



Indoor use of PROPANE-POWERED FORKLIFTS



Propane-powered forklifts are common in many industrial operations and warehouses. There's a widespread belief that propane is a clean burning fuel and that propane-powered equipment is safe. Although propane-powered forklifts offer many advantages over gasoline or diesel-powered equipment, they can produce dangerous toxins if not properly maintained and controlled.

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

EMISSIONS FROM PROPANE-POWERED ENGINES

In theory, complete combustion of propane will produce carbon dioxide (CO₂) and water vapour. However, this is not always the case, particularly with carbon monoxide and oxides of nitrogen.

Carbon monoxide is colourless, odourless and tasteless, yet very toxic. 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 tailpipe of a propane-powered engine can be 2,000-20,000 parts per million (ppm). CO is slightly lighter than air and therefore tends to follow air currents, vehicles and people in the workplace until it is removed by ventilation.

Nitrogen oxides are formed inside the engine by the combination of nitrogen and oxygen. Propane-powered engine exhaust can contain varying amounts (250-2,000 ppm) of these corrosive gases. Depending on the individual, the concentration of contaminants and the duration of exposure, immediate effects may include eye, 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 (NO₂) in the work environment. New Brunswick legislation references the 1997 Threshold Limit Values set out by the American Conference of Governmental Industrial Hygienists (ACGIH). These are:

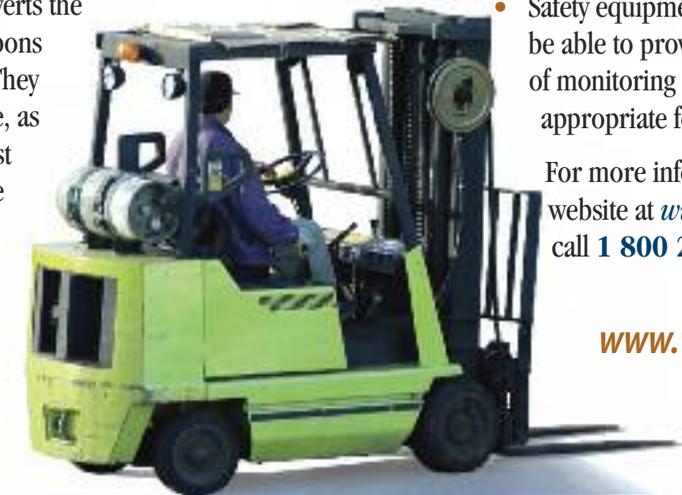
Occupational exposure limits	CO	NO	NO ₂
8-hour exposure limit	25 ppm	25 ppm	3 ppm
Short-term (15 min) exposure limit			5 ppm

8-hour exposure limits – The average airborne concentrations to which it is believed workers may be repeatedly exposed without adverse effect during an eight-hour shift and 40-hour workweek, day after day.

Short-term exposure limits – Limits to which workers may be exposed up to four 15-minute periods in an eight-hour workday, 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, or 75 ppm.

MEASURES TO REDUCE EMISSIONS:

- **Use of low-emission equipment.** When possible, try to use low-emission equipment. Your equipment supplier should provide you with information regarding the type of emission control devices installed, and on the tailpipe 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. You should have in place a regular maintenance program that includes analysis of tailpipe emissions (particularly the CO content). 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 tailpipe can be kept below 5,000 ppm by a good engine tune-up. Following a tune-up and after reaching a steady working pace, check the area around the forklift to ensure exposure standards are maintained.
- **Installation of after-treatment devices.** These devices are usually catalytic converters. The catalyst converts the CO and unburned hydrocarbons into CO₂ and water vapour. They require regular maintenance, as excessive loading of a catalyst can reduce its efficiency. The combination of a catalytic converter and a properly tuned engine can bring tailpipe emissions of CO below 100 ppm.



- **Ventilation of work area.** Internal combustion engines require air for fuel combustion. 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 for proper operation. Catalytic converters reduce the amount of ventilation-air required.
- **Proper work practice.** Since emissions from propane-powered engines are higher when the engine is cold, you should warm up the engine outdoors before operating the unit indoors.

AIR-QUALITY MONITORING

Periodic air monitoring is important to ensure propane-powered forklifts are operated and maintained properly, and to minimize hazards to a worker's health and safety.

- Air-monitoring equipment for CO and NO are required for evaluating 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, visit our website at www.worksafenb.ca or call 1 800 222-9775.

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