

## Indoor use of propane-powered forklifts



Propane-powered forklifts are a common sight in many industrial operations and warehouses. It is a common belief that propane is a clean burning fuel and that propane-powered equipment is safe. Certainly, when maintained properly, propane-powered forklifts offer many advantages over gasoline or diesel-powered equipment. However, toxic gases produced by propane-powered forklifts can be dangerous – if not controlled properly.

Propane engines, like every internal combustion engine, emit combustion products from the exhaust. Some toxic products, such as carbon monoxide (CO) and oxides of nitrogen, can be generated in such quantities as to pose a health hazard to workers. This is particularly important indoors and in confined spaces, where little or no ventilation is present.

### Emissions from propane-powered engines

In theory, complete combustion of propane will produce carbon dioxide and water vapour. However, this is not always the case. The combustion products of concern are the carbon monoxide and oxides of nitrogen.

Carbon monoxide is a colourless, odorless and very toxic gas. Depending on the equipment and the operating environment, CO levels can rapidly rise and reach dangerous levels. A CO rich environment can lead to headaches, lethargy, dizziness, loss of consciousness, and even death. The range of CO in the tail pipe of a propane-powered engine should be 2,000 – 20,000 parts per million (ppm). CO has less density than air. Therefore, it tends to stay where it is generated – until it is removed by ventilation.

Oxides of nitrogen are formed inside the engine by the combination of atmospheric nitrogen and oxygen. Propane-powered engine exhaust may contain varying amounts (250 – 2,000 ppm) of these corrosive gases. Immediate effects of exposure include eyes, nose and throat irritation. Effects may also be felt several hours after the exposure and can cause a build-up of fluids in the lungs.

### Occupational exposure limits

There are permissible limits for airborne CO, nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) in the work environment. The New Brunswick legislation is based on the 1997 limits set out by the American Conference of Governmental Industrial Hygienists (ACGIH).

Occupational exposure limits	CO	NO	NO <sub>2</sub>
8-hour exposure limit	25 ppm	25 ppm	3 ppm
Short-term (15 min) exposure limit			5 ppm

**8-hour exposure limits** – The average airborne concentrations to which workers may be exposed to during an eight-hour shift.

**Short-term exposure limits** – Limits to which workers may be exposed for up to four 15-minute periods, with at least a one-hour interval between each period. Where there is no short-term limit set, a good way to determine a safe short-term exposure limit is to multiply the eight-hour exposure limit by three. For example, the limit for short-term exposure to CO would be 25 ppm x 3, so 75 ppm.

### Measures to reduce emissions

- **Use of low emission equipment.** When possible, preference should be given to low-emission equipment. Your equipment supplier should provide you with information regarding the type of emission control devices installed and on the tail pipe emissions. Factory-installed emission control devices are more advantageous than trying to retrofit machines after the purchase.
- **Regular and proper maintenance of equipment.** This is a key measure. A regular maintenance program with analysis of tail pipe emissions (in particular the CO content) should be in place. When tuning an engine, a compromise between the optimum performance and the minimal emissions needs to be reached. In most engines, the CO level in the tail pipe can be kept below 5,000 ppm by good engine tune-up. Following a tune-up and after reaching a steady working pace, the area around the forklift must be checked to ensure that exposure standards are maintained.
- **Installation of after-treatment devices.** These devices are usually catalytic converters. The catalyst converts the CO and unburnt hydrocarbons into carbon dioxide and water vapour. They require regular maintenance, as excessive loading of catalyst can reduce its efficiency. The combination of a catalytic converter and a properly tuned engine can bring tail pipe emissions of CO below 100 ppm.
- **Ventilation of work area.** Internal combustion engines require air for the combustion of fuel. This air is aspirated into the engine from the surrounding area. As a guideline, a 60 horsepower forklift requires 5,000 cubic feet/minute (cfm) of

ventilation-air in order to operate properly. Catalytic converters reduce the amount of ventilation-air required.

- **Proper work practice.** The emissions from propane-powered engines are higher when the engine is cold. Thus, it is recommended to warm up the engine outdoors before operating the unit indoors.

### Air-quality monitoring

Periodic air monitoring is important to ensure that propane-powered forklifts are operated and maintained properly, and to minimize hazards to the health and safety of workers.

- Air-monitoring equipment for CO and NO are required for the evaluation of work environments.
- Measuring instruments are available in many forms, from sophisticated electronic instruments to manually operated aspirator pumps.
- Safety equipment distributors should be able to provide you with the type of monitoring devices most appropriate for your workplace.



For more information, contact  
**WHSCC Prevention Services at**  
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