

## Introduction

Fumigants are widely used for pest control by sterilizing soil before planting, and during storage and shipment of foods and other plant-derived materials such as wooden furniture and wood chips. Many seaports now require fumigation before wood-containing products can be released for overland shipment. Common fumigants include Phosphine (PH<sub>3</sub>), Methyl Bromide (CH<sub>3</sub>Br or MeBr) and Vikane (Sulfuryl Fluoride, SO<sub>2</sub>F<sub>2</sub>).

Phosphine is the most common fumigant, while Methyl Bromide is being phased out due to its ozone-depletion effects. But Methyl Bromide (MeBr) is also used as a pharmaceutical intermediate and will still be used for some time as a fumigant. Methyl Bromide and Phosphine have low exposure limits, with 8-hr ACGIH TWAs of 1 ppm and 0.3 ppm, respectively (see Table below). Typically, it is desired to measure high initial concentrations of several hundred ppm to ensure an adequate fumigation dose, followed by low concentrations after ventilation to prevent over-exposure of workers entering to load the goods. Fumigation during ship transport is done at lower concentrations but can last for weeks, and the crew's living quarters need to be monitored in case some fumigant leaks over from the vessel holds.

## Fumigant Toxicity\*

	Phosphine	Methyl Bromide
<b>ACGIH TWA</b>	0.3 ppm	1.0 ppm
<b>ACGIH STEL</b>	1.0 ppm	
<b>OSHA Ceiling</b>		20 ppm
<b>IDLH</b>	50 ppm	250 ppm
<b>Lethal in 45 min</b>	500 ppm	
<b>Lethal in 1-3 min</b>	2000 ppm	

*\*The TWA and STEL differs per country, so always follow your company policy when handling hazardous materials.*

## Phosphine (PH<sub>3</sub>) by UNI or POLI

Phosphine is a gas that is supplied either directly from a cylinder or is generated on-site from solid forms (usually aluminum phosphide or calcium phosphide) by reaction of with moisture in the air or the stomach acid of rodents. Common trade names for Phosphine-generating solids include Phostoxin, Agtoxin, Celphos, and Quickphos. These pellets can be placed in the fumigation area for slow release of Phosphine (PH<sub>3</sub>), or they can be converted more quickly using generators.

Two monitors for Phosphine are available: the UNI single gas monitor for low concentration personal protection and the POLI multi gas monitor fitted with both low- and high-range sensors for both personal protection and ensuring adequate fumigation levels. The low cost of ownership UNI has a battery life approaching 3 years continuous operation and therefore is convenient for both post-fumigation worker entry, and for long-term continuous shipcabin monitoring. The POLI could be fitted as a 5-gas monitor with LEL, O<sub>2</sub>, H<sub>2</sub>S/CO plus two PH<sub>3</sub> sensors to serve both confined space entry and fumigation needs.

PH <sub>3</sub> sensor	Low Range	High Range
<b>Range</b>	0-20 ppm	0-1000 ppm
<b>Extended Range</b>	0-100 ppm	0-2000 ppm
<b>Resolution</b>	0.01 ppm	1 ppm
<b>Detection Limit</b>	0.05 ppm	3 ppm
<b>Response Time</b>	t <sub>90</sub> ≤60 s	t <sub>90</sub> ≤60 s
<b>Temp. Range</b>	-20 to +50°C	-20 to +50°C
<b>Warranty</b>	2 years	1 year

## Phosphine by PID

Phosphine has reasonable sensitivity on a PID, (Correction Factor of 4 @ 10.6 eV) but tends to form a coating on the PID lamp, which reduces the response even when concentrations are constant. To minimize this effect, we recommend 1) keeping the exposure concentrations and times as low as possible (<10

ppm for <1 minute or so), 2) performing frequent bump checks with calibration gas, and 3) cleaning the lamp if readings are low. We do not recommend using a PID to measure high initial doses or using a fixed PID for PH<sub>3</sub>. Alternatively, it is possible to calculate the mass of fumigant and the volume of the chamber being treated.

### Methyl Bromide (MeBr)

Methyl Bromide (MeBr) can be measured by PID at both high initial concentrations and low clearance concentrations. With the 10.6 eV lamp, the Correction Factor is 1.7, which gives a detection limit of about 0.05 ppm using the NEO handheld. These monitors can also measure the high initial doses of Methyl Bromide (MeBr), if needed (no lamp-fogging issues occur with Methyl Bromide the way they do with Phosphine).

MeBr Monitor	NEO	POLI
Portability	Handheld	Handheld
Range	0-5000 ppm	0-2000 ppm
Resolution	0.01 ppm	0.1 ppm
Detection Limit	0.05 ppm	0.5 ppm
Response Time	t <sub>90</sub> ≤ 3 s	t <sub>90</sub> ≤ 15 s
Temp. Range	-20 to +50°C	-20 to +50°C
Run Time	24 hrs	12 hrs

### POLI Multi-gas Meters for Fumigants

A POLI multi-gas monitor fitted with a PID sensor is a low-cost option for PID for Methyl Bromide (MeBr). However, it is marginal in being able to measure accurately at a 1 ppm TWA, and therefore the NEO is recommended. The POLI has an advantage in that it could have both a Phosphine sensor and a PID for Methyl Bromide (MeBr), should both fumigants be used in the same facility.

### POLI for Confined Spaces and Fumigants

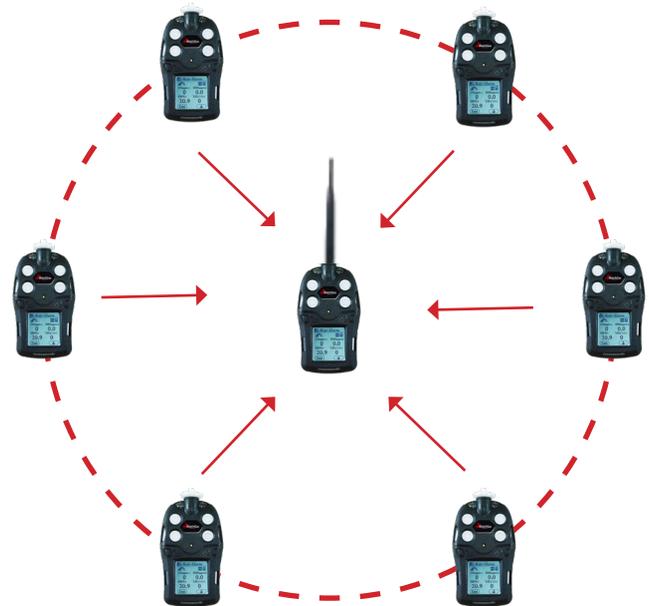
A POLI could also be fitted as a 5-gas monitor for confined spaces (LEL, O<sub>2</sub>, H<sub>2</sub>S/CO) and the 0-20 ppm PH<sub>3</sub> sensor for the 5th sensor, to serve both confined space entry and fumigation needs.

### WatchGasSquad Wireless Systems for Remote or Perimeter Monitoring

POLI multi-gas meter with fumigant sensors can be connected in a wireless networks for remote or perimeter monitoring. In WatchGasSquad systems with up to 8 monitors communication is up to 0.5 miles (line of sight) to the head monitor and in WatchGasPlatoon systems with up to 64 units up to 2 miles distance (line of sight) to an WatchGas-Link modem can be connected.

### Other Fumigants: Vikane and Methylisothiocyanate

Vikane (Sulfuryl Fluoride), commonly used in home tenting for termites, cannot be detected by PID or a simple electrochemical sensor. Some less-common alternative pesticides such as Mm-sodium (Methylisothiocyanate) can be detected with a PID using the standard 10.6 eV lamp. The response is quite sensitive, with a correction factor of 0.6. Contact WatchGas if there is any question whether the fumigant can be measured.



WatchGasSquad remote monitoring system