

# Landfill Gas Control -Guidance on the landfill gas control requirements of the Landfill Directive

## 1. Scope

This guidance is relevant to all landfills to which Annex I of the Landfill Directive applies.

## 2. Purpose

The purpose of this document is:

- To help competent authorities improve methane collection through the enforcement of the Landfill Directive requirements.
- To provide clarity on landfill gas control requirements within the context of all of the Landfill Directive technical and regulatory requirements.
- To set out the most important criteria in ensuring effective collection, treatment and use of landfill gas.

## 3. Structure of the guidance

The requirements of the Landfill Directive on gas control are set out and sections of this guidance expand upon each of the individual requirements.

## 4. Extract from Annex I of the Landfill Directive

4. **Gas control**
- 4.1 Appropriate measures shall be taken in order to control the accumulation and migration of landfill gas (Annex III).
- 4.2 Landfill gas shall be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and used. If the gas collected cannot be used to produce energy, it must be flared.
- 4.3 The collection, treatment and use of landfill gas under paragraph 4.2 shall be carried on in a manner which minimises damage to or deterioration of the environment and risk to human health.

## 5. Control accumulation and migration (Section 4.1 of Annex I)

Landfill gas presents a hazard through explosion or asphyxiation.

Landfill operators must ensure that there is no significant risk of gas migrating out of the landfill through the subsurface or accumulating outside of the landfill in a mixture that could be explosive or cause asphyxiation.

Appropriate measures for landfill gas control are outlined in Section 3 of Annex I of the Directive. These include:

- Lining of the landfill base and sides to create a low permeable barrier to sub-surface gas flow.
- Surface sealing including impermeable mineral layers and gas drainage layers.

The provisions of Section 3 of Annex I allow for some flexibility in applying the measures on the basis of the environmental risk.

The collection of landfill gas required by Section 4.2 of Annex I (see below) is an important appropriate measure to ensure control of the landfill gas. Active extraction of the gas within the landfill is necessary to prevent a build-up of landfill gas pressure within the site that could result in flow of landfill gas out of the landfilled waste into the sub-surface environment.

The procedures for demonstrating the effectiveness of the landfill gas controls are described in Annex III and may include monitoring of soil gas outside of the landfilled waste and monitoring of fugitive emissions in addition to monitoring of the landfill gas conditions within the landfill (see the requirements in Annex III of the Directive).

There are additional technical measures that can be used to control the migration of landfill gas that are not set out in the Landfill Directive. These include techniques such as gas drains at the edge of the waste (though care must be taken to ensure these do not become a source or air ingress or a source of emissions to air).

More details on the measures that can be taken can be found in technical guidance as provided by member states (see appendix):

## **6. Collection from all landfills receiving biodegradable waste (section 4.2 of Annex I)**

Landfill gas must be collected at landfills that receive biodegradable waste.

### *Biodegradable waste landfills*

The Landfill Directive, through the Council Decision of 19 December 2002, lays down uniform waste classification and acceptance procedures. Due to limits imposed on accepted waste by the Waste Acceptance Criteria landfills for inert waste, for hazardous waste and landfills (or cells) accepting stable, non-reactive hazardous wastes (as well as other non-hazardous waste of similar properties) are not expected to generate significant quantities of landfill gas consisting of methane and carbon dioxide.

Member states are able to set more stringent measures and to define sub-categories of landfills, reflecting their waste strategies. These sub-categories may help to define whether biodegradable waste can be accepted and how the waste will behave in the landfill setting. This may therefore indicate whether landfill gas collection is necessary. If the categories and

criteria do not sufficiently prevent the disposal of biodegradable waste, an assessment of behaviour of the landfilled waste will be necessary.

The requirement to collect landfill gas will be clear in the majority of cases due to types and quantities of biodegradable waste accepted at the site.

There may however be some landfills, due to the nature of the wastes accepted or physical attributes such as shallow or very small landfills, where it is not clear whether anything other than negligible quantities of gas are or will be produced. These sites will need to demonstrate to the competent authority that landfill gas collection is not required.

#### *Negligible landfill gas production*

Landfill gas must be collected from landfills receiving biodegradable waste unless the landfill operator can prove to the competent authority that it is not necessary to do so.

This proof must be based on a demonstration that the waste types accepted will not produce more than negligible amounts of landfill gas and can be supported by evidence such as from monitoring of the landfill.

If the competent authority accepts that landfill gas collection is not required there must be a continuous review process to ensure that landfill gas is not produced in anything other than negligible quantities.

The test for determining whether there are negligible quantities of landfill gas is whether an active methane treatment method can be sustained at the landfill.

The quantity of landfill gas considered to be negligible will depend on the methane content and volume of landfill gas that can be sustainably extracted from the waste mass. At landfills where the waste types accepted or the physical attributes of the site mean that there will be very low landfill gas generation then the operator will need to prove that active collection, extraction and treatment of the gas using bio-oxidation techniques or low calorific flaring is unsustainable.

Where the competent authority accepts that landfill gas collection is not required but there are low levels of landfill gas present then passive methane oxidation systems should be considered.

#### *Predicting landfill gas generation*

The operator should model and estimate the generation of landfill gas throughout the lifecycle of the site as guide to the design and phasing of the gas extraction scheme. There are a variety of gas generation models commercially available which can predict landfill gas generation based on the types and quantities of waste accepted at the site. The model should be kept up to date using site specific data such as actual waste inputs.

More details on demonstrating the need for gas collection can be found in in the national guidelines (see appendix).

## 7. Collection of landfill gas (section 4.2)

The emission of landfill gas to the atmosphere is a local environmental issue due to the presence of odorous and toxic compounds and a global environmental issue due to the presence of methane (and, to a lesser extent, those trace gases which also contribute to global climate change).

Landfill operators must maximise the amount of landfill gas that they collect.

In order to maximise the amount of landfill gas collected, landfill operators must address the following key points:

- Landfill gas extraction should start as soon as possible following the deposit of the waste. Monitoring within the waste can identify the onset of methane production at a rate that can be sustainably extracted (without increasing the risk of air ingress to the waste) and that produces a flow rate of gas with a methane content capable of either being combusted or treated by bio-oxidation.
- The phasing plan for the landfill should be designed to facilitate the collection of landfill gas and to minimise the release of landfill gas.
- The active tipping area should be minimised to ensure that only the smallest possible area of waste is open and not sealed (either permanently or temporarily)
- Landfill gas should be collected from the operational area and this should include the use of temporary or sacrificial gas collection systems. Temporary and permanent caps and associated gas collection should be installed as soon as possible.
- Emissions from waste flanks (slopes) should be minimised by ensuring that the gradient is not too steep to allow effective capping and allow active extraction systems to be installed, maintained and if necessary replaced.
- All landfill infrastructure that protrudes through the surface of the waste or capping layer, such as leachate or gas wells, should be sealed to prevent emissions of landfill gas.
- Regular monitoring (which may include monitoring of fugitive gas emissions) and immediate remediation should take place for all sealing systems (e.g. caps) and landfill infrastructure to ensure that leaks are detected and repaired as soon as possible.
- The landfill gas extraction system should be monitored and adjusted regularly to maximise the collection of landfill gas and minimise the ingress of air into the waste mass. The performance of the system should be monitored over time and steps taken to remediate any deterioration in performance and maintain landfill gas collection efficiency.
- Operator audits of the gas collection system should be undertaken annually to assess the efficiency of the system and to develop a programme of improvements. The results of the audit, including the improvement programme, should be supplied to the competent authority.

Technical guidance on the techniques for landfill gas collection can be found in the national guidelines (see appendix).

## **8 .Using the collected gas (section 4.2)**

Energy must be recovered from the collected landfill gas. If a landfill operator considers that landfill gas cannot be used at the landfill then they must demonstrate to the competent authority that, at that individual landfill, there are site-specific reasons why utilisation is not feasible.

Landfill operators should recover the maximum amount of energy from the landfill gas over the whole lifecycle of the landfill. The best available techniques should be applied. The following utilisation techniques have been applied successfully:

- Introduction of the treated methane into the gas mains
- Combined heat and power utilisation
- Direct use of the gas as a fuel
- Electricity generation

The most common form of recovering energy from landfill gas is to generate electricity by burning the gas in an engine. Whether the gas can be utilised in this manner will depend on the economics of energy market within individual Member States and the costs of exporting the electricity to the supply grid.

The cost of collecting and flaring the landfill gas is part of the normal operation of the landfill and as such is not subject to a cost benefit analysis but must be covered by the charge for waste disposal (Article 10 of the Landfill Directive). For the use of the landfill gas, any cost benefit analysis should consider the additional costs of utilisation above and beyond the cost required for collecting and flaring the gas.

Further guidance can be found in the national guidelines (see appendix).

## **9. Flaring where the gas collected cannot be used to produce energy (section 4.2)**

The landfill gas generation rate will decline over time producing lower volumes of gas with a low methane content. Landfill operators must have regard to the following hierarchy of treatment techniques over the life of the landfill to ensure that the maximum amount of landfill gas is oxidised over the whole lifecycle of the landfill.

- High temperature flaring
- Low calorific flaring
- Other techniques for oxidation of methane

The techniques for methane oxidation, to be used when flaring is no longer viable, must be verifiable and agreed with the competent authority. As gas generation declines on older completed phases of the landfill, the operator should consider using different methane oxidation techniques to maximise the quantity of methane collected and oxidised.

At the beginning of the life of the landfill there will be a period where the gas quality and quantity will not be adequate for gas utilisation. During this period, the operator should consider the above hierarchy to maximise the quantity of methane collected and oxidised prior to the introduction of gas utilisation.

## **10. Minimising harm (section 4.3)**

Landfill gas can cause harm to human health through explosion, fire, asphyxiation, toxicity and odour. Maximising landfill gas capture reduces harm to human health and the environment including reducing the emission of greenhouse gases that contribute to global climate change.

Landfill operators must ensure that the collection, treatment and use of landfill gas minimises the release of gases.

The incomplete combustion of landfill gas can produce toxic by-products. The combustion for utilisation and in flares must maximise the destruction efficiency. The combustion must be monitored to ensure that the operation of the combustion will meet the local emission requirements.

Guidance on point source emissions from landfill gas treatment can be found in the national guidelines (see appendix):

The health and safety of workers is beyond the scope of this guidance but information on this can be found in the national guidelines (see appendix).

## Appendix: List of guidances recommended by the Member States:

### United Kingdom

- UK Waste Industry Code of Practice on Landfill Gas  
[www.esauk.org/reports\\_press\\_releases/esa\\_reports/LandfillgasICoP](http://www.esauk.org/reports_press_releases/esa_reports/LandfillgasICoP)
- UK Waste Industry Code of Practice On Perimeter Soil Gas  
<http://www.candpenvironmental.co.uk/docs/perimeter.pdf>
- Environment Agency Guidance on the Management of Landfill Gas  
[LFTGN 03](#)

### Ireland

- EPA Guidance Note on Landfill Flare and Engine Management and Monitoring (AG7)  
<http://www.epa.ie/pubs/advice/air/emissions/guidancenoteonlandfillflareandenginemanagementandmonitoringag7.htm>
- EPA Guidance on Surface VOC Emissions Monitoring on Landfill Facilities (AG6)  
<http://www.epa.ie/pubs/advice/air/emissions/surfacevocemissionsmonitoringonlandfillfacilitiesag6.htm>
- EPA Guidance on Management of Low Levels of Landfill Gas  
<http://www.epa.ie/pubs/advice/waste/waste/managementoflowlevelsoflandfillgas.html>

### Sweden

- SGI guidance on inventory, survey and risk classification of old landfills - leachate and landfill gas (in Swedish)  
<http://www.naturvardsverket.se/upload/stod-i-miljoarbetet/vagledning/deponi/deponi-rapport-sgi-lakvatten-o-deponigas.pdf>

### France

- ADEME guidance on optimisation of landfill gas capture (in French):  
[http://www.optigede.ademe.fr/sites/default/files/fichiers/Guide\\_optimiser\\_captage\\_bio\\_gaz.pdf](http://www.optigede.ademe.fr/sites/default/files/fichiers/Guide_optimiser_captage_bio_gaz.pdf)