OPERATION & MAINTENANCE MANUAL

For

Ex-Power DEFENDER Generator

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Prepared For

Department of Defense

Prepared By

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Overview – Applications and Features

Ex-Power DEFENDER Generator Applications:

The Man-Portable Ex-Power DEFENDER from **Novatio Engineering** is the reliable choice for mobile electric power requirements, specifically designed, built, and tested for military use. Utilizing patented technology from Novatio that aerosolizes military grade JP-8,F24, JET-A, and JP-5 fuel, this lightweight, portable generator will dependably start in even the most austere climates without the need for any starting agents. Rigorously tested for harsh environments, this durable and compact generator will automatically maintain optimum internal operating temperatures for peak performance. With a dry weight of only 32.9 pounds, the Ex-Power DEFENDER is the undeniable solution to provide the war-fighter with a true expeditionary portable generator that provides continuous 900W (1000kW Peak) of clean AC power.

Ex-Power DEFENDER 1.0 Generator Features:

- **2 AC Receptacles (GFCI Protected)**
  - AC Voltage Output: 120VAC, 60Hz
  - AC Power Output: 0-900W continuous at sea level
  - Peak AC Output Power: 1000W
- **Parallel Operation:**
  - 1.8 kVA Output Continuous Power
  - Peak AC Output Power: 2.0 kVA (maximum load of up to 1000W for brief surge capacity)
- **DC Receptacle**
  - DC Output: 96W (8A at 12VDC)
  - DC Circuit Protector
- **Climatic Temperature Operating Parameters:** 0°F to 120°F (derated to 750W above 104 degrees F)
- **Auto-Temperature Control During Generator Operation**
- **Audio Noise:** 59dB(A) at 900W, 53dB(A) at 300W
- **Fuel Tank Capacity:** 0.6 gallons
- **Fuel:** JP-8, F24, JET-A, and JP-5 (Diesel or Gasoline may be used on select models)
- **Dry Weight:** 32.9 LBS
- **System Dimensions:** 17.8” x 11.5” x 14.9”
- **Ground Terminal**
- **Hour Meter**
- **Oil Level Alert Indicator Light:** turns red when oil level is low
- **Overload Indicator Light:** turns red when generator is overloaded
- **Output Indicator Light:** turns green when generator is putting out power

Version History

Date	Revision #	Author	Revision Description
29-Sept-2015	(Original)	Jim Eiland	Original Release
15 Jan 2016	01	Jim Eiland	Added hour meter.
14-Feb-2018	02	D. Schiller	Added muli-fuel information; updated UIB configuration; added jump start procedure; added JET-A and JP-5 to fuel list; removed Defender 1.0 reference

Keep this Operation and Maintenance Manual handy so that it can be referred to at any time. This Operation and Maintenance Manual is considered a permanent part of the generator and should remain with the generator.

Hazard Awareness Notice

Abide by all warnings within this manual. Improper operation can result in injury, damage the generator, or other property. Most injuries or property damage can be prevented by following all instructions in this manual. Report all hazards. If at any time you detect a hazard, it is your responsibility to report the hazard through your chain-of-command to ensure that it is corrected. This action ensures that this hazard is investigated, publicized, or corrected, as required.

GENERAL WARNING

The Ex-Power DEFENDER is designed for 1kW operation. Major generator repairs are only done safely by Novatio Engineering trained personnel. Know how to stop the generator in case of an emergency. Operators can be burned from hot parts. Let the engine exhaust system cool, since the exhaust system gets hot enough to burn flesh or ignite materials. Exhaust from the generator contains poisonous carbon monoxide in unventilated spaces, which can cause loss of consciousness and may lead to death. Therefore, do not run generator in a confined area. To prevent electrical shock from generator, do not use generator in wet conditions. Before refueling, turn engine off and allow generator to cool to prevent fuel fires. Only refuel outdoors in a well-ventilated area and wipe up fuel spills immediately. Keep flames and other sparks away from generator while refueling.

Warnings, Cautions, and Notes within the Manual

WARNING

Definition: An operating procedure, practice, or condition, etc., that may result in injury or death, if not carefully observed or followed.

CAUTION

Definition: An operating procedure, practice, or condition, etc., that may result in damage to equipment or property, if not carefully observed or followed.

NOTE

Definition: An operating procedure, practice, or condition, etc., that is essential to emphasize.

Foreword/Preface

This manual provides safety aspects, as well as operation and maintenance instructions for the Ex-Power DEFENDER. The Ex-Power DEFENDER generator is light-weight, portable, and compatible for use in all services (Army, Navy, Marines, and Air Force).

Operator Technical Level and Prerequisites

Operators: must read and understand safety concerns and user instructions presented in this manual.

Intermediate Level Maintainers: must have completed safety training as an integral part of standard mechanical, engine, and electrical training in order to service this equipment.

Depot Level Maintainers: are factory trained and handle repairs/replacements after the generator is sent back to Novatio, as noted in the maintenance section of this technical manual.

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1. Introduction and Generator Safety

1.1.1 Purpose

The purpose of the Operation and Maintenance Manual is to provide instructions for the safe operation and maintenance of Novatio's Generator (Ex-Power DEFENDER).

NOTE

This entire manual contains important safety information, please read carefully. This operation and maintenance manual does not warn about all possible hazards, therefore use good judgement while operating generator.

1.1.2 Safety Information and Warning Labels on Generator

Safety information on printed labels alert operators to potential harmful hazards.

⚠ WARNING **You CAN be KILLED or SERIOUSLY HURT if you do not follow instructions.**

1.2 Important Safety Information

Ex-Power DEFENDER generators are designed for use with electrical equipment that has suitable power requirements. Other uses can result in injury to the operator or damage to the generator and other property. Most injuries or property damage can be prevented by following all instructions in this manual. The most common hazards are discussed below, along with the best way to protect yourself and others.

1.2.1 Operator Safety Responsibilities

Know how to stop the generator quickly in case of emergency (turn Engine Switch to OFF). Understand the use of all generator controls, output receptacles, and connections, as described in this manual. Be sure that anyone who operates the generator receives proper instruction and understands procedures and safety requirements contained in this manual.

1.2.2 Carbon Monoxide Hazards

Exhaust contains poisonous carbon monoxide, a colorless, odorless gas. Breathing carbon monoxide can cause loss of consciousness and may lead to death. Do not run generator in an area that is confined or even partly enclosed. Never run generator inside a garage, house, or near open windows or doors.

1.2.3 Electric Shock Hazards

The generator has GFCI Protected AC outlets. Generator produces enough electric power to cause a serious shock or electrocution if misused or not properly maintained. Using a generator or electrical appliance in wet conditions, or when hands are wet, could result in electrocution if the GFCI Protected AC outlets are not working properly. Keep generator dry. Do not connect to a building's electrical system. Never connect different generator models in parallel operation.

1.2.4 Fire and Burn Hazards

The exhaust system gets hot enough to ignite materials. Keep generator at least 3 feet (1 meter) away from buildings and other equipment during operation. Do not enclose generator in any structure. Keep flammable materials away from generator. The muffler becomes very hot during operation and remains hot for a while after stopping the engine. Be careful not to touch muffler while it is hot. Let engine cool before storing generator indoors.

1.2.5 Refueling Hazards

Fuels are extremely flammable, and fuel vapors can explode. Allow engine to cool if generator has been in operation. Refuel only outdoors in a well-ventilated area with the engine OFF. Do not overfill the fuel tank. Never smoke near fuels, and keep other flames and sparks away. Always store fuels in an approved container. Make sure that any spilled fuel has been wiped up before starting engine.

1.3 Safety Label Locations

Refer to warning labels on generator to warn against potential hazards that can cause serious injury. Read warning labels carefully. If a label comes off or becomes hard to read, contact Novatio for a replacement.

Figure 1-1: Warning Labels

2. Description of Generator Controls and Components

The following figures show external components and frequently used controls.

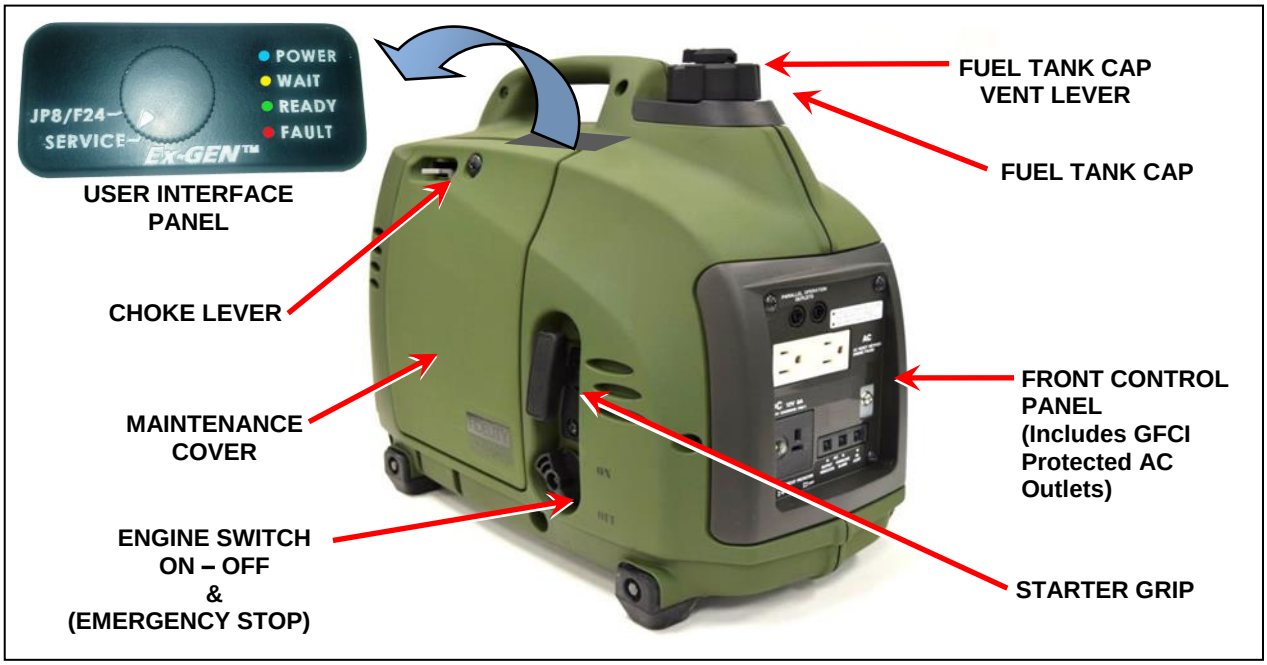

Figure 2-1: External Components and Features

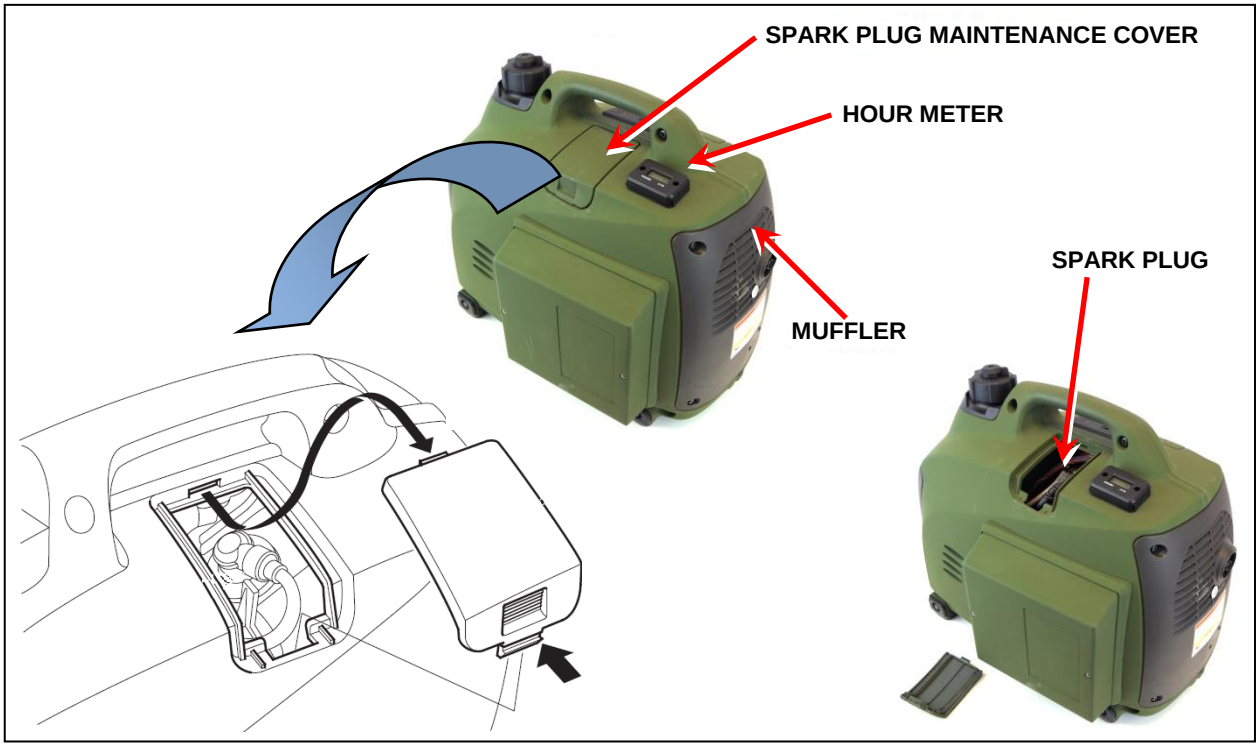

Figure 2-2: Spark Plug, Muffler and Hour Meter

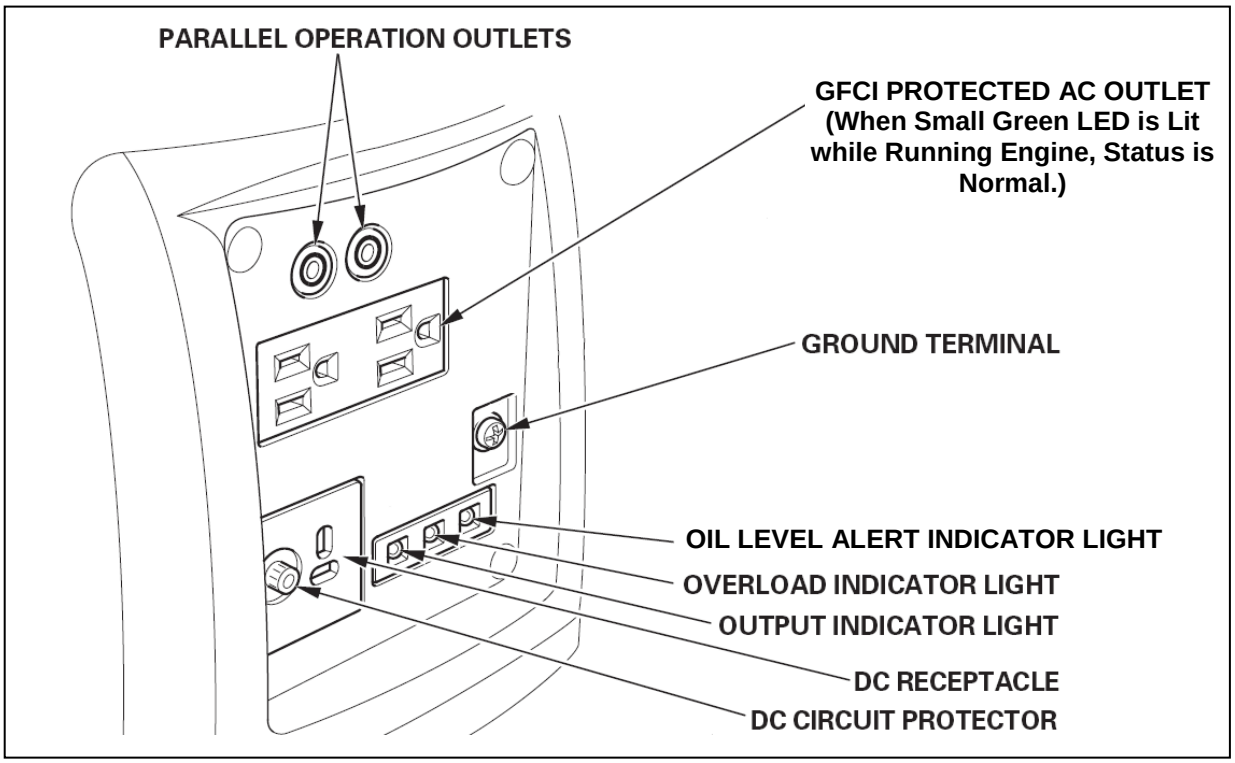

Figure 2-3: Front Control Panel

2.1 Engine Switch and Starter Grip

The engine switch controls ignition system and fuel valve. Pulling starter grip operates the recoil starter to crank the engine, shown below.

ON - Running position; opens fuel valve and allows engine to be started.

OFF - Stops engine and closes fuel valve.

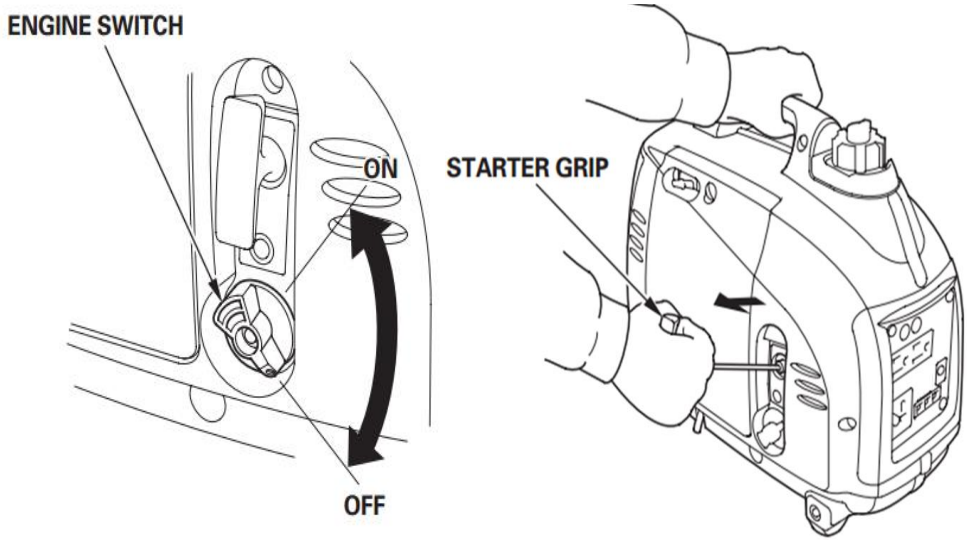

Figure 2-4: Engine Switch and Starter Grip

CAUTION

Do not allow starter grip to snap back against generator. Return it gently to prevent damage to the starter.

2.2 Fuel Tank Cap, Vent Lever, and Choke

The fuel tank cap is provided with a vent lever to seal the fuel tank, as shown below.

The vent lever must be in the ON position for engine to run.

When starting a cold engine, temporarily set the choke lever CLOSED to enrich the air/fuel mixture. Gradually OPEN the choke lever as the engine warms up.

When the engine is not in use, leave vent lever in the OFF position to reduce the possibility of fuel leakage. Allow engine to cool before turning the vent lever to the OFF position to preclude pressure buildup in the fuel tank.

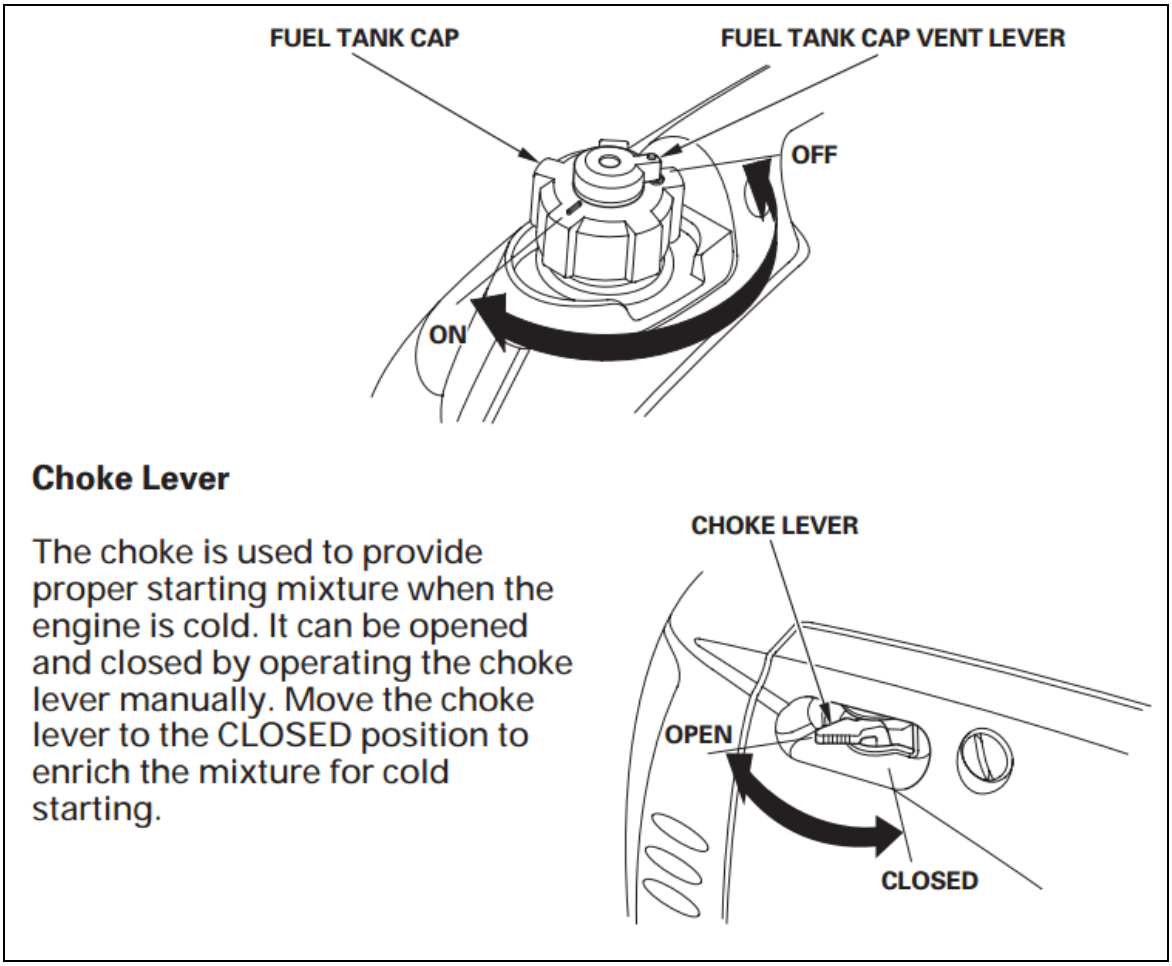

Figure 2-5: Fuel Tank Cap, Vent Lever, and Choke

2.3 Parallel AC Operation Connections

These connections are used for connecting two Ex-Power DEFENDER generators for parallel operation. Parallel AC operation cables (optional equipment) are required for parallel operation. (Optional parallel cable assemblies are available from Novatio.)

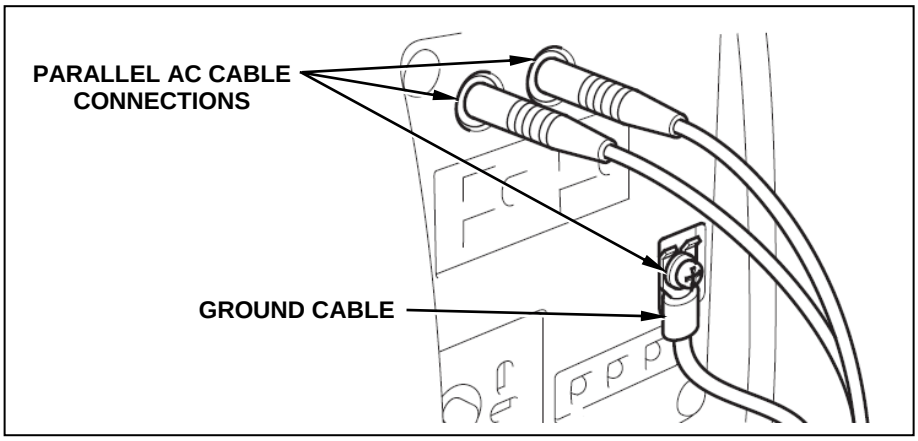

Figure 2-6: Parallel AC Operation Connections Using Optional Cable Assembly

2.4 DC Receptacle and DC Circuit Protector

The DC receptacle (shown below) should ONLY be used for charging 12-volt automotive type batteries. The DC charging output is not regulated.

The DC circuit protector automatically shuts off the DC battery charging circuit when the DC charging circuit is overloaded, when there is a problem with the battery, or when the connections between the battery and the generator are improper. However, the circuit protector does not prevent overcharging.

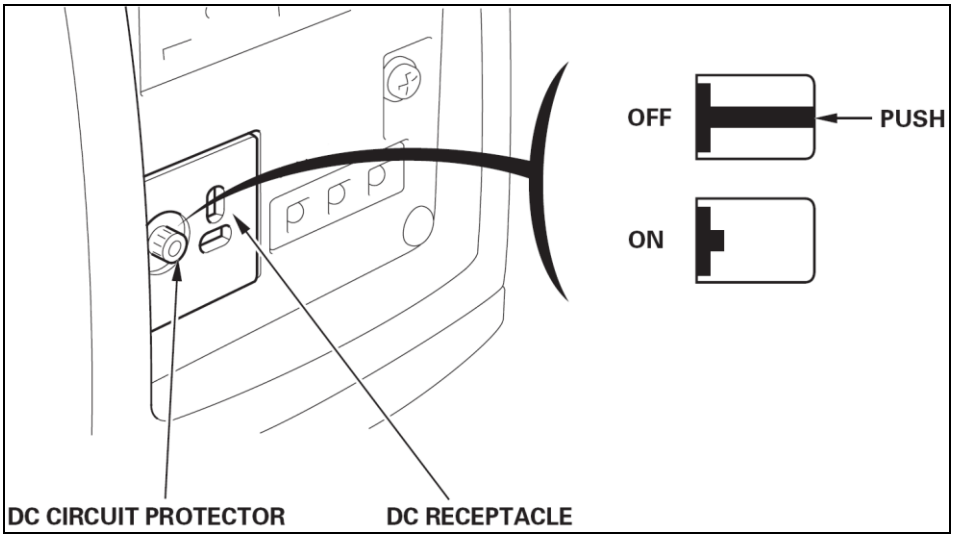

Figure 2-7: DC Receptacle (Used with Optional DC Cable)

2.5 Output Indicator

The output indicator (green) is illuminated when generator is operating normally to indicate that generator is producing electrical power at the receptacles. Green LED on GFCI AC outlets should also be on when running engine.

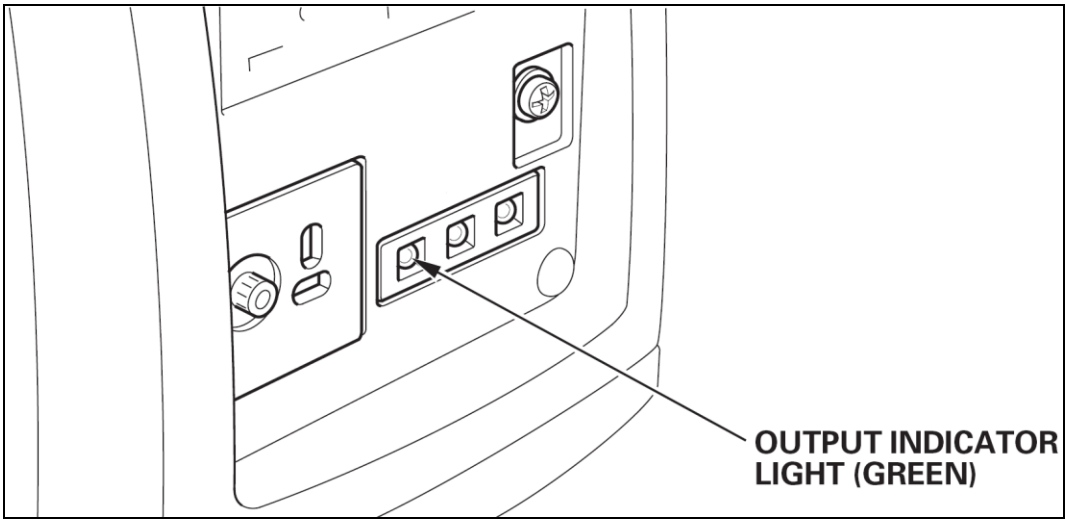

Figure 2-8: Output Indicator Light

2.6 Overload Indicator

If the generator is overloaded (in excess of 1.0 kVA), or if there is a short circuit in a connected appliance, the overload indicator (red) will come ON. The overload indicator (red) will stay ON, and after about four seconds, the current to the connected appliance(s) will shut off. The output indicator (green) will go OFF, but the engine will continue to run. See below.

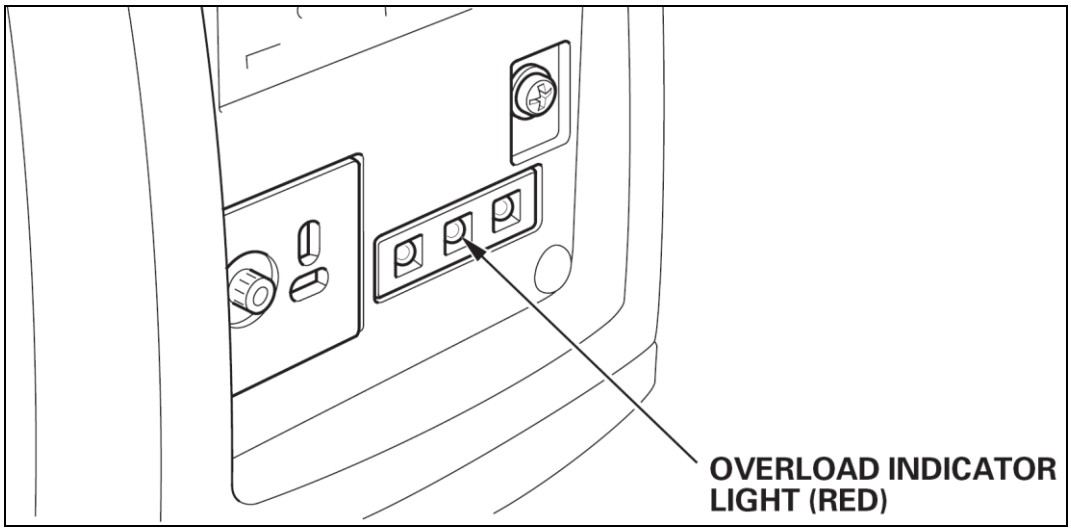

Figure 2-9: Overload Indicator Light

2.7 Oil Level Alert Indicator

The Oil Level Alert Indicator system is designed to prevent engine damage caused by an insufficient amount of oil in the crankcase. Before oil level in crankcase can fall below a safe limit, the Oil Level Alert Indicator (red) comes on (shown below) and the Oil Level Alert Indicator system automatically will stop the engine (engine switch will remain in ON position). If engine stops or the Oil Level Alert Indicator (red) comes on after pulling the starter grip, check the engine oil level (see section 5.2) before troubleshooting in other areas.

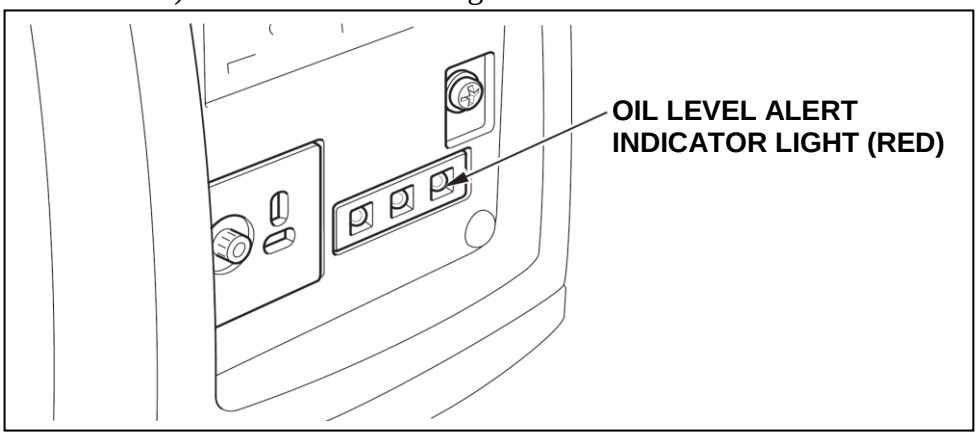

Figure 2-10: Oil Level Alert Indicator Light

2.8 Ground Terminal

The generator ground terminal is connected to the frame of the generator, the metal non-current-carrying parts of the generator, and the ground terminals of each receptacle. If using the ground terminal for grounding the Ex-Power DEFENDER generator, consult a qualified electrician, electrical inspector, or local agency having jurisdiction for local codes or ordinances that apply to the intended use of the generator. The ground terminal is mainly used when connecting two Ex-Power DEFENDER generators for parallel AC operation via the optional AC parallel cable assembly (available from Novatio).

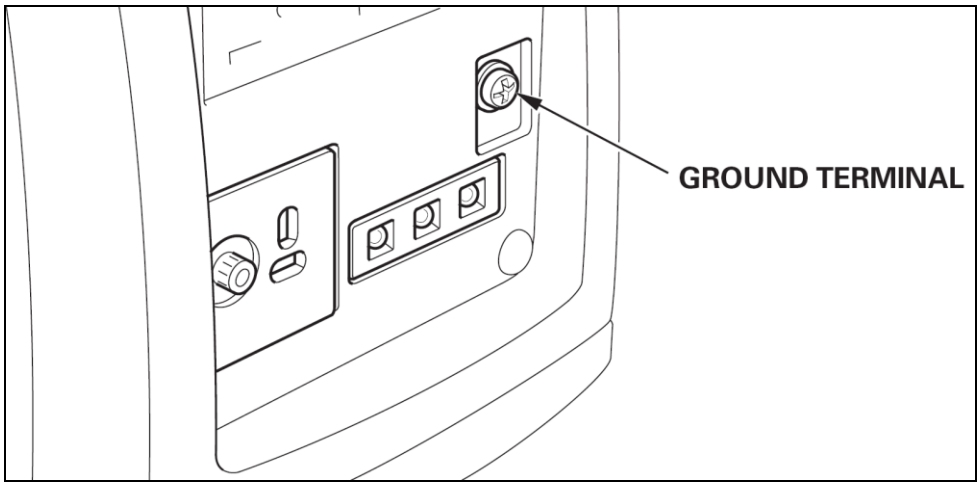

Figure 2-11: Ground Terminal

3. Operation

When operating engine on JP-8, F24, JET-A or JP-5 fuel, a load of up to 900W can be applied. Engine has been de-rated to 750W for 4000 ft and 95°F operation; at sea level a load of up to 900W may be applied continuously without causing the engine to stall and a maximum load of up to 1000W for brief surge capacity. No other modifications or special operating procedures are required.

When performing procedures in this Section, it is important to follow steps in their given order.

3.1 Operation Time and Power Rating

- Limit operation requiring maximum power to brief surge capacity.
- Maximum power in parallel operation is: 2.0 kVA.
- Rated power in parallel operation is: 1.8 kVA
- For continuous operation, do not exceed the rated power.
- The total power requirements (VA) of all appliances connected must be considered. Appliance and power tool manufacturers usually list rating information near the model number or serial number.
- It is not recommended to operate at no load conditions for long periods of time

3.2 Pre-operation - Warnings, Cautions, and Checking the Engine

3.2.1 Pre-operation Safety, Warnings, and Cautions

Safety is your responsibility. Understand and abide by all safety warnings stated in this Operation and Maintenance Manual. Read and understand this manual. Know what the controls do and how to operate them. Familiarize yourself with the generator and its operation before using it. Know how to shut off the generator in an emergency. If the generator is being used to power appliances, be sure they do not exceed the generator's load rating.

To prevent an injury or damage the equipment, check the condition of the generator before operating. Be sure to take care of any problems or send the generator back to Novatio to fix any problems, before operating the generator.

WARNINGS

- Improperly maintaining this generator or failing to correct problems before operation, could cause a malfunction in which could result in serious injuries. Always perform a pre-operation inspection before each operation, and correct any problem.

- Exhaust contains poisonous carbon monoxide gas that can build up to dangerous levels in closed areas. Breathing carbon monoxide can cause unconsciousness or death.
- Never run generator in a closed or even partly closed area where people may be present.
- Use grounded 3-prong extension cords, tools, and appliances, or double-insulated tools and appliances.
- Inspect cords and plugs, and replace if damaged.
- Make sure that the appliance is in good working order. Faulty appliances or power cords can create a potential for electric shock.
- Operate generator at least 3 feet (1 meter) away from buildings and other equipment.
- Do not operate generator in an enclosed structure.

CAUTIONS

- Keep all cooling holes open and clear of debris, mud, water, etc. Cooling holes are located on the side panel, the control panel, and the bottom of the generator. If the cooling holes are blocked, the generator may overheat and damage the engine, inverter, or windings.
- Do not lay the generator on its side when moving, storing, or operating it. Oil may leak and damage the engine or property.
- Make sure the electrical rating of the tool or appliance does not exceed that of the generator. Never exceed the maximum power rating of the generator. Power levels between rated and maximum may be used for only brief surge capacity.

3.2.2 Check the Engine before Starting

Check the oil level (see Section 5.2). A low oil level will cause the Oil Level Indicator system to shut down the engine.

Check the air filter (see Section 5.4). A contaminated air filter will restrict air flow to the carburetor, reducing engine and generator performance.

Check the fuel level (shown below) by opening cap vent lever (ON position to release internal pressure), removing fuel tank cap, and checking fuel level. If adding fuel, ensure that JP-8 and F24 fuels are not mixed. Starting with a full tank, will help to eliminate or reduce operating interruptions for refueling.

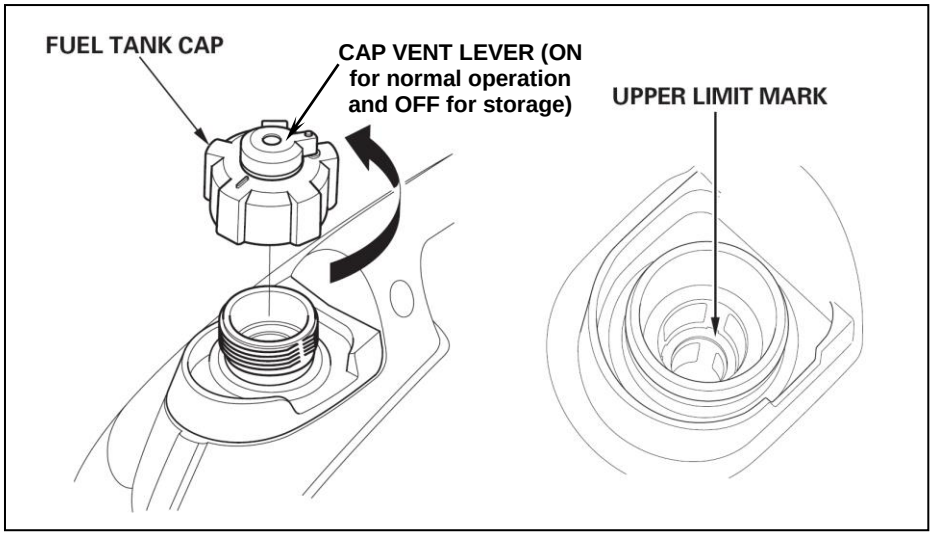

Figure 3-1: Fill Fuel Tank with Proper Fuel Type

3.3 Starting Engine and Applying Load

If generator is equipped with a Throttle switch, ensure it is in the OFF position at all times during operation.

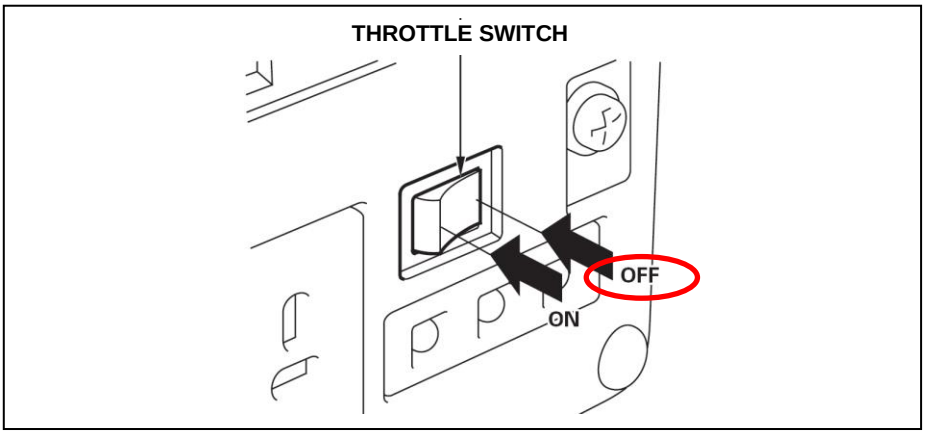

Figure 3-2: Throttle switch

1. Make sure that all appliances or tools connected to generator are turned off.
2. Turn fuel tank cap vent lever to **ON** position.
3. Turn Engine Switch to **ON**.

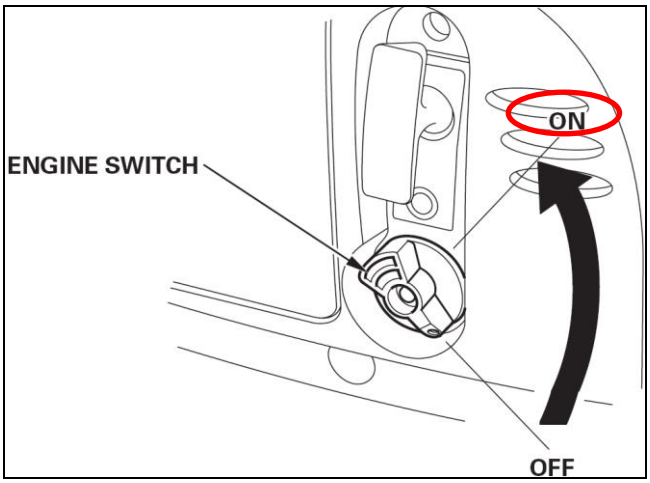

Figure 3-3: Engine Switch

4. On User Interface Panel (see placard below), ensure **FUEL SELECTOR SWITCH** is set to the same fuel that is in the tank.

Figure 3-4: Fuel Selector Switch

5. On User Interface Panel shown above, wait for blinking yellow (**WAIT**) light to stop blinking and for green (**READY**) light to be lit (up to 6 seconds if engine is cold). (Blue **POWER** light should be on.) ??

6. Set choke lever CLOSED when starting a cold engine to enrich the air/fuel mixture.

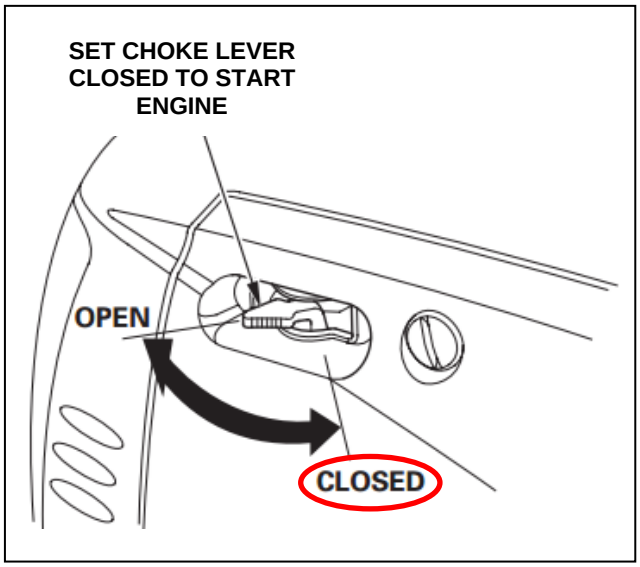

Figure 3-5: Setting Choke Lever to Closed Position when Starting Cold Engine

7. Pull engine starting grip engine crank chord and release it slowly back into its home position.

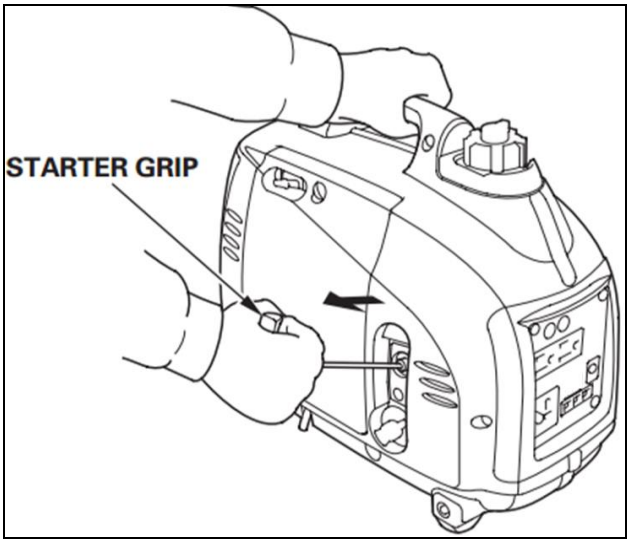

Figure 3-6: Starter Grip

NOTES

- Exhaust could be visibly cloudy for up to three minutes after cold start-up.
- Status is normal when Small green LED on AC GFCI outlets is lit while running engine. If green LED is not lit, reset GFCI switch.
- If starting the motor takes longer than 30-seconds the red **FAULT** light on the User Interface panel comes on and the control aborts the start sequence. Turn the Engine Switch OFF, and then ON again, and re-initiate the Start Sequence. If there is a problem starting the engine, refer to Troubleshooting in Section 6.1. After correcting any problems, restart the engine following the steps at the beginning of this procedure.

8. If the choke lever was moved to the CLOSED position to start the engine, gradually move it to the OPEN position as engine warms up.
9. Apply load after engine ramps up (up to 45 seconds if engine is very cold, immediately if engine is at typical ambient conditions).
10. If engine stalls, the operator should remove load, re-set ON/OFF switch and restart engine.

3.4 Stopping Engine

3.4.1 Emergency Stop

To stop engine in an emergency, turn Engine Switch (shown below) to the OFF position.

3.4.2 Stopping Engine Under Normal Conditions

1. Turn off appliance(s) or tool(s) and disconnect from generator.
2. Turn Engine Switch to OFF position.

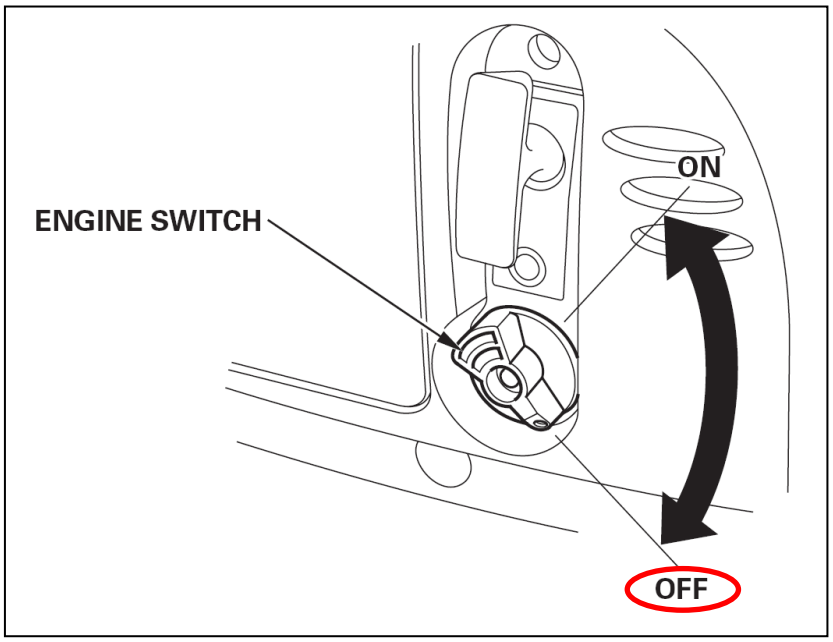

Figure 3-2: Engine Switch and Emergency Off

3. Allow engine to cool, and then turn the fuel tank cap vent lever to OFF position.
4. If two generators were connected for parallel operation, disconnect the parallel operation cables after stopping the engines, unless parallel operation is to resume. (Refer to Section 3.5.3 for details.)

3.5 AC Operation

Start the engine (see Section 3.3) and make sure the output indicator (green) comes on. Most motorized appliances require more than their electrical rating for startup. When an electric motor is started, the overload indicator (red) may come on. This is normal if the overload indicator (red) goes off within 4 seconds. If the overload indicator (red) stays on, consult Novatio.

3.5.1 Connecting an Appliance or Power Cord to Generator

1. Make sure that it is in good working order. A faulty appliance or power cord can create a potential for electrical shock.
2. If an appliance begins to operate abnormally, becomes sluggish, or stops suddenly, turn it off immediately. Disconnect the appliance, and determine whether the problem is the appliance or the rated load capacity of the generator has been exceeded.
3. Make sure that the combined electrical rating of the tools or appliances do not exceed that of the generator. Never exceed the maximum power rating of the generator. Power levels between rated and maximum may be used for no more than brief surge capacity.

CAUTION

Substantial overloading will open the circuit protector. Exceeding the time limit for maximum power operation or slightly overloading the generator may not switch the circuit protector OFF, but will shorten the service life of the generator.

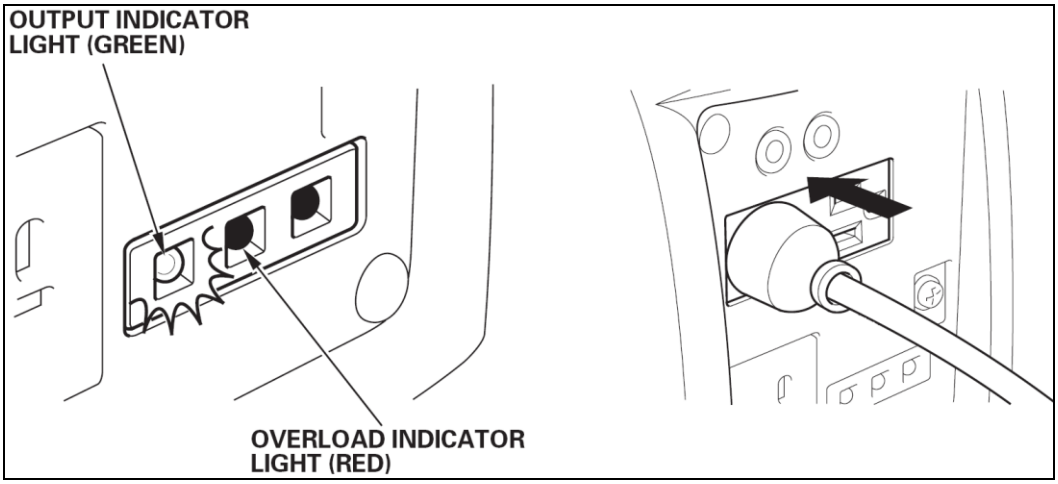

Figure 3-3: Connecting AC Appliance to Generator

4. Plug the power cord (if required) and appliance into the AC receptacle.
5. Turn on appliance.

If the generator is overloaded [overload indicator (red) on front control panel], or if there is a short circuit in a connected appliance, the overload indicator (red) will go ON. The overload indicator (red) will stay ON, and after about four seconds, the current to the connected appliance(s) will shut off, and the output indicator (green) will go OFF. Stop the engine and investigate the problem. Determine if the cause is a short circuit in a connected appliance or an overload. Correct the problem and restart the generator.

3.5.2 AC Parallel Operation - Cautions and Notes

Follow the instructions included with the optional parallel operation cable assembly, before connecting an appliance or power cord to the generator (optional equipment, provided by Novatio). For single generator operation, the parallel operation cables must be removed.

CAUTIONS

- Never connect or remove the parallel operation cable assembly when the generators are running.
- Substantial overloading that continuously lights the overload indicator (red) may damage the generator. Marginal overloading that temporarily lights the overload indicator (red) may shorten the service life of the generator.
- Never connect different generator models.
- Only use approved parallel operation cables (optional equipment, provided by Novatio) when connecting two Ex-Power DEFENDER generators for parallel operation.

Review the "Pre-operation – Warnings, Cautions, and Checking the Engine" information in Section 3.2 before starting procedures in the following subsection.

3.5.3 AC Parallel Operation - Connections and Operation Procedures

1. Connect the parallel operation cables (optional equipment shown below) between the two Ex-Power DEFENDER generators, following the instructions supplied with the parallel operation cables.
2. Start the engines and make sure the output indicator (green) on each generator comes on.

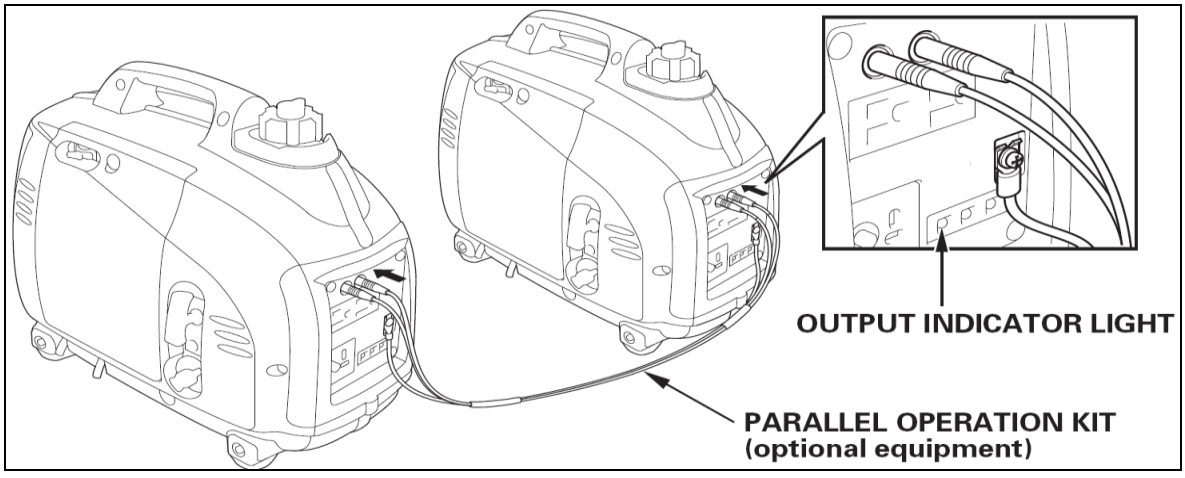

Figure 3-4: Parallel Operation (Using Optional AC Parallel Cables)

3. Plug the appliance into one of the AC receptacles. Follow the instruction provided with the parallel operation cable assembly.
4. Turn ON the appliance.
5. When finished parallel operation, turn OFF the appliance.

6. Turn OFF the generators.
7. Disconnect the parallel operation cables after stopping the engines, unless parallel operation is to resume.

If the generators are overloaded [overload indicator (red)] or if there is a short circuit in a connected appliance, the overload indicator (red) will go ON. The overload indicator (red) will stay ON, and after about four seconds, current to the connected appliance(s) will shut off, and the output indicator (green) will go OFF. Stop both engines and investigate the problem.

Determine if the cause is a short circuit in a connected appliance or an overload. Correct the problem and restart the generator.

3.6 DC Operation (Using Optional Battery Charging Cable)

The Ex-Power DEFENDER has NOT BEEN APPROVED for charging external batteries from the DC Output. Use of the DC Output for battery charging is not supported at this time. Please contact Novatio for support if DC power is required.

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4. General Routine Maintenance and Safety Concerns

4.1 The Importance of Maintenance

Proper maintenance is essential for safe, economical, and trouble-free operation, and will help reduce air pollution. Follow the inspection, maintenance recommendations, and schedules in this operation and maintenance manual.

For routine maintenance, refer to the maintenance schedule, routine inspection procedures, and simple maintenance procedures using basic hand tools.

For major repairs or depot level maintenance, contact Novatio Engineering.

The maintenance schedule applies to normal operating conditions. If the generator was operated under unusual conditions, such as sustained high-load or high-temperature operation, or used in dusty conditions, consult Novatio for recommendations applicable to that particular condition.

WARNINGS

- Improper maintenance or failure to correct a problem before operation can cause a malfunction in which you can be seriously hurt or killed.
- Failure to properly follow maintenance instructions and precautions can cause you to be seriously hurt or killed. Always follow the procedures and precautions in this operation and maintenance manual and consult Novatio Engineering personnel if there are questions concerning higher level maintenance or repairs.

4.2 Safety Precautions

Make sure the engine is off before beginning any maintenance or repairs. This will eliminate several potential hazards:

- **Carbon monoxide poisoning from engine exhaust** – Operate outside away from open windows and doors.
- **Burns from hot parts** – Let the engine exhaust system cool before touching.
- **Injury from moving parts** – Do not run the engine unless instructed to do so.
- **Electrocution from generation of power** – Running the generator while performing maintenance can cause electrical shocks.

Before performing maintenance, read the instructions below and make sure to have the proper tools and skills required.

To reduce the possibility of fire or explosion, be careful when working around fuel. Use only a non-flammable solvent, not fuel, to clean parts. Keep cigarettes, sparks, and flames away from all fuel and fuel-related parts.

4.3 Maintenance Schedule

Use of the Hour Meter (shown below) will assist in keeping maintenance records current.

Following the Preventive/Routine Maintenance schedule given below will ensure the Ex-Power DEFENDER unit will provide the best service and preclude early problems.

Table 4-1: Preventive/Routine Maintenance

Item	Each Use	Basic Preventive Maintenance				
		First month or 10 hrs.	Every 3 months or 50 hrs.	Every 6 months or 100 hrs.	Every year	Every 2 years or 300 hrs.
Engine Oil	Check oil and add if necessary	Change oil	Change oil [1]			
Air Cleaner	Check and clean if necessary.		Clean [2]			
Spark Plug				Check - Adjust		Replace
Spark Arrestor				Clean		
Valve Clearance						Check – Adjust [3]
Combustion Chamber						Clean [3]
Fuel Tank and Filter					Clean [3]	
Secondary Fuel Filter					Clean [3]	
Fuel Tube						Check [3]

NOTES:

[1] If operating generator in temperatures below 20°F, change oil every 25 hrs.

[2] Service Air Cleaner more frequently when used in dusty areas.

[3] These items should be serviced by a qualified mechanic, unless the person performing maintenance is mechanically proficient: Valve Clearance, Combustion Chamber, Fuel Tank and Filter, Secondary Fuel Filter, and Fuel Tube.

5. Servicing, Storage, Transporting and Removing from Storage

5.1 Refueling

WARNINGS

- Fuel is highly flammable and explosive.
- You can be burned or seriously injured when handling fuel
  - Stop engine when refueling and keep heat, sparks, and flame away.
  - Handle fuel only in a safe environment.
  - Wipe up any fuel spills immediately.
- Refuel in a well-ventilated area before starting the engine. If the engine has been running, allow it to cool. Never refuel the engine inside a building where fumes may reach flames or sparks. Keep fuel away from electrical appliances.
- Refuel carefully to avoid spilling fuel. Spilled fuel is not only a fire hazard, it causes environmental damage.
- Do not fill above the upper level mark.

CAUTION

Fuel can damage paint and plastic. Be careful not to spill fuel when filling fuel tank.

1. Stop the engine, open fuel cap vent, and remove the fuel tank cap to check the fuel level.
2. Refill the fuel tank if the fuel level is low.
3. After refueling, reinstall fuel tank cap securely.

5.2 Engine Oil Level Check

The Oil Level Indicator system will automatically stop the engine before the oil level falls below safe limits. To prevent an unexpected shutdown, check the oil level regularly.

1. Check the engine oil level with the generator on a level surface and the engine stopped.
2. Loosen the cover screw and remove the maintenance cover.

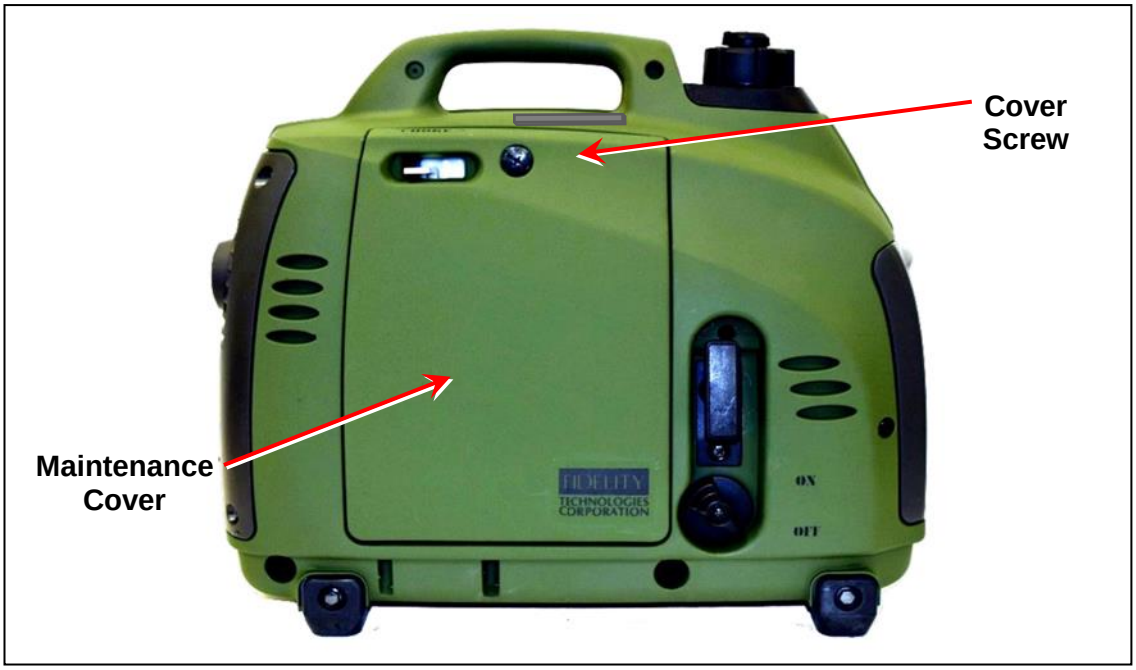

Figure 5-1: Cover Screw & Maintenance Cover

3. Check the oil level by inserting the dipstick into the oil filler neck without screwing it in.
4. If the level is low, fill to the upper limit of the oil filler neck with the recommended oil (SAE 10W 30)
5. Reinstall the maintenance cover and tighten the cover screw securely.

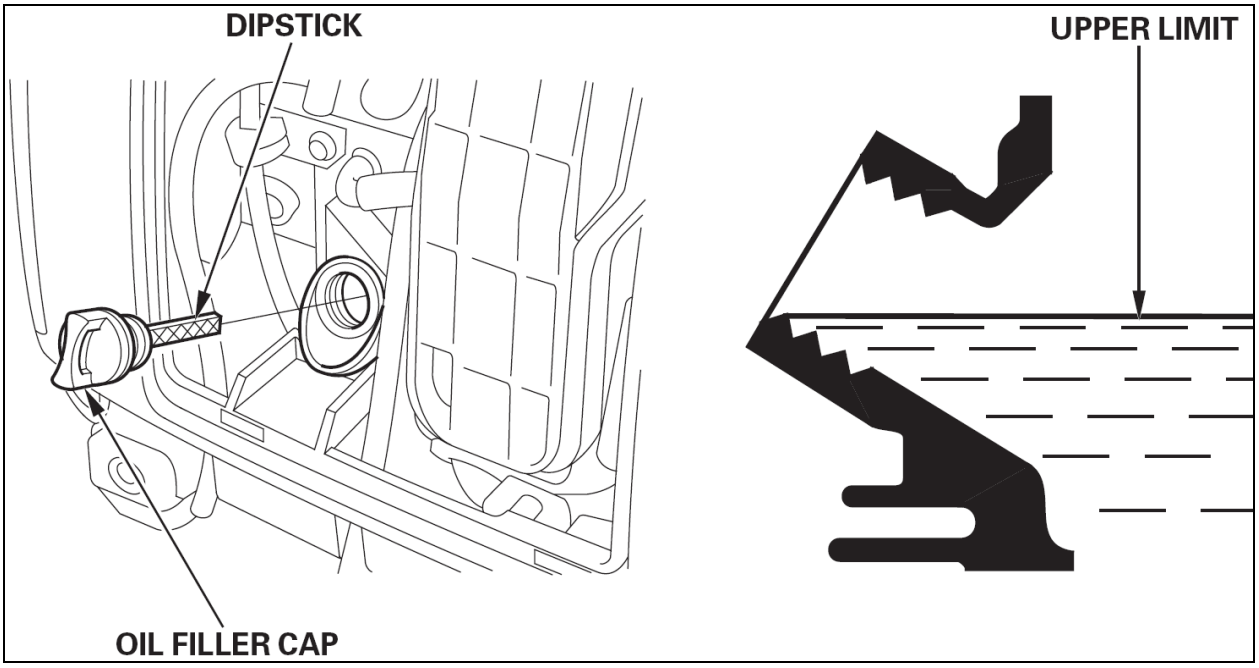

Figure 5-2: Dipstick & Upper Oil Level Limit

5.3 Engine Oil Change

5.3.1 Draining Oil

CAUTION

Improper disposal of engine oil can be harmful to the environment. After changing oil dispose of the used oil properly. Put it in a sealed container, and take it to a recycling center. Do not discard it in a trash bin, dump it on the ground, or pour it down the drain.

Drain oil while the engine is warm to assure rapid and complete draining.

1. Turn the engine switch and fuel tank cap vent lever to the OFF position to reduce the possibility of fuel leakage.
2. Loosen the cover screw and remove the maintenance cover
3. Place a suitable container next to the engine to catch the used oil.
4. Remove the oil filler cap/dipstick, and drain the oil into the container by tipping the engine toward the oil filler neck.

5.3.2 Replenishing Engine Oil

1. With the engine in a level position, fill to the upper limit of the oil filler neck (capacity: 0.26 US quart) with the recommended oil (SAE 10W 30).
2. Reinstall the oil filler cap/dipstick securely.
3. Reinstall the maintenance cover/battery pack assembly, taking care to redo the electrical connections, and tighten the cover screw securely (see Section 5.2).

Wash your hands with soap and water after handling used oil

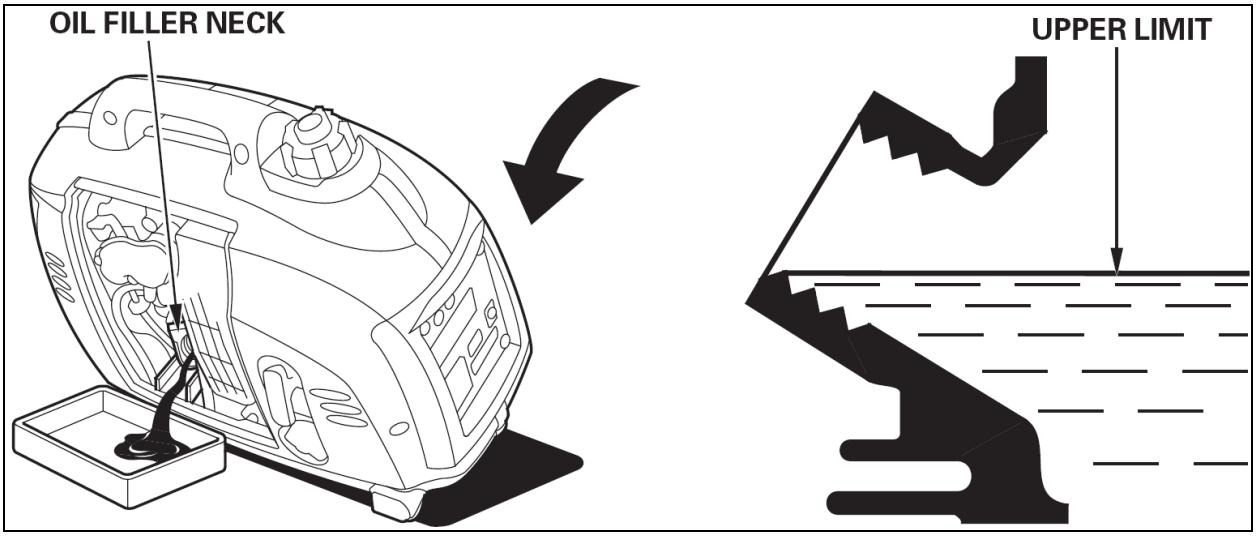

Figure 5-3: Replenishing Oil - Oil Filler Neck & Upper Limit

5.3.3 Engine Oil Recommendations

Oil is a major factor affecting performance and service life. Use 4-stroke automotive detergent oil.

SAE 10W 30 is recommended for general use. Other viscosities shown in the chart below may be used when the average temperature in operating area is within the recommended range.

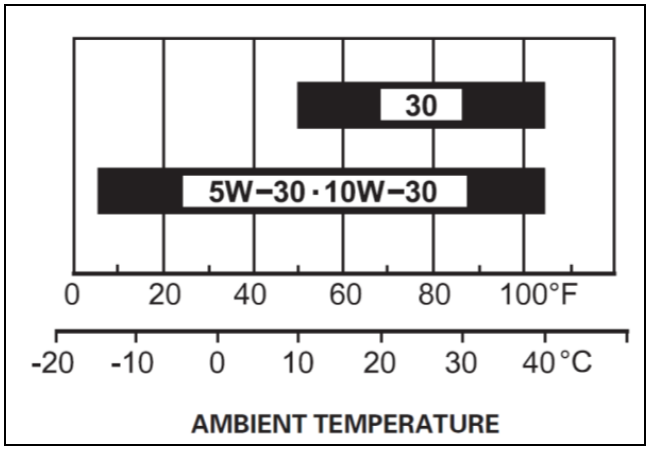

Figure 5-4: Ex-Power DEFENDER Generator - Oil Viscosity Chart

The SAE oil viscosity and service category are in the API label on the oil container. Use API service category SJ or equivalent oil.

5.4 Air Cleaner Service

CAUTION

Operating the engine without an air filter or with a damaged air filter will allow dirt to enter the engine, causing rapid engine wear.

5.4.1 Remove and Replace Foam Air Filter

See below while performing the following steps.

1. Loosen cover screw and remove maintenance cover.
2. Press latch tab on top of air cleaner case, and remove air cleaner cover.
3. Check foam air filter to be sure it is clean and in good condition.
4. If foam air filter is dirty, clean it as described in the next subsection.
5. Replace foam air filter if it is damaged.
6. Reinstall the air filter.
7. Make sure that the rubber seal is set in the groove of the air cleaner cover.
8. Reinstall air cleaner cover by inserting the lower tab and the latch tab.
9. Reinstall maintenance cover, and tighten cover screw securely.

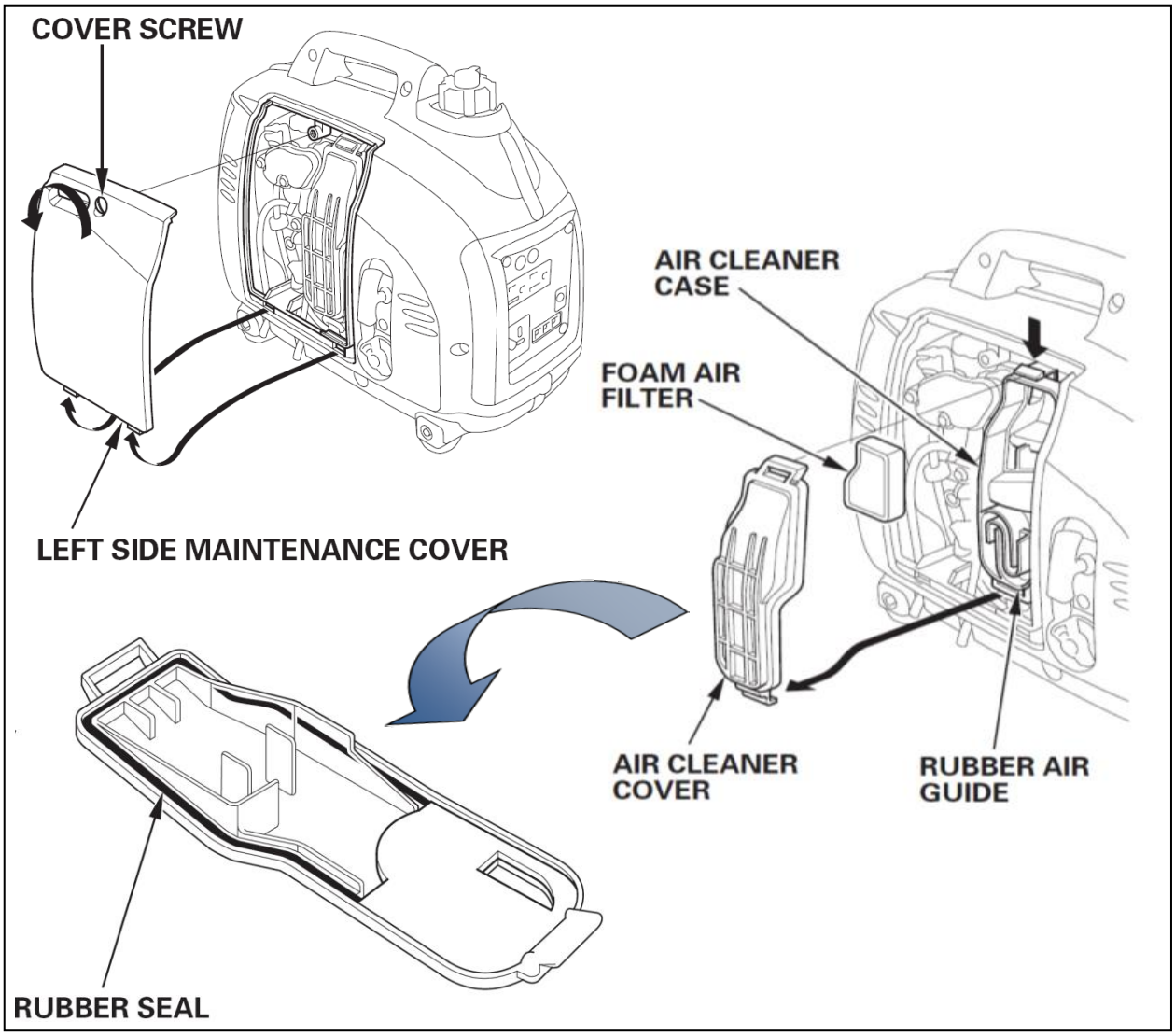

Figure 5-5: Removing & Replacing Foam Air Filter

5.4.2 Foam Air Filter Cleaning

Clean foam air filter to prevent the air flow from being restricted to the carburetor and to maintain engine performance. After operating the generator in very dusty areas, clean the foam air filter more frequently than specified in the Maintenance Schedule (see Section 4.3).

1. Wash foam air filter in a solution of household detergent and warm water, then rinse thoroughly, or wash in non-flammable or high flash point solvent. Allow foam air filter to dry thoroughly.
2. Soak foam air filter in clean engine oil and squeeze out excess oil. The engine will smoke during initial startup if too much oil is left in the foam air filter.

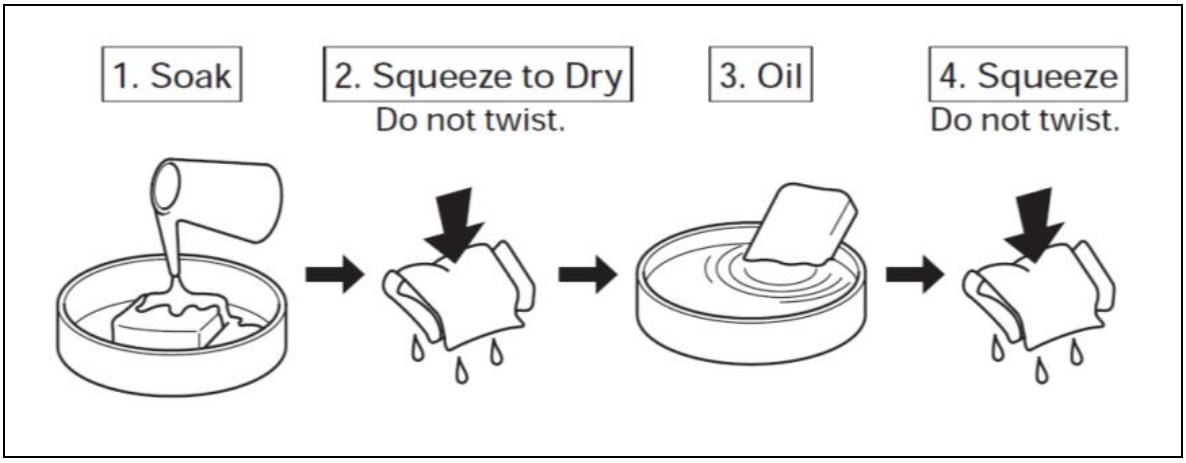

Figure 5-6: Cleaning Foam Air Filter

3. Remove the rubber air guide from air cleaner case.
4. Clean rubber air guide and air cleaner case with a damp rag and reinstall the rubber air guide.

5.5 Spark Plug Service

WARNING

If engine is hot, allow it to cool before servicing spark plug to prevent burns.

Remove, Inspect, and Clean or Replace Spark Plug

1. Remove spark plug maintenance cover shown below.
2. Remove the spark plug cap.

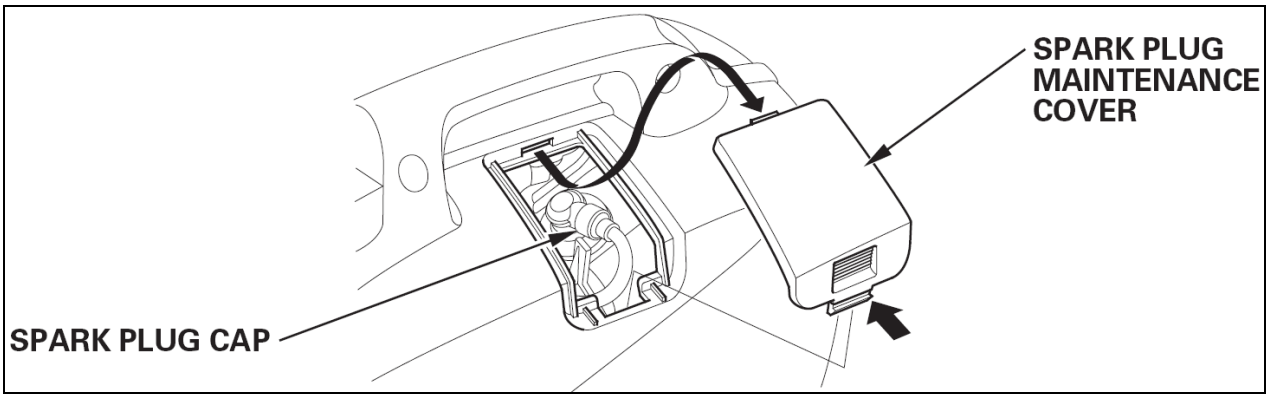

Figure 5-7: Spark Plug Cap & Spark Plug Maintenance Cover

3. Clean any dirt from around the spark plug base.
4. Use a spark plug wrench to remove spark plug.

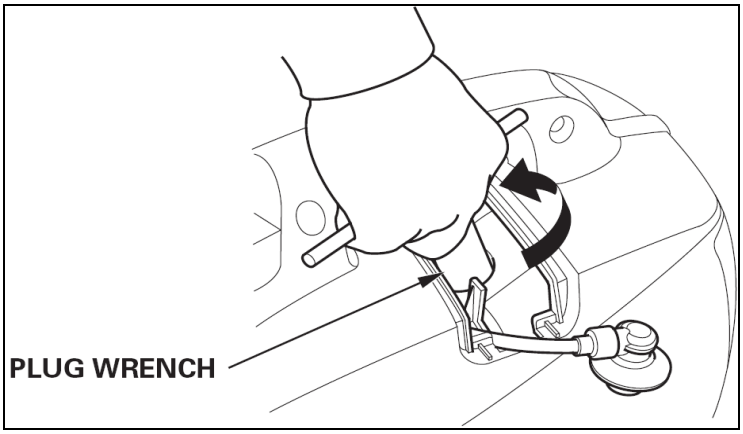

Figure 5-8: Removing Spark Plug from Engine

5. Inspect the spark plug.
6. Clean with wire brush if spark plug is in good condition.
7. Replace spark plug if the electrodes are worn or if the insulator is cracked, chipped, or fouled.

   Recommended Spark Plug Replacement Types:

   CR5HSB (NGK)

   U16FSR-UB (DENSO)

CAUTION

An incorrect spark plug can cause engine damage. To ensure proper engine operation, the spark plug must be properly gapped and free of deposits.

8. Measure the spark plug electrode gap with an approved feeler gauge. Correct the gap, if necessary, by carefully bending the side electrode.

   GAP: 0.024-0.028 in (0.6 – 0.7 mm)

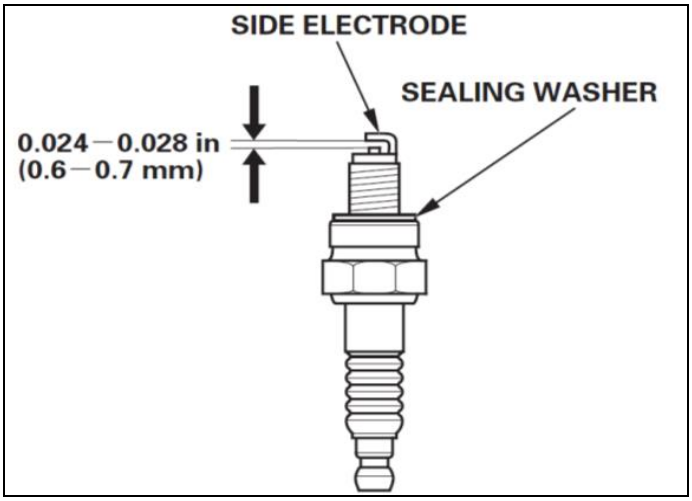

Figure 5-9: Spark Plug Gap Setting

9. Make sure the spark plug sealing washer is in good condition, and thread the spark plug back into the engine by hand to prevent cross-threading.
10. After the spark plug is seated, tighten with a spark plug wrench to compress the sealing washer.

    If reinstalling a used spark plug, tighten 1/8-1/4 turn after the spark plug seats.

    If installing a new spark plug, tighten 1/2 turn after the spark plug seats.

    CAUTION

    A loose spark plug can overheat and damage the engine. Over-tightening spark plug can damage threads in the cylinder head.
11. Reinstall spark plug cap on spark plug securely.
12. Reinstall spark plug maintenance cover.

5.6 Servicing Spark Arrestor (in Muffler)

The spark arrester must be serviced every 100 hours to keep it functioning as designed.

WARNING

If the engine has been running, the muffler will be very hot. Allow muffler to cool before servicing spark arrester.

Procedure for Removing, Cleaning, and Replacing Spark Arrestor

1. Remove the four 5 mm screws, and remove muffler protector (cover).
2. Disconnect the wiring connector that goes to the engine temperature vent control.

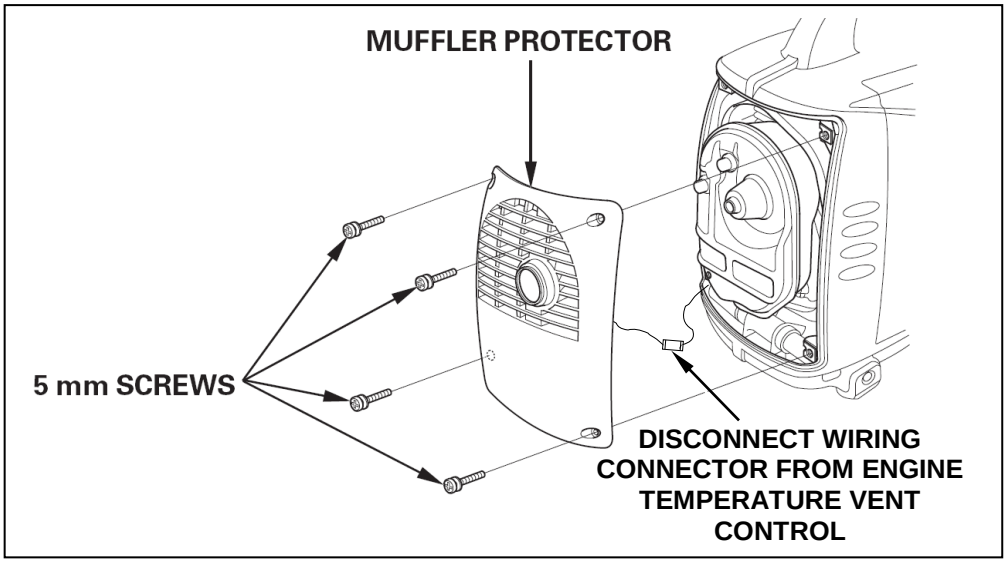

Figure 5-10: Removing Muffler Protector Cover

3. Remove the three 6 mm bolts, and remove muffler, spark arrester, and muffler gasket as shown below.

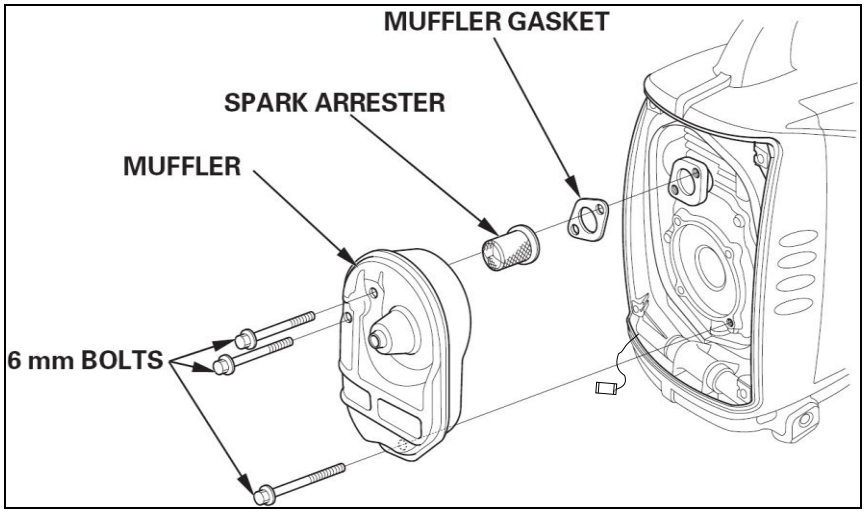

Figure 5-11: Spark Plug Arrester Access

4. Use a brush to remove carbon deposits from the spark arrester screen as shown below.

CAUTION

Be careful to avoid damaging the screen. The spark arrester must be free of breaks and tears.

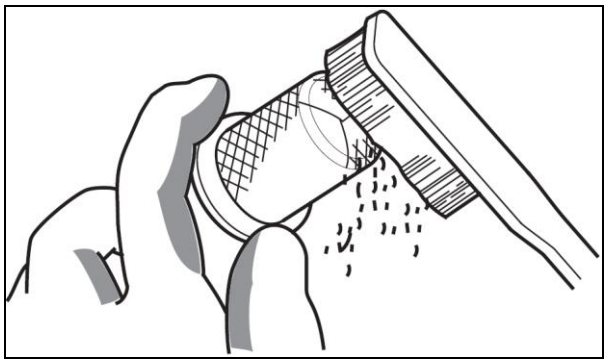

Figure 5-12: Cleaning Spark Plug Arrester

5. Replace the spark arrester if it is damaged.
6. Check the muffler gasket; replace if damaged.
7. Reassemble in the reverse order of removal (reinstall the muffler gasket, spark arrester, muffler, reconnect the wiring connector that goes to the engine temperature vent control, and reinstall muffler protector cover).

5.7 Storage

5.7.1 Generator Storage Preparation

Proper storage preparation is essential for maintaining the generator for reliable future use. Rust and corrosion can impair the generator's function and appearance, and to make the engine harder to start when removed from storage.

5.7.2 Cleaning Generator before Storage

Wipe generator with a moist cloth. After generator has dried, touch up any damaged paint, and coat other areas that may rust with a light film of oil.

5.7.3 Engine Fuel System – Short-Term and Long-Term Storage Requirements

CAUTIONS

- Depending on the region where the generator is operated, fuel formulations may deteriorate and oxidize rapidly. Fuel deterioration and oxidation can occur in as little as 30 days and may cause damage to the fuel system. For long-term storage it best to drain the fuel to prevent damage to the generator when restarting.
- JP-8,F24, JET-A, and JP-5 fuels have unique storage concerns, hazards, and shelf life. The effects on generator performance, and the amount of time the unit can be stored without damage, all depend on which fuel is in the generator when it is stored.

Short-Term Storage – Fuel Stored in Generator

1. For short-term storage, with fuel still in the generator (less than 30 days), close the fuel fill cap tightly and turn vent to OFF position.

   CAUTION

   Be sure to clearly label generator with the type of fuel that is in the tank. This will ensure that whoever removes the generator from storage will not mix different fuels by accident and cause damage to the fuel system.

2. Store generator in an upright position.

Long-Term Storage – Fuel Removed from Generator

Filling the engine with fresh fuel, after the generator has been in storage for longer time periods, provides a better chance of trouble-free starting when the generator is placed back in service.

1. For long-term storage, drain any existing fuel from the tank (example shown below).
2. Start the generator, and run until any fuel in the system has been depleted.
3. Close the fuel fill cap tightly and ensure vent is in OFF position.
4. Store generator in an upright position.

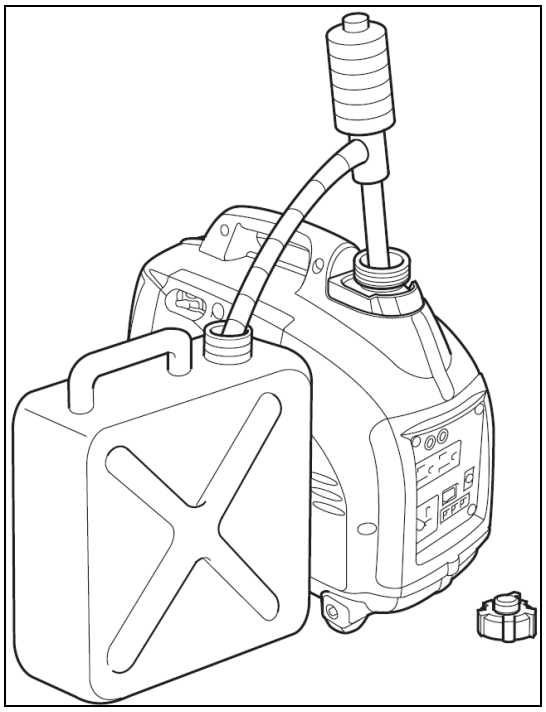

Figure 5-13: Draining Fuel Tank for Long-Term Generator Storage (Example Method)

5.7.4 Engine Oil Service before Long-Term Storage

1. Change the engine oil (see Section 5.3).
2. Remove spark plug (see Section 5.5), and apply a couple of drops of clean engine oil into the cylinder. Crank the engine several revolutions to distribute the oil, and then reinstall the spark plug.
3. Reinstall spark plug cap on the spark plug securely.
4. Reinstall spark plug maintenance cover.
5. Reinstall maintenance cover and tighten cover screw securely.
6. Pull starter grip slowly until there is resistance, and then return starter grip gently. (This closes the valves so moisture cannot enter.)

5.7.5 JP-8, F24, and other Fuel Storage Recommendations

Abide by local recommendations, concerns, and hazards for storing fuels.

WARNINGS

- Select a well-ventilated storage area for fuel storage, away from any appliance that operates with a flame, such as a furnace, water heater, or clothes dryer.
- Avoid any area with spark-producing equipment. A hot engine and exhaust system can ignite or melt some materials.
- Do not use sheet plastic as a dust cover.

CAUTIONS

- If generator will be stored with fuel in the tank, it is important to reduce the hazard of vapor ignition by closing the vent lever on the fuel fill cap.
- Unless all fuel has been drained from the fuel tank, leave the engine switch and fuel tank cap vent lever in the OFF position to reduce the possibility of leakage.
- Place the generator on a level surface. Tilting or laying generator on its side can cause fuel or oil leakage.
- If possible, avoid storage areas with high humidity that can cause rust and corrosion.
- With the engine and exhaust system cool, cover generator with a porous material to keep out dust. A nonporous cover will trap moisture around the generator, promoting rust and corrosion.

5.8 Removal of Ex-Power DEFENDER from Storage

Check generator as described in Section 3.2.

If the fuel was drained during storage preparation, fill the tank with fresh fuel. Ensure the fuel is fresh to make starting engine easier.

If the cylinder was coated with oil during long-term storage preparation, the engine may smoke briefly at startup. This is normal.

If the User Interface Panel does not light up when the unit is turned on you may have to jump start the unit by performing the following operations:

1. Turn generator OFF and remove the side cover as described in section 5.4.1
2. Unbundle the jump start cable from inside the generator as shown in the Figure 5-14.
3. Remove the dust cover for the jump start cable connecter
4. Attach the connector to a fully charged 2590 battery and allow at least 1 minute to charge **NOTE:** fuse my fail if unit is powered up too soon

5. Turn ON the generator and start engine as described in section 3.3
6. Allow engine to run for 2-5 minutes, then disconnect the jump start cable from the 2590 battery.
7. Install the dust cover and bundle the jump start cable into the generator
8. Reinstall the side cover and let the generator run for at least 1 hour to fully charge the batteries inside the generator.

Figure 5-14: Jump Start Cable Location

5.9 Transporting Ex-Power DEFENDER

CAUTION

Do not lay the generator on its side when moving, storing, or operating. Oil may leak and damage engine or property.

Allow the generator to cool for at least 15 minutes before loading the generator on the transport vehicle. A hot engine and exhaust system can cause burns and can ignite some material.

To prevent fuel spillage when transporting, the generator should be secured upright in its normal operating position, with the engine switch OFF and the fuel tank cap vent lever turned fully counterclockwise to the OFF position. Take care not to drop or strike the generator when transporting. Do not place heavy objects on the generator.

6. Troubleshooting

6.1 Troubleshooting - Engine Will Not Start

Table 6-1: Troubleshooting - Engine Will Not Start

Possible Cause	Correction
Engine Switch OFF	Turn Engine Switch ON.
Fuel selector switch set to 'SERVICE'	Confirm the FUEL SELECTOR SWITCH is in the correct fuel type position.
Fuel tank cap vent lever OFF	Turn fuel cap vent lever ON.
Too long a wait until engine starts. (Red FAULT light is on.)	Turn Engine Switch OFF and correct any engine problems. Turn Engine Swicth ON and restart the generator engine.
Low oil level caused Oil Level Alert Indicator system to keep engine from starting	Add oil. Turn engine switch to OFF and then restart the engine.
Out of fuel	Refuel
JP-8 fuel mixed with Diesel fuel	Drain fuel tank. Refuel with fresh fuel (either JP-8 or F24). [Diesel or Gasoline my be used on select models]
Engine flooded	1. Turn FUEL SELECTOR SWITCH to 'SERVICE' position Turn Engine Switch to ON position. 2. Pull engine grip cord 5-6 times. (Engine could briefly start.) 3. Turn FUEL SELECTOR SWITCH to the correct fuel type position. Restart engine normally.
Spark plug wet with fuel (after flooding engine).	Dry, check condition and gap, and reinstall spark plug.
Air in fuel line	Repeat starting procedure necessary times to ensure fuel flow.
Bad fuel; generator stored without treating or draining fuel, or refueled with bad fuel	Drain fuel tank. Refuel with fresh fuel.
Spark plug faulty, fouled, or improperly gapped	Gap or replace spark plug.
Fuel filter restricted, ignition malfunction, valves stuck, etc.	Notify Novatio

Table 6-1: Troubleshooting - Engine Will Not Start	
With main Engine Switch ON and **FUEL SELECTOR SWITCH set to the correct fuel type position**, lights are not lit on User Interface Panel due to internal battery problem	Perform Jump Start Procedure described in section 5.8 of this manual. If unit still fails to start notify Novatio Engineering.

6.2 Troubleshooting - Engine Lacks Power or Shuts Down

Table 6-2: Troubleshooting - Engine Lacks Power or Shuts Down	
Possible Cause	**Correction**
Air Filter restricted	Clean or replace Air Filter. Stop and restart the generator engine.
Bad fuel; generator stored without treating or draining fuel, or refueled with bad fuel.	Drain fuel tank and refuel with fresh fuel per the Fuel Selector Switch setting. Stop and restart the generator engine.
Low oil level caused Oil Level Alert Indicator system to stop engine	Add oil. Turn engine switch to OFF and then restart the engine.
Fuel filter restricted, ignition malfunction, valves stuck, etc.	Notify Novatio.
Engine temperature vent control not working properly	Notify Novatio.
Generator is equipped with Eco-Throttle switch and it is ON	Ensure Eco-Throttle switch is turned OFF.

6.3 Troubleshooting - AC Appliance not Working

Table 6-3: Troubleshooting - AC Appliance not Working	
Possible Cause	**Correction**
GFCI outlet tripped (green LED is not lit while running engine)	Reset GFCI outlet and watch for green LED to come on while engine is running.
Output indicator light is OFF, and Overload Indicator is ON (Main Generator Control Panel).	Check AC load (appliance) for malfunctions. Stop and restart the engine. Check the cooling air inlet for blockage. Stop and restart the engine.
If running in parallel operation	Check condition of optional parallel cables and ensure they are properly and securely connected to each generator. Notify Novatio for new parallel cables if faulty.
Faulty power cord, power tool, or appliance.	Replace extension cord, power tool, or repair power tool or appliance. Stop and restart the generator engine.
Faulty generator	Notify Novatio.

NOTES

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