



# WHITE PAPER

## Protecting Workforces from the Dangers of Carbon Monoxide - the Need for Flue Gas Analysers

According to the Health and Safety Executive, and their publication of workplace exposure limits as of November 2021, the long term exposure limit for carbon monoxide gas is 20ppm (parts per million) and the short term exposure limit is 100ppm.

CO is classified as a toxic substance that can have many adverse, and even deadly, effects on the human body. As a result it is important that workplaces, specifically those in the HVAC industry, are proactive in both their understanding of the risks of CO, and the ways in which they can protect their staff and customers from it.

**“This gas can cause a range of physical problems, depending on how much CO is in the air. Headaches and nausea can become life threatening within 3 hours.”**

## What is CO and What Could it Do?

Firstly, let's explore Carbon Monoxide (CO) in more detail to fully understand the impact it can have on individuals when ingested. CO is generated by incomplete combustion of fossil fuels such as wood, oil, coal, paraffin, LPG, petrol and natural gas.

This tends to happen when there is a general lack of maintenance or insufficient air (or the air is of a poor quality) to allow complete combustion.

When natural gas is efficiently combusted carbon dioxide and water vapour are produced. However, if there is inadequate air where that combustion takes place, or if the air used for combustion becomes spoiled, combustion fails and produces soot and carbon monoxide instead. If there is water vapour in the atmosphere, this can reduce the oxygen level still further and speed up CO production.

CO is an odourless, colourless and tasteless gas that, as well as being highly toxic, is also potentially flammable when at higher levels of 10.9% Volume or 109,000ppm.

**CO is both highly toxic and flammable at higher concentrations**



CO can have a serious impact on the human body. Haemoglobin transports oxygen through the bloodstream, but CO is actually easier for this part of the blood cells to absorb and circulate than oxygen. Therefore when there is CO in the atmosphere it is incredibly dangerous as, technically, our bodies prefer CO to oxygen. Carbon monoxide seeps into the blood cells and is promptly and efficiently transported to all parts of the body in the form of carboxyhaemoglobin.

This can cause a range of physical problems, depending on how much CO is in the air. Headaches and nausea can become life threatening within 3 hours when there is 500ppm in the air, and when the measurement steps up to 800 ppm, individuals can suffer from seizures, severe headaches and vomiting in under an hour, and become fully unconscious within two hours. When the ppm increases to 1,500 it causes dizziness, nausea, and unconsciousness in under 20 minutes, and death within one hour. With 6,400 ppm in the air, individuals are unconscious after two to three breaths and can die within 15 minutes.





## Risks in the HVAC industry of CO

For those in the heating, ventilation and air conditioning industry there can be a heightened risk of carbon monoxide. This is because HVAC systems and units burn fossil fuels. Workers in this sector may have even noticed feelings of dizziness or nausea, or had a headache, during or after a specific job. This could be the impact of CO.

There are a range of specific events that are common in HVAC settings that may lead to CO exposure. Individuals working in confined spaces, such as basements or lofts are at risk. As are those working on heating appliances that are malfunctioning, in a poor state of repair, or that have broken or worn seals and blocked, cracked or collapsed flues and chimneys. All of these faults allow products of combustion to enter the working area.

Those working on open-flued appliances, especially if the flue is spilling, ventilation is poor or the chimney is blocked, could be at risk alongside those working on flue-less gas fires and cookers, especially where the room volume is of inadequate size and/or the ventilation is otherwise poor.





## Protecting staff and customers from CO

The HVAC and heating engineers, plumbers and boiler manufacturers present in these risky environments on a daily basis will of course want to protect themselves from dangers, great or small. The best way to protect yourself and stay safe from the hazards of CO is to wear a high quality, portable CO gas detector.

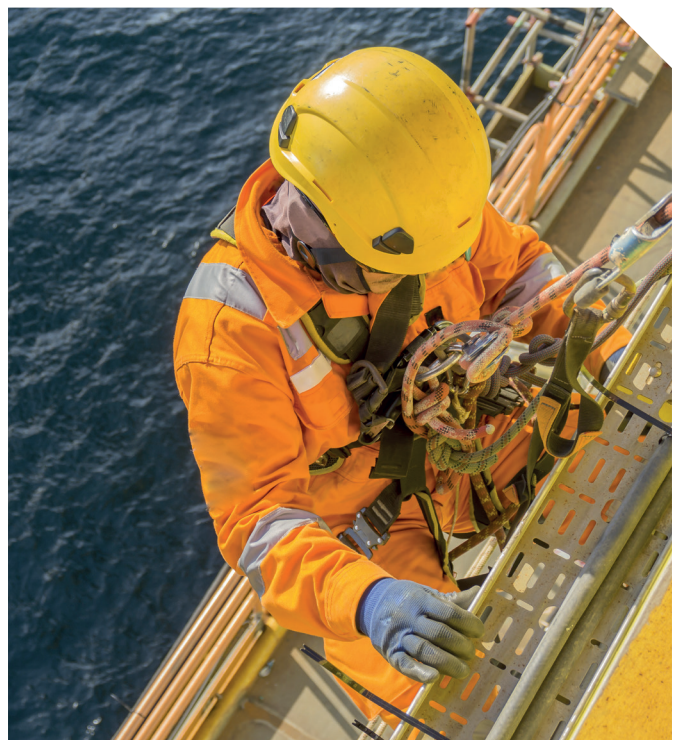
Making sure you have the accurate equipment at hand to alert you as and when danger arises is a must to ensure your personal safety. It is also very important in these instances to utilise a high quality flue gas analyser (FGA), or combustion analyzer, to provide accurate readings of the immediate atmosphere and appliance performance.

Many appliance manufacturers now make the use of a combustion analyzer when installing, and maintaining their products a mandatory requirement. Crowcon provides Sprint Pro as an efficient, reliable and robust solution for those working within environments that produce carbon monoxide. The device is long lasting, with a fast charging battery to ensure workers are supported and safe throughout all their shifts, by a unit that holds its charge long-term. Sprint Pro is a multifunction device combining 7 tools into one. Having one robust solution, such as this, also means that there is no need to purchase, carry, store, charge and calibrate multiple devices. In turn, individuals can save the transportation and maintenance of multiple bulky units.

A functional and reliable FGA, such as Sprint Pro, also allows users to stay on the job for longer with fast start-up times and auto self-purging when powering down which extends sensor life. Having troubleshooting capacity built in is a must for FGA's, as it allows users to perform the required tests quickly, safely and accurately.

Having damage protection functionality built in also means that those on the ground can spend more time working and less time waiting for repairs which is very convenient. Sprint Pro has industry leading triple filter hydrophobic protection to prevent all instances of water ingress damage to the sensors this is the number1 cause of flue gas analyzer downtime. The Sprint Pro is constructed from the same material as motorbike helmets in order to provide a rugged exterior that can withstand all environments.

Crowcon also supply a high quality maintenance free CO personal protection alarm called the Clip CO. This small rugged device clips to a belt or shirt pocket and provides 2 levels of audible, visual and vibrate alarms to protect against unsafe CO levels in the working environment. It's a disposable unit that runs for 2 years from the point of activation with no maintenance overheads.



## **“Education creates awareness and allows customers to remain abreast of the important information they need to alert you to.”**

### Training to empower customers against CO

As well as ensuring your workforce are safe and protected from the dangers of carbon monoxide, HVAC businesses must also consider the safety of their customers. By being rigorous around the instrument used for CO measurement it is not only the workers who are protected, but in turn also the customers.

Another element that empowers customers to become aware and remain alert about CO warning signs, is the delivery of thorough training about the issue. Explaining in detail what CO is, how HVAC systems burn fossil fuels and the impact of them on the human body is a valuable tool for all involved. Education creates awareness and allows customers to remain abreast of the important information they need to alert you to toxic gas presence in their environment.

### What causes a leak?

A leak within a heating system can be catastrophic for the engineers, and those within the same environment. Making sure the FGA you are using has a flammable gas leak detector, to ensure that a leak can be found quickly, is important. Having an FGA with this functionality is especially useful if a tightness test has been failed.

Internal seal breakdowns, welding on the flue degrades, or the flue terminating in a position where the products of combustion become trapped around the flue terminal are all ways in which flue gas leaks can occur. These issues have the effect of drawing “spent” flue gases back into the boiler’s air supply.

Most modern FGAs have functions which can assist the user in determining a range of issues, including flue integrity tests to check that there’s a good supply of fresh air on the inlet to the boiler, alongside checking that the internals of the flue aren’t compromised and letting products of combustion back into the air inlet. Most analysers can also perform let-by and tightness tests too, as well as other pressure tests and temperature tests.





## Using a flue gas analyser/combustion analyzer to detect leaks

As probes are placed in the exhaust of a car to sample the gases to determine the condition of the engine, taking a sample from the flue, the boilers "exhaust", to determine the condition of any fuel burning appliance is a very similar process.

The samples drawn by the FGA from a working appliance measures the critical gases produced in the combustion process to determine if it is operating efficiently and safely.

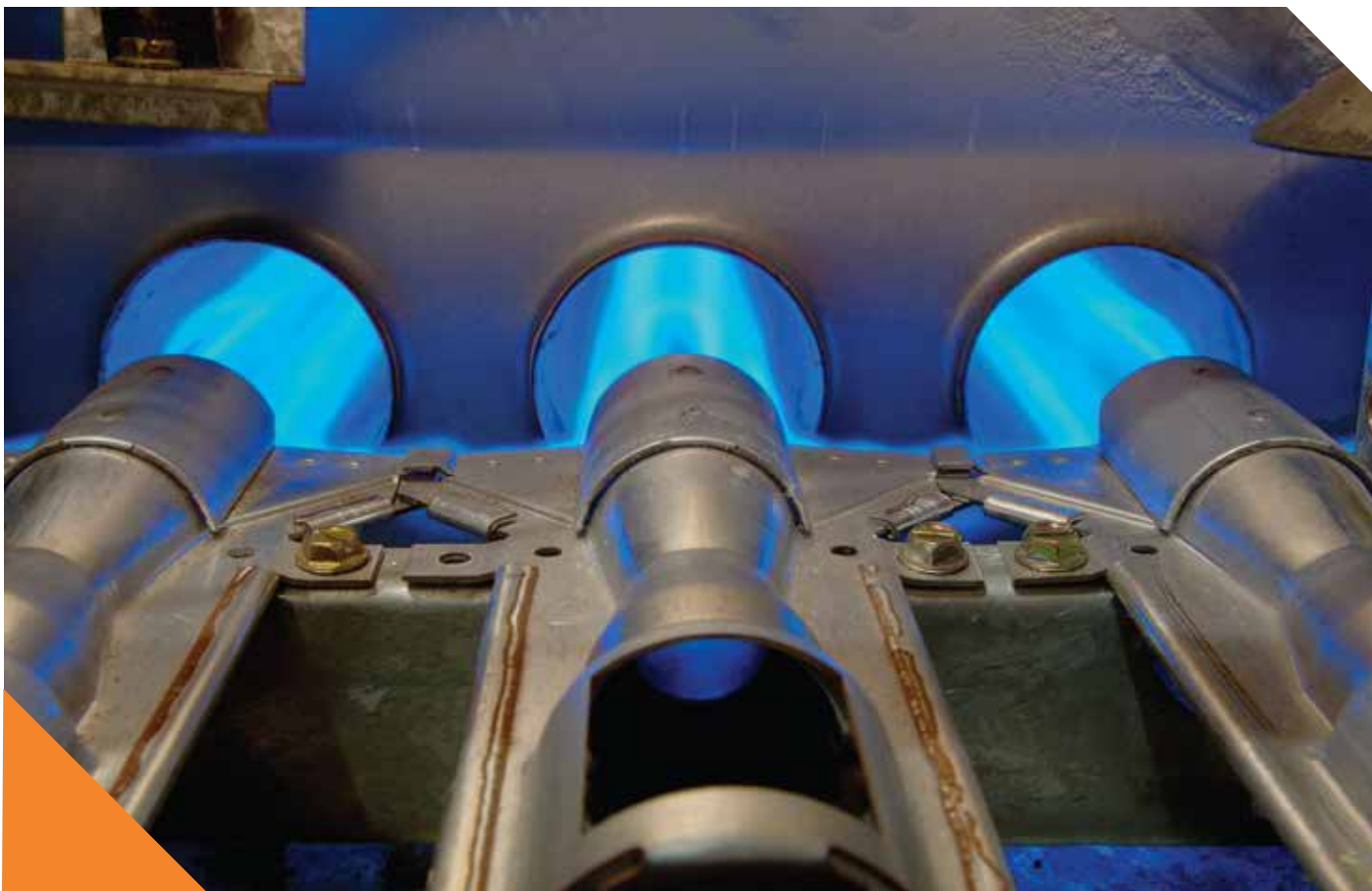
The concentration of carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>) can be determined in this process to assess environmental safety; as can other measurements such as oxygen (O<sub>2</sub>) concentration, XS air and flue temperature.

When reading the manufacturer's instructions for the appliance you can see if the flue gas measurements are in specification for the appliance and from there you can be confident that the appliance is left in a safe working condition. If the gas readings do not correlate with the manufacturer's instructions it is an alert to a potential problem.

There can be many reasons for the issues, as explored above, however some typical examples might be a problem with the installation or integrity of the flue, an issue with a restricted gas supply to the appliance, a fault on the boiler or perhaps a poorly adjusted air/gas supply valve.

The FGA you use should help you to diagnose and identify the issue, make the necessary adjustments to correct it and then confirm and document that your corrective actions have been effective in getting the appliance back within specification to prove compliance.

In the event of a suspected CO incident or alarm activation FGAs can be used to perform ambient CO testing in accordance with BS:7967 guidelines. These provide assistance to a suitably qualified engineer to build a picture of what might be causing the elevated CO situation. An FGA is a vital piece of equipment for all registered heating engineers, and is often so heavily relied upon that most are unable to perform essential and routine daily tasks without one.



**“As sensors degrade over time, regular calibration is the best way to stay on top of whether your device is providing inaccurate reading.”**

## The importance of FGA calibration

Making sure the flue gas analyser (FGA) you utilise is regularly maintained is obviously very important. Here, let's explore a little further the ways in which you can effectively calibrate your machine to ensure the safety of all involved.

Calibrating a combustion analyser or FGA involves testing the sensors to make sure they are accurately measuring a known concentration of certified calibration gas. The first step in doing this is to adjust the reading to match the gas concentration through an initial sensor calibration of the new or existing unit. Then a calibration drift should be undertaken by using existing instruments to bring the reading back after the drift occurs. Measuring the amount of drift in the gauge is a chance to see how far into inaccurate territory it has moved, and rule out measurement errors moving forward.

As sensors degrade over time, regular calibration is the best way to stay on top of whether your device is providing

inaccurate readings, whether it is an electrochemical, catalytic bead or infra-red sensor. Regular calibration raises the gain to the correct levels and brings the sensor back in line to avoid dangerous incorrect readings.

Once the sensor reaches a certain point of degradation, it cannot be brought back into the correct position and this is the time when a new sensor needs to be installed.

When undertaking calibration a certified calibration centre will set the device to calibration mode. This feeds a test gas of a known concentration onto the sensors to see how they respond. The gain levels are adjusted within the sensor to match the readings to the concentration fed in whilst mitigating drop off.

The new settings are locked into the device's firmware and a calibration report is produced, creating a PASS or FAIL result.



## FGA calibration best practice

Sprint Pro FGA comes with servicing options to support those on the ground with keeping their device functional and reliable at all times against the dangers of CO. However, if you undertake your own maintenance there are some tools and techniques to ensure your device is properly maintained each year.

As moisture is a by-product of combustion it can become sucked into the FGA. As a result it is important to regularly clear out the water trap. Water ingress is the primary cause of damage in flue gas analysers, so it is crucial to check, empty and replace the unit's inbuilt water traps and filters when required.

Next tip, ensure you purge the device in clean air before turning off to rid the machine of trapped noxious gases. These may have become stuck there when drawn from the flue and passed over the sensors to gain a reading. Not purging the

device in clean air and releasing the noxious residue can cause corrosion damage and shorten the life of the unit.

To avoid the risk of condensation build up and further water damage in your FGA, ensuring units are taken inside into warm environments, instead of being left outside in a cold vehicle is a great preventative step.

Using approved chargers with outputs tailored for the target device also avoids non approved chargers causing unwanted damage to the battery and lessening overall charge retention, or even impairment to the battery and IC chips themselves.

Finally, always check the devices' probes and connector pipes to locate any splits or cracks in the rubber house which if left could cause incorrect readings. Regular checks will help the device's hoses to remain in good operating condition.





**With 50 years experience in the field we are ideally placed to meet your needs, offer peace of mind to you and your team and offer advice and suggestions for effective and secure gas detection within your environment.**

## Preventative action is key

Although the dangers of carbon monoxide can be overwhelming to read about, as this document illustrates, there are ways to prevent CO from seeping into your workspace and to ultimately protect the workers and customers that may come into contact with the toxic gas. Utilising a personal CO alarm such as Crowcon Clip CO and a robust and reliable flue gas analyser, or combustion analyzer, such as Crowcon Sprint Pro, will ensure the alert system and measurement process can be relied upon to be accurate and efficient if CO is generated.

For those in the HVAC industry, where the generation of fossil fuels is a known entity, preventative action is needed to ensure safety. Training for engineers, plumbers and boiler manufacturers, and HVAC customers, can provide another preventative step to empower individuals to take action against the risks of carbon monoxide.

**For more information about flue gas analysers, CO or Sprint Pro solutions please get in touch with a member of our friendly team to find out more.**

 **CROWCON**  
Detecting Gas Saving Lives

