



THL series diesel gensets

Manual for users

Please read the manual before operation, for the manual contains all the information you need to operate and maintain your genset safely and effectively. It also can help the genset to work longer and smoother for you.

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Safety Regulation

Please read this instruction before use the gen-set. For it contains all the information you need when you install, operate and maintain your set, and assure the safety and effect when you operate.

◆Fuel is easy to burn; improper operation will cause fire and explosion

When the set is working, fill the fuel tank is forbidden, as it is very dangerous that fuel touch with diesel engine and exhaust.

Smoking and firing is forbidden, for the fuel is inflammable.

Please check the fuel pipe is fixed and no leaking.

Please assure all the pipes having valves.

Smoking is forbidden when battery is overhauled. Lead-acid battery can bring hydrogen which is explosive.

◆Fatal exhaust gas

Please assure a proper exhaust system, and check the system frequently to avoid leakage.

According to the maintenance schedule, to check and assure the pipes are stable. Exhaust gas can't be used to warm house.

Please assure the ventilation is unblocked.

◆Operating machine can cause accidents.

Please keep away from the running machine, such as your hands, clothes and metal accessories.

Please disconnect the battery loop before you maintain and service for the gen-set. To avoid unexpected start up, please disconnect negative wire firstly, and then disconnect the positive wire.

Please check the stable degree of all components. Please check brackets and pipe clamps are fixed, and the shields of gadgets are going to driving belt and fan.

Don't wear loose clothes and metal accessories. For loose clothes can be sucked into whirling machine, while metal accessories can cause the short of electric terminal.

Please apart from hot and rotational components, when the working set needs adjustment.

◆Electroshock can cause heavy wound and death

Please disconnect the electricity before you open the cover of electric equipments. Put dry wood board on the metal floor near the equipments and use insulating mat. Wet clothes (especially wet shoes) and skin are forbidden.

Please pay more attention on high voltage when operating.

Please comply with the rules, all the operation and maintenances are operated by a trained and certificated technicians. To avoid the unexpected close, please put a label on an open switch.

Any commercial electricity can't connect with genset directly. Or it can produce a dangerous voltage. Thus we need to connect an approved isolation switch or an approved parallel system.

◆Common safety precaution

The boiling point of cooling water in genset is too high. Please don't open the cooling tank or the pressure head of heat exchanger when genset is not working, if you want to relief pressure, please cooling the genset first.

Some cancerogenous substances are discovered in fuel, such as benzene and some leaded substance, please don't suck or contact with the fuel.

Safety Regulation

Some cancerogenous substances are discovered in used lube. Please don't suck or contact with the fuel when you checking or exchanging lube oil.

Put fire extinguishers in a convenience place. Foam extinguisher can't use to put out electric burning.

Keep rag from genset.

Keep the surrounding of genset clean and dry, and remove all the blocks.

Operating when you tired or drunk is forbidden.

Preface

This manual contains all the information of installation and operation, maintenance and service, faults tracing and solutions of THL series standard gensets. Manual introduced the working principles and some parameters. Please read this manual as well as the attached files, such as diesel engine manual, generator manual, before install, operate and maintain your genset.

It's strongly recommended that the operation, maintenance and service of a genset should be done by a trained and certificated technician for the long and smooth running.



Genset attached many precise components. Please prevent damages of components. Any electric welding when installation and maintenance need to consult us.

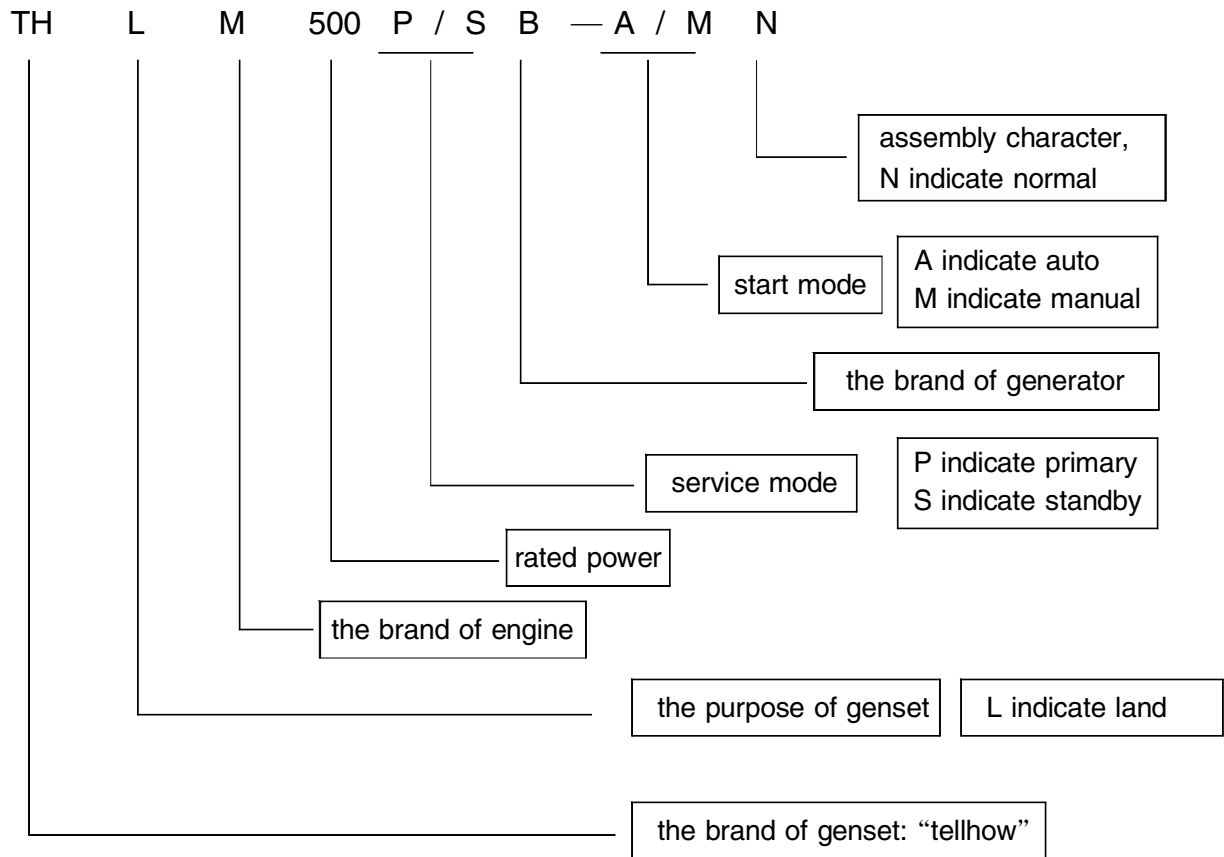


To prevent any accidents, please don't open the genset before you read the manual.

Chapter 1 Purpose And Operate Condition

- ◆ THL series diesel genset is a stationary generating set, which is assembled by diesel engine, generator, control panel, radiator (heat exchanger), and coupling. It's designed to apply to different occasions and purposes, such as factory and mine, department, schools, buildings, hotels, military, hospitals, construction sites, oil field, telecommunications, as primary or backup power. Various types of diesel gensets can be designed with relevant configuration to meet customers' different need. ATS and auto refuel system provide auto unattended primary and emergency power supply mode, as well as the remote control function, and actualize the auto transfer between genset and main load, genset and genset.
- ◆ If the altitude under 1000 meters, ambient temp between $+5^{\circ}\text{C}\sim+40^{\circ}\text{C}$, and relative humidity is 60%, Genset can run continuously for 12hrs in rated mode (which contains overload 10% running 1 hr). When the working hour exceeds 12hrs, the output power will be adjusted to 90% of rated power, and the power can't higher than the rated power of genset.
- ◆ If the parameters are above the mentioned parameters, then the output power of diesel engine should be adjusted according to the diesel engine manual, while the generator's according to GB755-2000 "rotating generator rated parameter and performance".
- ◆ Please don't operating genset when conductive dust and corrosive gas filling in air. Even though genset is waterproof and mould proof.
- ◆ Highland genset can run continuously for 12hrs in rated mode (which contains overload 10% running 1 hr), when altitude is 4500 meters. Ambient temp between $-40^{\circ}\text{C}\sim+45^{\circ}\text{C}$, and relative humidity is 60%. If the working hour exceeds 12hrs, the output power will be adjusted to 90% of rated power, and the power can't higher than the rated power of genset.

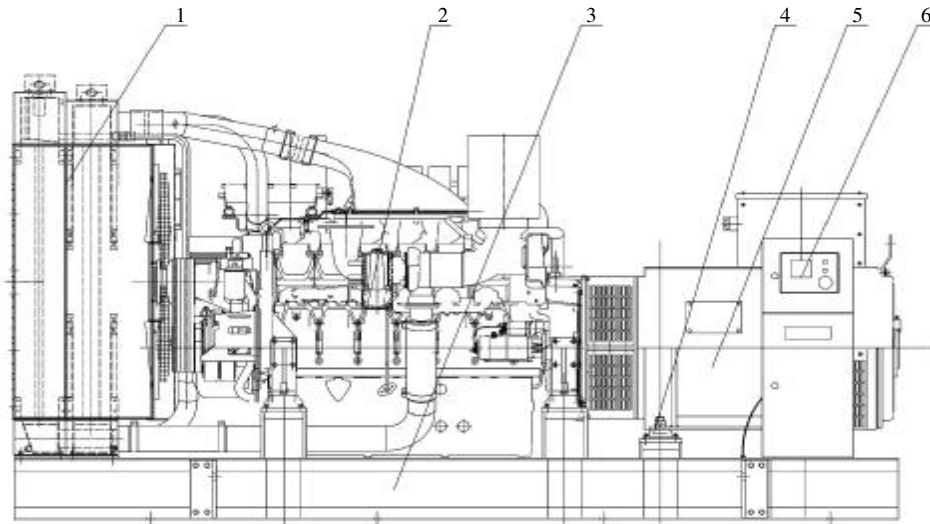
Chapter 2 General Introduction



Chapter 3 Main Technical Performance

- ◆ When the voltage of genset between 95%~100% of the rated voltage, power factor between 0.8 (lagged) ~1. when 3-phase symmetry load is changing slowly or suddenly in the range of rated load which is between 0~100%, or 100%~0, genset can achieve the parameters as follows:
 1. steady voltage regulation factor: $-2.5\% \sim +2.5\%$
 2. steady frequency regulation factor: $\leq 5\%$
 3. transient voltage regulation factor: $-15\% \sim +20\%$
 4. voltage stable time: $\leq 1.5S$
 5. transient frequency regulation factor: $-10\% \sim +10\%$
 6. frequency stable time: $\leq 5S$
 7. voltage fluctuate factor: $-1\% \sim +1\%$
 8. frequency fluctuate factor: $-0.5\% \sim +0.5\%$
- ◆ The rated voltage of no load voltage is 95~105%.
- ◆ In rated mode, the voltage change from cool to hot is less than $\pm 2\%$ of rated voltage.
- ◆ In no load state, voltage and frequency are rated, the line voltage waveform deviation factor of brushless generator is less than 5%, and the factor of brush generator is less than 10%.
- ◆ Under rated power factor, genset has some 3-phase symmetry load, add 25% resistive load of rated phase power on any phase, while the total load current of the added phase can't exceed the rated value, the genset can work normally. In that case, the difference between the max (or min) voltage and the average value of 3-phase line voltage can't exceed 5% of the average value of 3-phase line voltage.
- ◆ The genset can parallel operate, in rated power factor and the load range between 20~100% of total rated power, 2 sets are same model and capacity can parallel operate stably, and actualize the exchange between active power and reactive power. The allotted difference of active power and reactive power, are less than $\pm 10\%$.

Chapter 4 Configuration



Graph 1 outline of land using genset

1 radiator 2 diesel engine 3 base frame 4 generator 5 absorber 6 control panel

Genset is made of diesel engine, generator, control panel, radiator, coupling and base frame. Diesel engine and generator are connected by a resilient shaft coupling. The flywheel of diesel engine drives generator by the help of coupling. The flywheel housing of engine and the end shield of generator connected by flange and screw. This method assures the axially between engine's crankshaft and generator's rotor. It also absorbs the shock bring from start, stop and load change. Absorbers are fitted between engine, generator and base frame.

Diesel engine coupled with charging generator and charging regulator. You can charge the accumulator when genset is working. And the genset keeps and regulates the output voltage in the rated range automatically. The cooling system of engine is closed circulating water cooling.

Chapter 5 Lifting Of Genset

Please use tight wire or rope with proper length and lifting capacity to lift the genset. To avoid accident, please operate carefully, for genset will tilt a little when lifting.



Wrong lifting method and wrong wire or rope will cause serious accident and equipments damage. The rings on engine and generator can't used for lifting whole set.

Chapter 6 Working Principle

The working principles please refer to:

- (1) Operating instruction of diesel engine
- (2) Operating instruction of generator
- (3) Operating instruction of control panel

Chapter 7 Installation

1. Base and installation

1.1 installing factors

The main factors of installing a genset: floor's burden, the position of the aisle and maintenance and service, shock, ventilate, exhaust pipes' connection and heat insulation, noise reduction, dimensions and position of fuel tank, and also the Environmental regulation of your state.

1.2 antishock devices

For THL series diesel gensets, we installed efficient damper. This device absorb 85~90% shock of genset. Meanwhile, we sent along exhaust system bellows which insulate the shock from exhaust system. When you installing the genset, please apply some essential shockproof measure synchronistically, such as soft connecting of output cable, evase ventilate pipe, suspending installation of exhaust system.

1.3 base requirements

There is a set of high efficient damper in each THL series diesel gensets, so the genset needn't special base. You can install the genset on floor or mattress which is enough intensity. The floor must horizontal and smooth, and the flatness is $\pm 5^\circ$, and the floor should burden 1.5~2times of genset weight in steady.

If the floor can't meet the burden, please use concrete base. This is a simple, reliable and cheap method. Please refer to the following formula to design and calculate the thickness of the base:

$$FD=W/(D \cdot B \cdot L)$$

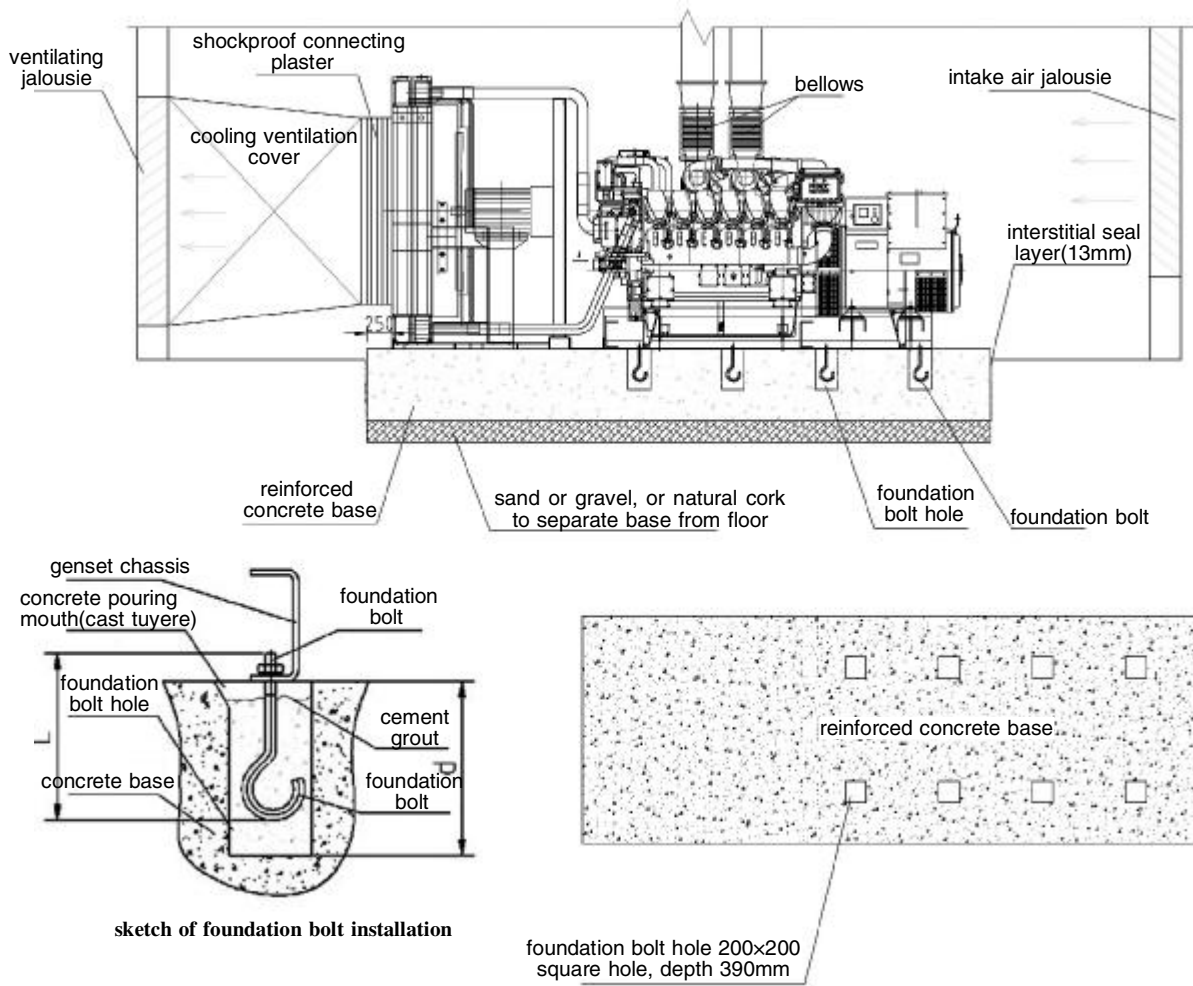
FD=thickness of base, M

W=gross weight of genset, Kg

D= Concrete intensity, 2403Kg/M³

B=width of base, M

L=length of base, M



Graph 2 constructions drawing of genset base

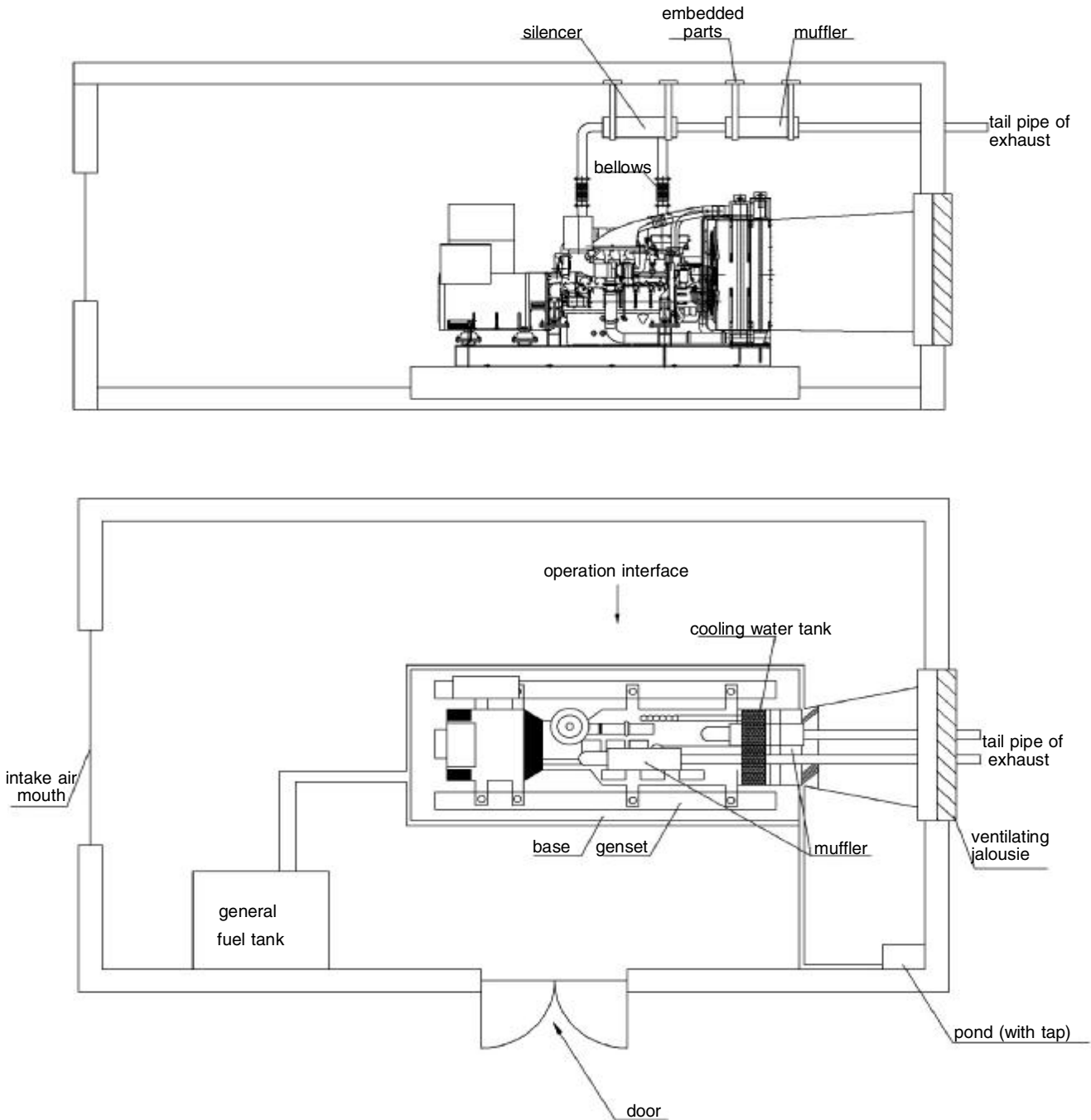
Concrete base should be higher than floor 100~200mm, and form a base.

When you pouring concrete please focus on:

1. Assure the concrete base is horizontal
2. Assure the base can burden the weight of the genset.

2. Genset installation

2.1 installing sketch of machine room



Graph 3 installing sketch of machine room

Machine room must be big enough to let the air recycle freely. Big room also can assure the good performance of genset, reduce the power loss, and prolong the life of genset. Combustibles and explosive materials are forbidden in the machine room. And other materials which are easily being inhaled into genset shouldn't put in this room.

For the installation of common genset, please assure the back pressure is less than rated value, the mouth of inlet air and exhaust air must meet the technical specification, and prevent the reflux of warm air, and enough room for maintaining.

Some gensets need to install standby fuel tank inside of machine room. Please separate the tank from the main room, and meet the requirement of environment and fire departments.

There is enough inlet or exhaust air hole. If the cooling value of the air is not qualified, please install additional exhaust pipe or separate water tank. We recommend you to reserve enough room for operating, maintaining and ventilating around and over the genset.



Please reserve enough room for operating and maintaining, when auto load transform system (ATS) or synchronization system are installed in the same room.

2.2 cable connecting

Considering the convenience and safety, when you connecting the cable of genset to ATS, switchboard and parallel cabinet, we recommend you to pave cable into cable channel in advance, and apply for some methods to prevent penetrant and electric loss. Electric connecting must be reliable connecting, prevent loosen and break caused by shock and the ageing or cracks of isolation.

3. Fuel supply system

3.1 Fuel

The elements of fuel have played an important role to ensure the normal performance and the useful life of diesel engine and the component of discharge. To gain the rated power, fuel economy and meet the discharge standards of local environment department, please use the clean light fuel which should meet the standards of Chinese and international. In china, common 0# clean diesel is ok. While the genset should assemble the oil water separator, and apply for some measures to anti freeze and congeal. The oil water separator should discharge water and other impurity periodically changing the filter core if necessary.

Most of the fuel will transform and deposit after long time storage. For standby genset, it's recommend to store some fuel for several hours continuous working. Thus, the best maintenance period to clear the fuel tank completely is 18 months.

3.2 Fuel tank

The capacity of fuel tank should design according to the fuel consumption of full load. The following aspects should be noted when you make the tank:

① To ensure the thorough discharge of water and heavy impurity, fuel discharge mouth should be in the bottom of the tank. Please keep the clearance of fuel, and the distance of oil outlet (inlet set) and tank bottom is no less than 50mm. to ensure the pure of fuel, any water and other impurities are forbidden in combustion chamber.

② To avoid the reduction of burning efficiency and prolong the working time and useful life of diesel engine, the hot oil of vitta and air can't enter into the oil outlet and engine directly. Thus the min distance between oil outlet and oil return mouth should be 300mm. Generally, oil suction is lower than oil transfer pump, while the vitta is higher than oil transfer pump. However, to avoid the pressure difference too large, the former distance can't less than 1000mm, and the latter distance is 2500mm (different engine, the value will be different). For the difference has played an important

role to ensure the normal performance of oil transfer pump and the normal supply of fuel.

③ Additionally, please add a drip pan with a little inclination in the tank bottom to collect the overflowing or leaking oil.

④ Vent pipe is necessary in the tank top, to exhaust the foul gas and balance the air pressure timely.

⑤ Steel board is the best material of fuel tank. To avoid the chemical reaction between fuel and tank material, and form impurity and worsen fuel subsequently, painting and galvanizing is forbidden. Copperplate and galvanized sheet can't be the material of tank.

⑥ The capacity of tank according to the set working time and the requirement of local fire department. If the fuel tank is lay in the machine room, an insulating wall is necessary, and a fire door is added.

The formula to calculate the tank capacity as follows:

Capacity (L) = rated power of engine (KW) × fuel consumption of engine (L/KW.H.) × refuel period (H) × 1.2

3.3 oil pipe installation

The material of oil pipe should be black iron seamless steel tube, can't be galvanized tube. The channel of pipe should keep away from the heat bring by the engine. The max temp of fuel before the injection pumps between 60°~ 70°. Different type, the temp will be different. It's recommended to apply flexible joint between engine and vitta, and make sure the vitta is no leaking.

4. Lubrication system

The main function of lube is to lubricate and cool the moveable components of the gensets.

5. Exhaust system

The exhaust gas and smoke create by the working genset can't affect the surroundings. So the exhaust system should be good designed and installed. The system must contain no less than one muffler. The THL series diesel gensets assembled industrial heavy-duty muffler.

To avoid the high temp in machine room, ensure a good running environment and no scald of operators subsequently and also decrease the noise of exhaust system and turbocharger, contracting thermal insulation muffling materials on the exhaust air ducts is necessary. On the out end of the duct should be waterproofed, such as cut a proper angel on the duct end or add waterproof cap on it.

The number of elbows and total length of exhaust duct should as small as possible. Or else, the exhaust back pressure will be higher and lead output power loss, affect the normal operation and short useful life of genset. The pipe diameter in the genset specification usually is based on the exhaust pipe length (6m) and one elbow and one muffler at most. In actual installation, the length of pipe and the number of elbows are more than the prescript in specification, please increase the diameter accordingly. The range depends on the length of pipe and the number of elbows.

The first duct from the exhaust main pipe of turbocharger must contain a section of flexible bellows which was sent along with the genset. The second part of the exhaust pipe should be flexible supporting, to prevent the incongruous installation, and the side press and compressive stress created by the relative displacement of exhaust system in thermal effect of working genset. All the supports and suspending equipments should flexible.

When the machine room has several sets, please design and install the exhaust system separately for each set. Common exhaust pipe for several gensets is forbidden. For different set has different exhaust pressure, the common pipe will cause abnormality and add the exhaust back pressure. Foul air and smoke will return through common pipe, and affect the normal power output, even damage the gensets.

5.1 exhaust muffler

THL series diesel gensets assembled industrial muffler. Please choose following mufflers if necessary:

① industrial heavy-duty muffler

To silence high frequency noise, be fit for common area.

② residential muffler

To silence middle or low frequency noise, be fit for the area with high demanding of environment.

5.2 exhaust pipe

The thickness of exhaust pipe can't thinner than 2mm.it's recommended to choose steel pipe with low thermal expansion parameter. If condition permit, all pipes should be contracted thermal insulation muffling materials. Especially, in those places easily burn the operators.

Usually, the pipe increase per 6m, the sectional area of pipe should be increase 4~6%.

Elbows should be calculated in the total length of the pipes. The method is: the length of elbows with 90°equal to 2.5~2.8 times of the pipe's outer diameter.

The corresponding length please according to formula (1):

$$L=2.5 \times D \quad (1)$$

L= corresponding length of the pipe

D= pipe diameter

Formula (2) used to calculate the exhaust back pressure:

$$P = \frac{1.98CLRQ^2}{D} \quad (2)$$

P= the pressure of mercury.

C=0.00059(exhaust flow of engine is 100~400cfm)

0.00056(exhaust flow of engine is 400~700cfm)

0.00049(exhaust flow of engine is 700~2000cfm)

0.00044(exhaust flow of engine is 2000~5400cfm)

L=length of the exhaust pipe (m)

R=exhaust density per cube (kg/m³)

$$R = \frac{39.2}{\text{temp of exhaust air} + 273.3^{\circ}\text{C}}$$

Q= exhaust flow per minute (L/min)

D= diameter of pipe (mm)

5.3 installation of exhaust pipe

If the exhaust pipe need to through the wall, a flexible expansion joint is necessary. Otherwise, exhaust pipe will be longer for the affection of thermal expansion and cold shrink, and create side pressure and compressive stress which affect the stability of the exhaust system, speed up the abnormal consumption of the exhaust and supercharge system, and break the wall.



When installing the pipe, no side pressure, no compressive pressure and no lifting force is best, so please keep the bellows trip free release.

5.4 reduction of exhaust resistance

The total exhaust back pressure will be reduced, if exhaust air and smoke flowing freely. If the exhaust back pressure of diesel genset is over large, it will lead the output power loss, the

performance and life time will be shorter.

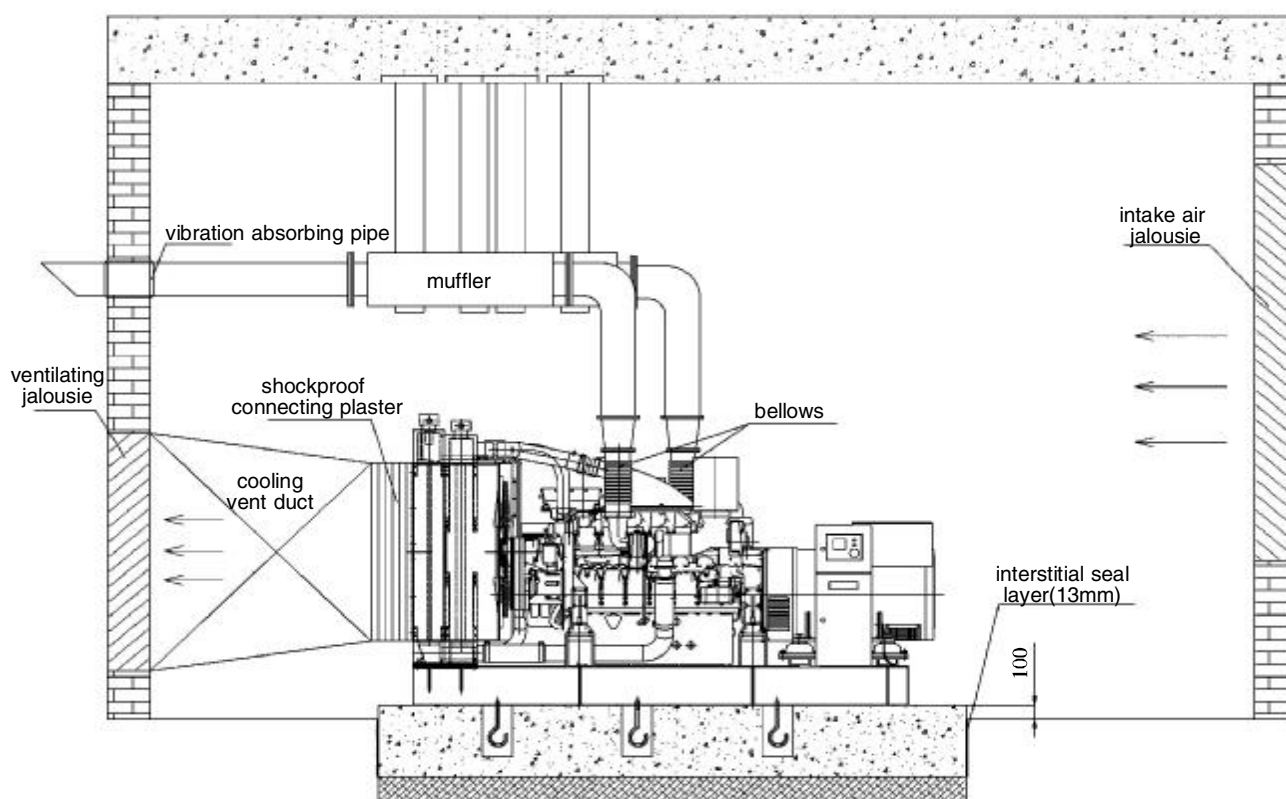
The main factors to lead the high exhaust back pressure of genset:

- ① the diameter of pipe is too small
- ② the length of pipe is too long
- ③ the number of elbow is too many
- ④ the smooth degree inside of the pipe is too low
- ⑤ the muffler resistance of exhaust system is too big
- ⑥ the high back pressure caused by some critical length

THL series diesel gensets assembled industrial muffler solved the question about exhaust resistance when we're design it. The data of max exhaust back pressure mentioned in some relative specification eliminated the harmful affection of muffler. When designing and installing the exhaust system, you needn't consider the exhaust resistance created by the device. The length of exhaust pipe, elbows and the smooth degree inside of the pipe, affect the value of the back pressure directly. Therefore, increase the diameter of pipe accordingly is a good method to avoid the back pressure created by overflowed resistance. The max back pressure value of different type will be different. Please refer to the attached file 《Genset Technical Parameter》. The pipe's length and the elbow's number also affected by the condition of machine room. Please ask the manufacturer for details.

6. Cooling and ventilation system

6.1 the venting system of machine room



Graph 4 ventilation system of machine room



Ventilation system has played an important role to affect the output power, consumption of fuel, exhaust of heat airflow and useful life.

When THL series diesel gensets working, clean air is sucked into combustion chamber and mix with fuel and create power by burning. Thus genset has been driven. Meanwhile, abundant of heat air is created when genset working must exhaust out of machine room, it will consume lots of cool air. Therefore, standard genset must possessing recycle water cooling or oil cooling system in itself, the cooling and ventilation system of machine room is necessary. Please make sure there is enough air flowing in the machine room to renew the cool air burning in the engine and exchanging with the heat air in machine room so that the temp in the machine room near the environmental temp and keep the genset temp in normal working range. If the dimensions of inlet and outlet air in your machine room can't meet the requirement of the manual, please apply imperative vent mode to meet the need of normal burning and cooling of genset.

In building, the vents always assembled with jalousies and metal safety mesh curtains. When calculating the size of air inlet, please take the useless section of jalousie and metal curtain. In winter, genset is in standby mode, it running occasionally. However, the temp in machine room must keep proper temp, to prevent the freeze of cooling water, and affect the normal startup or damage the genset. Thus, the vents must be regulable so that the vents can be closed be auto or manual when genset stopped. Additionally, install the attached water tank heater is better, and keeps the heater working.

6.1.1 Air inlet

The proper position of air inlet should meet: the density of dust is as low as possible; no impurity nearby. If condition permits, the inclined top near the control penal is the best choice. Install jalousie and metal safety mesh curtains on it to insulate impurity and ensure the cross-ventilation. To prevent the return of thermal air, air inlet should far away from air exit, and let the air flow directly. Air inlet should be preventing to keep rain and other impunities away. For general recycle water cooling diesel gensets with closed type, the min net dimensions of air inlet is not less than 2 times of the effective area of radiator core of gensets. If the dimension is too small, the air inlet will be reduced and the temp of genset will rise consequently. And affect the genset work, the power output, the maintained period and the useful life.

6.1.2 Air exit

If the air exit installed jalousies and metal safety mesh curtains, please make sure the min net dimensions is not less than 1.4 times of the effective area of radiator core. The centre of the air exit and the centre of radiator core should be concentric. And the ratio between width and length of air exit is in consonance with the ratio of radiator core. To prevent the return of thermal air and the outspread of mechanical shock, it's recommended to install flexible damping trumpet-shaped ventilate channel between radiator and air exit.

6.1.3 Air recycles

Good ventilation system must ensure enough air to inflow and outflow, and recycling freely in the machine room. Thus, the machine room should be big enough, and keep the temp steady and air flowing smoothly in the room. If condition permits, ventilation system should be inflow and outflow directly, and prevent the thermal air return to the machine room absolutely.

6.2 Cooling system

The cooling system of THL series diesel gensets can be divided into 3 types to meet customer's need:

- ① water cooling with closed recycling fan
- ② separate heat exhaust system
- ③ heat exchanger cooling

6.2.1 Water cooling with closed recycling fan

Usually, the standard configuration of THL series diesel gensets contain closed recycling fan water cooling with water tank inside. Totally, cooling system contains cooling water system and cooling air system.

When radiator is installed in the end of engine, to place the genset, radiator core should near the air exit just as the preliminary requirement (it's recommended the max distance between radiator core and exit is 150mm). Otherwise, thermal air will be return.

If the genset can't be placed as mention method, a canvas ventilating channel with steel flange must be installed in the system so that the radiator and ventilating jalousie can be connected.

The elbows of ventilating channel must have perfect curvature radius. If long flowing pipe is necessary, the sectional area must increase, to decrease the back pressure of radiator. The channel to attenuate the noise asks long flowing and the design must according to the building.

6.2.2 Separate heat exhaust system

When genset be installed in the basement, the actual space may limit the use of ventilating channel. In this case, we usually apply for other cooling method.

The cooling system with divided cooling water tank is a choice we recommend. In this system, radiator is separate from genset, electric fan used to cooling. This system can be used as a totally enclosed unit in the wild, and as a room device in open mode. To ensure the synchronous working of electric fan and genset, we recommend customer apply genset output power as the power source of electric fan.

When radiator is installed over 3m or the horizontal distance is over 10m, a separated water tank and an electric water pump is necessary. The measure of separated tank depends on the capacity of cooling system that is needed pipes plus cooling water consumption.

Cooling water is driven by an electric recycling pump and recycling from divided tank to radiator and genset. Usually, the power source of radiator fan and water pump motor is genset. Their consumed power should be calculated into output power of genset. When genset is not working, the cooling water will inflow to water tank from radiator. When genset is working, keep enough cooling water in tank, to assure the good performance of cooling system.

Notes: ① prevent any impurity into coolant

② the overflow of divided water tank may cause the oxygenation of coolant

③ air can't stay in this system, so the venting pipe is necessary.

④ proper water treatment is necessary to meet the working requirement of genset.

⑤ prevent the coagulation of coolant

⑥ make sure coolant flowing freely (no press) in genset

⑦ if radiator and genset are in the same level, then divided tank is useless. An expanding water tank over the radiator can be used instead. The expanding tank allow the water expanding be heated and replace the cooling water.

6.2.3 Heat exchanger system

Another method is heat exchange cooling method which can be divided to 2 modes, one is

standard heat exchanger cooling, and the other is divided water tank with heat exchanger cooling. The essential room of this system less than divided water tank cooling. The closed water channels of this system using the ball valve of supplement water tank to auto replace the losing cooling water in vaporization, to ensure enough cooling water in this system.

THL series diesel gensets can assemble heat exchanger to meet customer's requirement. Heat exchanger can be used in many occasions, such as: the area where water may be polluted, the occasion where cooling water supplied by cooling tower or storage water tank. However, the water flowing from heat exchanger can't be used in home.

For the water outflow the cooling system will inflow waste water pipe, drinking water can't be use in heat exchanger. Please keep the water pressure of heat exchanger near 0.14MPa.

Full ventilation in divided water tank cooling system or heat exchanger cooling system is necessary. For the burning in engine need enough air, and the ventilating in machine room and the cooling of radiant heat bring from genset need air too.



To divided water tank cooling system and heat exchanger cooling system: some engines with turbo charge and (air to air) supercharge cooling system can't apply divided water tank cooling system. While some engines with (air to water) supercharge cooling system are fit for this system.



The engine with (air to air) supercharge cooling system apply the heat exchanger cooling system, will lead output power loss.

6.2.4 Cooling water treatment

In low temp area, cooling water may be frozen, so the anti-frozen measure of cooling water in genset is necessary. The detail is: when you pouring the pure cooling water into genset, please add antifreeze fluid contains 40%~60% ethylene glycol at the same time. The best solution is homogeneous mixing water and antifreeze fluid in special container firstly, and preheats the genset after pouring.

Install a jacket water heater for genset will be better. The power of jacket water heater is main load 220VAC or 1-phase/3-phase voltage 380VAC. When genset is stopping, the heater can auto heat the water according to the ambition temp and water temp in genset, and keep the water temp in genset between +5~+40°C.

In the non-frozen area, it's recommended to homogeneous mixing cooling water and anti-rust fluid with proper proportion to avoid pipe rust, and ensure the smooth recycling of water and the good performance of cooling system.



To prevent the metal rusting in cooling system, anti-rust fluid in pure water is necessary.

7. Reduction of noise

In the area with high demanding of environment, you should pay more attention on decreasing noise and reducing pollution when you installation.

Common measure to decrease noise:

- ① apply noise reduction machine room
- ② apply soundproof or super soundproof genset

The noise pollution created by working genset can be divided into 2 aspects: noise transmission created by machine and noise transmission created by air. The former is vibration expanding from genset to brace structure, such as cement base, or to linkage structure. The noise intensity depends on the balance degree inside genset, shock insulation degree of bumper system, the quality of machine and the shocking frequency of genset.

In order to effectively control the noise transmission by air, following 3 parts is very important:

- ① exhausting noise

It's the obvious noise exhaust from machine room. Install a high efficiency muffler such as high efficient residential muffler to control. Additionally, to reduce the exhaust noise more efficient, and decrease the noise and gas pollution from working genset, please design and install the exhaust system higher than normal so that the pollution can be exhausted to the higher place of the building top. In principle, the distance between vent and the highest building in the circular with the diameter of 60m is no less than 5m. Meanwhile, to gain the better reduction effect, the exhaust system in the machine room should be contracted thermal insulation materials.

- ② machine noise

Silence treating all circulating parts of the machine room, then the machine noise will be reduced furthest. Detail measures are: install high efficiency mufflers which are special for diesel genset on air inlet and air exit; install special silencing door for machine room. If the width and height is enough, the condition for air inlet and exhaust is good, and requirement for environment is high, please apply secondary muffling measure for inlet and exhaust equipment, and make special muffling room for air inlet and air exit. If requirement is higher, please stick proper muffling materials on the walls and ceiling of the machine room additionally.

To resist the transmission of machine noise, please choose proper thickness and frame for the walls of machine room. More detail please contact with local agent and franchiser, or contact with the manufacturer directly.

To avoid the operator working in the noise, all startup control screen, gauges and switchboards should be installed in a separate soundproof control room.

- ③ radiator noise

The measure is the same as the machine noise.

To reduce the expense, high standard is needless, please refer to the standard of local environment department and the operational requirement of itself when designing and constructing

To reduce the adverse effect of noise and foul gas, the position of machine room need far away from center area. Additionally, TH soundproof series is making of soundproof metal shell with reasonable design and reliable performance. This series decrease noise greatest and possessing the performance for all-weather. Trailer soundproof genset and truck type soundproof genset are adapting to outdoors, and meet the customer's requirement furthest.



wrong installation, operation, maintenance and replacement will cause serious accident and damage of the genset. Please operate by a trained and certificated people.



The genset isn't earthing when it out of the factory. Genset earthing must refer to the site condition. Wrong earthing and protection will cause serious accident.

Chapter 8 Preparation Before Start

- ◆ Check and make sure there is no abnormality of connecting fittings, fastener and control parts, such as loosen, fall and lock. Check and make sure the connecting joints of cable are fasten and correct, and no poor contact.
- ◆ Check the storage of diesel; make sure it's enough for running in set working time.
- ◆ Turn the switch from “fuel tank” to “fuel transfer pump”, and clean the air in fuel system with manual fuel pump.
- ◆ Check the oil sump and injection pump of diesel engine; make sure there is enough lube in governor.
- ◆ Make sure the cooling water in cooling tank is full.
- ◆ Set the main switch of genset on “off”.
- ◆ Check and make sure the circuit of electric start system is correct, and the capacity of storage battery is enough.

Chapter 9 Start Up

Details about start of genset please refer to the instruction of control system. After the genset working normally, close the main switch, work in load. Operators must monitor the gauges of voltage, frequency, current, and power, power factor, oil pressure, oil temp, and water temp, charge current and rotating speed momentarily. Any indicate value exceed the rated value, check and apply efficient measure immediately. After recovery, genset will work continuously.



When genset is working, you may need to open the cover board to check or regulate the controller. Some wire holders or components with electricity will show in air. To avoid serious accidents and genset damage, only trained operator with electric maintenance qualification can operate.

Chapter 10 Procedure For Normal Stop

- ◆ Decrease the load gradually, turn off the main switch.
- ◆ In no load state, transform rotate speed to idling gradually, after the temp of water and oil in genset under 70°C, and then stop the genset.

Chapter 11 Parallel Operation

When genset parallel operating (apply manual standard synchronous method), it must meet following conditions: same phase sequence, same voltage, same frequency and same phase.

- ◆ Parallel operating procedure
- ◆ According to the principle of same phase sequence, correctly connecting the parallel circuit of 2 sets, and then start the 2 sets respectively in term of the startup steps
- ◆ Set “single– parallel” on “parallel” position, “auto–manual” on “auto” position.
- ◆ Setting the regulating difference rate of 2 sets by regulating difference potentiometer (usually, the regulating difference rate is set when genset out the factory), let the 2 ratio as same as possible.
- ◆ Close a main switch of one genset, regulate the voltage of the second one, and let them close to the rated value.
- ◆ Observe the synchron lights of rotating indicator on the 2 sets which are waiting to be paralleling, clockwise indicate the frequency of the 2 sets is fast while anticlockwise indicate the frequency is slow. For the gensets assembled synchronous meter, you can observe the synchron between two sets by the meter. After regulated the frequency of the two sets, the speed of rotating indicator lights decreased. After a indicator light over the rotating light is off, or synchronous meter indicate synchron finished, close the main switch immediately (during the regulating process, try to let the frequency near the rated value), and then the 2 set are paralleling at once.
- ◆ Power transfer during paralleling
- ◆ Change the position of the gun of diesel engine can actualize the regulation of active power. When decrease the gun, the active power transfer to another genset.
- ◆ Change the voltage potentiometer and regulating difference potentiometer can actualize the regulation of reactive power. When the potentiometers of a genset are rising, then the reactive power transferred to this genset. By contraries, the reactive power transferred to the other one.
- ◆ To keep the voltage and frequency of paralleling sets near the rated value, try not regulating largely on one genset during regulating the distribution of active and reactive power. Please balance the load between the two gensets.
- ◆ Step out the paralleling
When one set in the paralleling need to step out, firstly reduce the total load so that one set can burden. Secondly, transfer the load of the set which need to step out to the other one (emptying is not necessary), thirdly, open the main switch of the genset which is waiting out. And then the paralleling is finished. When single operating, switch “single– parallel” on “single” position.

Chapter 12 Maintenances And Services

Proper maintenance ensures the diesel genset runs smoothly with long duration and guarantees power supply. All the customers are required to perform the maintenance according to the following steps.

1. Before start-up

- ① Clean the surface of genset.
- ② Check the coolant liquid level in water tank.
- ③ The liquid level should be within the limit of 3cm under weld face of tank cover, please not overflow.
- ④ Check and make sure the core of water tank radiator and outside of intercooler are not blocked.
- ⑤ Disassemble the genset if it is dirty. Remove the protective equipment, take the charge valve off the genset, then take the intercooler off the radiator and fold it backward/upward. Clean it with detergent of low concentration, pay attention to the slice and protect it from damage.



Don't flush the genset with high -pressure water, assemble it correctly after cleaning.

- ⑥ Check air cleaner blockage



If blockage indicator is in red area, cleaner should be replaced as soon as the genset stops running. Press the red button to reset the indicator after replacement. The replaced air filter is not allowed to be reused. Check the cleaner every 8 hours when the genset runs continuously. Don't move the cleaner before the indicator is in red area.

- ⑦ Check the lubricant level of diesel engine



Make sure the liquid level is between maximum scale and minimum scale. Check the liquid lever every 8 hours when the genset runs continuously. The replaced oil filter is not allowed to be reused.

2. After start-up

- ① Check and screw bolts of all rotating parts, especially the connecting bolts of injection pump, water pump, belt pulley and fan. Fasten the foundation bolt.
- ② Check tri-leakage phenomenon and clear it when necessary.
- ③ Eliminate minor faults and abnormal phenomenon when genset is running.
- ④ Clean the dust on the core of air filter.
- ⑤ Check the liquid level of fuel and injection pump. Add qualified oil when necessary
- ⑥ Check the liquid level of coolant in water tank; add soft pure water when necessary. Clean the surface of genset.

3. Every 50 hours

In addition to the maintenance items above, the following steps are required:

- ① If clutch is in disengaged position, please lubricate the clutch release bearing. (Applicable for the

case of disengagement over 15 to 20 times everyday. Or every 400 hours.)it's recommended to use small amount of grease lubricant

② Check the battery

The liquid level should be 10mm above lead plate. Check battery voltage and charge it when necessary.



Please wear eye-protection glasses. There is explosive gas and corrosive vitriol inside the battery. Ignition near battery may cause explosion.

③ Check tri-leakage phenomena

④ Check tri-filter system. Replace it when necessary.

⑤ Check and adjust the tightness of fan belt.

⑥ Add or change the coolant in water tank when necessary.

⑦ Check the fastness of connection terminals of generator and electric parts.

4. Every 250 hours

① Replace oil (Discharge the oil when heating the genset.)



After initial running for 50 hours replace all the oil and filters. (Oil class is not lower than API-CE). Hot oil may cause scald.

② replace oil filter and bypass oil filter;

Use special tools to demount the filter. Make sure the new filter is filled with oil so as to empty the air inside, and then screw it by hands. Screw three or four turns after sealing plate is placed. Start the genset to check the oil-leakage, stop the genset to check the oil level.

③ Replace the air filter

④ Replace the diesel oil filter.

Use special tools to demount the filter. Lubricate the gasket and screw the new filter filled with clean diesel oil by hands. Screw one or two turns after sealing plate is placed.



No dust is allowed in the fuel system. Replace it after the genset is completely cooled lest the diesel spills onto the exhaust pipe and causes fire.

⑤ Check and adjust valve clearance

⑥ Check the temperature of genset bearing

5. Every 400 hours

① Check and fasten triangular belt

Unscrew the holding screw before fasten the belt conveyer of synchronous alternator. Belt between each pulley may be pushed down 10mm. Belts used in pairs should be replaced together. Fan belt is equipped with auto-fastening set

② Check and make sure the radiator and intercooler are not blocked. (If they are attached)

6. Every 800 hours

① If condition permits, please clean the grease accumulated in fuel tag thoroughly.

② Check and make sure there is no leakage in oil pipe of turbocharger.

③ Check and make sure there is no leakage at the interface part of air valve.

- ④ Check all the air valves and make sure they are not damaged. Replace it when necessary and screw tight all the screws.
- ⑤ Check the oil injector pressure and atomization. Clean the injector parts and adjust injector pressure when necessary. Replace the injector nozzle when it's invalid.
- ⑥ Check the advance angle of oil injection pump and replace oil inside.
- ⑦ Clean the fuel tank and pipe.
- ⑧ Clean oil sump tank and oil filter
- ⑨ Check and fasten the connecting rod bolt, main bearing stud and bolt of gas tank cap
- ⑩ Check the specific weight of battery electrolyte, add it when necessary.
- ⑪ Check and adjust excitation circuit.

7. Every 1200 hours

- ① Fulfill all the tasks need to be done after every 800 hours
- ② Check the valve clearance. Engineers and technicians who have been trained are required to do it



Stop the genset while checking.

8. Every 2400 hours or based on demand.

- ① Fulfill all the tasks need to be done after every 1200 hours
- ② Check the oil injection nozzle.



Engineers and technicians who have been trained and qualified required checking the nozzle.

- ③ let professional technicians check the turbocharger, and complete a general examination to diesel engine and its attachments.

9. Every 6 months

- ① Replace coolant filter

Turn off the coolant tap, demount the filter by special tools, replace a new one and turn on the tap.

10. Every 12 months

- ① Fulfill all the tasks need to be done after every 6 months
- ② If the genset is equipped with air compressor, please replace the air filter on it.
Steps: Turn on the valve clamp device, demount the filter and destroy it, install a new one and fasten the bolt.
- ③ Clean the cooling system/replace the coolant(Only for genset without coolant filter)
- ④ Check the leakage

11. Every 24 months

- ① Clean cooling system/ replace the coolant(Only for genset with coolant filter)
- ② Check the leakage

High coolant temperature are possibly caused by low coolant liquid level, temp valve malfunction, fan malfunction, and block in side cooler /radiator or other part of cooling system.

Remark: different genset, the maintenance step will be different. The details please change according to your genset.

Chapter 13 Usual faults and solution

Diesel engine

1. The engine does not start or runs too slowly

Reason	Processing method
A) Charge is not enough for battery.	A) Checking electrolyte level. You can supply it, if not enough. Charging the battery. Changing the battery, if necessary.
B) Main switch break.	B) Close the main switch.
C) One of semiautomatic protective tubes in the terminal box uncouples.	C) Pressing the button of the protective tube and making it reset.
D) Poor contact/ lines break.	D) Getting rid of all of the breaking faults and poor contacting faults. Checking if the contactor is oxygenized. If necessary, clearing them.
E) Key-switch faults	E) Changing key-switch.
F) Startup relay faults.	F) Changing the startup relay.
G) Startup motor faults.	G) Contacting the authorized officer.
H) Any faults in start lines.	H) Checking all the other start lines.
I) Water in engine.	I) Contacting the authorized officer. Don't try to start engine.
J) Lubricant oil temperature is low.	J) Fixing the lubricant oil pan heater.
K) The lubricant oil type is wrong.	K) Changing the lubricant oil and filter. Ensure make use of the right lubricant oil.
L) The other reasons influence the engine revolution.	L) Checking if the crankshaft can be flexible twist.

2. Engine is difficult to start, but exhaust smoke

Reason	Processing method
A) Engine's revolution is too low when startup motor drives it.	A) Refer to "can't drive or drive speed is low".
B) Engine's driving gears gear into engine.	B) Uncouple the driving gears.
C) Making use of the cold start gears is wrong.	C) Refer to our customer handbook "How to operate the cold start system".
D) Preheating is not enough.	D) Refer to our customer handbook. Checking semiautomatic protective tubes. If necessary, pressing the reset button and checking lines, chain button and preheating relays. If need change the preheating components, you must contact the authorized officer.
E) Fuel filter is blocked.	E) Changing the fuel filter.
F) Air in fuel system.	F) Getting rid of air in fuel. Screwing up the joint of fuel pipe and fuel filter.
G) Inlet line is blocked.	G) Clearing inlet line.
H) Gas handling system blocked.	H) Clearing air duct.
I) Water in fuel.	I) Changing fuel. Adding oil water separator.
J) The fuel type or grade is wrong.	J) Starting engine in a temporary fuel box in differentiate.
K) Injector fault or type is wrong.	K) Test or adjust pressure. Changing injector.
L) Sucker's and oil return tube's joints loose in injector.	L) Screwing up the joints.
M) Oil transfer pump faults.	M) Checking and repairing oil transfer pump. If necessary, you can change it.
N) Injection pumps fault.	N) Please request pump agent to check it.
O) Fuel feeding timing faults.	O) Looking over the injection pump's data and adjusting it.
P) Distribution timing faults.	P) Adjusting data and making it meet specification.
Q) Compression pressure is low.	Q) Refer to "Compression pressure is low".
R) Fuel cut-off valve is blocked.	R) Refer to "Fuel cut-off valve's faults may occur".
S) Discharge pipe is blocked.	S) Checking if discharge pipe is blocked.

3. Engine can start, No exhausted smoke

Reason	Processing method
A) No fuel in fuel box.	A) Adding fuel.
B) Stop electromagnet faults.	B) Checking stop electromagnet. If necessary, change it.
C) Fuel cut-off valve faults.	C) Refer to "Fuel cut-off valve's faults may occur".
D) No fuel is injected from injection.	D) Screwing off the fuel pipe from fuel pump to cylinder head. And the same time starting engine, checking if there is fuel outflow.
E) Oil transfer pump's and Inlet line's joints loose.	E) Screwing up all the pipe joints of filters from fuel box to fuel pump.
F) Fuel filter or inlet line is blocked.	F) Changing fuel filter, and checking if the fuel soft pipe is blocked.
G) No fuel in fuel pump.	G) Add fuel to fuel pump.
H) Gas handling system or discharge air system is blocked.	H) Checking if gas handling system or discharge air system is blocked.
I) Fuel pump's drive shaft is broken.	I) Contacting agent.
J) Gear pump is damaged or gears are abraded.	J) Contacting agent
K) Oil transfer pump faults.	K) Checking and repairing oil transfer pump. If necessary, changing it.
L) Jet hole of injection is blocked.	L) Checking, clearing and changing injection.

4. Engine starts but stops again

Reason	Processing method
A) Air in fuel system.	A) Getting rid of air in fuel. Screwing up the joint of fuel pipe and fuel filter.
B) Fuel system is leaked or blocked.	B) Checking fuel box's up rise.
C) Engine's driving gears gear into engine.	C) Uncouple the driving gears.
D) Fuel filter is blocked. Fuel is frozen because temperature is low.	D) Changing fuel filters, and add fuel heater.
E) Inlet line is blocked.	E) Clearing inlet line.
F) The fuel type or grade is wrong.	F) Starting engine in a temporary fuel box in differentiate.
G) Water in fuel.	G) Changing fuel. Adding oil water separator.
H) Preheating is not enough.	H) Refer to our customer handbook. Checking semiautomatic protective tubes. If necessary, pressing the reset button and checking lines, chain button and preheating relays. If need change the preheating components, you must contact the authorized officer.
I) Gas handling system blocked.	I) Clearing air duct.
J) Pressure pipe is damaged.	J) Fixing new pressure pipe.

5. Black exhaust smoke

Reason	Processing method
A) Gas inlet system blocked.	A) Checking if gas inlet system is blocked.
B) Injector faults or type isn't right.	B) Checking, adjusting or changing injector.
C) Cold startup system faults.	C) Fixing, checking and repairing cold startup devices. If necessary, changing it.
D) The fuel type or grade is wrong.	D) Starting engine in a temporary fuel box in differentiate.
E) Discharge pipe is blocked.	E) Checking if discharge pipe is blocked and dimensions are right.
F) Temperature is too low for engine.	F) Refer to "Coolant temperature is lower than normal".
G) Clearance dimension is wrong between gas gates.	G) Adjusting the dimension of clearance between gas gates.
H) Air duct leak between turbocharger and cylinder head.	H) Checking if oil return tube is blocked.
I) Oil return tube is blocked	I) Checking if oil return tube is blocked, twisted and hollowed.
J) Because temperature or altitude is too high, air is thin.	J) According to the engine sales handbook, modifying it
K) Fuel feeding timing faults.	K) Looking over the injection pump's data and adjusting it.

6. Low lubricant oil pressure

Reason	Processing method
A) Lubricant oil level is poor.	A) Checking if lubricant oil leak. Add or release lubricant oil.
B) Lubricant oil pressure gauge faults.	B) Checking lubricant oil scale.
C) Lubricant oil is diluted by fuel.	C) Checking lubricant oil pressure gauge.
D) Lubricant oil grade is wrong.	D) Changing lubricant oil. If lubricant oil is diluted by fuel again, Checking lubricant oil grade.
E) Lubricant oil temperature exceeds normal value. (120°C)	E) Checking, clearing or changing lubricant oil cooler.
F) Lubricant oil filter is smudged.	F) Changing lubricant oil filter.
G) Cranked bearing is abraded or damaged.	G) Checking or changing cranked bearing.
H) Lubricant oil pump is abraded.	H) Checking, repairing or changing lubricant oil pump.
I) Reducing valve isn't closed.	I) Changing reducing valve.
J) Reducing valve is damaged.	J) Changing reducing valve.
K) Inlet line faults on lubricant oil pump.	K) Checking, repairing or changing inlet line and clearing nutsch filter.

7. Reeking blue or white smoke.

Reason	Processing method
A) Lubricant oil type is wrong.	A) Changing lubricant oil and filter. Ensuring make use of the right lubricant oil type.
B) Cold startup system faults.	B) Fixing, checking and repairing cold startup devices. If necessary, changing it.
C) Temperature is too low for engine.	C) Refer to "Coolant temperature is lower than normal".
D) Lubricant oil is too much in engine.	D) Checking lubricant oil level.
E) Seal gaskets and bearings are abraded in turbocharger.	E) Repairing or changing turbocharger.
F) The fuel type or grade is wrong.	F) Starting engine in a temporary fuel box in differentiate.
G) Engine had been overhaul life.	G) Overhaul engine.
H) Cylinder head leaks water.	H) Checking cylinder head and cushion. If necessary, changing it.

8. Engine can not get rated speed.

Reason	Processing method
A) Engine load is heavy relative to rated power.	A) Reducing load or making use of low grade.
B) Tachometer faults.	B) Checking speed in hand tachometer or digit tachometer.
C) Control shaft of accelerograph be adjusted wrong.	C) Checking accelerograph excursion.
D) Inlet line is blocked.	D) Checking if inlet line is blocked. If necessary, changing it.
E) Speed governor faults or setting wrong	E) Checking and adjusting speed governor.
F) Speed governor's highest limited speed setting low.	F) Checking and adjusting speed governor.
G) Water in fuel.	G) Changing fuel. Adding oil water separator.

9. Engine can not stop.

Reason	Processing method
A) One of semiautomatic protective tubes in the terminal box uncouples.	A) Pressing the button of the protective tube and making it reset.
B) Poor contact/ lines break.	B) Getting rid of all of the breaking faults and poor contacting faults. Checking if the contactor is oxygenized. If necessary, you must clear it.
C) stop button faults	C) Changing stop button
D) Stop electromagnet faults.	D) Checking stop electromagnet. If necessary, you can change it.
E) Fuel cut-off valve faults.	E) Refer to "Fuel cut-off valve's faults may occur".
F) Oil return tube is blocked	F) Checking if oil return tube is blocked, twisted and hollowed.

10. High lubricant oil pressure

Reason	Processing method
A) Reducing valve isn't opened.	A) Changing reducing valve.

11. Low coolant temperature

Reason	Processing method
A) Coolant level is low.	A) Adding coolant.
B) Radiator is blocked or damaged.	B) Cleaning it as our customer handbook. If necessary, repairing it.
C) Radiator soft pipe is blocked or hollowed.	C) Checking soft pipe. If necessary, changing it.
D) Fan belt looses.	D) Checking belt's tightness, and screwing up.
E) Lubricant oil level is poor.	E) Adding or releasing lubricant oil. Checking lubricant oil scale.
F) Cool fan head is damaged or loosed.	F) Checking fan head. Repairing, changing or re-fixing it.
G) Radiator pressure head is damaged or type is wrong.	G) Checking radiator pressure head. If necessary, repairing it.
H) Thermometer faults.	H) Checking and repairing it. If necessary, repairing it.
I) The shutter of radiator didn't open enough.	I) Check/fix shutter. If necessary, change it
J) Air filter is blocked or type is wrong.	J) Checking and changing it.
K) Injectors faults or type is wrong.	K) Checking, adjusting and changing it
L) Discharge pipe is blocked.	L) Checking if discharge pipe is blocked and dimensions are right.
M) Fan is damaged.	M) Changing it.
N) Radiator air duct or water duct is blocked.	N) Checking and cleaning it.
O) Coolant is poor in system.	O) Adding it.
P) Air is collected in cool system.	P) Discharging air in cool system.
Q) Water pumps fault.	Q) Checking, repairing and changing it.
R) Temperature controller faults or type is wrong.	R) Checking and changing it.
S) There is air in cool system.	S) Checking if there is leaking on the side of suction hose clamp .Checking there is air leaking on cylinder head.
T) Injection pumps fault.	T) Checking it by agent.
U) Fuel feeding timing faults.	U) Looking over the injection pump's dates and adjusting it.
V) Distribution timing faults.	V) Adjusting dates and making it meet specification.
W) Cylinder cushions leak.	W) Checking it.
X) Pistons are damaged.	X) Changing cylinder sleeves and pistons. Examining the reasons.

12. High fuel-consumption

Reason	Processing method
A) Air filter is blocked or type is wrong.	A) Examining the reasons. If necessary, changing it.
B) Injectors faults or type is wrong.	B) Checking, adjusting and changing it
C) Temperature is too low for engine.	C) Refer to "Coolant temperature is lower than normal".
D) Clearance dimension is wrong between gas gates.	D) Adjusting and checking the dimension of clearance between gas gates.
E) Pressure regulator faults or setting is wrong.	E) Repairing or re-adjusting it
F) Fuel feeding timing faults.	F) Looking over the injection pump's data and adjusting it.
G) The control shaft of accelerograph is adjusted wrong.	G) Checking accelerograph excursion.
H) Because temperature or altitude is too high, air is thin.	H) According to the engine sales handbook., modifying it
I) Engine is overload.	I) Checking the highest load. If necessary, reducing load.
J) Fuel leaks inner or outer.	J) Discharging leak.
K) Fuel box air is blocked.	K) Clearing and fixing air drain.
L) Discharge pipe is blocked.	L) Checking if discharge pipe is blocked and dimensions are right.
M) Cold startup system faults.	M) Fixing, checking and repairing cold startup devices. If necessary, changing it.
N) Air gates are blocked.	N) Cleaning, changing or refacing it.
O) Compression pressure is low.	O) Refer to "Compression pressure is low".

13. Engine knock cylinder

Reason	Processing method
A) Oil transfer pump faults.	A) Checking and repairing oil transfer pump. If necessary, change it.
B) Injector faults or type isn't right.	B) Checking, adjusting or changing injector.
C) Cold startup system faults.	C) Fixing, checking and repairing cold startup devices. If necessary, changing it.
D) The fuel type or grade is wrong.	D) Making use of good quality and lower sulphur content diesel. Recommending the max 0.05% sulphur content.
E) The control shaft of accelerograph is adjusted wrong.	E) Checking accelerograph excursion.
F) Temperature is too high for engine.	F) Refer to "engine temp is higher than normal".
G) Clearance dimension is wrong between gas gates.	G) Adjusting and checking the dimension of clearance between gas gates.
H) Lubricant oil is too much or type is wrong.	H) Looking over user manual. Making use of the correct capability and type of lube.
I) Inlet line leaks air.	I) Checking if there is leaking. Changing the broken-down components.
J) Fuel feeding timing faults.	J) Looking over the injection pump's setting data and adjusting it.
K) Air gates are blocked.	K) Cleaning, changing or refacing it.
L) Compression pressure is low.	L) Refer to "Compression pressure is low".
M) Cranked bearings are abraded and damaged.	M) Changing it. Checking lubricant oil replacing period.
N) Valve springs are broken.	N) Changing it.

14. High lubricant oil consumption

Reason	Processing method
A) Seal gaskets and bearings are abraded in turbocharger.	A) Repairing or changing turbocharger.
B) Piston rings are abraded or damaged.	Checking lubricant oil replacing period.
C) Cylinder sleeves and pistons abraded or damaged.	B) Refer to "Pistons, Piston rings, Bearings and bearing locations are abraded".
D) Lubricant oil grade is wrong.	C) Refer to "Pistons, Piston rings, Bearings and bearing locations are abraded".
	D) Changing lubricant oil or filter. Ensure make use of the correct lubricant oil.

15. Engine runs unstably

Reason	Processing method
A) Fuel ducts are blocked.	A) Checking and changing it.
B) Oil transfer pump faults.	B) Checking and repairing oil transfer pump. If necessary, changing it.
C) Fuel filter is smudged.	C) Changing it.
D) Governor spring is adjusted and fixed wrong.	D) Adjusting and checking it.
E) Injector faults or type isn't right.	E) Checking adjusting and changing it.
F) Fuel box air is blocked.	F) Cleaning and fixing vent pipe.
G) Air in fuel system.	G) Discharging air in fuel.
H) Air filter is blocked or type is wrong.	H) Changing it. Ensure make use of the correct type.
I) Engine speed governor system is stagnated.	I) Checking and cleaning it.
J) Temperature is too high for engine.	J) Refer to "Coolant temperature is higher than normal".
K) Clearance dimension is wrong between gas gates.	K) Adjusting and checking the dimension of clearance between gas gates.
L) Lubricant oil is too much or type is wrong.	L) Checking and adjusting lube volume. Or making use of the correct capability and type.
M) Cold startup system faults.	M) Fixing, checking and repairing cold startup devices. If necessary, changing it.
N) Discharge pipe is blocked.	N) Checking if discharge pipe is blocked and dimensions are right. Getting rid of it.
O) Injection pumps fault.	O) Contacting agent.
P) Compression pressure is low.	P) Refer to "Compression pressure is low".
Q) Air gates are blocked.	Q) Cleaning valve shaft and duct hole.
R) High-pressure oil tube is used or fixed wrong.	R) Rectifying or changing.
N) Valve springs are broken.	N) Changing it.

16. Vibration.

<p>Reason</p> <p>A) Injector faults or type isn't right. B) Engine speed governor system is stagnated. C) Temperature is too high for engine.</p> <p>D) Cool fan faults. E) Engine assembly faults. F) Injection pumps fault. G) Compression pressure is low. H) High-pressure oil tube is used or fixed wrong. I) the axiality between flywheel and flywheel casing don't meet the requirement.</p>	<p>Processing method</p> <p>A) Checking, adjusting or changing injector. B) Checking and cleaning it. C) Checking and add coolant, fan, thermostat, checking leakage of water. D) Repairing it. E) Contacting authority's maintenance man. F) Contacting agent. G) Refer to "Compression pressure is low". H) Rectifying or changing. I) Contacting agent.</p>
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17. Unstable

<p>Reason</p> <p>A) Control shaft of accelerograph. B) Air in inlet line. C) Fly block of speed governor is stagnated.</p>	<p>Processing method</p> <p>A) Checking if control shafts joints' clearance is bigger. Adjusting correct clearance. If necessary, changing components. B) Checking if there is leakage. Changing the damaged units. C) Repairing it. If necessary, changing it.</p>
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18. Pistons, Piston rings, Bearings and bearing locations are abraded.

<p>Reason</p> <p>A) There is leaking air between air filter and turbocharger. B) Fuel includes too much sulphur.</p>	<p>Processing method</p> <p>A) If necessary, changing parts. Ensure not leak between air filter and turbocharger. B) Checking fuel type. Contacting supplier. Recommending the max 0.05% sulphur content.</p>
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19. High crankcase pressure

<p>Reason</p> <p>A) Air drain is blocked. B) Cylinder sleeves are abraded.</p> <p>C) Piston rings are stagnated, abraded or broken. D) Gas valve shaft or gas valve ducts are abraded. E) Pistons are damaged.</p>	<p>Processing method</p> <p>A) Checking if air drain is blocked. B) Refer to "Pistons, Piston rings, Bearings and bearing locations are abraded". C) Refer to "Pistons, Piston rings, Bearings and bearing locations are abraded". D) Changing gas valves or gas valve ducts. E) Refer to "Pistons, Piston rings, Bearings and bearing locations are abraded".</p>
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20. Low compression pressure

Reason	Processing method
A) Air filter or air inlet system is blocked.	A) Cleaning air inlet system and changing air filter.
B) Clearance dimension is wrong between gas valves.	B) Adjusting and checking the dimension of clearance between gas valves.
C) Distribution timing faults.	C) Adjusting data and making it meet specification.
D) Cylinder cushions leakage.	D) Looking over maintenance handbook. How do you measure flatness and change cylinder cushions
E) Gas gates can not operate flexibly.	E) Cleaning, changing or refacing gas gate.
F) Cylinder sleeves are abraded.	F) Refer to "Pistons, Piston rings, Bearings and bearing locations are abraded".
G) Air leakage between gas valves and valve seating.	G) Changing or re-abrading gas valves and valve seating.
H) Piston rings are clamped, abraded or broken.	H) Changing it.
I) Gas valves shaft or gas valve ducts are abraded.	I) Changing gas valves or gas valve ducts.
J) Valve springs are broken.	J) Changing it.

21. Fuel valve faults.

Examining item	Examining method
A) Fuel valve voltage	A) Under the working position, electromagnetic valve joints should have voltage. In the working state, purple electrical lines should have voltage. Electromagnetic valve coil customs 24W in 24V current about 1A, and black electrical line should be negative pole.
B) Is there clatter of the magnet?	B) Making key switch turn to the working position, then turn to the "0" position. If you can listen, there is a clatter. If necessary, checking magnet operation. When startup button and stop button crawl, fuel valve should have clatters. (repeating If necessary)
C) Overflow valve	C) Checking if overflow valve on injector pump can be inversion sealed. If not, changing it.

Remark: detailed faults and solutions of diesel engine refer to the operating instruction of diesel engine.

Alternator

1. Genset runs without voltage output

- A. Checking if the connection of AVR excitation short wires is correct and firm
- B. Checking diesel genset's rotate speed.
- C. Checking alternator's remnant magnetism voltage. If necessary, charging magnetism.
- D. Checking alternator and AVR according to excitation apart testing method.

2. Unstable genset voltage output

- A. Checking if rotate speed is stability.
- B. Checking if steady setup is correct.

3. High output voltage

- A. Checking if rotate speed is higher.
- B. Checking if load is capacitive load. (Factor exceeds.)

4. Low voltage without load

- A. Checking if rotate speed is lower.
- B. Checking if the connection is firm between AVR to external voltage potentiometer. If not, please checking if external voltage potentiometer is short connecting.

5. Low voltage with load.

- A. Checking if rotate speed is normal.
- B. Checking if setup is correct between AVR and low frequency protecting voltage potentiometer.
- C. Checking alternator and AVR according to excitation apart testing method.
- D. Revolving diodes damage.

Electrical control

1. When key turns to "START" or press the "START", genset doesn't start.

- A. Checking if key "START" can operate normally.
- B. Checking if faults are indicated. If necessary, repair and reset faults.
- C. Checking if battery voltage is low. If it is too low, battery should be re-charged. If it is normal, checking if voltage signal is send to all of controlling annulus correctly step by step in drawing.
- D. Checking if emergency button has been loosed.

2. After pressed "START", the set still can't be started manual/automatic.

- A. Checking if emergency button has been loosed.
- B. Checking if controlling key is at "STOP" position.
- C. Checking if faults are indicated. If necessary, repair and reset faults.
- D. Checking if battery voltage is low. If it is too low, battery should be re-charged. If it is normal, checking if voltage signal is sent to all of controlling annulus correctly step by step in drawing, oil electromagnetic valve and starter motor etc
- E. If there are not problems with exterior connection governor, should change relevant governor units.

3. Startup motor operators. But genset can't start.

- A. Checking fuel level and keeping fuel pipe connection correctly.
- B. For mechanism governor system genset, checking if throttling electromagnetic valve has been connected correctly.
- C. For electrical governor system genset, checking if EPG power has been connected and voltage is normal.
- D. For electrical governor system genset, when startup motor operators, measuring if MPU has a correct alternating voltage single in voltage gauge.
- E. Checking if rotate speed has got or exceeded startup normal speed.
- F. Checking if fuel transportation system is blocked.
- G. Checking if air filter is blocked.
- H. In cold area's genset, before starting, ensure genset be preheated.

4. High water temperature faults warning/ cut down.

- A. Checking if genset is overload.
- B. Checking if radiator is blocked.
- C. Checking fan belt's tightness.
- D. After genset has been cooled, checking if coolant level is enough.
- E. Checking if water temperature sensor is damaged.
- F. For MRS-10, AFM-25, IG-CU control system, checking if high water temperature warning/ cut down set point is correct.
- G. Checking if temperature regulator can be opened correctly.
- H. Checking if clearance is fitting between water pump and water tank.
- I. Ensure no higher than 40°C in machinery room.

5. Low oil pressure faults warning/ cut down.

- A. Checking lubricant oil level.
- B. Checking lubricant oil quality and viscosity.
- C. Checking lubricant oil temperature.
- D. Checking if lubricant oil pressure sensor is damaged.
- E. For MRS-10, AFM-25, IG-CU control system, checking if Low oil pressure warning/ cut down set point is correct.
- F. Checking lubricant oil filter and oil ducts are blocked.

6. Excessive speed faults cut down

- A. Checking if speed gauge has been faults.
- B. For mechanism governor system genset, checking if throttling column is flexible. And ensuring adjustment is correct.
- C. For electrical governor system genset, checking if throttling column is flexible. Checking if actuating mechanism operates is correct.
- D. revising and adjusting excessive speed protection limited value.
- E. For MRS-10, AFM-25, IG-CU control system, checking if excessive speed protection limited value is correct
- F. After getting rid of faults, resetting alarm signal on the high voltage control panel.

7. High voltage alarm.

- A. Measuring the actual value from genset output.
- B. Ensure display instrument have no difference.
- C. If voltage is high, checking and re-adjusting AVR in careful process.
- D. Ensuring load is not capacitive. Factor doesn't exceed.
- E. Ensuring genset speed and frequency is normal.
- F. If voltage is normal, checking if display voltage circle is correct.
- G. For MRS-10, AFM-25, IG-CU control system, checking if high voltage warning limited value is correct.

8. Low voltage alarm.

- A. Measuring the actual value from genset output.
- B. Ensure display instrument have no difference.
- C. If voltage is low, checking and re-adjusting AVR in careful process.
- D. Ensuring genset speed and frequency is normal.
- E. If voltage is normal, checking if display voltage circle is correct.
- F. High spot checking if three fuses back of alternator terminal box are connected normally.
- G. Ensuring three phases voltage value have no major difference.
- H. Ensuring there are not lose phase.
- I. Ensuring when there is alarm, range ability is not major.
- J. Ensuring genset have not excessive load.
- K. For MRS-10, AFM-25, IG-CU control system, checking if low voltage warning limited value is correct.

9. Genset can't drive load.

- A. Checking if voltage is normal.
- B. Checking load feature. Ensuring genset have not excessive load and factor doesn't exceed.
- C. Ensuring MCCB hand grip and every enactment are correct.
- D. To customers with our ATS, high spot checking ATS and related parts.
- E. Checking ATS control transfer's all inters tar connections. And ensure correct.
- F. Ensuring ATS control transfer switch is not in "MAINS" position.
- G. When ATS control transfer switch is in "AUTO" position, ensuring connection city electricity haven't the normal electricity.
- H. Ensuring genset power connects to the genset side of ATS.
- I. Ensuring ATS's main contactor is flexible. And it is not locked.

10. Manual drive can't cut down.

- A. Checking if key switch and control switch are correct in the position.
- B. Ensuring electrical regulators are all normal.
- C. Checking if fuel electromagnetic valve is normal. If necessary, changing it.
- D. To electrical governor system genset, checking if EPG every installation is correct.
- E. Ensuring injector bump's oil mass installation is correct.
- F. For MRS-10, AFM-25, IG-CU control system, ensuring genset operates under manual mode.

11. Under “AUTO” mode, genset can't cut down automatically.

- A. Ensuring city electricity comes back normal.
- B. Ensuring inductor has been acted.
- C. Ensuring genset auto delay has been over.
- D. Checking if fuel electromagnetic valve is normal. If necessary, changing it.
- E. To electrical governor system genset, checking if EPG every installation is correct.
- F. Ensuring injector bump's oil mass installation is correct.

12. Can't realize remote monitor.

- A. Ensuring monitor soft has been installed remote PC.
- B. Ensuring monitor interface's communication parameters correspond with actual attended mode.
- C. When using dial-in mode, ensuring MODEM of genset side has been checked and remote MODEM has been installed correctly.
- D. Ensuring communication line is correct and reliable and isn't busy.
- E. Ensuring communication terminal of genset has been connected with communication module correctly.

13. Can't realize remote emergency cut down.

- A. Ensuring genset has realized remote communication.
- B. Ensuring control has been fixed protocol adaptor. And connection is correct.
- C. Ensuring dependent inters tar connections are correct and not lose.
- D. Ensuring genset is the auto standby mode.
- E. Ensuring remote control password has been inputted correctly.

Remark: the faults and solution of generators are different. Mentioned above are common faults, details faults and solution please referring to operating instruction of generator.

Chapter 14 Maintenance And Instruction Of Battery

1. Operating principle

The accumulator of diesel genset is consisted of several individual battery grids with lead (Pb) plates insides. They are immersed in the well-proportioned (H₂SO₄) electric conduction, and continuously generates DC signal from chemical reaction of Pb and vitriol. The chemical reaction in the battery is reversible, which means the battery can be recharged and re-discharged as the following formula:



2. Electrolyte

The electrolyte in the lead-acid battery is diluents vitriol solution with specific concentration. It's mixed with vitriol and pure water in special ratio, which causes chemical reaction of sheet metal and becomes conducting medium.

3. Density

Density is unit to measure density. The density of full charged battery should be 1.27 at temperature of 25°C. The vitriol concentration of electrolyte is lower, the density is lower. When the accumulator is discharging, chemical reaction will reduce density of vitriol in electrolyte. So, the concentration of electrolyte reflects the charge situation of accumulator. The most simple and reliable method to check the density of electrolyte is to use araeometer, which is a global glass aspirating tube, use the tube to draw some electrolyte out of the accumulator, the scale at the same level with glass buoy of araeometer indicates the density of electrolyte.

In the process of checking the density of electrolyte, customers should pay attention to the following aspects:

- ① To ensure a real result, please don't measure the density as soon as the battery grids have been filled with liquid. Charge the battery to smoothly mix the water and deposited vitriol, the density measured in this way is reliable.
- ② The density measured after genset runs long time is higher than the real value.
- ③ Araeometer scale is adjusted at temperature of 25°C(77°F), density of electrolyte should be adjusted according to the temperature, that is, every 5.5°C(10°F) rise in temperature, the reading is 0.004 more, while if the real temperature is 5.5°C(10°F) lower than the referenced temperature, the reading is 0.004 less.



Slowly add the electrolyte into the accumulator to prevent the liquid from splashing

4. Density adjustment

In the area where the temperature is over 25°C(77°F), use electrolyte with density of 1.240, because the high temperature makes the electrolyte more active, and moderate electrolyte extends the life period of accumulator. On the contrary, in the cold area, accumulator should be filled with electrolyte of higher density, in some cases, even electrolyte with density of 1.290–1.300 can be used.

5. Maintenance of accumulator



In the process of maintenance, it's required to wear acid proof apron, face mask and eye-protector. If the electrolyte spills onto the skin or clothing, wash it in water at once

The accumulator attached with genset is no electrolyte when it arrives at the customer's, add smoothly mixed electrolyte at proper density before using it. Unscrew the cap of battery grid, slowly pour the electrolyte to the middle of two scales up the sheet metal, and close the upper scale. Don't use it at once until the accumulator is discharged for 15 minutes. Customers can connect the accumulator with the charging set if it's available.

The charging time should be within 4 hours at the first time, or the life period of accumulator will be shortened.

The charging time can be extended on the following cases.

- ① The storage time is over 3 months; charge time can be over 8 hours.
- ② Ambient temperature is continuously over 30°C (86 °F) or the relative humidity is continuously over 80%, charge time can be over 8 hours.
- ③ The storage time is over one year; charge time can be over 12 hours.
- ④ If the charger output is inadequate, the charge time should be extended at proper proportion.
- ⑤ When the charge is about to finish, check the liquid level of electrolyte, add standard electrolyte of proper specific weight when necessary.

What needs to note, the charge current and charge time depends on the accumulator condition and quantity of electricity remain in the accumulator.



When the accumulator is charged, unscrew the filter cap or gas nozzle, check the liquid level of electrolyte. Adjust it with distilled water when necessary.

Turn on the charger to observe normal charging rate. Capacity (Amp-hours) depends on accumulator condition and charged level. Charging current will decrease with the saturation of battery. Disconnect the charger and let the accumulator rest for a while before checking the charging situation, use areometer to measure the density of each battery.

Liquid will be evaporated a little under normal operation, so the accumulator liquid needs to be charged at any moment. Clean the accumulator surface, especially around its charging intake to keep the dirt out of the battery grids, and then take off the spout plug and charge distilled water to proper liquid level. Besides, to exhaust waste gas and prevent the globule from curdling inside the battery grid, it's required to uncover the vent hole to ensure the air circulation.

6. Charge Accumulator




Make sure it's charged in draughty environment without spark or naked flame around. Don't charge it in windy or snowy environment. Keep the charger away from water.

There are three types of power supply to charge accumulator: Charging set equipped by our customers themselves, battery floating set installed in control panel, charging set attached with genset. These three charging equipments have different working condition; the brief introduction is as follows

- ① If the genset is set as manual start of control panel, our customers need to install another charger to the accumulator on long time storage condition, because there is no battery floating set in the control


panel.

	<p>Make sure the charging set is disconnected before diesel genset starts.</p>
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② The control panel of THL-series genset attached with accumulator. There is floating set indicating charging voltage inside the panel, with single commercial power of standard voltage (220VAC) as its power supply, which prevents genset from over-discharge in long time storage, which causes damage of batter and affects genset start-up.

As for genset of BC700/12VDC system, BC701/ 24VDC system, customers are only required to correctly connect single commercial power of 220VAC with relative connecting terminal in the control panel. No need to install charging set. The battery floating set is capable of continuous charging for 24 hours. Its merits are: No extra maintenance to accumulator is required after the power supple is correctly connected. Besides, because it's is provided with special charging method as well as overall protection of over voltage and over current, the charging process does no harm to the accumulator under standard voltage of 220VAC. After genset starts, electric control will automatically disconnect floating circuit, which well protects the charging set and accumulator.

③ When diesel genset is running, electric connection of genset ensures the floating set will be automatically disconnected with accumulator. And the attached charging set of genset will keep charging to the accumulator. The floating set won't charge automatically until the genset stops running.

	<p>High temperature can also damage the accumulator. The temperature of accumulator is forbidden to over 48°C in the process of charging.</p>
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7. Charging faults and solutions

Fault No.1 : No charging current

Reason	Fault clearance
Charger cable is not correctly connected Accumulator terminal is not good.	Check and clean cable and terminal.
Accumulator is damaged or charging voltage is too low.	Replace the accumulator or adjust the voltage
No voltage from commercial power, Wrong connection	Check the commercial power and its connection with charger.
Charger fuse is burned out.	Replace it with new one.
Rectifier diode is damaged	Replace it with new one.

Fault No.2: No charging current display

Reason	Fault clearance
Charging ammeter	Replace it with new one

Fault No.3:Low charging efficiency

Reason	Fault clearance
Commercial power is low	Check the commercial power
The tap of charger transformer is wrong	Check whether the commercial power corresponds with tap
Terminal of charging cable is loose	Check and fasten the terminal.

Fault No.4:Charging terminal heats

Reason	Fault clearance
Bad connection of terminal	Clean and reconnect terminals
Terminal screw is loose	Clean and fasten the screw.

Measure Conversion Table

	the metric system change to the British System			the British system change to the metric System		
	before conversion	after conversion	parameter	before conversion	after conversion	parameter
Length	mm	inch	0.03937	inch	mm	25.40
	cm	inch	0.3937	inch	cm	2.540
	m	foot	3.2808	inch	m	0.3048
Area	mm ²	sq. in.	0.00155	sq. in.	mm ²	645.2
	m ²	sq. ft.	10.76	sq. ft.	m ²	0.093
Volume	cm ³	cu. in.	0.06102	cu. in.	cm ³	16.388
	liter, dm ³	cu. ft.	0.03531	cu. ft.	liter, dm ³	28.320
	liter, dm ³	cu. in.	61.023	cu. in.	liter, dm ³	0.01639
	liter, dm ³	imp. gallon	0.220	imp. gallon	liter, dm ³	4.545
	liter, dm ³	U. S. gallon	0.2642	U. S. gallon	liter, dm ³	3.785
	m ³	cu. ft.	35.315	cu. ft.	m ³	0.0283
Force	N	lbf	0.2248	lbf	N	4.448
Weight	kg	lb	2.205	lb	kg	0.454
Power	kW	hp(metric)	1.36	hp(metric)	kW	0.735
	kW	Bhp(British)	1.341	bhp(British)	kW	0.7457
	kW	BTU/min	56.87	BTU/min	kW	0.0176
Torque	Nm	lbf ft	0.738	lbf ft	Nm	1.356
Pressure	MPa	psi	145.038	psi	MPa	0.0069
	Pa	mmH ₂ O	0.102	mmH ₂ O	Pa	9.807
	Pa	inH ₂ O	0.004	inH ₂ O	Pa	249.098
	kPa	inH ₂ O	4.0	inH ₂ O	kPa	0.24908
	mH ₂ O	inH ₂ O	39.37	inH ₂ O	mH ₂ O	0.0254
Energy Work	kJ/kWh	BTU/bhp	0.697	BTU/bhp	kJ/kWh	1.435
	kJ/kg	BTU/lb	0.430	BTU/lb	kJ/kg	2.326
	MJ/kg	BTU/lb	430	BTU/lb	MJ/kg	0.00233
	kJ/kg	Kcal/kg	0.239	Kcal/kg	kJ/kg	4.184
Fuel Consumption	g/kWh	g/hp	0.7355	g/hp	g/kWh	1.36
	g/kWh	lb/hp	0.00162	lb/hp	g/kWh	616.78
Inertia	kgm ²	lbf ²	23.734	lbf ²	kgm ²	0.042
Flow	l/s	cu. ft./min.	2.1189	cu. ft./min.	l/s	0.47194
Speed	m/s	ft. /min.	196.85	ft. /min.	m/s	0.00508
Temp.	$^{\circ}\text{F} = 9/5 \times ^{\circ}\text{C} + 32$			$^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$		

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