



FIELD GEAR

Predeployment

Most group and personal camping gear you take into the field will be issued to you upon arrival at McMurdo Station. All gear you receive will be tagged “RFI” (ready for issue). This means it has been serviced and checked and is ready to deploy into the field. Your team must inspect all its gear before going into the field. This ensures that participants are familiar with operation and setup in a controlled environment and helps catch any problems (e.g., malfunctioning equipment, broken parts) before deploying. The field team lead builds time into the deployment schedule to accomplish this, during gear issue at McMurdo Station. If your team requires specific guidance on equipment operation or maintenance, discuss this with your implementer or supervisor early so time and space can be dedicated to your field preparation.

This section of the manual covers safety, basic operation and troubleshooting of stoves, heaters, sleds, generators, snowmobiles and renewable-energy power systems. Most field gear will come from the BFC, MEC and Carp Shop. Contact the appropriate work center for assistance.

Stoves

The BFC issues propane and white-gas cooking stoves (liquid fuel stoves to field parties. This guide provides information on stove safety, basic operation and troubleshooting.

Safety

Liquid-fuel stoves are potentially hazardous due to the flammability of the fuels and the toxicity of the CO they produce. It is important for field personnel to follow these safety measures when using stoves or heaters:

- Test all stoves before field deployment.
- Do not use stoves without adequate ventilation.
- Use extreme caution when refueling. Skin contact with supercooled fuel can cause instant frostbite.

- Check for leaks before every use.
- Release pressure in the fuel tank before packing and storing the stove.
- Pack stoves and fuel away from food.
- Do not cook in mountain tents, except in emergencies. Cooking in the Scott tents is safe with proper mitigation (see the next subsection).
- Use caution when priming the stove, as it can flare up when fuel is lit.
- Insulate the base of the stove so it does not melt through the tent floor. Use a rock-box lid, preferably covered in aluminum foil, a metal platform or another non-fabric surface.
- Do not release fuel tank pressure near an open flame.

Residues of evaporated gasoline are combustible. Designate a pair of rubber gloves for fueling operations, and do not use them near stoves. Should someone's clothing ignite, have them stop, drop and roll to extinguish the flames.

Use in Scott Tents

It has been common practice in Antarctica to use stoves inside Scott tents. Historically, many camps were small, and Scott tents were the main "home" for a field camp, so stoves were used inside. This is still a practice in various locations, either for full kitchen duties or to heat water and the tent in places with extreme cold or dampness. Stove use in tents is a strategy to stay warm and comfortable, but it can lead to complacency and is often discouraged in favor of safer ways of staying warm in tents. Do the following to use stoves safely:

- Ensure all sleeping bags, sleeping pads and personal clothing are stowed away from the stove before starting it.
- If running the stove, put a kettle on to boil water for hot water bottles, which also prevents an open flame.

- Communicate any signs or symptoms of CO poisoning, which is intensified by altitude.
- Use a CO monitor.

CO Risks

CO is a colorless, odorless, tasteless toxic gas produced by the incomplete combustion of carbon compounds, including the fuels used in heaters and stoves. Dangerous amounts of CO can accumulate when fuel does not burn properly or when an area is poorly ventilated. Both situations can occur when someone is cooking in or heating a tent.

Inhaled CO displaces oxygen in the bloodstream, starving the heart, brain and other vital organs. People are even more susceptible to CO poisoning at altitude. Several cases of CO poisoning have occurred in Antarctic field camps due to improper stove use. The best way to avoid CO poisoning is by ensuring any structure in which cooking occurs is well ventilated. Because CO has no color, taste or smell, it is better to be safe than sorry:

- Always ventilate the tent.
- Never cook in or heat a tent without leaving a door or window cracked.
- Be especially vigilant if sleeping in a heated structure.
- **Ventilate, ventilate, ventilate.**

Scott tents are the main type of tent in which a stove would be used. It is important to keep the tent door open and ensure all vent tubes at the top of the tent are free from snow and ice. If there is little wind, condensation can build up and freeze in the vent tubes, leading to poor ventilation.

Field teams must use a CO detector (issued by the BFC) when cooking in a tent. Do not directly attach the detector to the stove. The detectors are not foolproof, so all team members must be vigilant about CO risks and symptoms. See the “United States Antarctic Program Field First-Aid” manual, or contact Medical for more information.

Camps do their best to offer alternative means of staying warm and drying clothes, to avoid indoor stove use and its risk. Warm water bottles in the sleeping bag are a great way to stay warm at night, and they can be topped off by bringing a Thermos when you go to bed. Hanging cord above stoves in the larger, communal tents also allows for drying clothes.

MSR WhisperLite Stove

Assembly

1. Fill the MSR fuel bottle to within two inches of its cap.
2. Screw the pump snugly into the fuel bottle.
3. Pump the plunger 15 to 20 times for a full bottle. Additional strokes are necessary if the bottle is not full.
4. Insert the fuel line through the hole in the heat reflector.
5. Rotate the stove legs into the slots in the flame reflector.
6. Insert the end of the fuel line into the fuel tube bushing on the pump. Lubricate the end of the fuel line with lip balm, and be extremely gentle when inserting.
7. Securely snap the catch arm into the slot on the pump body.

Priming

1. To preheat the stove, the priming flame must contact the generator tube.
2. Open the control valve until fuel flows through the jet and fills half the priming cup.
3. Close the control valve.
4. Light the priming cup or wick.
5. Place a windscreen around the stove.

Lighting

1. As the priming flame diminishes, slowly open the control valve.
2. If the stove goes out, wait for the stove to cool and reprime it.
3. If the stove burns with a yellow, erratic flame but the priming cup is still burning, turn the control valve off and prime longer.

Cooking

1. The stove should burn with a steady blue flame.
2. To simmer, operate the stove with low pressure in the fuel bottle (see Handouts in the References section for manufacturer manual). There will be a delay between control valve turns and changes in flame intensity.

Shutoff

1. Turn the control valve off.
2. Wait for the stove to cool before disassembling.
3. Before depressurizing the fuel bottle, move away from heat, sparks and flames. Turn the stove assembly upside down, and open the control valve. Pressure will be eliminated through the jet.

PRO TIPS

- Do not use these stoves in mountain tents, except in an emergency and only in the tent's vestibule.
- Ensure the stove assembly has no fuel leaks.
- Securely lock the catch, and ensure the stove is properly assembled.
- Clear the area of flammables and spilled fuel.
- Do not open the control valve more than three full turns.

Troubleshooting

MSR WhisperLite Stove Troubleshooting

Problem		Fix
No/low pressure		Tighten loose pump on fuel bottle.
		Replace damaged pump cup.
		Oil the dry pump cup to loosen plunger.
Yellow flame		Reduce fuel bottle pressure and allow more oxygen through windscreen.
		Close windscreen around stove and use heat reflector. (Generator tube may be too cold.)
		Ensure flame rings in correct order from top (burner cap) to bottom (flame reflector). 7 rings on wire-leg stoves = wavy, flat, wavy, flat, wavy, flat, wavy. 8 rings on flat-leg stoves = wavy, flat, wavy, flat, wavy, flat, flat, flat.
Weak flame		Pump plunger to increase pressure in fuel bottle.
		Ensure correct jet installed for fuel type.
		Clear jet and fuel line of any obstructions.
		Allow more oxygen through windscreen.
		If burner cap is bright red and stove makes dull roar, flame is burning under cap instead of flame rings. Clean jet, confirm correct jet installed, and ensure flame rings are clean and installed correctly (see last fix at "Yellow flame").
Fuel leak at	Control valve	Replace control valve O-ring if damaged.*
		Replace pump if control valve threads damaged or stripped from overtightening.
	Pump connection	Ensure only MSR fuel bottle is used.
		Replace bottle if threads damaged or bottle dented.
		Replace O-ring for bottle or fuel tube if damaged.*
		Replace fuel tube bushing if damaged.*

Problem		Fix
	Fuel line	Replace fuel line or entire stove if line damaged.
	Shaker jet	If fuel leaks through jet when control valve off, pump is damaged from overtightening valve. Replace pump.
		Tighten if necessary with jet and cable tool.*
		Replace jet if damaged.*

Note: Based on information from Cascade Designs, Inc., "MSR WhisperLite Stove Instruction Manual," https://cascadedesigns.com/cdn/shop/files/11368_Instructions_WL_All_Lang_33-946.pdf, and from USAP's Berg Field Center.

*Stove/pump replacement parts are available in the repair kit.

Coleman Gas Stove

Setup

1. Close the valve and unscrew the tank cap. Do this carefully if the tank has pressure inside.
2. Use a fuel funnel with a filter. Use white gas only.
3. Wipe off any spilled fuel, and replace the cap.
4. **Never open the tank around an open flame or remove the cap while the stove is running.**

Tank Pressurization

1. Close the cap, and ensure the generator valve is closed.
2. Turn the pump plunger handle to the left to open.
3. Place a thumb over the small hole in the handle and pump 35 to 50 times.
4. Turn the plunger handle to the right to tighten.
5. Put the stove handle into the opening on the side, insert the generator into the mixing chamber, and place the tank in hanger brackets.

Lighting

1. Close the auxiliary burner valve.
2. Turn the fuel valve lever to the “up” position.
3. Hold a match above the main burner, and open the fuel flow valve wide.
4. Let the stove burn for one minute with the fuel valve lever up.
5. When the flame is blue, turn the valve lever down.
6. Add pressure if needed while firmly holding the tank.
7. If the flame does not burn fully, open and close the valve to clean the tip.
8. After the main burner is lit, the auxiliary burner can be lit by opening the valve on the left side of the stove. If there are problems, refer to the “Troubleshooting Guide” included with the stove and the next Troubleshooting subsection here.

Shutoff

1. Put the fuel valve lever in the “up” position, and let the stove burn for one minute to reduce carbon deposits.
2. Turn off the valve. The flame will burn for a few minutes until the gas in the generator is gone.
3. When the flame is out, let the stove cool before packing it away.

PRO TIPS

Most problems with Coleman stoves occur in extremely cold temperatures, which the stove was not designed for. Take these measures to enhance its performance:

- Use only clean, filtered white gas.
- Do not overfill the tank, as this impedes performance.
- The pump mechanism becomes impaired as temperatures drop. Keep the pump plunger oiled. Also keep the rubber or leather pump cup oiled and pliable, as it can dry out.
- In temperatures below -6°C (21°F), the stove generator must be preheated to ensure the fuel vaporizes.
 - Apply priming paste along the generator and above the burner.
 - Light it with a match.
 - Allow at least three minutes of burning to ensure the stove is sufficiently preheated. When the flame burns down, ensure the lever is up and open the valve. The burner should light from the paste.
- Keep the stove and tank clean. Grease deposits can flame up. Line the inside of the stove with foil for easy cleaning.
- Place the stove where it can be thrown out of the tent in an emergency. Keep a small fire extinguisher nearby.

Troubleshooting

If the fuel does not vaporize, liquid gas collects in the manifold assembly and a strong, blue flame cannot be achieved. The stove will sputter and spark, and the flame will be orange and sooty. If this occurs, shut the stove down and allow it to cool off completely. Remove the tank assembly and clean fuel from the manifold and burners with absorbent pads provided in the spill kit (i.e., the small, black nylon bag). Replace the tank assembly, and repeat the lighting process.

Access the control valve assembly (behind the knobs and under the burners) as follows:

1. Unscrew the burners.
2. Turn the stove over and unscrew the nuts on the bottom.
3. It should be possible to push the burner assembly up and release the retaining ring that holds the burner to the metal tray. Alternatively, spread the retaining rings to release the burner assembly.
4. Remove the metal tray for access to the burner and control valve assemblies.

Additional troubleshooting tips are provided in the next table.

Coleman Gas Stove Troubleshooting

Problem	Fix
No pressure	Remove and inspect pump for cracks, dryness, creases, or tears. Replace and oil.
	Check tank lid gasket for pressure leak.
	Check for flooded pump cylinder. If so, pump valve is faulty and needs replacing.
	Check for broken seal at valve assembly and tank junction. Tighten by one rotation if possible.
Loses pressure	Tank naturally loses pressure the longer it sits without periodic pumping.
	If pressure is lost soon after pumping, check all joints and gaskets.
	Check for leaky cap gasket. Replace gasket/cap.
Yellow flame	Clean or replace dirty/faulty generator.
	If manifold assembly is flooded, turn stove off, cool, remove tank assembly, and wipe out excess fuel.
	Fuel may be contaminated. Drain and replace with new fuel.
	Ensure tank and generator seated properly.
Flame at generator tip	Tighten tip of generator if loose.

Problem	Fix
Poor gas flow to burner	If generator clogged, clean or replace.
	Check if cleaning needle at end of generator is bent. Replace needle.
	Ensure tank and generator seated properly.
Weak flame	Preheat generator.
	Clean or replace dirty/faulty generator.
	Increase pressure.
	If manifold assembly is flooded, turn stove off, cool, remove tank assembly, and wipe out excess fuel.
	Fuel may be contaminated. Drain and replace with new fuel.
	Ensure tank and generator seated properly.
Flaring	Tighten tip of generator if loose.
	Ensure tank and generator seated properly.
	If burner flooded, shut down and dry out.
	Reduce excessive pressure in tank.
	Shut down and reprime insufficiently primed stove.
	Refrain from opening fuel flow switch (i.e., changing to "on" position) too early.
	Fuel may be contaminated. Drain and replace with new fuel.
	If grease in stove, clean grease out, line bottom of stove with foil, and change foil when dirty.
Note: Based on information from USAP's Berg Field Center.	

Coleman Propane Stove

Propane cylinders must be stored outside of a tent. Use a long propane hose through an opening in the tent door or window to connect the cylinder to the stove.

Setup

1. Press on the latch to open the lid.
2. Position the wind baffles.
3. Insert the wire clips into the slots.
4. Firmly close both burner valves.
5. Remove the regulator from storage under the grate.
6. Attach and hand-tighten the regulator to the hose or propane bottle.
7. Inspect the gasket on the stove connection before attaching the regulator.
8. Screw the regulator hand-tight onto the stove.
9. Ensure the regulator and connections are not cross-threaded, as this will cause a leak.

Lighting

For electronic ignition stoves, open the burner valve and rotate the igniter knob several times until the burner lights. Use a match to light the burner if the igniter fails.

For standard ignition stoves, hold a lit match near the burner and open the valve. Adjust the flame with the burner valves.

Shutoff

Firmly close the burner valves.

Storage

Remove the propane cylinder or hose, then unscrew the regulator from the stove and store it under the cooking grate.

Heaters

The Carp Shop maintains heaters in semipermanent field camps and sea ice huts. The continental field inventory has three types of heaters to warm tents. These may be used only in Arctic Oven, Weatherhaven or Scott tents. The heaters are not designed for mountain tents.

Use the heaters only on a non-flammable surface (e.g., aluminum table), keep them far away from combustible materials, and never leave them unattended. Take significant care to properly ventilate the tent to reduce the risk of CO poisoning. Do not use the heaters to dry clothing.

If you smell propane or gas when a heater or cook stove is in use, stop, turn off all valves and recheck the hose and cylinder connections. The odor may be more detectable closer to the floor since propane gas is heavier than air.

Do not store heaters or propane cylinders near the open flame of cook stoves. Store propane cylinders outside the tent when they are not in use.

Preway Diesel (AN-8) Heater

These heaters are installed in huts in the Dry Valleys.

Lighting

1. Ensure the Preway is level. If it is not, it will not burn correctly.
2. Ensure the outside fuel valve at the tank and the breather tube are open, to prevent air lock. If there is no breather tube, loosen the upper bung cap.
3. Open the valve behind the Preway.
4. Take a small piece of toilet paper, wrap it around the end of a wire, and place a small amount of burn paste on it.
5. Push the safety lever down on the carburetor.
6. Open the valve knob on the carburetor to "3" (the halfway position).
7. Allow a small amount of fuel (about two tablespoons) to puddle in the bottom of the burn chamber.
8. Shut off the valve knob on the carburetor.
9. Light the fuel in the burn chamber with the tissue on a wire, removing it once the fuel is lit.

10. Allow the fuel to burn until the flame is nearly out. This preheats the chamber.
11. Open the valve knob on the carburetor to “3” again and push down the safety lever.
12. Adjust heat as desired.

Preway heaters usually burn poorly and produce excessive soot when their valve knob is set to “1” (too low) or “6” (too high). To avoid reduced performance and frequent cleaning of the heater, use settings “2” through “5.” A properly burning heater does not require cleaning more than once every couple of months.

Shutoff

Close all valves and lift the safety lever on the carburetor.

PRO TIPS

- Do not use the Preway as an incinerator by leaving burnt tissue or tossing any combustibles in the chamber. Otherwise, the heater will stop working and fill with partially burnt ashes.
- At startup, do not immediately turn the valve knob to a high number. Let the heater warm up first on “3,” or it will make woofing sounds.
- Do not leave the burn chamber door open longer than necessary when the heater is burning. Otherwise, the heater will improperly draft by due to excess air.
- Never wire down the safety lever on the carburetor. If it needs to be “held down” for the heater to operate, then an internal problem must be fixed. Wiring down the lever poses two risks:
 - Flooding the heater with too much fuel (creating a mess)
 - Flooding the structure with the full contents of the fuel barrel (creating an even bigger mess)

Kuma Arctic Heater

Kuma Arctic heaters will replace the old Preway heaters and are installed in sea ice huts, some Dry Valleys huts and deep-field fixed camps. **Beware that the handles on the side of the heater are surprisingly hot.** Do not touch or hang towels or clothing over the handles. Read all the instructions before lighting the heater.

Lighting

1. Ensure the burn chamber is clean before lighting the Kuma.
2. Open the heater door, and remove the stainless-steel mesh cylinder and burn ring from the burn pot.
3. Turn on all supply valves (i.e., tank and in-line valves).
4. If there are any leaks in the system, immediately turn off all valves.
5. Turn the control knob on the carburetor to "1."
6. Move the "ON/OFF" lever on the carburetor to the correct position to start the flow of fuel oil into the burn pot. Based on the carburetor model, the lever may need to be pressed down or pulled up for "ON," as indicated on the carburetor near its lever.
7. When enough fuel has entered the burn pot to fill the center groove (~four tablespoons), turn both the control knob and carburetor lever off.
8. Replace the burn ring into the burn pot so the cupped part of the ring is face up (as if it would hold water). The heater will not burn properly if the ring is face down.
9. Squeeze a small amount of burn paste (about the size of a marble) onto the end of the metal wire, light the paste, and place the fireball into the puddle of oil in the burn pot.
10. Use the wire to spread the fireball around the fuel puddle.
11. Replace the mesh cylinder, and close the door tightly, turning the door handle until it is snug. Do not overtighten.

12. Wait for the fuel in the burn pot to catch fire. After the flame begins to die down, which could take several minutes, turn the carburetor on again using the "ON/OFF" lever and turn the control knob to "1."
13. The flame should slowly grow. Within a few minutes, the heater should begin burning a blue flame.
14. Run the heater for at least 15 minutes on "1" to allow the chimney and heater to heat up before adjusting the temperature. Failure to allow proper heating time will cause the system to soot up.
15. After 15 minutes, ensure the flue and heater are warmed before making any carburetor adjustments to achieve the desired heat level. Adjustments should be of no more than one-quarter turn, and each adjustment should be allowed to stabilize for five minutes before making any further adjustments. The highest setting is "6."

Shutoff

1. Trip the float switch on the carburetor, and turn the dial on the carburetor to "0" or "OFF" (clockwise).
2. The ball valve near the fuel filter can also be turned off to stop the flow of fuel to the heater.
3. Do not adjust the "firematic" valve that is between the fuel filter and heater (the only round handle on the fuel line that resembles a spigot).

PRO TIPS

- Do not use the Kuma as an incinerator by leaving burnt tissue or tossing any combustibles in the chamber.
- Do not light a flooded or hot heater!

Empire Vented Propane Heater

Empire heaters are installed in sea ice huts.

Lighting

1. Turn on the propane at the tank by turning the knob all the way to the left.
2. Open the combustion air vents on the heater wall.
3. Open the valve behind the heater (the handle in line with the tube to the heater).
4. Set the heat dial to "1."
5. Remove the front panel of the heater by lifting the bottom out then up.
6. Remove the pilot-light sight glass.
7. Push and hold down the control knob, turning it from "off," past "ign," to "pilot."
8. Light the pilot with a match — do not use the piezo igniter.
9. Hold the control knob down in the "pilot" position for one minute after lighting.
10. Let the control knob pop up, then move it to the "on" position.
11. Replace the sight glass and front panel of the heater.
12. Adjust the heat dial as desired. The maximum setting is "7."

Shutoff

1. Set the heat dial to "1" and the control knob to "pilot."
2. Close the combustion air vents.
3. Leave the pilot light on at all times, unless the tank is being changed or the hut is being moved. If moving the hut, turn off the propane at the tank.

Sleds

The BFC issues several types of sleds that can be towed behind a snowmobile or pulled by someone skiing or walking. Each field team should consult with BFC staff to determine which sled type matches the team's requirements.

Nansen Sleds

Nansen sleds can haul two drums side by side.

Siglin UHMW Sleds

Siglin ultra high molecular weight (UHMW) sleds can accommodate two drums side by side. There are an eight-foot and a 12-foot version. A snowmobile can tow these sleds, which have side ropes for lashing down gear.

Komatik Sleds

Komatik sleds can carry up to five drums side by side.

Banana Sleds

Banana sleds have fabric cargo covers attached along the sides. The cover folds over the cargo and is tied down. These sleds are heavy and best towed by a snowmobile.

Loading and Securing Cargo

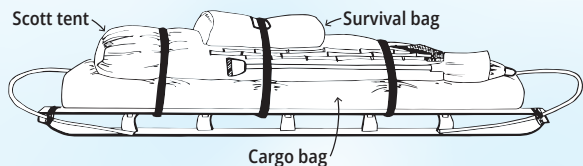
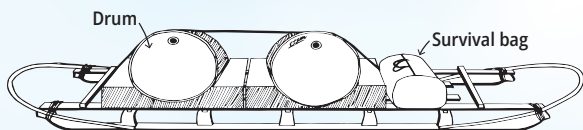
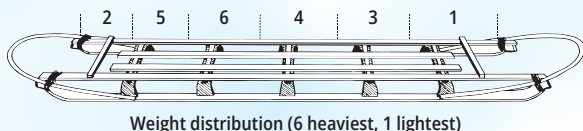
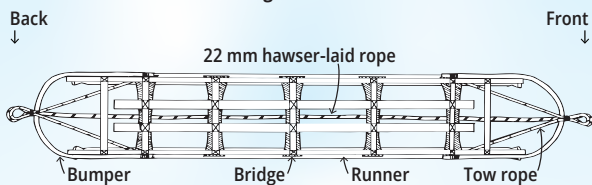
The following Nansen sled diagrams also apply to the other sleds. Load with the heaviest items on the bottom. Place small items in sled bags. Put the survival bag at the top of the load, along with anything the team members may need during the day. Rock boxes (wooden and measuring 18 × 12 × 12 inches) make convenient containers for fieldwork and can be loaded with both samples and gear. Rock-box platforms are available if the team anticipates hauling a large number of boxes.

It is best to transport fuel drums on drum cradles for stability. Secure the finished load tightly with cord, cargo straps or bungee cords. Avoid using hard knots when rigging loads for travel. Use taut-line hitches or trucker's hitches

instead, as they are easy to undo if it becomes necessary to retension a cord.

Check all lashings periodically and every time the team stops for any reason. During this time, if towing the sled with a snowmobile, also inspect the snowmobile, tow plate, ropes and sled for any developing structural issues. Retighten the lashings if they have become loose. It is prudent to bring extra lashing supplies into the field.

Loading a Nansen Sled



Pulling Sleds by Snowmobile

With ideal surface conditions, a tail wind and light loads, a snowmobile pulling a sled can get seven miles per gallon (mpg) of fuel. Soft snow conditions, heavy loads and strong head winds significantly reduce fuel efficiency, to as low as two to three mpg. Likewise, a snowmobile can pull up to 1,500 pounds (lb) when conditions are good and much less when they are not. Keep these environmental conditions in mind when planning loads and fuel consumption.

Snowmobile operators pulling a sled should adhere to the following rules:

1. Attach sleds equipped with rigid tongues directly to snowmobiles. Other sleds attach with a tow rope.
2. Before driving, rock the sleds back and forth to break the runners and the bottom free of ice.
3. Drive slowly. Driving fast over uneven terrain may cause a sled to tip over, which can severely injure people and damage the sled, cargo and snowmobile.
4. Drive even slower if pulling passengers. Everyone must wear a snowmobile helmet, including persons riding on the sled.
5. Maintain situational awareness and regularly look back to ensure everything is riding securely, especially passengers.
6. Stop gradually so the sled does not run into the back of the snowmobile.

Snowmobiles

Snowmobiles are maintained by the MEC, which provides a basic snowmobile course for groups who will them. This indoor class aims to familiarize you with the basic components and operation of the machines. FS&T provides more advanced training as needed (e.g., if you have new riders who would like to build confidence on snowmobiles or will work in a location with more complex terrain). This subsection provides general operation and troubleshooting guidance. For advice, contact

the MEC at 720-568-1080 (ask to be transferred) or MCM-MEC-Supervisor@usap.gov.

Safety

- All snowmobile riders and passengers must wear a helmet. This includes people towed on a sled behind a snowmobile.
- Each operator is responsible for checking the machine before each use.
- Ensure the correct fuel is used. Snowmobiles have four-stroke engines and require MoGas (motor vehicle gasoline, or standard unleaded fuel).
- A snowmobile's center of gravity is just in front and toward the bottom of the fuel tank. Operators must shift their body weight for turning and as needed for the load, terrain and snow and ice conditions.
- Be mindful of track tension. In general, if the track is slapping against the frame tunnel while the snowmobile is in motion, it is too loose.
- Watch for loose trailing straps and ropes, as these can get tangled in the tracks and around axles.
- Never shift the transmission unless the machine is stopped. Shift gently. If gears will not engage, turn off the engine, shift gears and restart. Abusive shifting can cause drive-train problems that are not repairable in the field.
- Park snowmobiles facing into the prevailing wind and always cover them. This reduces the likelihood of snow accumulating under the cowling.

Precheck

- Before starting the snowmobile, check all hardware on the suspension. Tighten any loose nuts or bolts with the tool kit under the seat.

- Look for broken components, such as H-arms, springs, the shock mount, the shock and tracks. Inspect everything.
- Remove any snow from under the engine hood, drive belt, pulleys, exhaust pipe and lower steering arms.
- Ensure the machine is in neutral. All riders should make it a habit to shift into neutral when stopping.
- Ensure the throttle moves through its full range of motion and snaps back to idle when released.
- Ensure the brake moves through its full range of motion. It is normal to feel resistance, and the brake lever should never pull all the way to the handlebar. Also, the brake should never go all the way to the floor.

Startup

1. Do the following for the first cold start of the day or if the snowmobile is off for more than an hour:
 - A. Ensure the transmission is in neutral.
 - B. Insert the key, and push the button to start.
 - C. Let the snowmobile warm up, bearing in mind that it will idle up to 12 minutes before automatically turning off.
2. Once the machine is warm, engage the gear then ease into the throttle.
3. If the engine is off for less than an hour, ensure the transmission is in neutral and engage the electric starter. Allow the engine to warm thoroughly before driving it.

Preventive Maintenance

Daily

1. Do a walk-around of the machine each day before starting, which is the single best thing you can do to keep it running throughout the season.
2. Check the suspension, especially when operating on ice.

3. Look for broken suspension components.
4. Importantly, check all parts at the end of the day! Finding a broken machine at the beginning of the following day can result in a lost day of science.

Weekly

Check for loose mounting bolts on bogie wheels, skis (particularly the two bolts through the springs), rear suspension and steering. A small suspension problem can rapidly become serious (e.g., slashed tracks, broken bogie mounts).

Loading

- Maintain a low center of gravity.
- Keep straps tied down, ensuring there are no loose ends.
- Place often used items where they are easy to get to.
- Do not exceed the 150-pound limit for loads on the rear of the snowmobile.

Towing

- Sleds may be towed with rigid tongues (preferred) or ropes, depending on the circumstances.
- Check the hitch mechanisms on both the snowmobile and sled for proper operation.
- Cover the load to protect it from track spray if necessary.
- Check load tie-downs for tightness and security shortly into each trip.
- Check both the sled and the load frequently.

Communication

Use the following hand signals when driving a snowmobile in a group.

Snowmobile Hand Signals

OK, ready to depart
(hand on head)



Watch out for crevasse/hazard
(arm out, pointing)



Stop or stopping
(fist in air; elbow at right angle)



Slow/slowing down
(arm out, palm down and patting)



Speed/speeding up
(arm out, palm up and pushing)



Driving

- Whenever possible, drive on a proven trail or hard surface.
- If the snowmobile begins to bog down while driving in powdery snow, maintain the throttle and head in the straightest line possible for firmer or packed snow. Sharp turns will compound the problem.
- If the machine slows and reaching firmer snow appears impossible, then **stop and do not continue spinning the track**. Instead, take the following steps:
 - Tip the snowmobile on its side (in both directions if necessary), clear snow from the track, and pack the snow under the track.
 - Dig a ramp out of the hole and attempt to ease the machine out of the hole, with other people pushing.
 - Alternatively, use a tow rope and have another snowmobile pull the stuck one out.
 - If a stuck machine does not come out quickly, stop towing and dig more. Continual towing wears drive belts prematurely and can cause them to break. It can also damage the engine.

Honda Generator

Before science teams deploy to the field, the MEC trains them in the operation and maintenance of generators.

Safety

- Place the generator on a firm, level surface. If the generator is tilted or turned over, fuel may spill or the generator may become contaminated with soil or water.
- To prevent a fire hazard and provide adequate ventilation, keep the generator at least one meter (~three feet) away from tents or other equipment during operation. Do not place flammable objects close to the generator.

- Know how to operate all the controls and to stop the generator quickly.
- Do not let the generator get wet or operate it with wet hands. The generator is a potential source of electrical shock if misused.
- Gasoline is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks near any stored gasoline or the generator refueling area. Refuel the generator in a well-ventilated area, with the engine stopped.
- The engine muffler becomes hot during operation and remains hot for some time after engine shutoff. Do not touch the muffler or engine or store the generator indoors until the generator has cooled.

Precheck

1. Check and add MoGas to the generator if necessary.
2. Check the engine oil level with each fueling, and add any needed oil (i.e., 0W-30).
3. Check the air cleaner element to ensure it is clean and free of ice and snow. It should feel oily.

Startup

1. Ensure the AC circuit breaker is in the “off” position. It may be hard to start the generator if a load is connected.
2. Turn the fuel valve to the “on” position.
3. Pull the choke rod or lever to the closed position — do not use the choke if the engine is warm.
4. Ensure the auto-throttle switch is off if the generator has one.
5. Move the engine switch to the “on” position.
6. Slowly pull the starter grip until resistance is felt, then pull briskly. Do not allow the starter grip to snap back. Return it slowly by hand.

7. Once the generator has started, push the choke rod or twist the choke lever to the open position as the engine warms up.
8. Allow the engine to warm up for three to five minutes. Do not apply a load during this time.
9. Once the generator is warm, turn on a breaker or plug in a load.

Shutoff

1. Turn off the breaker or unplug the load.
2. Allow the generator to run unloaded for two minutes to cool down.
3. Turn off the engine switch.
4. Turn off the fuel supply.

Troubleshooting

Honda Generator Troubleshooting

Problem	Fix
Engine does not start	Turn engine switch on if off.
	If oil-alert lamp flashes when starter is pulled, oil is low. Add oil.
	Ensure all loads are unplugged from AC receptacles.
	Check for spark at spark plug, grounding side of electrode to engine and pulling recoil starter to see if spark jumps the gap. Replace plug if no spark.
	Place suitable container under carburetor, loosen drain screw, and ensure fuel flows freely to carburetor. If not, check fuel valve on tank.
Engine starts but stops immediately	Check for low oil level, fill oil reservoir to top of dipstick, then restart engine.
No electricity at receptacles	Turn on AC circuit breaker if off.
	Check the appliance or the equipment plugged into generator for defects. Fix as needed.
Note: Based on information from USAP's Berg Field Center.	

Mini Portable Field Power Systems

Before science teams deploy to the field, the MEC also trains them in the operation and maintenance of the mini portable field power system, a self-contained solar power supply that can be quickly assembled and connected for transportation. The unit includes a weatherproof box, solar panel stand and output cable. The input and output cables connect to the battery box via sturdy, screw-on, weatherproof connectors. The system is fully grounded, and all wiring and electrical components are rated to -40°C. Maximum output is 300 watts AC or 80 watts direct current (DC).

1. Before the season begins, inspect the unit for damage or loose wires and fix them as needed.
2. Choose a configuration for the solar panels:
 - A. Mounted atop the box with four $1/4 \times 20$ bolts (i.e., bolts that are $1/4$ inch in diameter with 20 threads per inch)
 - B. Standing independently and tied down
 - C. Spread out to face the sun for maximum input
3. However configured, ensure the solar panels are secure against possible wind gusts.
4. Connect the three-pin solar plug to the three-pin receptacle.
5. Connect the five-pin extension cord to the five-pin receptacle.
6. Turn both the 40-amp breaker and the switch on the far side of the inverter to the "on" position. AC power will now be available.
7. When battery power is low, the AC and DC outputs will disconnect, and power will not return until battery voltage reaches 12.2 volts DC.
 - A. Disconnect loads, and let the system recharge.

- B. Recharging from an 80% discharge takes about three days in the sun.
- C. Plan for recharging to take time, especially during cloudy days and given three consecutive days of full sun in Antarctica is rare.