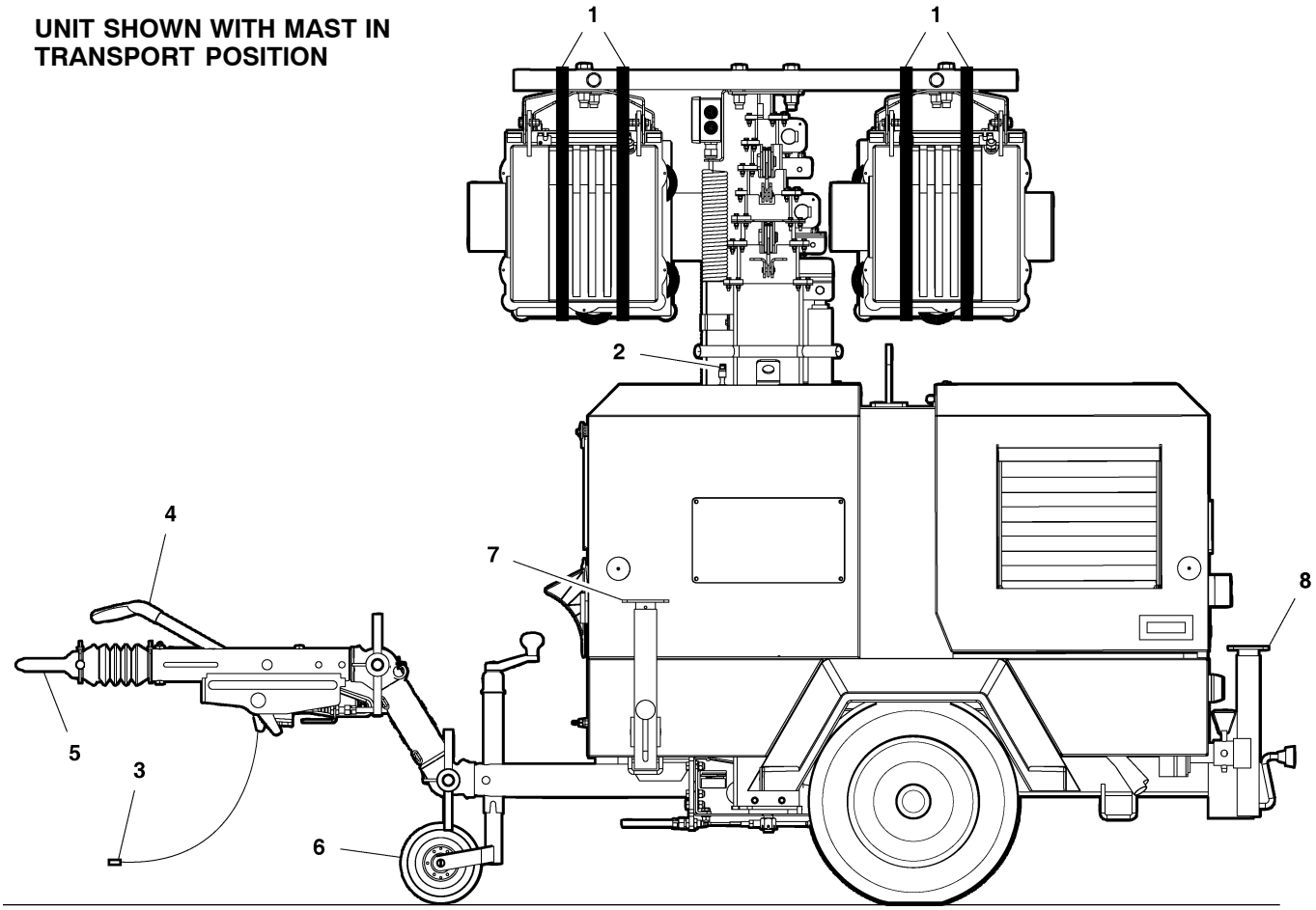
NOTE: The maximum total socket outlet is 26Amps @ 230Volts with all lights off. Each socket rating is 16Amps @ 230Volts.

STOPPING THE ENGINE

1. Turn the Lamps “OFF”.
2. Turn the socket breakers “OFF” if they are on.
3. Turn the Main Breaker “OFF”.
4. Turn the Ignition Switch “OFF”.

NOTE: If the lights are turned off, they should not be restarted for 15 minutes.

UNIT SHOWN WITH MAST IN TRANSPORT POSITION



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MAST OPERATION

WARNING: Check that no person is behind the machine (within 10m) while the tower is raised or lowered.

Check that no obstruction is overhead.

Before operating the mast, inspect the cable for damage. Replace damaged cables if necessary.

Before and during all mast operation, ensure the area is clear of persons and obstructions within a 2m radius.

When the mast has completed its normal travel, or is prevented from travelling, immediately release the control switch, to avoid cable overtension.

Raising the tower

1. Start the engine.
2. Use the mast control switch to raise the tower.
3. Lift the pin **[2]** to rotate tower. Release the pin after rotating the tower to the desired position.

Lowering the tower

1. Start the engine.
2. Switch the lamps off.
3. Lift the pin **[2]** to rotate tower. Release the pin after rotating the tower to the desired position.
4. Make sure that the pin has engaged and locked the tower in position.
5. Use the mast control switch to lower the tower to transport position.

TOWING

WARNING: Make sure that the tow vehicle has a towing capacity of the weight of this unit as stated in "GENERAL INFORMATION" section of this manual.

NOTE: This unit is equipped with a mast lowering switch, when parking brake is released, to avoid towing with raised mast.

WARNING: Beware of lamps lowering when operating under mast area.

1. Connect the machine to the vehicle.
2. Rotate the lamps to transport position and secure by fitting straps **[1]** around the lamp bodies.

WARNING: The lamp bodies may be HOT.

3. Make sure that the tow vehicle hitch **[5]** is the proper size to securely connect to the eye or coupler on the unit.
4. Check eye or coupler bolts for any looseness or wear. Tighten or replace as required.
5. Check the wheels.
6. Position the tow vehicle to align the hitch with the eye or coupler **[5]**.
7. Stand aside while operating the jockey wheel **[6]** to seat the eye or coupler onto the hitch.
8. Secure the hitch.
9. Make sure outriggers and jacks are stored in transport position and the handles are secured by the chains.
10. Attach the brake actuator breakaway chain /cable **[3]**.
11. Make sure the light tower lighting is working properly, in accordance to the towing vehicle's lighting as well as local regulations.
12. Connect lighting plug.
13. Remove wheel chocks.
14. Release hand brake **[4]**.
15. Check that the units brakes are operating correctly.
16. Unit is ready to be towed.

WARNING: Make sure the hitch is completely engaged to the tow vehicle and is secure. Failure to do so could result in serious personal injury.

Do not use the eye or coupler with any bent or otherwise damaged parts.

LIFTING THE MACHINE

Before lifting the machine, carry out the following checks:

1. No loose objects are stored inside or on top of the machine.
2. No additional equipment is hung onto or under the machine.
3. Any device used for lifting is rated at a minimum of 2000kg.
4. No personnel should be on or under the machine at any time during lifting.

RE–STARTING AFTER AN EMERGENCY STOP

If the machine has been switched off because of a machine malfunction, then identify and correct the fault before attempting to re–start.

If the machine has been switched off for reasons of safety, then ensure that the machine can be operated safely before re–starting.

Refer to the *PRIOR TO STARTING* and *STARTING THE UNIT* instructions earlier in this section before re–starting the machine.

MONITORING DURING OPERATION

Should any of the safety shut-down conditions occur, the unit will stop. These are:

. Low engine oil pressure

. High engine water temperature

DECOMMISSIONING

When the machine is to be permanently decommissioned or dismantled, it is important to ensure that all hazard risks are either eliminated or notified to the recipient of the machine. In particular:–

. Do not destroy batteries or components containing asbestos without containing the materials safely.

. Do not allow lubricants or coolants to be released into land surfaces or drains.

. Do not dispose of a complete machine without documentation relating to instructions for its use.

MAINTENANCE SCHEDULE

	Initial.		Daily	Weekly	Hours	Monthly / Hours			
	km (miles)	Hours			200/400	1/–	3/250	6/500	12/1000
	850(500)	50							
Engine Oil Level			C						
*Radiator Coolant Level			C						
Gauges/Lamps			C						
*Air Cleaner Service Indicators			C						
Fuel Tank (Fill at end of day)			C						
*Fuel/Water Separator Drain			C						
Oil Leaks			C						
Fuel Leaks			C						
Drain Water From Fuel Filters			C						
Coolant Leaks			C						
Header Tank Cap.			C						
Fan/Alternator Belts				C					
Battery Connections/Electrolyte				C					
Tire Pressure and Surface				C					
*Wheel Lug Nuts						C			
Hoses (Oil, Air, Intake, etc.)						C			
Automatic Shutdown System						C			
Air Cleaner System						C			
*Engine Rad/Oil Cooler Exterior						C			
Fasteners, Guards							C		
Air Cleaner Elements								R/WI	
*Fuel/Water Separator Element								R	
Engine Oil Change		R			R/–				
Engine Oil Filter		R			R/–				
*Water Pump Grease.									R
*Wheels (Bearings, Seals, etc.)								C	
*Engine Coolant								C	

*Disregard if not appropriate for this particular machine.

(1) or 3000 miles/5000km whichever is the sooner

(2) or as defined by local or national legislation

C = Check (adjust, clean or replace as necessary)

CBT =check before towing.

CR = Check and report

D = Drain

G = Grease

R=Replace

T = Test

W I =or when indicated if earlier.

Refer to specific sections of the operator's manual for more information.

	Initial.		Daily	Weekly	Hours	Monthly / Hours			
	km (miles)	Hours			200/400	1/–	3/250	6/500	12/1000
	850(500)	50							
Fuel Filter Element					–/R				
*Injection Nozzle Check								C	
Shutdown Switch Settings									T
*Feed Pump Strainer Cleaning.									C
Coolant Replacement									R
*Valve Clearance Check									C
Lights (running, brake, & turn)			CBT						
Pintle Eye Bolts			CBT						
*Brakes	C					C			
*Brake linkage	C								
Emergency stop		T							
Fasteners		C							
Running gear linkage						G			
Running gear bolts(1)							C		
Evidence of Arcing Around Elect. Terminals			C						
Tower Cables			C						
Nylon Guides / Slide check			C						
Hydraulic Oil Level			C					R	
Loose Wire Routing Clamps			C						
Proper Grounding Circuit			C						
Wiring Insulation			C						
Obstructions in Air Vents			C						
Control Compartment (Interior)								C	
Engine Shutdown System Switches (setting)									C
Exterior Finish	As needed								
Engine	Refer to Engine Operator Manual								
Decals	Replace decals if removed, damaged or missing								

*Disregard if not appropriate for this particular machine.

(1) or 3000 miles/5000km whichever is the sooner

(2) or as defined by local or national legislation

C = Check (adjust, clean or replace as necessary)

CBT = Check before towing.

CR = Check and report

D = Drain

G = Grease

R=Replace

T = Test

W I = Or when indicated if earlier.

Refer to specific sections of the operator's manual for more information.

Do not tow this unit with a vehicle that has a towing capacity that is less than the unit gross weight shown in General Data.

ROUTINE MAINTENANCE

This section refers to the various components which require periodic maintenance and replacement.

The *SERVICE/MAINTENANCE CHART* indicates the various components' descriptions and the intervals when maintenance has to take place. Oil capacities, etc., can be found in the *GENERAL INFORMATION* section of this manual.

For any specification or specific requirement on service or preventative maintenance for the engine, refer to the *Engine Manufacturer's Manual*.

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

Prior to attempting any maintenance work, ensure that:–

. the machine cannot be started accidentally or otherwise, by posting warning signs and/or fitting appropriate anti–start devices.

. all residual electrical power sources (mains and battery) are isolated.

Prior to opening or removing panels or covers to work *inside* a machine, ensure that:–

. anyone entering the machine is aware of the reduced level of protection and the additional hazards, including hot surfaces and intermittently moving parts.

. the machine cannot be started accidentally or otherwise, by posting warning signs and/or fitting appropriate anti–start devices.

Prior to attempting any maintenance work on a *running* machine, ensure that:–

. the work carried out is limited to only those tasks which require the machine to run.

. the work carried out with safety protection devices disabled or removed is limited to only those tasks which require the machine to be running with safety protection devices disabled or removed.

. all hazards present are known (e.g. pressurised components, electrically live components, removed panels, covers and guards, extreme temperatures, inflow and outflow of air, intermittently moving parts, safety valve discharge etc.).

. appropriate personal protective equipment is worn.

. loose clothing, jewelry, long hair etc. is made safe.

. warning signs indicating that *Maintenance Work is in Progress* are posted in a position that can be clearly seen.

Upon completion of maintenance tasks and prior to returning the machine into service, ensure that:–

. the machine is suitably tested.

. all guards and safety protection devices are refitted.

. all panels are replaced, canopy and doors closed.

. hazardous materials are effectively contained and disposed of.

ELECTRICAL SYSTEM

WARNING: Always disconnect the battery cables before performing any maintenance or service.

Inspect the safety shutdown system switches and the instrument panel relay contacts for evidence of arcing and pitting. Clean where necessary.

Check the mechanical action of the components.

Check the security of electrical terminals on the switches and relays i.e. nuts or screws loose, which may cause local hot spot oxidation.

Inspect the components and wiring for signs of overheating i.e. discolouration, charring of cables, deformation of parts, acrid smells and blistered paint.

ELECTRICAL TERMINALS

Check daily for evidence of arcing around the electrical terminals.

GROUNDING CIRCUIT

Daily check that the grounding circuit is in accordance with local code requirements. Check to ensure continuity between the grounding terminal, frame, generator and engine block.

WIRING INSULATION

Daily check for loose, or frayed wiring insulation or sleeving.

BATTERY

Keep the battery terminals and cable clamps clean and lightly coated with petroleum jelly to prevent corrosion.

The retaining clamp should be kept tight enough to prevent the battery from moving.

INSTRUMENTS

Inspect the instrument lamps, gauges and switches prior to start–up and during operation to ensure proper functioning.

CONTROL COMPARTMENT

Every six months or 500 hours with the unit "OFF", perform visual inspection for loose connections, dirt, arcing, damage to electrical components.

TOWER CABLES

Each day the tower lifting cables should be inspected to ensure the ends are attached securely. The cables should be checked for fraying or other damage and replaced if damaged. Also the pulleys should be checked for unusual wear or damage and replaced if worn excessively or damaged.

WIRE ROUTING CLAMPS

Daily check for loose wire routing clamps. Clamps must be secure and properly mounted. Also check wiring for wear, deterioration and vibration abrasion.

TOWER GUIDES

Every month inspect all of the tower guides for proper operation. Clean sliding surfaces. Replace any missing or damaged parts before raising the tower.

ENGINE RADIATOR

Check the coolant level in the radiator. The coolant must cover the tubes in the top tank (approximately 1 inch high on a clean measuring rod, stuck down filler neck).

WARNING: 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.

The engine coolant system is normally filled with a 50/50 mixture of water and ethylene glycol. This permanent type anti–freeze contains rust inhibitors and provides protection to –35°F (–37°C). The use of such a mixture is recommended for both summer and winter operation. It is recommended to test the freezing protection of the coolant every six months or prior to freezing temperatures. Replenish with a fresh mixture every twelve months. Each month, inspect the radiator exterior for obstructions, dirt and debris. If present, blow water or compressed air containing a non–flammable solvent between the fins in a direction opposite the normal air flow. Should the radiator be clogged internally, reverse flushing, using a commercial product and the supplier's recommended procedure, may correct the problem.

It is recommended to test the freezing protection of the coolant every six months or prior to freezing temperatures. Replenish with a fresh mixture every twelve months.

Each month, inspect the radiator exterior for obstructions, dirt and debris. If present, blow water or compressed air containing a non–flammable solvent between the fins in a direction opposite the normal air flow. Should the radiator be clogged internally, reverse flushing, using a commercial product and the supplier's recommended procedure, may correct the problem.

ENGINE PROTECTION SHUTDOWN SYSTEM

The operation of the engine protection shutdown system should be checked every month, or whenever it appears not to be operating properly. The three switches involved in this protective shutdown system are the engine coolant high temperature switch, the engine oil pressure switch and the low fuel switch. (optional)

The engine oil pressure switch prevents the engine from operating with low oil pressure. Once a month, remove a wire from the engine oil pressure switch to check the shutdown system for proper operation.

Test the engine oil pressure switch by removing it and connecting it to a source of controlled pressure while monitoring an ohmmeter connected to the switch terminals.

As pressure is applied slowly from the controlled source, the switch should close at 12 psi (84 kPa) and show continuity through the contacts. As the pressure is slowly decreased to 10 psi (70 kPa) the contacts should open and the ohmmeter should show a lack of continuity through the contacts. Replace a defective switch before continuing to operate the unit.

Once a year, the temperature actuated switch should be tested by removing it from the unit and placing it in a bath of heated oil. The engine coolant high temperature switch will require a temperature of approximately 220°F (104°C) to actuate.

NOTE: The engine temperature switch does NOT offer protection when NO coolant is present. Test the switch operation by connecting an ohmmeter between the two wire terminals. The ohmmeter should show zero ohms. When the switch is placed in the heated oil bath and its contact open, the ohmmeter should indicate infinite ohms. Tap the switch lightly during the checking operation. Replace any defective switch before continuing to operate the unit.

CAUTION: *Never operate the unit with a defective safety shutdown switch or by by–passing a switch.*

AIR FILTER ELEMENTS

The air filter should be inspected regularly (refer to the *SERVICE/MAINTENANCE CHART*) and the element replaced when the restriction indicator shows red or every 6 Months (500 hours), whichever comes first. The dust collector box(es) should be cleaned daily (more frequently in dusty operating conditions) and not allowed to become more than half full.

Removal

CAUTION: *Never remove and replace element(s) when the machine is running.*

Clean the exterior of the filter housing and remove the filter element by releasing the nut.

Inspection

Check for cracks, holes or any other damage to the element by holding it up to a light source, or by passing a lamp inside.

Check the seal at the end of the element and replace if any sign of damage is evident.

Reassembly

Assemble the new element into the filter housing ensuring that the seal seats properly.

Reset the restriction indicator by depressing the rubber diaphragm.

Assemble the dust collector box parts, ensuring that they are correctly positioned.

Before restarting the machine, check that all clamps are tight.

VENTILATION

Always check that the air inlets and outlets are clear of debris etc.

CAUTION: *NEVER clean by blowing air inwards.*

COOLING FAN DRIVE

Periodically check that the fan mounting bolts in the fan hub have not loosened. If, for any reason, it becomes necessary to remove the fan or re–tighten the fan mounting bolts, apply a good grade of commercially available thread locking compound to the bolt threads and tighten to the torque value shown in the *TORQUE SETTING TABLE* later in this section.

The fan belt(s) should be checked regularly for wear and correct tensioning.

FUEL SYSTEM

The fuel tank should be filled daily or every eight hours. To minimise condensation in the fuel tank(s), it is advisable to top up after the machine is shut down or at the end of each working day. At six month intervals drain any sediment or condensate that may have accumulated in the tank(s).

FUEL FILTER WATER SEPARATOR

The fuel filter water separator contains a filter element which should be replaced at regular intervals (see the *SERVICE/MAINTENANCE CHART*).

HOSES

All components of the engine cooling air intake system should be checked periodically to keep the engine at peak efficiency.

At the recommended intervals, (see the *SERVICE/MAINTENANCE CHART*), inspect all of the intake lines to the air filter, and all flexible hoses used for air lines, oil lines and fuel lines.

Periodically inspect all pipework for cracks, leaks, etc. and replace immediately if damaged.

Hydraulic hoses must be free of wear. All hydraulic fittings must be properly tightened and free of any leaks.

LUBRICATION

The engine is initially supplied with engine oil sufficient for a nominal period of operation (for more information, consult the Engine section of this manual).

CAUTION: *Always check the oil levels before a new machine is put into service.*

If, for any reason, the unit has been drained, it must be re–filled with new oil before it is put into operation.

ENGINE LUBRICATING OIL

The engine oil should be changed at the engine manufacturer's recommended intervals. Refer to the Engine section of this manual.

ENGINE LUBRICATING OIL SPECIFICATION

Refer to the Engine section of this manual.

ENGINE OIL FILTER ELEMENT

The engine oil filter element should be changed at the engine manufacturer's recommended intervals. Refer to the Engine section of this manual.

TYRES/TYRE PRESSURE

See the *GENERAL INFORMATION* section of this manual.

RUNNING GEAR/WHEELS

Check the wheel nut torque 20 miles (30 kilometres) after refitting the wheels. Refer to the *TORQUE SETTING TABLE* later in this section.

Lifting jacks should only be used under the axle.

The bolts securing the running gear to the chassis should be checked periodically for tightness (refer to the *SERVICE/MAINTENANCE CHART* for frequency) and re–tightened where necessary. Refer to the *TORQUE SETTING TABLE* later in this section.

RUNNING GEAR WHEEL BEARINGS

Wheel bearings should be packed with grease every 6 months. The type of grease used should conform to specification *MIL–G–10924.*

BRAKES

Check and adjust the brake linkage at 500 miles (850Km) then every 3000 miles (5000Km) or 3 months (whichever is the sooner) to compensate for any stretch of the adjustable cables. Check and adjust the wheel brakes to compensate for wear.

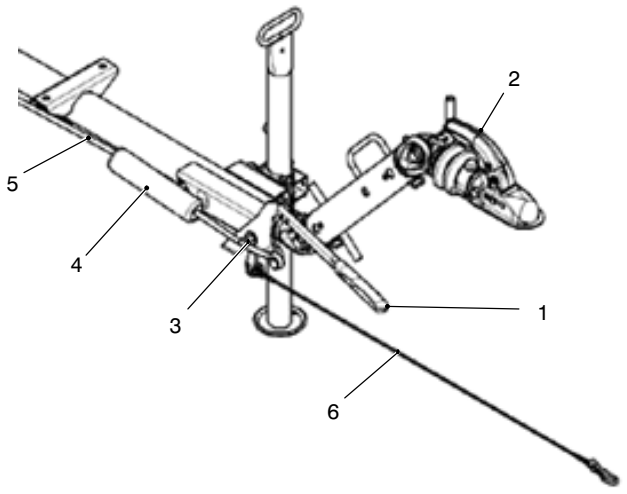
ADJUSTING THE OVERRUN BRAKING SYSTEM (KNOTT RUNNING GEAR)

1: Preparation

Jack up the machine

Disengage the handbrake lever [1].

Fully extend the draw bar [2] on the overrun braking system.



1 Handbrake lever
2 Draw bar and bellows
3 Handbrake lever pivot
4. Spring sleeve complete.
5 Brake cable
6 Breakaway Cable

Requirements:

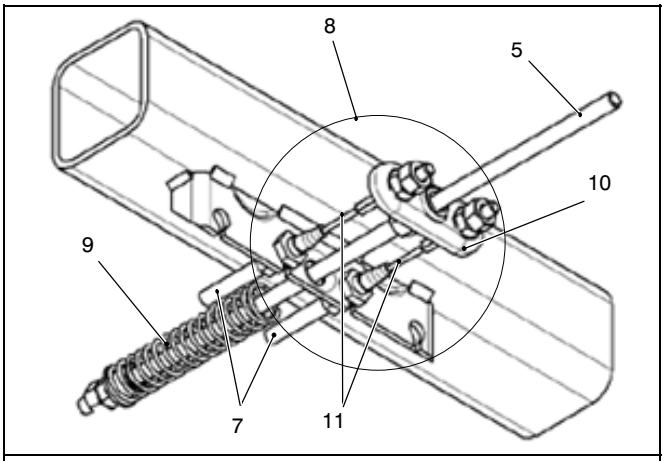
During the adjustment procedure always start with the wheel brakes.

Always rotate the wheel in the direction of forward movement.

Ensure that an M10 safety screw is fitted to the handbrake pivot.

The brake actuators must not be pre–tensioned – if necessary loosen the brake linkage [7] on the brake equalisation assembly [8].

Check that brake actuators and cables [11] operate smoothly.



7 Brake linkage

8 Equalisation assembly

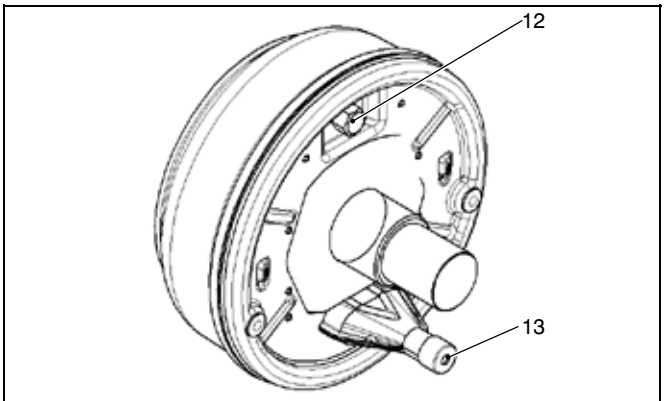
9 Compression spring

10 Equaliser plate

11 Cable

CAUTION
The compression spring [9] must only be lightly pre−tensioned and when operating must never touch the axle tube.
Never adjust the brakes at the brake linkage [7].

2. Brake Shoe Adjustment



12 Adjusting screw

13 Cable entry

Width across flats of adjusting screw [12]

Brake size	**Key width**
160x35 / 200x50	SW 17
250x40	SW 19
300x60	SW 22

Tighten adjusting screw [12] clockwise until the wheel locks.

Loosen adjusting screw [12] anti−clockwise (approx. ½ turn) until the wheel can be moved freely.

Slight dragging noises that do not impede the free movement of the wheel are permissible.

This adjustment procedure must be carried out as described on both wheel brakes.

When the brake has been adjusted accurately the actuating distance is approximately 5−8mm on the cable [11]

3: Compensator assembly adjustment

Variable Height models

Fit an M10 safety screw to the handbrake pivot.

Disconnect the handbrake cable [5] at one end.

Pre−adjust brake linkage [7] lengthways (a little play is permissible) and re−insert the cable [5], adjusting it to give a small amount of play.

Remove the M10 safety screw from the handbrake pivot.

All Models

Engage the handbrake lever [1] and check that the position of the equaliser plate [10] is at right angles to the pulling direction. If necessary correct the position of the equaliser plate [10] on the cables [11].

The compression spring [9] must only be slightly pre−tensioned and when engaged must not touch the axle tube.

4: Brake linkage adjustment

Adjust the brake linkage [7] lengthways without pre−tension..

Readjustment

Engage the handbrake lever [1] forcefully a number of times to set the brake.

Check the alignment of the equalisation assembly [8], this should be at right angles to the pulling direction

Check the play in the brake linkage [7]

If necessary adjust the brake linkage [7] again without play and without pre−tensioning

There must still be a little play in cable [5] (Variable Height Only)

Check the position of the hand brake lever [1]. The start of resistance should be approximately 10−15mm above the horizontal position.

Check that the wheels move freely when the handbrake is disengaged.

Final test

Check the fastenings on the transmission system (cables, brake equalisation system and linkage).

Check the handbrake cable [5] for a small amount of play and adjust if necessary (Variable height only)

Check the compression spring [9] for pre−tensioning.

Test run

If necessary carry out 2−3 test brake actions.

Test brake action

Check the play in brake linkage [7] and if necessary adjust the length of brake linkage [7] until there is no play.

Apply the handbrake while rolling the machine forward, travel of the handbrake lever up to 2/3 of maximum is allowed.

Re−adjusting the overrun braking system (KNOTT Running Gear)

Re−adjustment of the wheel brakes will compensate for brake lining wear. Follow the procedure described in *2: Brake Shoe Adjustment*.

Check the play in the brake linkage [7] and re−adjust if necessary.

Important
Check the brake actuators and cables [11]. The brake actuators must not be pre−tensioned.
Excessive operation of the handbrake lever, which may have been caused by worn brake linings, must not be corrected by re−adjusting (shortening) the brake linkage [7]

Re–adjustment

The handbrake lever [1] should be engaged forcefully several times to set the braking system.
Check the setting of the brake equalisation assembly [8], which should be at right angles to the pulling direction.
Check the play in the brake linkage [7] again, ensuring that there is no play in the brake linkage and that it is adjusted without pre–tension
Check the position of the hand brake lever [1], cable [5] (with little play) and the compression spring [9] (only slight pre–tension). The start of resistance of the handbrake lever should be approximately 10–15mm above the horizontal position.

Final test

Check the fastenings on the transmission system (cables, brake equalisation system and linkage)

Apply the handbrake while rolling the machine forward, travel of the handbrake lever up to 2/3 of maximum is allowed.

Check the handbrake cable [5] for a small amount of play and adjust if necessary (Variable height only)

Check the compression spring [9] for slight pre–tensioning.

CAUTION: *Check the wheel nut torque 20 miles (30 kilometres) after refitting the wheels (Refer to the TORQUE SETTING TABLE later in this section).*

GENERAL CLEANING INSTRUCTIONS

Keeping the machine clean of any oil and dirt is recommended for both appearance and maximum service life of the equipment. The frequency of cleaning will be dependent on local conditions and the severity and frequency of operation.

NOTE: Do not use high pressure water, steam or solvent on the exterior finish of the unit housing.

TORQUE VALUES

TABLE 1

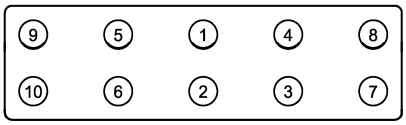
	ft lbf	Nm
Engine mounts to engine	29–35	39–47
Air filter to bracket	16–20	22–27
Autella clamp to exhaust	9–11	12–15
Enclosure	9–11	12–15
Drop Leg	53–63	72–85
Exhaust flange to manifold	17–21	23–28
Fan guard	9–11	12–15

	ft lbf	Nm
Fan to hub	12–15	16–20
Running gear front to chassis	63–69	82–93
Running gear rear to chassis	63–69	82–93
Running gear drawbar to axle	29–35	39–47
Band clamp on hose	106–133	143–180
Wheel nuts	50–80	67–109

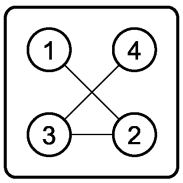
USE VALUES FROM TABLE 2 IF NOT SPECIFIED IN TABLE 1

TABLE 2 METRIC FASTENERS

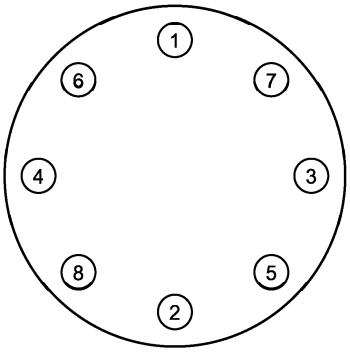
CAPSCREW OR NUT THREAD SIZE AND PITCH	NOMINAL DESIGN TORQUE					
	PROPERTY GRADE 8.8 (HEAD MARKING)		PROPERTY GRADE 10.9 (HEAD MARKING)		PROPERTY GRADE 12.9 (HEAD MARKING)	
	(Nm.)	(FT–LBF)	(Nm.)	(FT–LBF)	(Nm.)	(FT–LBF)
M6 X 1.0	11	8	15	11	18	13
M8 X 1.25	26	19	36	27	43	31
M10 X 1.5	52	38	72	53	84	62
M12 X 1.75	91	67	126	93	147	109
M14 X 2	145	107	200	148	234	173
M16 X 2	226	166	313	231	365	270
M20 X 2.5	441	325	610	450	713	526



TYPICAL RECTANGULAR TORQUE PATTERN



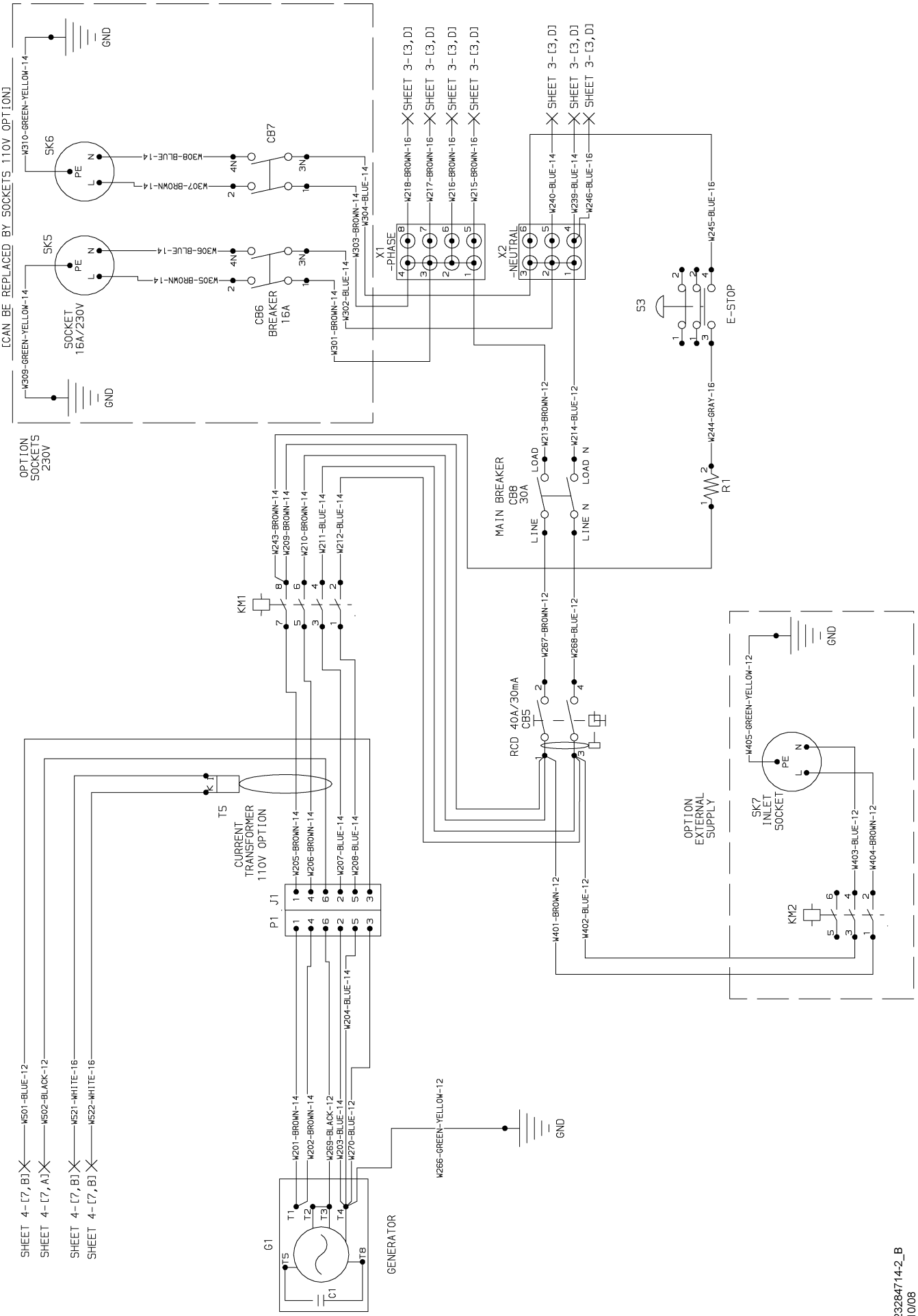
TYPICAL SQUARE TORQUE PATTERN



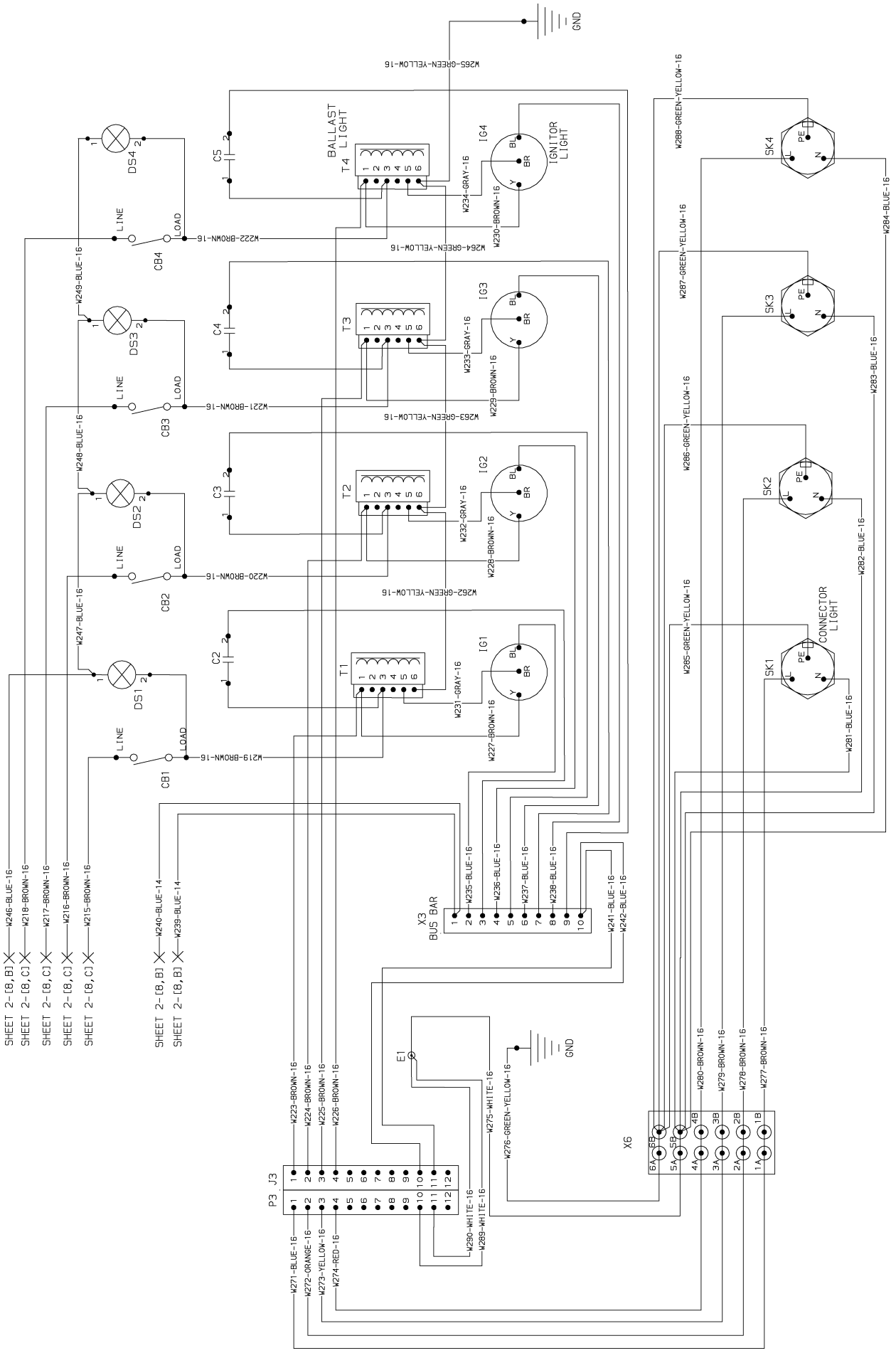
TYPICAL CIRCULAR TORQUE PATTERN


DOOSAN
Doosan Infracore
Portable Power

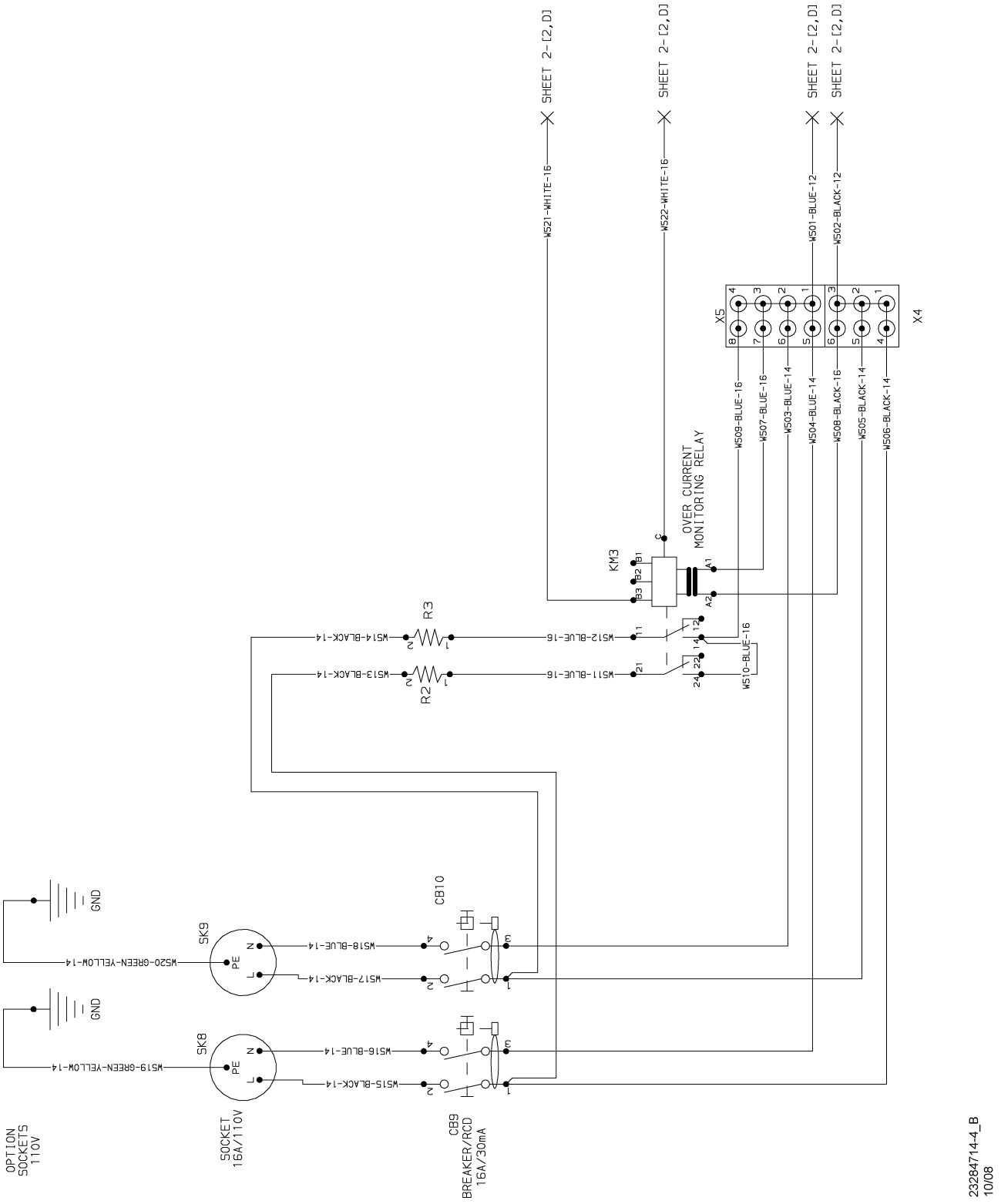
SCHEMATIC DIAGRAM FOR AC ELECTRICAL HARNESS



SCHEMATIC DIAGRAM FOR AC ELECTRICAL HARNESS



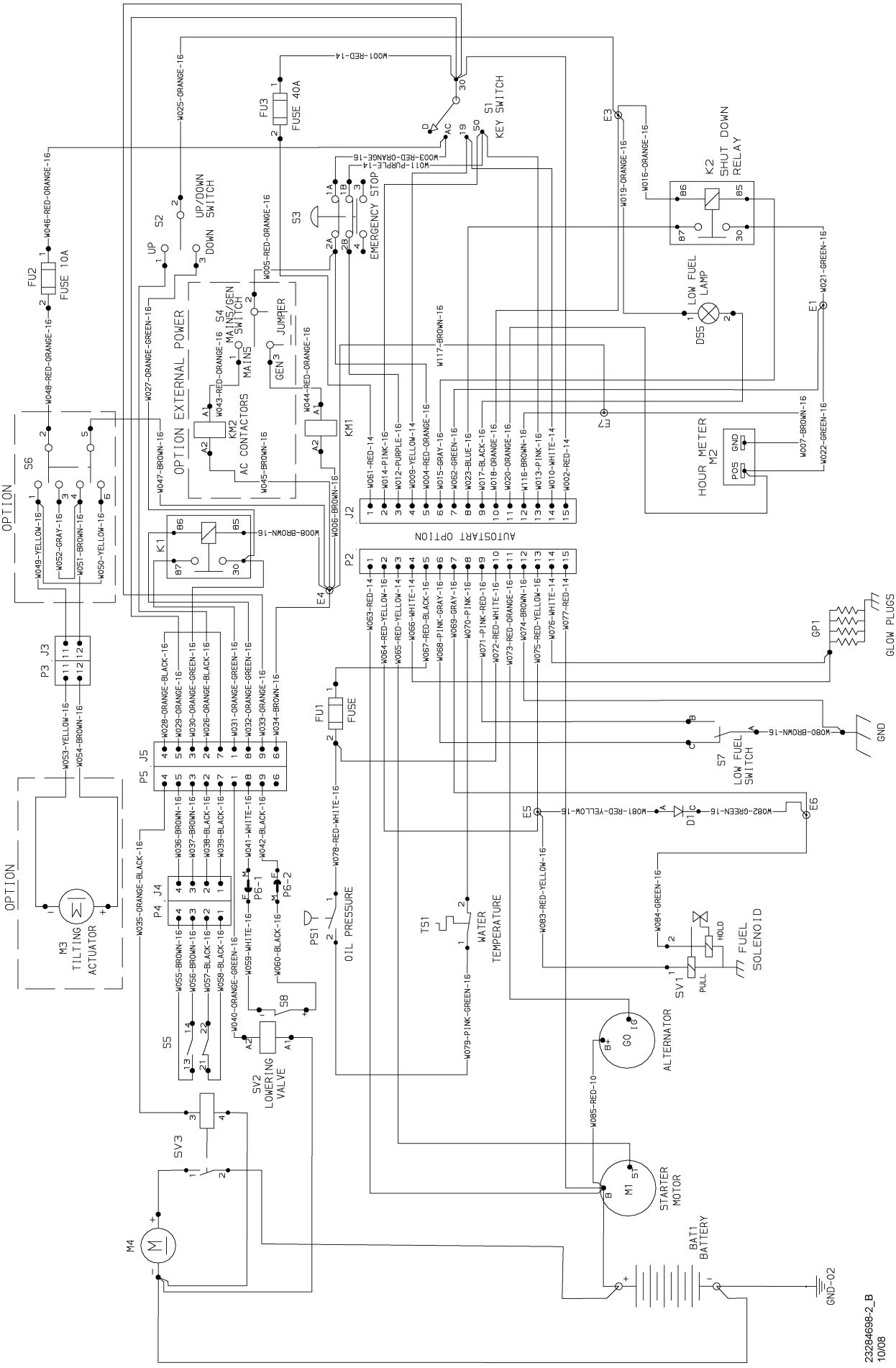
SCHEMATIC DIAGRAM FOR AC ELECTRICAL HARNESS



KEY

C2–5	Capacitor
CB10	Breaker/RCD (option)
CB1–4	Light switch
CB5	Residual current device (earth–leakage circuit–breaker)
CB6	Breaker 16A (option)
CB7	Breaker 16A (option)
CB8	Main breaker 30A
CB9	Breaker/RCD (option)
DS1–4	Lamp
G1	Generator
IG1–4	Ignitor, light
KM1	Contactors
KM2	Contactors (option)
KM3	Overcurrent monitoring relay (option)
R1	Resistor
R2	Resistor (option)
R3	Resistor (option)
S3	Switch, emergency stop
SK1–4	Connector, light
SK5	Socket 16A/230V (option)
SK6	Socket 16A/230V (option)
SK7	Inlet socket (option)
SK8	Socket 16/110V (option)
SK9	Socket 16/110V (option)
T1–4	Ballast, light
T5	Current transformer 110V (option)

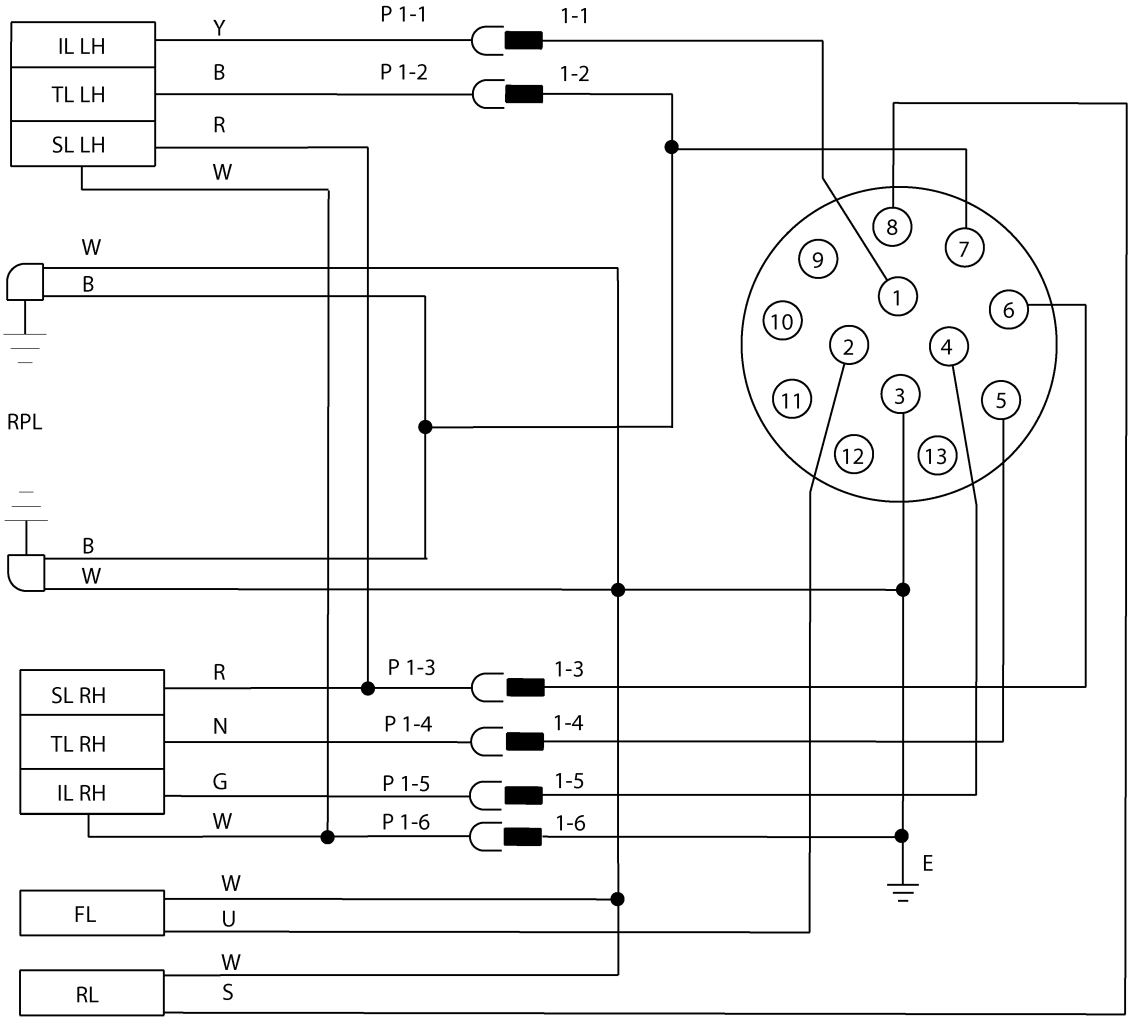
SCHEMATIC DIAGRAM FOR DC ELECTRICAL HARNESS



KEY

BAT1	Battery 12VDC
D1	Diode
DS5	Lamp, low fuel
FU1	Fuse
FU2	Fuse 10A
FU3	Fuse 40A
G0	Alternator
GP1	Glow plugs
K1	Relay
K2	Relay, safety shut-down
KM1	Contactors – Generator (option)
KM2	Contactors – Mains AC (option)
M1	Starter motor
M2	Hourmeter
M3	Tilting actuator (option)
M4	Motor, hydraulic pump
PS1	Engine oil pressure switch
S1	Key–switch
S3	Switch, emergency stop
S4	Switch, Mains/Gen switch (option)
S5	Inductive sensor –mast position down
S6	Switch, tilting (option)
S7	Switch, low fuel level
SV1	Solenoid, fuel
SV2	Solenoid, mast lowering
SV3	Solenoid, hydraulic pump
TS1	High water temperature switch (engine)

SCHEMATIC DIAGRAM FOR EUROPEAN CE LIGHTING SYSTEM



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KEY

IL LH	Indicator light – left hand
IL RH	Indicator light – right hand
FL	Fog light
RL	Reverse light
SL LH	Stop light – left hand
SL RH	Stop light – right hand
TL LH	Tail light – left hand
TL RH	Tail light – right hand
E	Earth
RPL	Registration plate lights

B	Black
G	Green
K	Pink
N	Brown
O	Orange
P	Purple
R	Red
S	Grey
U	Blue
W	White
Y	Yellow

FAULT	CAUSE	REMEDY
Engine fails to start.	*Low battery charge.*	Check the fan belt tension, battery and cable connections.
	Bad earth connection.	Check the earth cables, clean as required.
	Loose connection.	Locate and make the connection good.
	Fuel starvation.	Check the fuel level and fuel system components. Replace the fuel filter if necessary.
	Relay failed.	Replace the relay.
Engine starts but stalls when the switch returns to position *I*.	*Electrical fault*	Test the electrical circuits.
	Low engine oil pressure.	Check the oil level and the oil filter(s).
	Faulty relay	Check the relays.
	Faulty key–switch	Check the key–switch.
Engine starts but will not run or engine shuts down prematurely.	*Electrical fault.*	Test the electrical circuits.
	Low engine oil pressure.	Check the oil level and oil filter(s).
	Safety shut-down system in operation.	Check the safety shut-down switches.
	Fuel starvation.	Check the fuel level and fuel system components. Replace the fuel filter if necessary.
	Switch failure.	Test the switches.
	Water present in fuel system.	Check the water separator and clean if required.
	Faulty relay.	Check the relay in the holder and replace if necessary.
Engine Overheats.	*Reduced cooling air from fan.*	Check the fan and the drive belts. Check for any obstruction inside the cowl.
Engine speed too high.	*Incorrect throttle arm setting.*	Check the engine speed setting.
Engine speed too low.	*Incorrect throttle arm setting.*	Check the throttle setting.
	Blocked fuel filter.	Check and replace if necessary.
	Blocked air filter.	Check and replace the element if necessary.
Excessive vibration.	*Engine speed too low.*	See "*Engine speed too low*"
Refer also to the *engine section of this manual.*		

FAULT	CAUSE	REMEDY
The mast does not raise.	*Pump does not operate.*	Battery is not connected/charged.
		Key switch is not in “ON” position.
		Emergency stop button is pushed in.
	Pump operates but mast does not raise.	Hydraulic oil level is too low.
		The hydraulic hose is defective or leaking.
		Lowering valve has failed in open position.
		Suction tube in the tank is defective.
	Mast raises but not completely.	A pulley mounting pin is defective or missing.
		Cable assembly is damaged.
		Hydraulic oil level is too low.
The mast lowers on its own.	*The mast has lowered when the operator returns to the machine.*	The hydraulic hose is defective or leaking.
The mast does not lower.	*Hydraulic cylinder does not lower.*	Key switch is not in “ON” position.
		Emergency stop button is pushed in.
		The hydraulic hose is defective.
		Mast is jammed or damaged in raised position.
		The mast is raised while machine not levelled properly.
		The hose burst valve in cylinder is damaged or blocked.
		Damaged sliding pads stop the mast from coming down.
Mast falls down.	*Mast falls down suddenly and very fast.*	Cable failed.
		Pulley failed.

KUBOTA D1105 – ENGINE

CONTENTS

FOREWORD

In order to get the fullest use and benefit from your engine, it is important that you operate and maintain it correctly. This Manual is designed to help you do this.

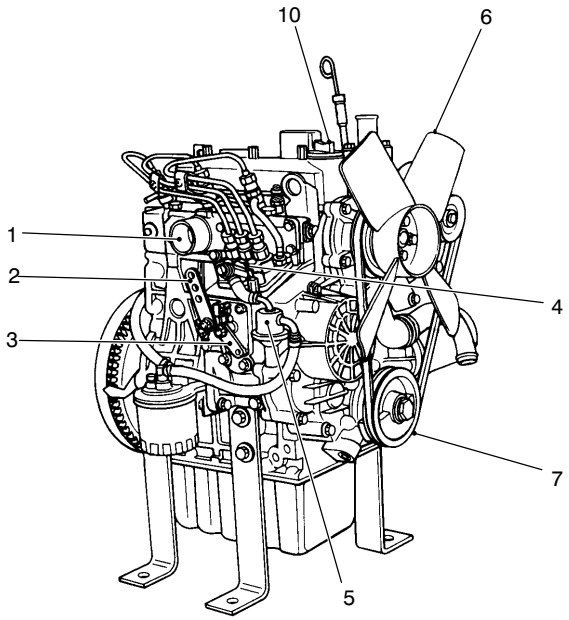
Please read this Manual carefully and follow its operating and maintenance recommendations. This will ensure many years of trouble−free and economical engine operation.

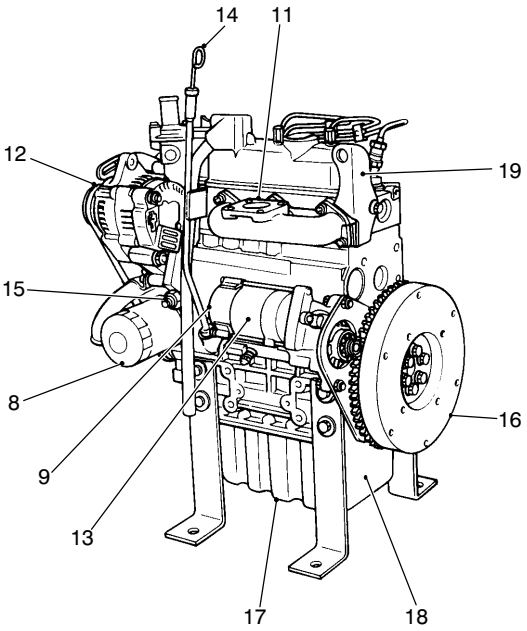
Should your engine require servicing, please contact your nearest branch or distributor.

All information, illustrations, and specifications contained in this Manual are based on the latest product information available at the time of publication.

The company reserves the right to make changes in this Manual at any time without prior notice.

DIESEL ENGINE Engine External View – Model





1. Intake manifold
2. Speed control lever
3. Engine stop lever
4. Fuel injection pump
5. Fuel feed pump
6. Cooling fan
7. Fan drive pulley
8. Engine oil filter
9. Water drain cock
10. Filler port (engine oil)
11. Exhaust manifold
12. Alternator
13. Starter motor
14. Dipstick (engine oil)
15. Oil pressure switch
16. Flywheel
17. Drain plug (engine oil)
18. Oil pan
19. Lifting eye

EPA CERTIFIED ENGINE DATA and SPECIFICATIONS

Model: Lightsource V9 – KUBOTA D1105–E2BG–DIPP–1

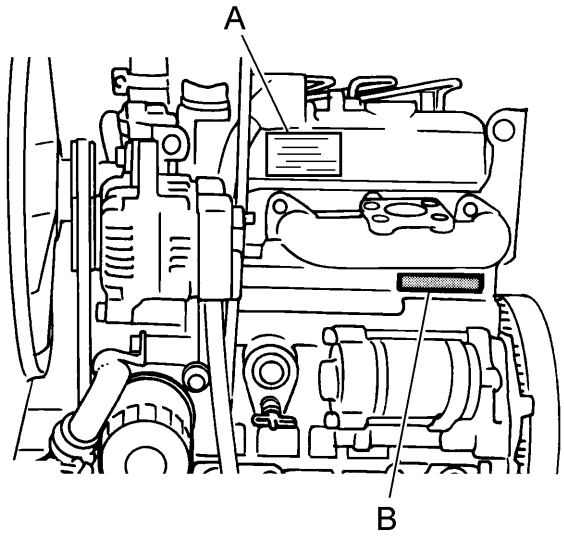
Engine model name		KUBOTA D1105–E2BG–DIPP–1
Engine type		Vertical inline water cooled diesel engine
Combustion type		Spherical type (E–TVCS)
No. of cylinders – bore x stroke. mm		3 – 78 x 78.4mm
Engine displacement cm^3		1,123
Compression ratio		22
Firing order		1 – 2 – 3
Exhaust emission control system		Fuel injection nozzles, fuel injector pump
Governor		Mechanical type
Injection nozzles		Bosch MD Type mini pump
Specified fuel		Diesel fuel No2 (ASTM D975)
Starter	(V–kW)	12–1.0
Alternator	(V–W)	12–360
Specified engine oil (API grade) (SAE grade)		(CD,CF) (10W–30 or 15W–40)
Coolant volume (Engine only) L		4.0
Engine dry weight kg		110
	Overall length mm	549
Engine dimensions	Overall width mm	396
	Overall height mm	608.7
Valve clearance (cold) mm		0.145–0.185
Nozzle injection pressure MPa		13.73
Injection timing B.T.D.C. at 2.5mm cam lift		16.5°

ENGINE IDENTIFICATION

Serial No Location

A. Label location

B. Serial No Location



Confirmation of Engine Number

It is advisable to quote the engine serial number together with the machine serial number, as it is required when you contact the company branch or distributor for repair, service or parts ordering.

CAUTION: Conduct confirmation of engine serial number with the engine stopped. To avoid being injured, do not check it, while the engine is still hot.

ENGINE AFTER SERVICE

Please feel free to contact your dealer for periodical inspection and maintenance.

Doosan Genuine Parts

Genuine Doosan parts are identical with those used in the engine production, and accordingly, they are warranted.

Genuine Doosan parts are supplied by your branch or distributor.

Please ensure that only genuine Doosan parts, lubricants and fluids are used for service and/or repair.

FUEL

Fuel Selection

The following properties are required of the diesel fuel:

Must be free from minute dust particles.

Must have adequate viscosity.

Must have high cetane value.

Must have high cetane value., (45 or greater)

Must have high fluidity at low temperature.

Must have low sulphur content.

Must have little residual carbon.

It is strongly advisable to use ASTM D975 No. 2D (the general automotive diesel engine purpose fuel oil) or equivalent which fully meets the above requirements.

Applicable Standard	Recommendation
JIS (Japanese Industrial Standard)	K22O4 – 2
DIN (DEUTSCHE INDUSTRIE NORMEN)	DIN 51601
SAE (Society of Automotive Engineers) Based on SAE–J–313C	NO. 2–D
BS (BRITISH STANDARD) Based on BS/2869–1970	Class A–1 or A–2
ISO 8217	DMA

FUEL REQUIREMENTS

Notice: the fuel injection pump, injector or other parts of the fuel system and engine can be damaged if you use any fuel or fuel additive other than those specifically recommended by Doosan.

NOTE: If any fuel other than the one specified is used, engine operation will be impaired. Engine failure or malfunction resulting from use of such improper fuel will not be warranted by Doosan.

To help avoid fuel system or engine damage, please read the following:

Do not use diesel fuel which has been contaminated with engine oil. Besides causing engine damage, such fuel can also affect emission control. Before using any diesel fuel, check with the fuel supplier to see if the fuel has been mixed with engine oil.

Your engine is designed to use either Number 1–D or Number 2–D diesel fuel. However, for better fuel economy, use Number 2–D diesel fuel whenever possible. At temperatures less than –7°C, (20°F), Number 2–D fuel may pose operating problems. At colder temperatures, use Number 1–D fuel (if available) or use a “winterized” Number 2–D (a blend of Number 1–D and Number 2–D). This blended fuel is usually called Number 2–D also, but can be used in colder temperatures than Number 2–D fuel which has not been “winterized.”

Check with the fuel supplier to be sure you get the properly blended fuel.

NOTICE: Do not use home heating oil or gasoline in your diesel engine; either may cause engine damage.

Handling of the Fuel.

Any fuel containing dust particles or water might cause engine failure .

Therefore, the following must be observed.

Take care to protect the fuel from ingress of dust particles or water when filling the fuel tank.

If refueling is done from an oil drum directly, ensure that it has been kept stationary to allow any dust, sediment or water to settle at the bottom. Do not draw fuel direct from the bottom of the drum to prevent pickup of any settled foreign material.

Always fully fill the fuel tank. Drain the sedimented particles in the fuel tank frequently.

Water in Fuel

During refueling, it is possible for water (and other contaminants) to be pumped into your fuel tank along with the diesel fuel. This can happen if a fuel provider does not regularly inspect and clean its fuel tanks, or receives contaminated fuel from its supplier(s). To protect your engine from contaminated fuel, there is a fuel filter system on the engine which allows you to drain excess water.

CAUTION: *The water/diesel fuel mixture is flammable, and could be hot. To avoid personal injury and/or property damage, do not touch the fuel coming from the drain valve, and do not expose the fuel to open flames or sparks.*

Be sure you do not overfill the fuel tank. Heat (such as from the engine) can cause the fuel to expand. If the tank is too full, fuel could be forced out. This could lead to a fire and the risk of personal injury and/or equipment damage.

Biocides

In warm or humid weather, fungus and/or bacteria may form in diesel fuel if there is water in the fuel.

NOTICE: Fungus or bacteria can cause fuel system damage by plugging the fuel lines, fuel filters or injector. They can also cause fuel system corrosion.

If fungus or bacteria has caused fuel system problems, you should have your authorized dealer correct these problems. Then, use a diesel fuel biocide to sterilize the fuel system (follow the biocide manufacturer‘s instructions). Biocides are available from your dealer, service stations, parts stores and other automotive places. See your authorized dealer for advice on using biocides in your area and for recommendations on which biocides you should use.

Smoke Suppressants

The use of a smoke suppressant additive is not allowed because of the greater possibility of stuck rings and valve failure, resulting from excessive ash deposits.

LUBRICANT.

The quality of engine oil can affect engine performance, startability and engine life.

Use of unsuitable engine oil will result in piston ring, piston and cylinder seizure and accelerate surface wear causing increased oil consumption, lowered output and, finally engine failure. To avoid this, use the specified engine oil.

1) Engine Oil Selection
PRO–TEC

2) Oil Viscosity

Engine oil viscosity affects engine startability, performance, oil consumption, wear and the potential for seizure, etc. Always ensure that lubricants with the correct viscosity for the operating temperature are used. Refer to fig 12.

NOTE

Using a mixture of different brands or quality of oils will adversely affect the original oil quality; therefore, never mix different brand or different type oils.

Do not use API, CA, CB grade and reconstituted engine oil.

Engine damage due to improper maintenance, or using oil of the improper quality and/or viscosity, is not covered by the warranty.

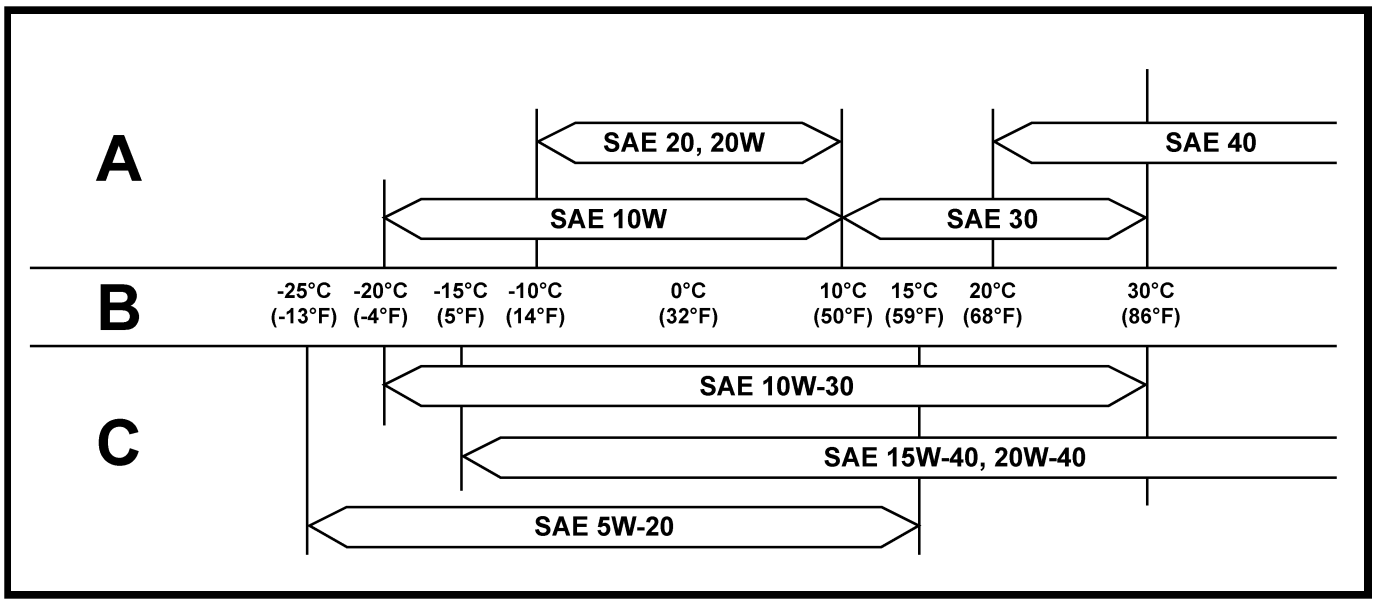


Fig. 12

A. (Single – grade)

B. Ambient Temperature

C. (Multi – grade)

COOLANT

All diesel engines are factory filled with a 50/50 Ethylene glycol base antifreeze/water mix. which provides protection to –33°C (–27°F).

IMPORTANT:

- *Be sure to add Long Life Coolant Antifreeze (LLC) to soft water. In cold season, the LLC is especially important. Without LLC, cooling performance will decrease due to scale and rust in the cooling water line. Without LLC, cooling water will freeze and expand to break the cooling line.*
- *Be sure to use the mixing ratios specified by the LLC manufacturer for your temperature range.*
- *Do not mix different types (brand) of LLC, chemical reactions may make the LLC useless and engine trouble could result*
- *Replace the cooling water every once a year*

***CAUTION**: When handling Long Life Coolant Antifreeze, wear protective rubber gloves not to contact with it. If contact with the eyes or skin should occur, wash with clean water*

ENGINE OPERATION

Engine Exhaust Gas Caution (Carbon Monoxide)

CAUTION

Do not breathe exhaust gas because it contains carbon monoxide, which by itself has no color or odor. Carbon monoxide is a dangerous gas. It can cause unconsciousness and can be lethal.

Do not run the engine in confined areas (such as garages or next to a building). Keep the exhaust tailpipe area clear of snow and other material to help reduce the buildup of exhaust gases under the equipment. This is particularly important when parked in blizzard conditions.

CHECK BEFORE OPERATION

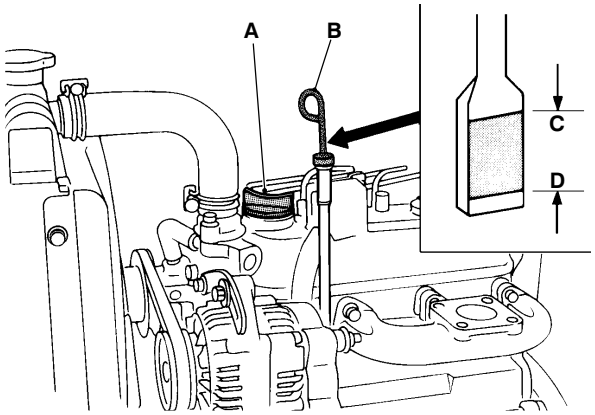
CAUTION: *For safety reasons, conduct the inspection with the engine stopped.*

Engine Oil Level.

Place the engine or the machine on a level surface

Remove the dipstick, wipe it with a cloth. Insert it fully and take it out gently again.

Check the oil level against the marks on the dipstick. The oil level must be between the upper level mark and the lower level mark as illustrated.



A. Filler cap

B. Dipstick

C. Upper limit

D. Lower limit

Remove filler cap on the rocker arm cover side of engine

Fill with engine oil up to the upper limit on the dipstick.

Manually tighten the filler cap. Do not use a tool such as pliers to tighten it.

A certain period of time is required before the engine oil completely flows down from the oil filler to the crankcase. Wait at least ten minutes before checking the oil level.

NOTE: Take care to avoid engine oil being splashed on the fan drive belt because it causes belt slippage or slackness.

CAUTION: *When adding oil, take care not to spill it. If you spill oil on the engine or equipment, wipe it properly, to prevent the risk of fire and personal injury and/or equipment damage.*

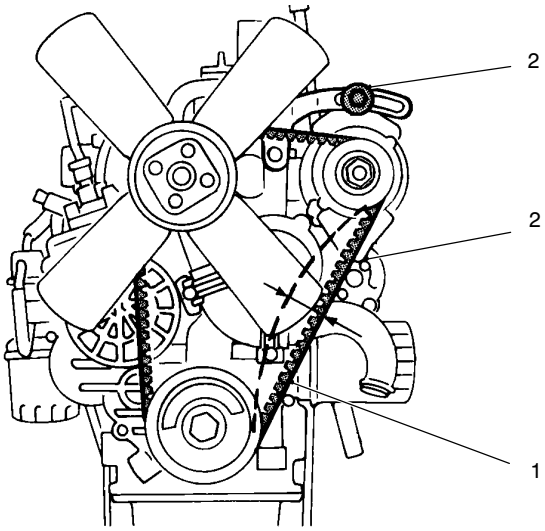
Fan Belt Check

Check the fan belt for tension and abnormalities.

When the belt is depressed 7 – 9 mm with the thumb (about 100 N [10 kg] pressure) midway between the bottom pulley and alternator pulley, the belt tension is correct.

If the belt tension is too high, it will result in alternator failure.

A loose belt will cause belt slippage which may result in a damaged belt, abnormal noise, poor battery charging and engine overheating.



1. Fan belt

2. Bolt and nut

Coolant Level Check

The coolant level must be between “MAX COLD” and “MIN” marks on the reserve tank depending on the temperature of the engine. Check and ensure that the level is correct.

CAUTION: *When removing the radiator filler cap, while the engine is still hot, cover the cap with cloth, then turn it slowly to gradually release the internal steam pressure. this will prevent anyone from being scalded by hot steam spurting out from the filler neck.*

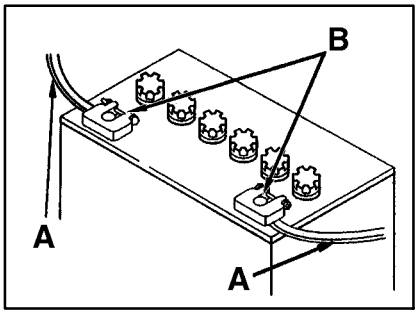
Add coolant mixed to the correct ratio: 50/50 ethylene glycol/water.

Radiator Cap Condition

After the replenishment of the coolant, install the radiator filler cap. Make sure the cap is securely installed.

Battery Cable Connection

Check the battery cable connections for looseness or corrosion. A loosened cable connection will result in hard engine starting or insufficient battery charge. The battery cables must be tightened securely. Never reverse "+" and "–" terminals when reconnecting cables after disconnection. Even a short period of reverse connection will damage the electrical parts.



A Battery cable

B Connections

Battery Electrolyte level

The amount of electrolyte in the batteries will be reduced after repeated discharge and recharge. Check the electrolyte level in the batteries, replenish with a commercially available electrolyte such as distilled water, if necessary. The battery electrolyte level checking procedure will vary with battery type. NOTICE: Do not replenish with dilute sulfuric acid in the daily service.

CAUTION:

When inspecting the batteries, be sure to stop the engine first.

As dilute sulphuric acid is used as electrolyte, be careful not to contaminate your eyes, hands, clothes, and metals with the electrolyte. If it gets in your eye, wash with a large amount of water at once, then seek medical advice.

As highly flammable hydrogen gas is released from the batteries, do not create a spark or allow any naked flame near the batteries.

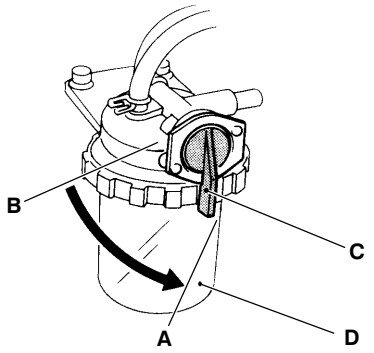
When handling such metallic articles as tools near the batteries, be sure not to contact the positive terminal because the machine body is negative and a dangerous short circuit might result.

When disconnecting the terminals, start with "–" terminal. When connecting them, connect the "–" terminal last.

Fuel level

Check the remaining fuel oil level in the fuel tank and re–fuel if necessary.

When starting the engine after a long storage (of more than 3 months), first set the engine stop lever to the "STOP" position and then activate the starter for about 10 seconds to allow oil to reach every engine part.



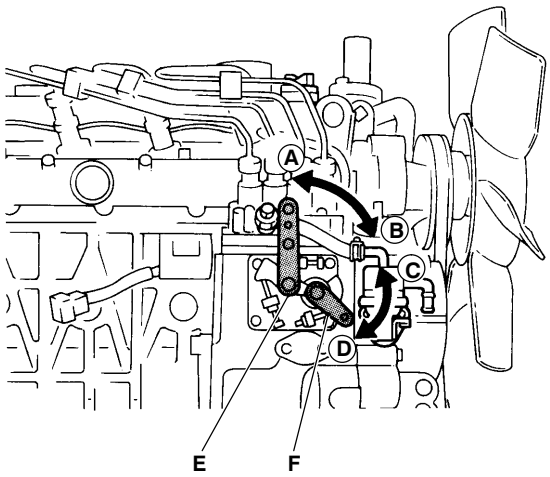
A. "ON"

B. "OFF"

C. Fuel filter lever

D. Fuel filter pot

1. Set the fuel lever to "ON".
2. Place the engine stop lever in the "START" position.



A. "IDLE"

B. "OPERATION"

C. "START"

D. "STOP"

E. Speed control lever

F. Engine stop lever

CHECKS AND OPERATION AFTER START–UP

Check after the Engine Start–up

Check the following items in the engine warming–up operation.

Engine noise and exhaust smoke color –

Listen to the engine and, if any abnormal noise is heard, check to determine the cause.

Check the fuel combustion condition by observing the exhaust smoke color. The exhaust smoke color after engine warm–up and at no–load condition should be colorless or light blue.

Black or white smoke indicates incorrect combustion.

Note: *After start–up from cold the engine might be noisier and the exhaust smoke color darker than when it has warmed up. However this condition will disappear after warm up.*

Leakage in the systems –

Check the following items:

Lubrication oil leakage –

Check the engine for oil leaks, paying particular attention to oil filter and oil pipe joints.

Fuel leakage –

Check the fuel injection pump, fuel lines and fuel filter for leakage.

Coolant leakage – Check the radiator and water pump hose connections and the water drain cock on the cylinder block for leakage.

Exhaust smoke or gas leakage

Checking coolant level

The coolant level could drop because any mixed air is expelled in about 5 minutes after the engine started.

Stop the engine, remove radiator cap, and add coolant.

CAUTION: *Hot steam can rush out and you could get burnt if the radiator cap is removed when the engine is hot. Cover the radiator cap with a thick cloth and loosen the cap slowly to reduce the pressure, then remove the cap.*

OPERATION AND CARE OF A NEW ENGINE.

Your engine is carefully tested and adjusted in the factory, however, further run–in is necessary. Avoid any harsh engine operation within the initial 100 operating hours.

Do not operate the unit at full load until the engine is warmed–up.

Do not allow the engine to run unloaded for extended periods so as to minimise the risk of cylinder bore glazing.

During operation, pay attention to the following points if the engine shows any sign of abnormalities.

(1) Engine Oil Pressure – The engine oil pressure is monitored by a switch that will stop the engine if the pressure falls below a pre–set value.

(2) Coolant Temperature – The engine performance will be adversely affected if engine coolant temperature is too hot or too cold. The normal coolant temperature is 75 to 85°C (167 to 185°F).

Overheating

CAUTION:

If you see or hear escaping steam or have other reason to suspect there is a serious overheat condition, stop the engine immediately.

If the Engine Coolant Temperature gage (where fitted) shows an overheat condition, or you have reason to suspect the engine may be overheating, take the following step:

- Close the service valve to reduce the load.
- Let the engine run at normal idle speed for two or three minutes. If the engine coolant temperature does not start to drop, turn off the engine and proceed as follows:

CAUTION: *To help avoid being burned –*

- *Do not open the canopy or door if you see or hear steam or engine coolant escaping. Wait until no steam or engine coolant can be seen or heard before opening the engine canopy or door.*
- *Do not remove the radiator filler cap if the engine coolant in the reserve tank is boiling. Also do not remove the radiator filler cap while the engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if either cap is taken off too soon.*

If no steam or engine coolant can be seen or heard, open the canopy or door. If the engine coolant is boiling, wait until it stops before proceeding. The engine coolant level should be between the “MAX COLD” and “MIN” marks on the reserve tank.

Make sure the fan belt is not broken, or off the pulley, and that the fan turns when the engine is started. If the engine coolant level in the reserve tank is low, look for leaks at the radiator hoses and connections, radiator, and water pump. If you find major leaks, do not run the engine until these problems have been corrected. If you do not find a leak or other problem, WAIT UNTIL THE ENGINE HAS COOLED DOWN then carefully add engine coolant to the reserve tank.

(Engine coolant is a mixture of ethylene glycol antifreeze and water. See “Engine Care in cold season” for the proper antifreeze and mixture.)

CAUTION: *To avoid being burned, do not spill antifreeze or engine coolant on the exhaust system or hot engine parts. Under some conditions the ethylene glycol in engine coolant is combustible.*

If the engine coolant level in the reserve tank is at the correct level but there is still an indication of an overheat condition and no cause was found, please consult your local Doosan branch or dealer.

Overcooling

Operating the engine at low coolant temperature will not only increase the oil and fuel consumption but also will lead to premature parts wear which may result in engine failure. Ensure that the engine reaches normal operating temperature 75 to 85°C (167 to 185°F) within ten minutes of starting.

(3) Hourmeter

This meter indicates the machine operation hours. Make sure that the meter is always working during engine operation. Periodical machine maintenance is scheduled on the operation hours indicated on the hourmeter.

(4) Liquid and Exhaust Smoke Leakage

Make regular checks for lubricant, fuel, coolant and exhaust smoke leakage.

(5) Abnormal Engine Noise

In the event of any abnormal engine noise, please consult your local Doosan branch or dealer.

(6) State of the Exhaust Smoke

Check for any abnormal exhaust smoke color.

ENGINE STOPPING

(1) Close service valves.

(2) Before stopping the engine, cool down the engine by operating it at reduced load about three minutes. In this period, check the engine noise for abnormalities.

LONG TERM STORAGE

If the equipment is to be out of operation for an extended period, it should be started at least once per week and run on load for about 15 minutes after it has reached normal operating temperature.

If this is not possible,

- Do not drain the cooling water
- Clean dust or oil from the engine extension
- Either fill completely or drain the fuel tank
- Grease accelerator joints and electrical connections
- Disconnect the negative battery terminal

When performing the following items, the daily inspection items should also be carried out.

IMPORTANT:
Establish a periodic check plan according to the operating conditions and make sure to conduct checks at specified intervals. Otherwise, malfunctioning may occur to shorten the engine life.
As special knowledge and skill are required for items marked with ●, consult your local branch or distributor.

○: Check ◇: Replace ●: Contact your dealer

System	Check item	Daily	Periodic inspection interval				
			Every 50 hours	Every 200 hours	Every 400 hours	Every 800 hours	Every 2000 hours
Fuel	Fuel tank level check and refill	○					
	Cleaning fuel tank			○			
	Draining from fuel / water separator		○				
	Cleaning fuel / water separator			○			
	Fuel filter replacement				◇		
Engine oil	Engine oil level	○					
	Engine oil replacement		◇ 1st time	◇ 2nd & after			
	Engine oil filter replacement						
Cooling water	Check & addition cooling	○					
	Radiator fin checking & cleaning			○			
	Cooling fan V−belt checking, adjusting & replacement		○ 1st time	○ 2nd & after	◇		
	Cooling water replacement					◇ or every 1 yr	
	Cooling water path flushing & maintenance						● or every 2 yrs
Rubber hoses	Fuel & cooling water pipe replacement						● or every 2 yrs
Operating system	Governor lever & accelerator check & adjust	○		○			
Intake and exhaust	Air cleaner element cleaning & replacement			○	◇		
Electrical equipment	Battery electrolyte check and recharging		○				
Cylinder head	Adjust intake / exhaust valve clearance					●	
	Lapping intake / exhaust valve seats						●
Fuel valve pump *	Check fuel injection valve pressure & adjust					●	
	Check & adjust fuel injection pump						●

* The specific emissions related parts for the EPA/ARB regulations

EPA allows to apply Maintenance schedule for Emission related parts as follows.

−	Check Fuel Valve Nozzle and clean	Adjust, cleaning and repair of fuel injection Pump and fuel valve nozzle
kW ≦ 130	1500 hours of use and at 1500−hour intervals thereafter	3000 hours of use and at 3000−hour intervals thereafter

Note:
★ This is a recommended maintenance. The failure to perform this maintenance item will not nullify the emission warranty or limit recall liability prior to the completion engine useful life. The company, however, urges that recommended maintenance service is performed at the indicated intervals.

EXPLANATION OF MAINTENANCE SCHEDULE

The following is a brief explanation of the services listed in the preceding Engine Maintenance schedule.

1.	**Oil level.**	Check that the oil level is between the max. and the min. level marks. Add oil to the max. level mark if it is below the min. level. If it is above the max. level mark, drain oil until the max. level is reached.
2.	**Engine oil replacement**	Change at 200 hours or 6 months, whichever comes first.
3.	**Oil filter element replacement**	Change at 200 hours or 6 months, whichever comes first.
4.	**Fuel leakage**	Replace any damaged or malfunctioning parts which could cause leakage.
5.	**Draining water in fuel filter/separator.**	Drain off water in the fuel filter/separator bowl.
6.	**Fuel filter element replacement**	Replace both primary (filter/separator) and secondary elements at 400 hours or 6 months whichever come first.
7.	**Injection nozzle check**	Check injection opening pressure and spray condition. (This is a recommended maintenance item ★). Consult your local branch or distributor.
8.	**Coolant level.**	Check coolant level and add coolant if necessary.
9.	**Coolant leakage check**	Replace any damaged or malfunctioning parts which could cause leakage.
10.	**Radiator filler cap fitting condition**	The radiator cap must be installed tightly and sealing correctly.
11.	**Fan belt tension check**	Check and adjust fan belt deflection. Look for cracks, fraying and wear. Replace if necessary.
12.	**Coolant temperature**	Normal running temperature is 75 to 85°C (167 to 185°F). Check and repair the cooling system if temperature is abnormal.
13.	**Coolant replacement**	Change coolant at intervals of 800 hours or 12 months, whichever comes first.
14.	**Radiator external face cleaning**	Check monthly. Clean at intervals of 200 hours or 3 months, whichever comes first. In very dusty environments, more frequent cleaning might be necessary.
15.	**Cooling system circuit cleaning**	Clean at intervals of 2000 hours or 24 months, whichever comes first.
16.	**Radiator filling cap function check**	Check radiator pressure cap periodically for proper operation. Consult your local branch or distributor.
17.	**Battery electrolyte level check**	Replenish with distilled water if necessary.
18.	**Battery cleaning**	Clean the terminals
19.	**Battery charge condition**	If cranking speed is too slow to start the engine, charge the battery.
20.	**Air filter element replacement**	Change element at 400 hrs or sooner if the restriction indicator shows red.
21.	**Cylinder compression pressure**	Consult your dealer or distributor
22.	**Valve clearance check**	Check and adjust every 1000 hours. Consult your dealer or distributor

Inspection after initial 50 hours operation

(1) Replacing the engine oil and engine oil filter (1st time)

When the engine oil is still hot, be careful with a splash of engine oil which may cause burns. Cool the engine to replace engine oil until the engine oil becomes warm. It is most effective to drain the engine oil while the engine is still warm.

In early period of use, the engine oil gets dirty rapidly because of the initial wear of internal parts. Replace the engine oil earlier.

Engine oil filter should also, be replaced when the engine oil is replaced.

Engine oil and engine oil filter replacing procedures are as follows.

Remove the oil filler cap to drain easily while draining the engine oil.

1) Prepare a waste oil container collecting waste oil.

2) Loosen the drain plug using a wrench (customer procured) to drain the engine oil.

3) Securely tighten the drain plug after draining the engine oil.

4) Turn the engine oil filter counter−clockwise using a filter wrench (customer procured) to remove It.

5) Clean the engine oil filter mounting face.

6) Moisten the new engine oil filter gasket with the engine oil and install the new engine oil filter manually turning it clockwise until it comes into contact with the mounting surface, and tighten it further to 3/4 of a turn with the filter wrench.

Tightening torque: 19.6∼23.5N•m (2.0∼2.4kgf•m)

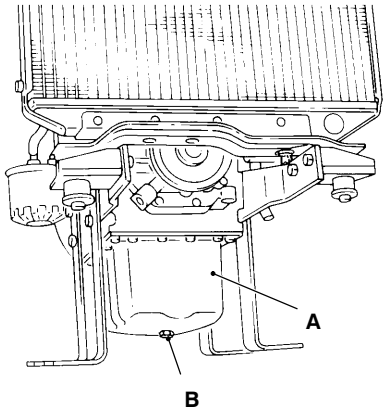
Applicable engine oil filter Part No.
CCN 22355481

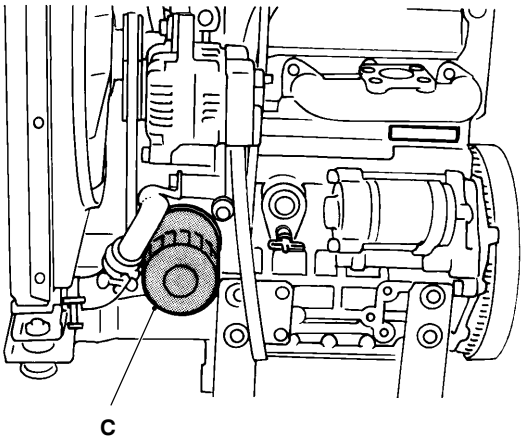
7) Fill with the new engine oil until it reaches the specified level as explained in OPERATION section.

IMPORTANT:
Do not overfill the oil pan with engine oil. Be sure to keep the specified level between upper and lower limit on the dipstick.

8) Warm up the engine by running for 5 minutes while checking any oil leakage.

9) Stop the engine after warming up and leave it stopping for about 10 minute to recheck the engine oil level with dipstick and replenish the engine oil. If any oil is spilled, wipe it away with a clean cloth.





A. Oil pan

B. Drain plug

C. Engine oil filter

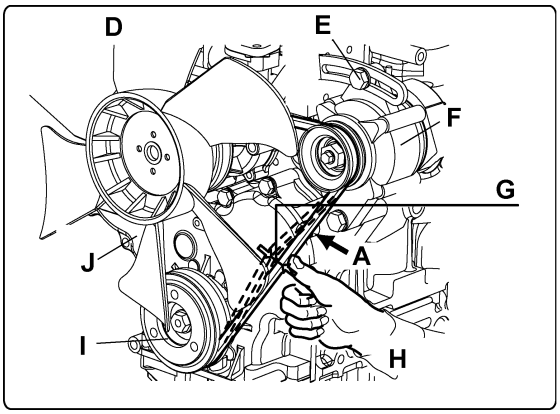
(2) Checking and adjusting cooling fan V−belt

When there is not enough tension in the V−belt, the V−belt will slip making it impossible for the alternator to generate power and cooling water pump and cooling fan will not work causing the engine to overheat. Check and adjust the V−belt tension (deflection) in the following manner.

1) Press the V−belt down with your thumb [approx. 100N(10.2kgf)]. at the middle of the V−belt span to check the tension (deflection).

The specified deflection should be as follows.

A
7∼9 mm



D. Radiator fan

E. Set bolt

F. Alternator

G. Deflection

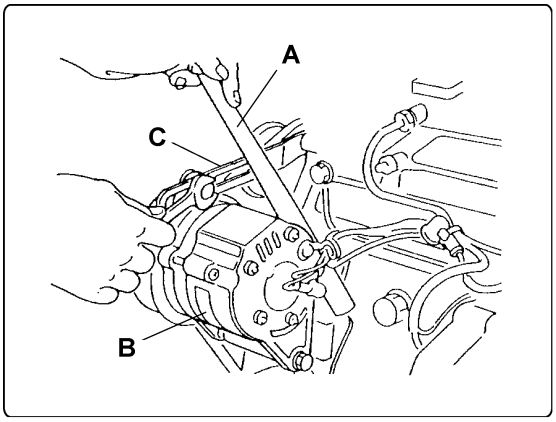
H. Press with thumb

I. Crankshaft V−pulley

J. V−belt

2) If necessary, adjust the V−belt tension (deflection). To adjust the V−belt tension, loosen the set bolt and move the alternator to tighten the V−belt.

3) Visually check the V−belt for cracks, oiliness or wear. If any , replace the V−belt with new one.



(Adjusting the V−belt tension)

A. Adjust the V−belt tension by prying with a wooden bar

B. Alternator

C. Adjusting bracket

Use of genuine Doosan fan belt

Always use genuine Doosan fan belts as they provide high driving ability and long operating durability. Use of non−Doosan fan belts could result in premature belt wear or belt elongation leading to engine overheating or excessive belt noise.

CAUTION:
To help avoid being injured, check and adjust the fan belt tension with engine stopped.

Inspection every 50 hours operation

(1) Inspection of battery

Fire due to electric short−circuit

- Make sure to turn off the battery switch or disconnect the negative cable (−) before inspecting the electrical system. Failure to do so could cause short−circuiting and fires.
- Always disconnect the (−) Negative battery cable first before disconnecting the battery cables from battery. An accidental “Short circuit” may cause damage, fire and or personnel injury.

And remember to connect the (−) Negative battery cable (back onto the battery) LAST.

Proper ventilation of the battery area

Keep the area around the battery Well ventilated, paying attention to keep away any fire source. During operation or charging, hydrogen gas is generated from the battery and can be easily ignited.

Do not come in contact with battery electrolyte

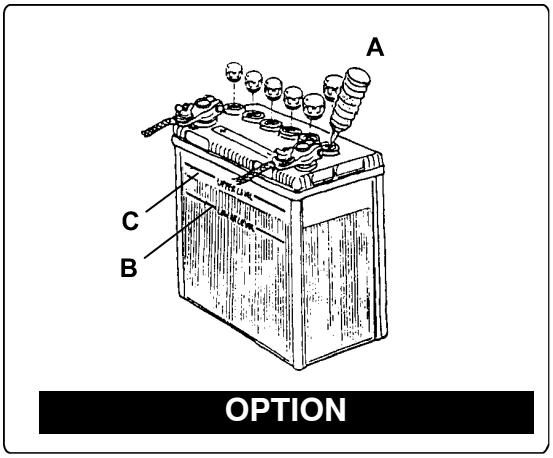
Pay sufficient attention to avoid your eyes. or skin from being in contact with the fluid. The battery electrolyte is dilute sulfuric acid and causes burns. Wash it off immediately with a large amount of fresh water if you get any on you.

- Clean the battery terminals
- Check the level of fluid in the battery.

When the amount of fluid nears the lower limit, fill with battery fluid (available in the market) to the upper limit. If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode.

- Battery fluid tends to evaporate more quickly in the summer, and the fluid level should be checked earlier than the specified limes.

- If the engine cranking speed is so slow that the engine does not start up, recharge the battery.
- If the engine still will not start after charging, replace the battery.
- Remove the battery from the battery mounting of the machine unit after daily use if letting the machine unit leave in the place that the ambient temperature could drop at −15°C or less. And store the battery in a warm place until the next use the unit to start the engine easily at low ambient temperature.



Follow the instructions an precautions in the manual from the battery maker.

A. Battery fluid

B. Lower limit

C. Upper limit

Inspection every 200 hours operation

(1) Draining and cleaning of the fuel tank

1) Prepare a waste oil container.

2) Take off the fuel tank.

3) Remove the cap of the fuel tank to drain (water, dust ,etc.) from the fuel tank bottom.

4) Drain fuel and clean fuel tank.

5) Put back the fuel tank.

(2) Cleaning The Fuel Filter Pot.

Clean the fuel filter in a clean place to prevent dust intrusion.

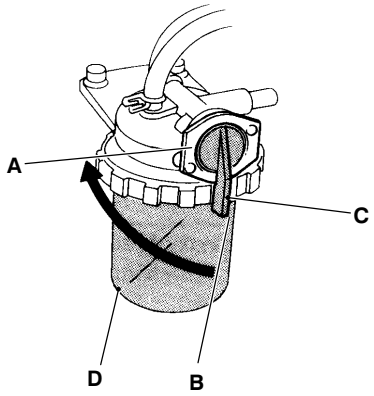
1) Close the fuel filter lever.

2) Remove the top cap, and rinse the inside with diesel fuel.

3) Take out the element, and rinse it with diesel fuel.

4) After cleaning, reinstall the fuel filter, keeping out of dust and dirt.

5) Air−bleed the injection pump.



A. "OFF"

B. "ON"

C. Fuel filter lever

D. Fuel filter pot

NOTE:
Entrance of dust and dirt can cause a malfunction of the fuel injection pump and the injection nozzle. Wash the fuel filter cup periodically.

Fuel System Air Bleeding

The entry of air into the fuel system will cause difficult engine starting or engine malfunction.

When carrying out service procedures such as emptying the fuel tank, draining the filter/separator, and changing the fuel filter element be sure to bleed air from the fuel system.

To activate the "automatic air−bleeding system", turn the key switch to the "ON" position and energize the electromagnetic pump" to bleed the air.

Air bleeding method**:**

When the "starter switch" is set to the "ON" position to activate the electromagnetic pump, fuel is forced to the fuel valve of each injection pump and then to the leak−off pipe of each injector nozzle, so that any air in the fuel system bleeds off automatically to the fuel tank.

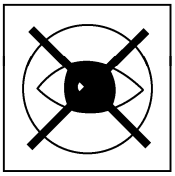
NOTE:
Although the fuel system can bleed air automatically when the key switch is in the "ON" position, air can also be manually bled by use of the primer pump facility in the filter/separator assembly.
By unscrewing the plastic primer pump head 'A' and stroking it up and down, any air bubbles in the system will be purged back to the fuel tank. When this has been completed, the pump head must be screwed back into the filter/separator assembly.

Start the engine and visually check the fuel system for leaks.

(3) Replacing the engine oil and engine oil filter (2nd time and after)

Replace the engine oil every 200 hours operation from 2nd time and on. Replace the engine oil filter at the same time.

(4) Checking and cleaning radiator fins.

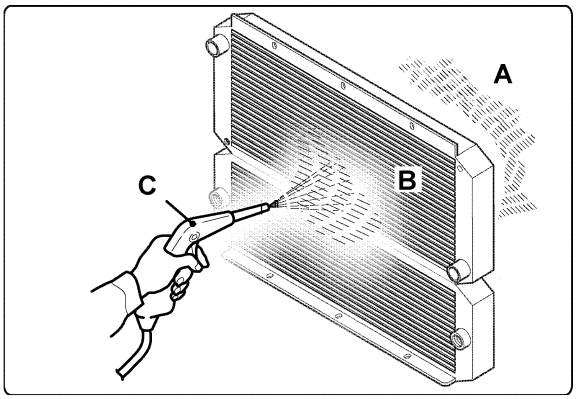


Beware of dirt from air blowing

Wear−protective equipment such as goggles to protect your eyes when blowing compressed air. Dust or flying debris can hurt eyes.

Dirt and dust adhering on the radiator fins reduce the cooling performance, causing overheating. Make it a rule to check the radiator fins daily and clean as needed.

- Blow off dirt and dust from fins and periphery with compressed air [0.19MPa (2kgf/cm^2) or less] not to damage the fins with compressed air.
- If contaminated heavily, apply detergent, thoroughly clean and rinse with tap water shower.



A. Dust, dirt.

B. Radiator fins

C. Air blow

IMPORTANT:
Never use high pressure water or air from close by fins or never attempt to clean using a wire brush. Radiator fins can be damaged.

(5) Checking the governor lever and accelerating device.

The governor lever and accelerating devices (accelerating lever, pedal. etc.) of the machine unit are connected by a fixed linkage to a pneumatic actuator. If the linkage becomes loose, the deviation in the position may result and make operation unsafe. Check the linkage connections for excess play. For adjustment of linkage see compressor operation section.

Governor Control Seals

As the governor is precisely adjusted, most of the controls are sealed, please do not break them. Should any adjustment be necessary, contact your local Doosan branch or distributor.

NOTE: The company will not accept any warranty claim on an engine with broken governor seals.

(6) Air cleaner element inspection

AIR INTAKE SYSTEM

Air cleaner

Engine performance and life vary with the air intake conditions.

A dirty air cleaner element reduces the amount of intake air, causing reduced engine output and possible engine damage.

Also, a damaged element leads to abrasion of cylinders and valves, resulting in increased oil consumption, reduced output and shortened engine life.

(1) Checking and adjusting cooling fan V−belt (2nd time and after)

Check and adjust the cooling fan V−belt tension every 200 hours operation from 2nd time and on.

Inspection every 400 hours operation

(1) Replacing the air cleaner element

Replace the air cleaner element periodically even if it is not damaged or dirty. When replacing the element, clean the inside air cleaner case at the time. If having the air cleaner with double elements, do not remove the inner element. If the engine output is still not recover (or the dust indicator still actuates if having the air cleaner with a dust indicator) even though the outer element has replaced with new one, replace the inner element with new one.

Inspection every 800 hours operation

(1) Replacing cooling water

Cooling water contaminated with rust or water scale reduces the cooling effect. Even when antifreeze agent (LLC) is mixed, the cooling water gets contaminated due to deteriorated ingredients. Replace the cooling water at least Once a year.

1) Remove the header tank cap.

2) Remove the radiator drain plug of the radiator and drain the cooling water.

3) After draining the cooling water, put the drain plug back.

4) Fill radiator and engine with cooling water via the header tank.

Beware of scalding by hot water

Wait until the temperature goes down before draining the Cooling water. Otherwise, hot water may splash to cause scalding.

(2) Checking and adjusting the fuel injection valve

As the adjustment requires specialized knowledge and skill, .consult your dealer. This adjustment is needed to obtain the optimum injection pattern for full engine performance.

(3) Adjusting intake / exhaust valve clearance

As this adjustment requires specialized knowledge and skill, consult your dealer. The adjustment is necessary to maintain the correct timing for the opening and closing of valves. Neglecting the adjustment will cause the engine to run noisily and result in poor engine performance and other damage.

Inspection every 2000 hours operation

(1) Flushing the cooling system and checking the cooling system parts

As this maintenance requires specialized knowledge and skill, consult your dealer. Rust and water scale will accumulate in the cooling system through many hours of operation. This lowers the engine cooling effect.

(2) Checking and replacing fuel hoses and cooling water hoses

As this maintenance requires specialized knowledge and skill, consult your dealer. Regularly check the rubber hoses of the fuel system and cooling water system. If cracked or degraded, replace them with new one. Replace the rubber hoses at least every 2 years.

(3) Lapping the intake and exhaust valves

As this maintenance requires specialized knowledge and skill, consult your dealer. The adjustment is necessary to maintain proper contact of the valves and seats.

(4) Checking and adjusting the fuel injection timing

As this maintenance requires specialized knowledge and skill, consult your dealer.

This item contains a simple troubleshooting. When a failure takes place on your engine, diagnose the cause referring this troubleshooting. Should the cause of failure not be detected or you are unable to manage the failure, consult your machine supply source or nearest company engine service outlet.

Engine does not start	Starter does not turn.	Battery discharged	
		Bad cable connections.	
		Starter or starter switch failure.	
		Safety relay failure.	
	Starter turns but engine does not fire.	No fuel injection.	Engine stop solenoid malfunction.
			No fuel in the fuel tank.
			Clogged fuel filter element.
			Air in the fuel system.
			Control rack is stuck at no fuel position.
		Fuel is injected but engine does not fire.	Incorrect preheating operation.
			Faulty air heater.
			Incorrect injection timing.
			Low cylinder compression pressure.
			Engine stop solenoid not fully returned.
	Engine fires but stalls immediately.	Air in the fuel system.	
		Incorrect low idle speed adjustment.	

Unstable engine running	Unstable low idling	Crack in injection pipe.	
		Injection nozzle failure.	
		Engine stop solenoid return failure.	
		Uneven compression pressure between cylinders.	
	Incorrect high idle speed adjustment.	Incorrect control lever adjustment.	
		Governor internal malfunction.	
	Engine hunting in medium speed range.	Governor spring deteriorated.	
	Engine malfunction in high speed range.	Insufficient fuel supply.	Air in the fuel system
			Clogged fuel filter element
			Piping failure (squeezed/restricted etc.)
		Uneven fuel injection amount between cylinders.	
		Deteriorated governor spring.	
		Incorrect valve clearance adjustment.	
		Deteriorated valve spring.	
	Engine speed stuck at high idle.	Engine control restriction or seizure.	
Engine overheat.	Cooling system defect	Insufficient coolant volume.	
		Fan belt slippage.	
		Thermostat malfunction.	
		Radiator filler cap malfunction.	
		Cooling system interior fouled.	
		Radiator clogged.	
	Improper servicing	Engine over−loaded.	
		Air cleaner element clogged.	
		Insufficient airflow/restriction.	
		Restricted coolant flow (high concentration of antifreeze, etc.)	
Low oil pressure	Lack of oil	Oil leakage	
		High oil consumption	
	Wrong oil	Wrong type and viscosity.	
	High coolant temperature.	Over heat.	
	Clogged filter and strainer.		
	Worn bearings and oil pump.		
	Faulty relief valve.		

Low engine output	Incorrect injection pump adjustment	Incorrect injection timing	Too far advanced.
			Too far retarded.
		Injection nozzle malfunction	Incorrect injection pressure.
			Incorrect spray condition.
		Insufficient fuel supply to the injection pump	Lack of fuel in tank.
			Air in injection pump.
			Fuel filter clogged.
			Overflow valve malfunction.
		Governor malfunction	Incorrect engine control adjustment.
			Deteriorated governor spring.
	Low cylinder compression pressure	Cylinder compression leakage	Incorrect valve clearance adjustment.
			Injector nozzle misalignment.
			Cylinder bore wear.
		Insufficient air intake volume.	Air cleaner clogged.
			Restricted air flow.
Excessive oil consumption	Incorrect oil	Wrong selection of type and viscosity.	
		Too much oil quantity.	
	Engine burning oil	Faulty piston rings/damaged cylinder bores.	
		Faulty valve stem seal.	
	Oil leakage	Damaged seal / Damaged turbocharger seal	
		Loose joints/gaskets.	
		Improper installation of filter and piping.	
Excessive fuel consumption	Fuel leakage	Damaged seals.	
		Improper component installation or tightening.	
	Excessive injection volume.	Injection pump defective.	
	Excessive mechanical loads		

Improper exhaust	Excessive black smoke	Clogged air cleaner.
		Damaged injector nozzle.
		Wrong injector nozzle.
		Injection timing incorrect.
		Excessive injection volume.
		Incorrect fuel.
	Excessive white smoke	Water mixing in fuel
		Low compression pressure.
		Injection timing incorrect.
		Low coolant temperature
		Faulty turbocharger
Battery over discharge	Low electrolyte level	Crack in battery body.
		Natural consumption.
	Charging failure	Loose or damaged belt.
		Faulty alternator.
		Damaged wiring or contact failure.
	Excessive electrical loads	Insufficient battery capacity for the application.