**Carbon monoxide (CO)**

***Who is this guidance for?***

This guidance is primarily aimed at employers or individuals with delegated responsibility for managing workplace exposure to substances. Whilst it is not exhaustive, the information presented is intended to demonstrate how biomonitoring can help with this duty. Some simple advice is presented to help non-specialist users to get the most out of biomonitoring covering (1) when to take a sample to ensure reliable and comparable results over time; (2) putting the result into context with respect to background (environmental) levels or what can reasonably be achieved with good exposure control; and (3) some basic technical data that can help to evaluate an analytical service provider. For further information you should consult your chosen analytical service provider who should be happy to discuss your specific requirements and find solutions.

**Carbon monoxide (CO) in breath**

**BMGV**: 30 ppm carbon monoxide in end-tidal breath

**Hazardous Substance:**

Carbon monoxide (CO)

CAS number: 630-08-0

**Workplace Exposure Limits:**

8-hour TWA: 30 ppm, 35 mg/m3

15-minute STEL: 200 ppm, 232 mg/m3

***Biological Monitoring Guidance Value (BMGV)***

30 ppm carbon monoxide in end-tidal breath

***Other Guidance Values***

The ACGIH BEI is 20ppm CO in breath at end of shift, or 3.5% carboxyhaemoglobin in blood

collected at the end of the shift. The DFG BAT is 5% carboxyhaemoglobin in blood collected at

the end of the shift. Guidance values set by different organisations will vary, based on factors including available data and scientific knowledge at the time and interpretation of the toxicology data.

***Sample Collection***

Breath CO is measured on-site using a portable CO breath analyser, which gives a direct readout of CO in ppm, or the equivalent percentage of carboxyhaemoglobin. Breath should be analysed at the end of the shift.

***Description of Suggested Method***

The good relationship between breath CO and carboxyhaemoglobin levels in blood means that measurement of CO in end-tidal breath is a reliable, non-invasive approach to biological monitoring. This is measured using a portable, direct-reading CO monitor. These are based on electro-chemical sensors and can display CO concentration in the breath, or its blood carboxyhaemoglobin equivalent.

**Analytical Evaluation**

Detection limit: 2-3 ppm

Calibration range: Typically 0-500 ppm

Drift: Less than 2% a month

Analytical Interferences: None likely to be encountered in breath. Negligable effect from organic solvents. Environmental CO exposure can influence the measurement; it is recommended to carry out breath analysis in an environment removed from external CO sources.

Quality Assurance: Not practical, however, regular calibration of the instrument should be performed as indicated by the manufacturer.

***Elimination Half-Life***

Elimination half-life is a measure of the rate of removal of a substance that has been taken into the body. It helps to identify when it is best to take a sample following potential exposure and indicates the potential ‘exposure window’ that will be reflected by a result.

Elimination half-time in breath after CO exposure is 3-5 hours.

**Other Information**

***Confounding factors***

CO exposure from confined vehicle exhaust emissions and tobacco smoke.

Some dihalomethanes (e.g. dichloromethane and bromochloromethane) are metabolised to CO. Passive smoking will not significantly influence breath CO levels.

***Unexposed level***

- in non-smokers: <6ppm

- in light smokers: <20ppm

- in heavy smokers: >20ppm

***Interpretation***

Exposure to the WEL of 30ppm CO in a non-smoker leads to an end-of-shift breath CO level

of 30ppm, equivalent to 5% carboxyhaemoglobin. Unexposed levels are much higher in smokers than non-smokers, and can be above 20ppm in heavy smokers. Therefore, smoking during the workshift will substantially reduce the value of the end-of-shift breath measurement as a measure of occupational CO exposure. Since the elimination half-time is 3-5 hours, if the worker has not smoked during the shift, its confounding influence is reduced. Although smoking during the shift can complicate the interpretation of the BMGV for CO for that individual, assessment of biological monitoring on a group basis may still be useful in determining the effectiveness of control.

***Links***

EH40 List of Approved Workplace Exposure Limits <http://www.hse.gov.uk/pubns/books/eh40.htm>

Biological Monitoring: A tool for helping to assess workplace exposure (August 2021). Published by British Occupational Hygiene Society (www.bohs.org). [BOHS-Biological-Monitoring-A-tool-for-helping-to-assess-workplace-exposure-rebranded.pdf](https://www.bohs.org/app/uploads/2021/08/BOHS-Biological-Monitoring-A-tool-for-helping-to-assess-workplace-exposure-rebranded.pdf)

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**Biological Monitoring at HSE**

<https://www.hsl.gov.uk/online-ordering/analytical-services-and-assays/biological-monitoring>