Monitoring Exposure to Gases

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CDC Workplace Safety and Health
National Institute for Occupational Safety and Health NIOSH

Why monitoring gases from diesel engines is important:

Monitoring the airborne concentrations of gases produced by diesel-powered vehicles is crucial for both underground coal and metal/non metal mines – For both, the exposure limits for regulated gases are based on ambient concentration levels.

1. Proper monitoring and management of the recorded data can be used to determine the compliance status a mine.

2. Evaluation of the effectiveness of specific control technologies and strategies.

3. Establishment of a successful ventilation strategy.

Exposure limits for gaseous pollutants from diesel engines

	CO_2	CO	NO	NO_2
ACGIH	0.5% TWA 3.0 % STEL	25ppm TWA	25ppm TWA	3ppm TWA 5ppm STEL
NIOSH	0.5% TWA 3.0% STEL	35ppm TWA 200ppm (C)	25ppm TWA	1ppm STEL
OSHA	0.5% TWA	50ppm TWA	25ppm TWA	1ppm STEL
MSHA coal	0.5% TWA 3.0% STEL	50ppm TWA 400ppm STEL	25ppm TWA	5ppm (C)
MSHA MNM	0.5% TWA 1.5% STEL	50ppm TWA 400ppm STEL	25ppm TWA 37.5ppm STEL	5ppm (C)

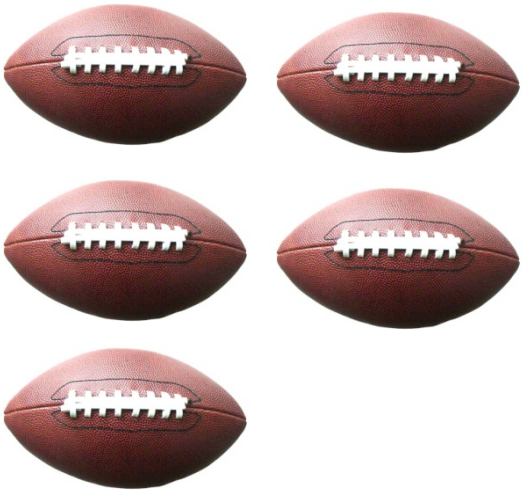
Threshold Value Limits (TLV)

TWA Time Weighted Average

STEL Short Term Exposure Limit

(C) Ceiling limit

How much is 5 ppm ?

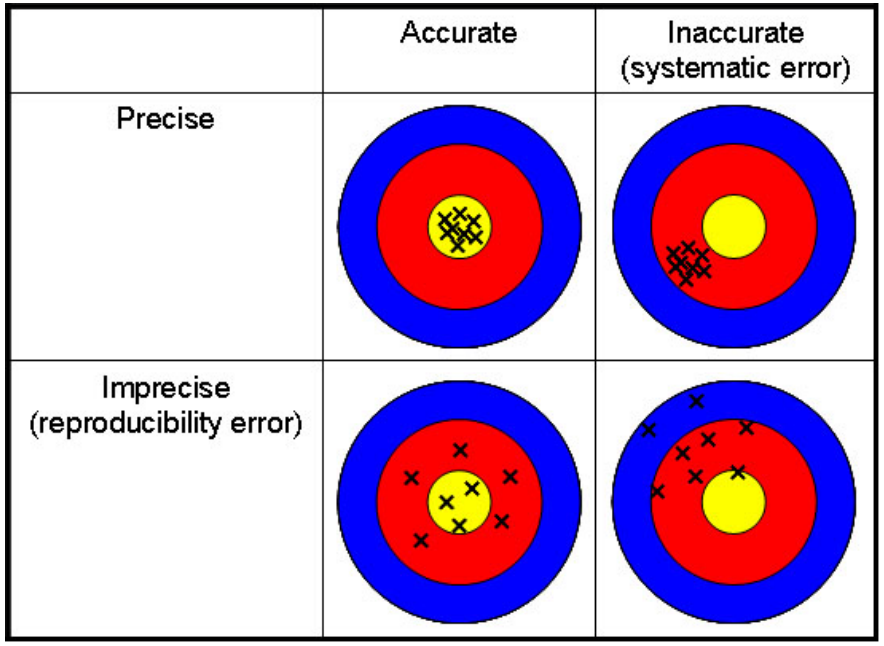


Like 5 footballs in a football field (1 foot deep)

Characteristics for a gas monitor

- **Accuracy and precision:**

Accuracy is a measure of how closely the monitor is able to quantify the true concentration. Precision is the degree of reproducibility of a measurement, whatever the measured value is.



- **Recorded data storage**
- **Capability to analyze multiple gases**
- **Portability**

Gas monitoring

Regulations:

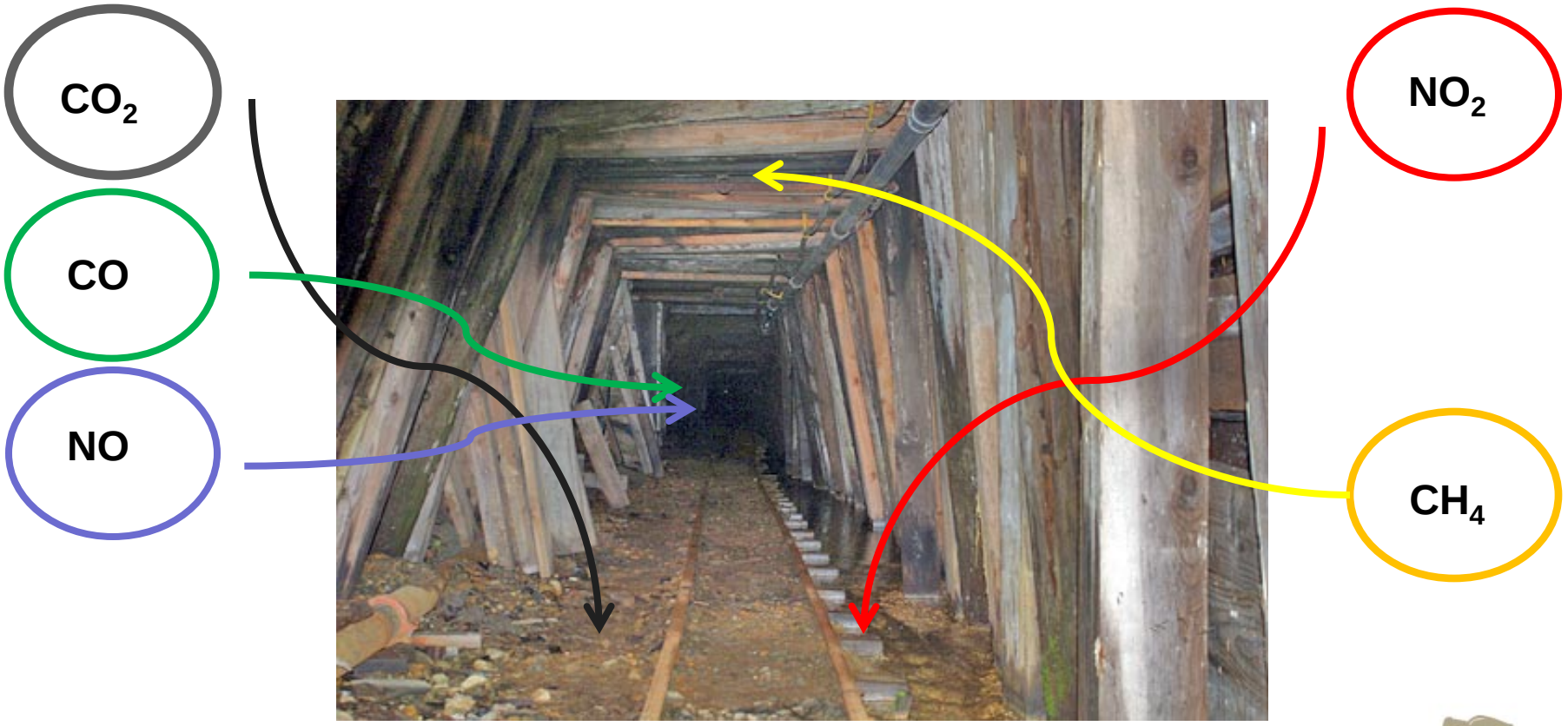
Coal mines - During on-shift examinations (30 CFR 75.362), a certified person must determine the concentration of carbon monoxide (CO) and nitrogen dioxide (NO_2) in the working drift (30 CFR 70.1900). When the CO and NO_2 concentrations exceed a level of 50% of the threshold limit value (TLV), the mine operator must take appropriate actions to reduce these values.

Metal/non metal mines - Gas surveys should be conducted as frequently as necessary to determine the adequacy of control measures (30 CFR 57.5002).

Monitor system characteristics –

- Sampling technique – active sampling (pump) or passive sampling (diffusion).
- Usually no pre-conditioning.
- Cross-interferences were found minimal if any.
- Collection media – liquid, solid
- Range of operability

CO_2	0-2	%		NO	0-100	ppm
CO	0-500	ppm		NO_2	0-50	ppm


CO_2
CO
NO
NO_2
CH_4

Gas monitors

Colorimetric dosimeter tubes – stain tubes

- Simple, inexpensive method to measure the exposure of a worker to gases from diesel engines.
- Method for **atmospheric monitor** only.
- Active or passive sampling.
- Different material for different targeted gas.
- The concentration is measured by comparing the tube with a scale or extracting the sample (post-analysis).

Gas monitors

Electrochemical sensors

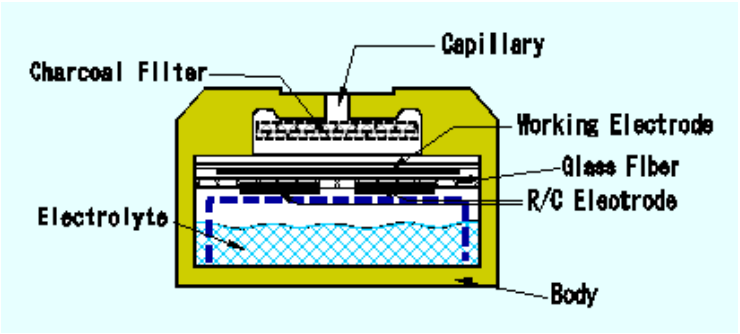
- The most used gas monitoring technique used in underground metal/non metal mines.
- Technique for **atmospheric monitor** and **tailpipe monitor.**
- Active or passive sampling.

How it works:

•The gas of interest comes into contact with a sensor specific for this gas, a chemical reaction occurs which creates an electrical signal that can be measured

• The amount of gas of interest supplied to the sensor is limited by diffusion - the output from the sensor is linearly proportional to the gas concentration.

• High sensitivity and selectivity, a wide linear range, minimal space and power requirements, and low-cost instrumentation.



Calibration or performance check ?

• Calibration is a procedure to check and adjust a measurement with a standard.

• Accuracy and reliability are strictly connected to a proper calibration.

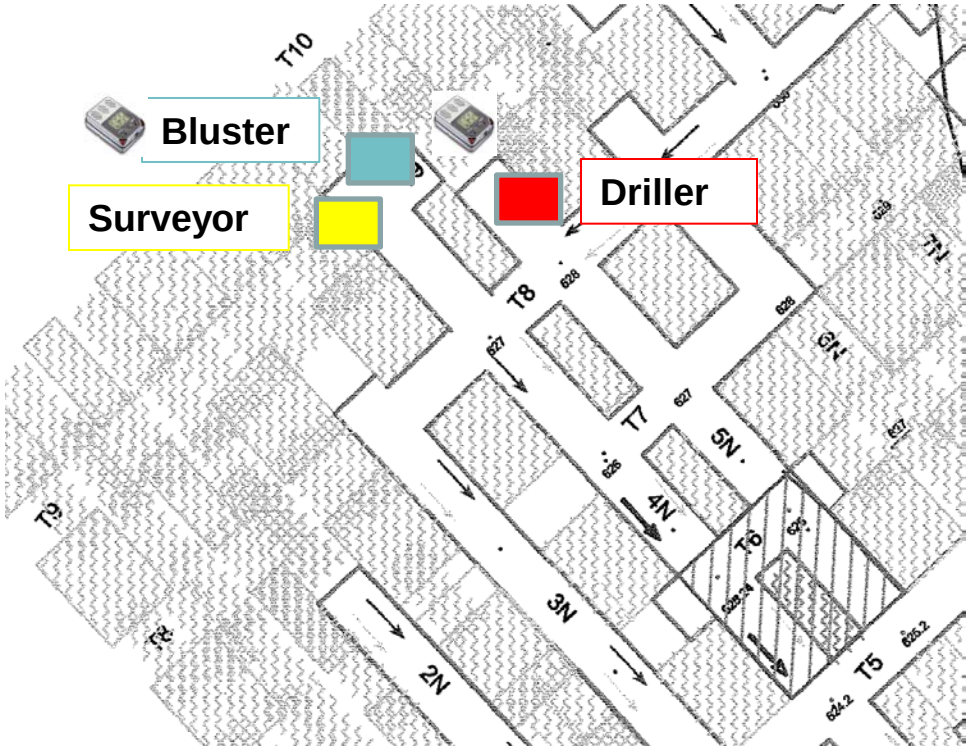
•The calibration is carried out by using calibration bottles (cylinders) with a specified known concentration.

•Follow the manufacturer's guidelines for proper calibration. Only use certified calibration gas before its expiration date. Never use calibration gas after its expiration date.

• Record calibration data – time, set-up, conditions, operator, data.

• To check the life expectancy of a electrochemical cell sensor is not a calibration. It is just a condition check.

The importance of the reviewing recorded data

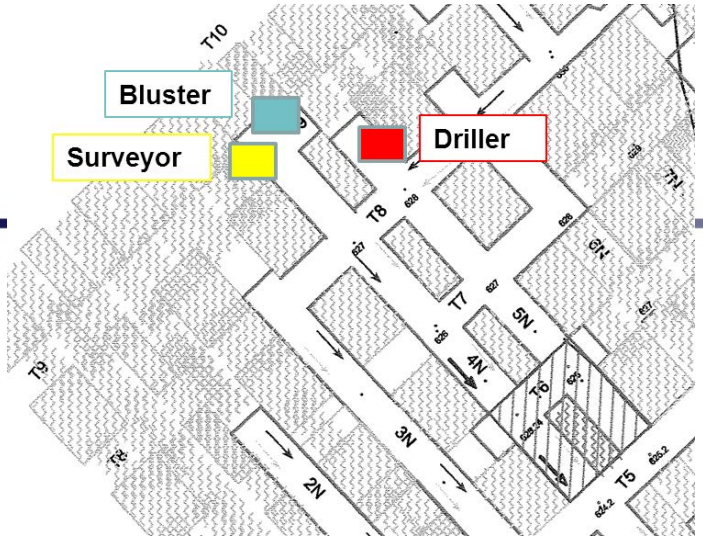


<u>Two gas monitors</u>

1 in a face area T94N
1 on a bluster

Three vehicles

- Diesel Driller (engine on)
- Bluster (engine off)
- Surveyor (engine on) -with burner DPF aftertreatment



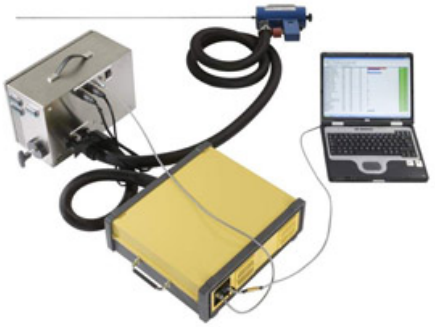
- The area has problems with ventilation. The build up of NO_2 is a clear sign that the exhaust gases are not forced out.
- The dirty vehicle (NO_2 perspective) is not the surveyor but the driller working up stream

Atmospheric monitoring system

- **Use primarily in coal mines. Is it true ?**
- **They can provide extremely valuable information when the data are supported by vehicles tracking systems.**
- **They can be the foundation of administrative control techniques and ventilation strategies.**

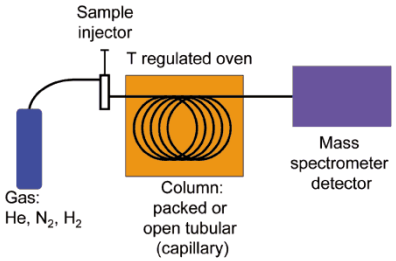
Advanced gas monitor techniques

Fourier Trasform Infrared Spectroscopy (FTIR)



FTIR detects gaseous compounds by their absorbance of infrared radiation. All gases—with the limited exception of compounds such nitrogen (N_2) and oxygen (O_2)— absorb in the infrared spectral regi and can, in principle, be detected.

Gas Chromatography Mass Spectroscopy (GCMS)



GCMS is a technique which is based on the **separation** and **analysis** of compounds that can be vaporized without decomposition. The separation of the compounds (usually collected in sampling canisters or other media) is carried out in the GC section.
The analysis is performed by a mass spectrometer (MS) or other analitical techniques – the mass spectrometer allows the chemical speciation of every compound separated by the GC.

• Suitable for the speciation analysis of gaseous hydrocarbons emitted by any diesel engine.

Questions??

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