

GENERATOR SET
Operation/Service/Maintenance Manual

Item	Chemkal symbol	Unit	Recommended limtt	Main malign effect	
				Corrosion and rust	Scale formation
pH, 25°C(77°F)	-	-	6.5 to 8.5 (6.5 to 8.0)	O	O
Electrical conductivity 25°C(77°F)	-	μΩ/cm	<400 (<250)	O	O
Total hardness	CaC03	PPM	<100 (<95)	-	O
M alkalinity	CaC03	PPM	<150 (<70)	-	O
Sulfuric acid ion	SO ₄ ²⁻	PPM	<100 (<50)	O	-
Total iron	Fe	PPM	<1.0 (<10)	-	O
Silica	Si0 ₂	PPM	<50 (-)	-	O
Residue from evaporation		PPM	<400 (<250)	-	O

The values indicated in o are the iimits set forth by O.E.M . In addition to the item specified above, turbidity is specified to be above <15 deg.

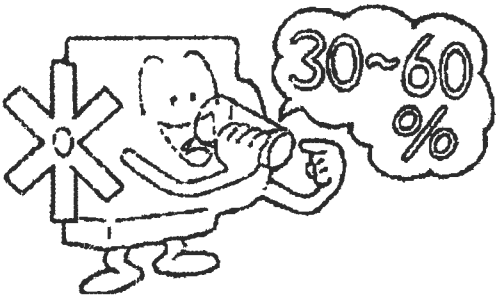
8. How to use non-amine type LLC
- (l) The engine coolant with any of the recommended additives should be changed every two years.

NOTE: When using any other LLC. refer to the coolant mixture chart on the container.



For disposal of a used coolant containing LLC, consult your DEAWOO dealer.

- (2) Proper concentration of LLC is from 30% t0 60% year-round. Aim at a temperature level lower by 5 °C (9°F) than the expected lowest temperature. LLC of less than 30% concentration does not provide sufficient corrosion protection. Concentrations over 60% adversely affect freeze protection and heat transfer rates.When adding coolant use LLC of the same concentration.



Recommended LLC Concentrations (Reference)

Ambient temperature °C(°F)	-10 (14)	-20 (-4)	-30 (-22)	-45 (-49)
LLC concentration, %	30	40	50	60

Foreword

The Diesel-Generator Set is consists of engine, alternator and generator sets control panel. This manual is for the Diesel-Generator Sets consist of all types of engines including internationally famous brand engines, such as CUMMINS, DEUTZ and PERKINS, matching with all types of alternators. This manual is a reference for the operation of equipment, please refer to “Running principle and conformation manual” for more detail about the running principle and conformation. For proper installation and operation, please read this manual and other technique information supplied by the O.E.M before installing and operating the Generator.

We use the latest technology and the highest quality components to produce the P-Series Diesel-Generator sets, so it has high safety and satisfactory performance, Incorrect installation, operation and maintenance could result in personal injury or death, equipments damage or shorten the life of the equipments, do not install and operate the Generator Set unless you have read and understood the instructions in this manual.

If you have any question or recommendation related with this manual, please do not hesitate to contact us. Thank you.

Data and specifi ca tions are subject to change without notice!

Editor
Jun.

Chapter 3 Maintenance of Soundproof Generator



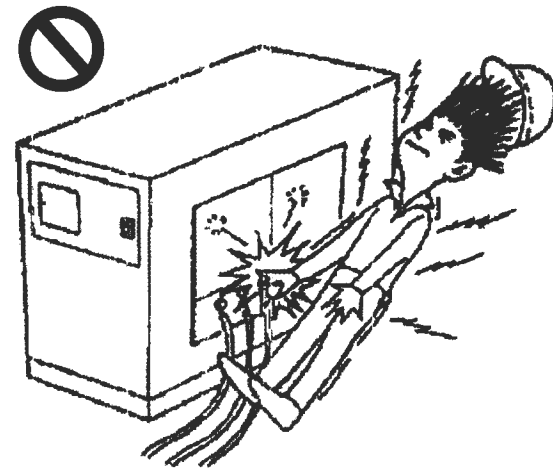
DANGER HIGH-VOLTAGE ELECTRIC SHOCK!

Don't touch output terminals during operation.

Before reconnecting load cables because of such as a change of load, be sure to shut down generator set.

Be aware of high voltage applying to a shut-down unit, to its output side

With two or more generator sets paralleled to load system and one unit being in shut-down, never assume that the load cables and output terminals of the shut-down set are dead: they are live with high voltage!



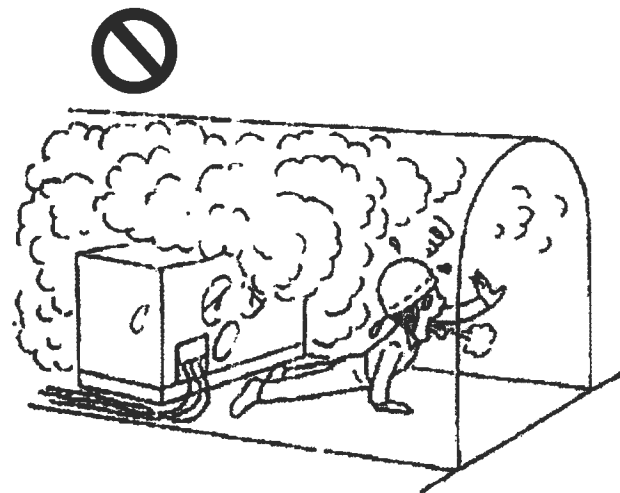
DANGER ENGINE EXHAUST FUMES CAN KILL!

Don't use generator sets within an enclosed area.

If necessary to start generator set within an enclosed area, provide adequate ventilation.

Remember this rule when you run the set in a crater-like low spot or in tunnel.

Observe the direction of wind carrying exhaust fumes, and take measures, as necessary, to prevent the fumes from migration to nearby dwellings.

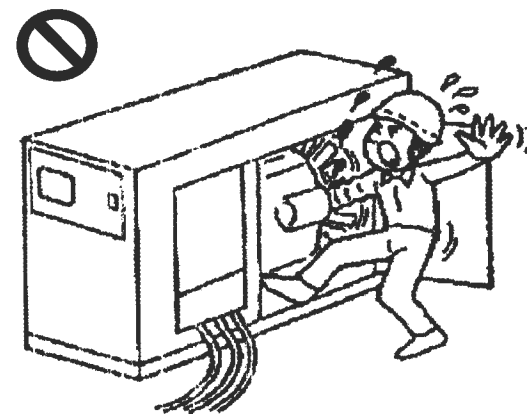


DANGER KEEP AWAY FROM RUNNING PARTS!

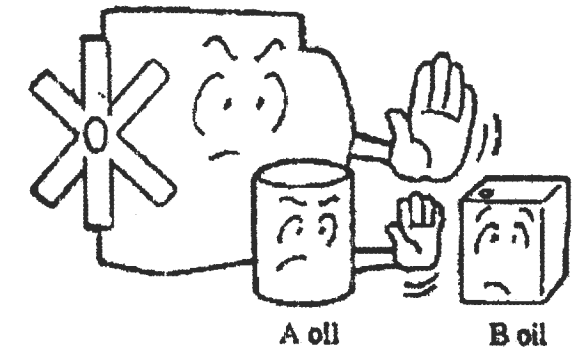
Stay clear of all rotating and moving parts.

The drive belt, pulleys and fan, for instance, of the engine are dangerous running parts. Always stay clear of them.

Perform servicing work only when the engine is not running.



Avoid mixing oils of different brands. In most cases, different brands are not compatible with each other and, when mixed, can seize parts such as piston rings, cylinders, etc. or abnormally wear moving parts. It is best to stick with one and the same brand of oil at successive service intervals.



Recommended Brands of Oils (Reference)

Manufacturer	Brands
Mitsubishi Oil	Diamond HDS-3 Engine Oil
Shell	White Parrot Super S-3 OIL CD
Mobil	Mobil Delvac 1300
Exxon	Exxon D-3



WARNING

Shut down the engine when fueling. Do not smoke while fueling – or when handling fuel containers.

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

After fueling, secure filler cap

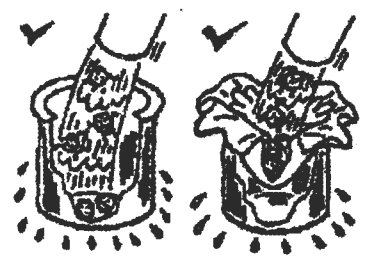
8. Coolant Specifications

Water used in the engine cooling system must be soft, or as free from scale forming minerals as possible and meet the requirements shown in the "Coolant Specifications" chart.

NOTE: Basically, harmful chemical properties and substances contained in water (as coolant) must not exceed the limits but they are tolerable up to the limits shown in the chart below:



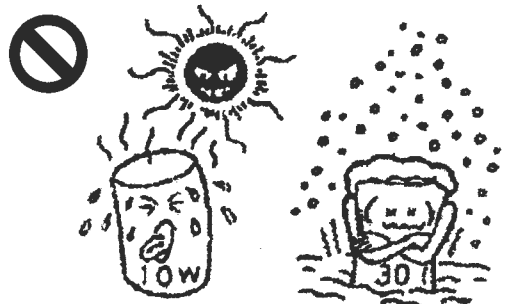
(3) Be sure to pour fuel through strainer in the filler opening. Use of a lint-free cheese cloth is a good practice for keeping dirt out.



5. Recommended Types of Engine Oils

Use oils that meet the engine Service Classification CD (MIL-L-2104C) . Proper oil selection assures cranking ability by maintaining an oil film on cylinder walls and bearing surfaces in a condition which provides low friction, and therefore, less cranking effort to achieve cranking speeds necessary for reliable starting. Improper oil selection may result in congealed oil film on cylinder walls and bearing surfaces, which result in high friction loads and more cranking effort, thus preventing sufficient cranking speeds for reliable starting, and affecting engine life.

Two important considerations related to satisfactory engine operation under ambient temperature conditions – (1) the ability to crank the engine fast enough to assure starting, and (2) adequate lubrication of internal wearing surfaces during start-up and warm-up. These considerations can be adequately met through proper grade selection. Recommended oil viscosities are shown in the chart below:



Recommended Oil Viscosities

Starting temperature. °C(°F)	-30 (-22)	-25 (-13)	-20 (-4)	-15 (5)	-10 (14)	-5 (23)	0 (32)	10 (50)	20 (68)	30 (86)	40 (104)
Oil Viscosities	The diagram illustrates the operating temperature ranges for four different oil grades. The temperature scale is marked from -30°C to 40°C in 5°C increments. SAE 5W-30 is represented by a right-pointing arrow starting at -30°C and ending at approximately -5°C. SAE 30 is represented by a double-headed arrow spanning from approximately -5°C to 35°C. SAE 10W-30 is represented by a double-headed arrow spanning from approximately -20°C to 40°C. SAE 15W-40 is represented by a left-pointing arrow starting at 40°C and extending to the left, beyond the -30°C mark.										

7. Recommended Brands of Oils

Recommended brands of oil are shown in the chart below

**DANGER**





**AVOID ELECTRICAL SHOCK, PINCHING AND BURN!**

Secure safety before doing any maintenance work, including daily servicing.

Pull off starter key and turn OFF battery switch. Attach "DO NOT OPERATE" or similar warning tag to starter switch

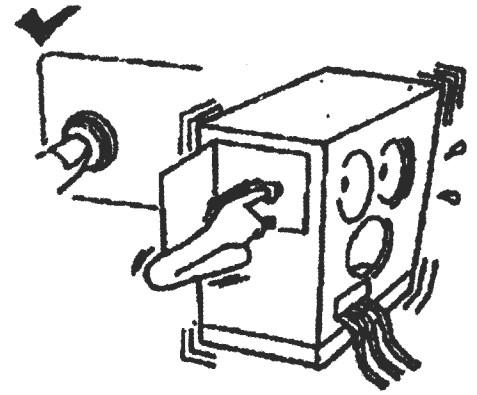


WARNING

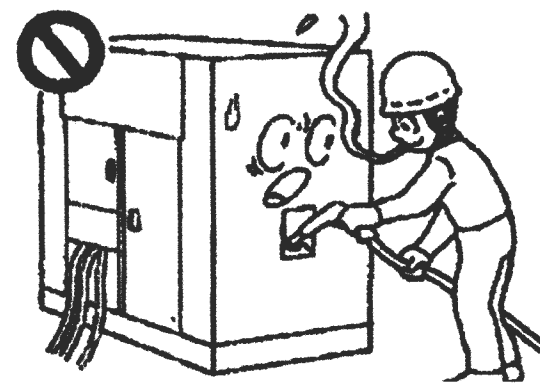
BASIC SAFETY PRECAUTIONS

Shut down generator set upon noting something wrong! Upon noting noise, odor or vibration that is abnormal, shut down the set immediately. Depending on the degree of abnormality, you may have to shut down instantly by pressing the emergency stop button

After shutting down the set investigate for the cause and if you can't tell what's wrong consult your engine dealer. Never keep on running the set exhibiting abnormal noise, odor or vibration or it will soon develop major trouble or a serious accident.

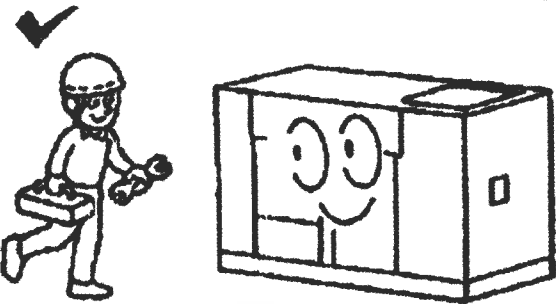


Avoid fire hazards! Fuel, lube oil, Anti-freeze fluid and the like are all inflammable. Do not smoke while filling the radiator or changing the coolant or oil. Never use an open flame near the running generator set



Be sure to perform daily and periodic inspections.

Serious accidents often have their beginning in poor maintenance. Know the importance of the periodic care your Generator set needs. (Service personnel must be qualified to perform electrical and mechanical service.)





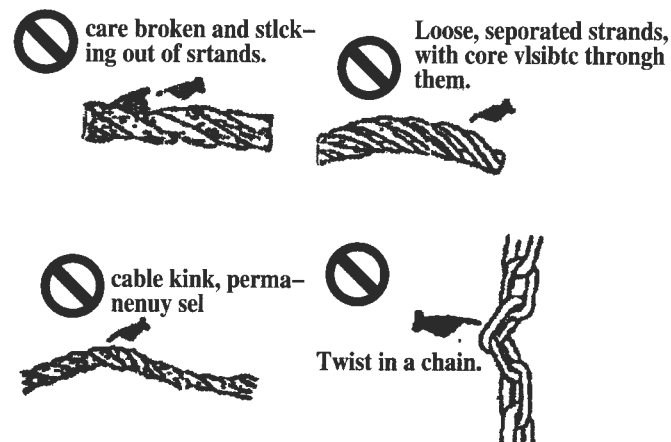
WARNING



BE AWARE OF ACCIDENTAL FALLING OFF OF GENERATOR SET!

Make sure the lifting equipment is in sound condition.

- (1) Don't use kinked or curled cables. Such a cable is likely to fail (break apart) while in lifting operation.
- (2) Wear leather gloves to protect your hands from wire whiskers when handling lifting cables.
- (3) Keep sling chain straight and free from twists. A twist is a potential point of chain failure.



Remember, sling hitching points are specified.

Lifting eyes of tiltable type are provided on the top. Use them, and never take a hitch to any other part of generator set or the set in suspension may become lopsided or, for worse, will fall off.

Before lifting the set with an overhead crane, check the crane capacity and the possible method of lifting which may require two or more persons to wait on the set by coordinating their actions with voice signals.

Don't attach sling cable or chain directly to the lifting eyes.

This is because the tiltable eyes present sharp corners. Make each hitch through a shackle or hook.

Don't allow anyone to stand under generator set suspended.

Don't allow anyone to stand under a suspended generator set. Accidental slipping off of the set can cause severe personal injury or death.

Qualified crane operator

Only qualified operator should operate crane.

weight percent		
Cetane number	45, min	40, min, under special opening conditions
Kinematic viscosity	2.0cSt, min, at 300C (850F) 8.0cSt, min, at 500°C (122°F) 10.5cSt, min, at 40°C (104°F) 16.0cSt, min, at 30°C (86°F)	
Sulfur, weight percent	1.0, max	
Water and sediment, volume	0.1, max	
Ash, weight percent	0.03, max	
Copper strip corrosion, at 100°C (212°F), 3 hrs	N0.3, max	ASTM:N0.3 JIS K 2213: Discoloration NO.3
Gravity, 15/40°C (39°F)	0.80–0.87	Reference

4. Care of Fuel Supply



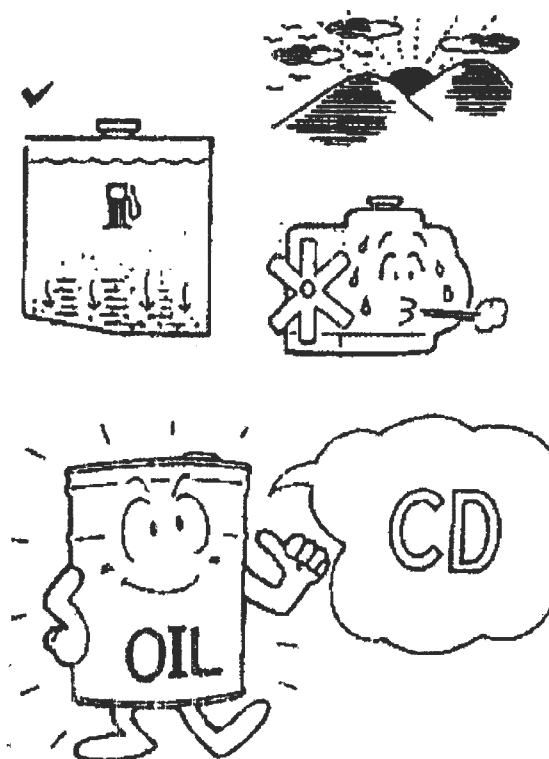
WARNING

Shut down the engine when fueling. Do not smoke while fueling – or when handling fuel containers.

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

After fueling, secure filler cap.

- (1) Fill the diesel fuel tank at the end of the day. This will drive out moisture-laden air and prevent condensation.



- (2) When refilling the diesel fuel tank, use clean tools, such as a hand pump, funnels, containers, hoses, etc. Wipe filler cap clean before removing it. When operating the hand pump, keep in mind that there could be water and sediment that has settled to the bottom of storage tank; tap the needed amount of fuel from clean top portion.

	Check protective devices for operation	Check circuit when contactor closes Check gauge when failure occurs Coolant temperature rise :IOIoC(2140F) Oil pressure drop :0. 15MPa[1.5 kgf/cm²](21 psi)			
Every 2000 service hours or 5 years	Check and adjust valve clearance				
	Check turbocharger				
	Check alternator				
	Check starter				
	Check vibration damper	Oil Jeaktb swilling, flaws			
Every 40000 service hours	Replace generator bearings				
Every 2 years	Change coolant				
When required	Prime fuel system				
	Clean air cleaner element				
	Change air cleaner element				
When top-overhauled	Replace top overhaul kit				
When overhauled	Replace overhaul kit				

Perform service on the following items for a new or reconditioned generator set, before using the generator set which has been stored or left standing for a long period of time:

Servicing interval	Item	Renukrks (service da ta)
Every 50 service hours	Retighten bolts and nuts	
	Change engine oil	
	Change engine oil filter	
Every 250 service hours	Check and adjust valve clearaace	

3. Recommended Type of Fuel

The quality of fuel oil is a very important factor in obtaining satisfactory engine perrormance, long engine life, and acceptable exhaust emission levels.

Use only fuel of recommended quality from an honest supplier. Overfillina can cause a fire.

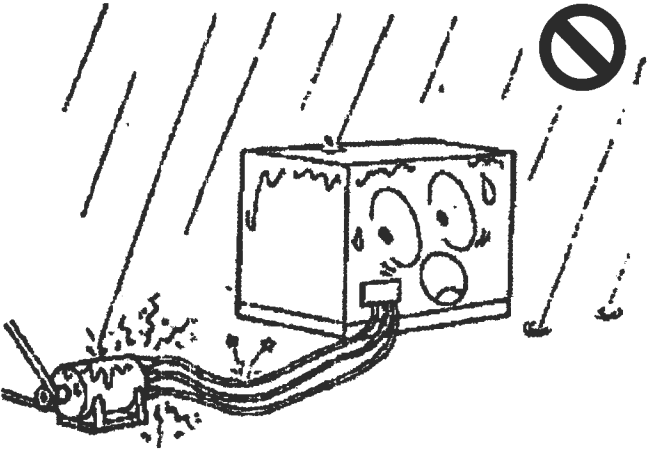
Limiting Requirements for Diesel FueJ Oils

Property	Limit	Remarks
Flash point, min	L.egal	JIS K2204, 2205 Diesel fuel oil: 500C(1220F) Frarnace oil : 60℃ (140°F)
Distillation temperarure, 90% point	380℃ (716°F), max	
Pour point	6℃ (11°F) , min, below the lowest atmospheric temperature	
Cloud point	Below the lowest atmospheric temperature	
Carbon residue on 10% residuum	1.0, max	

 **WARNING**   **BE AWARE OF POSSIBLE ELECTRIC SHOCK AND FIRE HAZARD!**

Installation in the rain involves some hazard

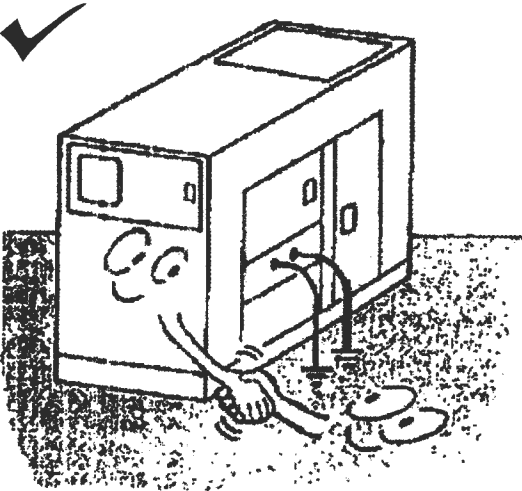
First, you have to anticipate the hazard of electric shock when generator set is installed in the rain. Before starting up such a set, check to be sure the output cables are well protected from rain, and that the power connections and load equipment are not exposed to rain.



Good grounding is essential for avoiding electrical shock!

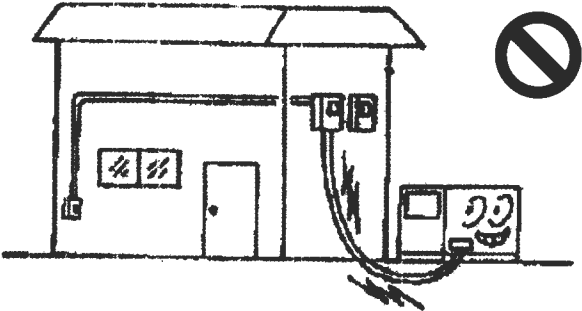
Chances of getting electric shock are much greater where generator set is not grounded.

- (1) Grounding is required on the peak-current relay at the output terminal block, on the laggings (enclosures) of the set and lead devices. The relay has a grounding terminal of its own. The laggings are to be grounded individually.
- (2) A grounded rod, to which an 8 mm² sheathed wire is connected, gives a good ground. Make sure that the ground resistance is not greater than 100 Ω. –The user is expected to furnish the needed grounding rods.
- (3) Checking by your physical reaction or sensory response is a taboo: always use proper instruments.



Don't tie generator set into utility line.

Such connection, even to the lighting load system of a building, is not only illegal but also dangerous because it increases the chances of electrically shocking people and of causing fire, let alone the likelihood of generator set developing trouble in itself.





WARMNG

BE AWARE OF FIRE HAZARD!

Install cables in flaw-less condition !

A damaged load cable can lead to an accident, such as fire and electrical shock. Before installing load cables, check to be sure they are in good condition. Repair or replace a damaged cable, if any, right way.

Make safe and reliable load cable connections.

Do the job right and avoid getting blamed in the future. There four rules are particularly important:

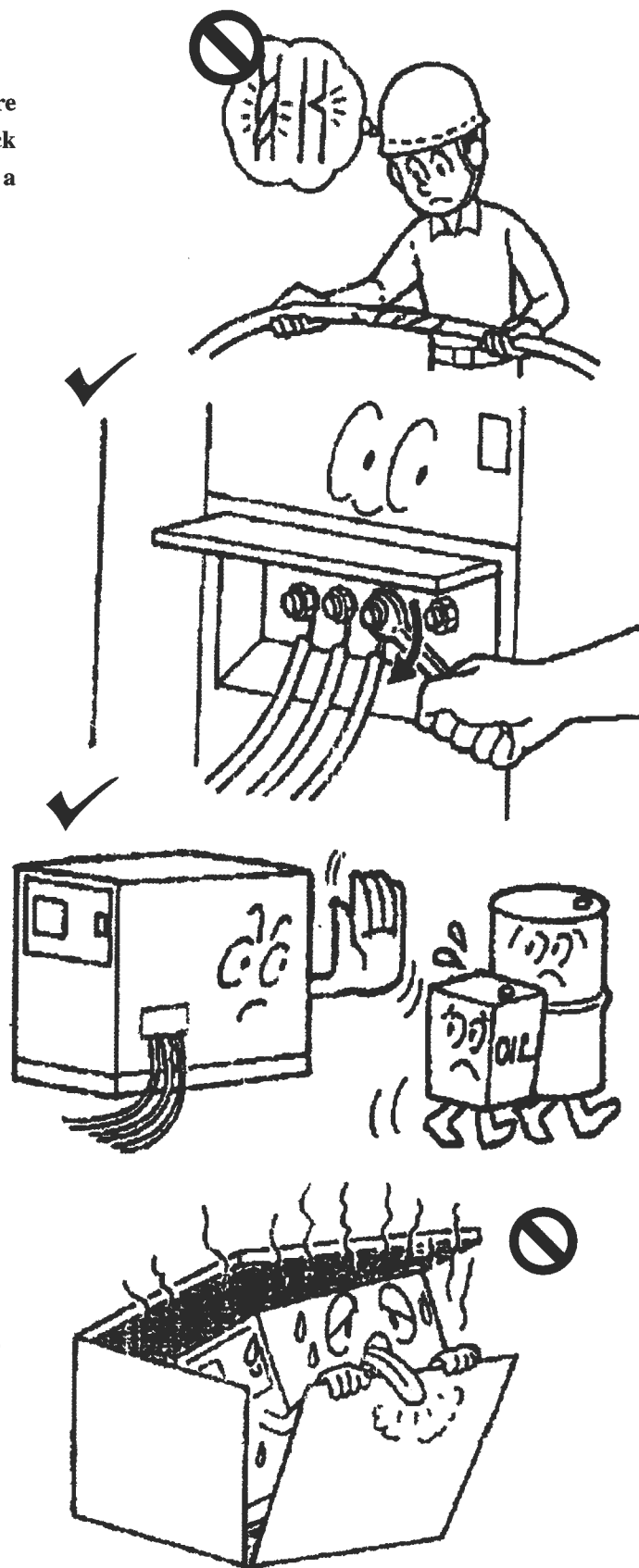
- (1) Clean connection parts completely. No dust, no grits and no greasy matter.
- (2) Never leave any load cable screw snug-tight: tighten each screw good and hard!
- (3) Can't load cable away from other output terminals.
- (4) Check the cables for load-carrying capacity. Be careful not to install undersize cables.

Don't start generator set when inflammable things are nearby!

"Inflammable" includes fuel oil, lube oil, anti-freeze, wiping rags, etc. When determining the place of installation, avoid sitting your generator set close to any permanent storage facility for keeping an inflammable material, liquid or solid.

Secure good ventilation for generator set

Keep your generator set well ventilated. It needs fresh air for its engine and for cooling purpose. Without ventilation, it will not give full performance and may raise its temperature dangerously to catch fire.



Chapter 6 Maintenance

1. Maintenance

The following maintenance tip will help you gain most from your generator set

Be sure to keep the battery switch turned OFF when you inspect or service the electrical components.

You may try to clean the set by washing with water, provided that you keep its doors shut tight to keep out water splash. Wetting the control panels in particular is very likely to cause misoperation, malfunctioning or even fire. Blow off water from wetted components, if any, with compressed air.

Oil change and cooling water change may be carried out after the day's work but never immediately after shutting down the set. The oil and cooling water could be so hot as to scorch the skin: wait for the engine to cool off.

2. Lubrication and Maintenance Chart

Servicing interval	Item	Remarks (service data)				
Every 10 service hours or daily	Walk-around inspection					
	Check engine oil level					
	Check fuel level					
	Check coolant level					
Every 50 service hours or monthly	Check fuel or water in engine oil					
	Drain fuel tank					
	Check battery electrolyte level and specific gravity					
	Check insulation resistance (generator main circuit)	IM Q , min,(500V insulating-resistance tester reading)				
Every 250 service hours or 1 year	Check V-belt Tension	Deflection: 10 to 15mm (0.4 to 0.6 in.)				
	Change engine oil	Refill capacity liter (U.S. gal)				
	Change oil filter	Also change when different pressure is indicated				
	Change bypass oil filter					
	Clean radiator fans					
	Drain water from exhaust muffler					
Every 1000 service hours or 3 years	Retighten bolts and nuts	Refer to SERVICE MANUAL for tightening torques				
	Change fuel filter					
	Check and adjust fuel injection nozzle	Injection pressure, MPa/kgf/cm ² (psi)				
	Check and adjust injection timing	See engine nameplate for injection timing				

Chapter5 Operation of Generator Set

1. Preparation for operation

- (1) Check to be sure that switches are provided on the load side, and they are now all OFF.
- (2) Make sure the lube oil, coolant and fuel are adequate.
- (3) Be sure that the conductor lines in the power cables from each set are properly connected to load-side switches to provide the pfescribed phase rotation. The plrase sequence is indi –.ated on ihe output tenninal block of each set. The simplest way of checking the rotation is to use a three–phase motor load. The motor will run in its forward direction if it receives power of correct phase rotation.

2. The generator Set start and stop

2.1 Genset Manual /Auto Start

1> MtrnualOperatun–z

Turn the Power switch "Key Switch" on the "Manurtl" position, theri Press Controller Panel "start".Genset will run.

2> Auto oper II 砌ion

Turn the select switch "K.ey Switch" on the "Auto" position. Genset will start automatically when there is a mains failure. When the Mains return to normal, Genset will stop the烈) wer suoply 'Tor Mains.

2.2 Genset Stop .

1> ManutrIstop

Turn the Power sw}tch "Key Switch" on the "OfP' positcon, Genset will stop

2> Auto stop

While the controller is in "AUTO' mode and the Mains return to mrmal, Oenset will stop.



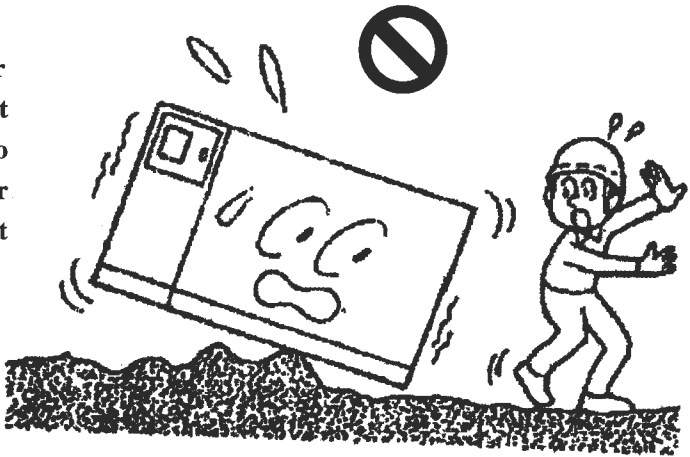
WARNING



AVOIO PERSONAL INJURY!

Is your generator set levef on solid floor!

At the place of installation, the floor (dirt ground or paved floor) has to be level and even. If generator set were on a slope, it might slide or cock by itself to cause personal injury. If the ground is irre'gular or sloped, put proper bolsters under the set to keep it level and stable.

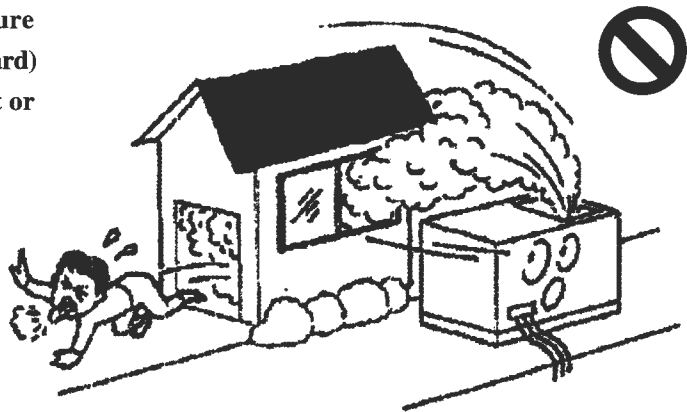


WARMNG



EXHAUST FUMES CAN KILL!

The exhaust smoke is poisonous gases. This fact makes it necessary to take an appropriate measure (sure as redirecting the gases leeward from windward) when your generator set is operated on the street or close to dwellings.





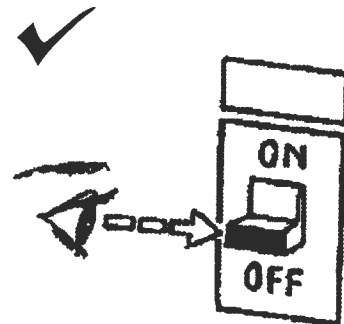
WARNING



AVOID ELECTRICAL SHOCK !

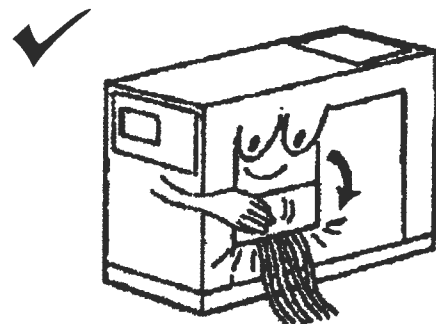
Start up the engine when the breaker is OFF

Make sure the breaker is OFF before starting generator set. After starting, check and be sure the output terminals and other live parts are all clear of people: then you may close the breaker (turn the switch to ON side) to run the set under load.



Have output terminal cover put on!

Leaving output terminals exposed (when generator set is running) can cause injury due to electrical shock. Keep the cover put on securely.



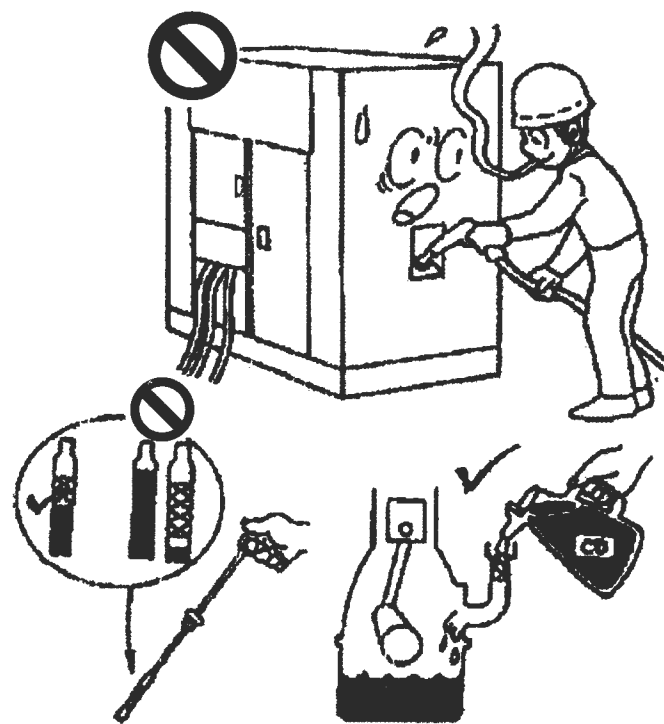
WARNING



AVOID FIRE HAZARD

Handle fuel and oil carefully !

- (1) Refill the fuel or oil tank, when the engine is down and there's no flame of any kind nearby.
- (2) Some parts of generator set that has been running are truly hot. Don't spill oil on such parts: if you did inadvertently, be quick to wipe the spill off.
- (3) After refilling, be sure to tighten the filler cap. Never leave the cap loose.



Use recommended fuel, lube oil and coolant. The specifications as well as capacity data are given in this manual. Be consistent in the selection and use of each. Using a wrong fuel oil, for instance, will prevent generator set from given full performance and may lead to fire accident.

1. Turn the starter switch key to the STOP position and pull the key from the switch. The engine will run until the coolant temperature drops, or for about 1 minute, then stops automatically.

2. Turn OFF the battery switch after the engine has come to a complete stop.

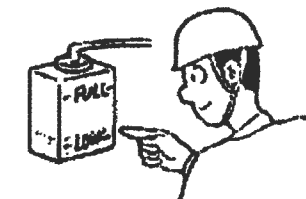
3. Check the coolant level in the reserve tank. Add coolant if the level is below LOW mark.

NOTE: When refilling the reserve tank, always use coolant premixed with LLC of the same concentration as before. Do not add water only

4. After a short interval, check the engine oil level. Add oil if necessary.

5. Check under the generator set for oil, fuel or coolant leaks.

STOP



WARNING

Never touch the output terminals of any of the sets in parallel operation, even if that set happens to be in shutdown. Remember, power cables are live and the output terminals of even a shut-down set are up in voltage.

When one set is carrying the whole load, the demand for load might increase, leading to exceed the rated output capacity of that set. In case, place the second set, and the third set if necessary in parallel operation before switching their power cables on the load side. In this respect, the genset is equipped with manual control devices for use in manually starting the sets in parallel operation

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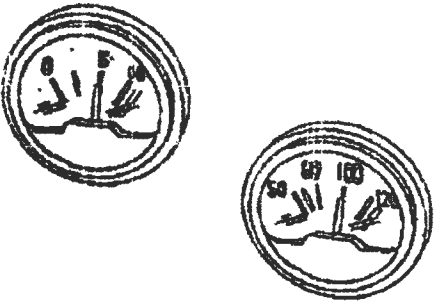
- **Inspection During Power Supply**
Observe the instruments and indication on the contro panel during power-supply operation

Oil pressure gauge	0.29–0.59MPA [3.6kgf/cm ²] (43–85psi)
Water temperature gauge	70℃–95℃ (158°F–203°F)

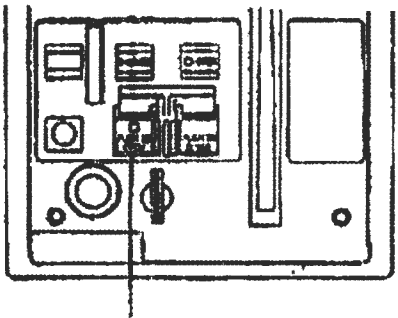
NOTE: Do not supply power to a large load when the coolant temperature is below 50℃(122°F).



- Do not attempt to move the generator set while it is ir operation.
- Keep hands off hot parts – muffler, exhaust pipe, etc. during operation, or immediately after shutting down engine.
- Do not use the generator set in overload condition.



- **Stop Supplying Power**
 1. Open the load-side switches.
 2. Press the breaker OFF switch button.



Breaker OFF switch

- **Stop the Generator Set**
 - At operating temperature, the engine coolant is hot and under pressure. Check the coolant level only



atler the engine has been stopped and the filler cap is cool enough to touch with your hand.
Keep hands off hot parts – rnuffler, exhaust pipe, etc. during operation, or immediately aiter shutting down engine.

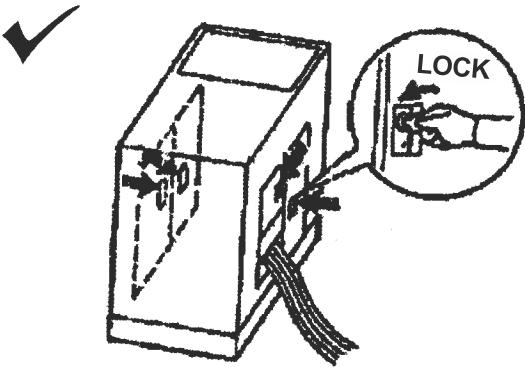


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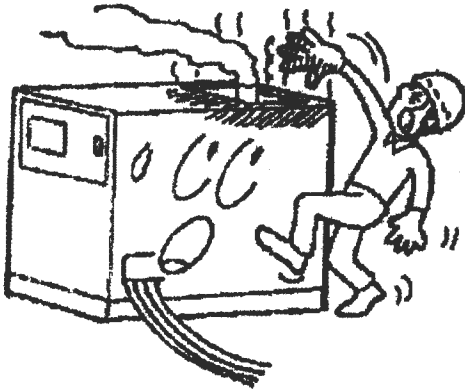


DON'T GET BURNS

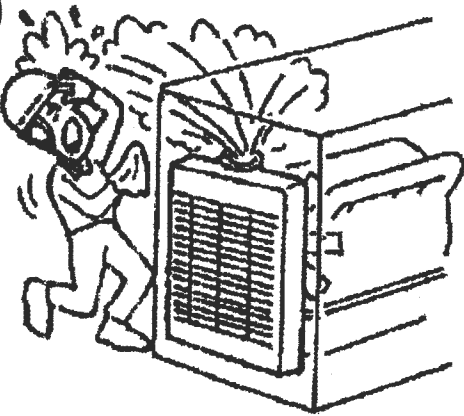
Keep side doors locked during operation !
Keep side doors shut and locked to keep others out, so that nobody will get burns by touching the hot parts or get caught in a running component to suffer serious injury.



Remember, exhaust pipe and muffler are hot !
When generator set is running or has just been shut down, don't put your hand to exhaust parts.

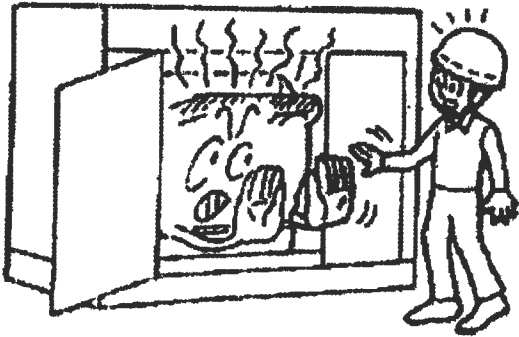


Open the radiator cap carefully !
Engine coolant is hot and under pressure when generator set is running or has just been shut down. Check coolant level only after engine has been stopped and filler cap is cool enough to touch with your hand. Remove filjer cap slowly to relieve pressure.



Never touch engine when it's running or has just been stopped I

Don 't touch any part of engine when it's running or has just been stopped.





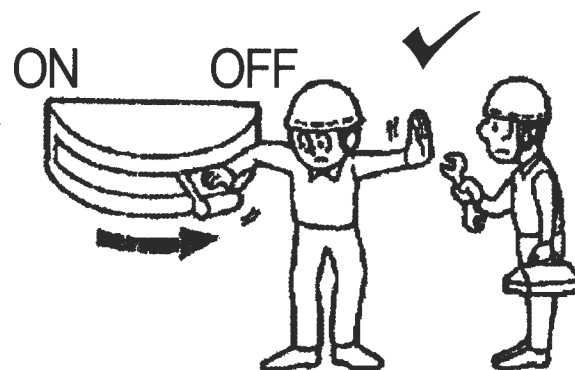
WARNING



AVOID BURNS AND FIRE HAZARD!

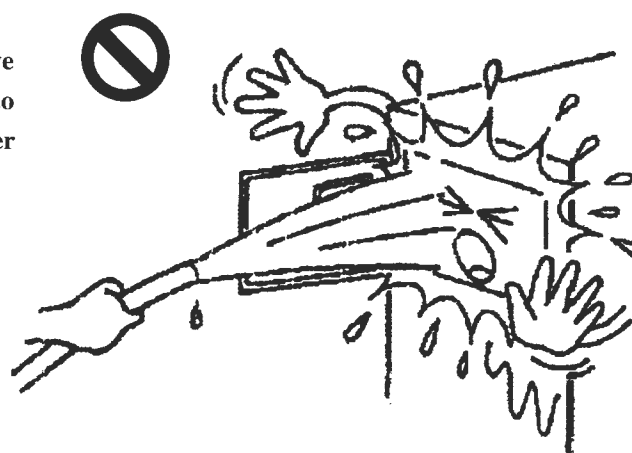
Turn OFF battery switch before servicing

Turn OFF battery switch before servicing or your hand might "short" live parts to draw heavy current from battery, resulting in your hands getting burns or, for worse, fire.



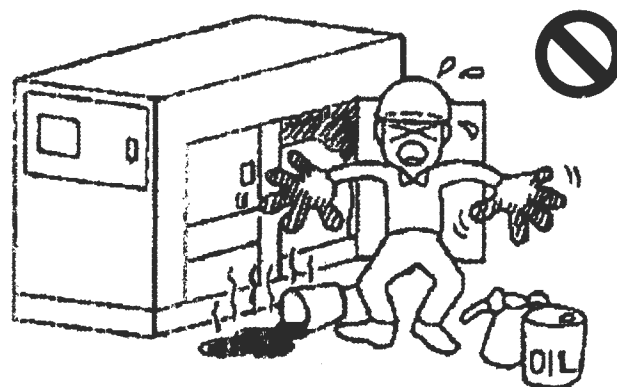
Keep water away from electrical parts!

When washing, keep all doors closed tight. When you've accidentally splashed water on control panel, be sure to blow water off with compressed air: air blowing is better than wiping with a cloth.



Don't change oil when engine is hot

Wait for engine to cool off. Remember, oil in oil pan is very hot!



STARTING



WARNING

Make sure the circuit breaker is OFF. Electrical shock can cause severe personal injury or death.

Make sure there is no one next to the generator set. Warn any personnel nearby that you are starting up



WARNING

Do not operate the generator set with protective covers, access covers or terminal box covers removed.

Keep the side doors locked during operation to prevent any personnel from coming into contact with rotating or hot parts of the generator set.

Do not run the starter for more than 10 seconds at a time. Then allow 30 seconds for cooling before using it again.

Heating Time

Starting temperature range	-5°C -15°C (23°F 5°F)	-45°C -30°C (5°F -23°F)
Heating time	20-40 Sec.	40-60 Sec.

Prolonged heating can cause battery to discharge early, or shorten air heater life.

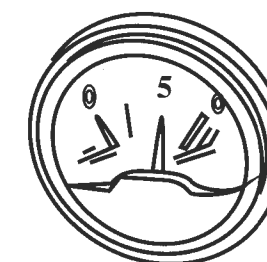
WARM-UP RUN



WARNING

- Long periods of engine warm-up is not recommended. This can result in carbon deposits in the combustion chambers and incomplete fuel burning.
- If the engine operates abnormally, stop it as soon as possible, try to find the problem and its source, then make necessary repairs before starting it again.

Warm up the engine for 5 to 10 minutes.



- During Warm-Up

Check engine oil pressure

Observe the pressure gauge.

Engine oil pressure (with engine idling)	0.15MPa [1.5kgf/cm ²] (21psi)
---	---

NOTE: Just after the engine has been started, the pressure gauge reading will be higher than the specification because the oil temperature is low. The pressure will gradually restore to the normal level.

Check for abnormal sound and Vibration

Stop the engine by pushing the emergency stop button if sound and/or vibration is abnormal.

● Check Coolant Level



WARNING

At operating temperature, engine coolant is hot and under pressure. Check coolant level ONLY when engine is stopped and the radiator fill cap is cool enough to touch with your bare hand.

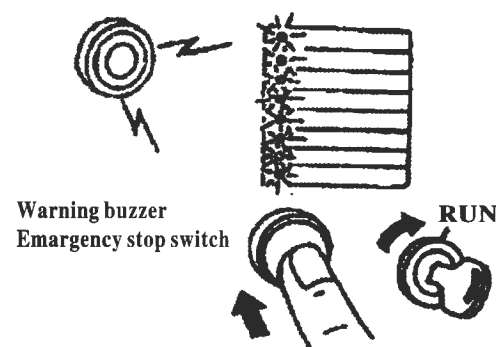
Maintain coolant level between FULL and LOW marks on the reserve tank during hot weather.

NOTE: When refilling the reserve tank, always use coolant premixed with LLC of the same concentration as before.



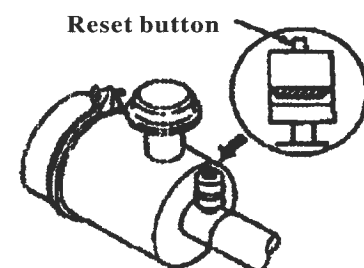
● Test Warning Buzzer

1. Turn ON the battery switch.
2. Turn the starter switch key to the RUN position.
3. Push the emergency stop switch (button) to see if all monitor indicators come ON and the buzzer sounds: if not, consult your engine dealer.



● Check Air Cleaner Indicator

Clean the element if the indicator shows RED. Reset the indicator after installing clean element.



WARNING



SAFETY PRECAUTIONS FOR BATTERY HANDLING!

Battery handling rules for safety

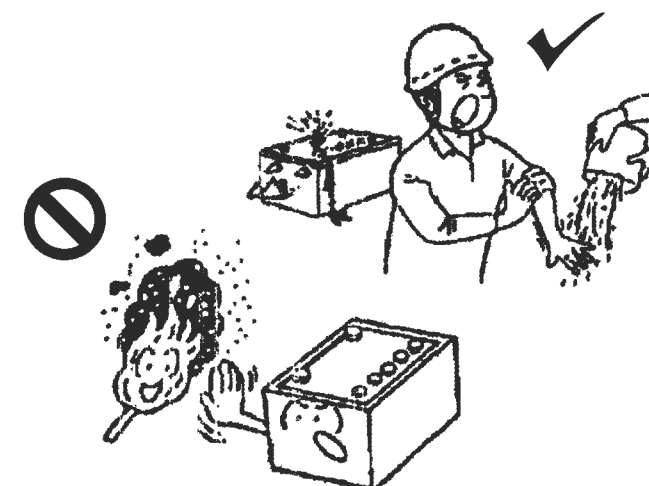
Battery emits more or less hydrogen (a highly inflammable gas). Don't use a lighter near the battery, and be sure ventilation is good. Take the following precautions for battery handling:

- (1) Use goggles to protect your eyes, and wear rubber gloves.
- (2) Don't smoke in the vicinity of battery.
- (3) Before inspecting or servicing battery, be sure to turn OFF battery switch.
- (4) Don't leave any metal object across battery terminals, less it should cause a destructive short circuit.
- (5) If you have to take out battery, be sure to disconnect its negative(-) terminal connection first.
- (6) Recharge battery in a well-ventilated room, with all battery plugs removed.
- (7) When reconnecting battery in place, make terminal connections tight and secure: remember, a loose connection can spark to trigger a gas explosion.
- (8) In case some manual are welding or some such job has to be performed on engine, be sure to have battery connection (negative) unmade (to prevent extraneous voltage from applying to battery).

Electrolyte (acid) handling rules for safety.

Battery acid is diluted sulfuric acid. Though diluted, the acid is strong enough to burn your skin and harm your eyes

- (1) Acid (called electrolyte) in battery is a proportioned solution, which is often measured indirectly by taking gravity readings on it. Have an experienced person refill battery with makeup acid, instead of attempting a trial-and-error method.
- (2) Don't keep battery in service with its electrolyte level below the level mark. Always be sure electrolyte is up to level. Otherwise there should be no accident! (gas explosion).
- (3) When you have spilled acid onto your hand, be quick to wash with water and soap. This applies also to your clothing.
- (4) In case the acid gets into your eyes, wash them with a lot of fresh water without delay and go to the doctor for treatment.
- (5) Should you by mistake drink the acid, the first-aid remedy is to drink as much water as you can and then rush to the doctor.





WARNING



BEWARE OF CRUMBLING DOWN

Stack generator set carefullyl

(1) Stacking two generator sets. one over the other, is permitted. Stack no more than two sets.

(2) Choose a firm, level floor to rest the first set on. Place the first set flat on its bottom.

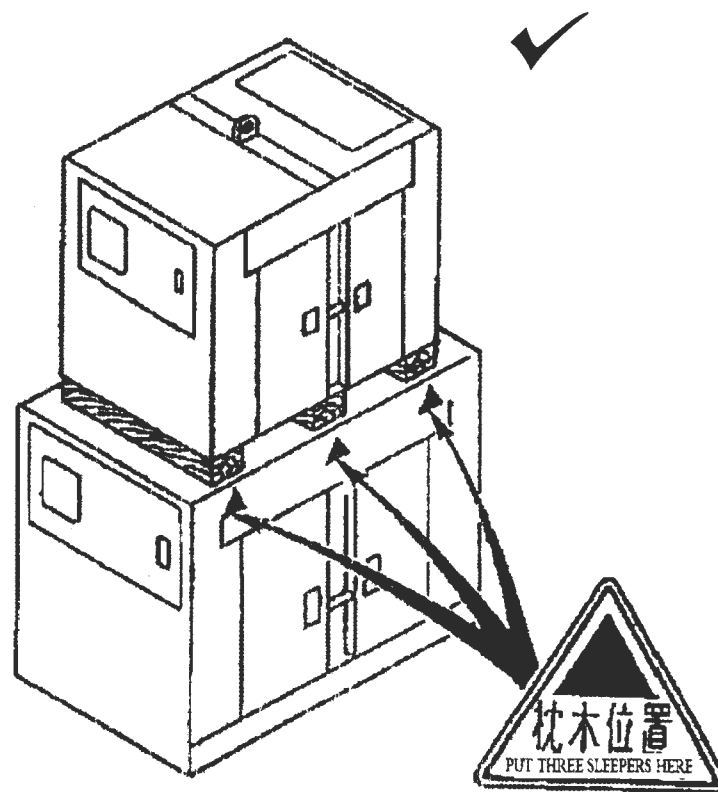
(3) On top of the first set, place three bolsters (sleepers) at the locations marked off.

(4) Be sure to align C.G. (center of gravity) of the second set to the prescribed lifting points of the first.

(5) When resting the second set on top of the first, lower it gently to make tne softest landing possible.

(6) After stacking, tie down the tap unit to the bottom unit to secure stability for protection against personal injury and against damage to the set.

(7) Be sure the second set is not heavier then the flrst resting on the floor



PREPARATION FOR USE (PRE-START INSPECTION)

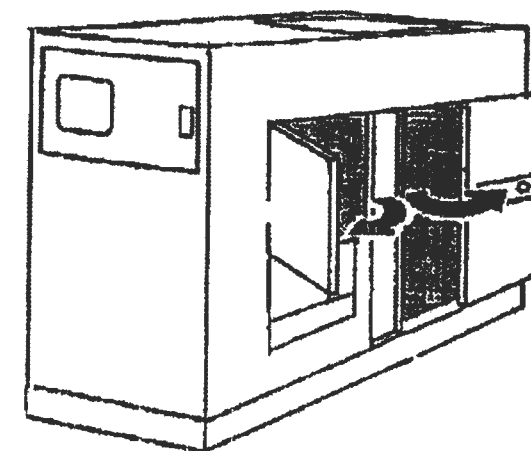
● Check Generator Set



WARNING

To gain access to the generator set, be sure to open the side doors fully. These doors will be flapped in the wind to pinch your hands unless they are opened properly.

Open the side doors and check under and around the generator set for oil, fuel or coolant leaks. If any leak is found, check for the cause.



● Check Fuel Level



WARNING

• Use only fuel of recommended quality from an honest supplier
Do not overfill the tank to prevent fire.

• If any one of the generator in parallel operation runs out of fuel, load on the other generator will be increased.

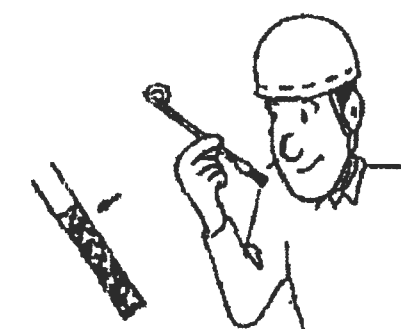
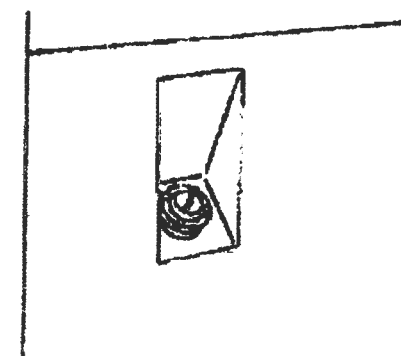
Check the fuel filler of the fuel tank to be sure the tarck is fu
Refill the tank if necessary.

NOTE: If the fuel tank runs out of fuel during operation, the fue
system should be primed.

● Check Engine Oil Level (Engine Stopped)

Maintain oil ievel between MAX and MIN marks on the dipstick.
Add oil if necessary.

NOTE: The dipstick should be withdrawn, wiped clean reinserted,
and again withdrawn so that the oil level on the dipstick can be seen.



● Connecting Load Cables

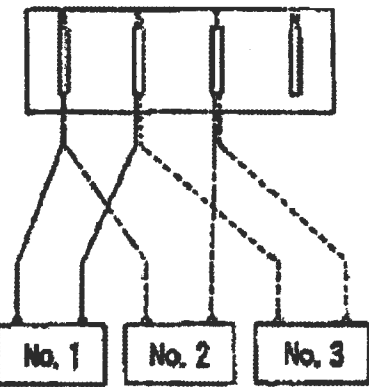
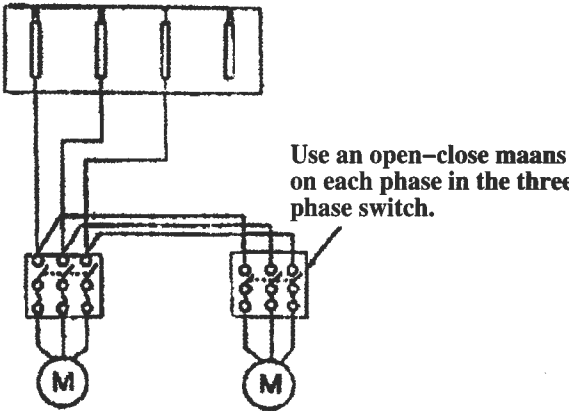
- **WARNING**
- Select rated output that meets the requirement of your expected load, keeping in mind that long-hour operation under light load is hard on the engine.
 - Have the cable end terminated with a pressure-clamp fitting, and fasten this fitting to the output terminal. If the cable conductor has to be connected direct to an output terminal, be sure to insert the bare conductor wire into the hole of the terminal and to secure it tight: use of pressure-clamp fittings together with this bare conductor method is not permissible.
 - All terminal connections must be absolutely tight. A loose connection introduces so-called contact resistance, which is often so large as to generate localized high heat, resulting in damage to equipment.
 - Never connect the load cables to the utility line or private lighting system. Consequences of such connection are electric shock and fire accidents.
- Connecting a Three-Phase Load to Generator Set

Pay attention to the phase sequence, which is R, S and T, marked clearly on the output terminal block. Where a three-phase motor is drawing power through these terminals and if the motor is found to run in reverse direction, you can correct it by merely "swapping" any two connections, R to S and S to R for instance; this will make the motor run in normal or forward direction.

● Connecting Three Single-Phase 200/220V Loads

For a load arrangement like the one shown on the right with No. 1, No. 2 and No.3 loads, be sure to equalize their load capacities as closely as possible.

- **WARNING**
- At the load side, you have to take as much precautions in making cable connections as you took at the output terminal block. Arcing, sparking, terminal melting and what not are but results of loose cable connection.
- (1) The cable connections must be kept clean at all times.
 - (2) Be sure that the securing screws used in the connections are always tight.
 - (3) Keep the load cables away from other output terminals.
 - (4) Take good care of the output terminal block and the SETTING FOR OUTPUT VOLTAGE chart plate, keeping them neat and clean.



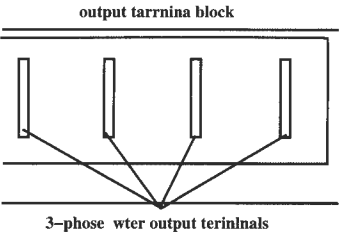
Chapter4 General Description of Soundproof Generator

Each generator set covered in this Manual consists of the following:
Main components: Diesel-engine, generator, radiator, fuel tank and battery

- All these are mounted on a common bed and housed in a sturdy sound-absorbing enclosure.
- (1) The generator set as a whole can be hoisted with a sling hitched, through a shackle or the like, to one tiltable lifting eye, which is centrally located.
 - (2) In the set, the generator is directly coupled to the engine, the two being mounted on the common bed through vibration absorbers.
 - (3) The control panel stands in front of the generator to facilitate control operation in or paralleling.

- Outstanding Features
1. Compact in size, light in weight and high output
The engine is of turbocharged high-output diesel engine; the generator is of brushless type, having its shell coupled direct to the engine. By logical component configuration and sound shielding, the overall length and width are minimized for space economy.
 2. Easy to control and maintain
From the control panel, both engine and generator can be centrally controlled with ease. The clusters of instruments on the panel are easy to read. Doors are arranged for easy open-close action. With the maintenance-free battery, coolant reservoir tank, and fuel filler accessible from outside of the enclosure, the set can be operated for long-hour run and is adapted to periodic inspection.
 3. High-quality electricity from the generator.
By its 2/3-pitch winding, the brushless generator produces steady output free of noise components in the waveform
 4. Friendly-to environment performance.
The enclosure effectively contains the running noise by its sound-absorbing sponge. The vibration absorbers minimize vibration reaching the floor through the common bed.
 5. High reliability
High reliability is substantiated by reputable performance records achieved by the host of high-output diesel engines everywhere in the world.
 6. High portability and easy storing.
It's light-weight and requires no heavy-duty hoist. Moreover, no special lifting equipment is needed. Just hook the sling to the central tiltable eye and you can hoist it readily.

● Output terminal block



● Protective devices

Incorporated in the generator set are protective devices, by which abnormal conditions in the set in operation are detected and brought to the operator's attention by means of alarm lights, buzzer sounder etc.

In the event of serious malfunction or trouble, the breaker is automatically tripped OFF and the engine is forced to stop, all by the working of these devices.

After such an automatic shutting down of the set be sure to take steps according to Troubleshooting. Your subsequent restarting procedure is to begin with the starter switch turned to STOP position (to reset the protective devices that have operated).

	Trouble item	Nature of trouble	Breaker tripping/ Engine stopping	Visual indication/ Buzzer sounding
Serious	Lube oil pressure low	The pressure is down to or below about 0.15MPa[1.5 kgf/cm ²] (21 psi)	O	O
	Water temperature high	The temperature is up to exceed about 101°C(214°F)	O	O
	Over current	Three-phase output is too large.	O	O
	Short circuit to ground	Power leakage has occurred at load side.	O	O
	Engine overspeed	The engine is running too fast.	O	O
	Reverse current	The generator set has started to draw power from the other unit (during parallel operation).	O	O

INSTALLATION

● General Precautions

Fresh air is constantly needed by the generator set in duty run to sustain fuel combustion in its diesel engine and for cooling both generator and engine. One other important fact is that engine exhaust gases contain a considerable amount of toxic gases. These facts, together with the following reminders, should be taken into account when you locate the generator set for installation.



WARNING

Places with poor ventilation are dangerous: examples are tunnels, deep depressions, and indoor areas. Any of these to be ventilated by forced or natural air circulation so that good air supply can be secured and that the exhaust gases can be driven away in order to avoid personal injury.

WARNING



WARNING

- When using the generator set in the vicinity of homes or streets, be sure to pay attention to the direction of exhaust gas flow and to the noise restrictions, if any, enforced in the area.
- The generator set, if it has to be operated in a dusty or saline-rich place, must be maintained more closely and frequently to avoid the clogging up or corrosion of its radiator and air cleaner among others.
- Be sure that the floor, be it dirt ground or paved one, is flat, level and firm for the generator set to stand on. Never set up the set on a sloped floor.
- Installing, operating or storing the generator set in the vicinity of inflammable materials cannot be tolerated. Keep the set away from any possible cause of fire: remember, its fuel oil, lube oil and raw anti-freeze are highly inflammable.
- Make sure good ventilation is maintained inside the generator set in operation. Don't use a covering of any kind to enclose the running set. Insufficient ventilation will decrease power output and result in poor performance, not to

● Power Cable (Load Cable) Information

For the power cables to use in supplying power to electrical equipment (load), the primary consideration is their size. How large must the cable size be for your use? The answer comes primarily from two factors: cable length (from unit to load) and load current the cable has to carry.

Capacity (current-carrying capacity) of a cable is the allowable maximum. If this maximum be exceeded, the cable would get hot to suffer burning damage. The longer the cable or the smaller its size, the lower will be the supply voltage at the load and, in extreme cases, the load will not work at all; this lowering is spoken of as voltage drop.

Try to memorize the following simple formula for determining a proper cable size and length (for three-phase 3-wire mode of supply line): the formula will help you make no mistake in load cable selection for your power unit.

Voltage drop e (volt)=

$$1/58 \times \text{length } L \text{ (m)} / \text{size (mm}^2\text{)} \times \text{current } I \text{ (A)} \times \sqrt{3}$$

Select such a cable length and size as will ensure a voltage drop not greater than 5% (which will be 10 volts if the supply voltage is 200 volts).

Be sure that the cable are of rubber-sheathed type. Cables come in two types: single-core and three-core. For these two types, the required cable size, mm², is given in the following two charts on the basis of load current A and cable length (meters). By selecting your cables according to these charts (which presupposes 200-V service allowing a voltage drop of up to 10 volts), you can be sure of not exceeding the cable capacity.

Rubber-sheathed single-core cables

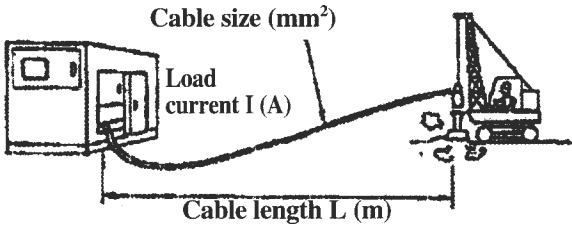
(Unit: mm²)

	Up to 50m	75m	100m	125m	150m	200m
50A	8	14	22	22	30	38
100A	22	30	38	50	50	60
200A	60	60	60	80	100	125
300A	100	100	100	125	150	200



WARNING

Never re-use damaged cables. Such a cable, if placed in service again, can cause electrical shock, current leakage or even fire.



Rubber-sheathed three-core cables

(Unit: mm²)

	Up to 50m	75m	100m	125m	150m	200m
50A	14	14	33	33	30	38
100A	38	38	38	50	50	60
200A	38 × 2	38 × 2	38 × 2	50 × 2	50 × 2	60 × 2
300A	60 × 2	60 × 2	60 × 2	60 × 2	80 × 2	100 × 2



● **Checking or Changing Output Voltage Setting**



Remember the starter switch key and attach "DO NOT OPERATE." or similar warning tag to starter switch before changing voltage setting.



After re-arranging bus bars on the voltage setting panel, be sure to tighten the bus bars fully. A loose bus bar in service is likely to get burnt because of heat that generator occurs at its parts in loose contact.

The generator set is designed to a double-voltage specification and, for this reason; it may occur to you that you have to check to see if the existing voltage setting is consonant to the electrical load it is to support. In case you have to make a change from the existing setting to a new setting to suit the load, proceed as follows:

1. Open the control panel.
2. Remove the front and side protective covers (transparent acrylic covers) from the voltage setting panel.
3. By referring to the SETTING FOR OUTPUT VOLTAGE chart, check to see if the selector switches are set to match the load in terms of voltage.
4. If not, re-arrange the bus bars and re-set the switches. Here's how to re-arrange the bars: A bus bar has its two ends secured with bolts and nuts; loosen and remove the bolt and nut at one end; turn the bar a half rotation, bringing the end up or down; and secure that end to the upper or lower terminal.
5. Put back the protective cover.
6. Close the control panel, and secure it fast by driving its screws.

mention the possibility of developing fire within the set itself due to abnormal rise of temperature.

- In rainy weather, it is a wise practice to set up a foldable tarpaulin tent over the generator set in order to keep it from getting wet (thus eliminating another cause of electrical shock).

● **Outdoor Installation**

- (1) Ensure that the generator set draw, through its cooling-air inlet (on the control panel side) fresh air that's free of dust particles and saline.
- (2) Keep the two outlets (of cooling air and exhaust gases) unobstructed by objects placed above them: the flow from each outlet must be free.

Indoor Installation

- (1) Secure adequate walking spaces around the generator set in position, recalling the need to open doors, to work at the fuel filler, to perform control manipulation, and to handle the cables.
- (2) Secure good room ventilation, and extend the engine exhaust line through a wall opening to outside.
- (3) As necessary, install a duct to guide the outgoing cooling air from the outlet through an opening in the room wall.
- (4) To secure the generator set to the foundation, utilize the anchor bolts provided in the common bed.
- (5) The vibration absorbing devices included in the generator set may not be effective to damp certain types of vibration. It may be necessary for the user to add some anti-vibration means of his own choice.



Lifting with Overhead Hoist



WARNING

- Closely inspect the chains, wire ropes and other lifting gear parts to be sure they are in good working order.
- When handling the ropes, wear hand gloves for protection against sharp wire barbs.
- Make use of the lifting eyes fitted to the housing top. Never try to make hitches to any other parts of the housing or the generator set will cock or tilt when lifted off the floor or, for worse, may slip off and fall.
- Be sure that the rope parts hitched to the eyes will not form an angle larger than 90 degrees when tensioned. The larger the angle, the greater is the tensile stress; it could be so great as to break the rope and cause the set to make a free fall onto hard ground.

As shown in the illustration (on the right), the generator set has two centrally located eye plates of tiltable type for use only in lifting the set. Take a hitch to each when lifting by using the hooks whose capacity is known.

Usable lifting hooks

VGP model	Hook capacity
VGP	1 tons minimum

Relationship of lifting angle to tensile stress

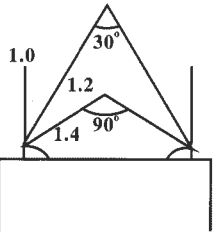
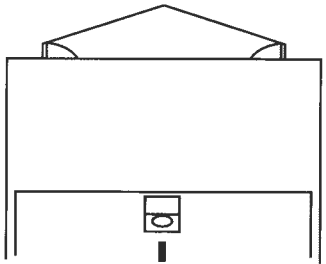
Lifting angle	Change in stress
Vertical	1 (s)
30 degrees	1.2 times
90 degrees	1.4 times



WARNING

- Hitching the rope or chain direct to the eye is prohibited. Be sure to use such as a shackle or hook. This is because the eye plate presents sharp corners and might cut the rope passing the eye;
- Be sure to inspect the hooks (specified for exclusive use on each VGP model) periodically and make sure their capacity is adequate.
- Lifting and lowering with the overhead hoist must be effected in a jerk-free manner to avoid shocking the generator set. Be sure to lift it very slowly, similarly to make softest landing possible.
- When moving the generator set in suspension, allow no one to come under it.

Diagram illustrating the correct hitching method for lifting the generator set using hooks.



WARNING

- Never fail to make the specified grounding connections. Grounding is essential for protection from electrical shock.
 - Never touch any electrical part just to see if it is live or not with voltage.
 - Connecting the grounding wire to water pipe or gas pipe is prohibited.
1. Use grounding rods (to be furnished by the user).
 2. Connect a grounding wire to the leak-current relay grounding terminal (for the relay use only) on the output terminal block. Connect another grounding wire to the body grounding terminal. These two terminals are to be ground separately.
 3. Ground the lagging or casing of each load device.
 4. For the grounding wire, use a shielded wire of 8 mm² or larger, and make sure the ground resistance is not greater than 100 ohms.
 5. Be sure to drive each grounding rod to a depth of at least 50 cm (20 in.).

NOTE: Don't ground the neutral (N) phase. With this phase grounded, lead-current detecting function will be impaired.

Connecting an External Fuel Line



WARNING

If the fuel tank is to be refilled from an external source through a locally installed fuel pipe, be sure to pipe the fuel return line, too, so that the fuel overflowing from the tank can be returned through a pipe line direct to the source side. A return line is indispensable because of the fire hazard which fuel oil spilling from the fuel tank presents. Fuel supply from an external source through a pipe line is recommendable where the generator set has to run each working day for long hours. In such a scheme of refueling, the hand-operated valves at inlet and outlet should be arranged, as shown on the right,

so that fuel overflowing from the tank will be conveyed direct to the supply-side tank.

