

# KAWASAKI GAS TURBINE STANDBY GENERATOR SETS

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[www.khi.co.jp/gasturbine/index\\_e.html](http://www.khi.co.jp/gasturbine/index_e.html)

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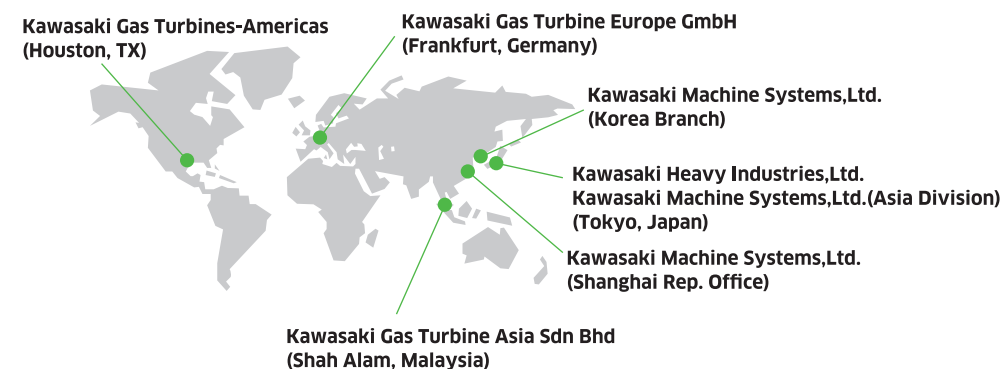
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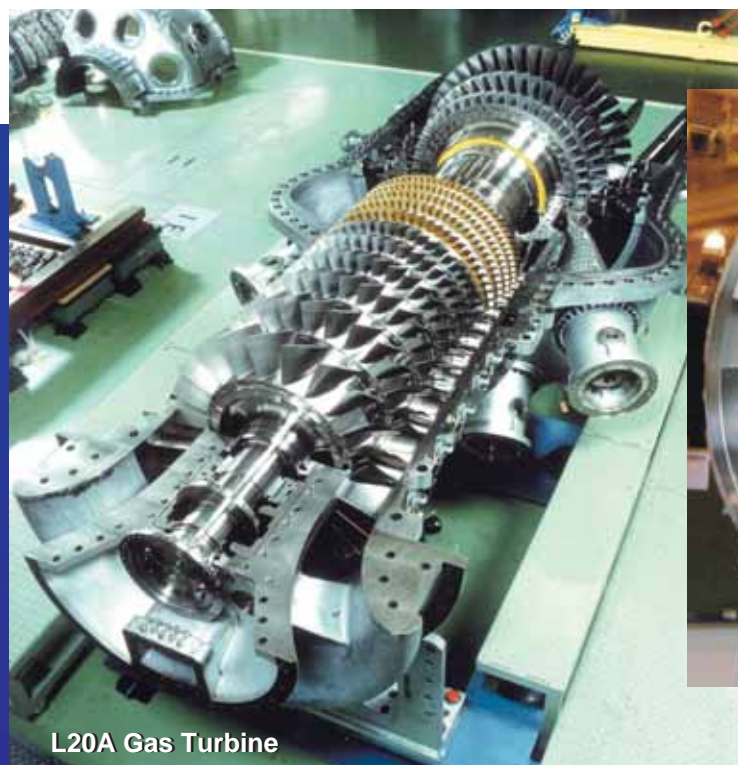
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### ISO 9001 / ISO14001 Certified

The Gas Turbine Division is located in Akashi Works. It designs and manufactures the Gas Turbine Co-generation System, and is certified for ISO 9001, the international standard of quality assurance, and ISO 14001, the international standard for environmental management.





L20A Gas Turbine



V2500 Turbofan

(International Aero Engines AG)



BK117 C-2 Type



R142A Subway Car For NYC



Wheel Loader 92ZV-2



Jet Ski® ULTRA260X



Industrial Robot



Boeing 787



Trent1000 Turbofan

(copyright Rolls-Royce PLC)



A Lime / Limestone Gypsum Flue Gas Desulfurization Plant



High Speed Train "efSET"



Akashi Kaikyo Bridge



Wind Turbine Generation Plant

# KAWASAKI HEAVY INDUSTRIES, LTD. An Integrated Engineering Manufacturer Spreading It's Interests by Land, Sea and Air.

Kawasaki Heavy Industries, established in 1878, has a history of more than 130 years of manufacturing integrated engineered products. Its business has expanded to include the manufacturing of ships, railway rolling stock, aircraft, gas turbines, many types of industrial plants, steel structures, general machinery and motorcycles. Its products are found on the land, in the sea and in the air. By constant attention to production efficiency and through exclusive technologies developed internally, we are continuing to develop additional technologies related to transportation innovations, national land and marine resources development, space exploration development, environmental controls, new energy development and biotechnology development. The range of our technologies is greatly expanding to encompass large, diverse projects.



Gas Engine



Two-Stroke Marine Diesel Engine



Submarine



Ninja 1400GTR



Marine Steam Turbine (UA-Type)



LNG Carrier



*Kawasaki Gas Turbine places importance on "Efficient Energy Use", "Eco-friendly" and "Reliable Product Care for Total Life Cycle" as a philosophy of our products. To enhance this philosophy, we have introduced a new title for our products....."GREEN Gas Turbines".*

## " Get Reliable Eco-friendly Energy Now "

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## Unique Features of Kawasaki GPS Standby Gas Turbine Generator

Kawasaki GPS standby gas turbine generator has served as backup power solutions since 1976, with over 7000 packages delivered worldwide, and has proven itself with continued high reliability through all phases of operation.

Unique features of Kawasaki GPS standby gas turbine generator include:

### 1. High Startup Reliability

*Continuous combustion systems with single can type combustors, provide very high startup reliability and prevent potential ignition failures sometimes experienced during startup on diesel engines.*

### 2. Clean Exhaust Gas

*With more efficient and complete combustion, low exhaust gas emissions can be realized, providing more eco-friendly power generation, compared to diesel engines.*

### 3. Ease of Maintenance

*Kawasaki gas turbine consists of a smaller number of parts compared with diesel engines and are not designed with any rubbing components such as reciprocating pistons in cylinders. Therefore, mechanical failures are fewer. These features enable operators to perform the simple maintenance tasks required, and a single monthly startup is sufficient as a periodic readiness check.*

### 4. Excellent Frequency Stability & Instant Overload Tolerance

Due to the rotating design, Kawasaki gas turbine provides power generation with very stable frequency. Also, the high rotating shaft speed of between 18,000 to 53,000 rpm provides superior, instant overload tolerance required for standby generator sets, compared with diesel engines.

### 5. Ease of Installation

The weight of Kawasaki gas turbine generator is approximately one fourth of an equivalent diesel generator, whilst the volume and required space is about one seventh. Kawasaki's light weight and compact design make the gas turbine much more suitable for installation in small and confined spaces, such as rooftops or basements.

### 6. Low Vibration, Excellent Earthquake-Proof

The in-house design of Kawasaki gas turbine provides for extremely low vibration characteristics of the rotating elements, and therefore, vibration mounting dampers, such as those used for diesel engines, are not required. This aspect eliminates the potential risk of resonance phenomenon with flexible mountings during catastrophic events such as an earthquake and provides continued high performance throughout the event.

### 7. Low-Noise Enclosure Design

Kawasaki's long experience in projects with strict site conditions provides the capability for excellent package noise-reduction designs, resulting in customized low-noise generator packages for use in hospital and urban applications.

### 8. No Requirement for Cooling Water

The self-cooling (air cooling) system eliminates the need for a separate cooling water system and realizes much higher reliability, without the potential risk of typical failures in water cooling systems such as freezing or loss of water.

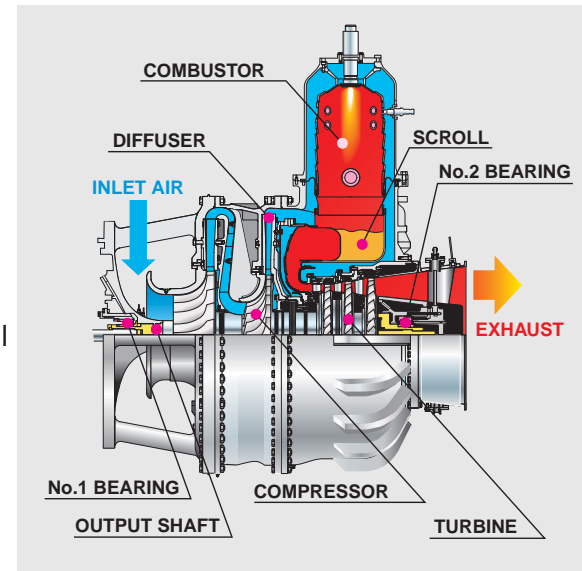
# Kawasaki Gas Turbine

## High-performance, single-shaft Kawasaki Gas Turbine provides high reliability

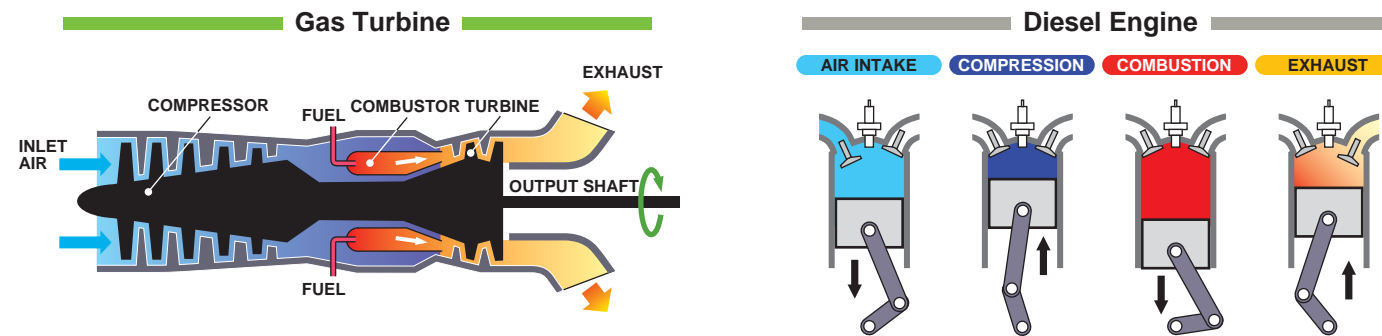
Kawasaki GPS standby gas turbine generators achieve 99.96% of startup reliability. Compared to typical diesel engine's startup reliability of about 95%, Kawasaki GPS reliability is significantly higher.

This high reliability is achievable due to the Kawasaki's superior technology and combustion system in the gas turbine.

A gas turbine is a rotating machine utilizing continuous combustion process. Continuous combustion prevents potential ignition failure sometimes experienced on diesel engine that is a reciprocating machine with intermittent combustion process, and all parts of the process taking place in one area, i.e., the cylinder. This difference is a major key of gas turbine's high reliability.



## Differences in the combustion process between Gas Turbine and Diesel Engine

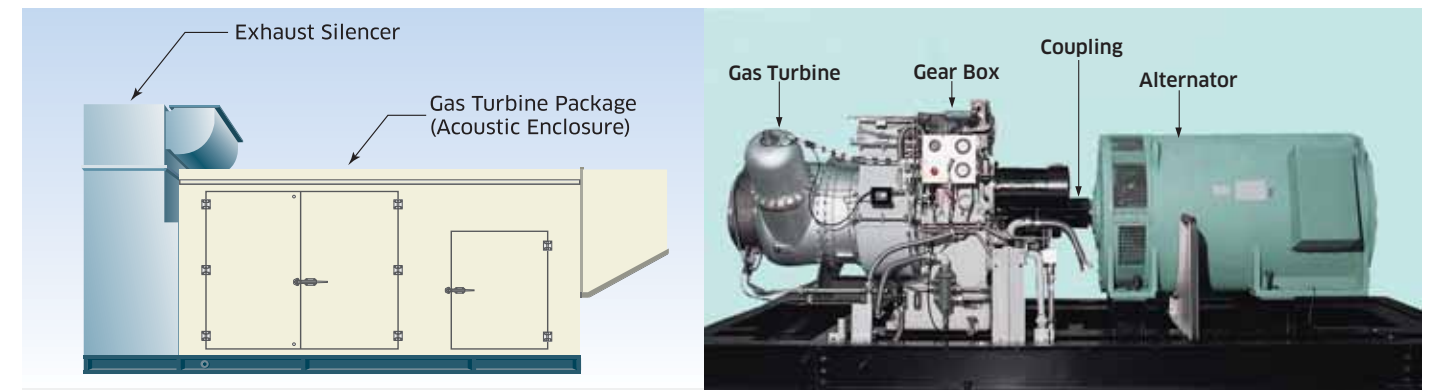


## Comparison of Gas Turbine & Diesel Engine

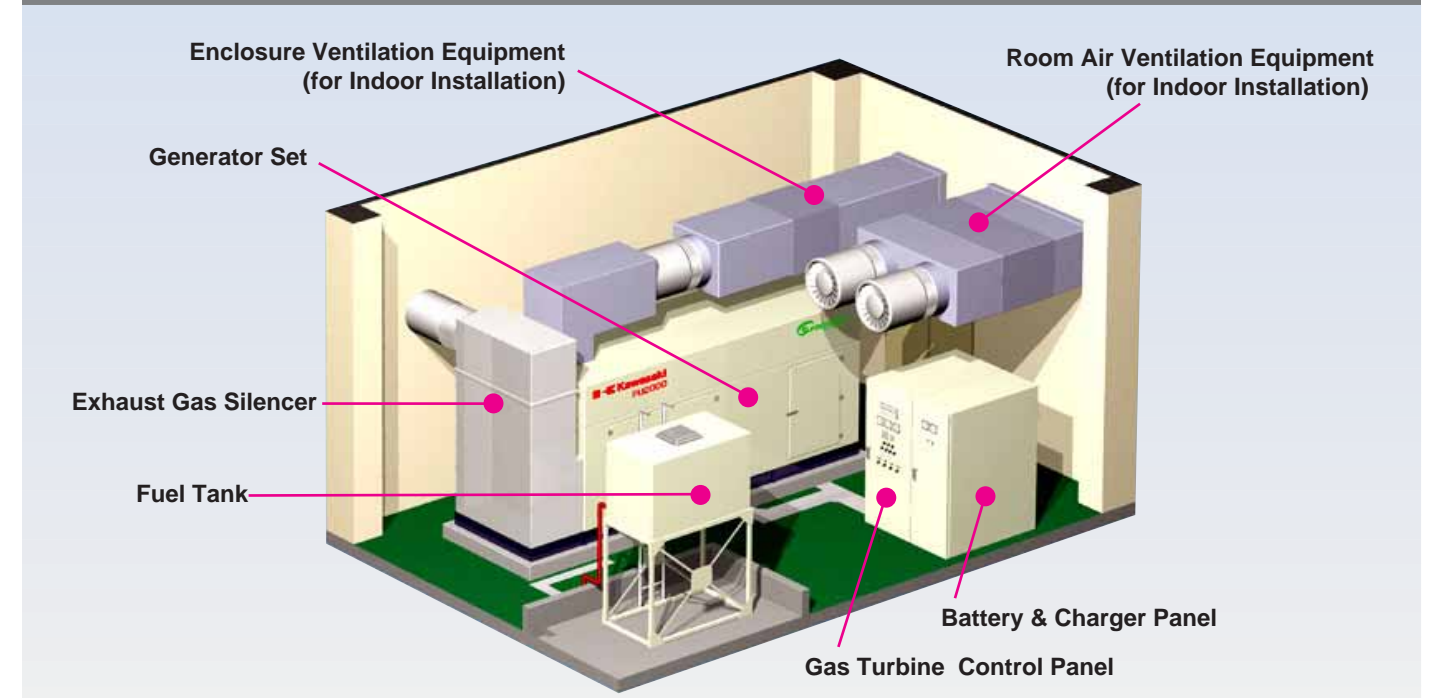
Type	Gas Turbine		Diesel Engine	
Starting Reliability	Over 99%	◎	Around 95%	△
Steady State Speed Fluctuation	± 0.3%	◎	± 5%	×
Starting Time	Approx.35-40sec.	△	Approx.10-20sec.	◎
Installation Space	Small	◎	Large	×
Emissions (Diesel Oil)	NOx 120ppm (O <sub>2</sub> : 15%) CO 15ppm (O <sub>2</sub> : 15%)	◎	NOx 700ppm (O <sub>2</sub> : 15%) CO 500ppm (O <sub>2</sub> : 15%)	×
Noise Level	85dB(A) at 1m (option 75dB(A) at 1m)	◎	105~115dB(A) at 1m	△
Vibration Level	10~15 μm	◎	50~60 μm	△
Cooling Water	Not necessary	◎	Approx.200ton/h	△
Fuel Consumption	Large	△	Small	◎

# Kawasaki Standby Gas Turbine Generator ( GPS Series )

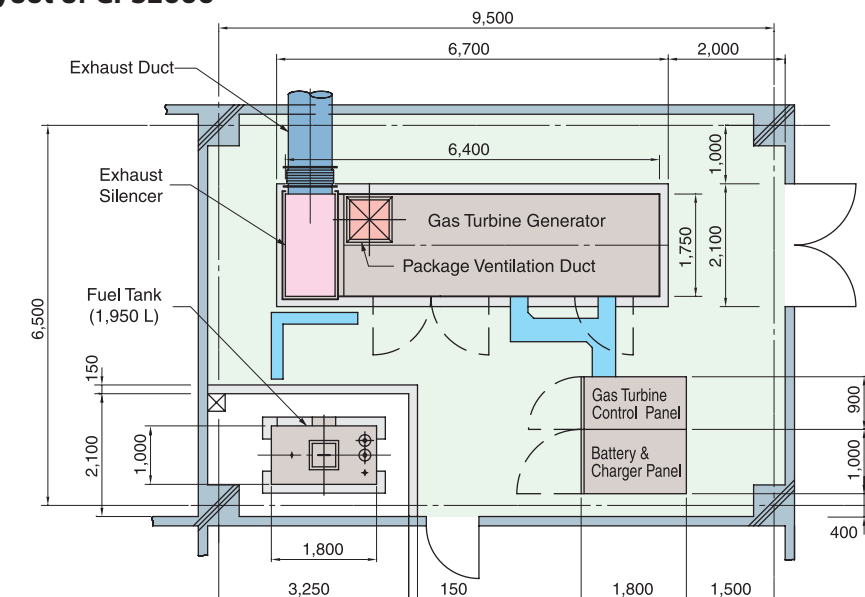
## ● Compact, Kawasaki Gas Turbine Generator Package



## Typical Layout of Gas Turbine Generator



## Referential Layout of GPS2000



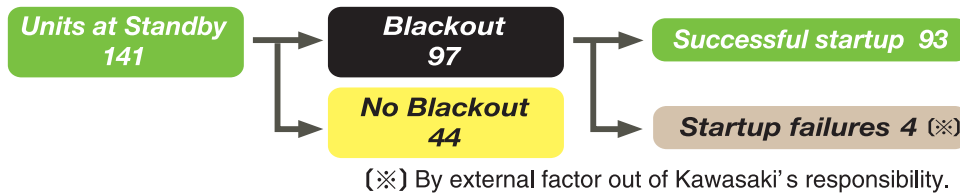
# Unique Features for Reliable Power Generation

## High Startup Reliability

Startup reliability is one of the most important factors for backup power supply system. Kawasaki GPS has proved its high startup reliability with actual performance in the disastrous situations.

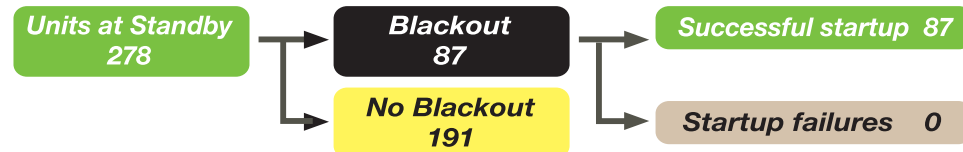
### Case:1 Great Hanshin Earthquake ( Jan.17,1995 )

Early morning on January 17, 1995, a magnitude 7.2 earthquake hit the Hanshin area, causing a blackout that hit about 3 million households in the area.



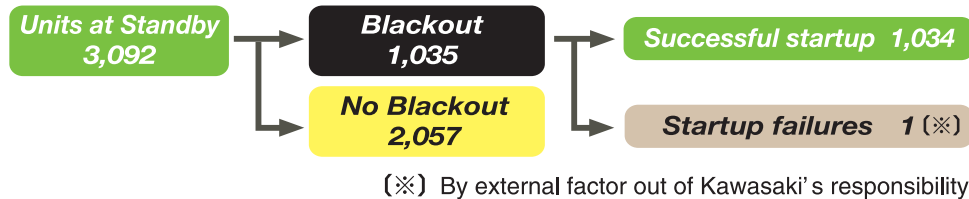
### Case:2 Tokyo Area Blackout ( Aug.14, 2006 )

On August 14, 2006, a crane barge crashed into one of the main power lines in Tokyo, causing a blackout that affected 139,000 households.



### Case:3 The Great East Japan Earthquake ( Mar.11, 2011 )

On March 11, 2011, a magnitude 7.9 earthquake hit the East Japan area, causing a blackout that hit about 3 million households in the area.



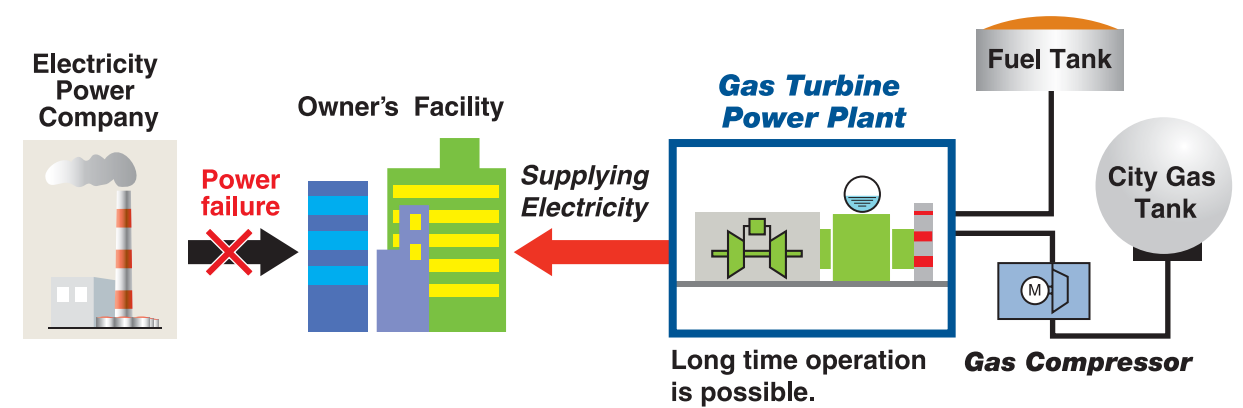
## Fuel Flexibility

Kawasaki gas turbine enables the choice of diesel fuel and gas fuel. This dual fuel capability realizes high reliable power supply and long term operation compared with diesel engine generator.



On September 2, 2008, hurricane "Ike" hit Houston, TX, USA. Total financial damage caused by Ike was the 3rd largest damage caused by hurricanes in the north Atlantic area. Blackout lasted for 2 weeks, but gas supply line was available under the situation.

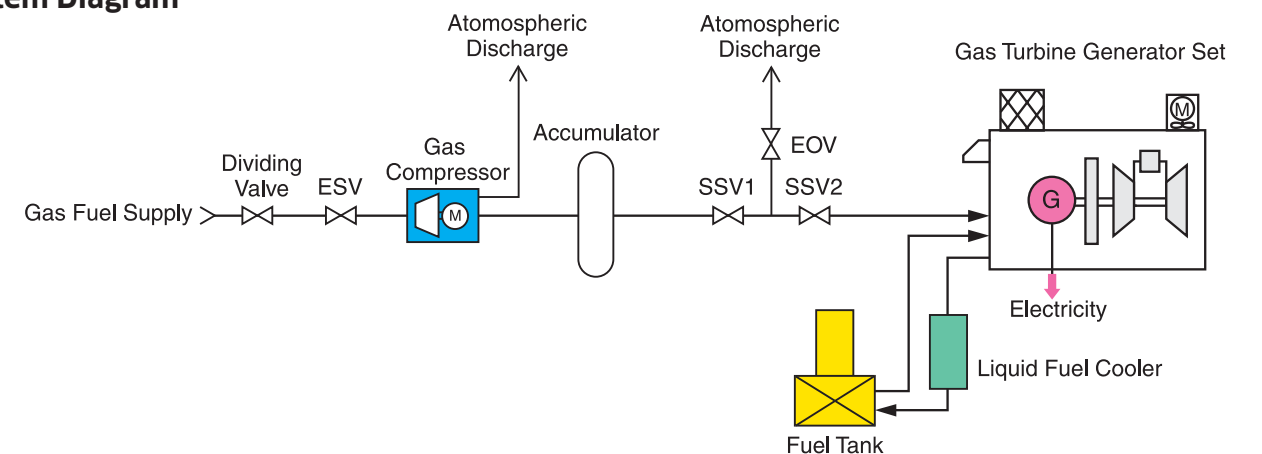
## Liquid Fuel Gas Fuel ▶ Power Generation



## Benefits of Dual Fuel System

- ▶ Long time operation without large fuel storage tank.
- ▶ Higher reliable operation than single fuel system.
- ▶ Clean exhaust gas with gas fuel.

## System Diagram



# Kawasaki GPS Product Lineup

## Basic Specifications

Item		GPS750	GPS1250	GPS1500	
Generator Set ※1	Electric Output (kW)	600	1,000	1,200	
	Starting Time	Within 40-sec.			
	Load Application Capacity	100% ( Resistive load )			
	Freq. Deviation Transient	Within ±4.5% ( with 100% block load on and off )			
	Steady State	Within ±0.3%			
Fuel Type	Kerosene, Diesel oil	Kerosene, Diesel oil, Gas (option)			
※2 Fuel Consumption (liter / hr)	305	525	620		
Gas Turbine	Turbine Model	S2A-01	M1A-01	M1A-03	
	Type	Heavy-duty, simple open cycle, single-shaft			
	Turbine Speed (rpm)	31,500	22,000		
	Output Speed (rpm)	1,500 (50 Hz), 1,800 (60 Hz)			
	Dry Weight (ton)	1.48	3.0		
	Lube Oil Type / Brand	Synthetic oil / Shell ASTO-500, Mobil jet II, Castrol AERO 5000, DP BPTO 2380			
	Lube Oil Tank Capacity (approx.L)	66	100		
	Lube Oil Consumption (liter / hr)	0.08			
	Alternator	Type	3-phase, open screen-protected, brushless, self-ventilated, synchronous		
		Output (kVA)	750	1,250	1,500
Voltage Regulation		Within ±2.5% ( steady state from no-load to full-load, at pf = 0.8 )			
Excitation System		Brushless by A.C. exciter and rotating diodes			
※3 Standard Voltage		6.6kV			
Starting System	Electrical start with D.C. motors ( Optional: Pneumatic start with air turbines )				
Type of Batteries	Valve Regulated Lead-Acid (VRLA) Battery				
GT Package ( Indoor Type )	Length (m)	4.0	4.9	4.9	
	Width (m)	1.6	1.7	1.7	
	Height (m)	2.1	2.5	2.5	
	Weight (ton)	6.8	10.5	11.4	
Noise Level at 1m	From Package	Approx. 85dBA ( optional system: 80 ~ 70dBA )			
	From Exhaust Silencer Outlet	Approx. 90dBA ( optional system: 85 ~ 65dBA at 1 m with a secondary silencer )			

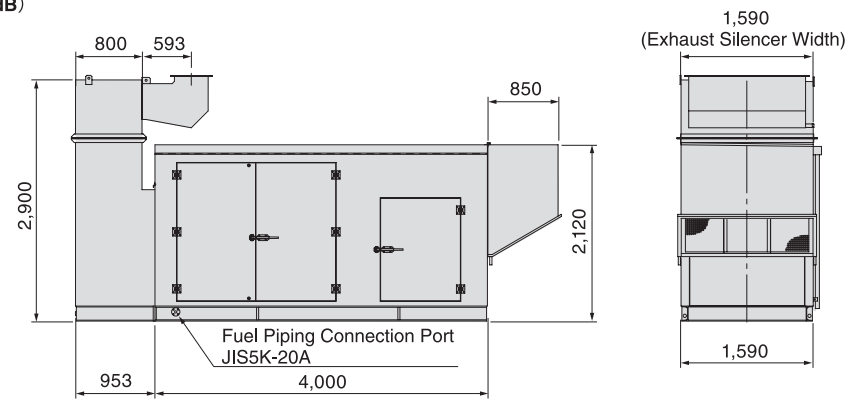
(Note) ※1 : Output : Up to 40°C of ambient temp., 150m above sea level.  
 ※2 : Fuel Consumption : At full load, 15 °C, using diesel fuel oil, allowance is 5%.  
 Diesel Oil : Density 0.83g /cm<sup>3</sup>, LHV 42,700kJ / kg  
 ※3 : Other voltage is available as option.

GPS2000	GPS2500	GPS3000	GPS4000	GPS5000	GPS6000
1,600	2,000	2,400	3,200	4,000	4,800
Within 40-sec.					
100% ( Resistive load )					
Within ±4.5% ( with 100% block load on and off )			Within ±5.0%		
Within ±0.3%					
Kerosene, Diesel oil, Gas (option)					
695	1,065	1,245	1,390	1,835	2,050
M1A-23	M1T-01S	M1T-03	M1T-23	M1T-33A	M1T-33
Heavy-duty, simple open cycle, single-shaft					
22,000			18,000		
1,500 (50 Hz), 1,800 (60 Hz)					
3.5	5.7	6.4	13.5		
Synthetic oil / Shell ASTO-500, Mobil jet II, Castrol AERO 5000, DP BPTO 2380					
210	160	240	360		
0.16			0.2		
3-phase, open screen-protected, brushless, self-ventilated, synchronous					
2,000	2,500	3,000	4,000	5,000	6,000
Within ±2.5% ( steady state from no-load to full-load, at pf = 0.8 )					
Brushless by A.C. exciter and rotating diodes					
6.6kV					
Electrical start with D.C. motors ( Optional: Pneumatic start with air turbines )					
Valve Regulated Lead-Acid (VRLA) Battery					
5.4	5.8	5.8	6.2	7.7	7.7
1.8	2.5	2.5	2.5	3.0	3.0
2.6	2.9	2.9	2.9	3.6	3.6
14.7	19.7	20.8	24.6	36.6	39.0
Approx. 85dBA ( optional system: 80 ~ 70dBA )					
Approx. 90dBA ( optional system: 85 ~ 65dBA at 1 m with a secondary silencer )					

# General Arrangement of GPS Generator Set

## GPS750

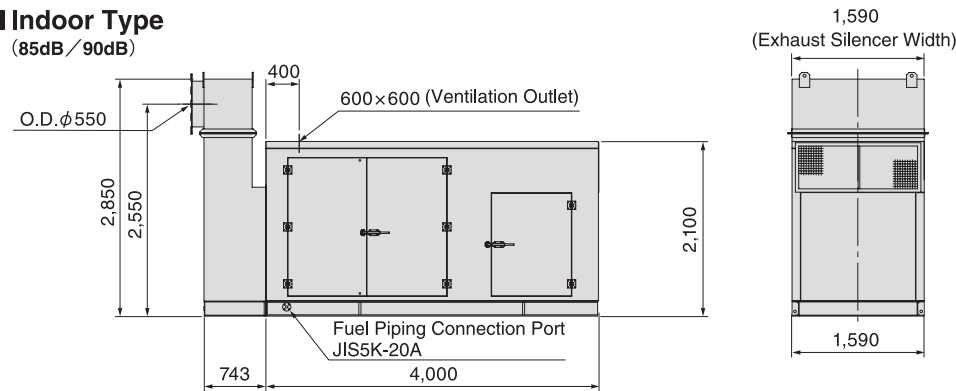
### Outdoor Type (85dB/85dB)



Weight (Unit: kg)

	Generator Set	Exhaust Silencer
<b>GPS750</b>	8,100	1,350

### Indoor Type (85dB/90dB)

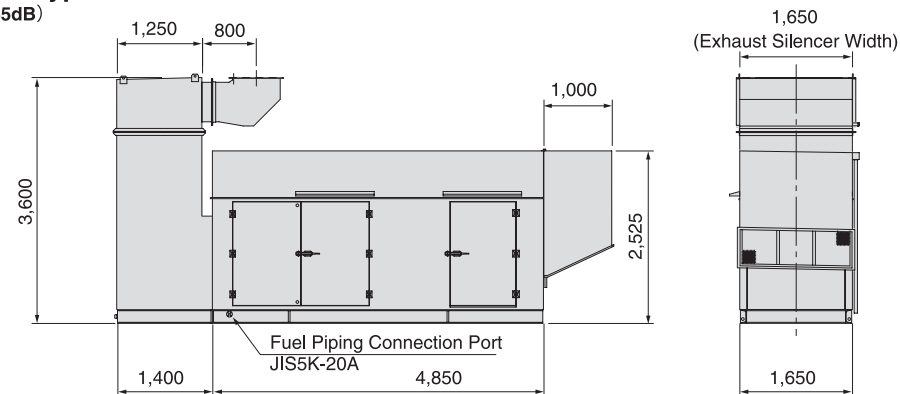


Weight (Unit: kg)

	Generator Set	Exhaust Silencer
<b>GPS750</b>	8,000	900

## GPS1250/1500

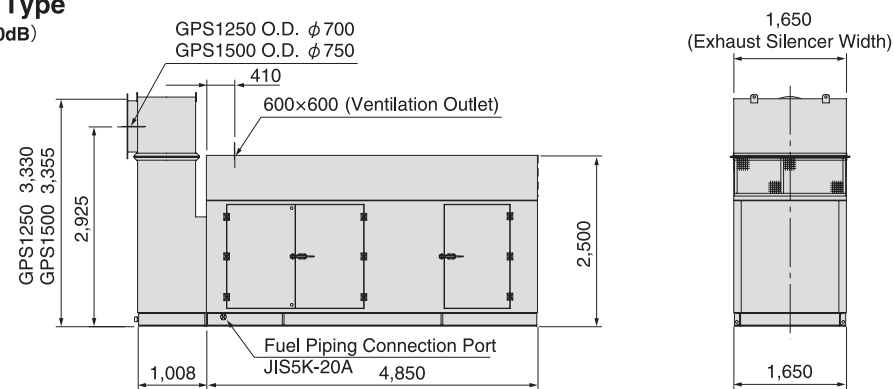
### Outdoor Type (85dB/85dB)



Weight (Unit: kg)

	Generator Set	Exhaust Silencer
<b>GPS1250</b>	13,220	2,420
<b>GPS1500</b>	14,220	2,420

### Indoor Type (85dB/90dB)

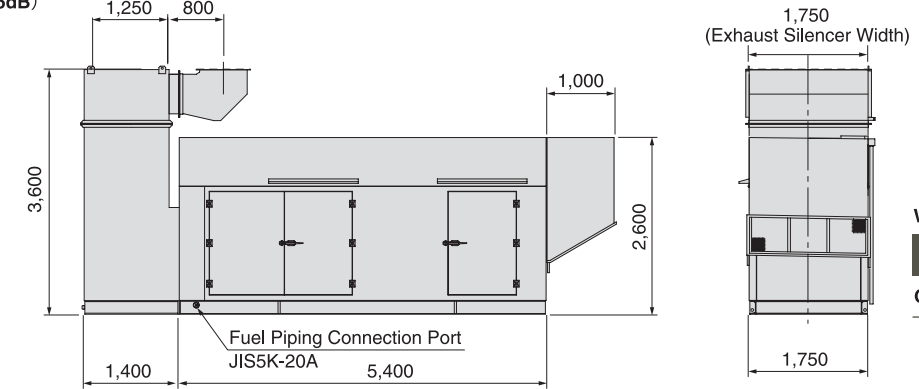


Weight (Unit: kg)

	Generator Set	Exhaust Silencer
<b>GPS1250</b>	12,000	1,650
<b>GPS1500</b>	13,000	1,650

## GPS2000

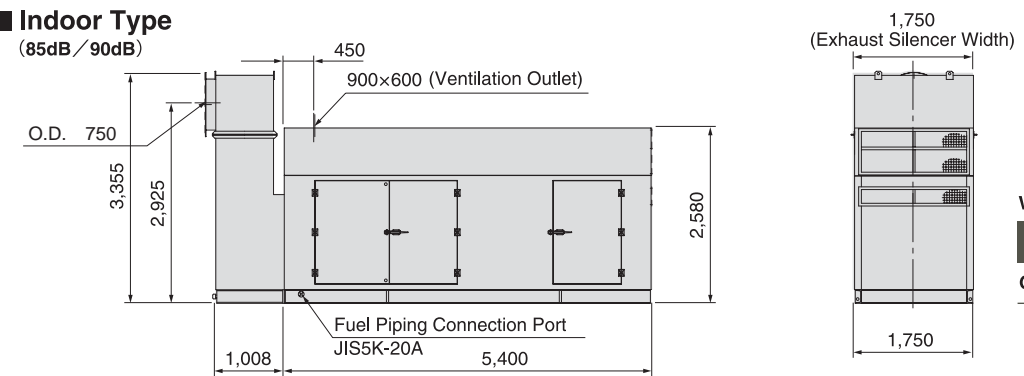
### Outdoor Type (85dB/85dB)



Weight (Unit: kg)

	Generator Set	Exhaust Silencer
<b>GPS2000</b>	16,800	2,300

### Indoor Type (85dB/90dB)

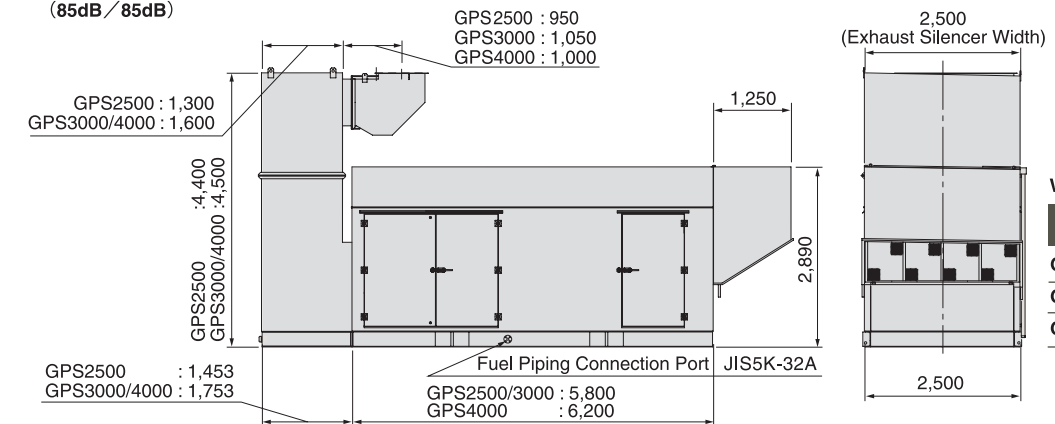


Weight (Unit: kg)

	Generator Set	Exhaust Silencer
<b>GPS2000</b>	16,060	1,810

## GPS2500/3000/4000

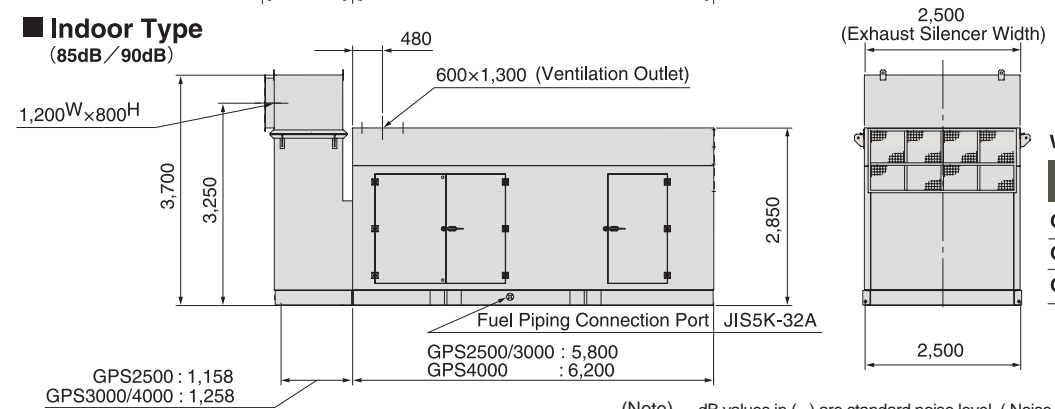
### Outdoor Type (85dB/85dB)



Weight (Unit: kg)

	Generator Set	Exhaust Silencer
<b>GPS2500</b>	24,150	4,800
<b>GPS3000</b>	27,150	4,900
<b>GPS4000</b>	29,650	4,900

### Indoor Type (85dB/90dB)



Weight (Unit: kg)

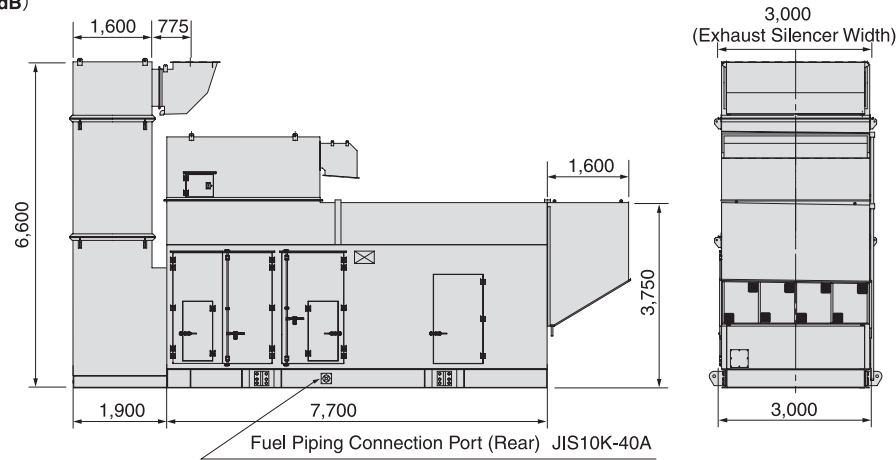
	Generator Set	Exhaust Silencer
<b>GPS2500</b>	22,000	3,100
<b>GPS3000</b>	25,050	3,250
<b>GPS4000</b>	27,650	3,250

(Note) · dB values in ( ) are standard noise level. ( Noise on equipment side / Noise on exhaust outlet )  
 · Lower noise package is available as option.  
 · Overall length and weight of equipment may change depending on specification of alternator.  
 · Weight of generator set includes weight of exhaust silencer.  
 · Dimensional unit is mm unless otherwise specified.

# General Arrangement of GPS Generator Set

## GPS5000/6000

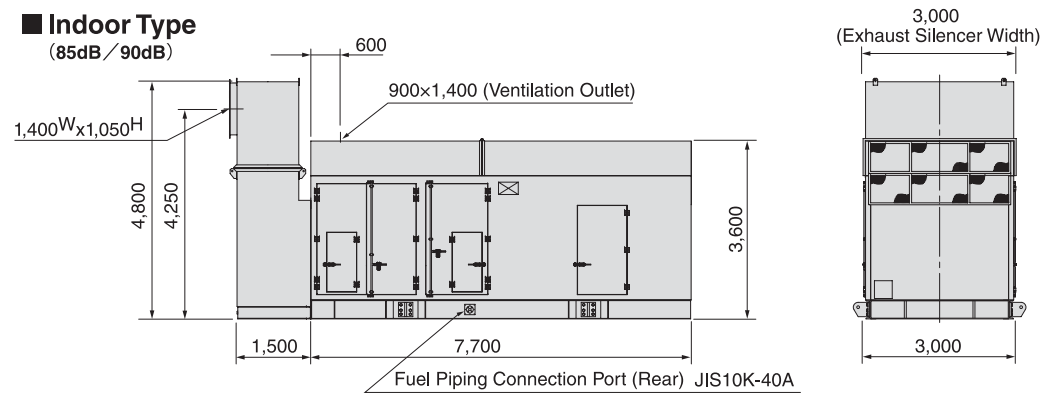
### Outdoor Type (85dB/85dB)



Weight (Unit: kg)

	Generator Set	Exhaust Silencer
<b>GPS5000</b>	55,470	8,270
<b>GPS6000</b>	55,570	8,270

### Indoor Type (85dB/90dB)



Weight (Unit: kg)

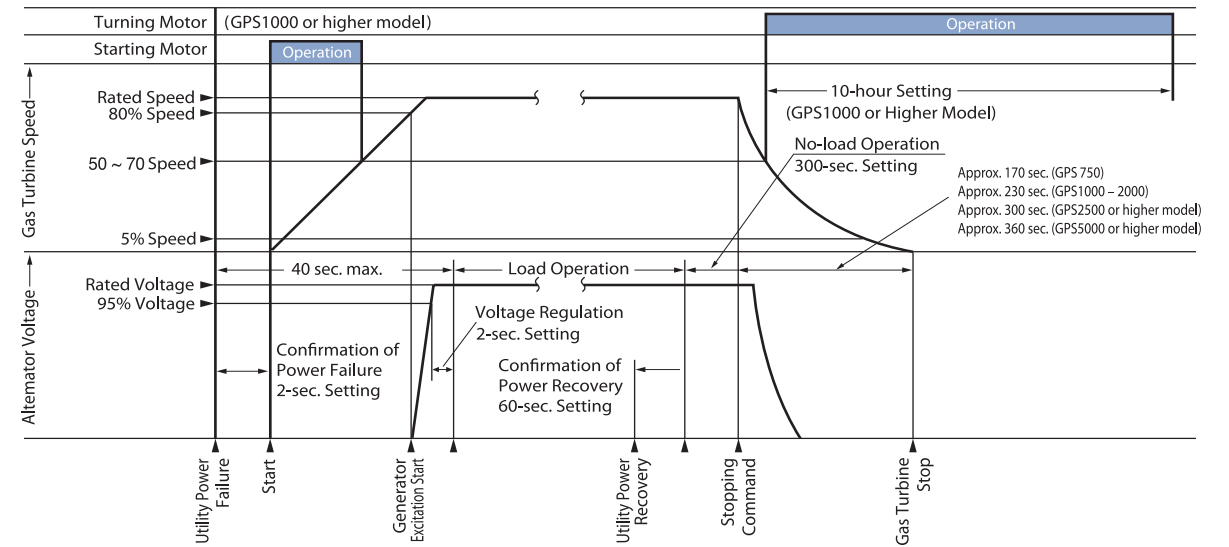
	Generator Set	Exhaust Silencer
<b>GPS5000</b>	48,000	5,300
<b>GPS6000</b>	48,100	5,300

- (Note)
- dB values in ( ) are standard noise level. (Noise on equipment side / Noise on exhaust outlet)
  - Lower noise package is available as option.
  - Overall length and weight of equipment may change depending on specification of alternator.
  - Weight of generator set includes weight of exhaust silencer.
  - Dimensional unit is mm unless otherwise specified.



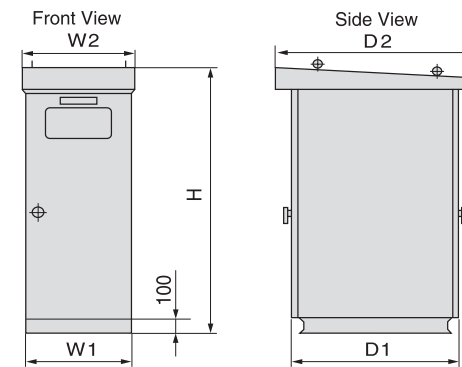
# Control / Electrical System

Gas turbine control panel furnishes engine control, generator voltage control, metering, protection, and other control functions required for operating gas turbine generator.

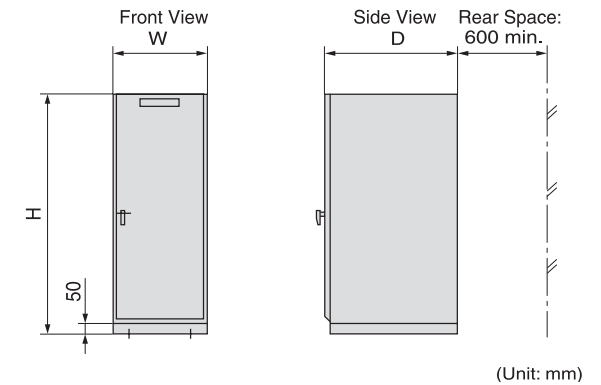


## Control Panel

### Outdoor Type

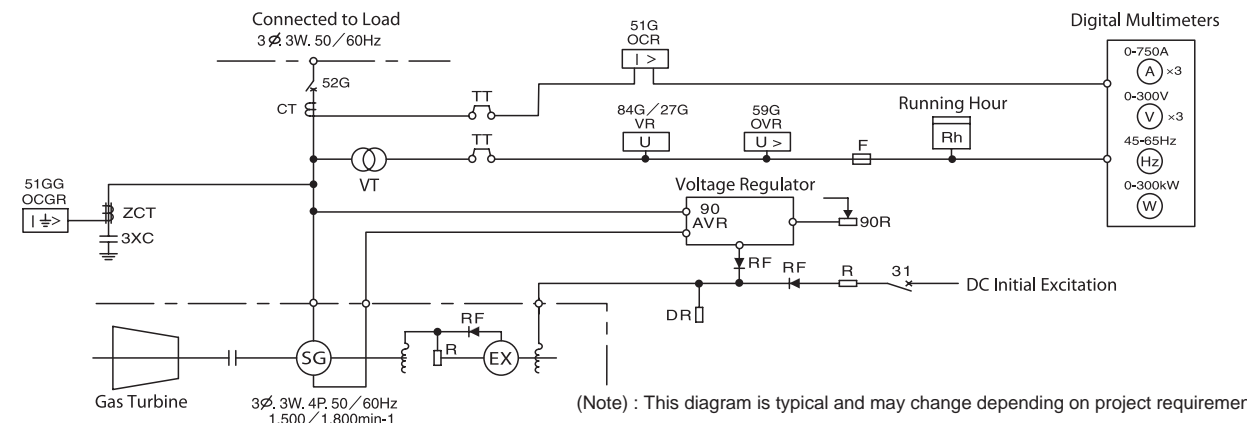


### Indoor Type



Model	Outdoor Type						Indoor Type			
	W1	W2	D1	D2	H	Weight (kg)	W	D	H	Weight (kg)
<b>GPS750</b>	1,000	1,040	2,000	2,300	2,450	1,100	900	1,800	2,350	900
<b>GPS1250 / 1500 / 2000</b>	1,000	1,040	2,000	2,300	2,450	1,100	900	1,800	2,350	900
<b>GPS2500 / 3000 / 4000</b>	1,000	1,040	2,000	2,300	2,450	1,100	900	1,800	2,350	900
<b>GPS5000 / 6000</b>	1,000	1,040	2,200	2,300	2,450	1,100	1,000	2,000	2,350	1,000

## Single Line Diagram



(Note) : This diagram is typical and may change depending on project requirement basis.



# Mobile / Trailer Model ( MGP / TGP Series )

Kawasaki MGP/TGP Series are gas turbine generators mounted on trucks or on trailers for mobile application. MGP/TGP integrate all necessary equipment and enable fully automatic operation without the need for external power supply. High durability against vibration and shock, and reliable operation are important for this application. Kawasaki MGP/TGP is designed to fully meet such demands.

## Advantages

### 1. Developed with Vast Field Experience

Gas Turbines on trucks or on trailers are susceptible to large vibration and shock when they run on roads. Kawasaki meets mobile installation condition, with gas turbines experience and technology from Kawasaki aircraft jet engines operating under similar severe environmental conditions.

### 2. Low Center of Gravity and Large Tumble-down Angle

Due to light weight of gas turbines, the center of gravity of MGP/TGP is low, and this makes it possible to have stable maneuverability.

### 3. Compact Integration

MGP/TGP incorporate all necessary equipment, including fuel tank, batteries, exhaust silencer, cable reel, etc., inside a compact aluminum enclosure. This feature enables easy maintenance.

### 4. Blackout Start Capability

MGP/TGP can start up and supply electricity without any external utility supply, such as electric power and fuel.

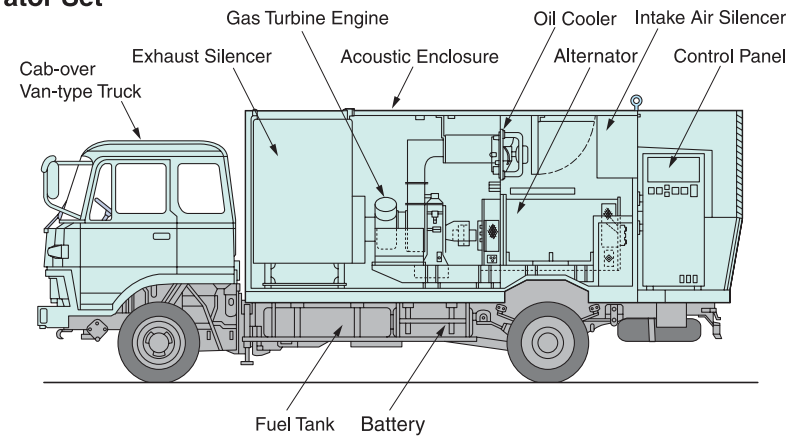
## System Specifications ( Typical )

Item	Model	MGP	MGP	MGP	MGP	MGP	TGP	TGP	TGP
		750	1000	1250	1500	2000	2500	3000	4000
Output	(kW) 40°C	600	800	1000	1,200	1,600	2,000	2,400	3,200
	Fuel	Kerosene, Diesel Oil							
Generator Sets	Load Application Allowance	100% (Resistance Load)							
	Freq. Deviation	within ±4.5% (with 100% block load on and off)							
	Transient	Steady State							
Fuel Consumption (l/h)	Kerosene	320	490	555	655	735	1,125	1,310	1,465
	Diesel Oil	305	465	525	620	695	1,065	1,245	1,390
Truck / Trailer	Type	Truck				Trailer			
	Dimensions	Max. Length (m)				Max. Width (m)			
Including Truck	Max. Length (m)	11.0				12.0			
	Max. Width (m)	2.5							
	Max. Height (m)	3.4				3.6			
Total Weight	(ton)	Less than 20 tons		Less than 22 tons			Less than 25 tons		Less than 33 tons
Noise Level at 1 m	(dBA)	85							

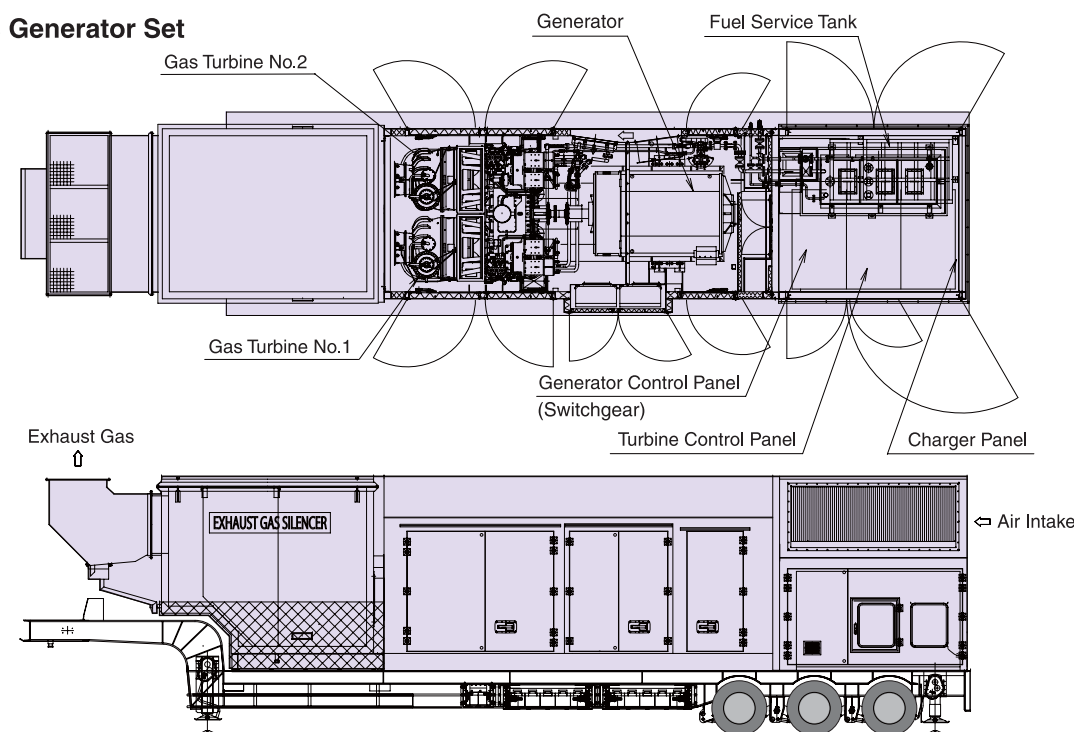
(Note)

※1 : Output : Up to 40°C of ambient temp., 150 m above sea level.

### ● MGP Series Generator Set



### ● TGP Series Generator Set



## Installation Example



TGP3000



MGP1250



MGP2000



MGP2000

# Maintenance and Customer Support

## ● Easy Maintenance

Kawasaki GPS requires very little maintenance due to its small number of components. Monthly start-stop test is sufficient as periodic check. Extended service agreement is available for all other required maintenance.



## ● High Skill Engineers

Kawasaki's service group is highly skilled. Our engineers and technicians train at our assembly and overhaul facility to ensure that they have the latest technique and knowledge to perform all the required field maintenance.



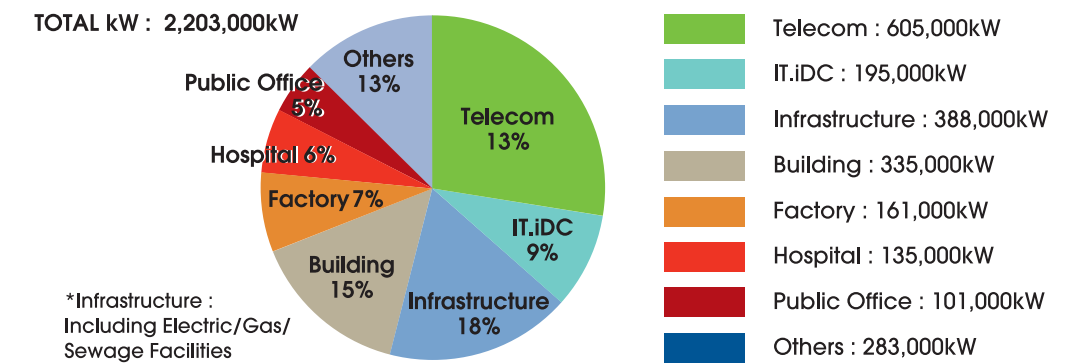
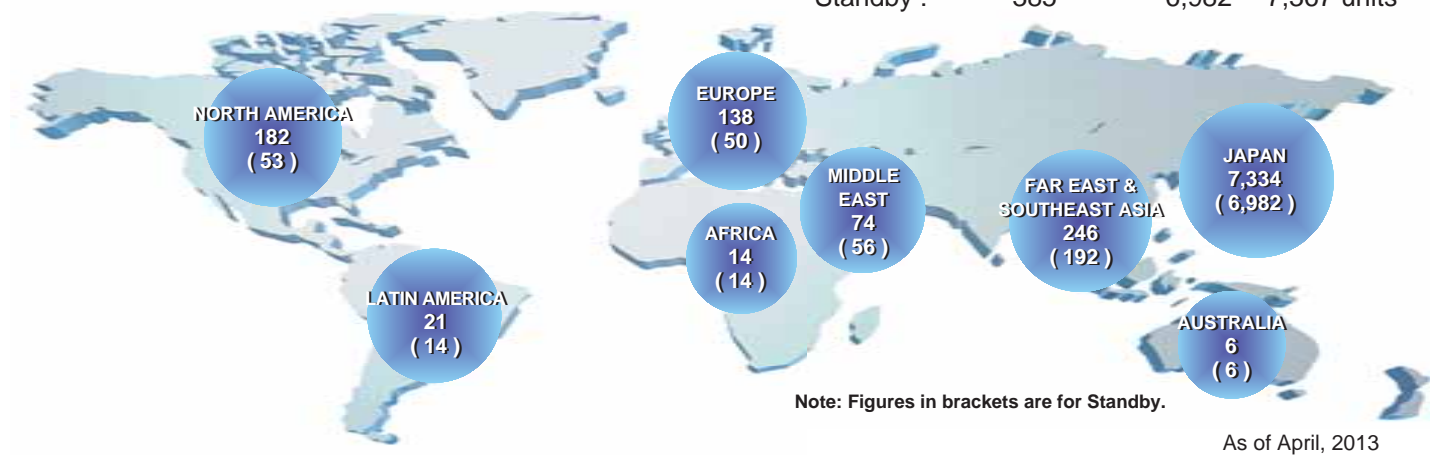
## ● Support from Worldwide Branches

Kawasaki has five branches and three spare parts centers around the world to respond to the customer's needs immediately. Each branch has capability to review and solve any issues that may arise. We fully support customers worldwide.



# Kawasaki Gas Turbine Worldwide Installation

	International	Japan	Total
Standby+Cogen :	681	7,334	8,015 units
Standby :	385	6,982	7,367 units



## ■ Typical Reference

