

Safety Awareness Manual **Developed For** ***Eagle Solutions LLC.***

***This* Safety/Training manual has been developed to encourage safe working habits of those using engine-powered equipment fueled by propane gas. This includes not only floor care equipment manufactured by *Eagle Solutions LLC.* but may be generally applied to all machines employing propane gas including small generators, pressure washers, cement finishing power trowels etc., that are used inside buildings or enclosed spaces.**

Please be reminded, this manual is *not* designed to teach you how to maintain floors, but is designed to instruct you how to avoid incidents brought on by unsafe actions, poor maintenance, and the lack of accurate knowledge.

Copyright © 2000 *Sagacious Solutions, Inc.*

All rights reserved.

Reproduction or translation of any part of this work is beyond that permitted by section 107 or 108 of the 1976 United States Copyright Act without the permission of the copyright owner is unlawful. Requests for permission or further information should be addressed to the Permissions Department, *Sagacious Solutions, Inc.* PO Box 1963 Salisbury, NC. 28145

This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is provided with the understanding that the publisher is not engaged in rendering legal or other professional services.

Eagle Solutions LLC.

Safety Awareness Manual

TABLE OF CONTENTS

• Preface and copyright information	1
• Table of Contents	2
• Before We Begin...Important Points	3
• Introduction	4
• Supposed Hazards	5
• Real Hazards	5
Toxic Emissions	5
Fire Related Hazards	7
Mechanical Action and Hot Machine Parts	10
• Proper Storage and Transporting of Cylinders	9
• Propane Cylinders	11
• Properties of propane	13
• Conclusion	14
• Appendix	15
• Glossary	16

Before We Begin Please Consider These Important Points!

- The safety of yourself and those working around you is ***your*** responsibility!
- Only ***Authorized*** persons are allowed to operate propane powered machines.
- Read and understand the "***Operation Manual***" shipped with your machine. Make sure everyone operating the machines reads and understands the basic operation of your particular machine.
- Preventative maintenance (PM) is the responsibility of the operator.
- Regular maintenance by trained service technicians will insure long life and satisfactory performance from your propane-powered machine. It will also prevent serious injury to you and others.
- Never alter or adjust the fuel system or carburetion of a propane engine. A trained service technician using the proper emission testing equipment should only do it.



Figure 3.1
**PROPANE POWERED
FLOOR BURNISHER**



Figure 3.2
**PROPANE POWERED STRIPPING
MACHINE**

INTRODUCTION

The floor maintenance industry was changed dramatically when propane powered floor buffers were introduced in the late 1970s. The cost of labor to maintain safe, clean shiny floors was reduced by nearly 600% in some cases. This made it the system of choice for most of the industry.

There are some supposed, as well as some real, hazards in using this equipment. The purpose of this publication is to inform you of these and differentiate between the real and the supposed hazards. Accurate knowledge is the best protection against the real hazards and identifying the supposed hazards is important for your professional profile.

Real hazards are generally divided into three categories:

(This is the order of the frequency of reported incidents)

1. Toxic Emission Exposure
2. Fire Related Incidents
3. Mechanical action of moving and hot machine parts.

Toxic Emission Exposure:

The toxic constituents generated by propane exhaust are:

- Carbon monoxide (CO)
- Oxides of nitrogen (NOx)
- Hydrocarbons (HC)

Of these, Carbon monoxide is the most harmful. Over exposure causes carbon monoxide poisoning. Extreme cases may even result in brain damage. It is for this reason that responsible manufacturers have taken great effort and expense in researching ways to limit exposure to this substance.

Fire Related Incidents:

Fire related incidents, while being few, are serious. Nearly all incidents with fire are attributed to overfilled fuel cylinders, improper storage, and/or the lack of knowledge of the properties of propane gas.

Mechanical action of moving and hot machine parts.

- Contact with pad or pad holder while engine is running
- Contact with hot exhaust muffler or manifold
- Carelessly hitting objects like displays, thresholds etc. with machine
- Operating machines with broken or damaged parts

Preventive maintenance (PM) and safety awareness is the best safety measure for all hazards. PM is the responsibility of the operator.

PM includes:

- Checking and cleaning air filters regularly
- Carefully, and regularly checking and adjusting the oil level
- Keeping a log book for required regular service
- Checking fuel cylinders for overfill before taking them into the building
- Carefully checking the condition of the pad and pad-holder for wear and/or cracks
- Being assured that adequate ventilation is supplied in buildings while working
- Properly storing propane fuel cylinders and machines
- Generally being aware of changes in operation, noise, smell etc. while operating
- Reporting to management with any concerns of a safety nature

Supposed Hazards

Most supposed hazards result from poor information, myths, or outright false information from those who fear the loss of business from the use of more modern maintenance methods and equipment.

Some of these are printed below:

1. ***Floors buffed with propane powered machines are hazardous because of increased slipperiness caused by the smoothness of hi-shine.*** This of course has been proven untrue. Ultra-hi speed buffing increases slip resistance using approved floor finish.
2. ***Fumes from propane exhaust contaminate fresh food products in market displays.*** Not true. Fresh meat and other food products that could be contaminated by dust and/or fumes from any source is safely wrapped or packaged. Otherwise people walking through the market, coughing etc. would expose fresh items to contamination. Also some fruits and vegetables are deliberately exposed to some chemicals and/or gasses to speed up the ripening process or control insects.
3. ***Many States have laws making it illegal to use propane powered floor machines.*** Again, not true. All States have statutes regulating the use of propane gas. Most use NFPA 58 as their standard for these codes and/or laws. NFPA 58 includes standards for the construction and use of propane powered floor machines.
4. ***Propane powered floor machines cannot be used in large malls and education buildings.*** The truth of this myth is challenged by NFPA 58 8-4.5 which states "Floor maintenance machines shall be permitted to be used in buildings frequented by the public, including the times when such buildings are occupied by the public".

So you see these *supposed hazards* are nothing but myths or misunderstood and misapplied information.

Real hazards

For the purpose of accurate knowledge let's examine the *Real Hazards* and see how they can be avoided.

Toxic emissions

Excessive exposure to carbon monoxide is dangerous, foolish, and unnecessary. The symptoms of CO poisoning are similar to the flu. Headache, nausea, dizziness. Extreme exposure could result in loss of consciousness, brain damage and even death. This should not be taken lightly. Let me sight an example.

EXAMPLE #1:

An untrained operator was using a propane powered floor machine in a small shop. There was no ventilation and the owner wanted the doors kept shut and locked. By the time the job was completed the operator felt like he had the flu. (Headache, dizzy etc.). When he went outside to load his equipment he collapsed. The paramedics were called and he was hospitalized and treated for carbon monoxide poisoning. It is possible that brain damage may have resulted also.

The machine was impounded by the Sheriff's office and tested for the production of excessive CO. It was found to be producing over 50,000 PPM CO. Upon inspection it was noted the machine was very dirty & oily. The air filters looked like a bird's nest, plugged up with dust lint and oil. The physical appearance of the machine revealed that it was not being maintained in a professional manner. The operator had no training and had not ever seen the operation manual for the machine.

The resulting fine of \$7500 alerted the contractor to pay attention to proper maintenance and training of his workforce. The possible expensive legal problems resulting from this are even more frightening.

OSHA has set a **Permissible Exposure Level (PEL)** at 50 Parts per Million (PPM) over a time-weighted average of 8 hours and a ceiling of 200 PPM. This is generally safe for most industries with industrial trucks etc. But the environment we work in, such as supermarkets malls schools etc., where the public may be present, calls for a different standard. We should rather be concerned with how much CO the machine we are operating is producing, because many of the places we run these machines are small and have little ventilation. It has been recommended that any machine producing in excess of 1500 PPM CO *sampled in the tail pipe* should be taken out of service immediately.

Most propane engines, without emission controlling systems, can run consistently below 750 to 950 PPM CO. With the addition of catalytic mufflers many record 0 to 10 PPM.

The **one thing** that determines the production of toxic emissions is the *air-fuel ratio* of the fuel system. If adjusted correctly it minimizes the production of CO. This is the reason it is recommended that *only trained service technicians adjust the fuel system!* And that they use proper instruments to detect the amount of CO in the exhaust. This should be checked regularly, at least every 3 months.

The air fuel ratio will be effected if the air filters are dirty or oily. This restricts the volume of air mixed with the propane and increases the production of toxic emissions. The operator is responsible to check & correct dirty air filters every time he uses the machine. It is a good practice to look after this when the work shift is concluded. This, as well as generally cleaning the exterior of the machine.

Something that has been overlooked by many is the effect overfilling the oil has on the production of harmful emissions. When the oil level is to high, the vacuum effect of the engine over the oil pan pulls oil vapor off the oil and distributes it on the carburetor air filter. This in turn collects dust and restricts the free flow of air to the fuel mixture. In turn it increases the production of CO. Operators should faithfully check the oil level and keep it at the recommended level. This also is the reason it is suggested that a machine should not be left idling while tilted back for more that a few minutes.

When checking the oil level be aware that different engine manufacturers have different instructions for checking the oil level. Some instruct to unscrew the dipstick, wipe it off and reinsert it without screwing it in. Then extracting it to read the level. Others instruct the dipstick to be screwed in before reading the level. Because of the importance of maintaining the correct level you can see why you should consult the operation manual for your engine for the correct information. At all times the machine should be setting level on the floor when checking the oil.

Keep in mind that carbon monoxide has no odor at all. Generally the slight odor you experience while operating is hydrocarbons or perhaps oil smoke from a worn engine. If the odor seems to be stronger than before the machine should be checked by a service technician to insure that it is safe.

Occasionally an untrained operator will turn the machine over on the carburetor side to change the buffing pad. This may allow oil to drain into the carburetor and/or the air filter. The result will be oil smoke and increased toxic emissions when the engine is restarted. Always tip the machine over, if necessary, with the carburetor on the topside.

Some manufacturers have developed machines with sensing devices that either control or monitor the emissions. Many of these use catalytic mufflers to burn off some of the toxic emissions. Some even shut the engine down if set limits are exceeded. These devices have reduced, but not eliminated incidents associated with the production of harmful emissions. If your machine has this advantage do not try to circumvent it by disconnecting it as some has done. If it gives you a warning of high emissions pay attention to it. First check the air cleaners to see if dust or oil has contaminated them. If that is not the case have the machine checked by a service technician. Do not continue to operate the machine!

Keep in mind that engines using catalytic mufflers and electronic emission controls have no ability to reduce the toxic emissions when they are first started. Most of these machines use an oxygen sensor to detect excess emissions. The oxygen sensor, as well as the catalytic muffler, needs a few minutes running time, (approximately 12 to 15 minutes), to heat up enough to be effective. So when preparing to operate machines equipped in this manner in a small store, or in a large market where a census of the public is present it is suggested the engine be started **outside** and allowed to warm up before bringing it inside. It is not considered dangerous, but being considerate of others is always a good practice.

Fire Related Hazards

As was mentioned earlier, nearly all fire related incidents are the result of overfilled fuel cylinders or improper storage of cylinders and machines.

The Federal Department of Transportation (DOT) has set regulations, included in the National Fire Protection Association's (NFPA) standards for the design, construction, marking and use of propane fuel cylinders. Included in these standards are the proper filling procedures and the propane capacity of each cylinder. This capacity is approximately 80% of the liquid capacity. The 20% not filled is for the expansion of the liquefied propane as temperatures increases. This also is the space in which vapor is generated for use as fuel for the vapor draw engines used on floor maintenance machines.

The fuel cylinder is equipped with a "*Fixed Liquid Level Gauge*" (see fig 8.1) that can be used to determine if the cylinder is overfilled. This is a valve, with a small knurled knob on top, it is connected to a "dip tube" extending down into the cylinder about 4 inches, or 20% of the liquid volume. When opened the vapor is hardly visible if properly filled. If the vapor is a white cloud spewing out, the level of the liquefied propane is above the lower end of the dip-tube and liquid propane is being exhausted.

Always check this outside the building in a safe area where no source of ignition is present. That also means NO SMOKING! If the cylinder is overfilled allow the vapor to exhaust until the white cloud turns to invisible vapor before taking it inside the building



Figure 8.1 Fixed liquid level gauge. Marking on disk reads, "STOP FILLING WHEN LIQUID APPEARS" (Photo courtesy of Engineered Controls, Inc.)

If liquid propane is drawn into the regulator of the fuel system it will first of all frost up the regulator and possible damage will result to the diaphragm of the regulator. Excessive emissions will also result from the rich mixture of fuel. This would never be the case if the cylinder is checked for overfill before bringing it into the building or attaching it to the machine.

Liquefied propane gas is concentrated, or liquefied, by pressure. It is not flammable in this state. (the air-fuel ratio for flammable propane gas is between 2 and 10 %). If the pressure is released one cubic foot of liquid propane will expand to 270 cubic feet of flammable vapor, so it is plain to see that fire from overfilled fuel cylinders, is 270 times likely to cause serious damage. Lets look at another example.

EXAMPLE #2:

An operator had a fuel cylinder filled as a spare before going to the jobsight. It was left in his van while he stripped a floor in a large supermarket. After the strip job was complete and the buffing started the operator needed the spare fuel cylinder. He went outside to get the extra cylinder and at the same time he opened the door to the van he lit his cigarette. The fuel cylinder in the van had been overfilled and while setting in the van in the hot sun the propane expanded to the point the pressure relief valve vented liquid propane inside the van. It quickly vaporized into flammable vapor. When the door was opened the propane gas ignited, either from his cigarette or the light in the van, and badly burned the operator. It continued to burn from the pressure relief valve and other flammable items in the van. The excessive heat continued to expand the liquefied propane gas in the cylinder faster than the pressure relief valve could vent it. The cylinder exploded sending the top of the cylinder through the top of the van, coming down nearly 200 feet from the van. Needless to say the van was a loss. The only one hurt was the operator. Checking the fuel cylinder for overfill and venting it properly and being aware of the properties of propane and the need for proper storage could have prevented it all. That calls attention to the need to understand an additional precaution.

Let me add an additional caution!

In some areas the propane supplier, or vendor, may offer an “exchange service” where they set up a security storage cage/rack and exchange filled cylinders for empty ones, or fill them on sight from a delivery truck. *If you subscribe to that type service be very careful to:*

- 1. Make sure the vendor installs a VERTICAL cylinder rack for vertical cylinders.**
- 2. Check each cylinder for over fill.**
- 3. Check each exchanged cylinder to be assured it is a VAPOR DRAW cylinder.**
- 4. Check the manufacturing date on the collar to be assured it has not passed its re-certification date (12 years).**

Proper Storage and Transporting of Fuel Cylinders.

Even properly filled fuel cylinders can add to the intensity of a fire originating from a different source. It has been observed that some machines have been stored in the back room of supermarkets with the fuel cylinder attached, some with the service valve open. In one case the machine was parked under an electrical service panel in the boiler room. It does not take much of an imagination to guess what the result would be if a small leak occurred and after a buildup of propane vapor in the room the boiler started or a switch sparked. This would not necessarily be the fault of an overfilled cylinder but would be the responsibility of the operator to understand and obey standards set for safety.

NFPA 58 Chapter 5 addresses the storage of portable containers. This standard says, "Containers in storage shall be located to minimize exposure to excessive temperature rise, physical damage, or tampering".

NFPA 58 5-3 details what is allowed to be store in buildings frequented by the public. NOTE: Only cylinders with a maximum LP-Gas capacity of no more than 16.8 OUNCES shall be permitted to be stored or displayed in buildings frequented by the public.

Cylinders used on propane powered floor machines are 20 POUND capacity cylinders so are not allowed to be stored in buildings frequented by the public. In addition the standard, (**NFPA 58 5-4.2.1 (b)**), says "Containers shall be protected by a lockable ventilated metal locker or rack that prevents tampering with valves and pilfering of the cylinder". The standard also includes the distance from any doorway or opening in the building "shall be at least 5 ft."

When transporting fuel cylinders it is recommended that the service valve is closed and the cylinders are firmly secured in the vehicle. If installed on a floor maintenance machine the machine its self should be firmly secured. A fuel cylinder rolling around in the back of a pickup, trailer or van is a candidate for disaster.

Even before loading fuel cylinders that have been recently filled into your vehicle it is the course of wisdom to check the cylinder for overfill. A case in point is the following example.

EXAMPLE #3:

Several cylinders had been received from a propane supplier after filling. The cylinders were to be distributed to stores by a janitorial supply distributor. After setting in the hot sun outside the warehouse they were loaded into a pickup for delivery. One cylinder started to vent propane gas from the pressure relief valve. The driver jumped up into the

pickup and opened the fixed liquid level gauge to vent the excess pressure caused by overfilling. He then realized the cylinders were all overfilled so he opened the fixed liquid level gauges on the remaining ones. A spark ignited the gas combined from all the cylinders and the heat from the venting gas raised the pressure in the cylinders until the pressure relief valves on all the cylinders opened. The heat from the additional fuel raised the pressure in the cylinders faster than the relief valves could relieve it. This resulted in an explosion of most of the cylinders, destroying the vehicle and damaging the building as well as badly burning the driver. A hard way to learn a lesson. Cooling the cylinders down with a water hose may have changed the accident to an incident with a different ending.

By the way, the fuel cylinders that did not explode were equipped with Overfilling Prevention Devices (OPD) and were not overfilled.

Mechanical Action of Moving and hot Machine Parts

To some it may seem foolish to consider the danger of mechanical action of moving and hot machine parts. But how many stories have you heard of farmers reaching in to tighten a loose and rattling bolt on a radiator of an old tractor while the engine is running and losing his fingers to the rotating fan blades. The same danger is true of any moving machinery, even floor maintenance machines. Unawareness of the hazards is the cause of many accidents.

Some may feel that the protection of a clutch mounted on a floor machine is an unnecessary expense and does not contribute to the safety of operation.

Please note that **NFPA 58 8-4** is the standard for "General Provisions for Vehicles Having Engines Mounted on Them (Including Floor Maintenance Machines)."

NFPA 58 8-4.4 says " Non-self-propelled floor maintenance machinery (floor polishers, scrubbers, buffers) and other similar equipment shall be **listed** and shall comply with the following..." The term "*listed*" is defined as being listed by an organization like Underwriters Laboratories (UL.) etc. stating that it meets appropriate standards for safety.

The UL standard for inspection (UL558), requires that the machine be equipped with a clutch. So if the machine does not have a clutch it cannot be UL listed and does not pass the standard of NFPA. **How does a clutch contribute to safety?**

UL uses a term we would like to avoid, "**Dead-Man switch**", which is a means of stopping the action of the machine in case the operator "drops dead" or loses control of the machine. If the machine would keep on rotating after the operator let loose of the handle it could do damage to others or cause related damage, even fire or disaster to the building and persons in the building. The clutch is the "dead-man switch" that prevents this from happening. Please note the following example:

EXAMPLE #4:

An employee of a supermarket was buffing a floor in a very confined area with a non-UL machine, (no clutch). He was overcome with carbon monoxide from the exhaust of the engine that was not properly adjusted. Collapsing, he fell over the machine. The

increased weight caused the pad to melt the floor tile from heat generated by the rotating pad. The hot muffler burned the operator. Also he came in contact with the pad rotating at 2000 RPM and received severe burns on his arms. He was hospitalized and treated for CO poisoning and burns. (**The exhaust manifold can reach temperatures exceeding 800 degrees**). No need to experience this to realize why a UL listed machine requiring a clutch is recommended.

A pad rotating at 2000 + RPM may create additional hazards in some cases. If the pad holder is not inspected regularly small cracks, from the stress of the rotation or from hitting thresholds or other objects, may break away and throw sharp pieces at ankle level at tremendous speeds. If hitting a person it could do untold damage to them. If hitting a window or other objects that also could be costly. **Each time you change pads carefully check the pad holder and belt to be assured of safe operation!** When cleaning the machine after the job is complete is a good time for this inspection.

PROPANE CYLINDERS



Figure 11.1
DOT 4E240 propane fuel
cylinder. (Photo courtesy of
Manchester Tank Company.)

The 20-lb. cylinders used on propane powered floor maintenance machines is classified as a DOT 4E240 cylinder. This cylinder is generally aluminum, but could be steel. Aluminum cylinders are supplied with new machines. They are lighter and do not rust.

The service pressure the cylinder is designed for is 240 psi. although the pressure in the cylinder at 70 degrees F. is approximately 130 psi. As the temperature increases the pressure also increases. The pressure relief valve in the top of the cylinder is set to start relieving the pressure when it reaches 300 psi. This pressure could be reached if the cylinder was exposed to high temperature or was overfilled. Obviously this would seldom occur.

In the event that the pressure relief valve started to vent it is necessary to cool the cylinder as quickly as possible using water or a fire extinguisher on the body of the cylinder. **If the propane vapor from the pressure relief valve should ignite do not**

attempt to extinguish the flame! It is consuming the propane gas as it is relieved. Instead play the fire extinguisher or water hose on the cylinder to cool it down and lower the pressure in the cylinder. The relief valve will close and the fire will go out. Please note the following experience:

Experience # 5:

An operator was buffing a floor in a large mall when the pressure relief valve started to hiss and allow gas to escape from an overfilled fuel cylinder. He stopped the engine and closed the service valve and took the machine with the cylinder attached to the service entrance of the mall trying to get the machine outside. At some point the gas vapor was ignited and fire flashed throughout the mall and flames were coming from the pressure relief valve like a blowtorch. He and a security guard extinguished the flame from the pressure relief valve with a fire extinguisher and got the machine outside luckily without it re-igniting. If the extinguisher had been played on the cylinder to cool it down the pressure relief valve would have closed and the fire would have been extinguished. Better than that, if the operator had checked the cylinder for overfill before bringing into the building and vented it properly none of this would have happened. The operator was badly burned from the flash fire.

It was mentioned earlier that some fuel cylinders have exploded. That is true but seldom happens. It is possible to heat a propane cylinder up and increase the pressure faster than the pressure relief valve can relieve it. This generally is the case if the cylinder is overfilled and room for expansion is not available. Note this experience:

Experience # 6:

A school building caught fire and burned several classrooms as well as a storage room in which paper goods were stored along with a propane floor maintenance machine with a fuel cylinder attached. This was the room where the fire originated. It was discovered that the fire was started by an electrical short in a light fixture and ignited the paper products. When the heat in the room was great enough to increase the pressure in the fuel cylinder, which had just been filled, to 300-psi. the pressure relief valve opened and started to relieve the pressure. It obviously ignited and added to the intensity of the fire.

On inspection, after the fire was put out and everything cooled down, it was found that the fuel cylinder vented successfully and did not explode. Instead it melted down in puddle of aluminum, as did the aluminum deck of the machine. This cylinder was not overfilled!



Figure 12.1
Melted machine deck after fire in school building



Figure 12.2
Melted propane fuel cylinder after fire in school building

But please note, **THE FUEL CYLINDER SHOULD NEVER HAVE BEEN STORED ON THE MACHINE!** It should have been outside in a storage cage. I am sure the damage done to the school building was greater because of the propane fire.

In the example on page 9, involving several fuel cylinders exploding, it was mentioned that those with overfilling prevention devices (OPD) did not explode. These are devices that prevent the fuel cylinder from being filled beyond 80%.

NFPA 58 2-3.1.5 (c) stated that after April 1, 2002, no cylinder shall be filled unless it is equipped with an OPD. This however does not apply to floor maintenance machines at this time. It should be noted that DOT E240 fuel cylinders equipped with OPD are available for propane powered floor maintenance machines from cylinder manufacturers. Sometime in the future it is expected that they will be required on floor maintenance machines because of the obvious protection it provides.

PROPERTIES OF PROPANE

- Propane is a clean burning, efficient fuel. Because of its physical makeup it burns cleaner than gasoline and thereby generates less harmful emissions. That is why it is used on engines used indoors and in enclosed spaces.
- It is unique because it is a gas at atmospheric pressure and a liquid when stored under pressure.
- When released to atmospheric pressure 1 cubic foot of liquefied propane will expand to 270 cubic feet of flammable vapor.
- The small HP Propane engines used on floor maintenance machines run on propane vapor. The cylinders used are "vapor draw" cylinders.
- Propane gas is heavier than air, approximately 1.5 times the specific gravity of air. Knowing this we understand that if propane leaks from the fuel system or cylinder it will lay close to the floor and seek low places like under doors etc.
- Propane has no natural odor. The odor, *ethyl mercaptan*, is added for safety to enable most people to recognize its presence.
- Liquefied propane has a boiling point of -44 degrees F. If venting propane from the fixed liquid level gauge be aware that the plume of gas can frostbite your flesh.
- The limits of flammability, (air-fuel ratio) of propane is between 2 and 10%.
- The ignition temperature, (exhaust temp), is 920 to 1,120 degrees F.

Understanding the properties of propane will assist you in avoiding incidents that may be harmful, hurtful and expensive. For example:

1. Knowing that liquefied propane will expand 270 times to flammable vapor emphasizes the need to avoid the release of liquefied propane and the danger of using overfilled the cylinders.
2. Knowing that propane is heavier than air reminds us that propane leaks will seek and spread in low places like under doors where it may be ignited and cause damage.
3. Knowing the cylinders approved by DOT are 4E240 are the only cylinders safe for use on propane powered floor machines prevents us from using cylinders designed for other services like barbecues etc.
4. Knowing the boiling point of propane helps us prevent personal damage from frostbite.
5. Knowing the temperature of the exhaust reminds us that the hot exhaust gases can not only burn the operator but also can cause damage to inventory in the markets we work in. Damaged plastic clad products or garments can be an expensive reminder.
6. Knowing that in case of a fire keeping the fuel cylinder cold with an extinguisher or hose may prevent a serious fire related incident.
7. Knowing that fuel cylinders should be stored outside of the building in the vertical position may protect you from expensive litigation resulting from fire damage even if it was not caused by your fuel cylinder.
8. Knowing how to test a fuel cylinder for overfill and knowing how to correct it will prevent most fire related incidents.
9. Being able to recognize the symptoms of carbon monoxide poisoning may prevent harm to yourself and/or others
10. Knowing the value of preventive maintenance (PM) in preventing incidents is of great value.

CONCLUSION

It is the intent of the author of this document that by your reading and meditating on the information contained in this manual you will be better informed and able to perform your duties of operating propane powered floor maintenance machines in a professional and responsible manner. And that you actively promote safety in the industry of floor maintenance.

Appendix

Index to examples

Note: The author investigated all of these examples personally, information Regarding them is considered matters of public record and does not infringe on anyone's privacy.

Example #1	Carbon monoxide poisoning	5
Example #2	Overfilled cylinder exploding in a Van	8
Example #3	Overfilled cylinders in pickup burning	9
Example #4	Worker overcome with carbon monoxide getting burns	10
Example #5	Overfilled cylinder venting in a mall	12
Example #6	Fire in School building	12

Index to Figures

Figure 3.1	Propane powered floor burnisher	3
Figure 3.2	Propane powered stripping machine	3
Figure 8.1	Fixed Liquid Level Gauge	8
Figure 11.1	DOT 4E240 propane fuel cylinder	11
Figure 12.1	Melted machine deck after fire	12
Figure 12.2	Melted fuel cylinder after fire	12

GLOSSARY

OSHA:

Occupational Health and Safety Administration is a federal agency responsible for workplace safety. It has the authority to set and enforce standards, which is recorded in the Federal Register.

EPA:

Environmental Protection Agency is a federal agency charged with the responsibility of enforcing the federal clean air act. Generally this is air in the outdoor environment.

Outdoor Air Quality:

The quality of air outside of buildings and/or enclosures. Contaminants may be from smoke, industrial pollutants, chemicals, smog, exhaust from internal combustion engines etc.

Indoor Air Quality:

The quality of air inside buildings or enclosures. Contaminants may be from chemicals, engine exhaust, gasses, etc.

Ambient Air:

The air surrounding, or in the breathing zone of the operator or others.

EXAMPLE: the air in a building or enclosure surrounding operators of propane powered floor machines while buffing the floor.

Exhaust Emissions:

Total of all gases exhausted from internal combustion engines while running. 5.5% of emissions from gasoline engines are toxic.

- Oxides of Nitrogen (NOx)
- Hydrocarbons (HC)
- Carbon Monoxide (CO)

Toxic emissions from propane fueled engines is considerably less than that from gasoline fueled engines.

NOx. (Oxides of Nitrogen):

Forms acid smog, which irritates the respiratory system and can cause lung tissue damage.

OSHA PEL is 25-PPM TWA 8 hr.

HC. (Hydrocarbons):

Cause some irritation to mucous membranes. Some may be carcinogenic. Some add to the smog with NOx. in sunlight which can irritate the eyes and respiratory tract.

CO. (Carbon Monoxide)

A colorless, odorless toxic gas. Its effect on the human body is that it replaces oxygen in the blood

stream and causes asphyxiation and in extreme cases even death. The symptoms of CO poisoning are headache, dizziness, nausea, and loss of consciousness. OSHA PEL is 50-PPM TWA 8 hr. with a ceiling of 200-PPM.

OSHA PEL: (Permissible Exposure Limit)

Permissible limit of exposure of workers to hazardous substances set by the Federal Occupational Safety and Health Act. (These limits are found in Table Z-1 of CFR 1910)

TWA (Time Weighted Average):

The average exposure during a continuous 8-hour period to hazardous substances listed in Table Z-1 of CFR 1910)

EXAMPLE: OSHA's TWA for carbon monoxide is 50-PPM for 8 continuous hours. The air sample is to be taken from the *breathing zone* of the employee.

Air Fuel Ratio:

The percent of fuel combined with air to make a combustible gas. (The limits of combustion of propane are from 2 to 10 % propane) If the air fuel ratio is "rich" the resulting exhaust emissions will be higher in toxic gases.

Catalytic Converter:

Converts, or burns off, some of the toxic gases generated by the engine exhaust. Most generally the catalyst is include in the muffler. To be effective it must be able to address all three of the toxic constituents in the exhaust.

NOTE: the catalyst must have time to get hot and start the burning process before it is effective.

Oxygen Sensor:

An electronic sensor designed to react to the % of oxygen. This sensor is placed in the exhaust path and generates an electrochemical signal indicating the percent of oxygen in the exhaust. In propane fueled engines these sensors are used to monitor, or control emissions generated from combustion. This, like the catalytic converter, needs time to heat up before the signal is accurate.

ECU: Electronic Control Module:

A module consisting of electronic components that translates the signals from the oxygen sensor allowing it to monitor or control the toxic emissions.

CFR. Code of Federal Regulations:

Codes and standards set as regulations for general industry and workplace safety. OSHA has the authority to enforce these regulations and impose fines for violations.