



European Cave Rescue Association



Foul Air

Detection

Awareness

- ▶ Before we can manage a Foul Air situation we must be aware
- ▶ Indicators - a very abstract subject
- ▶ Clearly exploring abandoned mines should have consideration of foul air high on the list
- ▶ Explorers using explosives - of any form
- ▶ Cave topography - are there areas in the cave known to be a problem
- ▶ For example where CO₂ may build up

- ▶ When we are aware of a possible Foul Air situation then what next...



Awareness

- ▶ Can and should we ask for the Fire Service/Pompiers for assistance
- ▶ Do we have the experience and training to be safe
- ▶ If so then we need to be able to detect the gas levels...
- ▶ We will look at working in Foul Air situations in the next presentation



Detection Equipment - Dräger Tubes



- ▶ Probably the simplest and cheapest option available
- ▶ There are Dräger electronic sampling equipment but will these stand up to cave conditions?
- ▶ We consider the manual sampling system to be the most effective solution
 - ❖ Small amount of training
 - ❖ Minimal maintenance - tubes can go out of date
- ▶ Disadvantage is that must sample at site of Foul Air -
- ▶ Does not provide continuous monitoring



Detection Equipment - Dräger Tubes

- ▶ Each of the various gases have a corresponding tube to detect that gas
- ▶ So it needs an awareness of the situation and for which gas(es) you need to check
- ▶ Select the tube, fit into the pump and sample





Detection Equipment - Dräger Tubes

- ▶ Each detection tube has its own instructions - which basically says how many presses of the pump are need to make a sample
- ▶ Tubes often allow for sampling high and low levels of gas
- ▶ Sample by the number of presses of pump !
- ▶ Once you have taken a sample then you simply read the scale on the tube
- ▶ Be aware - small writing can be difficult in the dark
- ▶ Remote sampling tube allows sampling at 'a distance'





Detection Equipment - Flame Metering

- ▶ Considered as unsuitable unless experienced members who regularly use and test the equipment are in the team
- ▶ Basic equipment that will show low oxygen levels - that is the lamp goes out in atmospheres with less than 17% oxygen approximately.
- ▶ Can measure both oxygen and methane
- ▶ Relatively cheap to buy and maintain.
- ▶ Can measure remotely by lowering down a shaft - suggest a mirror can be used to view



Detection Equipment - Flame Metering



- ▶ Not easy to carry or use in low passages found in cave conditions.
- ▶ If they go out not easy to relight, even when you get to good air!
- ▶ Very difficult to estimate methane unless well practiced and trained
- ▶ Hard to maintain and use in practice for the occasional user.

Some mining engineers doubt the effectiveness of this equipment in voluntary circles. They suggest that without proper periodic maintenance, the Flame Safety Lamp is likely to fail in use. It was also suggested more training to interpret the flame is required than appears on first inspection.



Detection Equipment - Electronic



Advantages

- ▶ Continuous monitoring with automatic warning of dangerous gas (user can set alarm point)
- ▶ Easy to use and interpret
- ▶ Same machine can monitor and alarm for a number of gases
- ▶ Can specify which gases are to be detected when purchasing.
- ▶ Accurate if properly maintained and calibrated.

Detection Equipment - Electronic



Disadvantages

- ▶ Expensive to purchase
- ▶ Require regular maintenance and calibration to ensure working properly
- ▶ Costs from £1200 upwards for multi-gas detectors
- ▶ But Single gas detectors from £250
- ▶ Units may not be sufficiently robust for cave rescue - particularly not suitable for wet conditions
- ▶ Require batteries to be correctly charged - if not just fail in cave at point of most need!

Detection Equipment - Electronic



- ▶ Teams within BCRC now all have QRAE monitors
- ▶ These can detect
 - ❖ Carbon Monoxide
 - ❖ Hydrogen Sulphide
 - ❖ Oxygen - alarms usually $< 19.5\%$ & $> 23\%$
 - ❖ LEL - lower explosive limit - combustible gases
- ▶ Note this list does not include CO_2
- ▶ Need for calibration every 6 months - we have people trained for this otherwise would be very expensive
- ▶ Alarm levels are set and teams advised to exit if triggered



Detection of gases

- ▶ We will now look at the individual gases



Detection of Oxygen

- ▶ A candle may be used to ascertain O₂ levels (will it burn?)
- ▶ **BUT** only use where methane is not anticipated - that is not in coal mines and the like
- ▶ If not it means the level is 17.5% or lower -
- ▶ Dräger tubes are very useful, but a new tube must be used each test
- ▶ Flame Safety Lamp - UK 'Davy' lamp - considered unsuitable unless experienced with the kit
- ▶ Gas meters can measure O₂ - low oxygen often means high CO₂



Detection of Carbon Dioxide

- ▶ Dräger tubes may be used to measure CO₂ levels.
- ▶ Electronic Gas meters
- ▶ Heavier than air



Detection of Carbon Monoxide

- ▶ Dräger tubes may be used to measure CO levels.
- ▶ Electronic Gas meters



Detection of Hydrogen Sulphide

- ▶ H₂S has about the same density as air so taking samples should be done at head height.
- ▶ Dräger tubes may be used to measure H₂S levels.
- ▶ Electronic Gas meters



Detection of Sulphur Dioxide

- ▶ This gas will seldom be encountered in caves and most mines (except possibly some coal mines subject to spontaneous combustion), and if present it will be accompanied by other signs - ie fume, smoke, CO₂ etc.
- ▶ Dräger tubes may be used to measure SO₂ levels.
- ▶ At first sign of the pungent irritating odour action should be taken to evacuate and ventilate the area.



Detection of Nitrous Oxides

- ▶ Nitrous Oxides (NO_x) are heavier than air and samples should be taken at low levels.
- ▶ Dräger tubes are the easiest measuring method -
- ▶ There are multi-meters and single gas meters that will measure NO_x but cost is high with regular maintenance needed.
- ▶ For the low incidence and likelihood of teams coming across this gas we feel Dräger tubes to be sufficient.



Detection of Methane

- ▶ Levels may be measured using a methaneometer BUT the operator MUST know how to use this equipment and it must be regularly serviced
- ▶ A Gas Detection lamp can also be used, but again expertise is needed, few if any cavers or rescuers will have this expertise so a methaneometer is the better option
- ▶ The likelihood of methane occurrence is low in most rescue teams areas
- ▶ If significant risk in the area (i.e. exploration of old coal mines is occurring in the area) access to experienced personal and a methaneometer or equivalent should be arranged either in the team or more probably outside it and available for emergency call. Each team will need to access this risk.

