

Introduction

8.1 During the construction phase, hazards may arise which are related either to the flammability of landfill gas or to its potentially asphyxiating properties. In particular cases, it is possible that toxicity effects may be significant. The following sub-sections of the Guidance Note may be used to form the basis of Specification Clauses for incorporation in Contract Documentation for developments within the Consultation Zone.

General Hazards Which May Be Encountered

8.2 The developer should be aware of, and should inform construction contractors accordingly, that methane and carbon dioxide are always likely to be present in the soil voids. In addition the developer should be aware of the potential hazards and other properties of landfill gas as described in [Section 1](#).

Outline of Safety Requirements

8.3 In all construction work adjacent to landfill sites, safety procedures should be implemented to minimise the risks of:

- fires and explosions;
- asphyxiation of workers; and
- toxicity effects.

8.4 Precautions should be clearly laid down and rigidly adhered to with respect to:

- trenching and excavation; and

- creation of confined spaces at, near to or below ground level.

8.5 In addition to normal site safety procedures, gas detection equipment and appropriate breathing apparatus should be available and used when entering confined spaces or trenches deeper than 1 metre.

Additional General Requirements

8.6 During the construction phase, the following additional precautions should be followed.

Appointment of Safety Officer

8.7 For large developments, a Safety Officer, trained in the use of gas detection equipment and landfill gas-related hazards, should be present on site throughout the groundworks phase. The Safety Officer should be provided with an intrinsically safe portable instrument (or instruments), appropriately calibrated and capable of measuring the following gases in the ranges indicated:

methane	0-100% LEL and 0-100 % v/v
carbon dioxide	0-100%; and
oxygen	0-21%

8.8 For smaller developments, if a Safety Officer is not appointed, then expert opinion and advice should be sought on a regular basis.

Safety Measures

8.9 All personnel who work on site and all visitors to the site should be made aware of the possibility of ignition of gas in the vicinity of excavations. Safety notices should be posted warning of the potential hazards.

8.10 Those staff who work in, or have responsibility for 'at risk' areas, including all excavation workers, supervisors and engineers working within the Consultation Zone, should receive appropriate training on working in areas susceptible to landfill gas, fire and explosion hazards.

8.11 An excavation procedure or code of practice to minimise landfill gas related risk should be devised and carried out by the project proponent.

8.12 No worker should be allowed to work alone at any time in or near to any excavation. At least one other worker should be available to assist with a rescue if needed.

8.13 Smoking, naked flames and all other sources of ignition should be prohibited within 15m of any excavation or ground-level confined space. 'No smoking' and 'No naked flame' notices should be posted prominently on the construction site and, if necessary, special areas designated for smoking.

8.14 Welding, flame-cutting or other hot works should be confined to open areas at least 15m from any trench or excavation.

8.15 Welding, flame-cutting or other hot works may only be carried out in trenches or confined spaces when controlled by a 'permit to work' procedure, properly authorised by the Safety Officer (or, in the case of small developments, other appropriately qualified person).

8.16 The permit to work procedure should set down clearly the requirements for continuous monitoring for methane, carbon dioxide and oxygen throughout the period during which the hot works are in progress. The procedure should also require the presence of an appropriately qualified person, in attendance outside the 'confined area', who shall be responsible for reviewing the gas measurements as they are made, and who shall have executive responsibility for suspending the work in the event of unacceptable or hazardous conditions. Only those workers who are appropriately trained and fully aware of the potentially hazardous conditions which may arise should be permitted to carry out hot works in confined areas.

8.17 Ground level construction plant should be fitted with vertical exhausts at least 0.6m above ground level and with spark arrestors.

8.18 Any electrical equipment, such as motors and extension cords, should be intrinsically safe.

8.19 During piping assembly or conduiting construction, all valves/seals should be closed immediately after installation. As construction progresses, all valves/seals should be closed as installed to prevent the migration of gases through the pipeline/conduit. All

piping/conduiting should be capped at the end of each working day.

8.20 Mobile offices, equipment stores, mess rooms etc. should be located on an area which has been proven to be gas free (by survey with portable gas detectors) and ongoing monitoring should be carried out to ensure that these areas remain gas free. The use of permanent gas detectors may be appropriate in some circumstances where there is a relatively high risk but for many developments it will be sufficient to have regular monitoring undertaken manually by the safety officer. The particular arrangements to be adopted at a specific site will need to be determined during the risk assessment/design of protection measures.

8.21 Alternatively, such buildings should be raised clear of the ground. If buildings are raised clear of the ground, a minimum, clear separation distance (as measured from the highest point on the ground surface to the underside of the lowest floor joist) should be 500mm.

8.22 During construction, adequate fire extinguishing equipment, fire-resistant clothing and breathing apparatus (BA) sets should be made available on site.

- At larger developments, fire drills should be organised at not less than six monthly intervals.
- The developer should formulate a health and safety policy, standards and instructions for site personnel to follow.

Monitoring

8.23 Periodically during ground-works construction, the works area should be monitored for methane, carbon dioxide and oxygen using appropriately calibrated portable gas detection equipment.

8.24 The monitoring frequency and areas to be monitored should be set down prior to commencement of ground-works either by the Safety Officer or by an appropriately qualified person.

8.25 Routine monitoring should be carried out in all excavations, manholes and chambers and any other confined spaces that may have been created by, for example, the temporary storage of building materials on the site surface.

8.26 All measurements in excavations should be made with the monitoring tube located not more than 10mm from the exposed ground surface.

8.27 Monitoring of excavations should be undertaken as follows:

For excavations deeper than 1m, measurements should be made:

- at the ground surface before excavation commences;
- immediately before any worker enters the excavation;
- at the beginning of each working day for the entire period the excavation remains open; and
- periodically through the working day whilst workers are in the excavation.

For excavations between 300mm and 1m deep, measurements should be made:

- directly after the excavation has been completed; and
- periodically whilst the excavation remains open.

For excavations less than 300mm deep, monitoring may be omitted, at the discretion of the Safety Officer or other appropriately qualified person.

Actions in the Event of Gas Being Detected

8.28 Depending on the results of the measurements, actions required will vary and should be set down by the Safety Officer or other appropriately qualified person. As a minimum these should encompass those actions specified in *Table 8.1*.

Table 8.1 Actions in the Event of Gas Being Detected in Excavations

Parameter	Measurement	Action
O ₂	< 19%	Ventilate trench/void to restore O ₂ to >19%

Parameter	Measurement	Action
	< 18%	Stop works evacuate personnel/prohibit entry increase ventilation to restore O ₂ to >19%
CH ₄	> 10% LEL	Post 'No Smoking' signs prohibit hot works ventilate to restore CH ₄ to <10% LEL
	>20% LEL	Stop works evacuate personnel/prohibit entry increase ventilation to restore CH ₄ to <10% LEL
CO ₂	>0.5%	ventilate to restore CO ₂ to <0.5%
	> 1.5%	Stop works evacuate personnel/prohibit entry increase ventilation to restore CO ₂ to <0.5%

Specific Advice Relating to the Drilling of Boreholes

8.29 As part of the site investigation and subsequent ground works for a development within a Consultation Zone, it will often be necessary to drill exploratory boreholes. Such work should be undertaken following the general advice given above. Specific recommendations relating to the drilling of boreholes within the Consultation Zone are presented below.

Supervision and Safety Management of Drilling Operations

8.30 Drilling should only proceed with adequate care and precautions against the potential hazards which may be encountered.

8.31 Before site works begin, the drilling contractor should devise a 'method-of-working' statement covering all normal and emergency procedures and the site supervisor and all operatives must be familiar with this statement.

8.32 The method-of-working statement should cover, *inter alia*:

- number of operatives;
- experience and special skills of operatives;

- normal method of operations;
- emergency procedures, including fire fighting;
- supervisors responsibilities;
- storage and use of safety equipment;
- safety procedures; and
- signs, barriers and guarding.

Safety Equipment and Clothing

8.33 An intrinsically safe, portable methane meter should be available at all times.

Other safety equipment should include:

- no smoking signs, to be placed prominently adjacent to the drilling area;
- portable fire extinguisher;
- high visibility clothing to be worn by all drilling operatives; and
- additional protective clothing should include stout industrial boots (with steel toe cap and insole), plastic hard hats, heavy duty waterproof industrial groves.

Working Procedures

8.34 On arrival at site the drilling rig should be set-up up-wind of the borehole location, 'No smoking' signs set out and the working area should be roped or coned-off.

8.35 When drilling on landfill sites, all spoil obtained from the borehole should be stockpiled alongside the borehole and disposed of (to an appropriately licensed disposal site) at the end of the working day. At the end of the working day all vehicles, the drilling rig and any hand tools should be hosed-down with clean water to remove deposits of excavated spoil. Suitable guards or barriers should be placed around the excavation or borehole to prevent access by unauthorised persons.

Safety Procedures

8.36 One person should be present at all times during drilling operations, with the sole responsibility of assuring the observance of all safety procedures. This person should be trained in the use of all recommended safety equipment.

8.37 Smoking should be prohibited anywhere on a landfill site and within 15 metres of a

boring or excavation at any locations within the Consultation Zone.

8.38 For large diameter boreholes, a working platform should be placed over the hole which will prevent accidental entry into the hole by operatives.

8.39 No worker should be allowed to work alone at any time near the edge of the well under construction. Another worker should always be present, beyond the area considered to be subject to the possible effects of landfill gas or cave-in.

8.40 Periodically during the well construction, the work areas should be monitored for levels of methane.

8.41 If the well construction is not completed by the end of the working day, the hole should be covered with a plate of sufficient overlap to prevent access to the hole and sufficient structural strength to support expected loads. The plate should be weighted down to discourage removal and, on landfill sites, the edges of the plate should be covered with sufficient depth of wet soil to prevent escape of gas.

8.42 All pipes or casings should be capped at the end of each working day.

8.43 Engine-driven rigs should have vertical exhaust stacks discharging not less than 1.5m above ground level and should have overspeed limits to prevent engine run away on ingested gas.

8.44 Diesel engine air-intakes should also be located not less than 1.5m above ground level.

8.45 Any electrical equipment should be intrinsically safe.

8.46 Additional safety advice and guidance may be found in 'Investigation into Establishing an Effective Practical Safe Working Practice When Drilling in Landfill Sites and Adjacent Areas and Contaminated Ground and Adjacent Areas' compiled by the British Drilling Association (1993).

Installation of Vertical Wells

8.47 To prevent uncontrolled gas release and to protect personnel from the risk of falling into the borehole, the open borehole should be covered with a sheet or plate strong enough to support personnel and having an overlap all round the borehole.

8.48 The drilling rig, boring machine or excavator should remain in place over the borehole and could be used as a support to assist placement of the casing.

8.49 The upper end of the well casing should be sealed, preferably with a fused or screwed end cap or alternatively with an inflatable bag type flow stopper, until the permanent headworks/monitoring tap is fitted. Landfill gas must not be allowed to vent freely at the site surface.