

ONYX

TECHNOLOGY POWERING A CLEANER FUTURE

JX SX TX ZX
X-SERIES PROPANE
FLOOR MACHINES



OPERATOR MANUAL

ONYX X-SERIES PROPANE FLOOR MACHINES

This Guide provides necessary instructions on machine operation and maintenance. Before operation or use of this machine, please carefully read and understand this Guide.

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12605 Commerce Station Drive • Suite 700
 Huntersville, NC 28078
 704.827.9368

Website: <https://www.onyxolutions.store/>

No further notice will be given for possible change of specification and parts.

Machine Information:

Please fill in when installing for future reference.

Model number: _____
 Machine serial number: _____
 Sales representative: _____
 PO number: _____
 Date PO placed: _____
 Installation Date: _____



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PARTS ORDERING

When ordering the replacement parts, please refer to the ONYX website at www.onyx solutions.com. Use of the published Illustrated Parts Lists (IPL's) to identify the correct part number required is required to support accuracy of parts ordering.

Machine IPL's can be found at the top of the SHOP page of the ONYX website. Before matching parts or accessories, please firstly determine your machine model and serial number. You can order parts and accessories from any authorized service center or dealer by telephone at 704-827-9368, or email us at sales@onyx solutions.com.

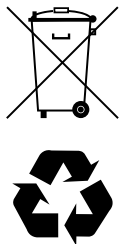
WARRANTY CLAIMS

ONYX Warranty Statement (policy) and Warranty Claim form can be found on the SUPPORT page of the ONYX website, <https://www.onyx solutions.store/support>.

TECHNICAL SUPPORT

Technical support is available by submitting a HELP TICKET on the CONTACT US page of the ONYX website, <https://onyx solutions.odoo.com/contact>.

PROTECT THE ENVIRONMENT



Please abandon the old machine components such as packaging material, battery, etc. and toxic liquid such as anti-freezing agent and oil according to your local regulations on waste disposal and on the premise of maintaining environmental safety. Please ensure to carry out the recycling well.



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SAFETY PRECAUTIONS



WARNING: Failure to read the Operator Manual prior to operating or attempting any service or maintenance procedure to your machine could result in death or injury to you or others, or damage to the machine or to other property. You must have training in the operation of this machine before using it. If you or your operator/operators cannot read English, have this manual explained fully before attempting to operate this machine.



WARNING: It is the owner/operator's responsibility to ensure that the air-exchange system installed in any location where a propane floor care machine is being operated is of sufficient capacity and quality to support the use of such a machine. OSHA and other County, State, or Federal Agencies publish guidelines on this subject that are usually most readily found in the possession of the respective owners and/or parent companies of any location or chain of locations. Failure on the part of the owner/operator to ensure that a propane floor care machine can be operated safely in a given location may lead to injury, sickness or even loss of life.



WARNING: This product contains one or more chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. Wash hands after handling.

SAFETY INFORMATION

The following terms and symbols are used to identify statements of potential hazards which affect safety of yourself and others. Read and observe all safety statements found on this Operator Manual and on your engine.



DANGER: The signal word DANGER indicates a hazardous situation which, if not avoided according to the instruction found in this Operator Manual or on your machine, will result in death or serious bodily injury.



WARNING: The signal word WARNING indicates a hazardous situation which, if not avoided according to the instruction found in this Operator Manual or on your machine, could result in death or serious bodily injury.



CAUTION: The signal word CAUTION indicates a hazardous situation which, if not avoided according to the instruction found in this Operator Manual or on your machine, could result in minor or moderate injury or damage to your engine or property.

DESCRIPTION OF SAFETY SYMBOLS

The following safety symbols are used on the product and in this manual to alert the operator of potential safety hazards. Read them carefully, and understand their meaning.



Indicates DANGER, WARNING, or CAUTION



Read Operator Manual before operating his machine. Failure to follow directions could result in death or serious injury.



Engine exhaust contains carbon monoxide, an odorless and deadly gas. Follow all Carbon Monoxide Safety instructions in this Operator Manual, Propane Engine Supplemental Operator Manual, and on machine. Failure to follow directions could result in death or serious injury.



Do NOT touch hot muffler, exhaust pipe, or cylinder. These parts are extremely hot from operation and may remain hot after operation. Severe burn or injury could occur if you touch these parts.



Propane is highly flammable. Follow all Propane Safety instructions in this Operator Manual, Propane Engine Supplemental Operator Manual, and on machine. Failure to follow directions could result in death or serious injury.



Wear eye and hearing protection when operating this machine.



There are rotating pads and parts under machine frame, which can cause serious injury. Keep hands and feet away.

GENERAL OPERATION SAFETY



DANGER: Severe burn or injury could occur if you touch the hot muffler, exhaust pipe, or cylinder. Do NOT Touch these hot parts.



WARNING: Any alterations or modifications of this engine could result in damage to the engine or injury to the operator or other bystanders. Alterations or modifications not authorized by the manufacturer voids any and all warranties and liabilities.



WARNING: To avoid injury or property damage, DO NOT leave the machine where it can be tampered with or started by persons untrained in its operation.



WARNING: Moving parts of this machine can cause serious injury and/or damage. Do not allow contact of clothing, hair, hands, feet, or other body parts with the rotating pad. Keep other people away from the machine while it's in operation. DO NOT leave the machine or engine running unattended.



WARNING: Operate the machine at a slow or moderate pace. DO NOT run when operating the machine.



WARNING: Substantial damage to the floor, the machine, or personnel may result if the machine is operated with the pad off center, damaged or missing. Do not operate the machine if the pad is off center, damaged or missing.



WARNING: Operating an engine that has loose parts could result in injury or property damage. DO NOT operate this engine if there are loose parts. Inspect the engine for loose parts frequently. This will promote safe operation and a long engine life.



WARNING: Vibration from machinery may cause numbness or tingling of the fingers in certain people. Smoking, dampness, diet, and heredity may contribute to the symptoms. Wearing warm clothing, gloves, exercising and refraining from smoking can reduce the effects of vibration. If the symptoms still persist, discontinue operation of the machine.



WARNING: Keep bystanders away from the engine while it is in operation.



WARNING: Injury to the eyes and/or body can occur if protective clothing and/or equipment is not worn while using this engine. Always wear safety goggles and safety clothing while using this machine.



WARNING: Long or continuous exposure to high noise levels may cause permanent hearing loss. Always wear hearing protection while using this machine.



WARNING: Injury to the operator or bystanders could occur if the machine's power is on while changing the buffing pad or making machine adjustments. Never try to change the buffing pad or attempt to make machine adjustments while the engine is running.

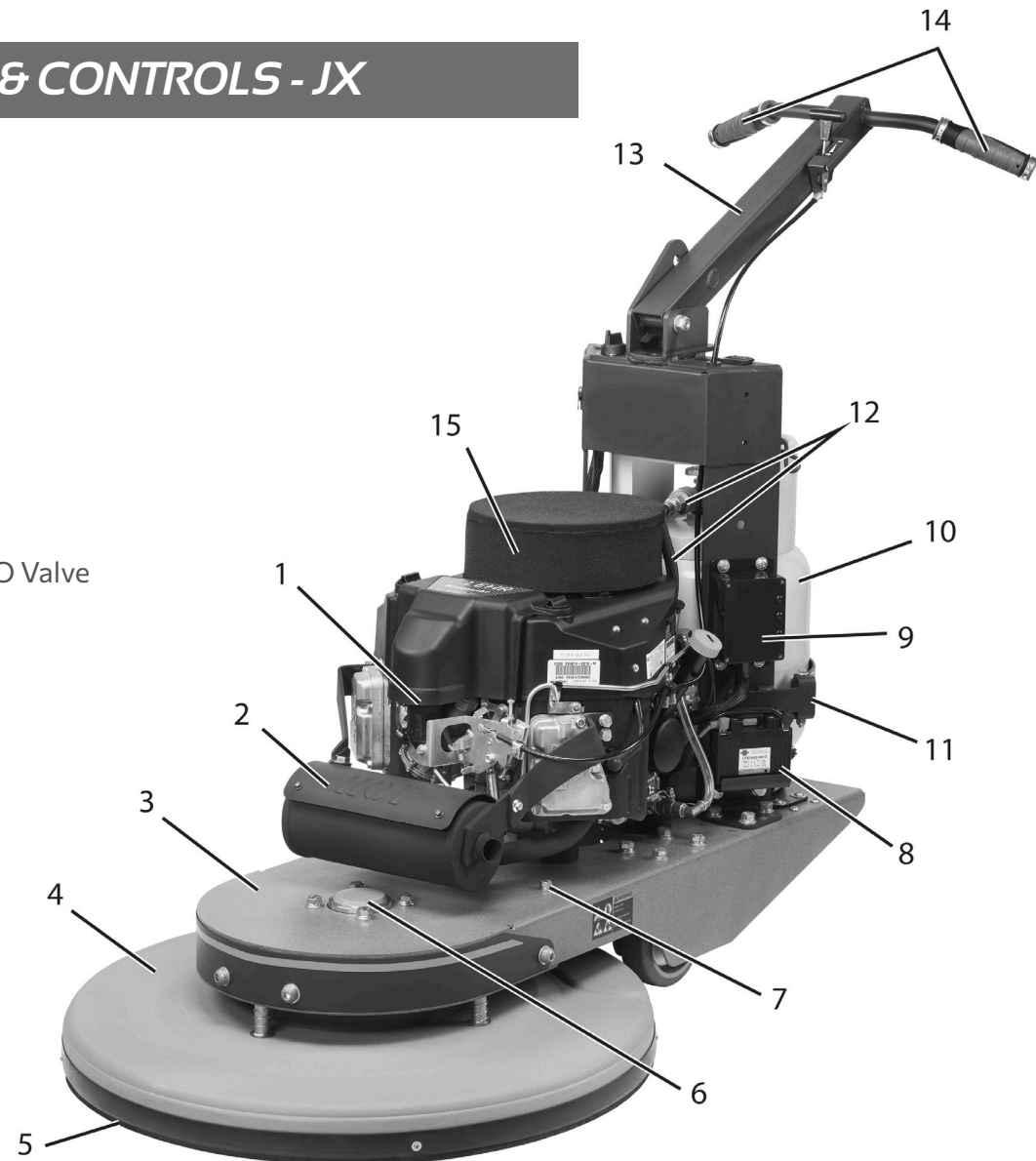
MACHINE SPECIFICATIONS - JX

Engine Size	603 CC
Pad Diameter	21 in. / 24 in. / 27 in.*
Net Weight	272 lb
Gross Weight	330 lb
Packaged Dimension	52 in. (L) x 30 in. (W) x 44 in. (H)
Front Wheels	6 x 1.5 in. (x2)
Pulley Ratio	4:8
Belt	BX51
Engine Idle RPM	2000
Engine MAX RPM	2900 to 3500*
PAD RPM	1000 to 1800
Propane Cylinder	20 LB Vertical Vapor

*Varies by model.

COMPONENTS & CONTROLS - JX

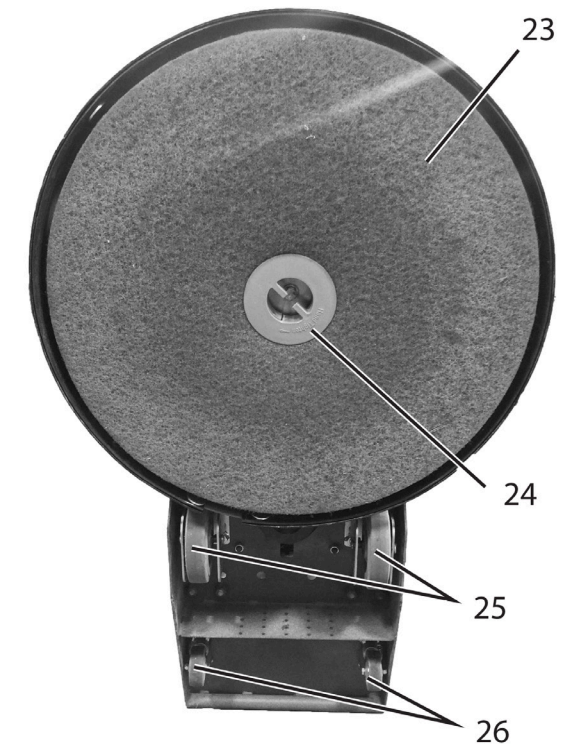
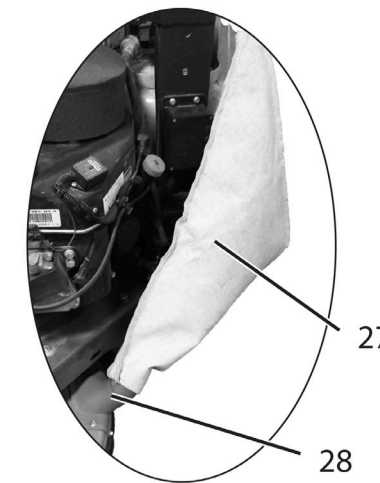
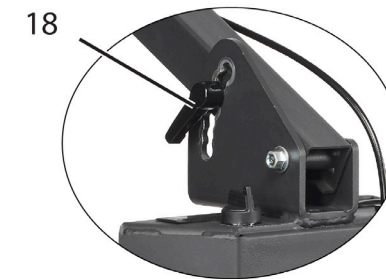
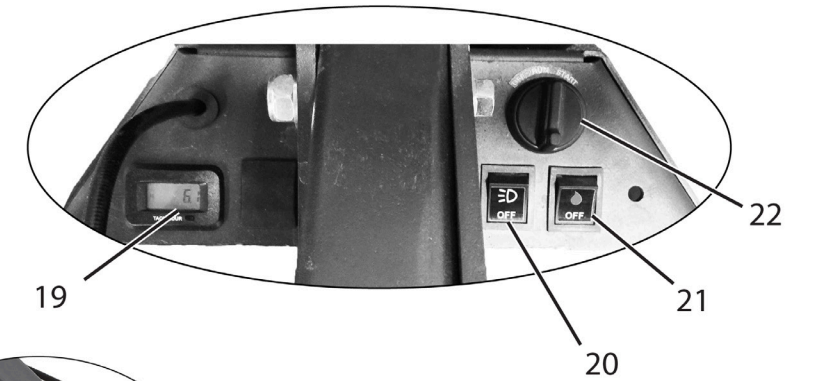
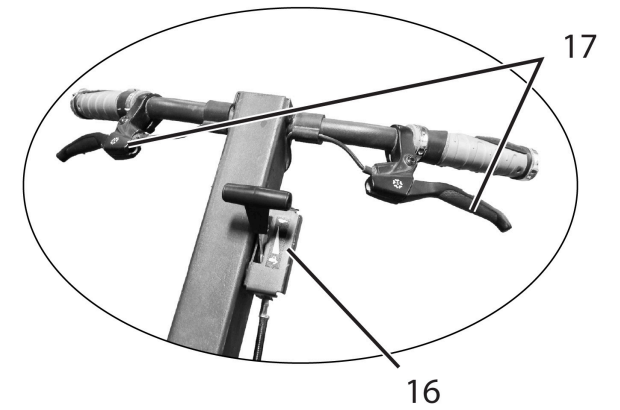
1. Engine
2. Catalytic Muffler
3. Machine Deck
4. Shroud
5. Shroud Seal
6. Front Bearing Housing
7. Belt Tensioner
8. Battery
9. Electronic Box & Cover
10. Propane Tank
11. Tank Strap
12. Propane Hose w/ REGO Valve
13. Handle
14. Grips
15. Bonnet Filter



COMPONENTS & CONTROLS - JX

16. Engine Throttle Control
17. Clutch Handles*
18. Handle Adjustment Knob
19. Hour Meter / Tachometer
20. Headlight Switch*
21. Water Switch*
22. Ignition Switch & Key
23. Pad
24. Pad Holder
25. Front Wheels
26. Rear Casters
27. Dust Bag*
28. Dust Chute*

* Not included on all models



OPERATION



CAUTION: OVERHEATING is a major cause of engine failure. Keep the engine clean and free of debris build up.



CAUTION: Low oil levels and dirty oil account for most of the other failures. Follow the engine manual's recommended oil change schedule.

PREPARATION

1. Check engine oil level according to Engine Operator Manual
2. Ensure propane cylinder has been properly filled according to section "Filling Propane Cylinders"
3. Check for any sign of wear or damage such as cracks, corrosion, punctures, etc. to the fuel system including propane cylinder, fuel hoses, fittings, regulator, carburetor, and electrical components.
4. Ensure main service valve on propane cylinder is closed (turned clockwise).
5. Screw the REGO fitting of the high-pressure propane hose onto the cylinder service valve and hand tighten. This connection **MUST** be tight and secure and fully seated to function.
6. Ensure propane tank is secured with clamping strap
7. Ensure handle is secure and at a comfortable position
8. Ensure all machine parts (belt, pad, handle, wheels, etc.) are in place and secure.
9. Ensure the pad is at least 1/3 inch thick, and that the pad holder is tight.
10. Ensure the pad driver is secure to the drive shaft.
11. Ensure the battery cable is connected.

STARTING THE ENGINE



WARNING: Before attempting to start engine, become familiar with all controls of the machine.

1. Slowly open the main service valve on propane cylinder to the fully open position.
 2. Set throttle to Idle position.
 3. Ensure machine is rocked back on its rear casters, so the pad is not in contact with the floor.
 4. Turn Ignition Switch to "Start", which will engage starter. Allow cranking for a maximum of 6 seconds or until the engine fires.
- If engine fails to fire on the first attempt, repeat this step. It will likely fire on the second attempt due to internal fuel priming.



CAUTION: Serious starter damage will result if starter is engaged for more than 6 seconds, and will void warranty.

- 5. Once engine has started, slowly increase throttle. Allow for a warm-up period for 30 Seconds before applying full load to the engine.

Note: If the engine fails to start, see the Troubleshooting Guide.

STOPPING ENGINE

Normal Stop

Follow these stopping procedures under normal use, including when the engine will be stored or transported:

1. Set throttle to Idle position.
2. Close the service valve on propane cylinder (turn clockwise fully).
3. Allow the remaining propane in the regulator and fuel hose to be consumed by engine, until engine stops.
4. Turn engine key switch to off.
5. Disconnect fuel line from propane cylinder.
6. If storing or transporting the machine, follow instructions in section "STORING & TRANSPORTING PROPANE CYLINDERS"

Immediate Stop

Follow these stopping procedures only when an immediate stop is required:

1. Turn engine key switch to off.
2. Close the service valve on propane cylinder (turn clockwise fully).
3. Disconnect fuel line from propane cylinder.

HANDLE ADJUSTMENT

The handle on this machine can be adjusted to several heights, to accommodate different sized operators and different operator preferences. To adjust the handle:

1. Stop the engine.
2. Loosen the Handle Adjustment Knob, until the Handle is allowed to pivot freely. Note: Do not fully remove this knob.
3. Adjust the Handle to desired position.
4. Tighten the Handle Adjustment Knob.

WHEEL POSITION ADJUSTMENT

The position of the two front wheels has significant affect on the performance and handling of the machine, including:

Pad pressure = The amount of force the pad has against the floor

Forward propulsion = The feeling of forward pull or drive caused by pad friction

Machine torque = The feeling that the machine wants to constantly turn, usually toward the left

When your machine was assembled, the wheels were installed in positions determined to allow for best performance under most conditions. However, depending on floor type, floor finish type, pad type, and operator preference, these wheel positions can be changed to affect machine performance.

For the purpose of clarity, the following terms will be used in this section:

Forward = closer to the front of the machine

Rearward = closer to the rear of the machine

Up = closer to the sky

Down = closer to the ground

Left = the left side when viewed from the Operator's position

Right = the right side when viewed from the Operator's position

Through wheel adjustment, the following changes can be made to the machine performance:

Desired Change	Adjustment to Make
Increase pad pressure	Move both wheels (left and right) Rearward
Decrease pad pressure	Move both wheels (left and right) Forward
Increase forward propulsion	Offset the two wheels, so the right wheel is Higher (more "up") than left
Decrease forward propulsion	Align the two wheels, so the left and right wheel are the same height
Increase machine torque	Move both wheels (left and right) Down
Decrease machine torque	Move both wheels (left and right) Up

To change the wheel position:

1. Stop the engine.
2. Adjust handle position to highest position and rock machine back, until handle grips are resting on ground.



CAUTION: Whenever working on a machine in the rocked back position, ask an assistant to hold the handle and prevent the machine from falling forward.

3. Remove the small cotter pin / hair pin from the wheel axle.
4. Remove the wheel axle.
5. Remove the wheel and any spacer.
6. Reposition the wheel and spacer in desired hole.
7. Insert the wheel axle.
8. Insert the cotter pin / hair pin.

MAINTENANCE



WARNING: To ensure personal safety, adjustments should ONLY be made by a qualified technician or an authorized service enter.



WARNING: Prior to any maintenance, ensure engine is turned off and disconnect spark plug wire from spark plug. Never attempt service or maintenance on a running engine.

MAINTENANCE SCHEDULE

	Daily	25hr	200hr
Check Engine Oil Level	X		
Check for Loose Hardware	X		
Check for Fuel or Oil Leakage	X		
Check/Clean Intake Air Filter	X		
Check/Clean Bonnet Filter	X		
Check, Clean, and/or Replace Dust Bag	X		
Check Pad	X		
Check Shroud & Shroud Seal	X		
Check Engine Mounts		X	
Check Belt for Wear or Slippage		X	
Check Pulleys, Drive Shaft, and Bearings		X	
Check Wheels & Bearings		X	
Overall Checkup at Authorized Service Center			X

Battery Specs:

Model	HJ TZ5S-30-GFP
Voltage (V)	12.8
Capacity (Ah)	3
Weight	0.7 kg / 1.5 lb
Charging Current	0.5A to 15A
Charging Voltage	14.4 0.5 V
Cold Cranking Amps	180
Cycle Life	≥1000

The equipment uses an onboard charging system integrated within the wiring harness which charges battery during normal use.

The battery can be recharged offline with any off-the-shelf battery charger with the following specs:

Voltage = 12 volts

Charging Amperage = 0.5 to 15 Amps

Battery Charging Procedures:

1. Disconnect the plastic battery cable terminal on equipment, and remove battery from equipment.
2. Connect the charger clamps to the battery posts:
 - Red clamp on the positive “+” post
 - Black clamp on the negative “-” (ground) post
3. If the charger has settings, set the output voltage and amperage within the ranges noted above.
4. Plug in the battery charger to standard wall outlet in a well ventilated area.
5. For best results, leave the charger connected for minimum of 8 hours.
6. Disconnect battery from charger by reversing steps 5-2
7. Reinstall battery on equipment, and connect the plastic battery cable terminal.

If equipped with a dust collection system, the dust bag should be serviced frequently as follows:

1. Stop engine.
2. Remove the bag from the dust chute, but pulling the elbow out of the dust chute.
3. Unzip the back of the bag.
4. Empty the contents of the bag into a garbage receptacle and shake out any debris. This is best done outside.
5. Reinstall the bag onto the dust chute, and secure the bag to machine via the rope loop and velcro on bag.

Note: The bag will remain functional for approximately 20-30 cycles, after which the bag should be replaced.

HOW TO CHANGE PAD

1. Stop the engine.
2. Adjust handle position to highest position and rock machine back, until handle grips are resting on ground.



WARNING: Whenever working on a machine in the rocked back position, ask an assistant to hold the handle and prevent the machine from falling forward.

3. Remove the Pad Holder by turning it counterclockwise.
4. Remove the Pad, by peeling it off of the gripper surface
5. Install a new Pad onto the gripper surface, paying attention to keep it centered and aligned with the gripper surface.
6. Reinstall the Pad Holder, and tighten it by turning it clockwise.

STORAGE

Take the following steps when storing the machine:

1. Ensure the ignition switch is turned to “off”.
2. Remove the propane tank, and store in an approved outside location.
3. Disconnect battery cable connectors, to prevent battery drain. When disconnected, the battery will keep its charge in storage for approximately 12 months.
4. Store machine in an indoor, climate controlled location with low humidity.

TROUBLESHOOTING

Note: When troubleshooting, always first check for simple causes which may at first seem too obvious. For example, an engine unable to start may be caused by an empty propane cylinder or an unopened service valve.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine does not turn over.	Weak or dead battery.	Recharge or replace battery.
	Battery cable is disconnected.	Connect battery cable at connector.
	Ignition switch faulty.	Check switch, replace if necessary.
	Faulty Starter.	Check starter, replace if necessary.
	Damaged or disconnected wire in wiring harness.	Check wiring harness to identify faulty connection, replace or reconnect as required.
	Numerous other causes.	See engine manual or dealer.
Engine turns over, but does not start or run.	Propane cylinder is empty.	Refill cylinder or replace with full cylinder.
	Main fuel service valve on propane cylinder is closed.	Manually open main fuel service valve on propane cylinder.
	REGO fitting (fuel hose to cylinder connector) is not fully seated.	Manually close main fuel service valve. Disconnect REGO fitting. Reconnect and hand tighten to ensure secure connector is fully seated. Slowly open main fuel service valve.
	Propane cylinder OPD (overflow protection device) has been triggered.	Manually close main fuel service valve. Disconnect REGO fitting. Wait 5 seconds. Reconnect and hand tighten to ensure secure connector is fully seated. Slowly open main fuel service valve.
	Propane regulator out of adjustment or faulty.	Have certified dealer inspect regulator and adjust or replace.
	Poor quality propane causes deposits of particles in regulator or valves.	Have certified dealer inspect regulator and clean or replace. Service engine valves according to engine manual instructions. Contact propane supplier to provide clean HD5 propane.
	Spark plug not firing.	Replace spark plug.
	Faulty oil pressure switch.	Check or replace oil pressure switch.
	Numerous other causes.	See engine manual or dealer.
	Propane regulator freezes and prevents flow of propane.	Liquid propane is entering regulator.
Low ambient temperature.		It is normal condition for propane regulator to operate at colder temperature than ambient, which may cause condensation or frost formation depending on ambient temperature and humidity levels.

TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Propane cylinder forms condensation or ice.	Propane fuel is leaking.	Close propane main fuel service valve. Check fuel lines, REGO fitting, and regulator for any leaks.
	Propane consumption is abnormally high.	Refer to section "Inconsistent or short cylinder run time" below.
	Low ambient temperature.	It is normal condition for propane cylinder to operate at colder temperature than ambient, which may cause condensation or ice formation depending on ambient temperature and humidity levels.
Inconsistent or short cylinder run time.	Propane cylinders not filled consistently.	Use cylinders that are properly and consistently filled to the 80% maximum level.
	Propane regulator out of adjustment or faulty.	Have certified dealer inspect regulator and adjust.
	Dirty air filter.	Service air filter.
	Excessive engine load.	See engine manual or dealer.
Engine backfires, difficult to start, reduced power, over-heating, or other poor performance	Excessive engine RPM	See engine manual or dealer.
	Propane regulator out of adjustment or faulty.	Have certified dealer inspect regulator and adjust.
	Propane flow restricted.	Refer to section "Engine turns over, but does not start or run", above.
	Dirty air filter.	Service air filter.
	Dirty propane filter.	Service propane filter.
	Ignition system faulty.	Check or replace ignition coils.
	Poor compression.	See engine manual or dealer.
	Engine timing issue.	See engine manual or dealer.
	Cooling Fins Clogged.	See engine manual or dealer.
Numerous causes.	See engine manual or dealer.	
Excessive machine vibration.	Pad is not centered on pad driver.	Remove pad and reinstall, paying attention to center it on pad driver.
	Pad driver is damaged.	Inspect pad driver and replace if necessary.
	Front end bearings are worn/damaged.	Inspect front end bearings and replace if necessary.
Clutch failure.	Blown fuse.	Check fuses in Electronic Box and replace if necessary.
	Disconnected wire at clutch.	Check wires that connect the actual clutch to the wiring harness. Reconnect if necessary.
	Disconnected wire under ignition switch.	Check wires that connect clutch handles to wiring harness located under the ignition switch. Reconnect if necessary.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine monitor shuts down machine.	Engine is running rich.	Have certified dealer inspect regulator and adjust.
	Engine monitor is faulty.	Replace engine monitor.
Battery does not hold a charge.	Battery is faulty.	Replace battery.
Battery is not being charged during machine running.	Faulty voltage regulator.	Replace voltage regulator.
	Damaged or disconnected wire in wiring harness.	Check wiring harness to identify faulty connection, replace or reconnect as required.

This machine is powered by an engine that uses propane fuel. Additional information about propane basics, propane cylinders, filling propane cylinders, and storing and transporting propane cylinders is provided in the “Propane” section of this operator manual. The following propane safety instructions should be fully understood and followed at all times when using this machine or propane cylinders. Failure to follow directions could result in death or serious injury.



DANGER: Propane is a highly flammable fuel. Cigarette lighters, pilot lights, and any other sources of ignition can create an explosion when in contact with propane. All sources of ignition should be extinguished or removed entirely from the work area. **DO NOT SMOKE** in the vicinity of a propane powered engine, machine, or propane cylinder.



DANGER: NEVER release or bleed propane inside any building or other enclosed space or near an open pit. Check for fuel leaks and damage to the propane cylinder prior to operating machine and storage. Turn off service valve on propane cylinder when machine is not in use. Always store propane cylinder in an approved outside location. It is **UNLAWFUL** to store a propane cylinder inside a building.



WARNING: If you smell propane gas, shut off the machine and turn off service valve on propane cylinder and move machine outside. Determine the source of the leak before using it again.



WARNING: Escaping propane can freeze skin and cause frostbite and damage eyesight. Always wear safety gloves and safety glasses when filling propane cylinders.

INTRODUCTION:

This Operator's Manual provides important information about safety, operation, transportation, storage maintenance, and warranty of your propane engine and propane cylinders.

SAFETY HAZARD INTENSITY LEVEL:

The following terms and symbols are used to identify statements of potential hazards which affect safety of yourself and others. Read and observe all safety statements found on this Operator Manual and on your engine.



DANGER: The signal word **DANGER** indicates a hazardous situation which, if not avoided according to the instruction found in this Operator Manual or on your engine, will result in death or serious bodily injury.



WARNING: The signal word **WARNING** indicates a hazardous situation which, if not avoided according to the instruction found in this Operator Manual or on your engine, could result in death or serious bodily injury.



CAUTION: The signal word **CAUTION** indicates a hazardous situation which, if not avoided according to the instruction found in this Operator Manual or on your engine, could result in minor or moderate injury or damage to your engine or property.

IMPORTANT SAFETY INSTRUCTIONS:

DANGER:

- Propane is a highly flammable fuel. Cigarette lighters, pilot lights, and any other sources of ignition can create an explosion when in contact with propane. All sources of ignition should be extinguished or removed entirely from the work area. DO NOT SMOKE in the vicinity of a propane powered engine or propane cylinder. If you smell propane gas, shut off the engine. Determine the source of the leak before using it again. NEVER vent propane gas inside a building. It is UNLAWFUL to store a propane cylinder inside a building.
- Severe burn or injury could occur if you touch the hot muffler or exhaust pipe. DO NOT TOUCH THE HOT MUFFLER OR EXHAUST PIPE.
- The combustion of propane by this engine produces carbon monoxide, a deadly, colorless, odorless, poisonous gas. This engine is specifically calibrated to operate at a very "lean" air/fuel ratio which minimizes the production of carbon monoxide. Additionally, a catalyst muffler is provided with this engine which specifically targets and eliminates any remaining carbon monoxide, making it safe to operate indoors.
- DO NOT OPERATE THIS ENGINE WITHOUT THE CATALYST MUFFLER.
- DO NOT TAMPER WITH REGULATOR OR OTHER SETTINGS WHICH WOULD ALTER AIR/FUEL RATIO.
- INSURE ANY INDOOR SITE OF USE HAS ADEQUATE VENTILATION WHICH MEETS INDUSTRY STANDARDS

WARNING:

- Propane is a highly flammable fuel. Cigarette lighters, pilot lights, and any other sources of ignition can • Failure to read the Operator Manual prior to operating or attempting any service or maintenance procedure to your engine could result in injury to you or others, or damage to the engine or to other property.

You must have training in the operation of this engine before using it. If you or your operator/operators cannot read English, have this manual explained fully before attempting to operate this engine.

- Any alterations or modifications of this engine could result in damage to the engine or injury to the operator or other bystanders. Alterations or modifications not authorized by the manufacturer voids any and all warranties and liabilities.
- To avoid injury or property damage, DO NOT leave the engine where it can be tampered with or started by persons untrained in its operation.
- DO NOT leave the engine running unattended.
- Operating an engine that has loose parts could result in injury or property damage. DO NOT operate this engine if there are loose parts. Inspect the engine for loose parts frequently. This will promote safe operation and a long engine life.
- Keep bystanders away from the engine while it is in operation.
- Injury to the eyes and/or body can occur if protective clothing and/or equipment is not worn while using this engine. Always wear safety goggles and safety clothing while using this engine.
- Long or continuous exposure to high noise levels may cause permanent hearing loss. Always wear hearing protection while using this engine.
- Injury to the operator or bystanders could occur if the engine is running. Never attempt to make engine adjustments while the engine is running.
- Dangerous carbon monoxide emissions from this engine will increase greatly due to a dirty air cleaner. Follow the engine manufacturer's air cleaner service instructions.

CAUTION:

- Overfilling propane cylinders is the number one cause of damage to the propane fuel system. This fuel system is designed to run off vapor propane, not liquid propane. When the cylinder is overfilled, liquid propane will enter the fuel system and can damage lock-off and regulator, in addition to causing the engine to run poorly or not at all. This voids the warranty on affected parts of the engine. To avoid problems, read and understand fully, the section "FILLING PROPANE CYLINDERS".
- OVERHEATING is a major cause of engine failure. Keep the engine clean and free of debris build up.
- Low oil levels and dirty oil account for most of the other failures. Follow the engine manual's recommended oil change schedule.

- Propane is flammable and commonly used as a fuel.
- The molecular formula of propane is C₃H₈, and it is in the family of liquefied petroleum gases (LP gases). The other LP gases include butane, propylene, butadiene, butylene, isobutylene and mixtures thereof.
- Propane is commonly available and has proven to be a dependable, safe, economical, and clean burning fuel. It can be used as a household fuel, industrial fuel, and fuel for internal combustion engines. Propane has been used as a fuel since 1910.
- At atmospheric pressure, propane boils at -44 degrees Fahrenheit, meaning it typically exists as a vapor. However, when contained under pressure, such as in a propane cylinder, it can exist as a liquid.
- Propane is naturally odorless, but includes an additive odorant, usually mercaptan, which gives it a distinct odor similar to rotten eggs or skunk.
- Vapor propane is heavier than air, meaning it will settle in low areas such as along the ground or in drains.

PROPANE CYLINDERS (TANKS):



WARNING: NEVER use a cylinder not intended engine fuel applications. DO NOT substitute cylinders that are used with a barbecue grill, etc.

Propane cylinders are constructed according to ASME and Federal DOT #4ET20 pressure safety codes. All valves and fittings are UL Listed. Propane gas is noncorrosive and will not rust the inside of a cylinder. It is recommended to have propane cylinders inspected regularly during re-fill by an authorized National LP Gas Association propane dealer. The fuel cylinder is supplied directly from the manufacturer and is void of propane.

PROPANE CYLINDER CONFIGURATIONS:

Propane cylinders are constructed to function in specific configurations. The primary configuration options are:

- Propane Withdrawal: Vapor or Liquid
- Cylinder Orientation: Horizontal or Vertical

IMPORTANT: Different cylinder configurations are not interchangeable.

All ONYX engines use Vapor cylinders, and the orientation can be either Horizontal or Vertical.



CAUTION: Do not use propane cylinders that are liquid withdrawal cylinders, such as cylinders for fork lift trucks or other liquid withdrawal applications.



CAUTION: Always install the propane cylinder in the proper orientation, which is identified by a label that say "THIS SIDE UP" or equivalent.



CAUTION: Failure to use a proper cylinder or failure to install cylinder in proper orientation will result in liquid propane withdrawal and cause damage the regulator.

WARNING:

- Propane cylinders should only be filled by your propane provider or by individuals who have been properly trained and certified.
- Escaping propane can freeze skin and cause frostbite and damage eyesight. Always wear safety gloves and safety glasses when filling propane cylinders.
- DO NOT overfill cylinders.
- DO NOT tamper with cylinder gauges or safety relief valves.
- At time of fill, ensure tank is in operable condition and meets all certification requirements. Discontinue use of any cylinder that is damaged or rusted or does not comply with certification requirements. Your propane service company will assist with compliance.

The maximum fill volume of a propane cylinder is ALWAYS considered 80% of the total cylinder volume to allow for expansion and to ensure proper vapor withdrawal from the cylinder.

For example, if your propane cylinder is referred to as a "20 lb cylinder", this means that when the propane cylinder is 80% full, the weight of the propane is 20 lb.

Cylinders should be filled in the vertical position.

When filling a propane cylinder, the fixed liquid level gauge should be opened (unscrewed counterclockwise) so it can be used to determine when propane has reached 80% full. As propane is added during filling, vapor will escape the small hole in this gauge. When the cylinder reaches 80% full, the escaping propane will turn to liquid propane. When this happens, the filling should be immediately stopped and the gauge should be closed (turned clockwise).



CAUTION: Always use HD-5 grade propane to operate this engine.



CAUTION: Propane cylinders must be purged at the time of the first fill. Your propane suppliers should be familiar with this operation and will provide this service.

SYMPTOMS OF A NON-PURGED CYLINDER:

- Relief valve opens due to over pressurized cylinder creating hazardous situation.
- Moisture in the cylinder.
- Powered engine operates initially but shuts down when propane mixture becomes too lean.

STORING & TRANSPORTING PROPANE CYLINDERS:

The NFPA Technical Committee prohibits the storage of propane cylinders in buildings. Propane cylinders should NOT be stored in buildings used by the public or frequented by anyone passing through or who is working in the building. Full or empty, never leave cylinders in small enclosed areas. Cylinders must be stored in a secure, tamper-proof storage enclosure that provides safety from accident or vandalism.

Propane cylinders should always be transported either secured to the machine using cylinder straps, or secured in an upright position during transportation.

WHAT YOU NEED TO KNOW

The engine performance, reliability and life are influenced by many factors, some external and some strictly associated with the quality of the products used and with the scheduled maintenance. The following information allow a better understanding and use of your engine.

ENVIRONMENTAL CONDITIONS:

The operation of a four-stroke endothermic engine is affected by:

a) Temperature:

- Working in low temperatures could lead to a difficult cold starting.
- Working in very high temperatures could lead to a difficult hot starting due to the evaporation of the fuel either in the carburetor float chamber or in the pump.
- In any case, the right kind of oil must be used, according to the operating temperatures.

b) Altitude:

- The higher the altitude (above sea level), the lower the max power developed by an endothermic engine.
- When there is a considerable increase in altitude, the load on the machine should be reduced and particularly heavy work avoided.

OIL:

Use always high quality oils, choosing their viscosity grade according to the operating temperature.

- Use only detergent oil classified SJ,SL or higher are acceptable.
- Choose the SAE viscosity grade of oil from this chart:
 - from 5 to 35 °C = SAE 30
 - from -25 to + 5 °C = 5W-20 or 5W-30 (Multi-viscosity)
 - from -7 to + 35 °C = Synthetic oils 10W-30 or 15W-40 (Multi-viscosity)
- The use of multi-viscosity oils in hot temperatures will result in higher than normal oil consumption; therefore, check oil level more frequently.
- Do not mix oils of different brands and features.
- SAE 30 oil, if used below 5°C, could result in possible engine damage due to inadequate lubrication.
- Oil should be at “MAX” mark do not overfill. Overfilling with oil may cause:
 - Smoking;
 - Spark plug or air filter fouling, which will cause hard starting.

AIR FILTER:

A good quality fuel is the major issue for the engine reliability of operation. The air filter must always be in perfect working order, to prevent debris and dust from getting sucked into the engine, reducing the efficiency and life of the machine.

- Always keep the filtering element free of debris and in perfect working order.
- If necessary, replace the filtering element with an original spare part. Incompatible filtering elements can impair the efficiency and life of the engine.
- Never start the engine without mounting the filtering element properly.

WHAT YOU NEED TO KNOW

SPARK PLUG:

Not all the spark plugs for endothermic engines are the same!

- Use only spark plugs of the recommended type, with the right heat range.
- Check the length of the thread, because – if too long – it will damage the engine beyond repair.
- Make sure that the electrodes are clean and their gap is correct.

STANDARDS OF USE

BEFORE EVERY USE:

Before every use, perform the following checking procedures in order to assure a regular operation.

CHECK THE OIL LEVEL:

See the specific chapter for the oil to be used.

- Place the engine level.
- Clean around oil fill.
- Unscrew the cap, clean the end of the dipstick and insert it, as illustrated, without screwing it down.
- Remove the cap with the dipstick and check the oil level that must be between “MIN” and “MAX” marks.
- If oil is required, add oil of the same kind up to the “MAX” mark, being careful not to spill any outside the oil fill.
- Fully tighten the filler cap and wipe off any spilled oil.

CHECK THE AIR CLEANER:

The efficiency of the air filter is fundamental for the engine to work properly. Do not start the engine if the filtering element is missing or broken.

- Clean around the filter cover.
- Open the clips of the two sides of the air filter cover.
- Check the condition of the filtering element. It must be intact, clean and in perfect working order; if not, either carry out maintenance or replace it.
- Put the cover back.

LONG STORAGE (OVER 30 DAYS):

In case the engine has to be stored for a long time (for example at the end of the season), a few precautions are needed to help the future start-up.

- To prevent the formation of deposits inside the tank, empty it of fuel by unscrewing the carburetor float chamber plug and collecting all the fuel in a suitable container. At the end of the operation remember to screw the plug back on and fully tighten it.
- Remove the spark plug and pour about 3 cl of clean engine oil into the spark plug hole, then, having blocked the hole with a rag, run the starter motor briefly to turn the engine for a few revs and distribute the oil over the inner surface of the cylinder. Finally replace the spark plug without connecting the cable cap.

These troubleshooting steps are specific for propane fuel system issues. For other engine issues, refer to the Engine Operator Manual and/or OEM Equipment Manual.

Problem	Reason	Solution
Engine does not turn over	Weak or dead battery	Recharge or replace battery.
	Ignition switch faulty Numerous other causes	Check or replace switch.
	Faulty safety interlock switch (operator presence control)	Engage safety interlock switch (operator presence control) prior to engaging starter.
	Safety interlock switch (operator presence control) not engaged	Check or replace safety interlock switch (operator presence control).
Engine turns over, but does not start or run	Numerous other causes	See engine manual or dealer.
	Propane cylinder is empty	Refill cylinder or replace with full cylinder.
	Main fuel service valve on propane cylinder is closed	Manually open main fuel service valve on propane cylinder.
	REGO fitting (fuel hose to cylinder connector) is not fully seated	Manually close main fuel service valve. Disconnect REGO fitting. Reconnect and hand tighten to ensure secure connector is fully seated. Slowly open main fuel service valve.
	Propane cylinder OPD (overflow protection device) has been triggered.	Manually close main fuel service valve. Disconnect REGO fitting. Wait 5 seconds. Reconnect and hand tighten to ensure secure connector is fully seated. Slowly open main fuel service valve.
	Propane regulator out of adjustment or faulty	Have certified dealer inspect regulator and adjust or replace.
	Poor quality propane causes deposits of particles in regulator or valves	Have certified dealer inspect regulator and clean or replace. Service engine valves according to engine manual instructions. Contact propane supplier to provide clean HD5 propane.
	Spark plug not firing	Replace spark plug.
	Faulty vacuum switch	Check or replace vacuum switch.
	Faulty oil pressure switch	Check or replace oil pressure switch.
Numerous other causes	See engine manual or dealer.	

Problem	Reason	Solution
Propane regulator freezes and prevents flow of propane	Liquid propane is entering regulator	<ul style="list-style-type: none"> Ensure cylinder is designed for VAPOR withdrawal and the correct orientation (horizontal or vertical). Ensure cylinder is installed in correct orientation. Make sure locator pin is inserted into positioning slot on cylinder collar, and follow orientation arrow indications/labels on cylinder. Ensure propane cylinder is not overfilled. Ensure use of application does not allow operating angles to exceed equipment OEM instructions.
	Low ambient temperature	It is normal condition for propane regulator to operate at colder temperature than ambient, which may cause condensation or frost formation depending on ambient temperature and humidity levels.
Propane cylinder forms condensation or ice	Propane fuel is leaking	Close propane main fuel service valve. Check fuel lines, REGO fitting, and regulator for any leaks.
	Propane consumption is abnormally high	Refer to section "Inconsistent or short cylinder run time" below.
	Low ambient temperature	It is normal condition for propane cylinder to operate at colder temperature than ambient, which may cause condensation or ice formation depending on ambient temperature and humidity levels.
Inconsistent or short cylinder run time	Propane cylinders not filled consistently	Use cylinders that are properly and consistently filled to the 80% maximum level.
	Propane regulator out of adjustment or faulty	Have certified dealer inspect regulator and adjust.
	Dirty air filter	Service air filter.
	Excessive engine load	See engine manual or dealer.
	Excessive engine RPM	See engine manual or dealer.

Problem	Reason	Solution
Engine backfires, difficult to start, reduced power, over-heating, or other poor performance	Propane regulator out of adjustment or faulty	Have certified dealer inspect regulator and adjust.
	Propane flow restricted	Refer to section "Engine turns over, but does not start or run", above.
	Dirty air filter	Service air filter.
	Ignition system faulty	Check or replace ignition coils.
	Poor compression	See engine manual or dealer.
	Engine timing issue	See engine manual or dealer.
	Cooling Fins Clogged	See engine manual or dealer.
	Numerous causes	See engine manual or dealer.

To protect the environment the manufacturer has incorporated (1) crankcase emission and (2) exhaust emission control systems (EM) in compliance with applicable regulations of the United States Environmental Protection Agency and California Air Resources Board.

1. Crankcase Emission Control System. A sealed-type crankcase emission control system is used to eliminate blow-by gases. The blow-by gases are led to the breather chamber through the crankcase where it is led to the air cleaner. Oil is then separated from the gases while passing through the inside of the breather chamber from the crankcase, and then returned back to the bottom of crankcase.

2. Exhaust Emission Control System. The exhaust emission control system applied to this engine consists of a carburetor and an ignition system having optimum ignition timing characteristics. The carburetor has been calibrated to provide lean air/propane mixture characteristics and optimum propane economy with a suitable air cleaner and exhaust system.

TAMPERING WITH EMISSION CONTROL SYSTEM PROHIBITED

Federal law and California State law prohibits the following acts or the causing thereof: (1) the removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any device or element at design incorporated into any new engine for the purpose of emission control prior to its sale or delivery to the ultimate purchaser or while it is in use, or (2) the use of the engine after such device or element of design has been removed or rendered inoperative by any person.

Among acts presumed to constitute tampering involve the parts/systems listed below:

- Carburetor and internal parts
- Spark plugs
- Magneto or electronic ignition system
- Propane filter element
- Air cleaner elements
- Crankcase
- Cylinder heads
- Breather chamber and internal parts
- Intake pipe and tube

EPA & CALIFORNIA EMISSION CONTROL WARRANTY STATEMENT

YOUR WARRANTY RIGHTS AND OBLIGATIONS

Federal law and California State law prohibits the following acts or the causing thereof: (1) the removal or The California Air Resources Board (CARB), the U.S. Environmental Protection Agency (EPA), and LEHR, LLC (herein "LEHR") are pleased to explain the emissions control system warranty on your 2015 small off-road engine (SORE). In California, new SORE must be designed, built and equipped to meet the State's stringent anti-smog standards. LEHR must warrant the emission control system on your SORE for the period of time listed below provided there has been no abuse, neglect or improper maintenance of your SORE.

Your emission control system may include parts such as the carburetor, fuel-injection system, the ignition system, catalytic converter, fuel tanks, fuel lines, fuel caps, valves, canisters, filters, vapor hoses, clamps, connectors, and other associated emission-related components.

Where a warrantable condition exists, LEHR will repair your SORE at no cost to you including diagnosis, parts and labor.

MANUFACTURER'S WARRANTY COVERAGE

The emission control system is warranted for 1000 hours (JLHRS.9992EM family) and 500 hours (JLHRS.6032EM family). If any emission-related part on your equipment is defective, the part will be repaired or replaced by LEHR.

OWNER'S WARRANTY RESPONSIBILITIES

As the small off-road engine (SORE) owner, you are responsible for the performance of the required maintenance listed in your owner's manual. LEHR recommends that you retain all receipts covering maintenance of your SORE engine, but LEHR cannot deny warranty solely for the lack of receipts or for your failure to ensure the performance of all scheduled maintenance.

As the SORE owner you should however be aware that LEHR may deny your warranty if your SORE or its part has failed due to abuse, neglect, improper maintenance or unapproved modification.

You are responsible for presenting your utility equipment engine to a LEHR distribution center as soon as the problem exists. The warranty repairs should be completed within a reasonable amount of time, not to exceed 30 days. If you have any questions regarding your warranty rights and responsibilities, you should contact LEHR.

GENERAL EMISSIONS WARRANTY COVERAGE

LEHR warrants to the ultimate purchaser and each subsequent purchaser that the equipment is:

Designed, built and equipped so as to conform with all applicable regulations; and

Free from defects in materials and workmanship that cause the failure of a warranted part to be identical in all material respects to that part as described in the application for certification.

The warranty period begins on the date the equipment is delivered to an ultimate purchaser or first placed into service. The warranty period is 1000 hours (FNYXS.9992EM family) and 500 hours (FNYXS.6032EM family).

Subject to certain conditions and exclusions as stated below, the warranty on emission-related parts is as follows:

(1) Any warranted part that is not scheduled for replacement as required maintenance in the written instructions supplied, is warranted for the warranty period stated above. If the part fails during the period of warranty coverage, the part will be repaired or replaced by LEHR according to subsection (4) below. Any such part repaired or replaced under warranty will be warranted for the remainder of the period.

(2) Any warranted part that is scheduled only for regular inspection in the written instructions supplied is warranted for the warranty period stated above. Any such part repaired or replaced under warranty will be warranted for the remaining warranty period.

(3) Any warranted part that is scheduled for replacement as required maintenance in the written instructions supplied is warranted for the period of time before the first scheduled replacement date for that part. If the part fails before the first scheduled replacement, the part will be repaired or replaced by LEHR according to subsection (4) below. Any such part repaired or replaced under warranty will be warranted for the remainder of the period prior to the first scheduled replacement point for the part.

(4) Repair or replacement of any warranted part under the warranty provisions herein must be performed at a warranty station at no charge to the owner.

(5) Notwithstanding the provisions herein, warranty services or repairs will be provided at all of our distribution centers that are franchised to service the subject engines or equipment.

WARRANTED PARTS

The repair or replacement of any warranted part otherwise eligible for warranty coverage may be excluded from such warranty coverage if LEHR demonstrates that the SORE has been abused, neglected, or improperly maintained, and that such abuse, neglect, or improper maintenance was the direct cause of the need for repair or replacement of the part. That notwithstanding, any adjustment of a component that has a factory installed, and properly operating, adjustment limiting device is still eligible for warranty coverage. The following emission warranty parts are covered:

- (1) Catalytic converter
- (2) Fuel system: Carburetor, pressure regulator and fuel lock off
- (3) Ignition system
- (4) Intake system including pre-filter
- (5) Exhaust manifold and muffler



WARNING: Remove the spark plug cap and read instructions before carrying out any cleaning, repair, or maintenance operation. Wear proper clothing and working gloves whenever your hands are at risk. Do not perform maintenance or repair operation without the necessary tools and technical knowledge.

IMPORTANT: Never get rid of used oil, fuel or other pollutants in unauthorized places.

MAINTENANCE SCHEDULE:

Follow the hourly or calendar - whichever occurs first - maintenance schedule shown in the following table.

Operation	After First 5 hours	Every 5 hours or Daily	Every 50 hours or every season	Every 100 hours	Every 200 hours	Every 500 hours
Check oil level		✓				
Check or clean air inlet screen ²		✓				
Change oil ¹	✓			✓		
Clean silencer and engine		✓				
Air filter clearing ² and check		✓				
Change oil filter				✓		
Check spark plug				✓		
Replace spark plug					✓	
Fuel filter check ³				✓		
Replace air cleaner primary element ²					✓	
Replace air cleaner secondary element ²						✓

¹) Change oil every 25 hours if the engine is operating under heavy load or in hot weather.

²) Clean air filter more frequently if the machine is operating in dusty areas.

³) To be carried out by a specialized center.

CHANGE OIL:

See specific chapter for the oil to be used.



WARNING: Drain oil while the engine is warm, being careful not to touch the hot engine nor the drained oil.

- Place the machine on a flat surface.
- Clean the area around the filler cap and unscrew the cap with dipstick.
- Provide a suitable container for collecting the oil and unscrew the drain plug.
- Refit the drain plug and fully tighten it having made sure that the gasket is in the right position.
- Fill up with fresh oil.
- Check that the oil level has reached the "MAX" notch on the dipstick.
- Close the cap again and clean up any traces of oil that was possibly spilt.

NOTE: The oil capacity is about 2.0 Liter



WARNING: The length of time that propane can be left in your fuel tank and carburetor without causing functional problems will vary with such factors as propane blend, your storage temperatures, and whether the fuel tank is partially or completely filled. The air in a partially filled fuel tank promotes fuel deterioration. Very warm storage temperatures accelerate fuel deterioration. Propane will oxidize and deteriorate in storage. Deteriorated propane will cause hard starting, and it leaves gum deposits that clog the fuel system. As a result, if the engine is not used for more than one month, the fuel oil shall be drained thoroughly to prevent from deterioration of the fuel in the fuel system and carburetor. The failure of the fuel system or engine performance arising from improper storage are beyond the scope of the warranty.

CLEAN SILENCER AND ENGINE:

Silencer must be cleaned when the engine is cold.

- Use a jet of compressed air to remove any debris and dirt that could cause a fire from the silencer and its protective cover.
- Make sure that the cooling air intakes are not blocked.
- Clean the plastic components with a sponge soaked in water and detergent.

AIR FILTER MAINTENANCE:

- Clean debris in the air filter cap and rain cover.
- Open the clips on the two sides of air filter cover.
- Gently shake element up and down, take out air cleaner primary element and secondary element.
- Tap the cartridge on a solid surface and blow it from the inside with compressed air to remove dust and debris.

IMPORTANT: Do not use water, petrol, detergents or any other products to clean the cartridge.

- Clean the inside of the filter housing, making sure to block the inlet duct with a rag to prevent dust and debris from entering the engine.
- Remove the rag blocking the air inlet duct. Reinstall the primary and secondary air filter elements.
- Reinstall the air filter cover and secure it to the filter housing with the holding clips.

SPARK PLUG SERVICE:

- a) Remove the spark plug using a spark plug socket wrench.
- b) Clean the electrodes with a metal brush and remove any carbonaceous build-up.
- c) Using a thickness gauge, check for the right gap (0.6-0.8mm) between the electrodes.
- d) Install the spark plug and tighten with a socket wrench.

Replace the spark plug if the electrodes are burnt or if the porcelain is broken or damaged.



WARNING: Fire hazard! Do not check the ignition system with spark plug removed.

IMPORTANT: Use only spark plugs of the recommended type.

TUNING THE THROTTLE CABLE AND THE CARBURETOR:

Should the engine not reach maximum revs with the throttle trigger set to “FAST”, it could be due to the throttle trigger and speed control lever being out of phase or to a carburetion problem. Go to a specialised center or contact your dealer to restore normal operation.

Problem	Reason	Solution
Hard starting	No fuel	Check and top up
	Stale fuel or build-ups in tank	Empty fuel tank and refill with fresh fuel
	Incorrect starting procedure	Perform the starting procedure correctly
	Spark plug disconnected	Check that the spark plug cap fits well over the plug terminals
	The spark plug is wet or the spark plug electrodes are dirty or placed inadequately	Check
	Air filter clogged	Check and clean
	Incorrect oil for the season	Replace with proper oil
	Fuel evaporation in the carburetor (vapor lock) due to high temperatures	Wait for a few minutes then start again
	Fault in carburation	Contact a Licensed Service Center
Inconsistent working	Hard starting	Contact a Licensed Service Center
	Dirty electrodes or incorrect gap	Check
	The spark plug cap is inserted incorrectly	Check that the cap is fitted correctly
	Air filter clogged	Check and Clean
	Throttle trigger in “CHOKE” position	Move the lever to the “FAST” position
	Fault in carburation	Contact a Licensed Service Center
Loss of power whilst operating	Fault in ignition	Contact a Licensed Service Center
	Air filter clogged	Check and clean
	Fault in carburation	Contact a Licensed Service Center
	Governor out of phase with respect to the accelerator	Adjust the cable

REFILLING AND OPERATION MATERIALS:

- | | |
|-------------------------------------|----------------------------|
| Fuel | Propane |
| Engine Oil: From 5° to 35° C | SAE 30 |
| From -25° to 5° C | 5W-20 or 5W30 |
| From -7° to 35° C | Synthetic 10W-30 or 15W-40 |
| Oil Capacity | 2.0 Liter |
| Spark Plug | F7TRC (NHSP) or equivalent |
| Spark Plug gap | 0.6-0.8mm |

CARBON MONOXIDE (CO) SAFETY

This machine and the engine that powers it have been specifically calibrated to operate safely in indoor spaces. This is accomplished by calibrating the engine to run with a very “lean” air/fuel ratio which minimizes the production of carbon monoxide. Additionally, a catalyst muffler is provided with the engine which specifically targets and eliminates carbon monoxide.

In order to maintain a safe working environment, and minimize risk of carbon monoxide poisoning, the following safety information and instruction in this section must be strictly adhered to:



DANGER: All LPG (Liquid Propane Gas) powered engines, including this engine, produce Carbon Monoxide (CO), a DEADLY, colorless, odorless, tasteless, non-irritating, and poisonous gas. Failure to provide for proper venting of CO produced during the operation of combustion powered engines may result in SERIOUS INJURY OR DEATH to the operator and those in the contaminated area.



DANGER: Do not operate this machine without catalyst muffler installed.



DANGER: Do not tamper with regulator or other settings which would alter air/fuel ratio.



WARNING: Dangerous carbon monoxide emissions from this engine will increase greatly due to a dirty air cleaner. Follow the engine manufacturer’s air cleaner service instructions.

The purpose of this section is to provide helpful information to explain how carbon monoxide can be managed to reduce risk of carbon monoxide poisoning:

- Potential effects of CO exposure
- Industry guidelines for acceptable CO exposure
- Measuring CO exposure
- Understanding factors that determine CO exposure
- Methods to reduce CO exposure

POTENTIAL EFFECTS OF CARBON MONOXIDE EXPOSURE



DANGER: Symptoms of carbon monoxide (CO) poisoning include headaches, irritability, confusion, dizziness, drowsiness, visual disturbance, nausea, vomiting, asphyxiation, or lack of consciousness. If you or any bystander experience any of these symptoms, shut off the machine immediately and go outside for fresh air. Do NOT operate the machine again until it has been tested by a qualified technician.

The toxic effects of carbon monoxide in the blood are the result of tissue hypoxia (lack of oxygen). Carbon monoxide combines with hemoglobin to form carboxyhemoglobin. Since CO and oxygen react with the same group in the hemoglobin molecule, carboxyhemoglobin is incapable of carrying Oxygen. The affinity

POTENTIAL EFFECTS OF CARBON MONOXIDE EXPOSURE

of hemoglobin for CO is 200 to 240 times greater than for oxygen. The extent of saturation of hemoglobin with CO depends on the concentration of the gas, the quantity of inspired air and on the time of exposure. The severity depends on the state of activity of the individual and his tissue oxygen needs. The effects of CO can be experienced at different exposure levels, depending on the health of the individual. Conditions that affect the tolerance of the individual are smoking, age, temperature, humidity, and other conditions.

According to Harrison’s Principles of Internal Medicine 7th edition:

- No symptoms will develop at a concentration of 0.01 % CO (100ppm) in inspired air, since this will not raise blood saturation above 10 %.
- Exposure to 0.05% (500ppm) for 1 hour during light activity will produce a blood concentration of 20% carboxyhemoglobin and result in a mild or throbbing headache.
- Greater activity or longer exposure causes a blood saturation of 30 to 50 %. At this point head ache, irritability, confusion, dizziness, visual disturbance, nausea, vomiting, and fainting can be experienced.
- Exposure for one hour to concentrations of 0.1 % (1000ppm) in inspired air the blood will contain 50 to 80% carboxyhemoglobin which results in coma, convulsions, respiratory failure and death.
- On inhalation of high concentrations of CO, saturation of the blood proceeds so rapidly that unconsciousness may occur suddenly without warning.

INDUSTRY GUIDELINES FOR ACCEPTABLE CARBON MONOXIDE EXPOSURE

Limits for permissible exposure to Carbon Monoxide vary substantially from region to region. Consult local, regional, and national workplace safety standards to determine limits for carbon monoxide exposure in your area, prior to use of any propane machines.

The current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for CO is 35 ppm, as an 8-hour time weighted average (TWA). This is computed by making measurements at intervals over 8 hours, then adding the sums of the concentrations and the intervals, and dividing by 8 hours. For example:

Time	Interval	PPM	
8:00-9:00	1 HR	100	
9:00-10:00	1 HR	25	
10:00-11:00	1 HR	25	Time intervals = 8 HR
11:00-12:00	1 HR	50	Total ppm = 400
12:00-1:00	1 HR	50	Time Weighted Average (TWA) = 400 ppm / 8 HR = 50 PPM/Hr
1:00-2:00	1 HR	50	
2:00-3:00	1 HR	50	
3:00-4:00	1 HR	50	

The current National Institute for Occupational Health and Safety (NIOSH) has determined that concentrations above the 1,200 ppm is “immediately dangerous to life and health” (IDLH). NIOSH defines the IDLH exposure level as the concentration that could result in irreversible health effects or death, or prevent escape from the contaminated environment within 30 minutes.



WARNING: Deployment of a monitor/detector is essential for the safe operation of any equipment that has the potential to produce carbon monoxide.

CO sensors/detectors became available on the mass market around 1978. The main differences between the technologies involved are battery or electric and Semiconductor or Biomimetic types. Detectors for carbon monoxide (CO) are manufactured and marketed for use in either the home or occupational industrial settings. The detectors for home use are devices that will sound an alarm before CO concentrations in the home become hazardous. There is an Underwriters Laboratories, Inc., performance standard (UL 2034) for residential CO detectors. Detectors currently available on the market are battery-powered, plug-in, or hardwired. Some models incorporate a visual display of the parts per million (ppm) concentration of CO present in the home. For more information on CO detectors for home use, call the Consumer Product Safety Commission:

Commission Hotline at 1-800-638-2772

CO detectors for use in residential settings are not designed for use in workplace settings. Monitoring requirements in an occupational setting are different from monitoring requirements in the home. In the workplace, it is frequently necessary to monitor a worker's exposure to carbon monoxide over an entire work shift and determine the time-weighted average (TWA) concentration of the exposure. It may also be necessary to have carbon monoxide monitors with alarm capabilities in the workplace. The direct reading instruments are frequently equipped with audio and/or visual alarms and may be used for area and/or personal exposure monitoring. Some have microprocessors and memory for storing CO concentration readings taken during the day. It is significant to note that some of the devices mentioned for workplace CO monitoring are not capable of monitoring TWAs, and not all are equipped with alarms. The appropriate monitor must be chosen on an application-by-application basis. For more information on the availability of workplace CO monitors or their application, call the National Institute for Occupational Safety and Health at 1-800-35-NIOSH (1-800-356-4674).

UNDERSTANDING FACTORS THAT DETERMINE CARBON MONOXIDE LEVELS

The primary factors that ultimately determine the expected level of Carbon Monoxide in a space where a propane machine is operating are as follows:

- Room air volume
- Air Exchange Rate (ventilation rate)
- Carbon Monoxide Production Rate

Room air volume can be determined by multiplying the length, width, and height of a room, and then reducing for any material in the room. For example:

A room that is 100 ft x 100 ft with a 10 ft ceiling has a volume of: $100 \times 100 \times 10 = 100,000$ cubic feet, when empty. If the room consists of 80% open air, and 20% material, the total room air volume = $100,000 \times 80\% = 80,000$ cubic feet.

UNDERSTANDING FACTORS THAT DETERMINE CARBON MONOXIDE LEVELS

Air Exchange Rate is a measure of the room's ventilation. Air exchange rate is typically measured in terms of the qty of air changes per hour (ACPH). In other words, the Air Exchange Rate when expressed as ACPH, measures the frequency (per hour) that the room's air is replaced by fresh air. The higher the ACPH, the more frequently air is being ventilated, for example:

In a room with ACPH = 6, the room's air would be completely extracted and replaced by fresh air 6 times every hour, or once every 10 minutes.

Here are some air exchange rates, expressed in ACPH, that would be expected in different types of industrial and commercial spaces:

Basement Parking	15-30	Restaurant Food Staging Area	10-12
Residential Basement	3-4	Restaurant Bar	15-20
Bedroom	5-6	Public Hallway	6-8
Residential Bathroom	6-7	Public Retail Store	6-10
Residential Living Rooms	6-8	Public Foyer	8-10
Residential Kitchen	7-8	Church	8-12
Residential Laundry	8-9	Public Auditorium	12-14
Business Offices	6-8	Commercial kitchens & Restrooms	15-30
Business Lunch Break Rooms	7-8	Smoking rooms	15-20
Business Conference Rooms	8-12	Laboratories	6-12
Business Copy Rooms	10-12	Classrooms	3-4
Computer Rooms	10-14	Warehousing	3-10
Restaurant Dining Area	8-10		

Carbon Monoxide Production Rate is, itself, the result of several factors:

- The total flow of engine exhaust, which is determined by the relative amount of engine load of application
- The amount of Carbon Monoxide present in the exhaust, expressed as PPM
- The quantity of propane engines in operation

A 603cc propane engine under normal operating conditions (50% of maximum load) will produce total exhaust at a rate of 13 CFM (cubic feet per minute), with Carbon Monoxide making up 50 PPM of the total exhaust.

Therefore, the CO production rate (in CFM) is calculated as follows:

$$\text{Qty of Engines} * \text{Exhaust Flow per Engine (CFM)} * \text{CO Level of Exhaust (PPM)}$$

Calculating the CO production rate of one 603cc engine operating under normal conditions is as follows:

$$1 \text{ engine} * 13 \text{ cubic ft / min per engine} * 50 / 1,000,000 = 0.00065 \text{ cubic feet/min}$$

Knowing all of these factors, we can calculate the equilibrium carbon monoxide level of a room (in PPM) as follows:

$$\frac{\text{Total CO production rate (in cubic feet / min)} * \text{Air Exchange Rate (expressed in minutes)}}{1,000,000 \text{ Room air volume (in cubic feet)}}$$

UNDERSTANDING FACTORS THAT DETERMINE CARBON MONOXIDE LEVELS

This table shows the calculated equilibrium carbon monoxide level under different examples with varying inputs:

Example No.	Qty of Engines	CO in Exhaust (PPM)	Exhaust Flow per Engine (CFM)	Total CO Production Rate (CFM)	Air Exchange Rate (ACPH)	Air Exchange Time (min)	Room Air Volume, ft ³	Room CO Level (PPM)
1	1	50	13	0.00065	3	20	80000	0.163
2	5	50	13	0.00325	3	20	80000	0.813
3	5	50	13	0.00325	3	20	80000	8.13
4	5	50	13	0.00325	1	60	80000	24.4
5	5	500	13	0.0325	1	60	80000	244

There are several important notes to take away from these calculations:

- More engines running in a space leads to higher room CO level. This is shown comparing Examples No. 1 & 2.
- Smaller room size leads to higher room CO level. This is shown comparing Examples No. 2 & 3.
- Lower ventilation (Air Exchange Rate) leads to higher room CO level. This is shown comparing Examples No. 3 & 4.
- Higher CO level in the exhaust leads to higher room CO level. This is shown comparing Examples No. 4 & 5.



DANGER: Operating this machine or any propane powered engine in a space with NO ventilation (a sealed space), is guaranteed to result in dangerously high level of CO, that will cause serious injury or death to the operator and bystanders. Never operate the machine in a sealed space with no ventilation.

METHODS TO REDUCE CARBON MONOXIDE EXPOSURE

Reviewing the above section, we already know that to reduce CO exposure the following action should be taken:

- Limit the quantity of engines running in a space.
- Insure adequate ventilation. Higher ventilation rates (higher air exchange rate) will always result in lower CO exposure.
- Insure proper maintenance and performance of engine to avoid high CO content in engine exhaust.
- All of these tips are especially important to follow when using the machine in small spaces.

METHODS TO REDUCE CARBON MONOXIDE EXPOSURE

This section offers additional considerations and best practices to reducing Carbon Monoxide exposure:

- Air Exchange and CO Diffusion
- Application Considerations
- Examples of CO Management in Spaces
- Maintenance of Equipment

AIR EXCHANGE AND CO DIFFUSION

The most reliable method to prevent CO Poisoning is to ensure all the CO produced is vented outside. With wood stoves or gas heaters this is performed with ductwork that carries the exhaust and CO outside. Non-stationary combustion type equipment must be used in such a way that CO is not allowed to rise to a harmful or dangerous level. CO does not readily dissipate or mix with air on its own. Air currents can “stir” the CO and dilute the concentration or ppm values by mixing it with the available air. When using equipment over a large area in a short time “stirring” occurs as you walk, or to say it another way, your Effective Operating Zone is large. When activity is concentrated to a smaller area as in a stripping application, the Effective Operating Zone is small, and “stirring” must be forced by the use of fans to increase the Effective Operating Zone and reduce high concentrations of CO. “Air” exchange rates (air exchange is defined as the exhausting of internal air to the external atmosphere), the size of the Effective Operating Zone, amount of CO produced, level of human activity, and the duration of exposure are all factors in the determination of the production of carboxyhemoglobin and the amount of CO blood saturation.

TYPE OF WORK CONSIDERATIONS

Different types of work (applications) present varying risk of CO exposure. The highest risk is associated with types of work that require slow movement, such as floor stripping or polishing. Due to slow movement, the activity and engine exhaust is concentrated to a relatively small area which results in higher CO levels for the operator. Types of work that require high movement, such as burnishing, will naturally stir the air and diffuse the engine exhaust and result in lower CO levels for the operator.

The term “Effective Operating Zone” is used to visualize this concept. The Effective Operating Zone can be defined by the amount of area covered during a given time frame. Small Effective Operating Zones result the greatest risk of CO Exposure.

When using equipment over a large area in a short time, as in most burnishing applications, your Effective Operating Zone is large. When activity is concentrated to a smaller area as in stripping applications, the Effective Operating Zone is small and stirring or CO mixing MUST be forced by the use of fans to increase the Effective Operating Zone and reduce high concentrations of CO. The Effective Operating Zone can be defined as the area covered in a given time.

TYPE OF WORK CONSIDERATIONS



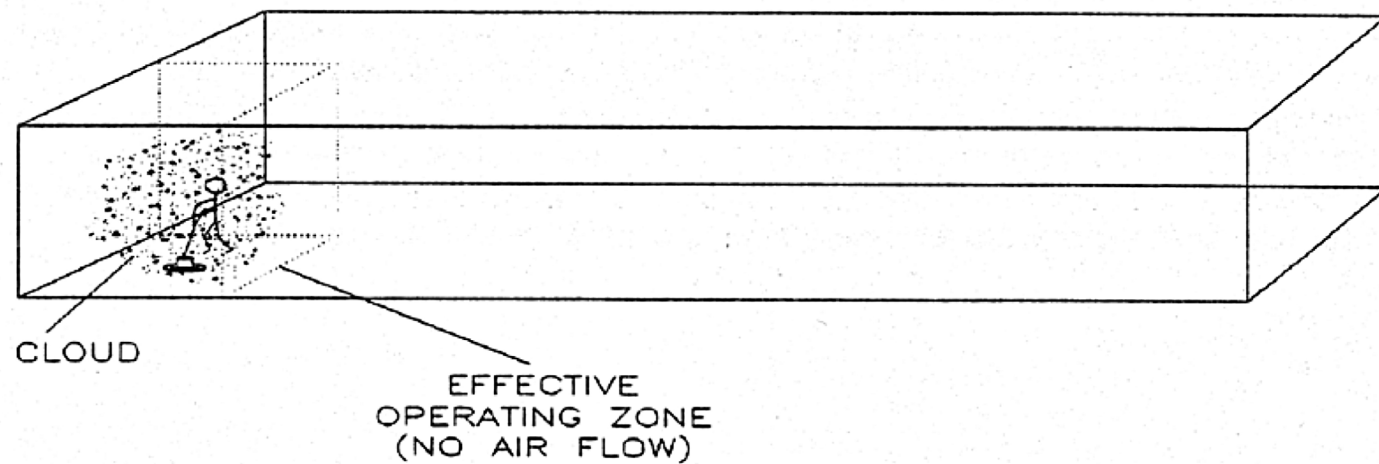
WARNING: When the Effective Operating Zone is small, fans must be used to force the mixing/stirring of air and reduce high concentrations of CO.



WARNING: Proper ventilation must be combined with air mixing/stirring to reduce CO to a safe level.

EXAMPLES OF CO MANAGEMENT IN SPACES

MODEL 1: Worst Case CO Management



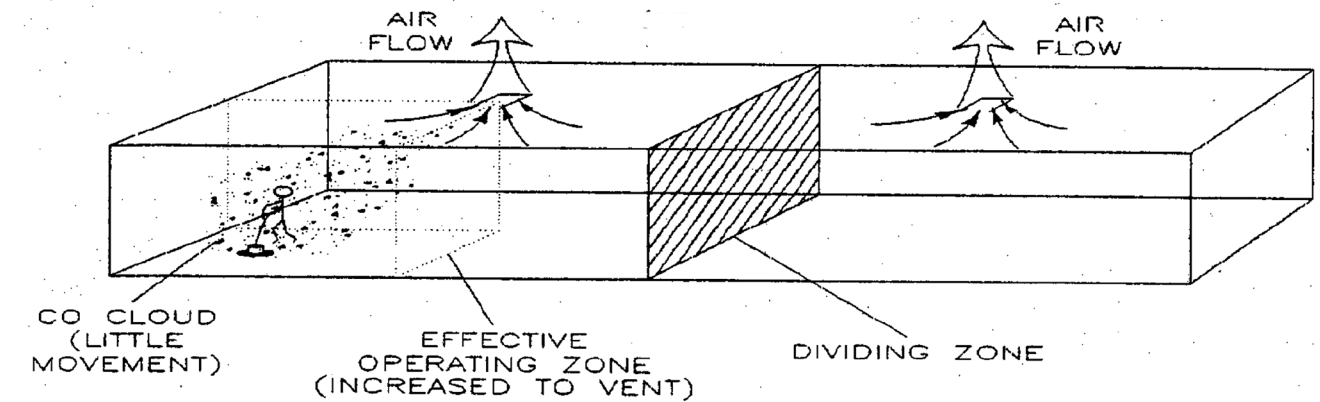
Model 1 illustrates the worst case of CO management for several reasons:

- The room is not properly ventilated
- The air in the room is not mixed/stirred with any fans
- The type of work shown (stripping) requires low speed movement and results in a smaller "Effective Operating Zone".

Note: Even though the room is large, due to these worst practices, the engine exhaust is concentrated near the operator, resulting in high CO exposure.

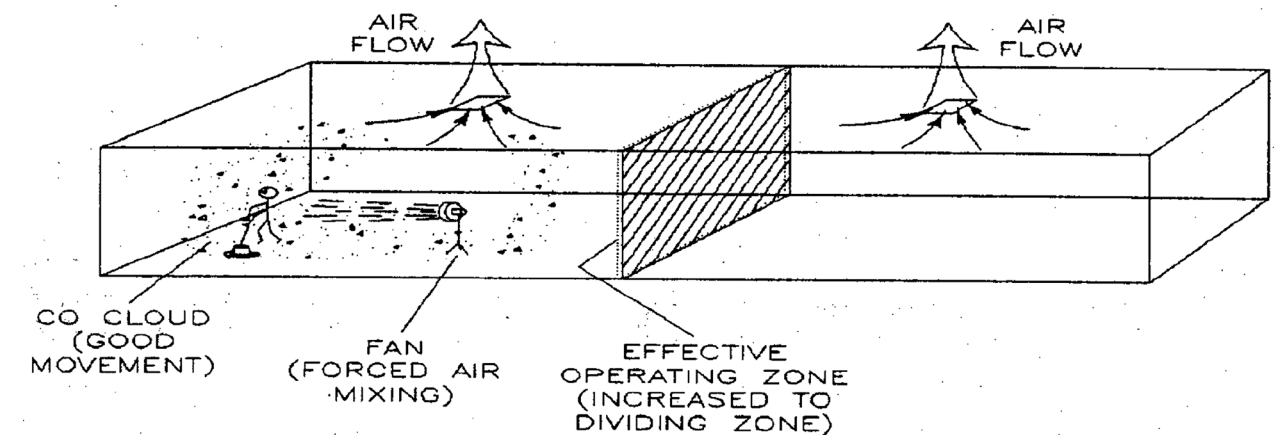
EXAMPLES OF CO MANAGEMENT IN SPACES

MODEL 2: Poor CO Management



Model 2 illustrates a slightly improved case of CO management, compared with Model 1, because air ventilation is introduced. As a result, the Effective Operating Zone is slightly increased and slightly lower levels of CO concentration would be expected. However, because air is not mixed/stirred, and because the type of work shown (stripping) requires low speed movement, there is still a potential risk of high CO exposure. The CO cloud is still concentrated in a small area. Note the "Dividing Zone" shown above, this is the line where airflow changes direction. Because all of the CO exists on one side of the dividing zone, only half of the room's ventilation is effectively evacuating CO.

MODEL 3: Better CO Management



Model 3 illustrates an even more improved case of CO management, compared with Model 2, because the air is being mixed/stirred with fan(s). Notice the CO concentration and the Effective Operating Zone (Expanded to the Dividing zone) due to the forced air mixing. The CO cloud is still concentrated on one side of the Dividing zone. As in Model 2, because all of the CO exists on one side of the dividing zone, only half of the room's ventilation is effectively evacuating CO.

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