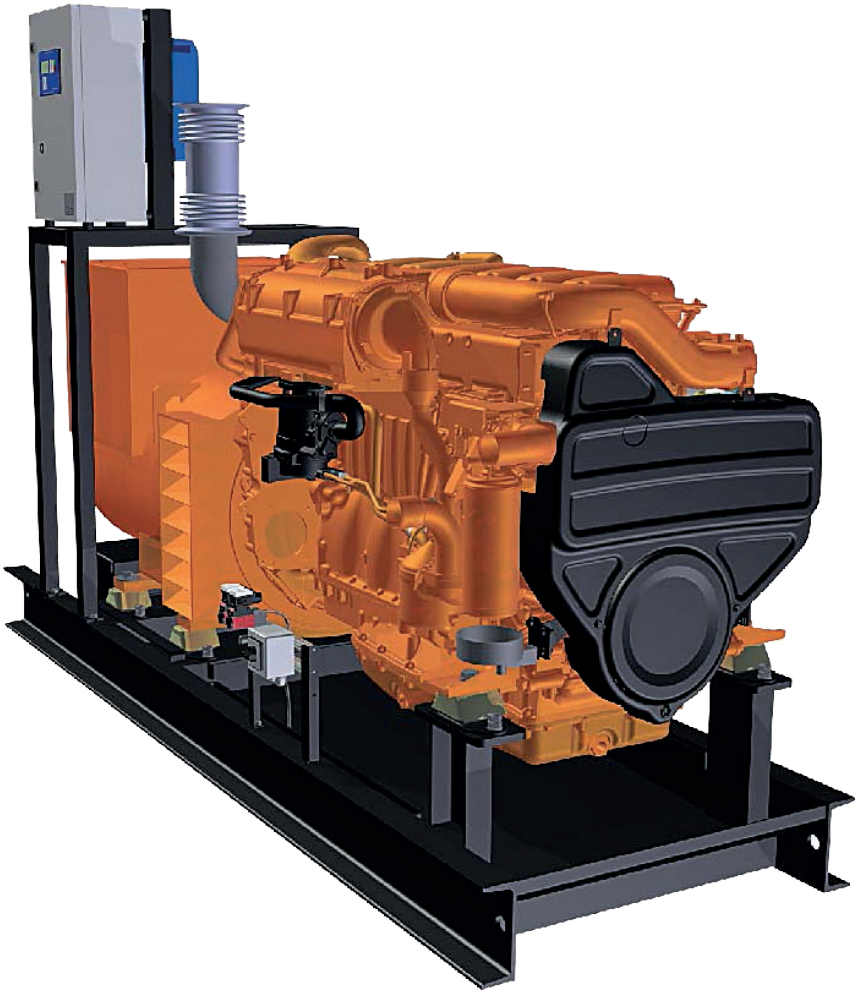
Professionals in TOP performance

SANDFIRDEN TECHNICS

Generator sets & pump engines

GL 621 B
(single speed)

Installation requirements



POWERED BY SCANIA

VERSION DATE: 23-03-2017

Subject to technical alterations in the interests of further development.

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Introduction

This Installation Manual is intended to provide support and advice on installing the **Gas Line Generator Sets (GL)**, delivered by Sandfirden Technics BV.

Because of the variation in execution, the rules given are of a general nature and try to cover the various options.

Please comply with the information given in this Manual. Compliance will ensure that you maintain the validity of the manufacturer's warranty and have at your disposal an engine that is serviceable and ready for use.
The purpose of this publication is to create the conditions for trouble free operation of the entire plant and to avoid faults and malfunctions caused by installation and any possibly resulting consequential damage to the engine.
Failure to comply with the information and instructions given in this publication may result in personal injury, in malfunctions and engine damage. For which the manufacturer will not be liable.

The relevant accident prevention regulations and other generally accepted rules pertaining to occupational safety and health must be observed.

Field of application
This Installation Manual applies to the installation of **Gas Line Generator Sets (GL)** manufactured in Den Oever. All previous installation guidelines for Gas Line Generator Sets (GL) are superseded by this Manual.

NOTE!
Always use genuine Sandfirden Technics BV parts in service and repair to keep the engine operating correctly.

IMPORTANT!
Use genuine Sandfirden Technics BV parts in service and repair for the warranty to be valid.

Sandfirden Technics BV can never be held responsible for the installation of the set, unless we have installed it ourselves.

If additional info is needed, please do not hesitate to contact our service department.

All data provided is for information purposes only, explicitly not-binding and subject to changes without further notice.

Liability for defects

Warranty claims can only be made to Sandfirden Technics if this Installation Manual has been followed and installation of Gas Line Generator Sets (GL) is carried out according to the recommendations in this issue.

The Generator Sets are built exclusively for the purpose corresponding to the scope of delivery (intended use). Any use that extends beyond this is deemed to be non-intended. Sandfirden Technics BV shall not be liable for damage resulting from such non-intended use. The risk for such use is borne solely by the user.

Intended use also includes adhering to the operating, service and repair conditions prescribed by the manufacturer. The Generator Set may only be used, serviced and repaired by persons who are familiar with such work and have been made aware of the dangers involved.

Sandfirden Technics BV performs installation acceptances on request for payment. Acceptances of prototypes are only applicable to standard built-in components if no subsequent alterations are made. Installation of the engine must correspond to the intended use.
Only parts approved by the manufacturer for the relevant purpose may be used for modification work. The manufacturer shall not be liable for any damage resulting from unauthorized alterations or modifications to the engine.
If you intend to alter a built-in engine component which has been accepted by Sandfirden Technics BV, you must inform Sandfirden Technics BV in writing. A renewed acceptance may be necessary.

Liability for defects on the part of Sandfirden Technics BV covers the scope of delivery defined in the order confirmation.

Table of contents

1. Safety instructions

A gas engine is not an independent machine as defined by the EC Machine Directive. The manufacturer of the complete installation must draw up a written declaration as to compliance with the EC Machine Directive (89/392/ENG, Appendix IIA) as well as a written Operator's Manual.

The existing quick summary sets out important instructions and regulations which must be observed during the installation and start-up of a power plant in order to impart the knowledge required to avoid accidents involving personal injury and damage to property and to the environment.
Please read the additional notes and information in the Operating Instructions.

1.1. When installing the engine and prior to startup

- Persons must not stand under an suspended engine. Keep lifting gear in good order.
- Read the Operator's Manual carefully before starting the engine.

- Attach the prohibiting sign "No unauthorized access" in an easily visible position at the entrance to the engine room of stationary engines.

- Only authorized personnel are permitted to operate the engine. When working on the engine, make sure that it cannot be started by unauthorized persons.
- Set up suitable equipment providing protection against accidental contact around rotating machine parts (e.g. propeller shafts, flanges). Do not get too close to rotating parts when the engine is running. Wear tight-fitting work clothing.

- Keep your tools in good condition.

1.2. Safety while operating and serviceing

Do not touch the engine when at operating temperature with bare hands: risk of burns. Set up suitable equipment providing protection against accidental contact around exhaust pipes. Insulating parts must be made of fireproof and fuel- and lube-oil-repellent material.

- Exhaust gases are toxic. Exhaust pipes must be gas-tight, made from suitable and stable material.

- Keep area surrounding engine, ladders and stairways free of oil and grease. Accidents caused by slipping can have serious consequences.
- Open the coolant circuit only after the engine has cooled down.

- Do not retighten or open pressurized pipes and hoses (lube-oil circuit, coolant circuit and possibly hydraulic-fluid circuit): risk of injury by escaping fluids.
- Smoking and naked flames in the engine room are strictly prohibited. Comply with the conditions applicable to gas installations.

- Wear protective goggles when using compressed air.

- Fuels, lubricants and coolants are hazardous to health and flammable. They may only be stored in containers.
- Follow the manufacturer's instructions for handling batteries.

WARNING!
Battery acid is toxic and caustic. Battery gases are explosive.

- When working on the electrical system, first disconnect the ground (-) cable of the battery and reconnect this last to prevent short circuits.
- When performing welding work, observe the adequate safety precautions.

1.3. Regulations designed to prevent pollution

ENVIRONMENT!
Fuels, lubricants and coolants - if improperly used - are a strain on the environment.
Do not allow suchfluids to drain into the ground or into the sewerage system.

1.3.1. Engine oil and filter cartridges/elements

- Old oil must be passed on for recycling.
- Rigorously ensure that no oil drains into the sewerage system or into the ground.

WARNING!
Danger of drinking-water contamination!

- Used filter elements and cartridges are classed as hazardous waste and must be treated as such.

1.3.2. Coolant

- Treat coolant and corrosion inhibitor and/or antifreeze to be disposed of as ha ardous waste.
- When disposing of used coolant, the regulations issued by the relevant local authorities
- must be observed.

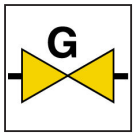
1.3.3. Safety instructions for handling gaseous fuels

Gaseous fuels are made up primarily of methane, propane and butane as well as traces of higher hydrocarbons and inert components such as carbon-dioxide and nitrogen.

- The provisions applicable to gas installations must be observed;

- Smoking and handling naked flames are prohibited;
- Leaks in the gas-supply system pose an explosion hazard and must be repaired without delay;
- Install a gas detection system;
- Fire extinguishers and other extinguishing apparatus must be readily to hand;
- Do not store any flammable materials in the engine room.

1.3.4. Action in event of gas discharge



- Close the gas-supply main valve;
- Switch off the master switch for the electrical system;
- Block off the danger area. Turn non-involved persons away from the danger area;
- Vent the room;
- In the event of a gas discharge, notify the relevant authorities immediately andinitiate repair measures.

1.3.5. Action in event of fire

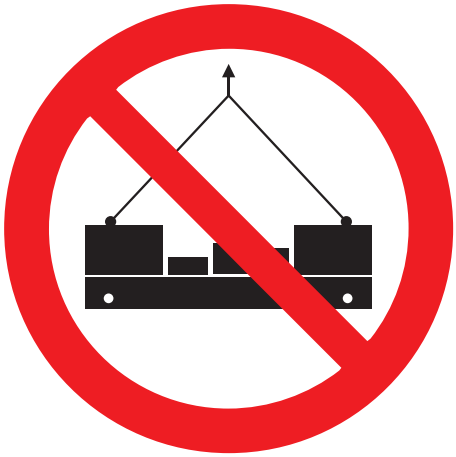
- Stay calm!
- Notify the fire service;
- Provide injured persons with immediate assistance; If necessary, notify first-aid attendants;
- In the event of a pure gas fire, do not extinguish the escaping gas flame
  Burning gas = monitored gas!
- If necessary, cool the burning object (or remove the oxygen: close doors and windows);
- Prevent the fire from spreading to surrounding areas;
- If the flames spread to the surrounding areas, fight the fire with a proper fire extinguisher.

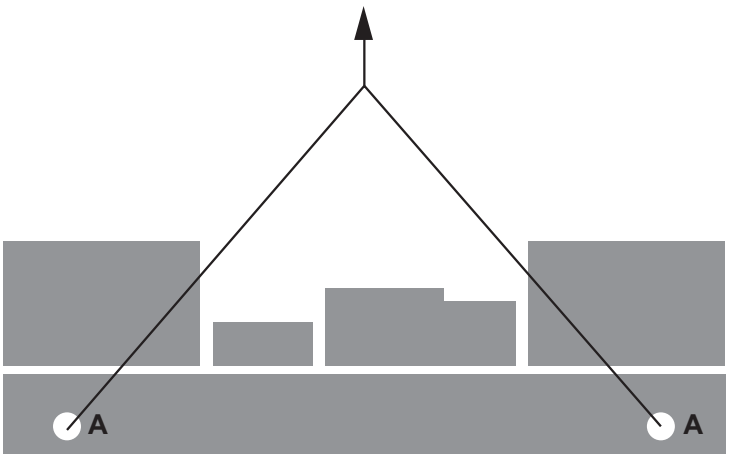
1.4. Notes on startup

- Installation check and start-up may only be carried out by authorized skilled personnel.
- Never run the engine dry, i.e. do not run without lube oil or coolant.
- Do not use additional start−assist measures (e.g. start pilot) during starting.
- Do not shut down the engine immediately from full load. Instead, run at no load for approx. 5 minutes so as to achieve temperature equalization, in particular at the exhaust turbocharger.
- Never pour cold coolant into an overheated engine, see chapter headed “Maintenance and care” in the Operating Instructions.
- Do not pour in engine oil over the max. notch on the dipstick. Failure to comply with this instruction can give rise to serious engine damage.
- Always ensure that the check and monitoring devices (charge indicator, oil pressure, coolant temperature, etc.) are working properly.
- The gaseous fuel must conform to the minimum requirements for Sandfirden gas engines, at least for the requirements it is designed for (see page 21). Use only fuels, lubricants and coolants in accordance with the Sandfirden Technics BV specifications, otherwise the manufacturer will not be liable for defects!
- Sandfirden Technics bv must timely be asked for attendance of a mechanic for installation inspection. **After inspection an appointment for commissioning will be made**.
- After mounting the engine in place, immediately connect a permanent earth-cable.
- Avoid the use of **copper, brass or galvanised** piping/parts for cooling and/or fuel systems. The use of these metals leads to galvanic damage of the engine
- Keep the plastic protection intact as long as possible. Additionally protect the installed engine with welding blankets or equivalent while installing the engine room is not finished.
- Please send us your installation drawings as soon as possible, so that we can check them. Be aware that although we have seen and signed them off, Sandfirden Technics BV never can be held responsible for the installation of the engine, unless we have installed the set/engine ourselves.

2. Engine

2.1. Lifting the set



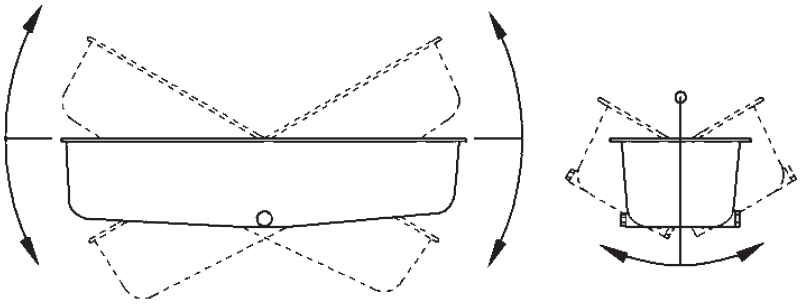


WARNING!
Safe lifting of the set can be done using the lifting eyes (A).

IMPORTANT!
The lifting eyes are designed to cope with a maximum inclination angle of 30°.

2.2. Basic installation requirements

2.2.1. Permissible installation and operating angle



Maximum angles of inclination and capacities of the oil sump

Angle to the rear (max. angle)		Angle to the front (max. angle)		Roll
Installation [a]	Operating [b]	Installation [a]	Operating [b]	Operating
8°	10°	8	10°	30°

a) Maximum permitted installation angle for an engine relative to the horizontal plane. The angle indicates the limit for engine inclination during continuous operation.

b) Maximum permitted inclination angle for an engine in operation and with minimum oil level. The maximum permitted operating angle may only be applied for short periods. The maximum forwards or rearwards operating angles are not applicable to their full extent if the engine is inclined laterally at the same time.

2.2.2. Genset dynamics

If vibration levels in a genset are too high, it could be due to resonance.
This can be caused by pulsations of torque and interfering forces that arise during normal combustion engine operation, with crankshaft speeds at the same frequencies as the resonance frequencies of the resulting system.

The resonance frequencies of the system depend on the mass and rigidity properties of component parts. It may therefore lead to changed vibration levels if e.g. the flywheel housing or adapter is replaced with a variant of a different rigidity.

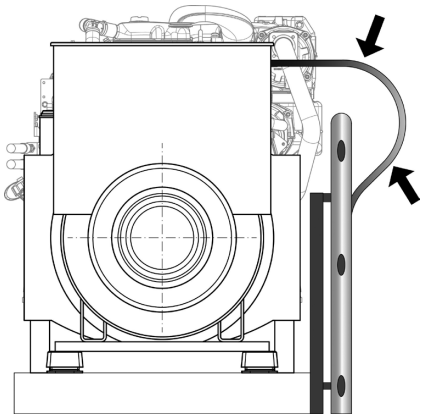
Taken in account what is stated before, it is essential to execute a torsional vibration calculation as part of the engine design.

IMPORTANT!
It is the responsibility of the installer to verify that no resonance frequencies or vibration levels that could damage component parts are found anywhere in the unit.

Measurement and evaluation of vibrations in the static parts is described in the international standard; see **ISO 8528-9**.

2.2.3. Genset connections

When connecting the generator to the power-grid, “free cable length” must be provided to compensate the movement of the generator set.
Mount the power lines tension-free as displayed in the picture below.
This minimizes transmitting vibrations to other parts of the room and stress on the generator.



When connecting the cable, make sure that there is no force exerted on the machine terminals.

The same conditions apply to all other external connections involved.
As there are: FUEL, COOLANT, EXHAUST, etcetera.

IMPORTANT!
Adequate precautions have to be taken to prevent transmitting vibrations via those connections.

2.3. Engine installation from a service perspective

When installing the engine, it is important to make sure that there is sufficient space available for the service work as specified in the Operation - and Workshop Manual and for any necessary engine overhaul after an extended period of operation.
Sufficient leeway must be created for movements of the engine due to elastic mounting, in order to safely prevent contact with neighbouring parts.

2.3.1. Installation requirements

The installer is responsible for ensuring that sufficient access is available that service and repair work can be carried out in a normal manner.
The following are some important requirements for accessibility:

- Superstructures and connected components must be designed so that the engine can be removed and fitted without time being lost due to remove obstructive structures;
- In the case of static installations, it is advisable to mount securing points for lifting devices above the unit;
- The gas system must be easily accessible for service;
- It should be possible to read the scale on the flywheel when adjusting valves (applies for Scania-powered Gas engines only);
- It should be possible to remove and fit the cylinder head, rocker covers and pushrods, setting the valves, tightening / retightening the cylinder head bolts without having to remove the engine from the installation site. (Dimension A in the figures.);
- It must be easy to top up and drain oil, changing the oil filters and easy access to the dipstick for checking the lube-oil level;
- It must be possible to remove the oil sump in order to change cylinder liners or pistons with the engine in place. Required minimum heights to the oil sump are shown in the figures;
- It must be easy to top up and drain coolant;
- Cranking the engine with the barring gear;
- Changing the spark plugs and checking compression pressure;
- Setting and changing the rotational speed sensor and checking and setting of the ignition timing;
- Maintenance and replacement of the battery;
- Maintenance of the air filter;
- Visual check and tightening of screwed, hose and pipe connections;
- Simple visual check for leaks.

To resume, the following components must be easy to access for service:

- **Turbo charger**
- **Starter motor**
- **Oil filter & oil cooler**
- **Radiator**
- **Batteries**
- **Gas mixer**
- **Alternator**
- **Coolant pump**
- **Radiator fan**
- **Crankcase ventilation filter**

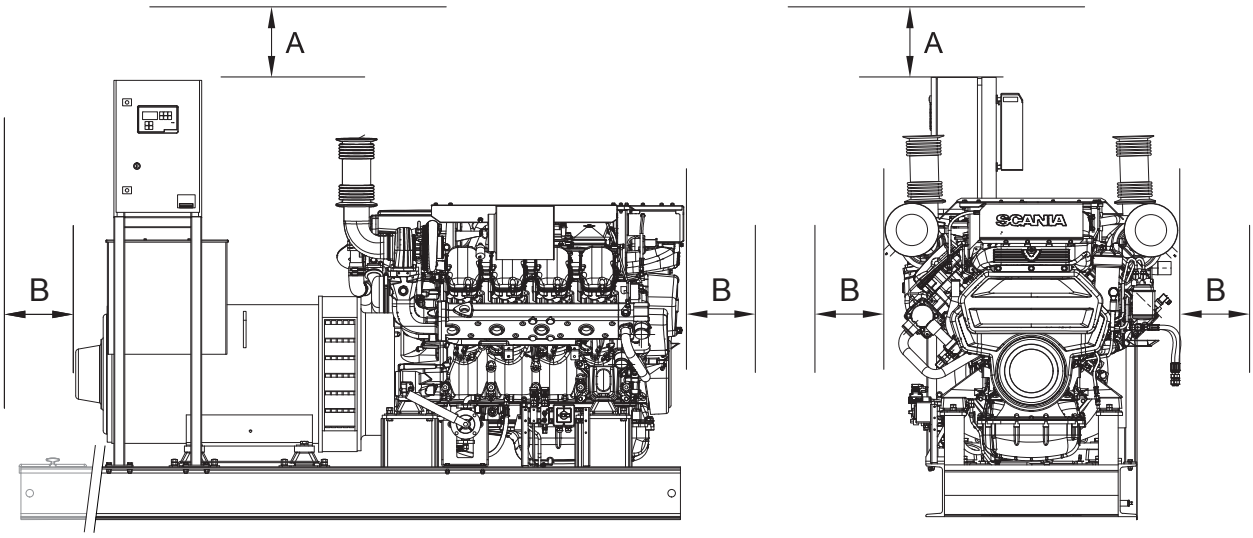
2.3.2. Clearance

The table and the subsequent figures show the engine with the most important clearances indicated. The specified measurements apply to the largest standard equipment option.

Measure	Minimum allowed Clearance mm For service or change of:	
A	-	E-Cabinet
B	500 mm	Various components

- Oil cleaners and oil filters must be easy accessible for service and maintenance.
- Air filters must be located to make it easy to inspect and change the filter cartridge.

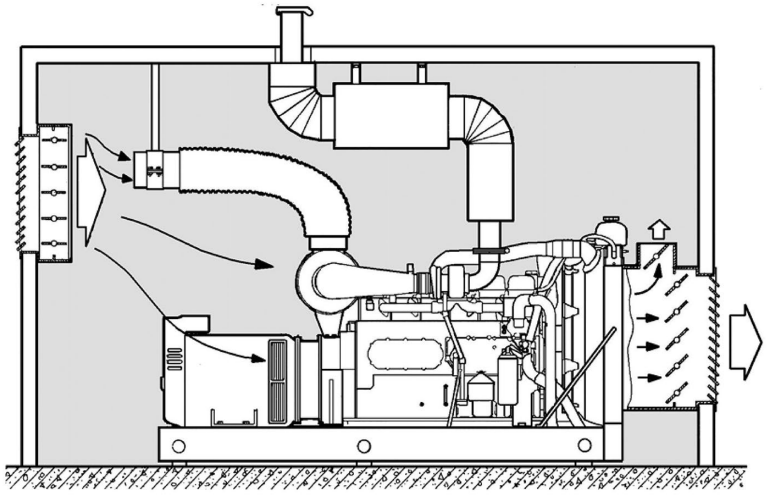
1.



Engine clearances for Gas Line gensets (GL)

3. Inlet system

Engine operation causes component surfaces to become hot, dissipating radiant heat which must be conducted away by means of an effective ventilation system.
High ambient air temperatures have negative effects on engine-output and service live of the components



3.1. Engine temperature

Even under the most unfavourable conditions an engine ambient temperature of 60°C must not be exceeded (critical components: vibration damper, starter).
The intake temperature must range between +10°C and +35°C in accordance with the intake requirements of the engine.
Ideally there should be a through flow of air through the engine room from the bottom diagonally upwards.
Cool fresh air should preferably be directed to the generator and to the air intake filter.
A permanently constant temperature should be guaranteed at the engine's air intake filter .
In order to avoid pressure variations, blowing against the air filter should be avoided by the use of cyclically actuated fans.
Sharp temperature and pressure variations in the engine room are not permitted.

10°C ≤ Intake−air temperature at the air filter ≤ 35°C

Hot intake air and heated fuel reduce power!
In the event of gas/air mixture temperatures after the charge-air cooler in excess of 45°C, it is necessary to reduce engine power.

3.2. Intake air for engine

3.2.1. General

The temperature of the intake air should be below +35°C. If it constantly exceeds +35°C, engine output will decrease.
If the engine is enclosed in some form of installation, or if it is located in a room designed for the purpose, it is therefore important to ensure that the supply of intake air is ensured.

The direct dependence of the engine output on intake air temperature is shown in the figure. 100% output is shown under actual test conditions at the factory. If the intake line is located close to exhaust pipes or other hot parts, protection should be provided against radiated heat to avoid unnecessary warming of the intake air.

Load deration vs Air inlet temperature*

Air inlet Temp. [ºC]	50	45	35	25
Rating Factor	0.85	0.9	1	1

*(Only applicable for aftercooled engines)

Contact your local distributor for advice in case of doubt.

3.2.2. Intake air taken from outside engine room

In installations where the engine intake air comes from outside the engine room and is led via a fresh air duct to the engine, the pressure drop for the intake system should be measured.

- The air intake should be located so that the intake air is as clean as possible and so that neither the engine exhaust nor heated air from the engine room can mix with the intake air.
- The intake air must not contain chemical pollutants (such as CFCs).
- The air intake should be designed to exclude water, snow and contamination.
- The maximum permitted pressure drop is 350 mm water column (0.0343 Bar). This value includes the pressure drop in new or cleaned air filters and in the fresh air line.

Checking the pressure drop is not essential if:

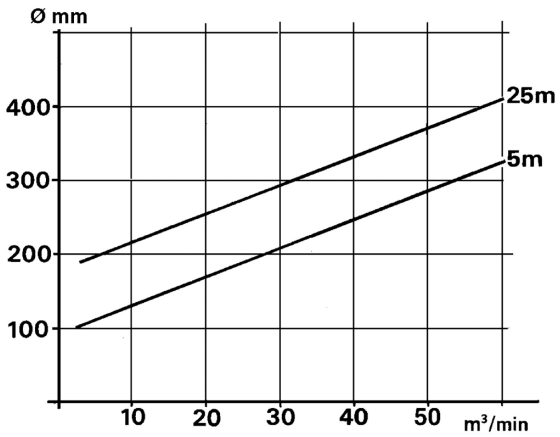
- the intake system comprises Sandfirden standard air hoses and pipes.
- the length of the fresh air line does not exceed 5 m and is dimensioned as follows:
- Up to a length of 5 m, the inside diameter of the fresh air line should be at least: Ø 210 mm
- The line must not be routed with tight bends.
- The inside of the line should be flat and even.
- If a hose is used, it should be reinforced to avoid crumpling.

If the length of the planned fresh air line exceeds 5 m, the required diameter must be calculated. See figure.

The vacuum before the turbocharger must be measured.

The air consumption for the different types of engine can be obtained from the tables showing the air consumption and radiated heat for the relevant engine type.

The pressure drop measurement is normally made at the vacuum indicator.



Graph indicating airflow in relation to diameter and length of intake line.

The total pressure drop in the intake system with a blocked air filter must not exceed 350 mm water column (0.0343 bar).

3.2.3. Ventilation of the engine room with fresh air line to the engine

When the intake air to the engine is taken from outside the engine room, it is important to check that the temperature in the engine room does not exceed 60°C.
If the temperature exceeds this value, there is a risk of malfunction in the engine's electrical components (alternator, charge regulator, control unit, etc).
It may therefore be necessary to arrange for ventilation of the engine room with a fan if there is a risk of the temperature exceeding 60°C.

When dimensioning the engine room ventilation, other air consumers in the engine room must also be considered. A generator, for instance, will dissipate 5% of the generated power as heat.
(See paragraph 3.4 on page - 28 -)

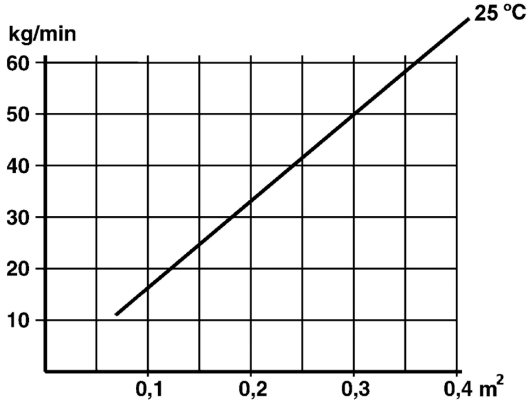
Exhaust pipes should be insulated to reduce the radiated heat in the engine room (see page 26).

3.2.4. Intake air from engine room

When the engine intake air is taken from the engine room :

- The open area should be large enough to ensure that no vacuum or overpressure arises in the engine room.
- The air intake should also be designed so that it cannot be closed or accidentally blocked.
- The air intake should be located so that the intake air is as clean as possible and so that neither the engine exhaust nor heated air from the radiator can mix with the intake air to the engine.
- The air intake should be designed to exclude water, snow and contamination.

Based on engine air consumption, the minimum recommended area of the air intake is indicated in the graph on the right.



Graph indicating minimum air intake cross-section.

3.3. Pressure in the engine room

Essentially, the ventilation can be configured to operate along “pressure” or “suction” lines. Both concepts have their areas of application.
It is recommended to regulate the ventilation system with fresh−air and exhaust fans in such a way that the pressure in the engine room corresponds approximately to atmospheric pressure.

Measure the pressure difference (in relation to the atmosphere) during operation when the engine has been running for approximately 5 minutes at full load. A simple and effective tool is a clear plastic hose filled with water, which can be read off directly at the difference in level in the hose in mm water column. The pressure difference must not be greater than 10 mm water column, corresponding to: 0.001 bar. For an engine without a fan, a vacuum of 20 mm water column can be allowed.

For installations where the engine draws the intake air directly from the engine room, the engine room must normally be equipped with a ventilation system which extracts the air heated by e.g. radiation in order for the low intake air temperature requirement to be met.

WARNING!
Maximum pressure difference Δp = ± 0.001 bar (opening of doors).

3.3.1. Air pressure

On delivery, the engine control unit is normally set so that the maximum gas quantity provides 100% output with an intake air pressure at sea-level.

If the engine will be used at high altitudes, you should contact your local distributor to check engine output.

Load deration vs Altitude

Altitude [m]	3000	2800	2300	1800	1300	800	300	0
Rating Factor	0.73	0.75	0.8	0.85	0.9	0.95	1.00	1.00

3.4. Radiation heat to be dissipated

The quantity of heat to be dissipated amounts, depending on the engine model, to approx. 5% of the heat output supplied with the fuel.
There is also additional heat due to efficiency losses in driven units in the engine room.

If silencers or long exhaust-gas pipes are fitted in the engine room, the heat dissipation of these components is to be taken into consideration as well. To keep the amount of radiation heat to be conducted away within limits, these components should be provided with fireproof insulation.

IMPORTANT!
The radiated heat from the engine exhaust line after the engine must be taken into account. The heat radiated depends on how much of the line is in the engine room and how much is insulated.

The air requirement to conduct away radiation heat is calculated as follows: $$V = \frac{\mathbf{Q \times 3600}}{\mathbf{cp \times \Delta t \times \rho}}$$

In this formula:

Q	=	Total amount of radiation heat in kW to be compensated
V	=	Air volume flow in m³ / h
cp	=	Specific heat capacity of air (1.005 kJ / kg x K)
Δt	=	Permissible temperature difference between engine room and surrounding area in ºK
ρ	=	Density of air in kg / m³

3.5. Total amount of air required

The total amount of air required is calculated from the sum of the air required to conduct away radiation heat and from the engine's combustion-air requirement.

The amount of air required for conducting away radiation heat is calculated by means of the formula in paragraph 3.4 - see page 18: above these page.

The technical data sheet provides information on the engine's combustion-air requirement.

Information on the amount of cooling air required by the generator can be obtained from the manufacturer.

3.6. Air cleaner

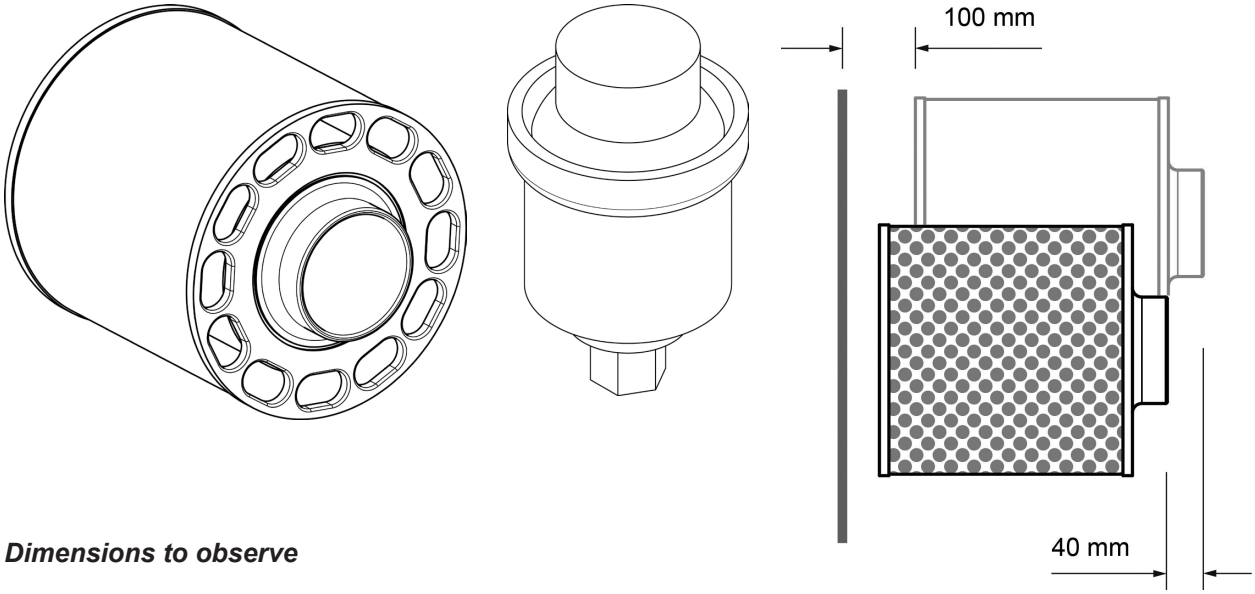
SGI-series gas engines are supplied with an air cleaner containing a paper filter and a safety indicator. See figures on the next page.

- The air cleaner can be fitted either horizontally or vertically. It should be easily accessible for cleaning and filter renewal.
- The air cleaner is equipped with a vacuum indicator which should be fitted so that it is easy to read. If the installation requires long intake lines, the vacuum indicator should be located a maximum of 1 m from the engine, and preferably on a straight section.
- Removing the filter element requires clearance in the air cleaner extension. See the following figures for the minimum permitted dimensions.
- The line between the air cleaner and the gas mixer must be thoroughly sealed so that no unfiltered air can be drawn into the engine. If the line being used between the air cleaner and turbocharger is not standard, it should be designed in such a way that it cannot collapse onto itself as a result of a large pressure drop.

It is very important to make sure that any insulation in the engine room and around the exhaust pipe cannot get loose and be drawn into the intake.

Always make sure to fit the proper filter cartridge as indicated in the part manual.

WARNING!
Unfiltered or insufficiently filtered intake air leads to rapid engine wear.



Dimensions to observe

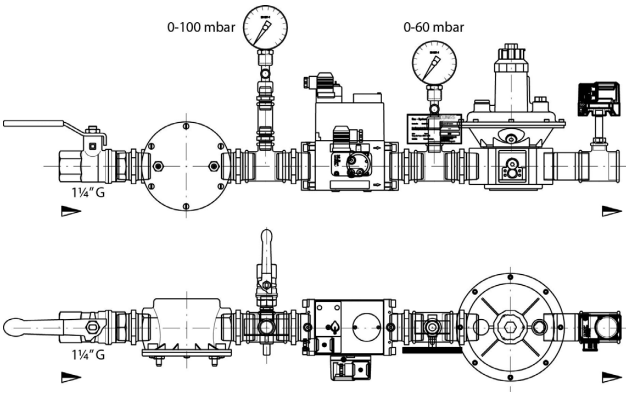
3.7. Summary

- Engine air consumption is approximately 7,5 m³ /100 kW output, at an air temperature of 35ºC.
- Accurate figures for each engine are available.
- The recommended maximum air-filter inlet temperature is 35ºC.
  Temperatures up to 50ºC are possible but will lead to loss of output capacity. It is recommended to position the air filter inlet away from the ceiling in order to avoid high inlet temperatures.
- Turbo inlet pressure drop may not exceed 0.035 bar under ambient pressure, measured with clean air-filter.
- Maximum engine room temperature is 60ºC, provided that a separate air inlet line is used.
- The air-inlet must be located in such a way that sucking in of water or exhaust gas will be prevented.

4. Fuel system

4.1. The gas train

Standard a gas train, as displayed example, is part of the engine delivery.The constituent components of this device ensure a proper flow of gas to the engine, regarding controlling, purifying and pressure adjustment.



4.2. Fuel gas system

WARNING!
The air -gas mixture used as engine fuel is easily ignited and may explode. As soon as fuel gas is present in the pipes no welding work must be carried out in the engine room concerned. No naked flames may be used and a strict ban on smoking must be observed.

Standard the gas train is factory set for a fuel gas as indicated in **4.3. Factory settings on page 21.**

On delivery the engine is equipped for the fuel gas quality specified by the customer when the engine was ordered. The engine must be adjusted for this gas when it is first put into operation.

IMPORTANT!
Notify your local supplier or Sandfirden Technics BV before you convert the system to another type of fuel gas and each time the fuel gas quality is changed..

Points to note

1. The engine room ventilation must be designed so that gas concentrations are prevented and a slight overpressure exist in the engine room.
2. Ensure that the pipes and components through which the fuel gas passes are fully leak-proof.
3. It is the operator's responsibility to ensure that the fuel gas delivery system is equipped with the necessary devices, that the system does not leak and satisfies official and local requirements.
4. Install a flame trap in the gas supply line (depending on the local legal requirements of the country where the equipment is installed).
5. Plant-side safety valves must always be directed downwards.
6. A manual stop valve must be provided outside the engine room for intentional shutdown of the machinery (e.g. for repair, maintenance and in emergencies), preferably where the gas pipes enter the engine room. The manual stop valve must be designed to ensure that no unauthorised person can actuate it, i.e. open it when in locked position.
7. The delivery line has to be air-tight connected to the gas train.
8. The connection between the module (engine gas intake) and the gas delivery system must be flexible.
9. The SGI-series gas engine are tested with a fuel gas with a caloric value as indicated below **(factory settings)**. A lower caloric value implies a higher gas demand, which automatically has implications for the intake line dimensions.

10. The entry pressure of the fuel gas in the gas train is limited to 50 Mbar. When the supply pressure is higher an extra reducing valve in the gas delivery line must be provided.
    Preferably place this reducing valve into the open, outside the engine compartment.

11. The inner dimension of the delivery line must be at least in conformity with the gas train dimensions, preferably one step bigger.

12. Generally, the dimensions of all the apparatus and piping before the gas train have to be engineered so that a sustainable supply of gas flow will be guaranteed.

4.3. Factory settings

Engines are factory-set to the following typical natural gas specification, at 288 K and 101 kPa.

G-gas (G) Wieringermeer, the Netherlands			
Upper calorific value		35,17	MJ/m^3
Lower calorific value		31,65	MJ/m^3
Upper Wobbe index		50,51	MJ/m^3
Relative density		0,67	relative to air
Methane	(CH_4)	78,7	vol%
Ethane	(C_2H_6)	4,3	vol%
Propane	(C_3H_8)	1,7	vol%
Butane	(C_4H_{10})	0,2	vol%
Nitrogen	(N_2)	13,1	vol%
Carbon dioxide	(CO_2)	2,1	vol%

4.4. Output derating factors

Methane Number
The knock resistance of a gas-fuelled engine depends on the methane number of the used gas. A fuel gas with a high methane number is known as very knock resistant. A low methane number has a negative effect on the engine output. Most natural gasses have a methane number between 78 and 98 and can be used without any adaption.

Methane Number	60	65	70	75	80	90	95	100
Rating Factor	0.00	0.87	0.90	0.95	1.00	1.00	1.00	1.00

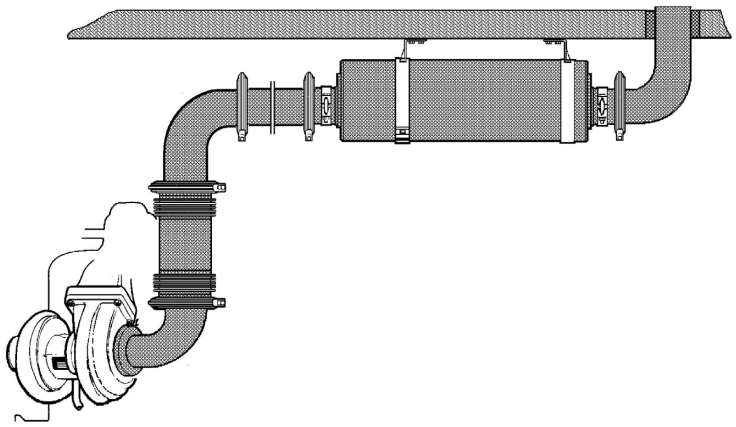
Methane Percentage
As shown below will a methane percentage below 70% effect the engine output.

Methane percentage (%)	40	45	50	55	60	70	95	100
Rating Factor	0.8	0.82	0.85	0.87	0.95	1.00	1.00	1.00

NOTE!
If special load or fuel specifications apply, consult the manufacturer or your local supplier.

5. Exhaust system

The exhaust system is an essential part of the motor configuration. A poorly configured and installed exhaust system can have a disastrous effect on engine output. Exhaust systems are always custom-made and vary from situation to situation. Therefore in the following pages some general indications concerning this part of the engine line-up.



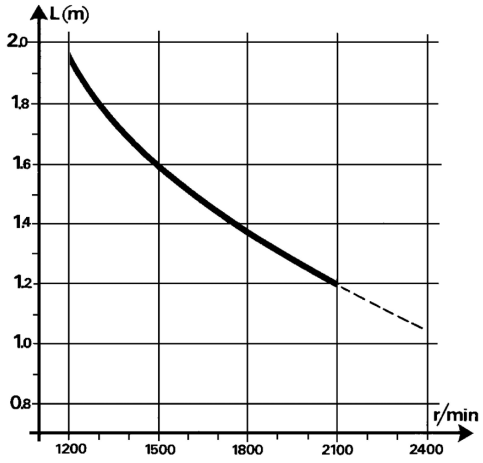
IMPORTANT!
The installer is responsible for ensuring that the exhaust system does not leak when it is installed and that the suspension of pipes and silencers is done in a way which prevents the system from leaking during operation..

5.1. Silencing

A well-designed form of exhaust system (with silencers) is required when installing a gas engine. However, the need for such systems in new installations should be assessed from case to case, based on actual conditions for noise level norms, length and type of exhaust system, location of the exhaust vent and other factors. Thermal insulation of the exhaust system has an effect on noise level and an insulated system can be noisier than one which is not insulated.

The silencer should be positioned as close to the end of the exhaust system as possible. In order to obtain the best noise dampening, there should only be a short tailpipe after the silencer. The relation shown in the graph is an indication.

If the silencer cannot be positioned close to the exhaust system vent because of a lack of space, it should be placed as close to the engine as possible.
This location is unfavourable in silencing terms if the pipes beyond it are long.



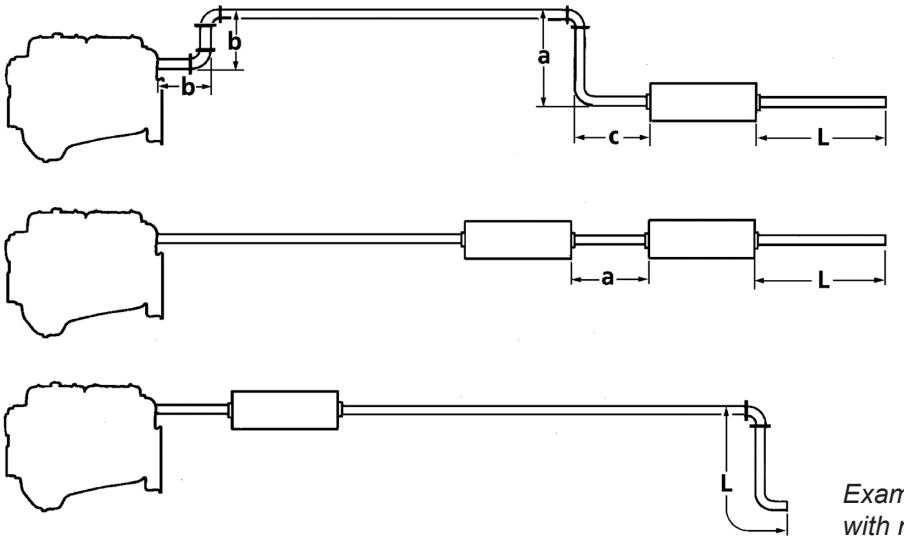
Graph for determining length of tail pipe.

It is therefore advisable to install an additional silencer close to the outlet or to the exhaust system end with two 90° bends, with a suitable length between them. (see next page examples.)
If two silencers are used in the system, they should be placed in series at a suitable distance from one another and with the silencer used to dampen high-frequency noise furthest away from the engine.
The end of the exhaust system should be located to avoid reflection of the noise from vertical walls as this can raise the noise level. In addition, the outlet should be positioned so that no exhaust fumes can be drawn into the intake. Exhaust fumes always contain soot particles, there is a risk of the air filter becoming blocked which causes the intake air temperature dramatically to increase.
In addition, the outlet should be positioned so that exhaust fumes will be kept away from areas occupied by people (e.g. residential buildings). Since the pipes, which make part of an exhaust system, also operate as silencers, it is important that they are dimensioned correctly.

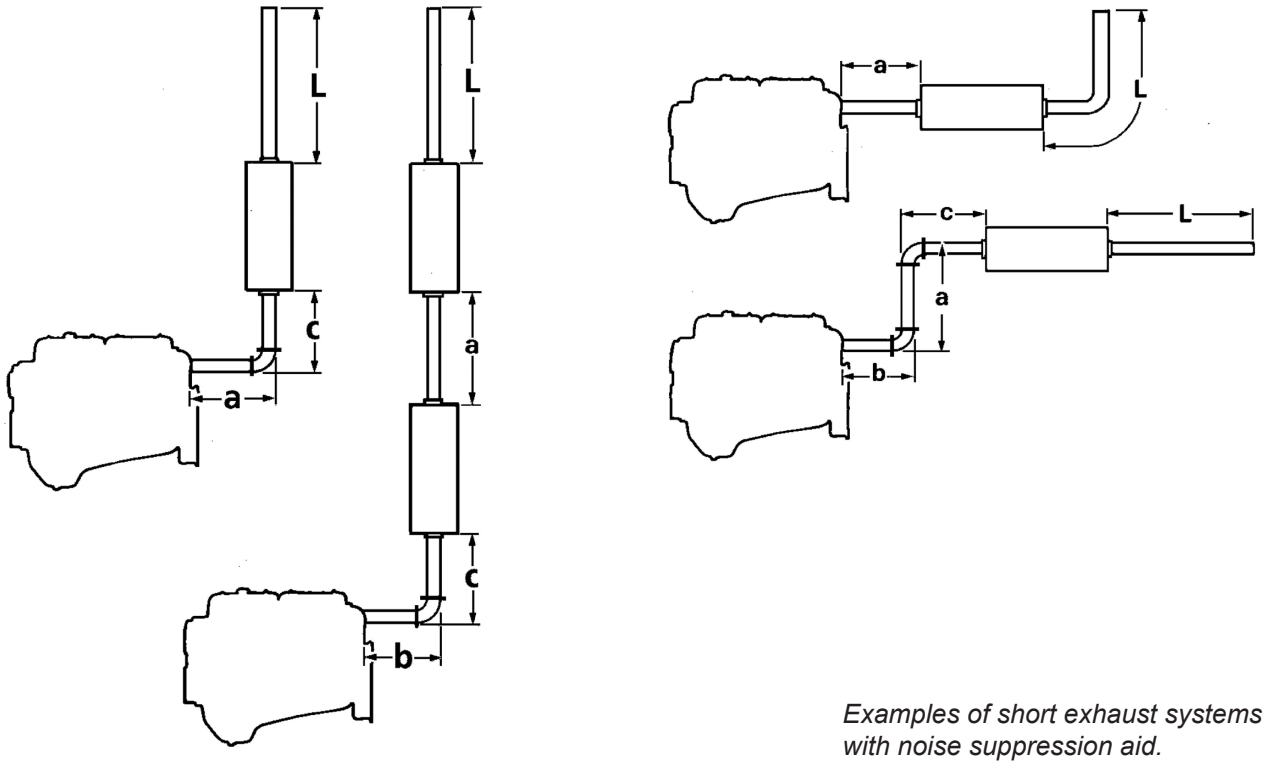
The next page shows a number of designs of long (>5 m) and short exhaust systems with favourable silencing properties.

IMPORTANT!
V-clamps must not be used forcing together joints, only for fixing the flanges.

NOTE!
Back pressure increases with the number of pipe bends and pipe length.



Examples of long exhaust systems with noise suppression aid (>5 m).



Examples of short exhaust systems with noise suppression aid.

L = length of tailpipe, determined from graph on previous page.
a = 2/3 of L.
b = length for pipe which should not be as long as any other pipe in the system.
c = pipe length with no significance for noise suppression, not exceeding 3 mtr.

5.2. Connection of exhaust system to engine

5.2.1. General

To absorb the movement of the engine a flexible connection between the exhaust line and the engine has to be installed, especially when it has flexible suspension and changes in length in the exhaust system due to temperature changes.

The need for a flexible connection is particularly important for turbocharged engines since the turbo-charger will otherwise be damaged by vibration, external forces applied and thermal stresses.

Such a flexible connection may consist of a compensator. See figure on next page.
The weight of the exhaust system should load neither the compensator nor the turbocharger.
Therefore a suspension point for the exhaust system must be provided immediately after the flexible connection.

5.2.2. Material

The most common material used in exhaust systems is carbon steel. The wall thickness should be 3 - 6 mm depending to pipe diameter. If an exhaust air cooler is installed or the environment is corrosive, use stainless steel for the exhaust pipe and silencer. Insulated pipes are more sensitive for corrosion.

5.2.3. Connection

When designing the exhaust system the movements allowed by the engine flexible mounting and also by the thermal expansion of the pipe should be taken into consideration.

IMPORTANT!
Turbocharger and exhaust manifold must not be loaded by the weight of the exhaust pipe and silencer. .

The engine should be connected to the exhaust system by a flexible compensator which is part of the delivery and allows at least ± 10 mm movement. Vertical position of the flexible part will improve its durability.

The pipe itself must be supported to allow heat expansion but prevent pipe vibration. A bracket or similar should be fitted immediately after the flexible tube or compensator to remove the weight of the exhaust pipe from the flexible connection and turbocharger.

If the exhaust pipes are very long or on exhaust systems that have a relatively long horizontal part between two vertical parts, it may be necessary to have several compensators in the system.
There must then be a fixed anchorage point on one side of the vertical compensator and a suspension which allows axial movement on the other side.

The outlet of the exhaust system should be located to avoid recirculation through the air intakes for combustion or ventilation air.

5.2.4. Compensator

A compensator consists of two flexible sections with several layers of deeply folded stainless steel plate, connected to a short pipe which can absorb movement both lengthways and laterally. This allows a maximum simultaneous lateral movement of ±20 mm and an axial movement of ±10 mm.

The compensator has an inside diameter of 127 mm and is bolted to the exhaust bend. On the other side to a loose flange that should be welded to the pipe which is to be connected to the compensator.

5.3. Back pressure in the exhaust system

Back pressure in the exhaust system, including the silencer, should not exceed 0.05 Bar (4,9 kPa).
A higher back pressure leads to increased fuel consumption and a loss of power.

Back pressure should always be checked when installation is complete.
Measurement is performed on a straight section of the system, as close to the engine as possible, after the compensator or flexible hose with bends, but at least 1 m from the nearest bend.

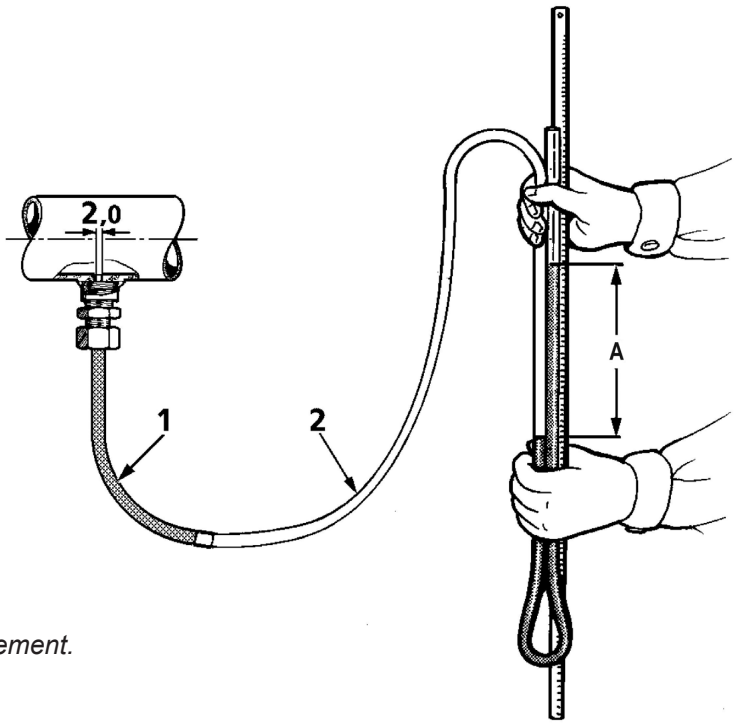
5.3.1. Measuring back pressure

A simple device for measuring the back pressure is a clear plastic hose which is connected to a test connection on the pipe as shown in the figure on this page.
The hose is bent and partly filled with water.

It is important for the hole (Ø 2.0 mm) which is drilled in the exhaust pipe to have a clean, sharp edge on the inside of the pipe. Residual burrs and unevenness can result in significant measurement errors.

After the engine has been warmed up it should be
driven with **maximum load and at full-load speed** while the difference in water level in the hose is measured (**A** in the figure).

This is a direct measurement of back
pressure in mm water column (mm. WC).



1. *Pipe*
2. *Clear plastic hose*

Example of exhaust back pressure measurement.

(500 mm water column = ± 0.05 bar)

5.4. Insulation of exhaust system

The need for insulating the exhaust system should be assessed from case to case.

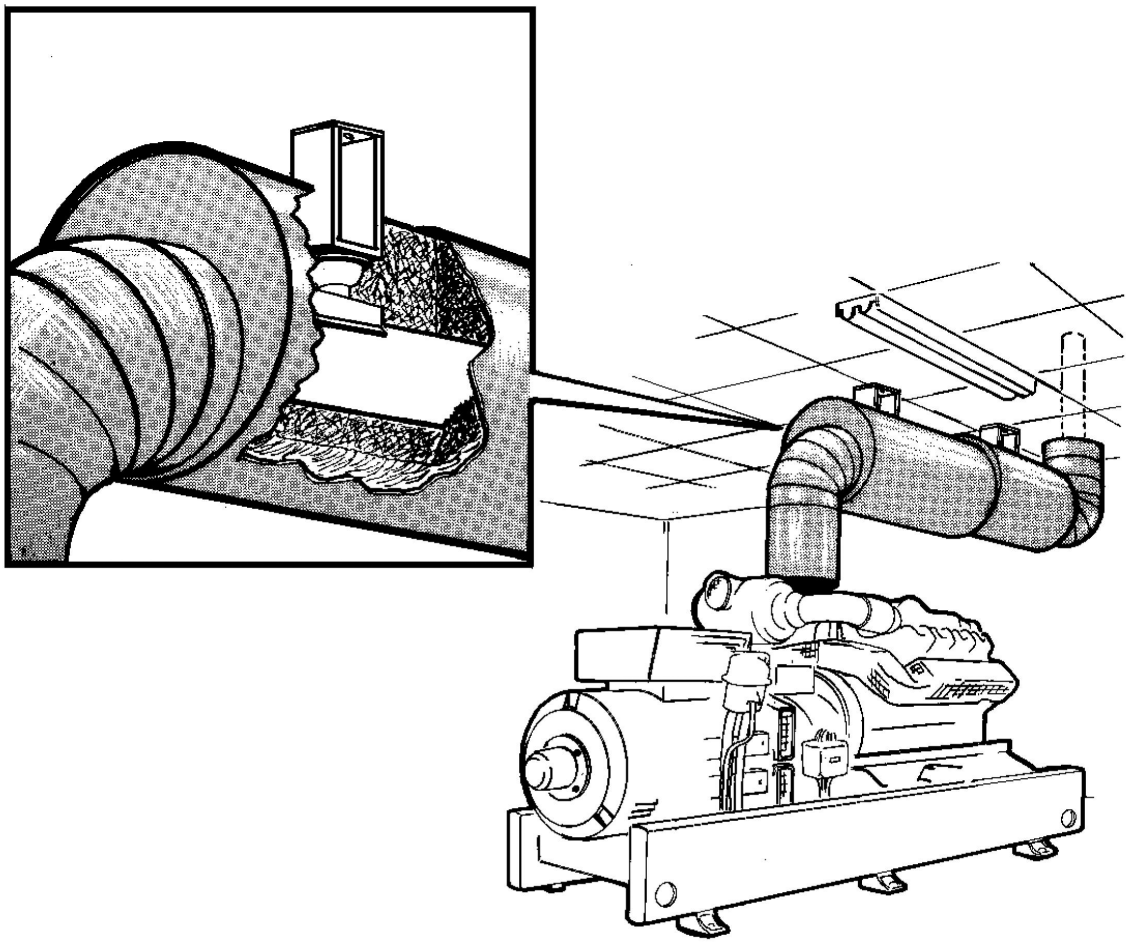
If the engine intake air is taken from the engine room, exhaust pipes should be insulated especially well to keep down the temperature in the engine room.

Other reasons for insulating are e.g.:
- To prevent burn injury to personnel;
- To reduce fire risk from leaking fluids (hydraulic fluid and the like), in passages or close to combustible materials;
- To reduce costs for ventilation etc.

Insulation should tolerate a temperature of at least 700°C and should be protected from splashes closest to the engine.
The outer shell of the insulation must be so well sealed that fibers from the insulation material cannot vibrate loose and block the air filter.

The insulation of long pipes affects the exhaust back pressure.
The diameter of the exhaust system should therefore be increased if it is insulated.
In addition, an insulated system may have a higher noise level at the outlet which should also be taken into account during dimensioning.

IMPORTANT!
It is important that the insulation is carried out so that the flexible part of the exhaust system is not restricted in its movement..



5.5. Protection against water penetration

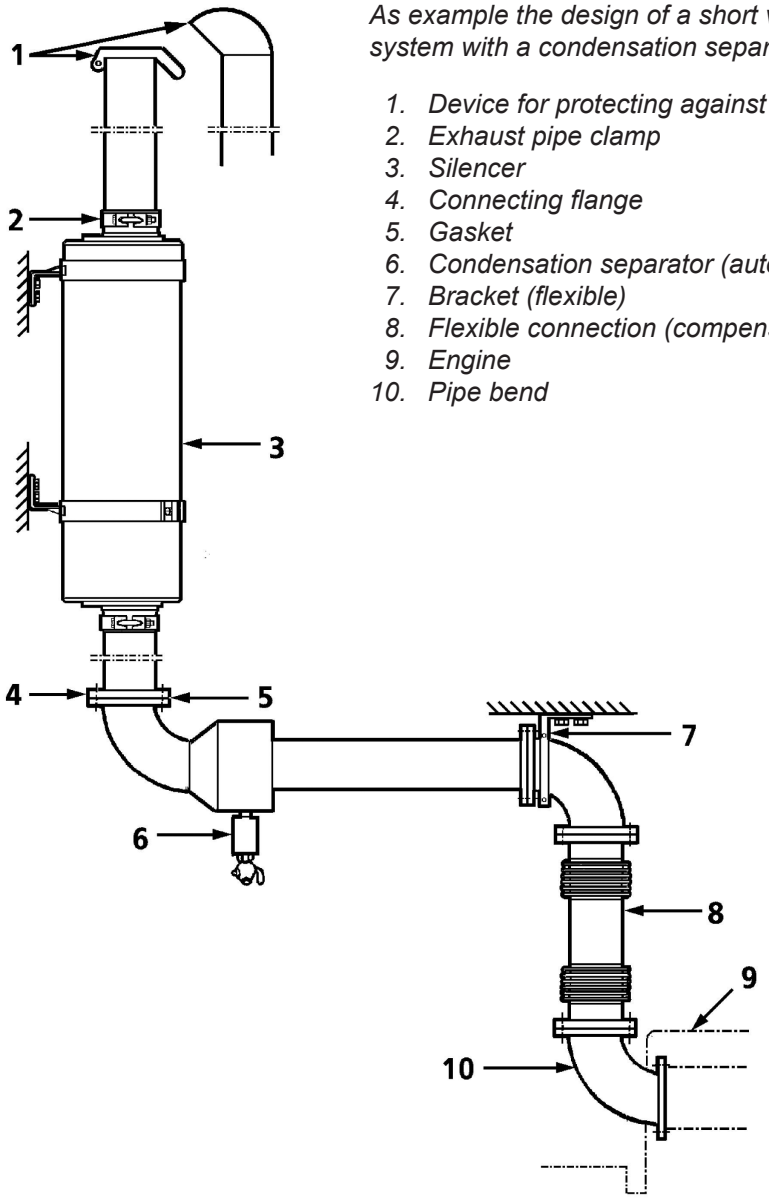
Rain or condensation which penetrates into the engine will cause corrosion damage and in the worst cases can cause liquid hammering which may result in bent connecting rods and the total destruction of the engine.

The exhaust system must therefore be designed to prevent water penetration.

Long exhaust systems should be equipped with a condensation separator. It should be located as close to the engine as possible but after the flexible connection.
The occurrence of condensation is greater with a vertical exhaust system since the exhaust gases in a horizontal system carry away much of the condensation.

Even with short exhaust pipes, it is a good idea to fit a condensation separator if there is any risk of rain water penetration.

Vertical exhausts should be equipped with a device to prevent water penetration.
A drainable water lock should also be connected to the water separator.



As example the design of a short vertical exhaust system with a condensation separator.

1. *Device for protecting against water penetration*
2. *Exhaust pipe clamp*
3. *Silencer*
4. *Connecting flange*
5. *Gasket*
6. *Condensation separator (automatic drainable)*
7. *Bracket (flexible)*
8. *Flexible connection (compensator)*
9. *Engine*
10. *Pipe bend*

6. Cooling system

6.1. General

For the correct choice of the coolant treatment for your engine, please contact the service department of Sandfirden Technics BV. The use of plain water is not allowed; it must at least contain sufficient corrosion inhibitor.

For heat balance figures please contact the service department of Sandfirden Technics BV.

6.1.1. Keel / box / cooling system

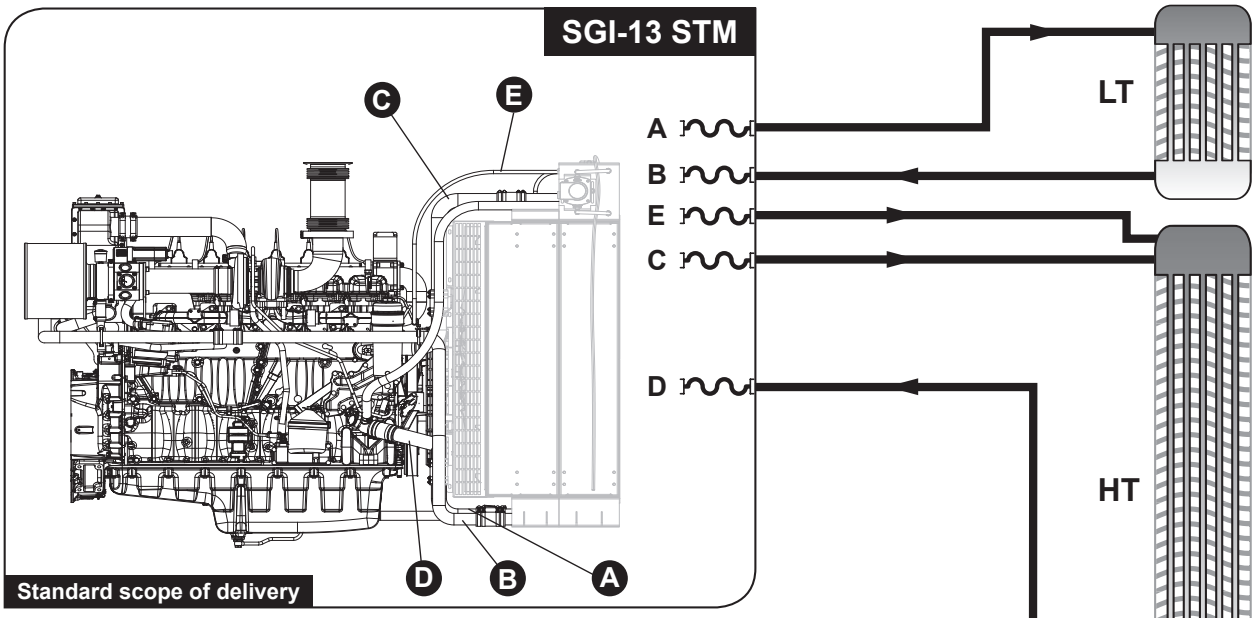
- Expansion-tank volume must be min. 3% of the system volume plus 10 litres.
- Mount a 10 mm vent pipe from the highest point of the outgoing coolant pipe to the expansion tank below coolant-level.
- From the engine vent connection, a 8-mm vent pipe must be led to the expansion tank-bottom.
- A 25-mm static supply line must be installed from tank bottom to the suction pipe close to the pump.
- The static pump inlet-pressure must be 35 kPa (0,35 bar) minimum and 85 kPa (0,85 bar) maximum.
- In general, a separate cooling system for each engine gives the best result. If more engines are combined in one system, the pump pressure of the engine with the lowest pressure must always be sufficiently higher than the system back pressure, to ensure a proper circulation of the coolant.

6.1.2. Charge air cooler

- The Sandfirden Technics BV service department can supply the heat rejection figures from the charge air cooler circuit on request. This separate circuit is not installed in all types.

6.1.3. Air cooled radiator

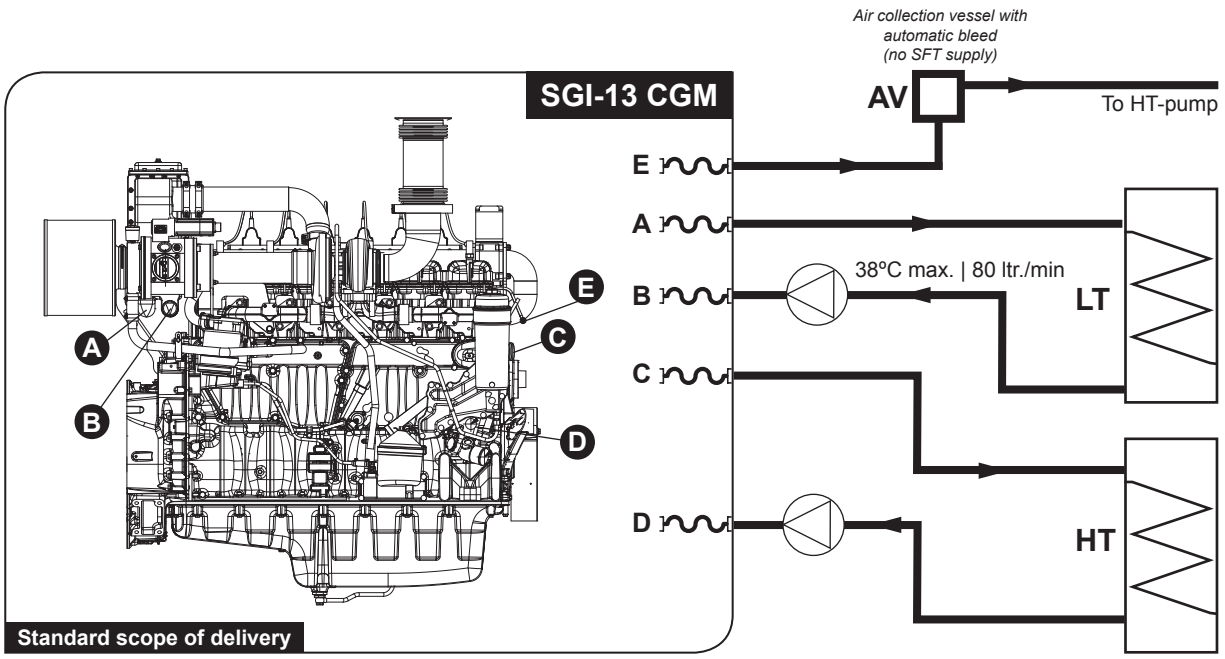
- To achieve a free flow of air, the radiator must be placed at least 50 cm from an opposite wall or other obstacles. Besides hot air must be prevented from re-entering the radiator.
- The engine room ventilation capacity must be at least equal to the capacity of the radiator fan.
- If air inlet ducts are mounted, the area must be at least as large as the radiator front area. For air outlet ducts the profile must be dimensioned in conformity with the air expansion.



Ref.: yellow labels on the engine

A = coolant in LT
B = coolant out LT
C = coolant out HT
D = coolant in HT
E = coolant vent connection

~ = flexible connection



Ref.: yellow labels on the engine

A = coolant out LT
B = coolant in LT
C = coolant out HT
D = coolant in HT
E = coolant vent connection

~ = flexible connection
= feed pump

Engine data sheet - SGI-13 Industrial (STM/CGM)

Basic data SGI-13 CGM-STM

General		
Engine speed	1500 rpm	1800 rpm
No. Of cylinders/configuration	6 in line	
Cycle	4 stroke	
Bore and stroke	130 mm x 160 mm	
Displacement	12,7 dm^3	
Compression ratio	12,5 : 1	
Piston speed	8,0 m/sec	9,6 m/sec
Rotation seen from flywheel end	CCW	
Number of teeth on flywheel ring gear	158	
Flywheel housing	SAE1	
Mech. efficiency/lower heat value	40,2%	40,3%

Lubrication	
Oil double filter type	Full flow Replaceable element + centrifugal filter
Oil capacity - With standard oil pan	30 dm^3
Oil type used by the factory	Mobil Pegasus Special
Oil consumption	< 0,3 gr/kWh
Oil changes interval stand (circumstances dep.)	600 h
Oil viscosity	See the technical information manual: Recommended fuel, cooling fluids and approved oils Sandfirden Gas Engines (Industrial and marine engines)

Fuel system	
Mixer type	Motortech VariFuel
Governor and actuator	Electronic throttle valve
Knock control	DetCon 2

Cooling system	
HT and LT	Circulation pump built on engine
Coolant volume (without heat exch.)	16 dm^3
Water pump type	2x Centrifugal-Polybelt driven
Opening temp. of thermostats	80 - 87°C
Max. pressure on engine pump inlets	1 bar
Max. coolant temperature engine ‘out’	90°C
Max. coolant temperature engine ‘in’	40°C
Coolant water flow HT	max. 370 l/min (@ 0,5 bar pressure drop)
Coolant water flow LT	± 80 l/min
Press drop over engine system @60l/min.	0,05 bar
Heating	Electrical element
Miscellaneous	See the technical information manual: Recommended fuel, cooling fluids and approved oils Sandfirden Gas Engines (Industrial and marine engines)

Air intake and ventilation		
Engine speed	1500 rpm	1800 rpm
Air filter type	Replaceable paper element	
Max. combustion air filter restriction	50 mmwc	
Permissible vacuum in engine room	20 mmwc	
Max. air intake temperature	30°C	
Air consumption at full load	21 kg/min	25,6 kg/min

Exhaust system		
Engine speed	1500 rpm	1800 rpm
Max. back pressure without power loss	500 mmwc	
Exhaust flow	22,4 kg/min	27,1 kg/min
Exhaust temperature after turbo	540°C	525°C

Electric system	
Control system	Optional control system
Starter motor electric capacity	6 kW
Start aid relay capacity min.	64 Amp
Cold start ability CCA10 min.	800 Amp

Generator data sheet - HCI 434C

Winding 311 / 0.8 Power Factor

RATINGS

Class - Temp Rise			Cont. F - 105/40°C				Cont. H - 125/40°C			
50 Hz	Series Star	V	380	400	415	440	380	400	415	440
	Parallel Star	V	190	200	208	220	190	200	208	220
	Series Delta	V	220	230	240	254	220	230	240	254
	kVA		220	220	220	220	250	250	250	250
	kW		176	176	176	176	200	200	200	200
	Efficiency		93.1	93.3	93.5	93.7	92.5	92.8	93.0	93.3
	kW Input		189	189	188	188	216	216	215	214
60 Hz	Series Star	V	416	440	460	480	416	440	460	480
	Parallel Star	V	208	220	230	240	208	220	230	240
	Delta	V	240	254	266	277	240	254	266	277
	kVA		265	270	275	281	281	294	300	313
	kW		212	216	220	225	225	235	240	250
	Efficiency	%	92.9	93.2	93.3	93.4	92.7	92.8	93.0	93.0
	kW Input		228	232	236	241	243	253	258	269

Class - Temp Rise			Standby - 150/40°C				Standby - 163/27°C			
50 Hz	Series Star	V	380	400	415	440	380	400	415	440
	Parallel Star	V	190	200	208	220	190	200	208	220
	Series Delta	V	220	230	240	254	220	230	240	254
	kVA		259	259	259	259	268	268	268	268
	kW		207	207	207	207	214	214	214	214
	Efficiency		92.2	92.6	92.8	93.1	92.0	92.4	92.6	92.9
	kW Input		225	224	223	223	233	232	232	231
60 Hz	Series Star	V	416	440	460	480	416	440	460	480
	Parallel Star	V	208	220	230	240	208	220	230	240
	Delta	V	240	254	266	277	240	254	266	277
	kVA		300	313	319	332	313	325	331	344
	kW		240	250	255	266	250	260	265	275
	Efficiency	%	92.3	92.5	92.7	92.7	92.0	92.3	92.5	92.5
	kW Input		260	271	275	287	272	282	286	298

Generator data sheet - HCI 434D

Winding 311 / 0.8 Power Factor

RATINGS

Class - Temp Rise			Cont. F - 105/40°C				Cont. H - 125/40°C			
50 Hz	Series Star	V	380	400	415	440	380	400	415	440
	Parallel Star	V	190	200	208	220	190	200	208	220
	Series Delta	V	220	230	240	254	220	230	240	254
	kVA		268	268	268	268	295	295	295	280
	kW		214	214	214	204	236	236	236	224
	Efficiency		93.3	93.5	93.5	94.0	92.8	93.1	93.3	93.7
	kW Input		230	229	229	217	254	253	253	239
60 Hz	Series Star	V	416	440	460	480	416	440	460	480
	Parallel Star	V	208	220	230	240	208	220	230	240
	Delta	V	240	254	266	277	240	254	266	277
	kVA		305	315	330	340	338	350	363	375
	kW		244	252	264	272	270	280	290	300
	Efficiency	%	93.4	93.5	93.6	93.7	92.9	93.1	93.2	93.3
	kW Input		261	270	282	290	291	301	312	322

Class - Temp Rise			Standby - 150/40°C				Standby - 163/27°C			
50 Hz	Series Star	V	380	400	415	440	380	400	415	440
	Parallel Star	V	190	200	208	220	190	200	208	220
	Series Delta	V	220	230	240	254	220	230	240	254
	kVA		313	313	313	295	323	323	323	305
	kW		250	250	250	236	258	258	258	244
	Efficiency		92.5	92.8	93.0	93.5	92.3	92.6	92.8	93.4
	kW Input		271	270	269	252	280	279	278	261
60 Hz	Series Star	V	416	440	460	480	416	440	460	480
	Parallel Star	V	208	220	230	240	208	220	230	240
	Delta	V	240	254	266	277	240	254	266	277
	kVA		356	375	388	400	363	383	398	413
	kW		285	300	310	320	290	306	318	330
	Efficiency	%	92.7	92.8	92.9	93.0	92.6	92.7	92.7	92.8
	kW Input		307	323	334	344	314	331	343	356

Generator data sheet - HCI 434E

Winding 311 / 0.8 Power Factor

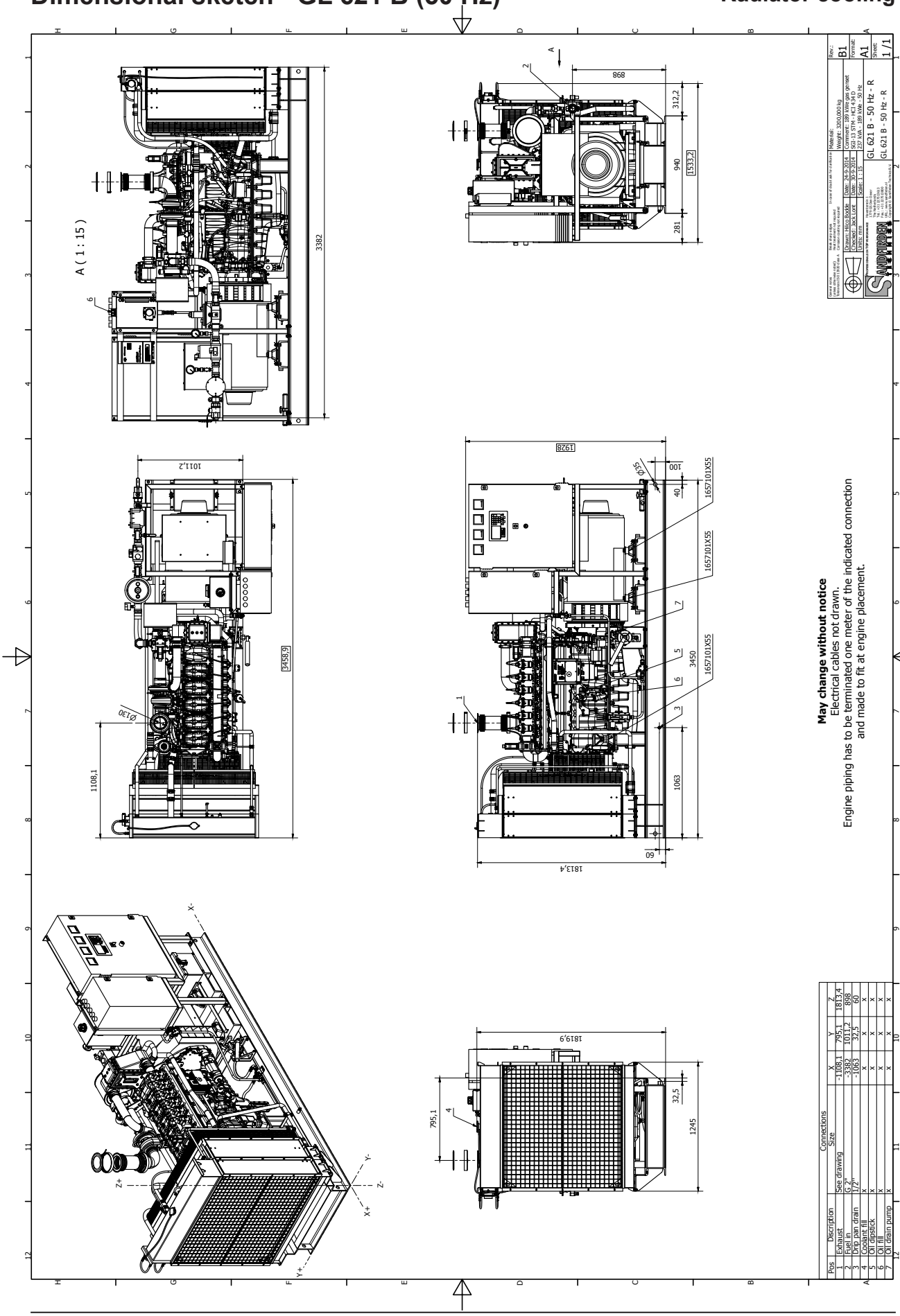
RATINGS

Class - Temp Rise			Cont. F - 105/40°C				Cont. H - 125/40°C			
50 Hz	Series Star	V	380	400	415	440	380	400	415	440
	Parallel Star	V	190	200	208	220	190	200	208	220
	Series Delta	V	220	230	240	254	220	230	240	254
	kVA		300	300	300	300	325	325	325	325
	kW		240	240	240	240	260	260	260	260
	Efficiency		93.9	94.1	94.2	94.3	93.6	93.8	93.9	94.1
	kW Input		256	255	255	255	278	277	277	276
60 Hz	Series Star	V	416	440	460	480	416	440	460	480
	Parallel Star	V	208	220	230	240	208	220	230	240
	Delta	V	240	254	266	277	240	254	266	277
	kVA		350	363	375	381	381	394	406	419
	kW		280	290	300	305	305	315	325	335
	Efficiency	%	93.9	94.0	94.1	94.2	93.6	93.7	93.8	93.9
	kW Input		298	309	319	324	326	336	346	357

Class - Temp Rise			Standby - 150/40°C				Standby - 163/27°C			
50 Hz	Series Star	V	380	400	415	440	380	400	415	440
	Parallel Star	V	190	200	208	220	190	200	208	220
	Series Delta	V	220	230	240	254	220	230	240	254
	kVA		345	345	345	345	358	358	358	358
	kW		276	276	276	276	286	286	286	286
	Efficiency		93.3	93.5	93.7	93.9	93.1	93.4	93.5	93.7
	kW Input		296	295	295	294	308	307	306	306
60 Hz	Series Star	V	416	440	460	480	416	440	460	480
	Parallel Star	V	208	220	230	240	208	220	230	240
	Delta	V	240	254	266	277	240	254	266	277
	kVA		406	419	431	444	419	431	444	456
	kW		325	335	345	355	335	345	355	365
	Efficiency	%	93.3	93.5	93.6	93.6	93.1	93.3	93.4	93.5
	kW Input		348	359	368	379	360	370	380	390

Dimensional sketch - GL 621 B (50 Hz)

Radiator cooling



Dimensional sketch - GL 621 B (60 Hz)

No drawings available!

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CE

DECLARATION OF CE COMPLIANCE AND INCORPORATION

Sandfirden Technics BV declares hereby that the below mentioned generator set

GL 621 B

complies with the following International Standards and Directives:

- **EC Machinery Directive 2006/42 EC, dated May 17, 2006**
- **EMC Directive Nr 2004/108/CE, dated December 15, 2004**
  as intrinsic levels of emissions and immunity are concerned
- **Low Voltage Directive Nr 2006/95/CE, dated December 12, 2006**
- **ISO 8528 - 5, dated July 15, 2005**
  Reciprocating internal combustion engine driven alternating current generating sets
  - Part 5: Generating sets

This Generator set, manufactured by Sandfirden Technics BV, is supplied solely to be part of a complete installation.

The here above mentioned generator set should not be commissioned until it has been incorporated into an installation, together with relevant CE marked machinery, which has been declared in compliance with the relevant Directives.

Bart Bakker
Director, Sandfirden Technics BV

Den Oever, August 1, 2014

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Printed in The Netherlands

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