

FIELD PROCEDURE: SOILGAS, SOIL VAPOR AND AIR SAMPLING

This is not a health and safety risk assessment

1. APPLICABILITY

This document describes the standard field procedures used to collect samples of soil vapor for field screening or laboratory testing.

Active sampling involves the use of a pump or a vacuum to draw samples of gas/vapor from the ambient air or from a monitoring well, for:

- Direct measurement (field testing) of fixed gases, trace gases or volatile contaminants, using equipment such as a landfill gas meter, photo-ionization detector (PID), Draeger tubes or Kitagawa tubes; and/or
- Laboratory testing, using samples collected into charcoal carbon tubes:

2. OBJECTIVE

The key objective of gas and vapor sampling is to obtain field measurements or samples for fixed gases (CO₂, CH₄ and O₂), trace gases (H₂S and CO) and/or soil vapors. Samples may be collected from indoor or outdoor air or from probes or monitoring wells.

3. EQUIPMENT SELECTION AND NOTES ON USE

Direct Measurement Equipment

Direct measurement instrument include the following:

- Infra-red analysers; e.g. GA94 and GA2000 used to measure methane, oxygen and carbon dioxide. The equipment pumps a gas sample into a cell within the monitor. Radiation is released and passed through the cell. The amount of radiation absorbed by the gas sample is converted to a concentration of gas measured within that sample.
- Photo-ionisation detectors (PID), used for semi-quantitative detection of ionisable volatiles. PIDs work by pumping air through the unit. The ionisation of vapors within the air creates an electrical current that is detected and converted to a vapor concentration. Two main factors are involved in selecting an appropriate PID:
 - Knowledge of the likely vapors present is needed to enable selection of the appropriate lamp energy (typically 10,6 eV or 11,7 eV). PIDs only detect vapors with ionising potentials less than the energy of the lamp. Refer to Field Procedure FP04 Headspace Screening of Soil Samples or to manufacturer information for details of the ionising potential of substances of potential concern. Also note that chemical-specific correction factors need to be applied to convert instrument readings into vapor concentrations.
 - Assessment of the purpose of the data and therefore the required sensitivity of the instrument (i.e. parts per million or parts per billion).

- Thermal conductivity devices
- Electrochemical cells.
- Chemical detector tubes; e.g. Draeger tubes or Kitagawa tubes. These provide instantaneous concentration readings using colorimetry (i.e. sorbent in tubes changes colour when in contact with chosen chemical). Results are only semi-quantitative and are typically in ppm range only. Method suitable for some occupational monitoring and borehole monitoring where relatively high concentrations might be expected. Note: sorbent tubes are designed to be used to detect a single chemical, but often suffer from interference from other similar chemicals in the air.

Adsorbent Tubes

Sorbent tubes are used actively; where the sample is pumped through the tube over a short time (usually seconds or minutes). Where pumped tubes are used, set up the equipment so that the gas or vapor to be sampled passes through the tube before it goes into the pump. This minimizes the potential for cross-contamination associated with the pump

4. GENERAL MONITORING AND SAMPLING PROCEDURES

Sampling Locations

Gas or vapor samples can be collected from various potential locations, including:

- Above ground locations (e.g. on a table or bench inside a room, or held within the breathing zone outside in ambient air)
- Below ground locations; for example:
 - Existing groundwater monitoring bore (providing that the well screen covers an appropriate depth interval that includes at least 100 mm of the unsaturated zone)
 - New soil vapor probes
 - Utility pits

Purging of Sample Equipment

Probes, tubing and fittings should be selected to minimise the overall void volume, and at least this volume must be purged through the equipment before sampling.

Sampling of Monitoring Wells

Procedures relating to well installation are included in AECOM Field Procedure FP08 *Installation of Groundwater or Gas Monitoring Wells*.

Where practicable, monitoring wells should be fitted with one or two sealed gas taps at least 24 hours before sampling in order to reduce the effects of atmospheric dilution. If this is not possible, this must be noted in the field records and accounted for in any interpretation of the sampling results.

For active sampling, generally accepted good practice is to purge at least one dead volume and aim to obtain steady vapor readings on a PID for example before sampling. The bore volume can be calculated from its internal diameter and the depth to groundwater or to the well base. The volume that is purged prior to sampling must be noted, especially if it is less than one bore volume.

Peak and steady concentrations should be recorded. Note that for comparison with sample results (and for calculation of sample volume requirements for pumped sorbent tubes), correction factors need to be applied to PID results. Correction factors appropriate to the chemical(s) of concern can generally be obtained from manufacturer data sheets.

Instruments should be checked that they are zeroed correctly between each measurement, and that they are generally working correctly.

Ensure that all monitoring and sampling equipment is appropriately calibrated. Check instrument calibration certificates and records, and conduct field calibration as appropriate. All field calibration must be recorded.

Critical to purging and sampling of wells is the use of low sampling rates. To minimise the risk of short-circuiting to atmosphere, the sampling rate must be equal or less than the rate at which soil gas can move into the probe from the surroundings. Typical recommended flow rates range from 1 L/hour to 1 L/minute. **Recommended flow rate is for sampling is 50ml/minute to 100 ml/min.** Purge rates can be higher but should not exceed 500 ml/min. Pump flow rates should be measured using a suitably calibrated flow meter, and some pumps (such as personal air sampling pumps) will need a low-flow adaptor to reliably pump at 50 ml/min to 100 ml/min. Flow rates must be measured using conditions comparable to those that exist during sampling (e.g. with a dummy sorbent tube fitted to the pump intake, to account for the resistance to flow caused by the tube).

5. ADDITIONAL PROCEDURE: PUMPED SORBENT TUBES

Sample volume should be judged to ensure (as far as practicable) that the saturation limit of the sorbent tube is not reached, that sample breakthrough does not occur/is minimised, and that the sample result falls within the calibration range of the laboratory analytical method.

Typical sorbent saturation limits are 1 mg TVOC on the tube. Typical analytical calibration limits are 1 ug on the tube. Typical laboratory detection limits are 1 ng on the tube. Sampling rate should be 50 ml/min. Guide sample volumes are as follows:

Corrected PID ppm reading	Sample Volume
0-10 ppm	3 litres (1 hour at 50 ml/min)
>10 ppm	1 litre (20 minutes at 50 ml/min)

If breakthrough is suspected, consider analyzing the control section of the sorbent tube.

Polyethylene (PE) or polytetrafluoroethylene (PTFE) tubing should be used for the connection of sampling apparatus, in preference to silicone tubing, due to the potential for desorption of siloxanes into the sample. Where the use of flexible tubing is required due to differing diameters of tube and apparatus connection points, silicone may be used however its exposure to the sample

should be minimised. This may be achieved by butting PE / PTFE tube as close to the apparatus connection point as possible and overlapping with only a small length of silicone.

5. ADDITIONAL PROCEDURES FOR SOIL FIXED GAS MONITORING

Pre-Sampling

Record the daily weather pattern (including barometric pressure changes for the week preceding the sampling/monitoring activity on site); data should also include temperature, wind, and rainfall).

Record daily (and if appropriate hourly) atmospheric pressure readings during the period prior to the monitoring visit.

Calibrate the instrument with calibration gas, ensure it is in correct working order and that the service/manufacture certificate is available and within date before entering the field. Recalibrate after particularly high results have been obtained.

On arrival at a well, note its condition. Where dual groundwater/gas monitoring wells are present, undertake wellhead gas monitoring prior to groundwater gauging and sampling. Take care when removing airtight well caps/gas taps in case there is sudden release of air or other vapors from inside the well casing.

Sampling should preferably occur during periods of higher temperature and falling atmospheric pressure, as this is when gas emission rates are likely to be highest.

Test Method

1. Start with soilgas if monitoring for both gas and vapors.
2. Before starting the monitoring, turn on the monitoring equipment, attach tubing, run through clean air and zero the methane. This needs to be done well away from any sources of soil gases and/or vapors such as vehicles and monitoring locations.
3. If dual gas taps are installed, connect instrument inlet to the tap with the short (or no) well tube, and the outlet to the gas tap with the longer well tube.
4. Record the atmospheric pressure reading from the monitoring equipment prior to sampling at each location. Also record weather, record air temperature and ground condition.
5. Measure the gas flow and pressure, using the flow meter. Record the readings on a copy of the attached pro forma data sheet. Then close the gas tap and remove the gas flow meter.
6. Attach the monitoring equipment (eg GA94/GA2000) tubing to the gas tap and open. Switch on the pump and record the **peak and steady** readings for methane (% v/v), methane (% LEL), carbon dioxide (% v/v) and oxygen (% v/v). Record the time taken to reach the steady reading.
7. If the gas readings have not reached a steady value after 3 minutes, record the concentrations and the direction and rate of change in concentration (e.g. steadily increasing). IMPORTANT: note the volume of air you have sampled (time x purge rate of gas meter) and compare to known/estimated air volume in monitoring well.

8. If readings are very high, continue monitoring for up to 10 minutes to determine whether the concentrations are being constantly replenished or whether they start to diminish over time.
9. During sampling, check the clear plastic tubing to see if water is being pulled from the monitoring well. If it is, detach the tubing and switch off the pump. Record the gas concentrations and make a note that water was pulled up. Check the filter and if wet, replace with a dry filter.
10. After monitoring is complete, purge the monitoring equipment in clean air (away from the borehole/and other sources of gas) until the methane and carbon dioxide concentrations return to zero and the oxygen reading shows atmospheric concentrations.
11. If soil vapor monitoring is required, do that next.
12. If the well contains (or may contain) water, record the water level using a dip meter. Then replace the gas tap or cover ensuring that the tap is closed and cover locked.
13. Make a note of any defects to the boreholes and perform maintenance if appropriate.
14. Leave the area around the well in a tidy condition and dispose of all wastes in an environmentally responsible manner.

6. REPORTING REQUIREMENTS

- Sampling depth
- Gas/VOC flow rates
- Gas/VOC concentrations
- Instrument(s) and technique(s) used
- Atmospheric pressure on day of sampling and three preceding days
- Weather conditions at time of sampling
- Ground conditions at time of sampling
- Details of leak tests and calibrations carried out on site
- Physical condition of well(s)
- Details of any works which might affect the readings
- Results of field measurements
- Results of laboratory analysis

7. ADDITIONAL INFORMATION

Air Toxics Ltd Guide to Air Sampling & Analysis

CIRIA C665 *Assessing risks posed by hazardous ground gases (soilgas) to buildings*

CIRIA (2009) *The VOCs Handbook*, C682

CIRIA R131 *The measurement of methane and other gases from the ground.*

Crowhurst, D and Manchester, SJ (1993) *The measurement of methane and other gases from the ground.*

Environment Agency (2000) *Monitoring Methods for Ambient Air*, Technical Guidance Note M9

Environment Agency (2002) Investigation of the composition and emissions of trace components in landfill gas, R&D Publication P1-438/TR

Environment Agency (2004) *The measurement of trace components of landfill gas.*

Geotechnical Instruments (UK) Ltd. *Infrared landfill Gas Analyser operating manual model GA94A.*
Geotechnical Instruments (UK) Ltd. *User calibration procedures for GA94, GA2000 Gas Analysers.*

ITRC (2007) Vapor Intrusion Pathway: A Practical Guideline, Interstate Technology and Regulatory Council

Perkin Elmer Techtips Volume 2, Number 2, 2020 *Photoionisation detector response factors (10.6eV)*

Rae Systems Technical Note TN-106, *Correction Factors, Ionisation Potentials, and Calibration Characteristics*

US EPA (1999) Compendium method TO-15

US EPA (2003) Standard Operating Procedure 11, General Air Sampling Guidelines