KUBOTA ENGINES APPLICATION MANUAL

For Small Spark Ignition Engine

November, 2010

KUBOTA

CONTENTS

PREFACE

1. This has been prepared so as to enable users to properly and efficiently utilize KUBOTA small SI engines.
2. This manual describes the features of the engines, the cautions and the check items for mounting the engines on various machines.
3. The contents of this manual are roughly divided into the following two items.
   1) General information
   2) Technical information
4. This manual describes only the content that should be mentioned specially for small SI engines. Please also refer to the diesel engine application manual.
5. Phase3 emissions regulations require confirmation of "Installation Instructions", "Contractual agreement" etc. between engine and equipment manufactures under 40CFR1068.
6. The specifications and features described in this manual are subject to change without advance notice for technical improvement.
7. If you have any question about this manual, please contact with nearest KUBOTA sales representatives or send e-mail to "k-iss@kubota.co.jp".

0. GENERAL

CONTENTS

1. SPECIFICATIONS

Item \ Model			WG752	
			Gasoline	LPG
Type			Vertical, In line, water cooled 4 cycle gasoline/LPG engine	
Number of cylinders			3	
Cylinder bore x Stroke		mm(in)	68.0 (2.68) x 68.0 (2.68)	
Total displacement		L(cu. in)	0.740 (45.2)	
High idle		min^{-1} (rpm)	3850	
Low idle		min^{-1} (rpm)	1500	
Brake horse power	SAE J1995 Gross int.	kW(HP)/ min^{-1} (rpm)	18.5 (24.8) /3600	17.7 (23.8) /3600
	SAE J1349 net int.		17.1 (23.0) /3600	16.4 (22.0) /3600
	SAE J1349 net cont.		13.4 (18.0) /3600	12.7 (17.0) /3600
Max. torque (SAE J1349)		N· m(ft-lb) min^{-1} (rpm)	54.9 (40.5) /2400	52.0 (38.3) /2400
Compression ratio			9.2	
Firing order			1—2—3	
Ignition timing			B.T.D.C.18°	
Fuel			Unleaded gasoline	Commercial LPG*
Direction of rotation			Counter-clockwise from flywheel side	
Starting system			Electric starting with cell starter	
Starter output		V-kW	12-0.7	
Alternator output		V-W	12-150 (Standard)	
Lubricating system			Forced lubricating by trochoid pump	
Lubricating oil			Quality better than SH class	
Lubricating oil capacity		L(US gal)	3.25 (0.86)	
Coolant capacity (with radiator)		L(US gal)	2.8 (0.74)	
Governor type			Centrifugal ball mechanical type governor	
Dimensions (L x B x H)		mm(in)	428.5 x 396.5 x 539.8 (16.9 x 15.6 x 21.3)	
Dry weight		kg(lb)	Approx. 61.7 (136.0)	

***Note : LPG regulator with vaporizer operates on a liquid withdrawal type system.**

Item \ Model			WG972	
			Gasoline	LPG
Type			Vertical, In line, water cooled 4 cycle gasoline/LPG engine	
Number of cylinders			3	
Cylinder bore x Stroke		mm(in)	74.5 (2.93) x 73.6 (2.90)	
Total displacement		L(cu. in)	0.962 (58.7)	
High idle		min^{-1} (rpm)	3850	
Low idle		min^{-1} (rpm)	1500	
Brake horse power	SAE J1995 Gross int.	kW(HP)/ min^{-1} (rpm)	24.2 (32.5) /3600	23.1 (31.0) /3600
	SAE J1349 net int.		23.1 (31.0) /3600	22.0 (29.5) /3600
	SAE J1349 net cont.		18.7 (25.0) /3600	17.5 (23.5) /3600
Max. torque (SAE J1349)		N・m(ft-lb) min^{-1} (rpm)	68.6 (50.6) /2400	64.6 (47.6) /2400
Compression ratio			9.2	
Firing order			1—2—3	
Ignition timing			B.T.D.C.8°/1000 min^{-1} (rpm) B.T.D.C.21°/3600 min^{-1} (rpm) *1	
Ignition system			Distributor-less Solid State type	
Fuel			Unleaded gasoline	Commercial LPG*2
Direction of rotation			Counter-clockwise from flywheel side	
Starting system			Electric starting with cell starter	
Starter output		V-kW	12-1.0	
Alternator output		V-W	12-480 (Standard)	
Lubricating system			Forced lubricating by trochoid pump	
Lubricating oil			Quality better than SH class	
Lubricating oil capacity		L(US gal)	3.4 (0.90)	
Coolant capacity (with radiator)		L(US gal)	3.5 (0.92)	
Governor type			Centrifugal ball mechanical type governor	
Dimensions (L x B x H)		mm(in)	452.6 x 416.4 x 502.5 (17.8 x 16.4 x 19.8)	
Dry weight		kg(lb)	Approx. 72.0 (159)	

Note :

*** 1 .Consult Kubota for further information.**

*** 2. LPG regulator with vaporizer operates on a liquid withdrawal type system.**

Item \ Model			DG972
Type			Vertical, In line, water cooled 4 cycle Natural Gas engine
Number of cylinders			3
Cylinder bore x Stroke		mm(in)	74.5 (2.93) x 73.6 (2.90)
Total displacement		L(cu. in)	0.962 (58.7)
High idle		min $^{-1}$ (rpm)	3850
Low idle		min $^{-1}$ (rpm)	1500
Brake horse power	SAE J1995 Gross int.	kW(HP)/ min $^{-1}$ (rpm)	18.7 (25.1) /3600 ※
	SAE J1349 net int.		17.6 (23.6) /3600 ※
	SAE J1349 net cont.		14.5 (19.4) /3600 ※
Max. torque (SAE J1349)		N・m(ft-lb) min $^{-1}$ (rpm)	55.0 (40.5) /2400 ※
Compression ratio			9.2
Firing order			1—2—3
Ignition timing			B.T.D.C.15°/1000 min $^{-1}$ (rpm) B.T.D.C.28°/3600 min $^{-1}$ (rpm) *2
Ignition system			Distributor-less Solid State type
Fuel			Natural Gas only *2
Direction of rotation			Counter-clockwise from flywheel side
Starting system			Electric starting with cell starter
Starter output		V-kW	12-1.0
Alternator output		V-W	12-480 (Standard)
Lubricating system			Forced lubricating by trochoid pump
Lubricating oil			Quality better than SH class
Lube. oil capacity		L(US gal)	3.4 (0.90)
Coolant capacity (with radiator)		L(US gal)	3.5 (0.92)
Governor type			Centrifugal ball mechanical type governor
Dimensions (L x B x H)		mm(in)	BBH ; 452.5 x 415.4 x 502.5 (17.8 x 16.4 x 19.8) SAEH ; 525.6 x 415.4 x 502.5 (20.7 x 16.4 x 19.8)
Dry weight		kg(lb)	BBH ; Approx. 72.0 (159) SAEH ; Approx. 95.4 (210)

Note :

*** 1 .Consult Kubota for further information.**

*** 2. With Japanese standard natural gas.**

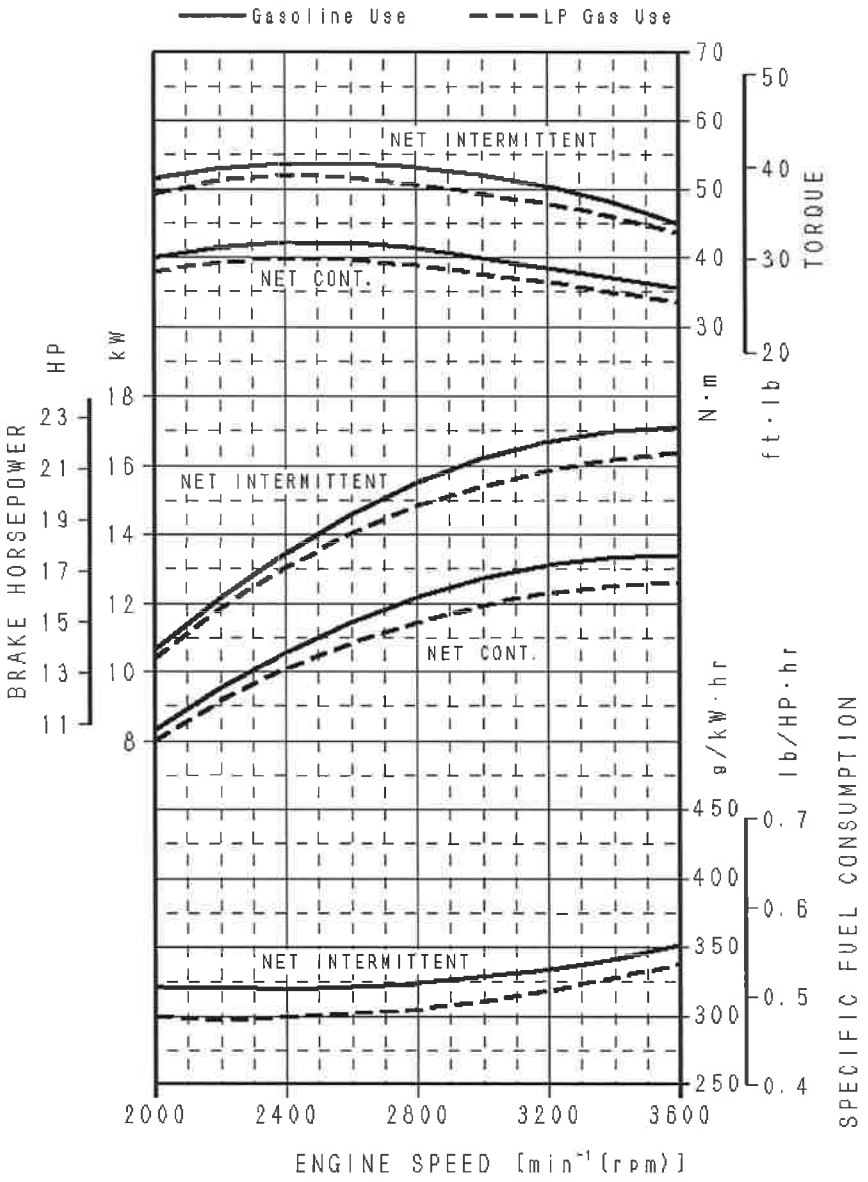
The lower heating value : 9699kcal/m^3 (1090BTU/ft^3).

CAUTION : This engine is only for stationary use. e.g. oil field and emergency generator.

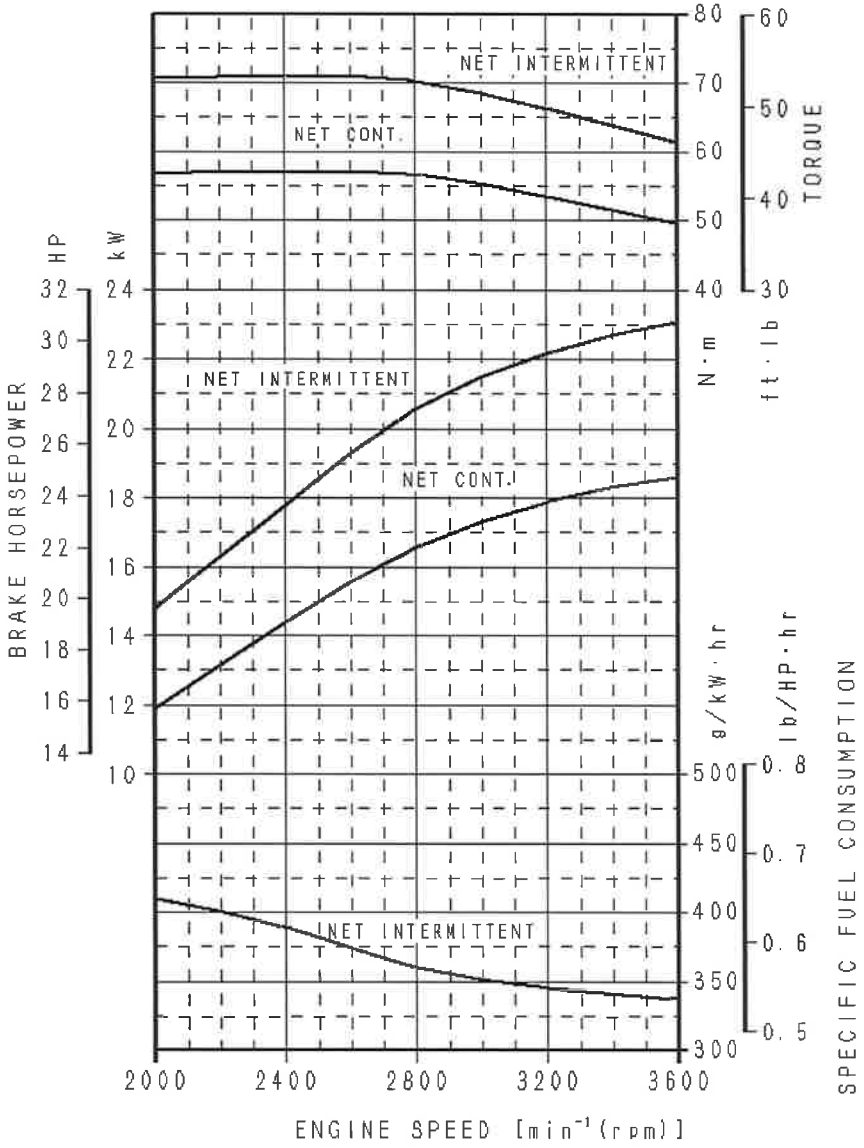
The brake horse power is limited under 19kW for emission regulations.

2. PERFORMANCE CURVES

WG752

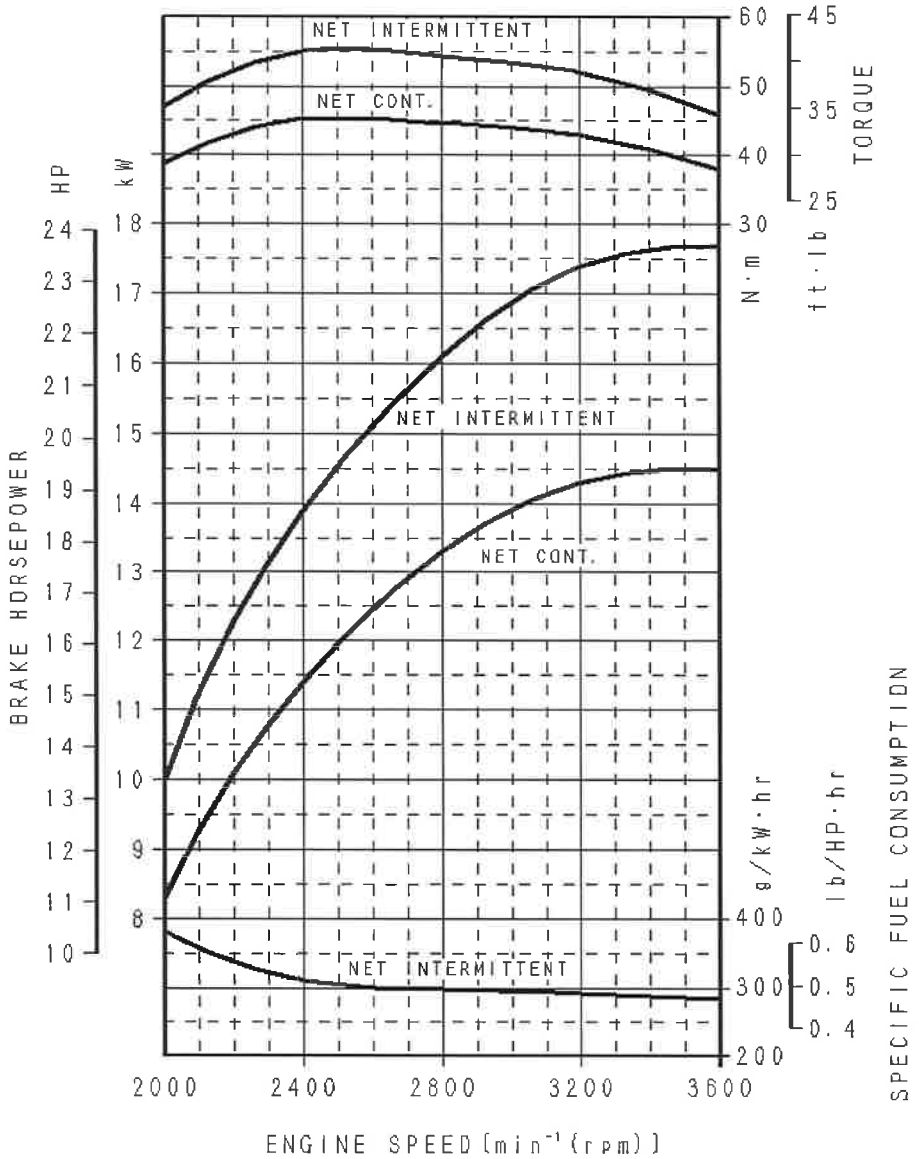


WG972



DG972

With Japanese standard natural gas: lower heating value : 9699kcal/m^3 (1090BTU/ft^3)
The brake horse power is limited under 19kW for emission regulations.



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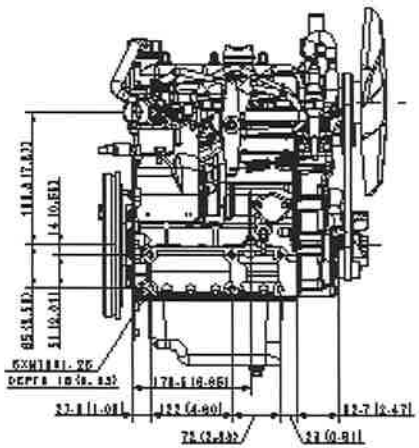

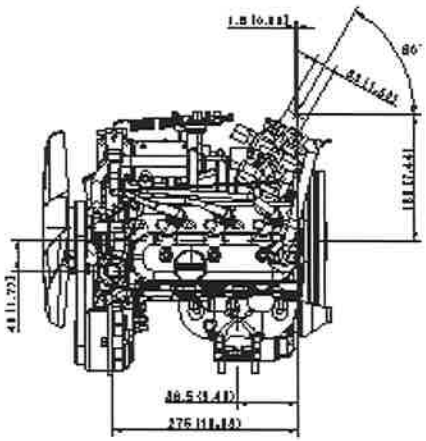

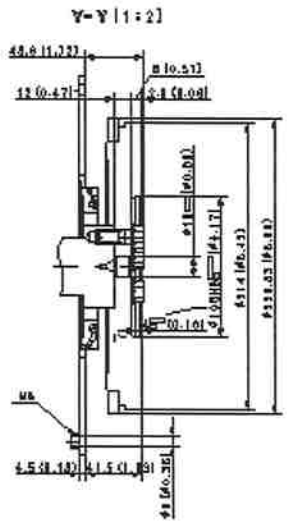

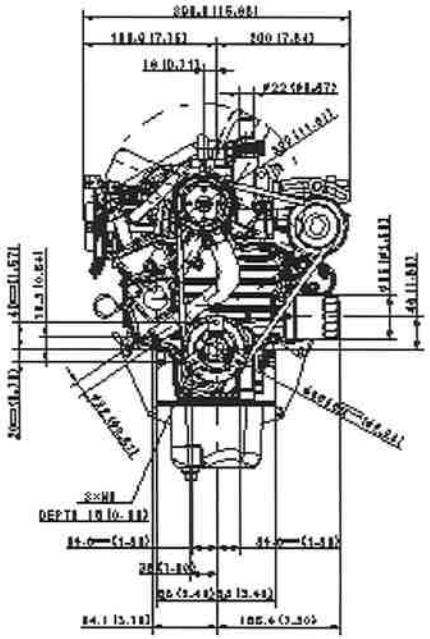

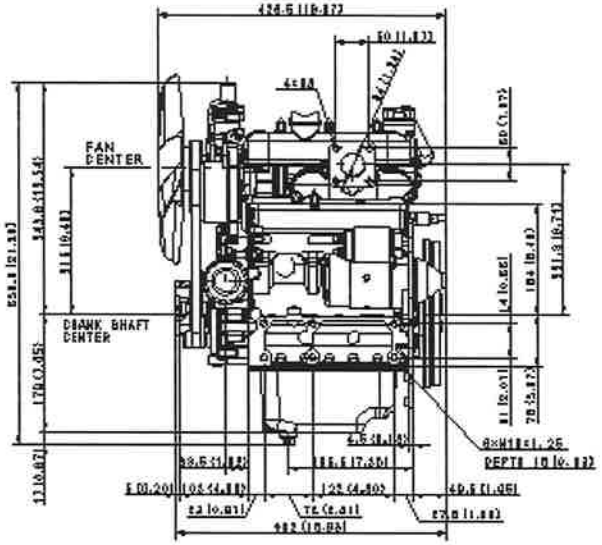

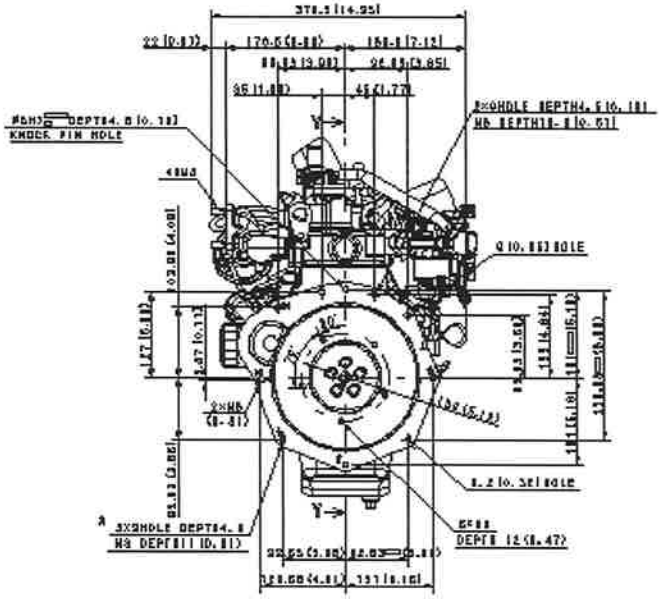

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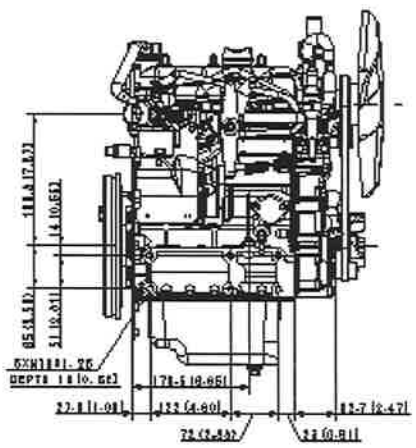

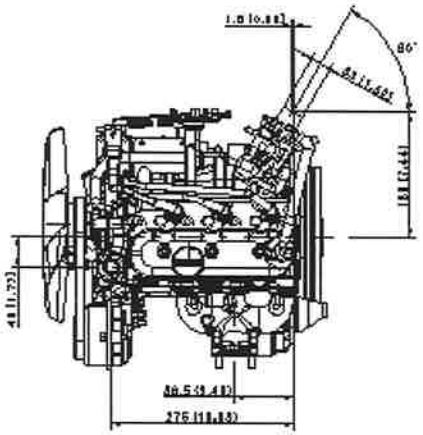

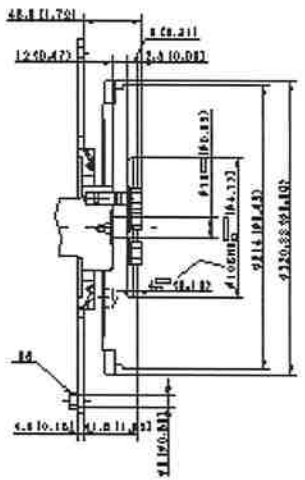

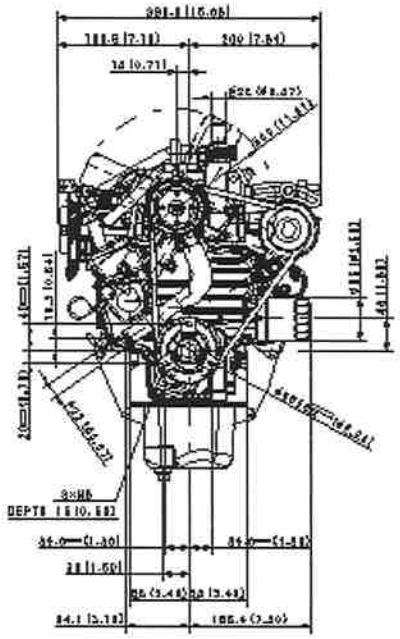

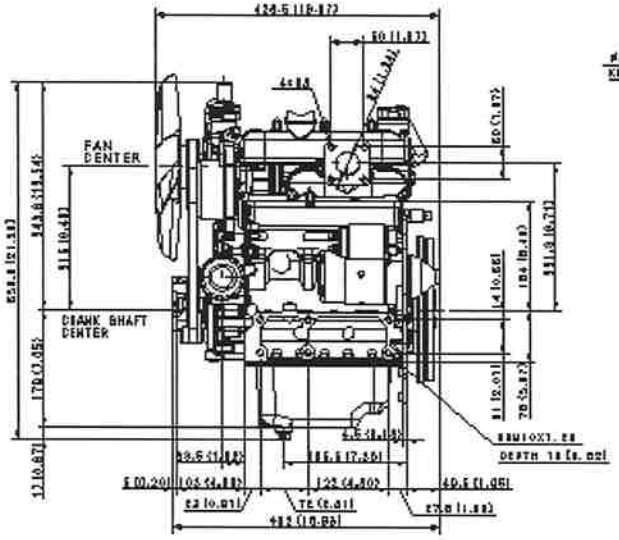

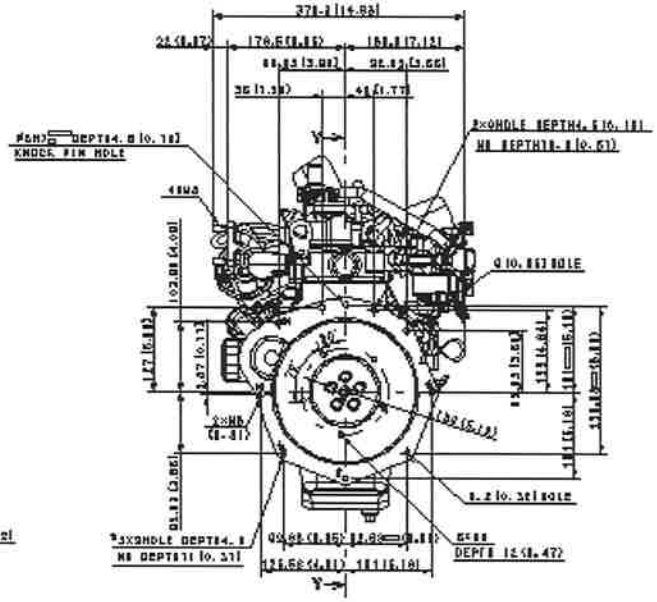

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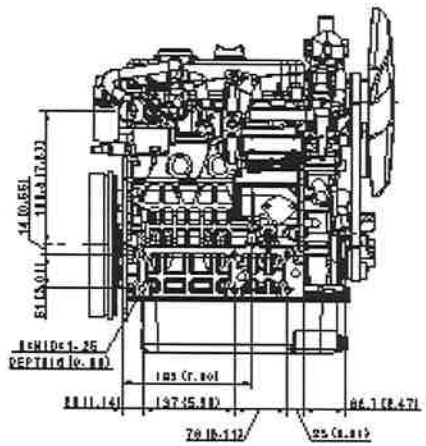

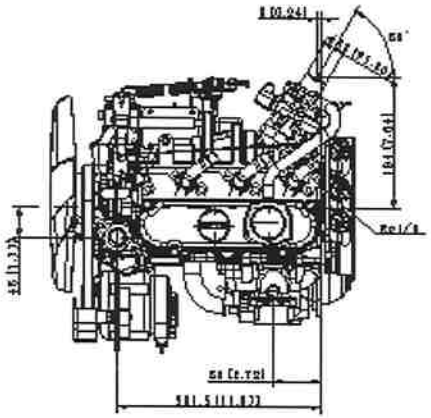

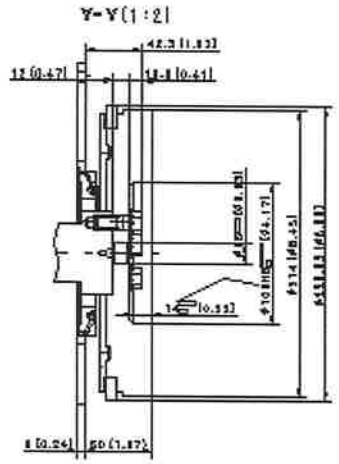

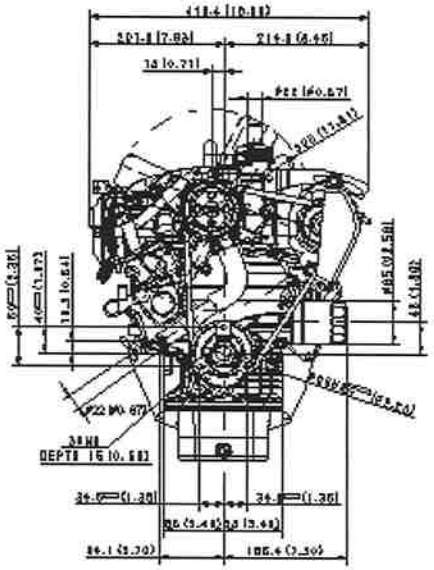

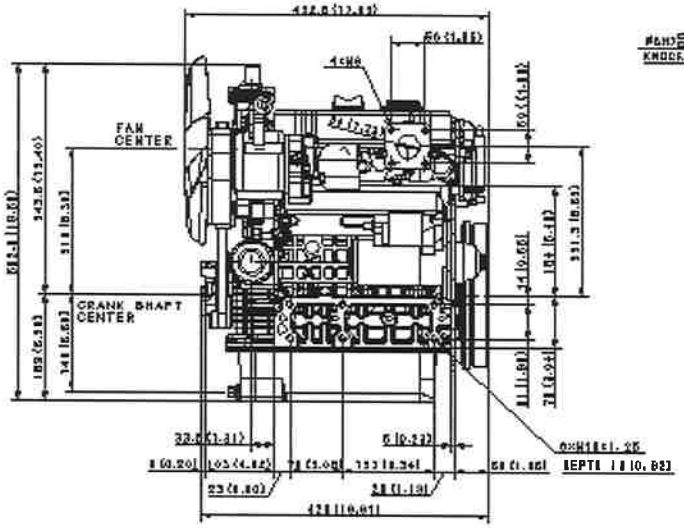

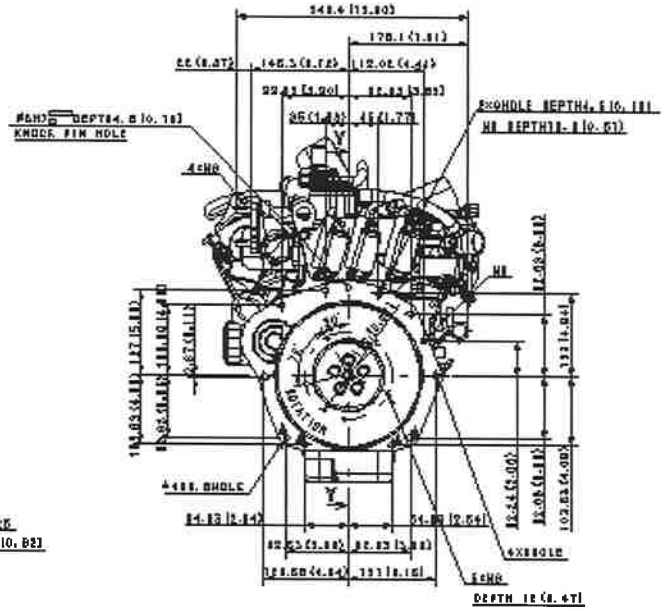

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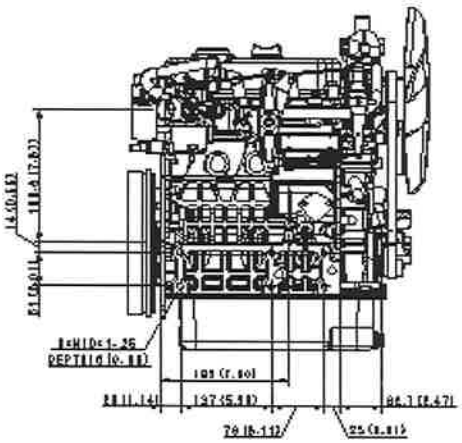

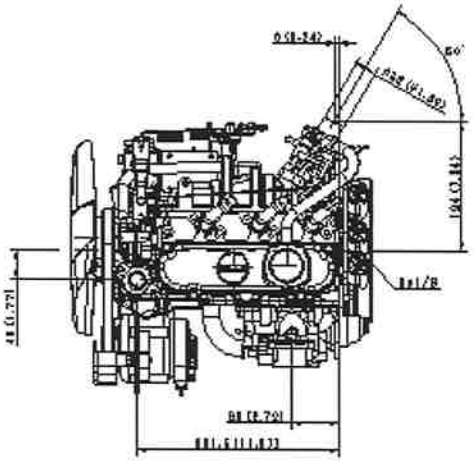

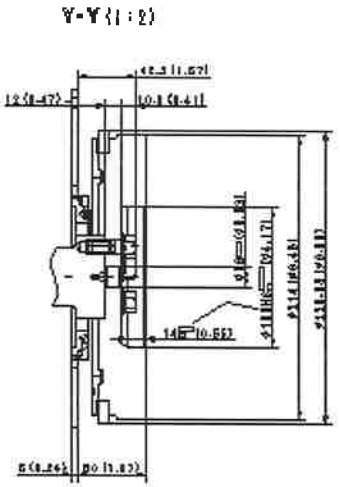

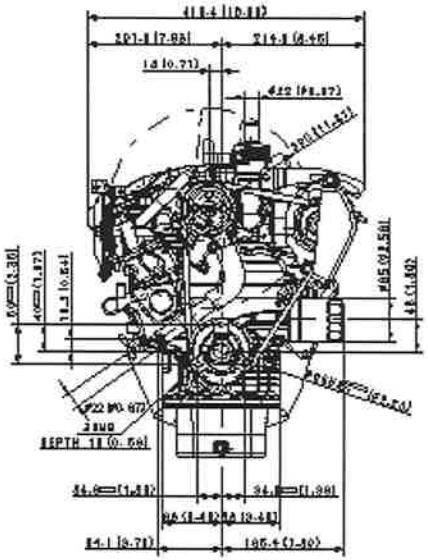

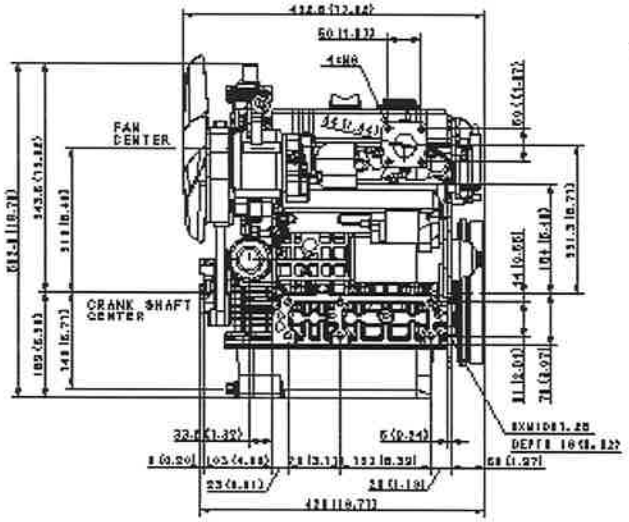

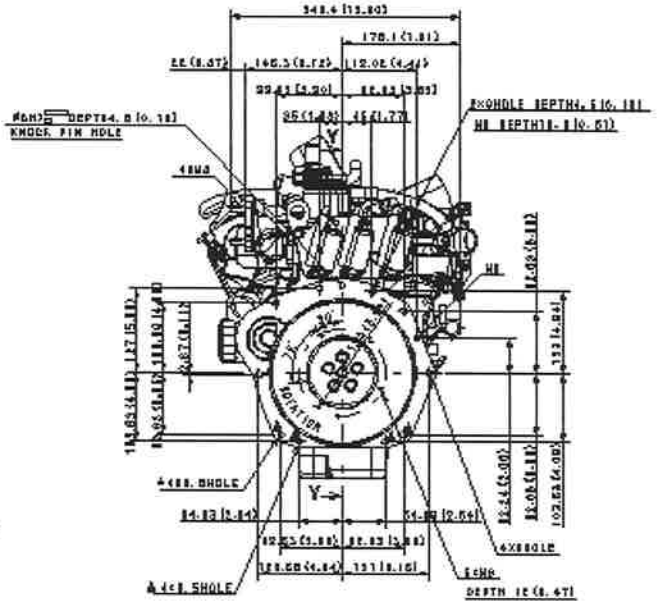

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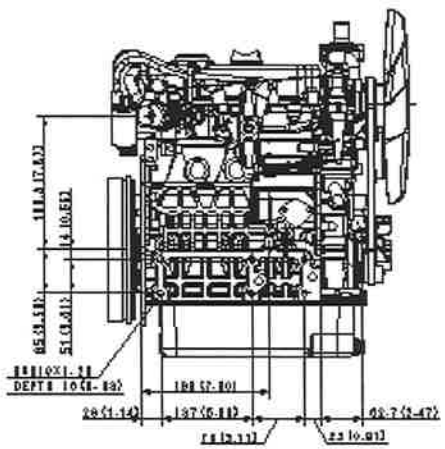

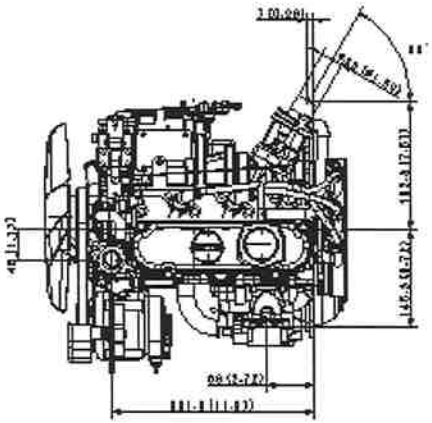

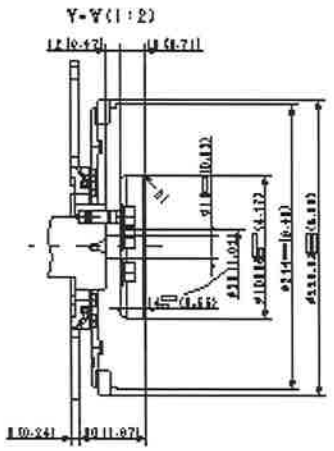

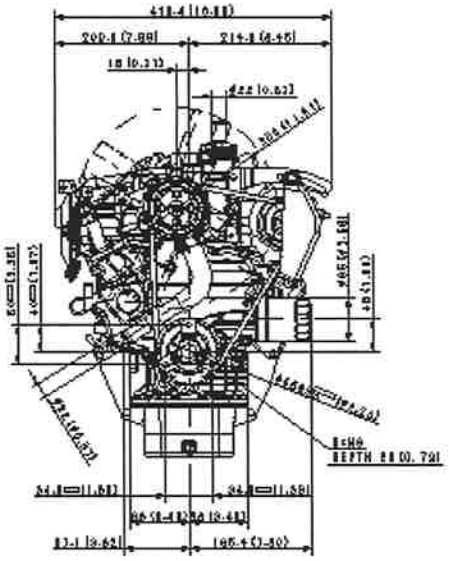

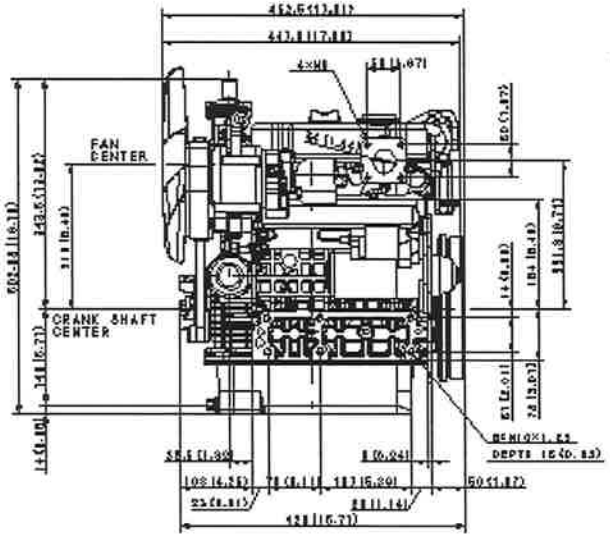

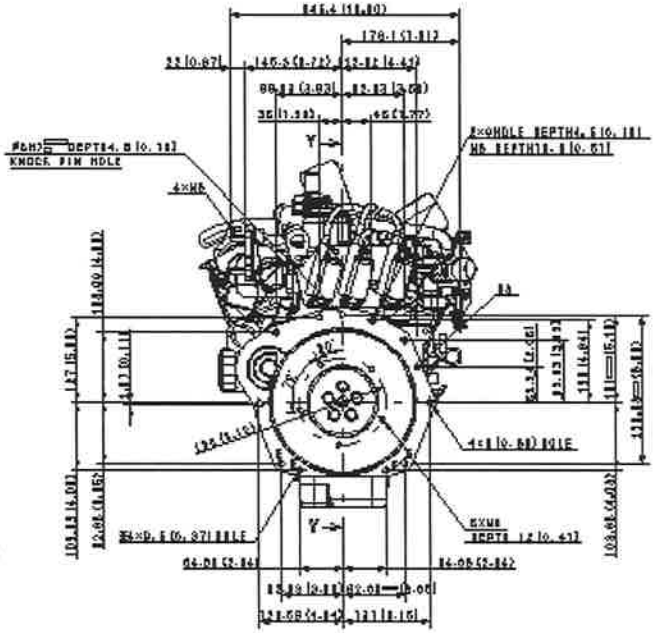

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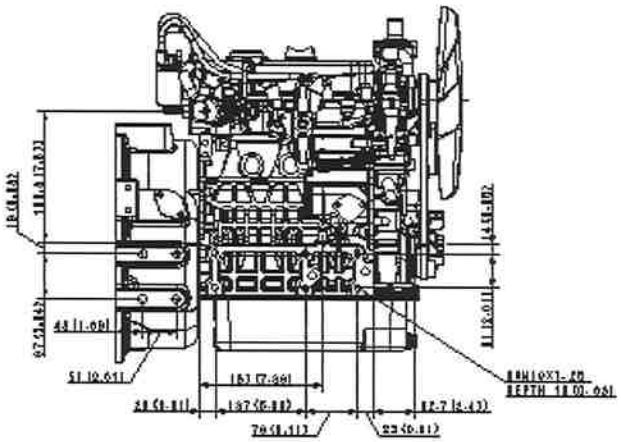

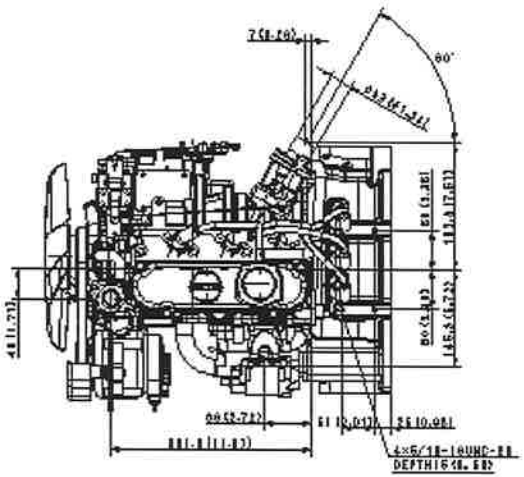

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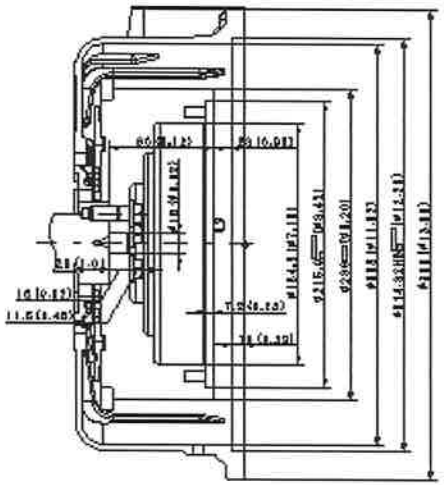
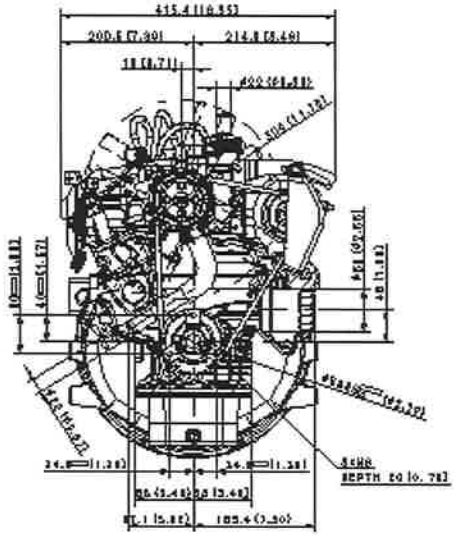
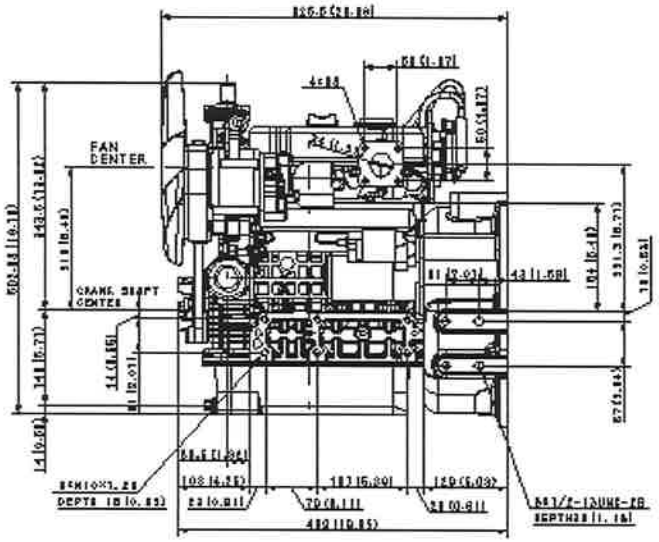
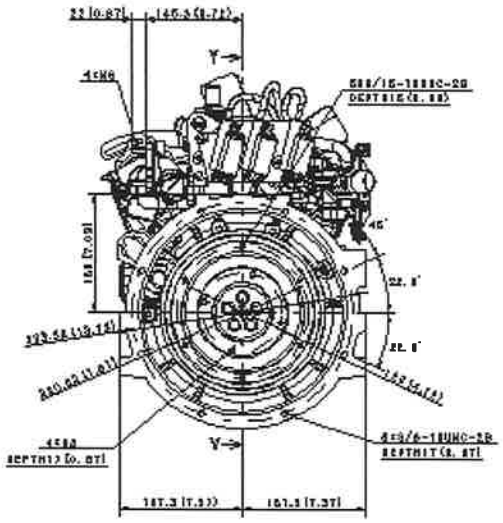




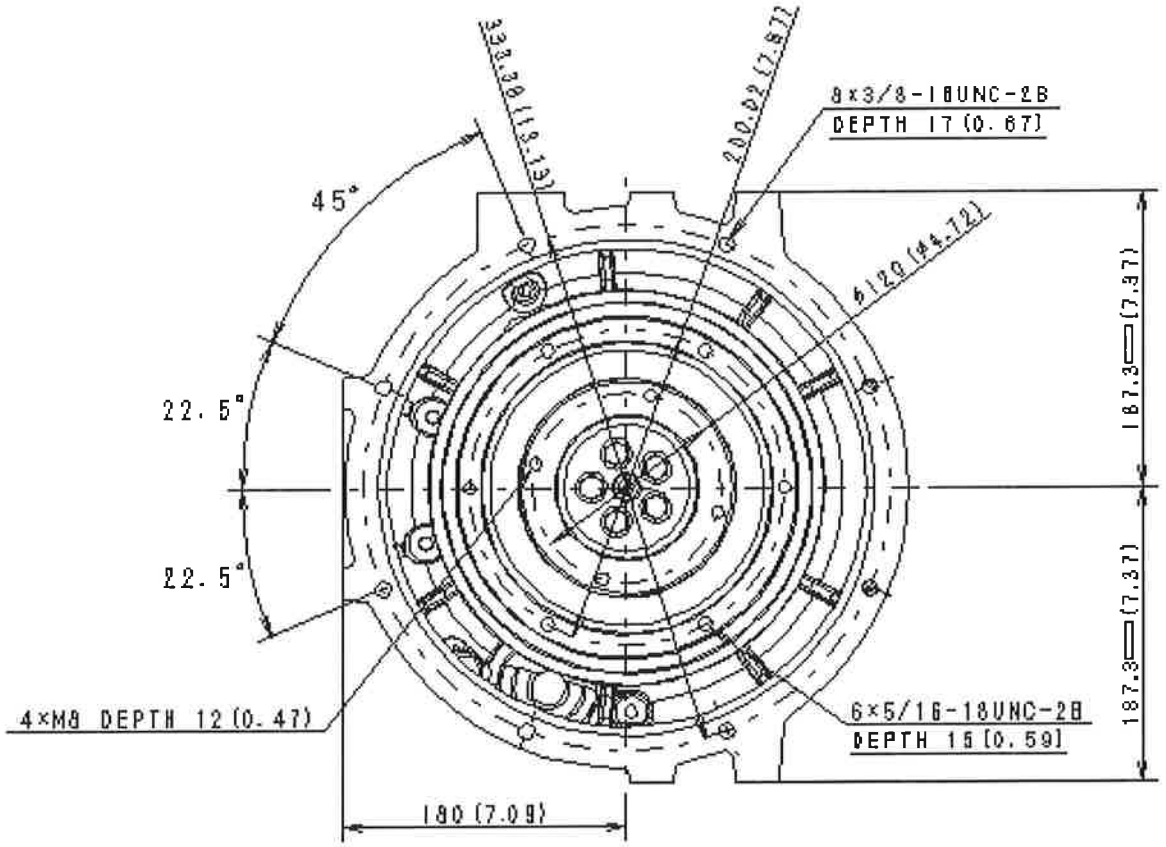


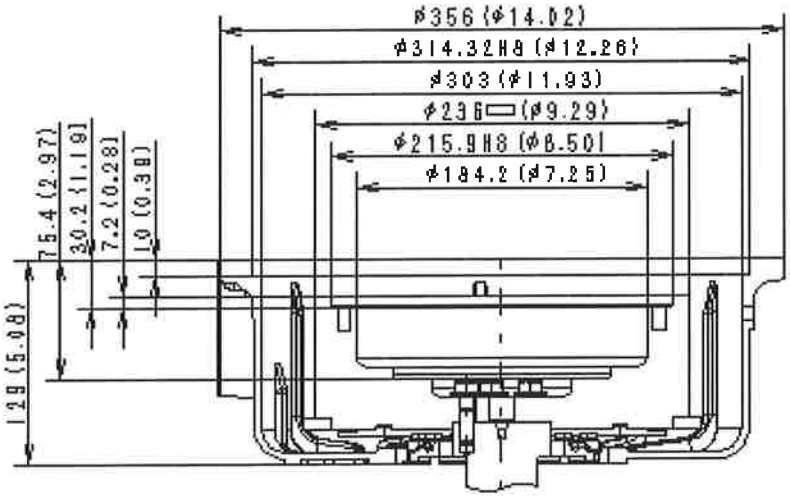


WG752, DG972

Flywheel:Normal SAE for Clutch No.6-1/2

Flywheel Housing:Normal SAE No.5





1. EMISSION REGULATION

CONTENTS

1. GENERAL

Along with E3 models, E2 models are yet available to be used in the following countries per output category.

kW,disp.	Model	Type	North America	Europe	Japan
P < 19 , 0.225≦ L	WG752-G/G L - E 3	E3	Y	N	Y
	WG/D F 752-E 2	E2	N	Y	Y
	DG972 ※	E2	Y	Y	Y
19≦ P < 30 , 0.825 < L≦ 1.0	WG972-G/G L - E 3	E3	Y	Y	N
	WG/D F 972-E 2	E2	N	Y	N

※DG972 is only for stationary use. e.g.oil field and emergency generator .

Current and future emission regulations. $HC+NO_X/CO$ (g/kWh)

Countries		kW,disp.	2009	2010	2011	2012	2013	2014	2015	2016
USA	CARB	P < 19 , 0.225≦ L	8.0/549 ※							
		19≦ P , L≦ 0.825	12.0/549		8.0/549 ※					
		19≦ P , 0.825 < L ≦ 1.0	12.0/549		6.5/375 ※				0.8/20.6 ※	
	EPA	P < 19 , 0.225≦ L	12.1/610		8.0/610 ※					
		19≦ P < 30 , L≦ 1.0	12.1/610		8.0/610 ※					
Canada		P < 19 , 0.225≦ L	12.1/610		8.0/610					
Japan		P < 19 , 0.225≦ L	12.1/610							
		19≦ P < 560	HC/0.6g/kWh, NO_x/0.6g/kWh, CO/20g/kWh							
EU		P < 19 , 0.225≦ L	12.1/610							
		19≦ P	None							

※ with evaporative emission regulation

2. IMPORTANT ITEMS

Important Notice

There are necessary emission-related items for compliance with emission regulations.
Please confirm whether emission-related items are certain on application review (Exhaust Emission Check Sheet).

For mass-production Kubota prepares the installation instructions.
These instructions are provided for the final engine assemblers who must ensure the engine, exhaust system (catalyst), intake system, gasoline fuel system and etc, are Installed correctly in the engine's certified configuration.

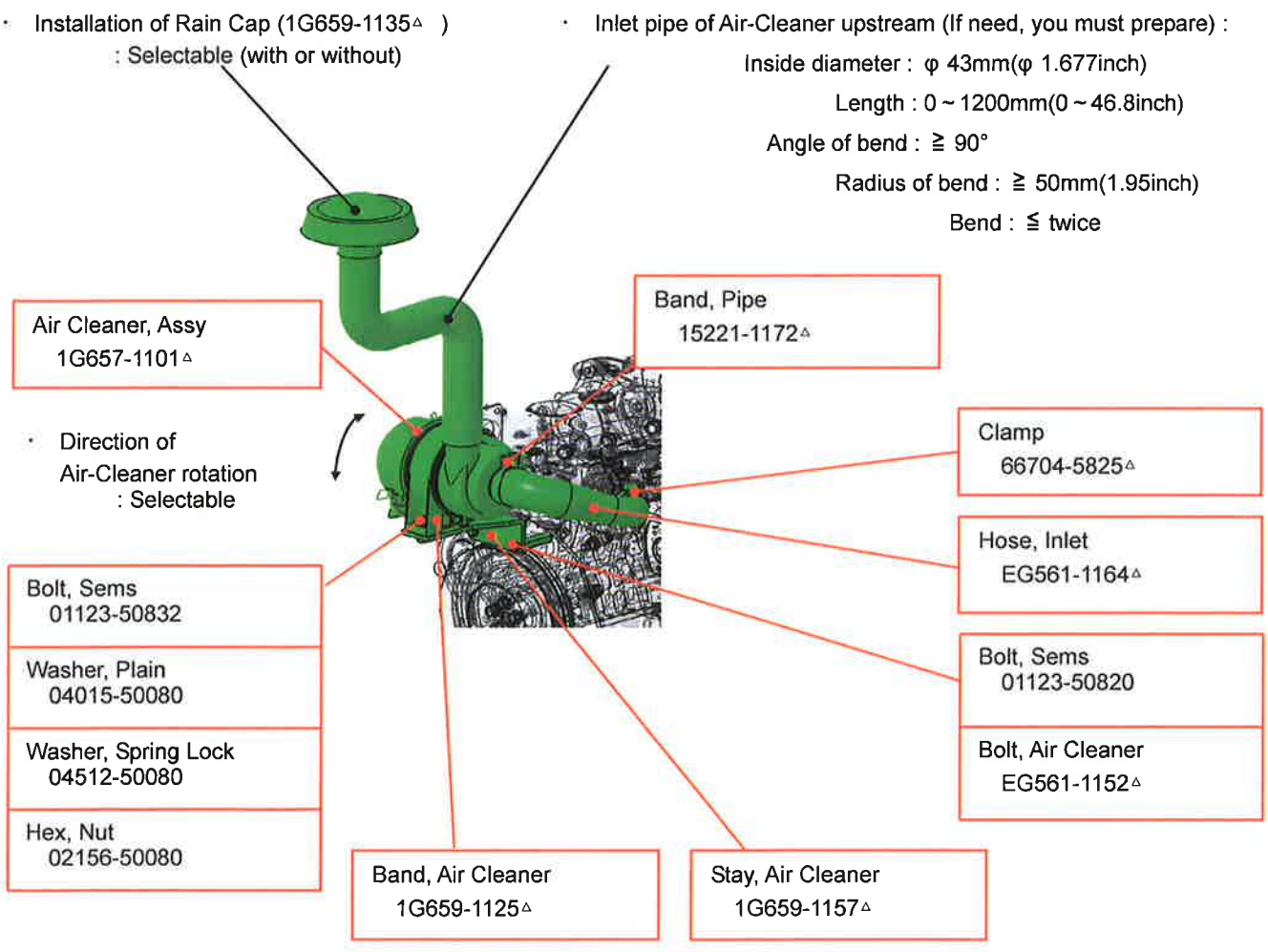
〔for EPA only〕
Failing to follow these instructions when installing a certified engine in a piece of non-road equipment violates federal law (40CFR 1068. 105(b)),subject to fines or other penalties as described in the Clean Air Act.
The contractual agreement contract is necessary before mass-production.

Emission-Related Installation Instructions

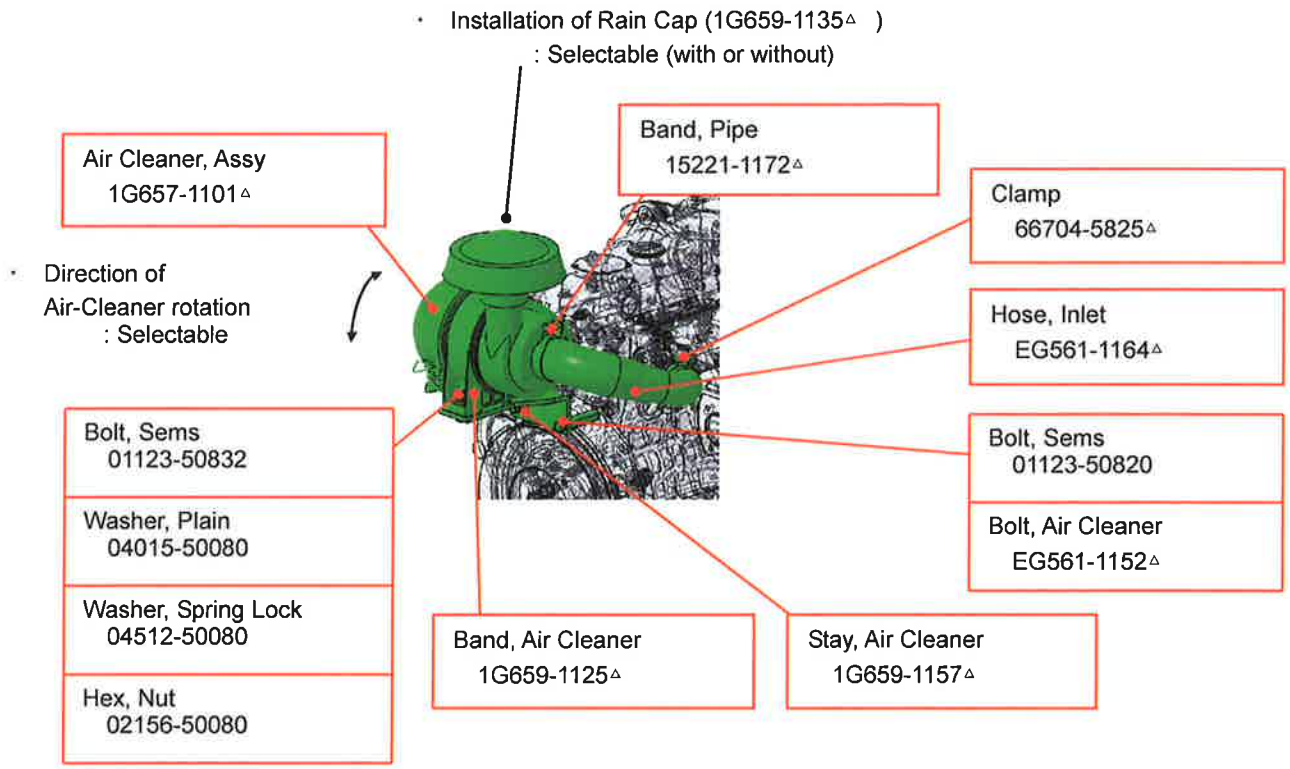
① Air Intake System

- Intake system means that layout of all parts from entrance of suction to air-cleaner flange.
- Kubota offers standard Air-cleaner kit. The intake parts should be installed as shown in figure below.
- If you use an OEM intake system for a spec engine, consult Kubota based on the Exhaust Emission Check Sheet before the application review.
- When the same specification engine is installed on multiple applications, you will have to inform to Kubota prior to the application review.
  Also, the final intake system of each application must be confirmed at the application review and/or the Exhaust Emission Check Sheet.
- You must install the intake system confirmed at the application review and/or the Exhaust Emission Check Sheet for mass-production. 〔**Important**〕
- You should consult Kubota based on the Exhaust Emission Check Sheet whenever you change the intake system.
  Do not change without consultation with Kubota.

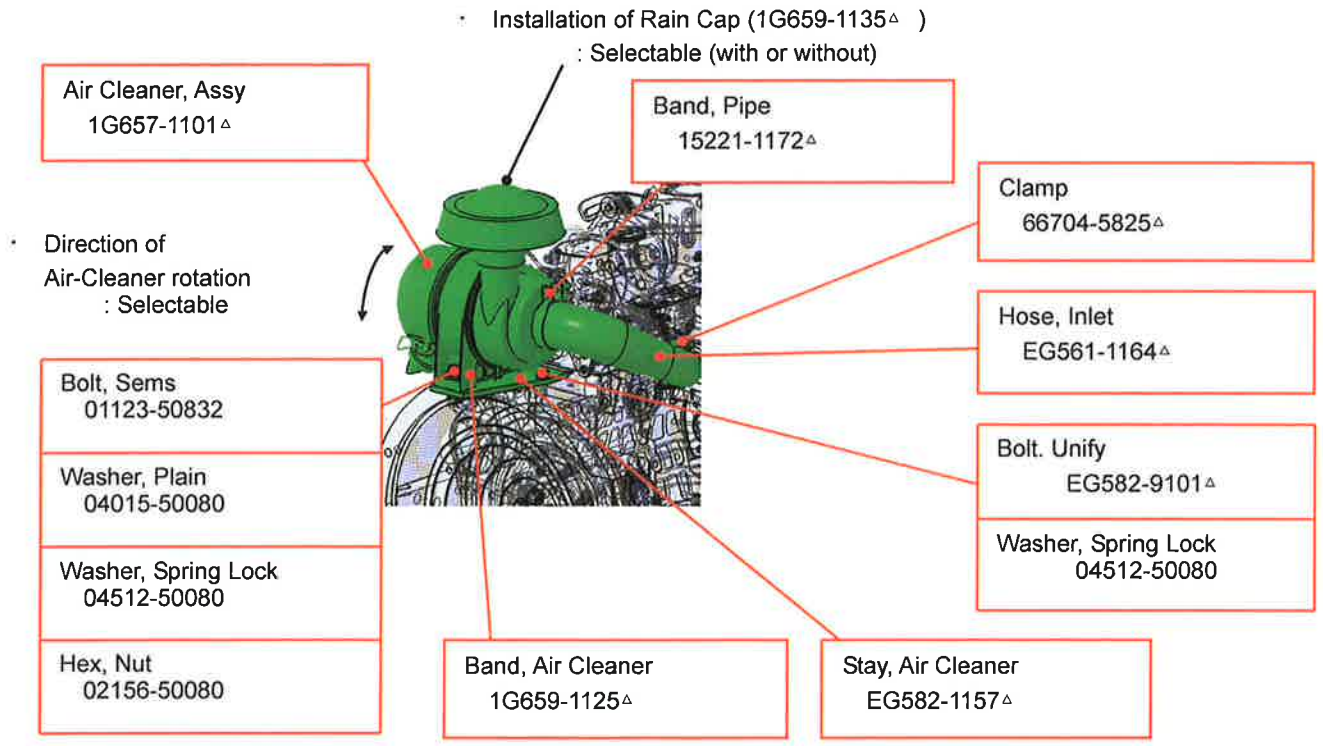
WG752 / WG972



DG972-E2-BBH



DG972-E2-SAEH



② Exhaust System (See EXHAUST SYSTEM section) :(WG752 - 972)

- Exhaust system means the layout of all parts from exhaust manifold to exhaust exit to atmosphere.
- Kubota offers certified catalytic mufflers and catalytic converters.

You must only use Kubota certified catalyst parts 〔**Important**〕 and assemble the exhaust parts according to instructions as specified in the EXHAUST SYSTEM section of this manual.
Catalyst parts other than Kubota must not be used because other catalyst is not certified our engine.
You must install the exhaust system confirmed at application review and/or the Exhaust Emission Check Sheet for mass-production. 〔**Important**〕

- You must consult Kubota based on the Exhaust Emission Check Sheet when you change the exhaust parts after application review. Do not change without the consultation with Kubota.

③ High Altitude Operation (See FUEL SYSTEM section):(WG752 - 972)

Kubota prepared genuine altitude compensation kit.
The ultimate users must comply with the regulations through the installation of the appropriate altitude compensation kit.

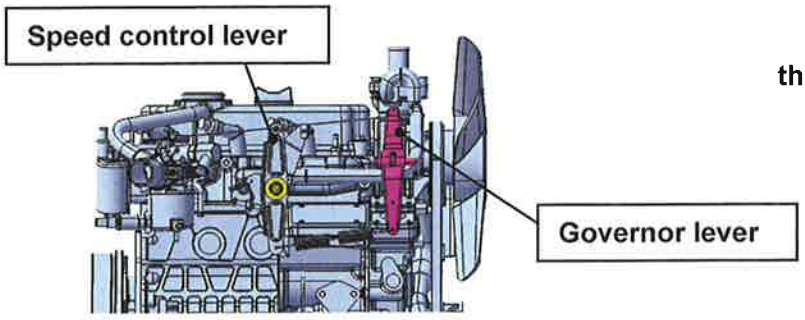
④ Evaporative Emission Controls (See EVAPORATIVE EMISSION CONTROL section): gasoline fuel

If your equipments use a volatile liquid fuel (such as gasoline), they must meet the evaporative emission standards of 40 CFR part 1060,as described in §1054.112.

⑤ Engine Set Speed

〔Mechanical Governor specification〕

- You should operate the engine within the range of engine speed range set at the time of Kubota shipment (without parasitic load).
- You should use the speed control lever and/or the governor lever when the speed change.



Standard engine speed set of the Kubota shipment (reference).

Low Idle : 1500±100rpm

High Idle : 3850 $^{+100}_{0}$rpm

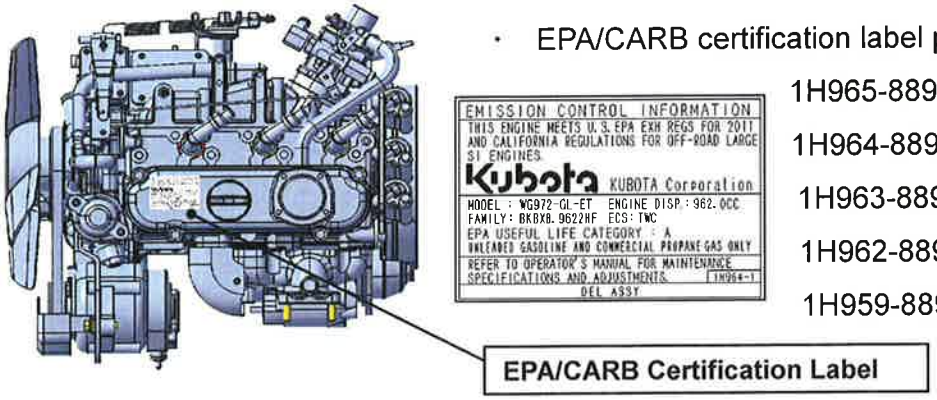
Rated Speed : 3600rpm

〔Electronic Governor specification〕

If you use the electronic governor, consult Kubota before the application review.

⑥ Engine Labels

The following labels must be visible. If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the equipment, as described in 40 CFR 1068.105.



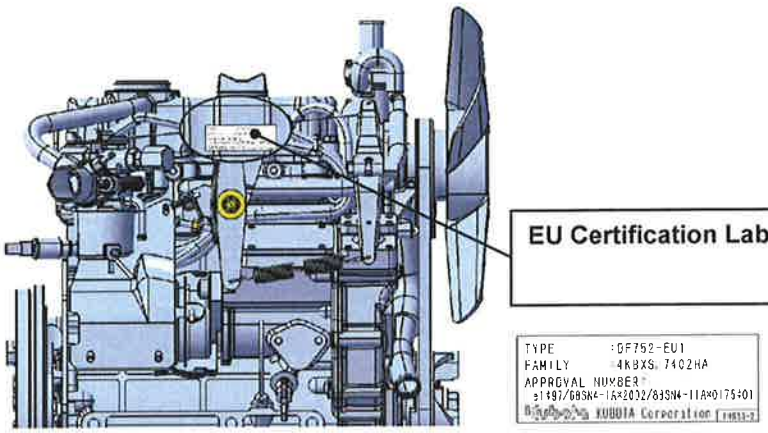
- EPA/CARB certification label part numbers:

1H965-8891△ : WG972 - G
1H964-8891△ : WG972 - G L
1H963-8891△ : WG752 - G
1H962-8891△ : WG752 - G L
1H959-8891△ : DG972

〔**WG752-E2, DF752-E2 only**〕

- EU certification label part numbers:

1H950-8896△ :WG752-EU1
1H951-8896△ :WG752-EU2
1H952-8896△ :WG752-EU3
1H953-8896△ :DF752-EU1



⑦Vaporizer (WG752-GL, WG972-GL), Gas Regulator (DG972) Connections (See FUEL SYSTEM section)

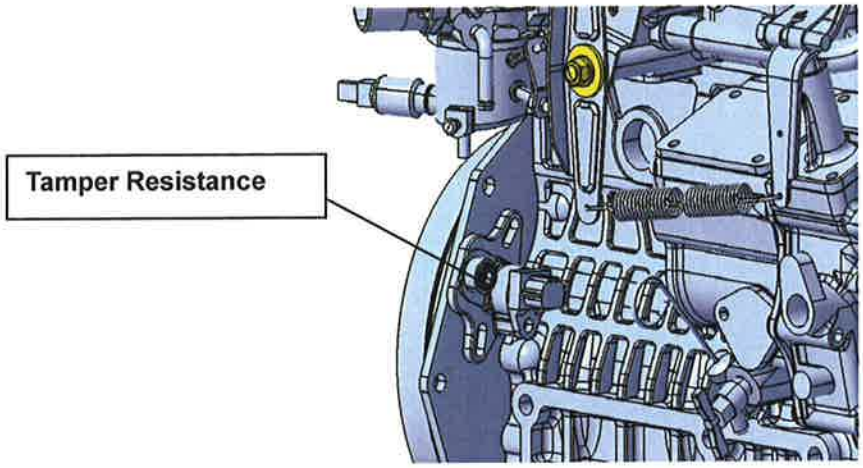
The hose length between the vaporizer (gas regulator) and carburetor (gas mixer) must be within 300±20mm (11.8±0.78inch). Only use hose appropriate for LPG.

⑧ Tamper Resistance

Any modifications to the tamper resistance parts on this engine will cause this engine to be in noncompliance with emission regulations.

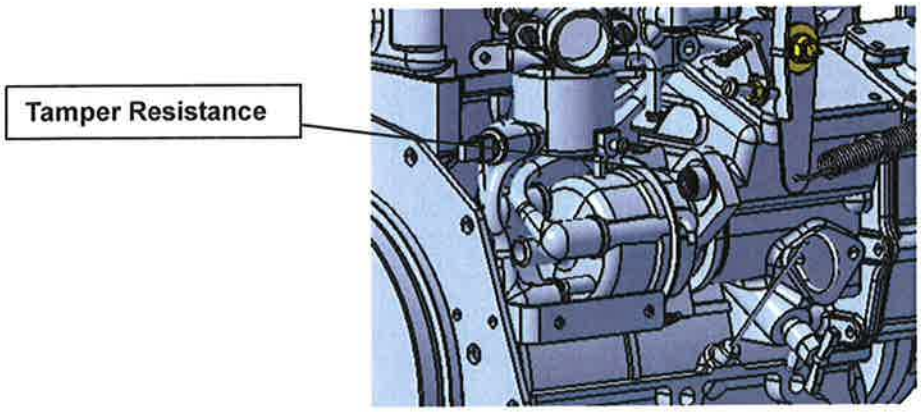
SENSOR (CRANK ANGLE): (WG/DG972)

The sensor is tamper resistant; the ignition timing adjustment screw has been covered after adjustment at the factory. You **CANNOT** adjust the ignition timing.



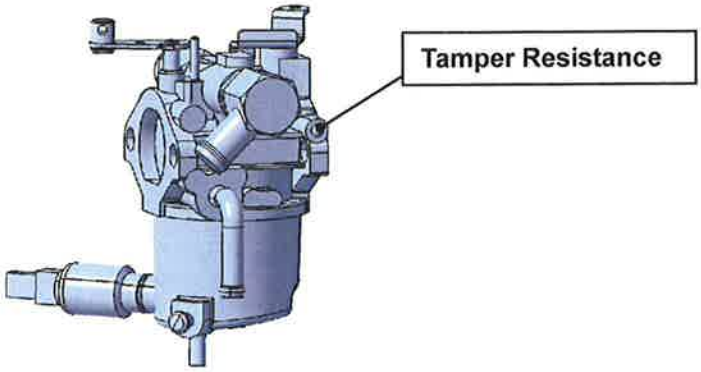
DISTRIBUTOR: (WG752)

The distributor is tamper resistant ; the ignition timing adjustment screw has been covered after adjustment at the factory. You **CANNOT** adjust the ignition timing.



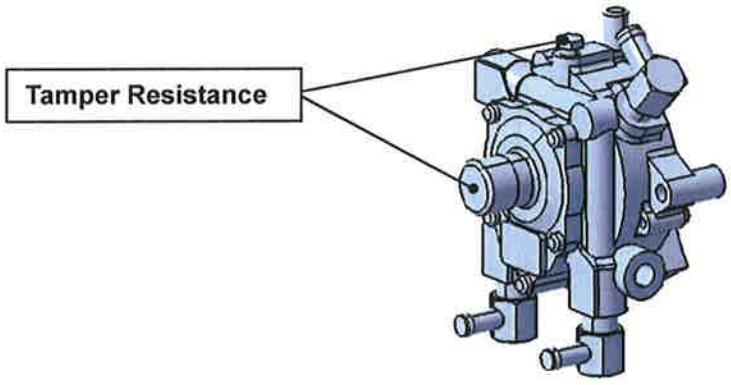
CARBURETOR: (WG752, 972)

The carburetor is tamper resistant ; the idle mixture screw has been covered by tamper plug after adjustment at the factory. You **CAN NOT** adjust this screw.



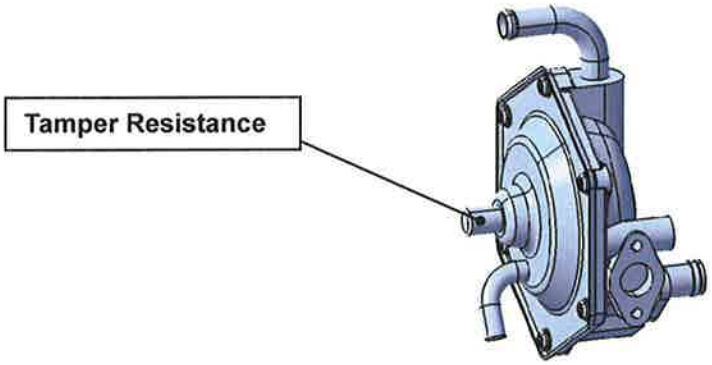
LPG REGULATOR: (WG752-GL, WG972-GL)

LPG regulator is tamper resistant ; the main and idle pressure adjustment screw have been covered by tamper caps after adjustment at the factory. You **CAN NOT** adjust the screws.



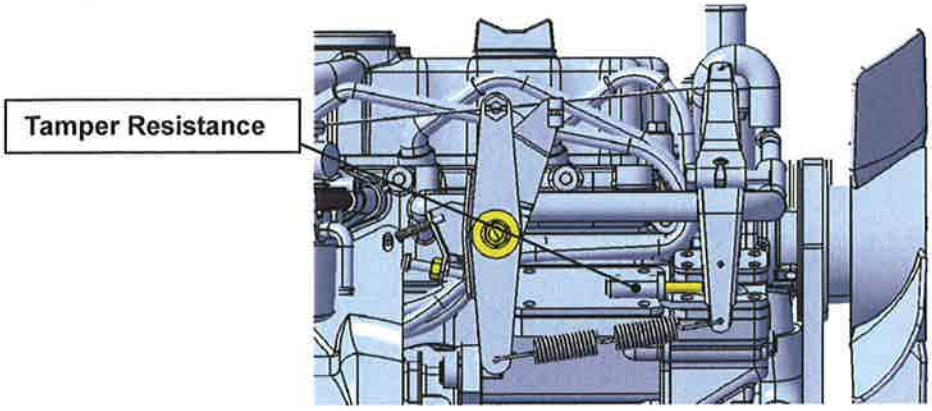
NATURAL GAS REGULATOR: (DG972)

Natural gas regulator is tamper resistant; idle pressure adjustment screws have been covered by tamper caps after adjustment at the factory. You **CANNOT** adjust the screw.



GOVERNOR LEVER (THROTTLE ANGLE):
(Only spec model of specification that limits throttle angle)

The governor lever is tamper resistant; the governor lever adjustment screw has been covered after adjustment at the factory. You **CANNOT** adjust the governor lever.



2. FUEL SYSTEM

CONTENTS

1. GENERAL

Fuel by which Kubota guarantees performance

1. Gasoline

- Unleaded regular gasoline
- E10 (10% ethanol is added to gasoline)

2. LPG

- Commercial liquid propane gas only.
- Equivalent to propane HD-5 of GPA* standards.
- KUBOTA RECOMMENDED LPG FUEL SPECIFICATIONS

C_3H_8	C_3H_6	C_4H_{10}	Others
≧ 90%	≦ 5%	≦ 2.5%	-

(vol %)

*GPA means Gas Processors Association (U.S.A)

3. Natural gas

- Natural gas equivalent to city gas
- This manual describes the performance with Japanese standard natural gas.
  The lower heating value : 9699kcal/m^3 (1090BTU/ft^3).
- Supply pressure of natural gas : between 0.98 and 3.45kPa.
- Consult KUBOTA for further information of fuel used.

2. FUEL DIAGRAM

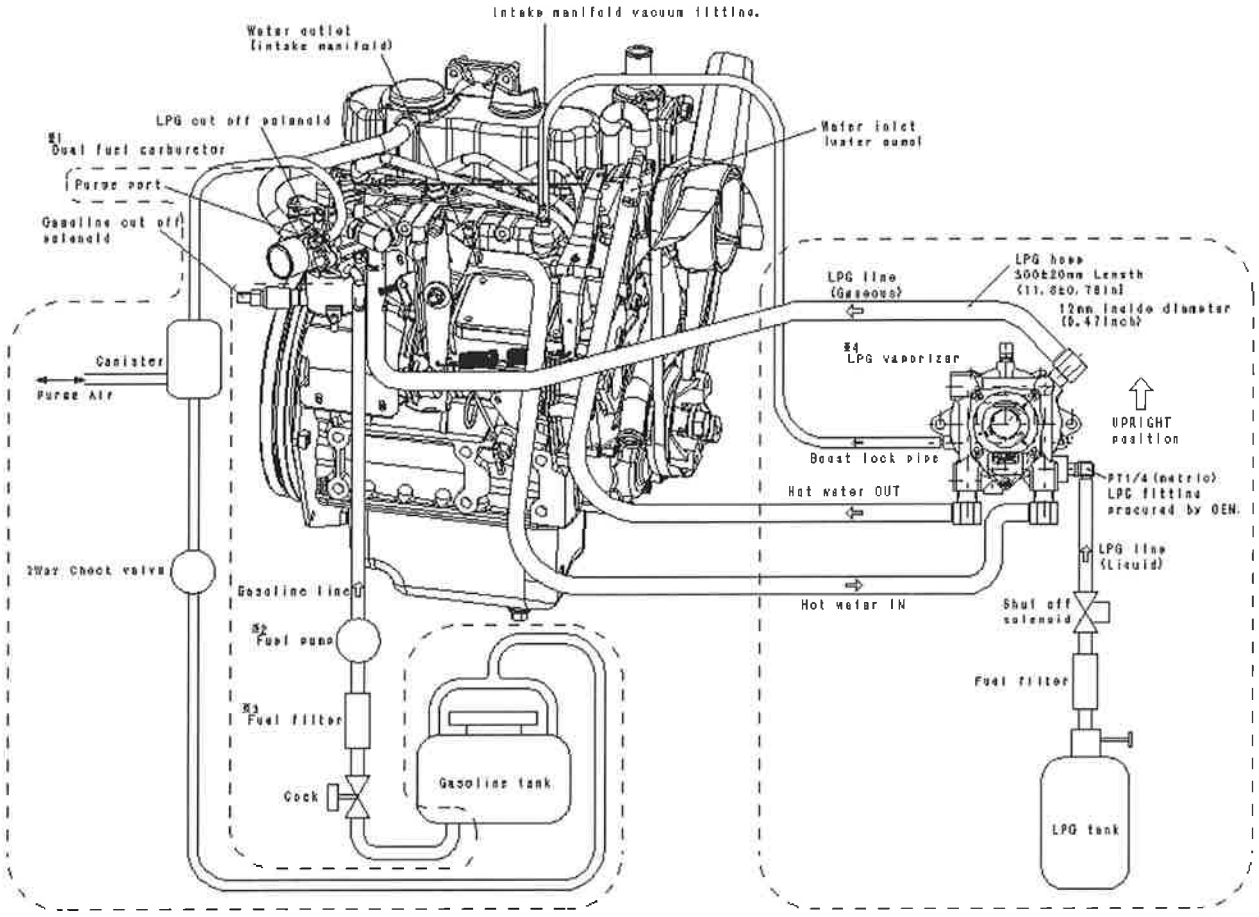
WG752, 972

- Mark ※1 ~ 4 are supplied by KUBOTA.

The other parts including hose should be procured by OEM.
The canister and the check valve should be procured by OEM if these are necessary for certification of Evaporative Emission Regulation.

- Each pipes should be surely connected by clamp.
- When gasoline tank location is lower than carburetor, gasoline cock is not needed.

When gasoline tank location is higher than carburetor, gasoline cock should be installed.
And gasoline cock should be surely closed when engine is in stop and operated by LPG.

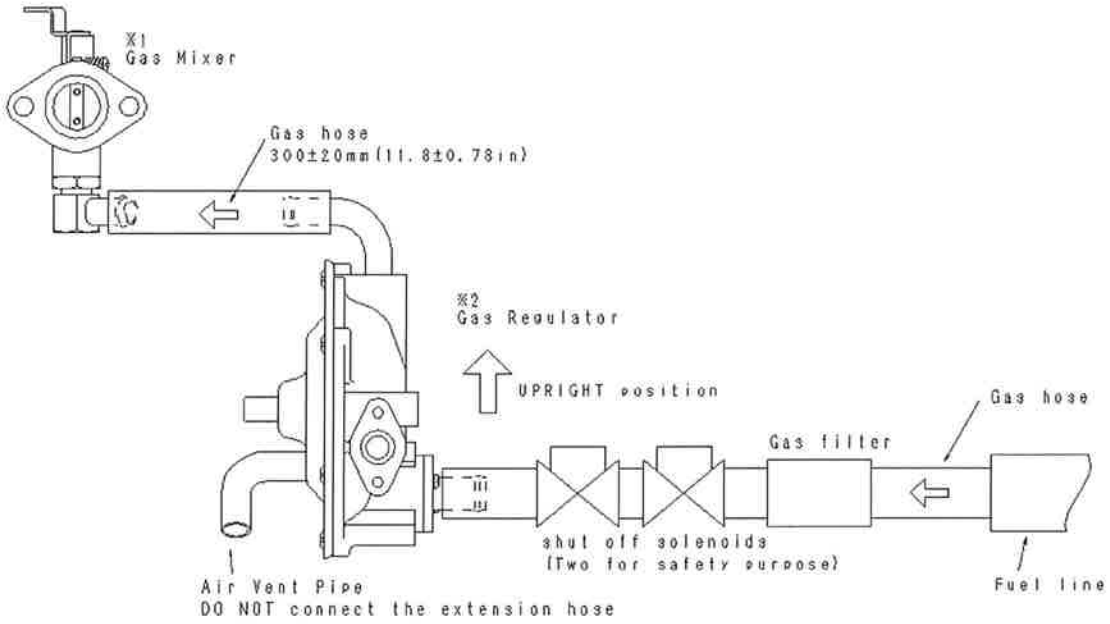


Related evaporative emission regulation
See page "EVAPORATIVE EMISSION CONTROLS"

WG752-GL,WG972-GL only
See next page "CAUTIONS"

DG972 (See next page “CAUTIONS”)

- Mark ※ 1 ~ 2 are supplied by Kubota.
  The other parts should be procured by OEM. (include hose)
- Each pipe should be surely connected by clamp.



3. CAUTIONS

① For safety (WG752-GL, WG972-GL, DG972)

- **All fuel connections added to this engine must be installed by qualified personnel utilizing recognized procedures and standards.**
- **The non-KUBOTA installed parts, such as hoses, fittings, piping, shutoff solenoid valve should be approved for LPG (Natural gas) use and conform to UL, CSA, NFPA, MSHA and all other applicable standards.**
- **An approved, listed fuel filter (gas filter) and shutoff solenoid valve (for safety purpose for DG972, two valves) must be installed between the LPG tank and Kubota LPG regulator with vaporizer before the Kubota gas regulator.**
- **Two shutoff solenoid valves must shut off the gas when engine stalls (DG972).**
- **The following standards must be followed prior to installation: UL, CSA, NFPA, and MSHA standards.**

1. Tightening torque and leak check for vaporizer and gas regulator

Each fitting must be sealed with approved joint sealant compound the joint must be installed to the gas entrance of the regulator by screw with O-ring. And fittings and screw are tightened to the specified torque using a wrench (driver), and leak check by a soap solution or its equivalent must be performed as shown in the below table.
Bubbles will indicate a loose connection.

[TIGHTENING TORQUE AND LEAK CHECK PRESSURE]

Fitting		Qty.	Size	Tightening torque			Leak check pressure		
				Nm	kgfm	ft-lb	kPa	kgf/cm^2	psi
GL	LPG OUT (VAPOR)	1	R3/8	29.4 to 58.8	3.0 to 6.0	21.7 to 43.4	>9.8	>0.1	>1.42
	LPG IN (LIQUID)*	1	R1/4	19.6 to 39.2	2.0 to 4.0	14.5 to 28.9	>1471	>15	>213
	WATER IN/OUT	2	R3/8	29.4 to 58.8	3.0 to 6.0	21.7 to 43.4	>245	>2.5	>35.6
DG	SCREW	2	M4	1.9 to 2.9	0.2 to 0.3	1.5 to 2.2	>4.9	>0.05	>0.7

*NOT KUBOTA supplied

2. Change the angle of LPG fitting of dual fuel carburetor and Gas fitting of gas mixer

The fitting may be mounted on any position since it is not sealed. The nut may by loosened using a wrench. Fitting may be changed to any specified angle. The nut should be tightened to the specified torque using a wrench as shown in the below table.

[TIGHTENING TORQUE]

	Fitting	Qty.	Size	Tightening torque			Leak check
				Nm	kgfm	ft-lb	
GL	LPG IN (VAPOR)	1	M12x1.25	11.8 to 26.5	1.2 to 2.7	8.7 to 19.5	Soap solution or its equivalent
DG	GAS IN (LOCK NUT)	1	M16×1	19.6 to 39.2	2.0 to 4.0	14.5 to 28.9	Soap solution or its equivalent

3. Setting and vibration limits

Install the LPG regulator (gas regulator) in **UPRIGHT** position, it must be installed within 4G vibration level. If not, it may not supply necessary LPG fuel to the engine.

DO NOT connect the extension hose with the air vent pipe of the gas regulator.
If do this, it may not supply necessary fuel to the engine.

4. Starting the engine (WG752-GL , WG972-GL)

Do not move the choke lever, when LPG starting.
Otherwise, the vaporizer might break down.

② For emission regulations (WG752-GL, WG972-GL, DG972)

1. Vaporizer and Gas regulator

In order to conform to applicable EPA and CARB Emissions regulations when operating WG752-GL,WG972-GL,DG972 engine, only a KUBOTA GENUINE VAPORIZER KIT (Gas regulator) can be used.
Vaporizer and Gas regulator can only be installed by an authorized KUBOTA DISTRIBUTOR or the manufacturer of the equipment in which this engine is used.

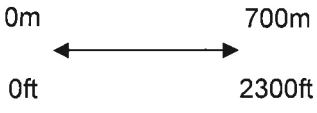
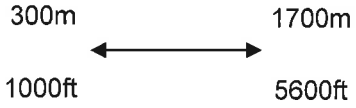
2. Length of the gas hose

The hose length between the vaporizer (gas regulator) and carburetor (gas mixer) must be within 300±20mm (11.8±0.78inch).
The incorrect use of the hose may not conform to emission regulations.

4. HIGH ALTITUDE OPERATION (WG752 · 972)

〔Important〕

Altitude compensation kit is applied for EPA and CARB certified engines only.
EPA and CARB emission regulations require the ultimate users of non-road SI engine, as their obligation, to adjust the emissions by installing the appropriate genuine altitude compensation kit. And the engine manufacturer must provide such kit when the engine is operated at an altitude that exceeds the standard level, as guaranteed by the engine manufacturer.
For this purpose, Kubota prepared genuine altitude compensation kit described below.
The ultimate users of SI engines must comply with the regulations through the installation of the appropriate altitude compensation kit for the altitude range where the engine will be operated.

Altitude Compensation Kit	Applicable Altitude Ranges
Original carburetor (with 0m kit)* P/N:EG651-9930△ (WG752-GL) P/N:EG601-9930△ (WG752-G) P/N:EG801-9930△ (WG972-GL) P/N:EG805-9930△ (WG972-G)	
1000m compensation kit P/N:EG651-9931△ (WG752-GL) P/N:EG601-9931△ (WG752-G) P/N:EG801-9931△ (WG972-GL) P/N:EG805-9931△ (WG972-G)	
2000m compensation kit P/N:EG651-9932△ (WG752-GL) P/N:EG601-9932△ (WG752-G) P/N:EG801-9932△ (WG972-GL) P/N:EG805-9932△ (WG972-G)	

*) Prepare for the users who have lost original carburetor's jet.

Altitude compensation kit part number: Please contact your local Kubota dealer and specify your engine type and engine serial No.
Please consult your local Kubota dealer for further information on the altitude compensation kit.

CONSULT YOUR LOCAL KUBOTA DEALER FOR FURTHER INFORMATION ON THIS PROCEDURE.

Refer Exchange Manual (EG601-9939△)

5.EVAPORATIVE EMISSION CONTROL (gasoline fuel)

1. Regulations

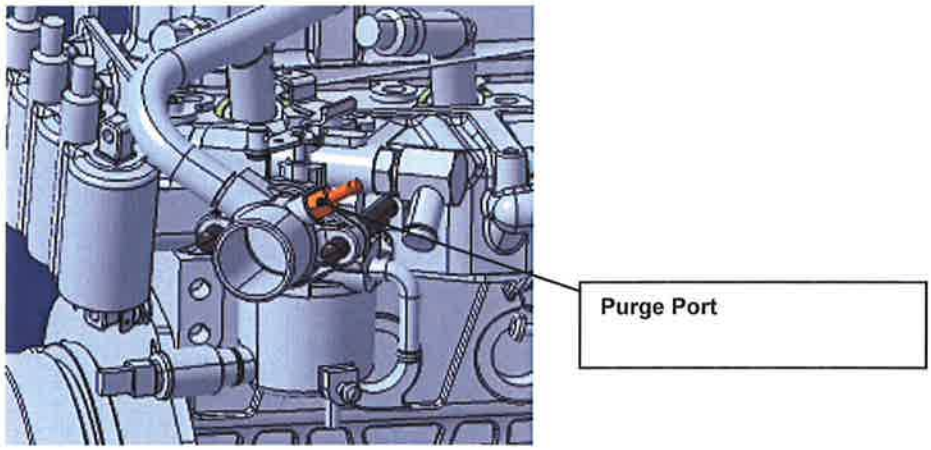
See the evaporative emission standards specified for your equipment in 40 CFR 1054.112 and CARB section 2754.
The standards and other requirements in 40 CFR part 1060 apply to the fuel lines, fuel tanks, fuel caps, canisters and others used or intended to your equipments and our engines.

- Nonmetal fuel lines must meet the permeation requirements specified in 40 CFR 1060.102.
- Fuel tanks must meet the permeation requirements specified in 40 CFR 1060.103 unless they are installed in equipment certified to meet diurnal emission standards under 40 CFR 1060.105(e).
- Your equipment must have a tethered fuel cap. Fuel caps must also include a visual, audible, or other physical indication that they have been properly sealed (EPA 40 CFR 1060.101(f)(1)(i) , CARB section 2756).
- Your equipment must have proper carbon canisters that are installed on the fuel tanks subject to running loss or diurnal emission standards (EPA 40 CFR 1060.104(b)(1), CARB section 2754).

〈KUBOTA recommendation〉

	Objective parts	Regulation requirements	Remarks
Equipment manufactures	Fuel Hose, Fuel Tank, Tank Cap, Canister	Use certified parts	40 CFR 1054.112 CARB section 2754
KUBOTA (engine)	※ purge port	Add the purge port	

※To route running loss emissions into the engine intake system, Kubota prepared the purge port on the air-cleaner flange. You may use this purge port to combust fuel vapors vented from the fuel tank.



2. Related Check Items

You must confirm that the fuel parts layout confirmed at application review.
Please confirm the following items.

- Installation of heat cover, fuel hose, etc. confirmed.
- The temperature of the fuel in the fuel tank must be less than temperature to prevent fuel boiling at all operating conditions.
- If you use a carbon canister, the capacity of fuel tank and the carbon canister is confirmed.
- The liquid gasoline does not enter from the fuel tank to the evaporative canister at all operating conditions (at inclination, volume expansion by heat, surface level difference by vibration and etc).

Note:

1. It is equipment manufacturer's responsibility to make sure the fuel system will comply with the applicable evaporative emissions regulation.
2. It is equipment manufacturer's responsibility to test and confirm the evaporative system will not cause engine performance issues at any operating condition.

3. EXHAUST SYSTEM

CONTENTS

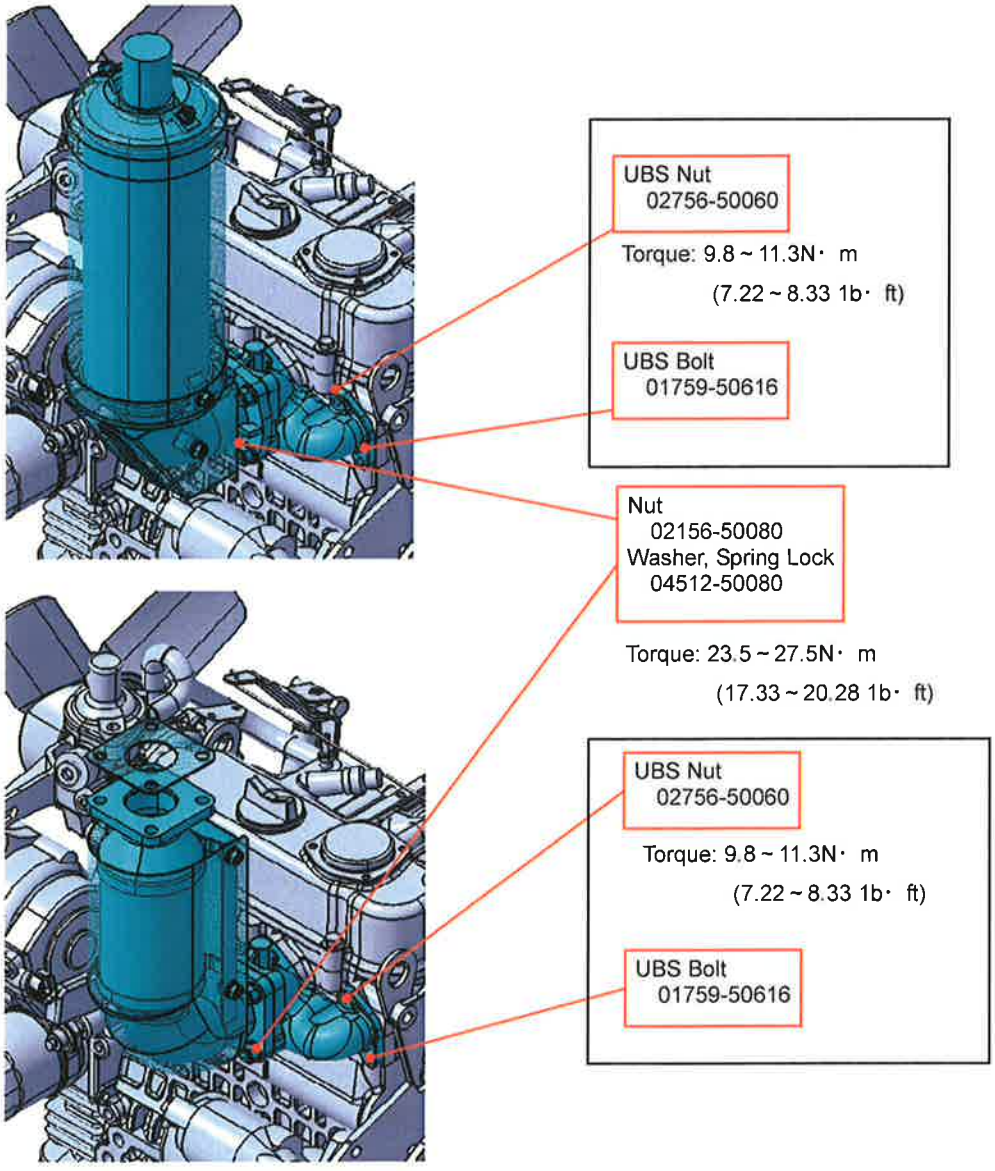
1. GENERAL (WG752 · 972)

Kubota offers certified catalytic mufflers and catalytic converters.
You should use only Kubota catalyst parts certified and assemble the exhaust parts as follows and/or the Exhaust Emission Check Sheet. Catalyst parts other than Kubota must not be used because other catalyst is not certified our engine.
You must consult Kubota when you change the exhaust parts after application review and/or the Exhaust Emission Check Sheet.

- You must install the catalyst parts directly to the exhaust manifold through the gasket.
See SOS option manual about selectable combinations of the catalyst parts and the exhaust manifold.
- When you use the converter, you must install the converter in the direction where the elbow side of the converter is attached to the exhaust manifold.
- Tighten with the specified torque to avoid exhaust gas leak. (Exhaust Manifold, Catalyst)
When you use bolt to tighten the catalyst, the material of the bolt must be SAE10B23H.

〔**Important**〕

- Handle catalyst parts with care. Damaged or catalyst that has been ‘ dropped’ cannot be used.



2. EXCEPTIONS (WG752 · 972)

· When it is necessary to offset the installation positions of the catalyst parts to avoid part interference or etc, a spacer can be used between the exhaust manifold and catalyst parts.
〔Only for WG972 with the exhaust manifold (EG511-1231△ ,EG511-1233△)〕

Allowable max thickness of the spacer is **20mm (0.78inch)**. 〔**Important**〕

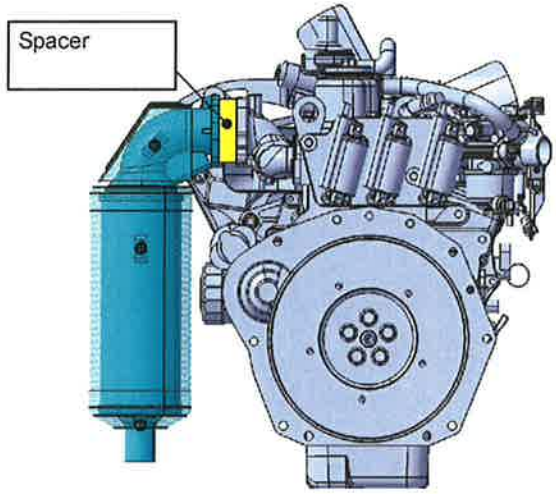
〔Only for WG752 with all exhaust manifold〕

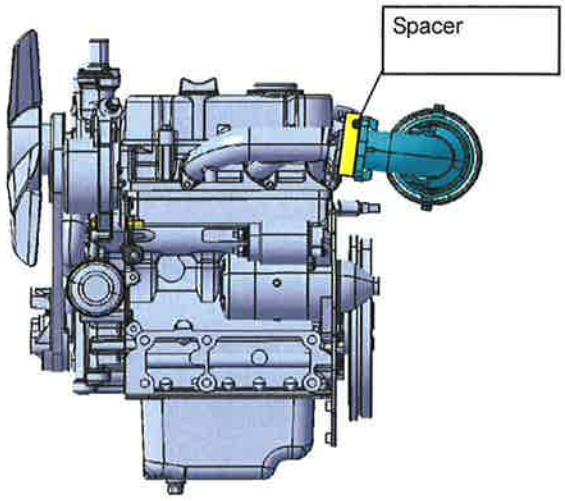
Allowable max thickness of the spacer is **13mm (0.51inch)**. 〔**Important**〕

〔**Caution**〕

- Kubota gasket must be installed on both sides of the spacer.
- The surface-roughness of both Sides of the spacer must be less than 3.2a (3.2μ m).
  And allowance of levelness must be less than 0.2mm.
- The material of the spacer must be corresponding of SPHC .
- Tighten torque must be within 23.5 ~ 27.5N· m(17.33 ~ 20.28 lb· ft)
- When change the stud on the exhaust manifold or use the bolt to tighten, the material of the stud and the bolt must be SAE10B23H.
- Refer to SOS option manual for the installation pitch and etc. of exhaust manifold and catalyst parts.

〔Example〕



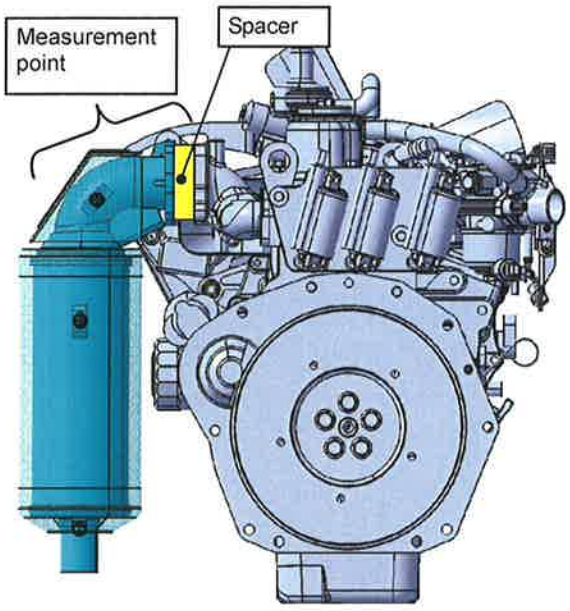


3. RELATED CHECK ITEMS

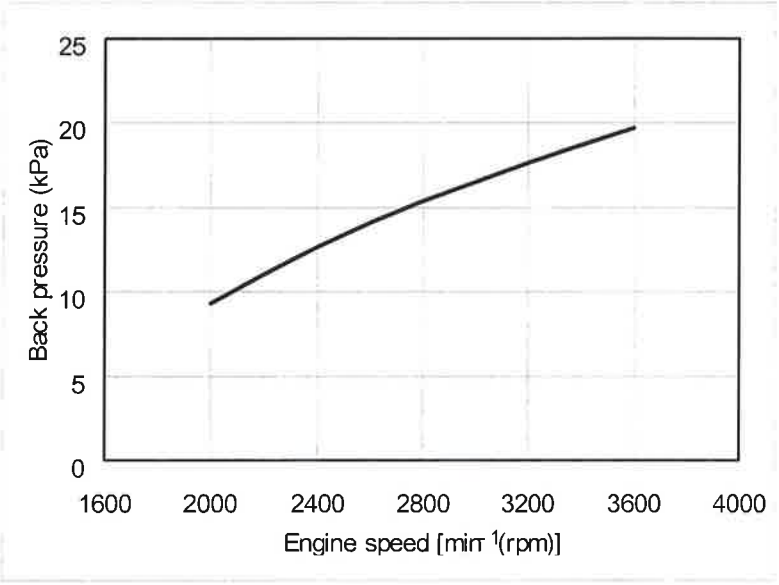
You must confirm that the other parts such as exhaust hoses layout around the catalyst parts confirmed at the time of the application review.
If the layout is not sure, the catalyst parts might be damaged.
Please confirm the following items.

- Installation of the heat cover confirmed.
- Installation of the stay of exhaust system confirmed at vibration test.
- Installation of the parts installed after Kubota catalyst parts.
- Installation of the other parts (ex. water cover, water cap, etc.) confirmed.
  Water must be prevented from entering into exhaust catalyst.
- You confirm that the wiring of igniter and IG coil do not come off because of vibration, and not to disconnect during operation. If wiring comes off or disconnect, catalyst parts might be damaged and the exhaust temperature become very high.
- You must confirm layout of the parts (ex. add the cover etc) around the catalyst parts to avoid a fire because there is possibility that the surface of catalyst parts the exhaust become a high temperature when the engine abnormality driving. And you must guide user to stop engine immediately when the engine abnormality driving.
- When you uses the Kubota catalytic converter with non-Kubota mufflers, it is necessary to confirm that the exhaust system back pressure is less than allowable limit. Refer to the curve below.
  Check system back pressure, when you uses a tail pipe with Kubota catalytic muffler, too.
  Position to measure back pressure is at the outlet of exhaust manifold. Refer to the figurer below.

Back pressure measurement point
Pipe of the catalyst parts or the spacer



Allowable limit of back pressure at WOT operation
(DG972: the catalyst is not necessary)



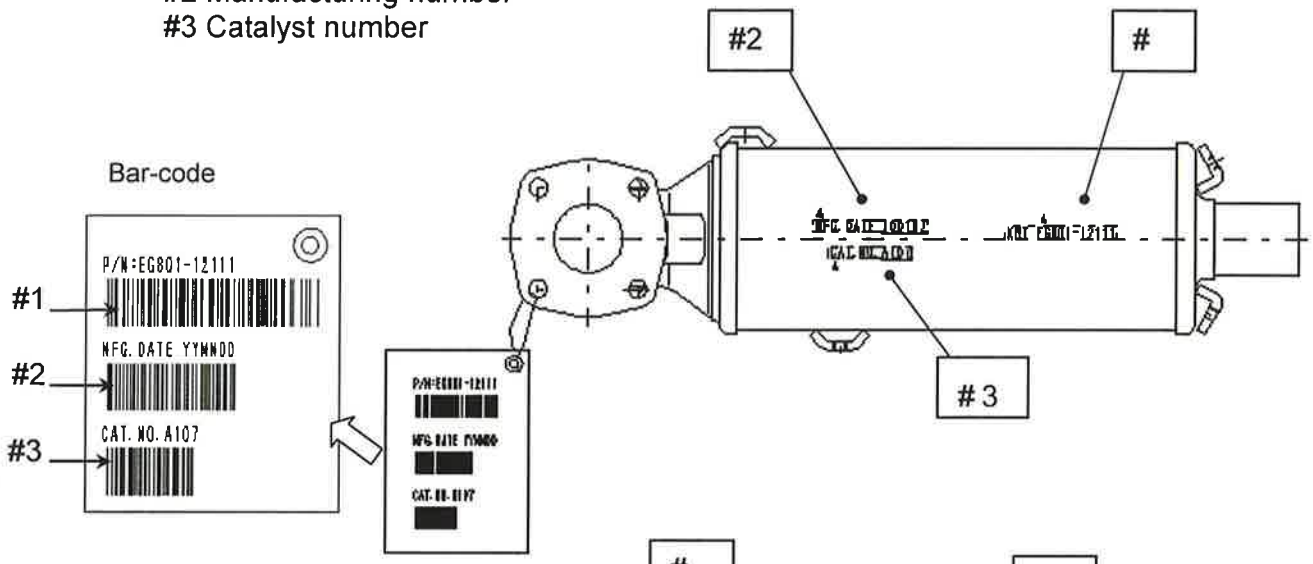
4. FOR MASS PRODUCTION (WG752 · 972)

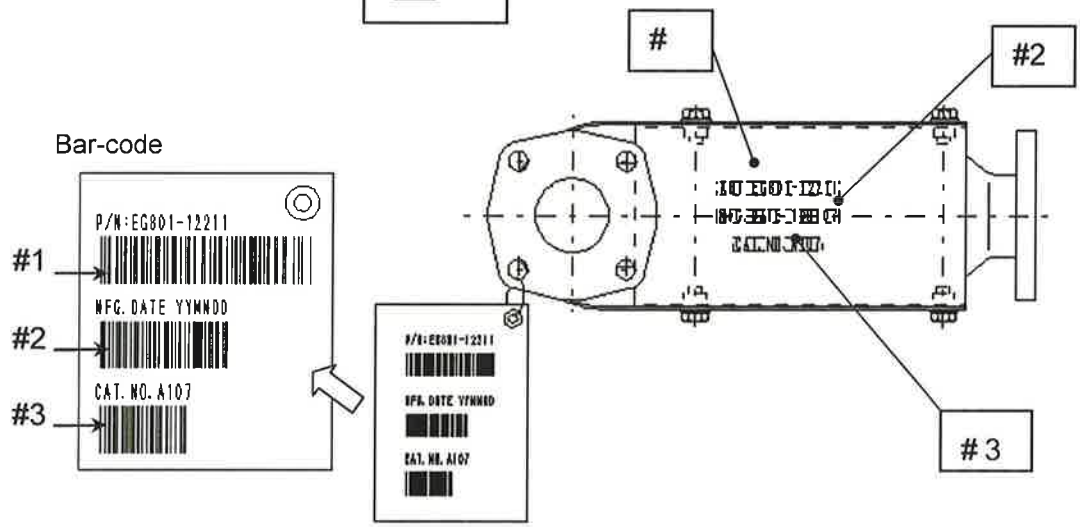
· Catalyst Identification Marks

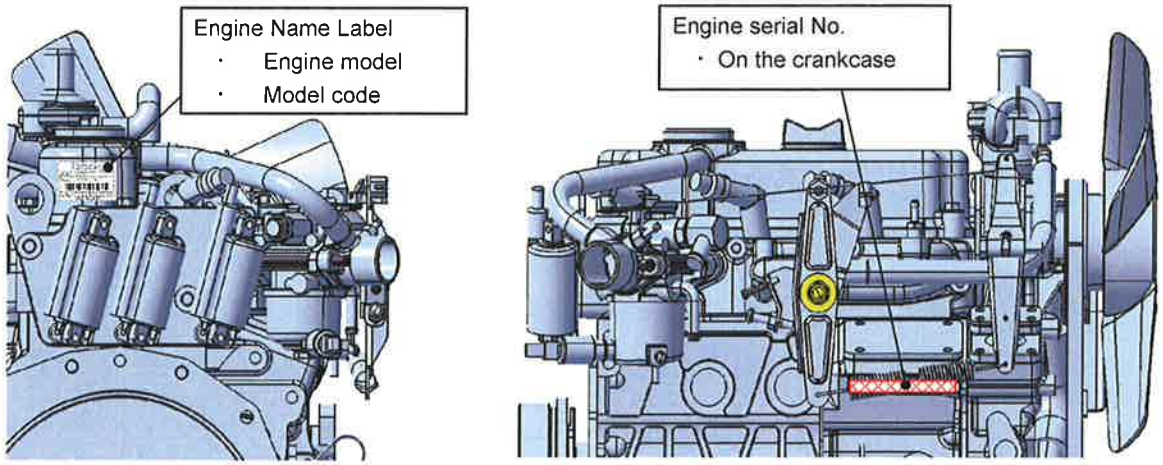
The manufacturing number and the catalyst number are marked on surfaces of the catalyst parts. You must keep record of the catalyst identification information with the engine model and engine serial number that the catalyst is installed. 〔**Check Item**〕

The catalyst parts are shipped with bar-code identification information.

#1 Part number
#2 Manufacturing number
#3 Catalyst number



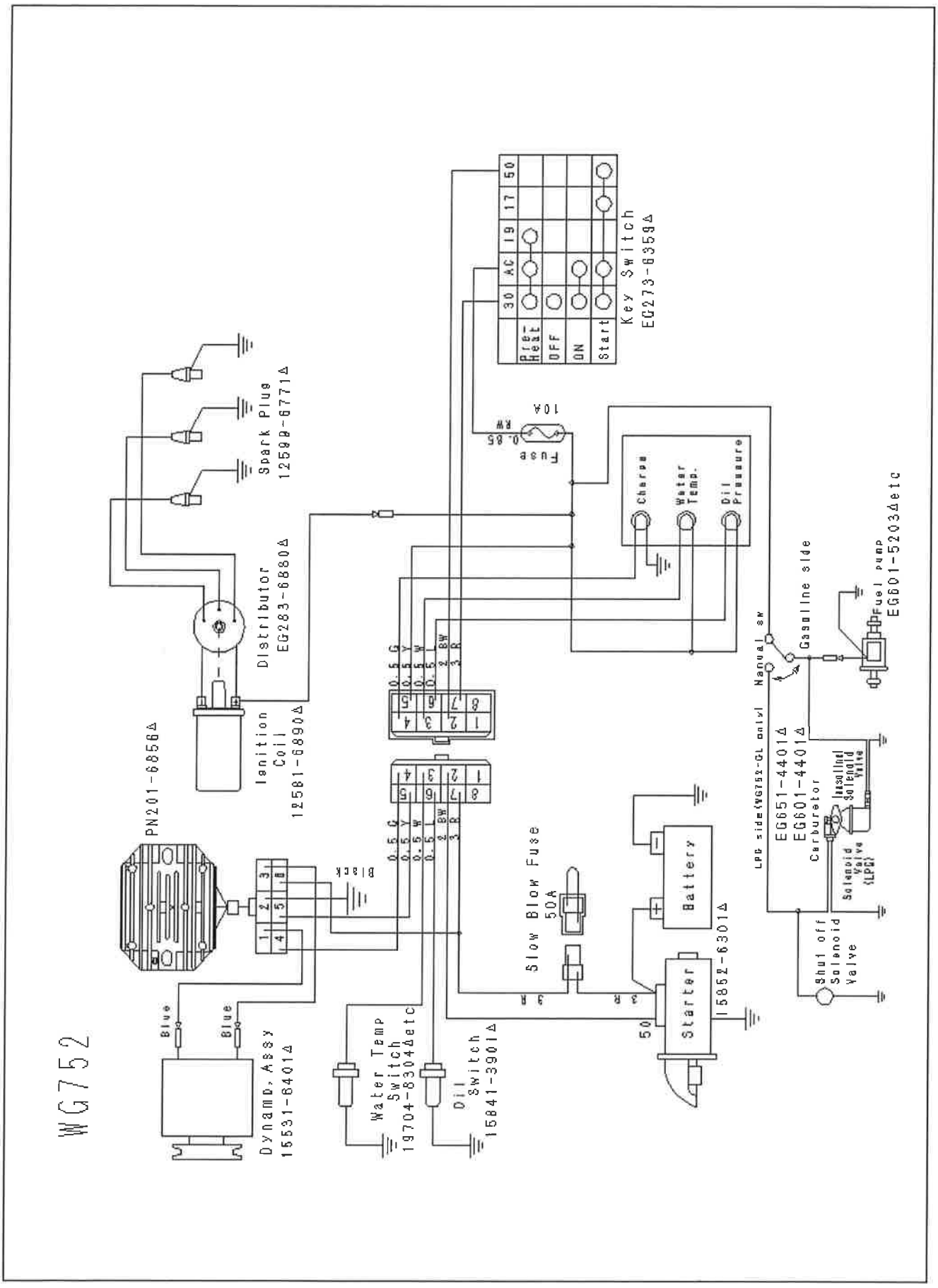




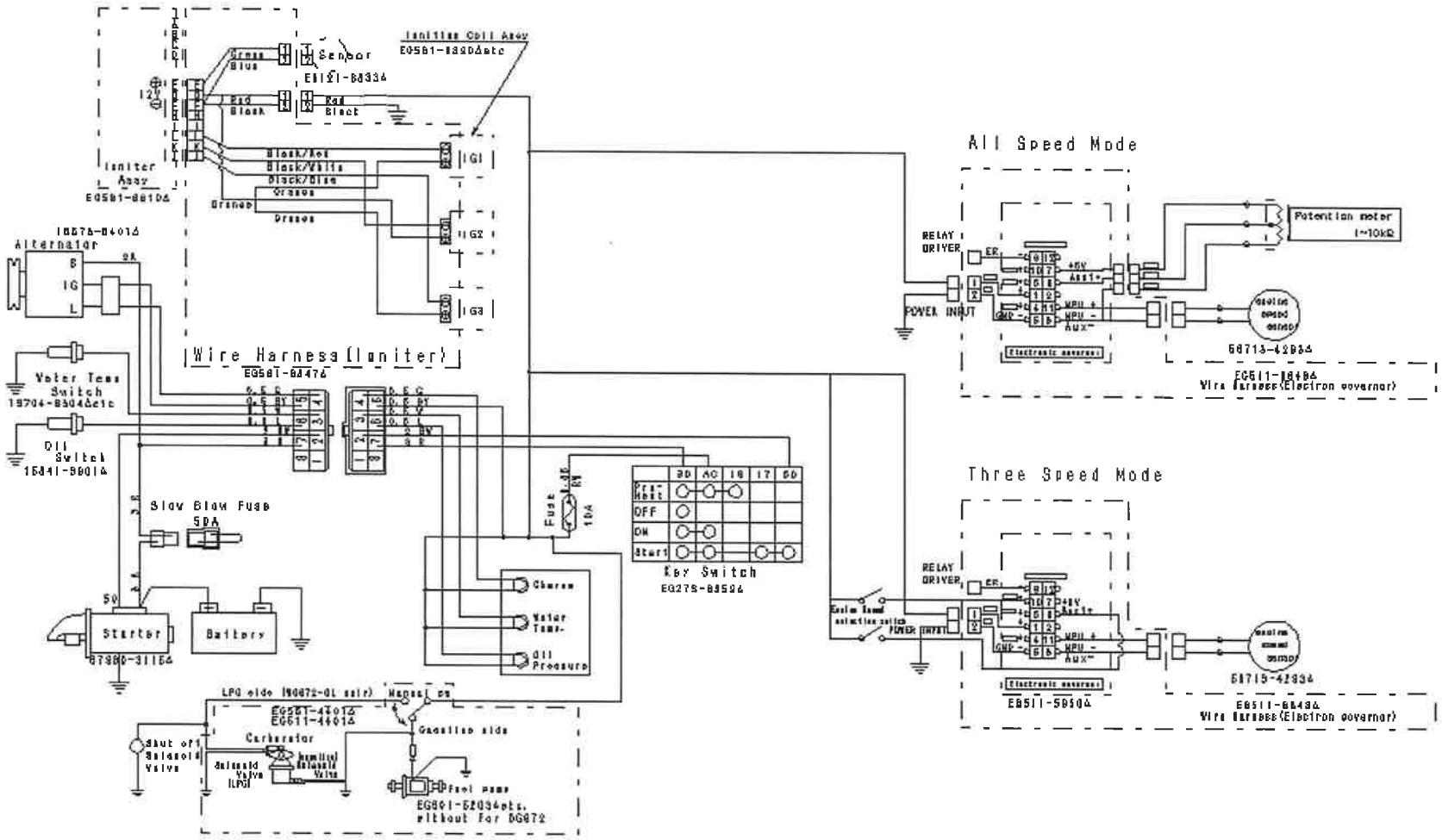
4. ELECTRICAL SYSTEM

CONTENTS

1. WIRING DIAGRAM



WG/DG972


All Speed Mode
Three Speed Mode
Wire Harness (Igniter)
Alternator
Water Temp Switch
Oil Switch
Slow Blow Fuse
5A
Starter
Battery
Key Switch
Fuse
10A
Charge
Water Temp.
Oil Pressure
Carburetor
Shut off Solenoid Valve
Fuel pump
Potention meter
1~10kΩ
RELAY DRIVER
POWER INPUT
Electronic governor

2. CAUTION (WG752 · 972)

- Please confirm that the electrical wiring for the igniter and IG coil(s) do not disconnect due to excessive vibration, poor routing or tension on wire and connector.

  If wires become disconnected, catalyst parts may be damaged and very high exhaust gas temperature may result.

- Please confirm that the connecting order of cylinder number of the igniter and IG coil(s) do not make a mistake at mass-production and maintenance.
  If the connecting order is not correct, catalyst parts may be damaged and very high exhaust gas temperature may result.

TECHNICAL INFORMATION
CONTENTS

1. BRAKE HORSE POWER

SAE J1349

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG752	Gasoline	Net intermittent	kW	11.3	13.8	15.6	16.7	17.1
			HP	15.1	18.5	20.9	22.4	22.9
			PS	15.4	18.8	21.2	22.7	23.2
		Net continuous	kW	8.8	10.8	12.2	13.1	13.4
			HP	11.8	14.5	16.4	17.6	18.0
			PS	12.0	14.7	16.6	17.8	18.2
	LPG	Net intermittent	kW	10.7	13.1	14.9	16.0	16.4
			HP	14.3	17.6	20.0	21.4	22.0
			PS	14.5	17.8	20.3	21.8	22.3
		Net continuous	kW	8.2	10.2	11.5	12.4	12.7
			HP	11.0	13.7	15.4	16.6	17.0
			PS	11.1	13.9	15.6	16.9	17.3

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG972	Gasoline	Net intermittent	kW	14.8	17.8	20.6	22.2	23.1
			HP	19.8	23.9	27.6	29.8	31.0
			PS	20.1	24.2	28.0	30.2	31.4
		Net continuous	kW	12.1	14.6	16.9	18.2	18.9
			HP	16.2	19.5	22.6	24.4	25.4
			PS	16.4	19.8	22.9	24.7	25.7
	LPG	Net intermittent	kW	14.7	17.8	20.1	21.2	22.0
			HP	19.8	23.8	26.9	28.5	29.5
			PS	20.0	24.1	27.3	28.9	29.9
		Net continuous	kW	11.9	14.4	16.3	17.2	17.5
			HP	16.0	19.3	21.8	23.1	23.5
			PS	16.2	19.6	22.1	23.4	23.8
DG972	NG*	Net intermittent	kW	10.0	13.9	16.1	17.4	17.6
			HP	13.4	18.6	21.6	23.3	23.6
			PS	13.6	18.9	21.9	23.7	23.9
		Net continuous	kW	8.3	11.4	13.3	14.3	14.5
			HP	11.1	15.3	17.8	19.2	19.4
			PS	11.3	15.5	18.1	19.4	19.7

Note

1. Conversion rates
   1kW=1.35962PS=1.34048HP
   1PS=0.7355kW=0.985925HP
   1HP=0.7457kW=1.01428PS

* Fuel detail
Japanese standard gas
lower heating value : 9699kcal/m^3 (1090BTU/ft^3)
supply pressure : 0.98 – 2.45kPa (2.27 – 5.68oz/$inch^2$)

2. FUEL CONSUMPTION

Specific at net intermittent (SAE J1349)

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG752	Gasoline	Brake horse power	kW	11.3	13.8	15.6	16.7	17.1
			HP	15.1	18.5	20.9	22.4	22.9
			PS	15.4	18.8	21.2	22.7	23.2
		Fuel consumption	g/kWh	325	315	323	343	347
			g/HPh	242	235	241	256	259
			g/PSh	239	232	238	252	255
			lb/HPh	0.535	0.518	0.531	0.564	0.571
	LPG	Brake horse power	kW	10.7	13.1	14.9	16.0	16.4
			HP	14.3	17.6	20.0	21.4	22.0
			PS	14.5	17.8	20.3	21.8	22.3
		Fuel consumption	g/kWh	301	296	306	322	337
			g/HPh	225	221	228	240	251
			g/PSh	221	218	225	237	248
			lb/HPh	0.495	0.487	0.503	0.530	0.554

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG972	Gasoline	Brake horse power	kW	14.8	17.8	20.6	22.2	23.1
			HP	19.8	23.9	27.6	29.8	31.0
			PS	20.1	24.2	28.0	30.2	31.4
		Fuel consumption	g/kWh	404	398	371	351	334
			g/HPh	301	297	276	262	249
			g/PSh	297	293	273	258	245
			lb/HPh	0.664	0.654	0.610	0.577	0.549
	LPG	Brake horse power	kW	14.7	17.8	20.1	21.2	22.0
			HP	19.8	23.8	26.9	28.5	29.5
			PS	20.0	24.1	27.3	28.9	29.9
		Fuel consumption	g/kWh	301	287	286	292	299
			g/HPh	224	214	213	218	223
			g/PSh	221	211	210	215	220
			lb/HPh	0.495	0.472	0.471	0.480	0.492
DG972	NG	Brake horse power	kW	10.0	13.9	16.1	17.4	17.6
			HP	13.4	18.6	21.6	23.3	23.6
			PS	13.6	18.9	21.9	23.7	23.9
		Fuel consumption	g/kWh	380	310	298	293	285
			g/HPh	283	231	222	219	213
			g/PSh	279	228	219	216	210
			lb/HPh	0.625	0.510	0.490	0.482	0.469

Note

1. Conversion rates 1kW=1.35962PS=1.34048HP 1kg=2.20462lb (1g=0.00220462lb)
   1PS=0.7355kW=0.985925HP 1lb=0.45359kg
   1HP=0.7457kW=1.01428PS

3. NOISE LEVEL

unit dB(A)

	Load × rpm	Fuel	Sound pressure at 1m(3.3ft)
WG752	0/4×3850	Gasoline	89
		LPG	87
	4/4×3600	Gasoline	91
		LPG	89
	0/4×1500	Gasoline	72
		LPG	72

unit dB(A)

	Load × rpm	Fuel	Sound pressure at 1m(3.3ft)
WG972 DG972	0/4×3850	Gasoline	90
		LPG	90
		NG	90
	4/4×3600	Gasoline	92
		LPG	92
		NG	92
	0/4×1500	Gasoline	72
		LPG	72
		NG	72

These data show the average noise level at four points.

Note

1. Measurement conditions: With radiator, cooling fan, air cleaner and muffler.

4. AIR REQUIREMENTS

(1) Combustion air requirements (Refer to 25deg.C and 1000hPa)

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG752	Gasoline	Combustion air requirements	L/sec	10.48	12.58	14.68	16.77	18.87
			m^3/h	37.74	45.29	52.84	60.38	67.93
			in^3/sec	640	768	896	1024	1152
			ft^3/min	22.21	26.65	31.09	35.54	39.98
	LPG	Combustion air requirements	L/sec	9.99	11.99	13.99	15.98	17.98
			m^3/h	35.96	43.16	50.35	57.54	64.74
			in^3/sec	610	732	853	975	1097
			ft^3/min	21.16	25.40	29.63	33.86	38.10

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG972	Gasoline	Combustion air requirements	L/sec	13.63	16.35	19.08	21.81	24.53
			m^3/h	49.06	58.87	68.69	78.50	88.31
			in^3/sec	832	998	1164	1331	1497
			ft^3/min	28.87	34.65	40.42	46.20	51.97
	LPG	Combustion air requirements	L/sec	12.99	15.58	18.18	20.78	23.38
			m^3/h	46.75	56.10	65.45	74.81	84.16
			in^3/sec	793	951	1110	1268	1427
			ft^3/min	27.51	33.02	38.52	44.02	49.53
DG972	NG	Combustion air requirements	L/sec	12.35	14.81	17.28	19.75	22.22
			m^3/h	44.44	53.33	62.22	71.11	80.00
			in^3/sec	753	904	1055	1205	1356
			ft^3/min	26.16	31.39	36.62	41.85	47.08

Combustion air requirements calculating formula

$Q_1=Vh \cdot N \cdot C \cdot \eta \cdot 10^{-3}$

Q_1: Amount of intake air (m^3/min) η: Intake efficiency

Vh: Total displacement (L)

N: Engine speed (rpm)

C: Coefficient=0.5

Gasoline: 0.85

LPG: 0.81

Natural Gas: 0.77

(2) Cooling air requirements (Refer to 25deg.C and 1000hPa)

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG752	Gasoline	Cooling air requirements	L/sec	359.4	418.8	476.5	550.6	651.3
			m^3/h	1294	1508	1715	1982	2345
			in^3/sec	21933	25554	29078	33598	39742
			ft^3/min	761.5	887.2	1009.5	1166.5	1379.8
	LPG	Cooling air requirements	L/sec	349.2	413.8	477.6	548.6	672.0
			m^3/h	1257	1490	1719	1975	2419
			in^3/sec	21307	25251	29146	33475	41005
			ft^3/min	739.7	876.7	1011.9	1162.2	1423.6

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG972	Gasoline	Cooling air requirements	L/sec	571.2	737.2	824.7	833.9	764.8
			m^3/h	2056	2654	2969	3002	2753
			in^3/sec	34859	44988	50328	50886	46668
			ft^3/min	1210	1562	1747	1767	1620
	LPG	Cooling air requirements	L/sec	469.8	586.7	686.6	734.2	722.3
			m^3/h	1691	2112	2472	2643	2600
			in^3/sec	28668	35800	41896	44806	44077
			ft^3/min	995	1243	1455	1556	1530
DG972	NG	Cooling air requirements	L/sec	420.6	518.3	600.2	633.0	577.9
			m^3/h	1514	1866	2161	2279	2080
			in^3/sec	25668	31628	36625	38630	35264
			ft^3/min	891	1098	1272	1341	1224

Above data is decided by following conditions.

1. Using the standard radiator.
2. Engine is run as open unit.

(3) Combustion and cooling air requirements (Refer to 25deg.C and 1000hPa)

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG752	Gasoline	Combustion and cooling air requirements	L/sec	369.9	431.3	491.2	567.4	670.1
			m^3/h	1331.6	1552.8	1768.3	2042.5	2412.5
			in^3/sec	22572	26322	29974	34622	40894
			ft^3/min	783.7	913.8	1040.6	1202.0	1419.7
	LPG	Combustion and cooling air requirements	L/sec	359.1	425.8	491.6	564.5	689.9
			m^3/h	1292.9	1532.8	1769.8	2032.4	2483.8
			in^3/sec	21916	25982	30000	34450	42102
			ft^3/min	760.9	902.0	1041.5	1196.0	1461.7

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG972	Gasoline	Combustion and cooling air requirements	L/sec	584.9	753.6	843.8	855.7	789.3
			m^3/h	2105.5	2712.9	3037.7	3080.5	2841.5
			in^3/sec	35690	45986	51492	52217	48165
			ft^3/min	1239.1	1596.5	1787.7	1812.9	1672.2
	LPG	Combustion and cooling air requirements	L/sec	482.8	602.2	704.7	755.0	745.7
			m^3/h	1738.0	2168.1	2537.1	2718.1	2684.5
			in^3/sec	29461	36751	43005	46074	45504
			ft^3/min	1022.8	1275.9	1493.1	1599.6	1579.8
DG972	NG	Combustion and cooling air requirements	L/sec	433.0	533.1	617.5	652.8	600.1
			m^3/h	1558.7	1919.2	2222.9	2350.1	2160.4
			in^3/sec	26422	32532	37680	39835	36620
			ft^3/min	917.3	1129.4	1308.2	1383.0	1271.4

Note

1. Cooling fan and fan pulley specifications(Cooling fan Part No. 15881-7411△)

Item	
Fan diameter	300mm (11.81in)
No. of blade and type of shape	4, S type
Diameter of fan driving pulley	100mm (3.94in)
Diameter of fan pulley	84mm (3.31in)

2. Conversion rates

$1L=61.0237in^3=0.035315ft^3$

$1ft^3=28.3168L$

$1L/sec=3.6m^3/h=2.1189ft^3/min$

5. EXHAUST GAS VOLUME

Refer to 25deg.C and 1000hPa

Model	Fuel	Engine speed	rpm	1500	2000	2400	2800	3200	3600
WG752	Gasoline	Gas volume	L/sec	22.58	30.11	36.14	42.16	48.18	54.20
			m^3/h	81.3	108.4	130.09	151.77	173.45	195.13
			in^3/sec	1378	1837	2205	2573	2940	3308
			ft^3/min	47.8	63.8	76.6	89.3	102.1	114.8
	LPG	Gas volume	L/sec	21.52	28.69	34.43	40.17	45.91	51.65
			m^3/h	77.48	103.3	123.96	144.62	165.29	185.95
			in^3/sec	1313	1751	2101	2451	2802	3152
			ft^3/min	45.6	60.8	73.0	85.1	97.3	109.4

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG972	Gasoline	Gas volume	L/sec	39.15	46.98	54.80	62.63	70.46
			m^3/h	140.93	169.11	197.30	225.48	253.67
			in^3/sec	2389	2867	3344	3822	4300
			ft^3/min	82.9	99.5	116.1	132.7	149.3
	LPG	Gas volume	L/sec	37.30	44.76	52.23	59.69	67.15
			m^3/h	134.29	161.15	188.01	214.87	241.73
			in^3/sec	2276	2732	3187	3642	4098
			ft^3/min	79.0	94.8	110.6	126.5	142.3
DG972	NG	Gas volume	L/sec	35.46	42.55	49.65	56.74	63.83
			m^3/h	127.67	153.19	178.73	204.26	229.8
			in^3/sec	2164	2597	3030	3462	3895
			ft^3/min	75.1	90.2	105.2	120.2	135.2

Note

1. Conversion rates

$1L=61.0237in^3=0.035315ft^3$

$1ft^3=28.3168L$

$1L/sec=3.6m^3/h=127.133ft^3/hr$

6. HEAT REJECTION TO COOLANT

1. Specific at net intermittent (SAE J1349)

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG752	Gasoline	Brake horse power	kW	11.3	13.8	15.6	16.7	17.1
			HP	15.1	18.5	21	22.4	23
			PS	15.3	18.8	21.3	22.7	23.3
		Fuel consumption	g/kWh	325	315	323	343	347
			g/HPh	243	235	241	256	259
			g/PSh	239	231	238	252	255
			lb/HPh	0.535	0.517	0.531	0.564	0.571
		Heat rejection to cooling water	MJ/h	28.85	32.90	37.03	42.32	45.91
			kcal/h	6891	7859	8846	10110	10967
			BTU/h	27735	31631	35604	40689	44141
	LPG	Brake horse power	kW	10.7	13.1	14.9	16	16.4
			HP	14.3	17.6	20	21.5	22
			PS	14.5	17.9	20.3	21.8	22.3
		Fuel consumption	g/kWh	301	296	306	322	337
			g/HPh	224	221	228	240	251
			g/PSh	221	218	225	237	248
			lb/HPh	0.495	0.487	0.502	0.53	0.554
		Heat rejection to cooling water	MJ/h	28.02	32.51	37.12	42.16	47.37
			kcal/h	6694	7766	8867	10072	11316
			BTU/h	26944	31255	35688	40539	45543

Note

Heat rejection to cooling water calculating formula

Ho=Hu•Ne•be•i

Ho: Heat rejection to cooling water

Hu: Fuel lower heating value

Gasoline: 42.7MJ/kg, 10201kcal/kg, 18361BTU/lb

LPG: 47.3MJ/kg, 11300kcal/kg, 20339BTU/lb

NG; 49.5MJ/kg, 11828kcal/kg, 21285BTU/lb

Japanese standard gas

lower heating value : 9699kcal/m^3 (1090BTU/ft^3)

supply pressure : 0.98 – 2.45kPa (2.27 – 5.68oz/$inch^2$)

Ne: Brake horse power

Be: Specific fuel consumption

i: Dispersion ratio to cooling water

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
WG972	Gasoline	Brake horse power	kW	14.8	17.8	20.6	22.2	23.1
			HP	19.8	23.9	27.6	29.8	31.0
			PS	20.1	24.2	28.0	30.2	31.4
		Fuel consumption	g/kWh	404	398	371	351	334
			g/HPh	301	297	276	262	249
			g/PSh	297	292	272	258	245
			lb/HPh	0.664	0.654	0.609	0.577	0.549
		Heat rejection to cooling water	MJ/h	44.37	47.51	54.81	58.90	64.88
			kcal/h	10599	11349	13094	14072	15501
			BTU/h	42058	45035	51957	55840	61509
	LPG	Brake horse power	kW	14.7	17.8	20.1	21.2	22.0
			HP	19.8	23.8	26.9	28.5	29.5
			PS	20.1	24.1	27.3	28.9	29.9
		Fuel consumption	g/kWh	301	287	286	292	299
			g/HPh	224	214	213	218	223
			g/PSh	221	211	210	215	220
			lb/HPh	0.494	0.471	0.470	0.480	0.491
		Heat rejection to cooling water	MJ/h	36.49	37.80	45.63	51.87	61.28
			kcal/h	8717	9031	10900	12391	14640
			BTU/h	34589	35837	43252	49167	58094

Model	Fuel	Engine speed	rpm	2000	2400	2800	3200	3600
DG972	NG	Brake horse power	kW	10.0	13.9	16.1	17.4	17.6
			HP	13.4	18.6	21.6	23.3	23.6
			PS	13.6	18.9	21.9	23.7	23.9
		Fuel consumption	g/kWh	380	310	298	293	285
			g/HPh	283	231	222	219	213
			g/PSh	279	228	219	216	210
			lb/HPh	0.624	0.509	0.489	0.483	0.47
		Heat rejection to cooling water	MJ/h	32.73	33.49	39.90	44.67	48.91
			kcal/h	7805	7979	9529	10683	11713
			BTU/h	30968	31638	37770	42398	46510

Note

Heat rejection to cooling water calculating formula

Ho=Hu•Ne•be•i

Ho: Heat rejection to cooling water

Hu: Fuel lower heating value

Gasoline: 42.7MJ/kg, 10201kcal/kg, 18361BTU/lb

LPG: 47.3MJ/kg, 11300kcal/kg, 20339BTU/lb

NG; 49.5MJ/kg, 11828kcal/kg, 21285BTU/lb

Japanese standard gas

lower heating value : 9699kcal/m^3 (1090BTU/ft^3)

supply pressure : 0.98 – 2.45kPa (2.27 – 5.68oz/$inch^2$)

Ne: Brake horse power

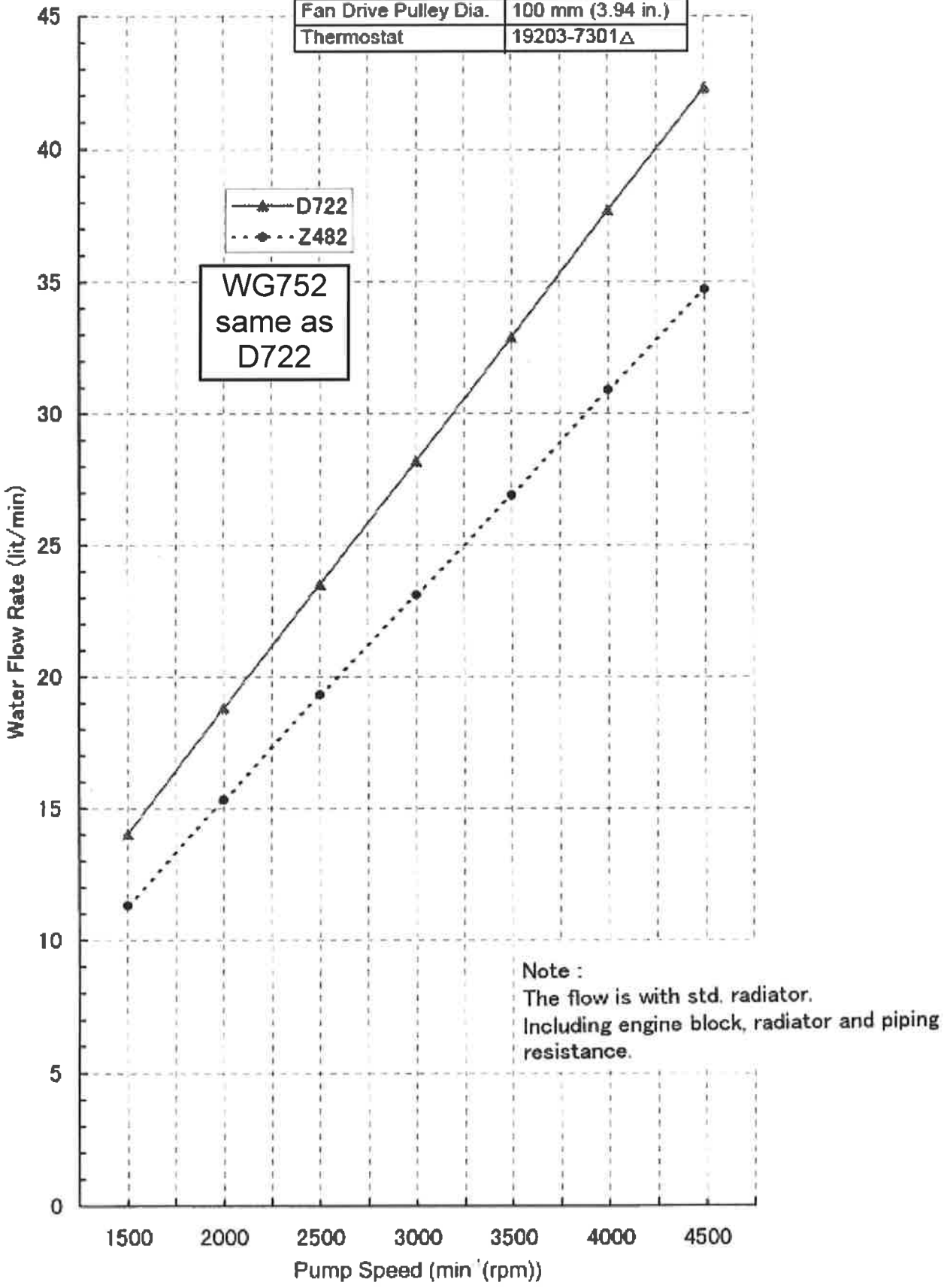
Be: Specific fuel consumption

i: Dispersion ratio to cooling water

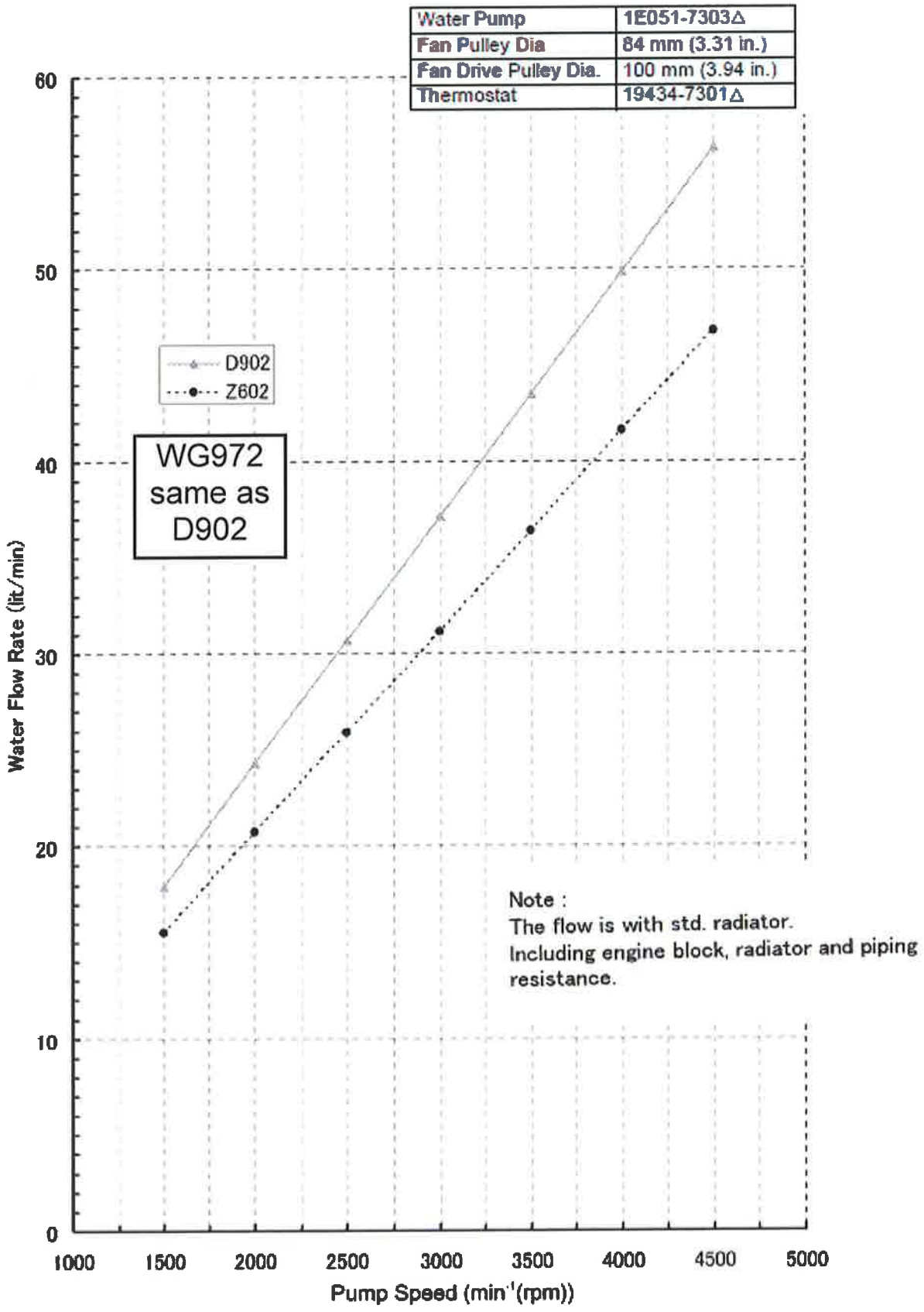
7. WATER FLOW RATE

(1) Water Flow Rate of Z482/D722

Water Pump	1E051-7303△
Fan Pulley Dia.	84 mm (3.31 in.)
Fan Drive Pulley Dia.	100 mm (3.94 in.)
Thermostat	19203-7301△



(2) Water Flow Rate of Z602/D902



8. CENTER OF GRAVITY

1. With standard flywheel and rear-end plate

Model	Dry weight kg (lb)	Center of gravity		
		X mm (in)	Y mm (in)	Z mm (in)
WG752	61.7 (136)	2 (0.08)	64 (2.52)	171 (6.73)

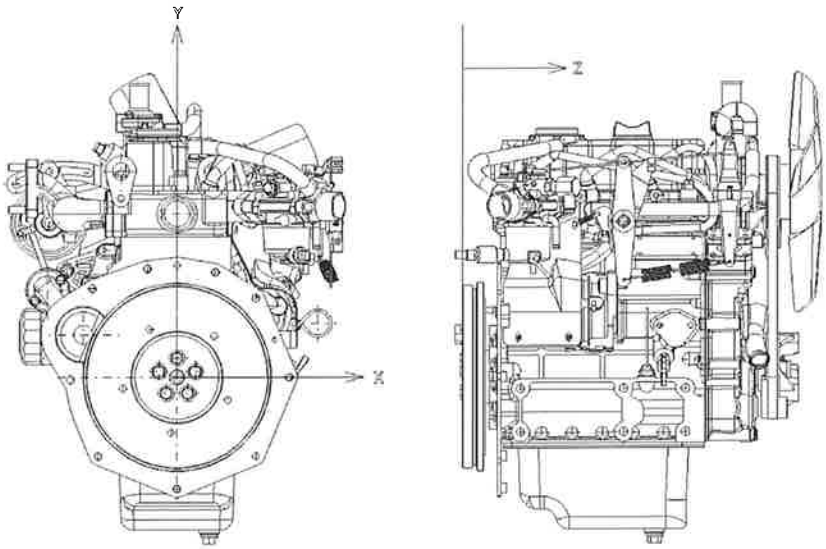
Model	Dry weight kg (lb)	Center of gravity		
		X mm (in)	Y mm (in)	Z mm (in)
WG/DG972	72 (159)	-25.5 (-1.00)	73.3 (2.89)	179.5 (7.07)

2. With SAE flywheel and flywheel housing

Model	Dry weight kg (lb)	Center of gravity		
		X mm (in)	Y mm (in)	Z mm (in)
WG752	89 (196.2)	1 (0.04)	47 (1.85)	188 (7.4)

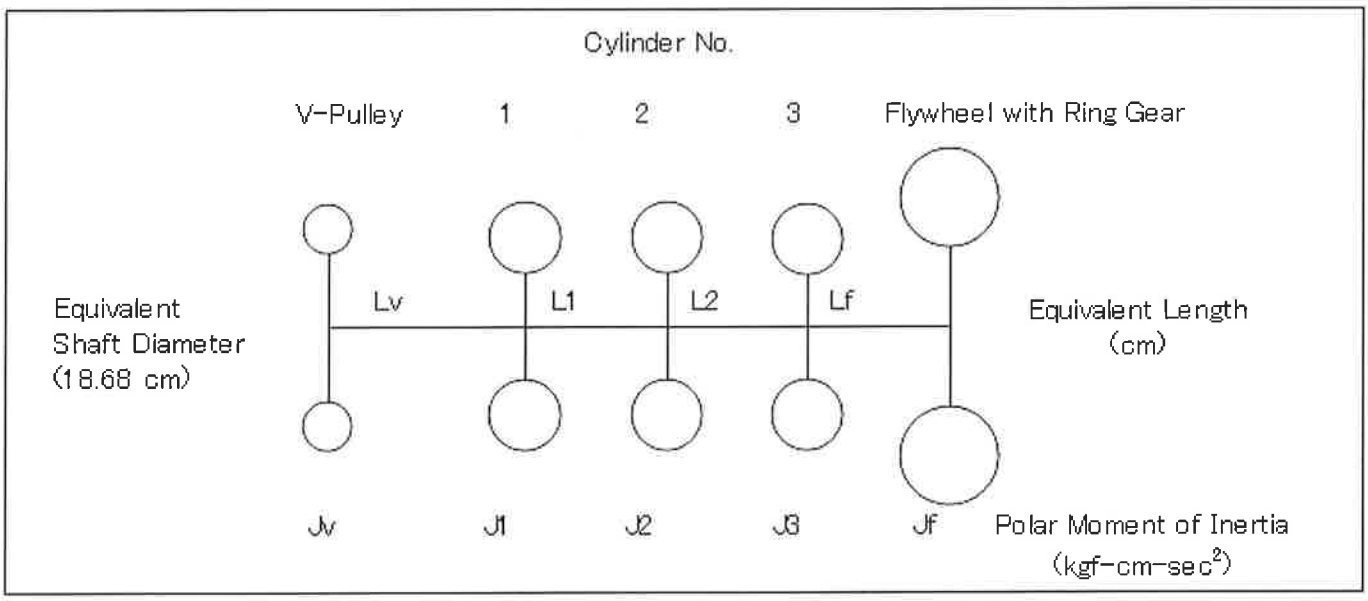
Model	Dry weight kg (lb)	Center of gravity		
		X mm (in)	Y mm (in)	Z mm (in)
DG972	95.4 (210)	-10 (-0.39)	28 (1.1)	207 (8.15)

Note
Cooling water and lubricating oil weight is not included in above engine weight.



9. MASS ELASTIC SYSTEM

Equivalent torsional vibration data



MODEL	EQUIVALENT LENGTH (cm)				POLAR MOMENT OF INERTIA (kgfcm-sec2)				
	LV	L1	L2	Lf	JV	J1	J2	J3	Jf
WG752	30670	5136	5136	3673	0.013	0.017	0.011	0.018	0.392

Note: Flywheel 16861-25110, V-Pulley 16861-74280

MODEL	EQUIVALENT LENGTH (cm)				POLAR MOMENT OF INERTIA (kgfcm-sec2)				
	LV	L1	L2	Lf	JV	J1	J2	J3	Jf
WG/DG972	35082	4528	4528	2824	0.013	0.026	0.026	0.026	0.523

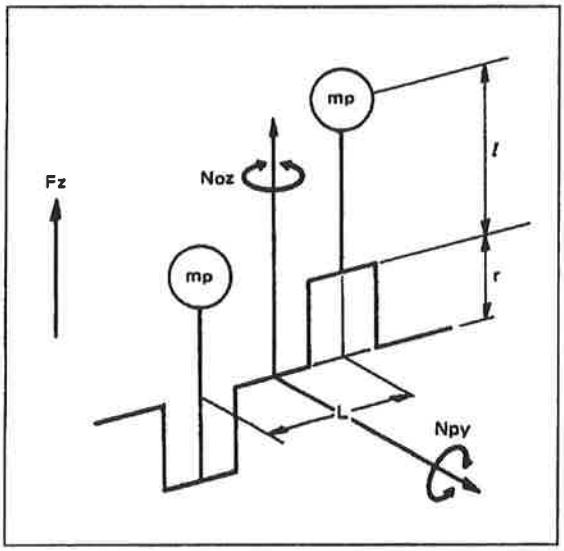
Note: Flywheel EG511-25110, V-Pulley 16861-74280

MODEL	EQUIVALENT LENGTH (cm)				POLAR MOMENT OF INERTIA (kgfcm-sec2)				
	LV	L1	L2	Lf	JV	J1	J2	J3	Jf
DG972	35082	4528	4528	2824	0.013	0.026	0.026	0.026	1.281

Note: Flywheel EG582-25110, V-Pulley 16861-74280

10. UNBALANCED FORCES

1. Base data



FZ: Unbalanced inertia force
Npy, Noz: Unbalanced inertia couple
mp: Reciprocating mass
r: Crank radius
l: Center distance of connecting rod
L: Cylinder distance
ω: Angular velocity
$2\pi n/60$
n: Engine speed(rpm)

Model	l (m)	r (m)	L (m)	Wp (kgf)	Bore (mm)	Stroke (mm)
WG752	0.0980	0.0340	0.0720	0.4320	68.0	68.0
WG/DG972	0.0980	0.0368	0.0800	0.3685	74.5	73.6

2. Unbalanced inertia force and couple

($x\omega^2$)

Model	No. of Cylinder	Cylinder Bore(mm)	Order	Fz	Npy	Noz
WG752	2	68.0	1	0	0.000093	0.000093
			2	0	0.000065	0
WG/DG972	2	74.5	1	0	0.000096	0.000096
			2	0	0.000072	0

3. An example of calculation

Calculation condition	ω^2	Fz, Npy, Noz		
			Order	Caluculation
Engine model : WG752 Engine speed : 3600rpm	$(2 \times \pi \times 3600/60)^2$ = 142122	Fz (kgf)	1	0
			2	0
		Npy (kgf-m)	1	0.000093 × 142122 =13.2kg
			2	0.000065 × 142122 =9.2kg
		Noz (kgf-m)	1	0.000093 × 142122 =13.2kg
			2	0
Engine model : WG/DG972 Engine speed : 3600rpm	$(2 \times \pi \times 3600/60)^2$ = 142122	Fz (kgf)	1	0
			2	0
		Npy (kgf-m)	1	0.000096 × 142122 =13.6kg
			2	0.000072 × 142122 =10.2kg
		Noz (kgf-m)	1	0.000096 × 142111 =13.6kg
			2	0