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Mechanical Engineering Safety and Maintenance on Generators

Afofu O.S, Bajela G, G Sule M

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ABSTRACT

These papers discuss safety, operation instructions and maintenance information. This paper could be referred to for troubleshooting purpose. Some photographs or illustrations in this paper show the detail or attachment that may varies from other engines. But all maintenance protocols comply with all other engines, which are done in noted or group intervals which is monitored by calendar dates or service hours.

Keywords: Safety, Maintenance, Troubleshooting, Cause and Remedy.

1.0 SAFETY

There may be several specific warning signs on an engine. The exact location of the hazards and the description of the hazards are reviewed in this section. Become familiar with all warning signs. Ensure that all of the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the pictures are not visible. When the warning signs are cleaned, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the warning signs. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs. The warning signs that are loosened could drop off the engine. Replace any damaged warning signs or missing warning signs. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Do not work on the engine and do not operate the engine unless the instructions and warnings in the Operation and Maintenance Manual are understood. Correct care is your responsibility. Failure to follow the instructions or failure to heed the warnings could result in injury or in death.

Universal Warning

Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.

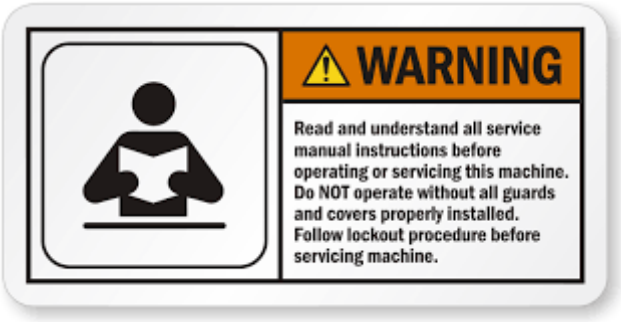

Illustration 1

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General Hazard Information

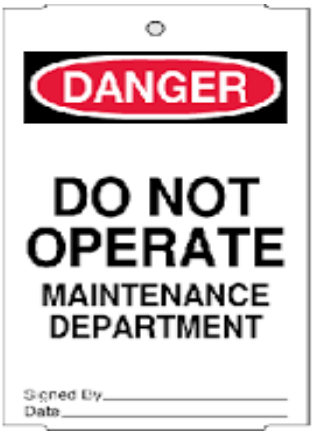

Illustration 2

Attach a "Do Not Operate" warning tag or a similar warning tag to the start switch or to the controls before you service the equipment or before you repair the equipment. Attach a "Do Not Operate" warning tag or a similar warning tag to the start switch or to the controls before you service the equipment or before you repair the equipment.

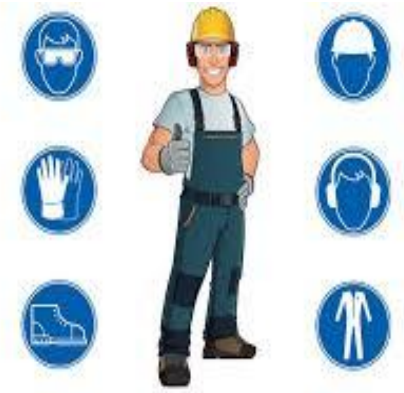

Illustration 3

Wear a hard hat, protective glasses, and other protective equipment, as required. Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine. Make sure that all protective guards and all covers are secured in place on the engine. Keep the engine free from foreign material. Remove debris, oil, tools, and other items from the deck, from walkways, and from steps. Never put maintenance fluids into glass containers. Drain all liquids into a suitable container.

1.1 Petrol Generators

This are equipment which converts the rotational energy generated by mechanical to electrical energy which serves as a means of producing power for domestic and commercial uses at specific range between 950 w To 9 KVA.

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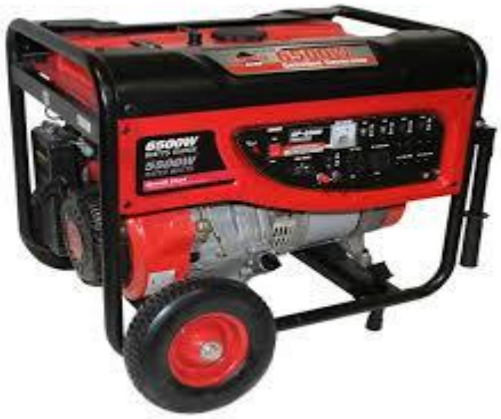

Illustration 4

Which is usually maintaine and recorded by calender dates which is the only means of keeping the records in other to know the next period of servise so as to prolong the life span of the equipment .

1.2 Maintenace Of Petrol Generator

Generally the maintenace of petorl generator is not as complex of that of the diesle engine. The following are been put in place to attain a perfect service of petrol generator.

1. Replacement of lubricants
2. Replacement of spark plug
3. Washing and service of carburetor
4. Replacement of air flilter
5. General washing

If the listed above are been put in place the the generator is ready to be used till the next service time which is noted by the date of the service

1.3 Daily Operational checks of Petrol Generator

1. Always check oil level before starting
2. Always check fuel level before stating
3. Always check if generator is sited in a well ventilated space before running.
4. Always check if cables are propelly fixed.

2.0 DIESLE GENERATORS

Maintenance is one key to diesel generator set reliability; Diesel engines comprise the vast majority of prime movers for standby power generators because of their reliability, durability and performance under load. Diesel powered generators are depended on for back-up power systems in the most critical locations: hospitals, airports, government buildings, telecommunications facilities, and even nuclear power plants. In standby power

applications, diesel generators can start and assume full-rated load in less than 10 seconds, and they typically can go 30,000hours or more between major overhauls.

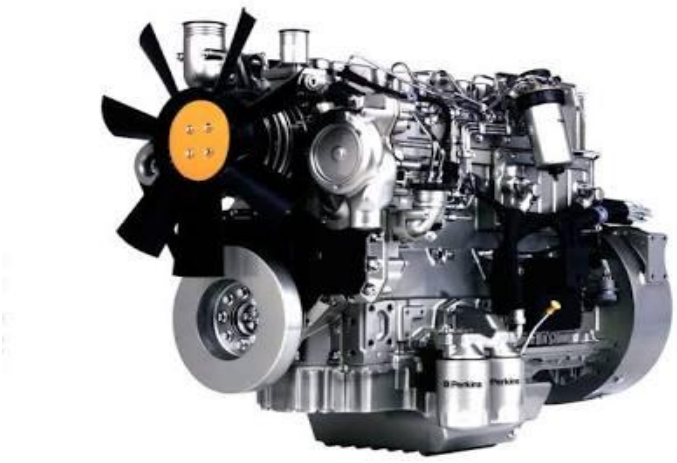

Illustration 5

This remarkable set of credentials is unique to diesel engines, but like any mechanical device, maintenance is critical for ensuring that a diesel powered standby generator will start and run when needed. Facilities with qualified in-house technical personnel can often perform required preventive maintenance on diesel generators. Other facility managers prefer to contract with a local service provider or power system distributor for regular maintenance service—especially if they have generators in multiple locations. (For unplanned maintenance, engine repairs or overhauls, it is always best to use qualified diesel service technicians.)

2.1 Preventive maintenance

Because of the durability of diesel engines, most maintenance is preventive in nature. Preventive diesel engine maintenance consists of the following operations:

- General inspection
- Lubrication service
- Cooling system service
- Fuel system service
- Servicing and testing starting batteries
- Regular engine exercise

It is generally a good idea to establish and adhere to a schedule of maintenance and service based on the specific power application and the severity of the environment. For example, if the generator set will be used frequently or subjected to extreme operating conditions, the recommended service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule include:

- Using the diesel generator set for continuous duty

(Prime power)

- Extreme ambient temperatures
- Exposure to weather
- Exposure to salt water
- Exposure to dust, sand or other airborne contaminates

If the generator set will be subjected to some or all of these extreme operating conditions, it is best to consult with the engine manufacturer to develop an appropriate maintenance schedule. The best way to keep track of maintenance intervals are to use the running time meter on the generator set to keep an accurate log of all service performed. This log will also be important for warranty support. Figure 1.3 shows a typical diesel engine maintenance schedule for generator sets.

Maintenance items	**Service times**					
	Daily	**Weekly**	**monthly**		**6months**	**yearly**
Inspection	X					
Check coolant heater	X					
Check coolant level	X					
Check oil level	X					
Check fuel level	X					
Check c-air piping	X					
Check/clean air cleaner		X				
Check battery charger		X				
Drain fuel filter		X				
Drain water from fuel tank		X				
Check coolant concentration			X			
Check drive belt tension			X			
Drain exhaust condensate			X			
Check starting batteries			X			
Change oil and filter					X	
Change coolant filter					X	
Clean crankcase breather					X	
Check radiator hoses					X	
Change fuel filters	X					
Clean cooling system						X

Table 1

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2.1.1 General inspection

When the generator set is running, operators need to be alert for mechanical problems that could create unsafe or hazardous conditions. Following are several areas that should be inspected frequently to maintain safe and reliable operation.

• **Exhaust system:** With the generator set operating, inspect the entire exhaust system including the exhaust manifold, muffler and exhaust pipe. Check for leaks at all connections, welds, gaskets and joints, and make sure that the exhaust pipes are not heating surrounding areas excessively. Repair any leaks immediately.

• **Fuel system:** With the generator set operating, inspect the fuel supply lines, return lines, filters and fittings for cracks or abrasions. Make sure the lines are not rubbing against anything that could cause an eventual breakage. Repair any leaks or alter line routing to eliminate wear immediately.

• **DC electrical system:** Check the terminals on the starting batteries for clean and tight connections. Loose or corroded connections create resistance which can hinder starting.

• **Engine:** Monitor fluid levels, oil pressure and coolant temperatures frequently. Most engine problems give an early warning. Look and listen for changes in engine performance, sound, or appearance that will indicate that service or repair is needed. Be alert for misfires, vibration, excessive exhaust smoke, and loss of power or increases in oil or fuel consumption

2.2 Lubrication service

Check the engine oil level when the engine is shut down at the interval specified in figure 1.3. For accurate readings on the engine's dipstick, shut off the engine and wait approximately 10 minutes to allow the oil in the upper portions of the engine to drain back into the crankcase. Follow the engine manufacturer's recommendations for API oil classification and oil viscosity. Keep the oil level as near as possible to the "full" mark on the dipstick by adding the same quality and brand of oil.

2.3 Cooling system service

Check the coolant level during shutdown periods at the interval specified in figure 1.3. Remove the radiator cap after allowing the engine to cool and, if necessary, add coolant until the level is about 3/4-inch below the radiator cap lower sealing surface. Heavy duty diesel engines require a balanced coolant mixture of water, antifreeze and coolant additives. Use a coolant solution as recommended by the engine manufacturer. Inspect the exterior of the radiator for obstructions and move all dirt or foreign material with a soft brush or cloth. Use care to avoid damaging the fins. If available, use low pressure compressed air or a stream of water in the opposite direction of normal air flow to clean the radiator. Check the operation of the coolant heater by verifying that hot coolant is being discharged from the outlet hose.

2.4 Fuel system service

Diesel fuel is subject to contamination and deterioration over time, and one reason for regular generator set exercise is to use up stored fuel over the course of a year before it degrades. In additional to other fuel system service recommended by the engine manufacturer, the fuel filters should be drained at the interval indicated in figure 1.3. Water vapor accumulates and condenses in the fuel tank and must also be periodically drained from the tank along with any sediment present.

The charge-air piping and hoses should be inspected daily for leaks, holes, cracks or loose connections.
Tighten the hose clamps as necessary. Also, inspect the charge-air cooler for dirt and debris that may be blocking the fins. Check for cracks, holes or other damage.
The engine air intake components should be checked at the interval indicated in figure 1.3. The frequency of cleaning or replacing air cleaner filter elements is primarily determined by the conditions in which the generator set operates. Air cleaners typically contain paper cartridge filter element which can be cleaned and reused if not damaged.

2.5 Starting batteries

Weak or undercharged starting batteries are the most common cause of standby power system failures. Even when kept fully charged and maintained, lead-acid starting batteries are subject to deterioration overtime and must be periodically replaced when they no longer hold a proper charge. Only a regular schedule of inspection and testing under load can prevent generator starting problems. See Figure 1.3 for the recommended inspection interval for the batteries and charging system.

• **Testing batteries:** Merely checking the output voltage of the batteries is not indicative of their ability to deliver adequate starting power. As batteries age, their internal resistance to current flow goes up, and the only accurate measure of terminal voltage must be done under load.

• **Cleaning batteries:** Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive. If corrosion is present around the terminals, remove the battery cables and wash the terminals with a solution of baking soda and water (1/4-pound baking soda to one quart of water).
Be careful to prevent the solution from entering the battery cells, and flush the batteries with clean water when done. After replacing the connections, coat the terminals with a light application of petroleum jelly.

• **Checking specific gravity:** Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell. A fully charged battery will have a specific gravity of 1.260. Charge the battery if the specific gravity reading is below
1.215.

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• **Checking electrolyte level:** Check the level of the electrolyte in the batteries at least every 200 hours of operation. If low, fill the battery cells to the bottom of the filler neck with distilled water.

2.6 Keeping the Engine Warm

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts. However, regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts, uses up fuel before it deteriorates, and, in general, helps provide reliable engine starting. Exercise the generator set at least once a month for a minimum of 30 minutes loaded to no less than one-third of the nameplate rating. Periods of no-load operation should be held to a minimum, because unburned fuel tends to accumulate in the exhaust system. If connecting to the normal load is not convenient for test purposes, the best engine performance and longevity will be obtained by connecting it to a load bank of at least one-third the nameplate rating.

2.7 Sample and Procedures of Preventive Maintenance

Preventive maintenance for diesel engine generators plays a critical role in maximizing reliability, minimizing repairs and reducing long term costs. By following generally recognized diesel maintenance procedures and specific manufacturer recommendations for your standby generator solution, you'll be assured that your standby generator solution will start and run when you need it most.

There are basically **6 steps** in practical preventive maintenance which will be stated below with illustrations.

Step 1

Start the generator allow to run for about 45 mins, which by doing so will help easy drain of the old lubricant in the bottom tray via the drain plug.

Step 2

Shut down the engine allow lubricant to settle a bit drain the old lubricant in a clean pan or bucket, after been drain fix back the drain plug.

Step 3

Loosen the oil filter with the use of a filter chain allow oil to drip, fill the new filter with fresh lubricant and replace the filter.

Step 4

Loosen the fuel filter housing and remove the old element and replace with a new element, and bleed the system to make sure its air free.

Step 5

Refill the engine crack casing with fresh lubricant to the maximum gauge.

Step 6

Remove the engine air cleaner element and clean with a compressor or replace with another element if still blocked after cleaning.

3.0 CORRECTIVE MAINTENANCE

This is a task performed to identify, isolate, and rectify a fault so that the failed equipment or generator can be restored to an operational condition within the tolerance or limits established for in service operations. Figure 1.4 shows suggested faults, effect and resolution.

S/N	Nature Of Faults	Effects	Resolutions		Remark
			Repair	Replace	
1	Water Pump Leakage	Overheating	X		Overheating Stops
2	Spoilt Rings	Less Compression		X	Perfect Combustion
3	Broken Piston	Loss Of Compression		X	Full Compression
4	Burnt Gasket	Water Spit age And Dilution		X	Coolants Remain In The Passage.
5	Crack Cylinder	Overheating	X		Lessing Heat
6	Block Or Radiator Leakage	Overheating	X		Overheating Stops
7	Bad Oil Seal	Oil Leakage		X	Leakage Stops
8	Worn Out Fan Belt	Overheating		X	Overheating Stops
9	Bad Fuel Pump	No Fuel Flow		X	Proper Fuel Flow
10	Worn Out Tubor Charger	Less Efficiency	X		Efficient
11	Bad Avr	Unstable Or No Voltage		X	Stable Voltage
12	Main And Con Bearing	Excess Friction		X	Less Friction
13	Bad Kick Starter	Engine Not Starting	X		Great Kick Starting
14	Bad Injector Rotor	Hard Starting		X	Normal Starting
15	Unstable Speed	Engine Under Voltage	X		Constant Speed(50 Hz)
16	Faulty Circuit Breaker	No Power Supply		X	Normal output supply

Table 2

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4.0 MALFUNCTION AND TROUBLESHOOTING FOR DIESEL ENGINE

* **Engine fails to start**

Cause	Troubleshooting
It is cold **Machine oil is viscous**	Fill machine oil into crankcase after warming-up. Fill machine oil into inlet pipe Remove the connection belt from the machine Start the engine and stop it when it is heating, assemble the belt and then restart the engine.
Failure of fuel system **Water mixed in the fuel**	Clean fuel tank, fuel filter and fuel pipe, and then change the fuel.
The fuel get thickening and can't flow easily	Use prescribed brand fuel
Air exists in fuel system	Emit the air, tighten each connect part to the fuel pipe
Injection fuel is little or the spray is not excellent	Check the position of governing handle or check and clean the fuel nozzle, change the nozzle if necessary.
Incomplete combustion	Mainly by ill spray Incorrect delivery angle Leakage in gasket of cylinder head Deficiency in pressure of compression
Interrupted of diesel fuel	Lack of oil, should fill fuel into the fuel tank. If have obstructions or leakage in the fuel pipe and fuel filter, drain out them with the air.
Deficiency in pressure of compression; **Loosen in the nut of cylinder head;** **Damage or leakage in the gasket of cylinder**	Tighten the nut of cylinder head in the diagonal sequence; check the gasket of cylinder as per the standard requirement. When the engine with the new gasket is heating, tighten the nut of cylinder head again.
Big gap in the piston ring due to wear and tear	Change the piston ring
Leakage caused by each gap of piston ring lined in one direction	Make each gap of piston at angle of 120
Serious stickiness or breakage in piston ring	Clean it by diesel fuel or change the piston ring.
Leakage in gas valves	Skive the gas valve, or send it to repair factory if the

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	vestige is too deep.
Incorrect in valve clearance	Adjust the gap as specified.
The valve stem is clipped in the guide pipe	Disassemble the gas valve, clean the stem and guide pipe with diesel fuel.

* **Deficient Power of Diesel Engine**

Causes	Troubleshooting
Malfunction of fuel system; **Parts obstruction in fuel filter and fuel pipe;** **Inadequate fuel supplying;**	Check the fuel switch, they should be opened fully. Clean the fuel filter and fuel pipe.
Bad pressing of fuel pump	Check or change the damaged parts of fuel pump.
Malfunction of the fuel nozzle; **Incorrect injection pressure**	Adjust the injection pressure
Carbon deposit in the nozzle hole	Clean
Needle was bit	Clean or change
Loose fit between needle and needle body	Change
Obstruction in air filter	Remove, clean or change the filter core.
Engine under speed	Check the speed of engine with the tachometer, and then readjust the speed limit bolt

* **Engine Stopping Automatically**

Cause	**Troubleshooting**
Malfunction of the fuel system **Run out of fuel**	Fill fuel.
Obstruction in fuel pip or air filter	Check or clean.
Air exists in fuel system	Emit the air..
Nozzle needle was bitted	Clean, skive the nozzle or change it if necessary.
Obstruction in air filter	Check, clean or brush off, or change the filter element
Sudden increase of load	Lighten the load

* **Exhaust with Black Smoke**

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Causes	Troubleshooting
Overload	Lighten the load; change the matched machine if it does not comply with the requirements.
Bad spray	Check injection pressure and spray condition and remedy; change the nozzle if it was damaged.
Lack of air or leakage	Clean the air filter; check the cause of leakage and remedy.

* **Exhaust with White Smoke**

Causes	Troubleshooting
Water mixed in diesel fuel	Clean the fuel tank and filter and change the diesel fuel.

* **Exhaust with Blue Smoke**

Causes	**TROUBLESHOOTING**
Machine oil mixed in cylinder	Check the oil level, drain off the redundant engine oil
Piston ring is clipped, worn or lack of elasticity, hatch of each ring turned to the same direction and make engine oil up	Check and replace the piston ring, and cross hatch of each ring
Big gap between piston and cylinder	Remedy or change
Wear and tear of valve and guide	Change

5.0 RESULT & DISCUSSION

The engine plays a very important role in power generation all over the world and as farm power mechanics in some part of the world.

The objectives of this work are to increase the engine performance and control the smoke to normal emission standard.

6.0 CONCLUSION

Preventive maintenance for diesel engine generators plays a critical role in maximizing reliability, minimizing repairs and reducing long term costs. By following generally recognized diesel maintenance procedures and specific manufacturer recommendations for your application, you'll be assured that your standby power system will start and run when you need it most. In a nutshell, this paper will largely discuss means of eliminating low

engine performance and poor emission, control in Perkins engine, and also create ideas on maintenance time and cost.

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ABOUT AUTHOR(S):

Afofu Oluwafemi Sulaimon
Field Engineer
Baolam Technical Nigeria Limited
Femex4sec@gmail.com

Bajela Gbenga Gideon
Principal instructor
Lagos state polytechnic, Lagos Nigeria
Bajelagg@ gmail.com

Sule Monday
Technologist
Federal Polytechnic Auchi, Edo State, Nigeria
Sule_Monday@yahoo.com