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for Environment
Food & Rural Affairs

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Process Guidance Note 1/13(13)

Statutory guidance for storage, unloading and loading petrol at terminals

December 2013



Llywodraeth Cymru
Welsh Government



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Revision of the guidance

The electronic version of this publication is updated from time to time with new or amended guidance. **Table 0.1** is an index to the latest changes (minor amendments are generally not listed).

Table 0.1 - Revision of the guidance		

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1. Introduction

Legal basis

- 1.1 This note applies to the whole of the UK. It is issued by the Secretary of State, the Welsh Government, the Scottish Government and the Department of the Environment in Northern Ireland (DoE NI) to give guidance on the conditions appropriate for the control of emissions into the air from storage, unloading and loading petrol at terminals. It is published only in electronic form and can be found on the [Defra](#) website. It supersedes PG1/13(04) and NIPG 1/13(07).
- 1.2 This guidance document is compliant with the [Code of Practice on Guidance on Regulation](#) page 6 of which contains the "golden rules of good guidance". If you feel this guidance breaches the code or you notice any inaccuracies within the guidance, please [contact us](#).
- 1.3 This is one of a series of statutory notes giving guidance on the Best Available Techniques (BAT). The notes are all aimed at providing a strong framework for consistent and transparent regulation of installations regulated under the statutory Local Air Pollution Prevention and Control (LAPPC) regime in [England and Wales](#), [Scotland](#) and [Northern Ireland](#). The note will be treated as one of the material considerations when determining any appeals against a decision made under this legislation. Further guidance on the meaning of BAT can be found for [England and Wales](#), [Scotland](#), and [Northern Ireland](#).
- 1.4 In general terms, what are BAT for one installation in a sector are likely to be BAT for a comparable installation. Consistency is important where circumstances are the same. However, in each case it is, in practice, for regulators (subject to appeal) to decide what are BAT for each individual installation, taking into account variable factors such as the configuration, size and other individual characteristics of the installation, as well as the locality (e.g. proximity to particularly sensitive receptors).

The note also, where appropriate, gives details of any mandatory requirements affecting air emissions which are in force at the time of publication, such as those contained in Regulations or in Directions from the Government. Which in the case of this note include the Pollution Prevention and Control (Petrol Vapour Recovery) (Scotland) Directions 2012.

1.5 In **Section 4** and **Section 5**, arrows are used to indicate the matters which should be considered for inclusion as permit conditions. It is important to note, however, that this should not be taken as a short cut for regulators to a proper determination of BAT or to disregard the explanatory material which accompanies the arrows. In individual cases it may be justified to:

- include additional conditions;
- include different conditions ;
- not include conditions relating to some of the matters indicated.

In addition, conditions will need to be derived from other parts of the note, in particular to specify emission limits, compliance deadlines and mandatory requirements arising from directions or other legislation.

Who is the guidance for?

1.6 This guidance is for:

Regulators

- local authorities in England and Wales, who must have regard to the guidance when determining applications for permits and reviewing extant permits;
- the Scottish Environment Protection Agency (SEPA) in Scotland, and district councils or the Northern Ireland Environment Agency (NIEA), in Northern Ireland;

Operators who are best advised also to have regard to it when making applications and in the subsequent operation of their installation;

Members of the public who may be interested to know what the Government considers, in accordance with the legislation, amounts to appropriate conditions for controlling air emissions for the generality of installations in this particular industry sector.

Updating the guidance

1.7 The guidance is based on the state of knowledge and understanding, at the time of writing, of what constitute BAT for this sector. The note may be amended from time to time to keep up with developments in BAT, including improvements in techniques, changes to the economic parameters, and new understanding of environmental impacts and risks. The updated version will replace the previous version on the [Defra](#) website and will include an index to the amendments.

- 1.8 Reasonable steps will be taken to keep the guidance up-to-date to ensure that those who need to know about changes to the guidance are informed of any published revisions. However, because there can be rapid changes to matters referred to in the guidance – for example to legislation – it should not be assumed that the most recent version of this note reflects the very latest legal requirements; these requirements apply.

Consultation

- 1.9 This note has been produced in consultation with relevant trade bodies, representatives of regulators including members of the Industrial Pollution Liaison Committee and other potentially-interested organisations.

Policy and procedures

- 1.10 General guidance explaining LAPPC and setting out the policy and procedures is contained in separate documents for [England and Wales](#), [Scotland](#) and [Northern Ireland](#).

2. Timetable for compliance and reviews

Existing processes or activities

- 2.1 This note contains all the provisions from previous editions which have not been removed. Some have been amended. For installations in operation at the date this note is published, the regulator should have already issued or varied the permit having regard to the previous editions. If they have not done so, this should now be done.
- 2.2 The new provisions of this note and the dates by which compliance with these provisions is expected are listed in **Table 2.1**, together with the paragraph number where the provision is to be found. Compliance with the new provisions should normally be achieved by the dates shown. Permits should be varied as necessary, having regard to the changes and the timetable.

Table 2.1 - Compliance timetable		
Guidance	Relevant paragraph/row in this note	Compliance date
For a full list of the main changes, please see Table 6.1 in Section 6.		

- 2.3 Replacement plant should normally be designed to meet the appropriate standards specified for new installations/activities.
- 2.4 Where provisions in the preceding guidance note have been deleted or relaxed, permits should be varied as necessary as soon as reasonably practicable.
- 2.5 For new activities, the permit should have regard to the full standards of this guidance from the first day of operation.
- 2.6 For substantially changed activities, the permit should normally have regard to the full standards of this guidance with respect to the parts of the activity that have been substantially changed and any part of the activity affected by the change, from the first day of operation.

Permit reviews

- 2.7 Under LAPPC, the legislation requires permits to be reviewed periodically but does not specify a frequency. It is considered for this sector that a frequency of once every eight years ought normally to be sufficient for the purposes of the appropriate Regulations. Further guidance on permit reviews is contained in the appropriate Guidance Manual for [England and Wales](#) chapter 26, [Scotland, Practical guide](#) section 10, Northern Ireland [Part B Guidance](#) page 9, Northern Ireland [Part C Guidance](#) chapter 17. Regulators should use any opportunities to determine the variations to permits necessitated by paragraph 2.2 above in conjunction with these reviews.
- 2.8 Conditions should also be reviewed where complaint is attributable to the operation of the process and is, in the opinion of the regulator, justified.

3. Activity description

Regulations

- 3.1 This note applies to LAPPC installations for the storage, unloading and loading petrol at terminals. The activities for regulation are listed in **Table 3.1**.

Table 3.1 - Regulations listing activities			
LAPPC Activity	England and Wales	Scotland	Northern Ireland
	EPR Schedule 1 reference	PPC Schedule 1 reference	PPC Schedule 1 reference
Part B	Section 1.2 Part B	Section 1.2, Part B	Section 1.2 Part B
Part C	n/a	n/a	Section 1.2 Part C

The links are to the original version of the Regulations. A consolidated version is not available on www.legislation.gov.uk

For England and Wales, an [unofficial consolidated version](#) is available but read the first page of that document in order to understand its status and content.

National control

- 3.2 It should be noted that the national environmental agencies exercise regulatory control in respect of processes for the storage, loading and unloading of petrol at petrol storage terminals where these processes are carried on at the same location by the same person as a part of another process described in Part A of section 1 Schedule 1 to the relevant Regulations.

Process or activity

- 3.3 This note relates to the storage, loading and unloading of petrol at petrol storage terminals.
- 3.4 Petrol is stored in stationary tanks which are fixed roof tanks, or tanks with either internal or external floating roofs.
- 3.5 The petrol is loaded into road tankers, rail tankers or inland waterway vessels which are defined as non-sea going vessels of over 15 tonnes dead weight. Petrol is also transported by pipelines.

- 3.6 The principal emissions are associated with the escape of petrol vapour displaced by the petrol which has been loaded into the fixed or mobile tank. (Petrol means any petroleum derivative, with or without additives, having a Reid vapour pressure of 27.6 kilopascals or more which is intended for the use as a fuel for motor vehicles, other than liquefied petroleum gas.)
- 3.7 In the context of this note, "process" or activity comprises the whole process from receipt of refined product via production of intermediates to dispatch of finished products, including the treating, handling and storage of all materials and wastes relating to the process.

4. Emission limits, monitoring and other provisions

- 4.1 Emissions of the substances listed **Table 4.1** should be controlled.
- 4.2 The emission limit values and provisions described in this section are achievable using the best available techniques described in **Section 5**. Monitoring of emissions should be carried out according to the method specified in this section or by an equivalent method agreed by the regulator. Where reference is made to a British, European, or International standard (BS, CEN or ISO) in this section, the standards referred to are correct at the date of publication. (Users of this note should bear in mind that the standards are periodically amended, updated or replaced.) The latest information regarding the monitoring standards applicable can be found at the [Source Testing Association website](#). Further information on monitoring can be found in Environment Agency publications, [M1](#) and [M2](#).
- 4.3 All activities should comply with the emission limits and provisions with regard to releases in **Table 4.1**.

The reference conditions for limits in **Section 4** are: 273.1K, 101.3kPa, without correction for water vapour content, unless stated otherwise.

Table 4.1 should be considered in conjunction with the monitoring paragraphs found later in this section.

Table 4.1 - Emission limits, monitoring and other provisions

Row	Substance	Source	Emission limits/provisions	Type of monitoring	Monitoring frequency
1	Vapour recovery units	Total organic carbon	35g/Nm ³ as 1 hourly average	Manual extractive testing as per the test appended at Annex 1 or continuous monitoring	Each unit tested once every three years

Monitoring, investigating and reporting

- 4.4 The operator should monitor emissions, make tests and inspections of the activity. The need for and scope of testing, (including the frequency and time of sampling), will depend on local circumstances.
- The operator should keep records of inspections, tests and monitoring, including all non-continuous monitoring, inspections and visual assessments. Records should be:
 - kept on site;
 - kept by the operator for at least two years; **and**
 - made available for the regulator to examine.
 - If any records are kept off-site they should be made available for inspection within one working week of any request by the regulator.

Information required by the regulator

- 4.5 The regulator needs to be informed of monitoring to be carried out and the results. The results should include process conditions at the time of monitoring.
- The operator should notify the regulator at least 7 days before any periodic monitoring exercise to determine compliance with emission limit values. The operator should state the provisional time and date of monitoring, pollutants to be tested and the methods to be used.
 - The results of non-continuous emission testing should be forwarded to the regulator within 8 weeks of completion of the sampling.
 - Adverse results from any monitoring activity (both continuous and non-continuous) should be investigated by the operator as soon as the monitoring data has been obtained. The operator should:
 - identify the cause and take corrective action;
 - clearly record as much detail as possible regarding the cause and extent of the problem, and the remedial action taken;
 - re-test to demonstrate compliance as soon as possible; and inform the regulator of the steps taken and the re-test results.

Abnormal events

- 4.6 The regulator needs to be notified about certain events, whether or not there is related monitoring showing an adverse result, and the operator should respond to problems which may have an adverse effect on emissions to air.
- In the case of abnormal emissions, malfunction or breakdown leading to abnormal emissions the operator should:
 - investigate and undertake remedial action immediately;
 - adjust the process or activity to minimise those emissions; **and**
 - promptly record the events and actions taken.
 - In the case of repeated failure of the vapour recovery unit, the operator should submit, and implement to a timetable, proposals to improve the operating efficiency of the unit.
 - The regulator should be informed without delay, whether or not there is related monitoring showing an adverse result:
 - if there is an emission that is likely to have an effect on the local community; **or**
 - in the event of the failure of key arrestment plant, for example vapour recovery units.
 - The operator should provide a list of key arrestment plant and should have a written procedure for dealing with its failure, in order to minimise any adverse effects.

Continuous monitoring

- 4.7 Continuous monitoring can be either “quantitative” or “indicative”. With quantitative monitoring the discharge of the pollutant(s) of concern is measured and recorded numerically. For pollution control this measurement is normally expressed in milligrams per cubic metre of air, (mg/m^3). Where discharge of the pollutant concerned is controlled by measuring an alternative parameter, (the “surrogate” measurement), this surrogate is also expressed numerically.

Continuous indicative monitoring is where a permanent device is fitted, for example, to detect leaks in a bag filter, but the output, whether expressed numerically or not, does not show the true value of the discharge. When connected to a continuous recorder it will show that emissions are gradually (or rapidly) increasing, and therefore maintenance is required. Alternatively it can trigger an alarm when there is a sudden increase in emissions, such as when arrestment plant has failed.

- 4.8 Where continuous indicative monitoring has been specified, the information provided should be used as a management tool. Where used and where the monitor has an hourly averaged emissions output, the monitor should be set up to provide a baseline output when the plant is known to be operating under the best possible conditions and emissions are complying with the requirements of the permit. Where used the hourly averaged emissions output to trigger alarms, the instrument manufacturer should be able to set an output level which corresponds to around 75% of the emission limit. Thus the alarms are activated in response to this significant increase in pollutant loading above the baseline, so that warning of the changed state is given before an unacceptable emission occurs. The regulator may wish to agree the alarm trigger level.
- 4.9 Where continuous monitoring is required, it should be carried out as follows:
- All continuous monitoring readings should be on display to appropriately trained operating staff.
 - Instruments which provide an hourly averaged emissions output should be fitted with audible and visual alarms, situated appropriately to warn the operator of arrestment plant failure or malfunction
 - The activation of alarms should be automatically recorded.
 - All continuous monitors should be operated, maintained and calibrated (or referenced, in the case of indicative monitors) in accordance with the manufacturers' instructions, which should be made available for inspection by the regulator.
 - The relevant maintenance and calibration (or referencing, in the case of indicative monitors) should be recorded.
 - Emission concentrations may be reported as zero when the plant is off and there is no flow from the stack. If required a competent person should confirm that zero is more appropriate than the measured stack concentration if there is no flow.
 - Any continuous quantitative monitor used should provide reliable data >95% of the operating time, (i.e. availability >95%). A manual or automatic procedure should be in place to detect instrument malfunction and to monitor instrument availability.

Calibration and compliance monitoring

- 4.10 Compliance monitoring can be carried out either by use of a continuous emissions monitor (CEM), or by a specific extractive test carried out at a frequency agreed with the regulator.
- 4.11 Where a CEM is used for compliance purposes it must be periodically checked, (calibrated), to ensure the readings being reported are correct. This calibration is normally done by carrying out a parallel stand-alone extractive test and comparing the results with those provided by the CEM.

Representative sampling

- 4.12 Whether sampling on a continuous or non-continuous basis, care is needed in the design and location of sampling systems, in order to obtain representative samples for all release points.
- Sampling points on new plant should be designed to comply with the British or equivalent standards (see paragraph 4.2).
 - The operator should ensure that relevant stacks or ducts are fitted with facilities for sampling which allow compliance with the sampling standards.
- 4.13 Where a new or substantially changed process is being commissioned, or where emission levels are near to or approach the emission concentration limits, regulators should consider increasing the frequency of testing.

5. Control techniques

Summary of best available techniques

- 5.1 **Table 5.1** provides a summary of the best available techniques that can be used to control the process in order to meet the emission limits and provisions in **Section 4**. Provided that it is demonstrated to the satisfaction of the regulator that an equivalent level of control will be achieved, then other techniques may be used.

Table 5.1 - Summary of control techniques		
Release source	Substance	Control techniques
Petrol storage	Petrol vapours	Minimise breathing losses Good seals Connect to vapour recovery unit (or hold vapour)
Loading fixed tanks	Petrol vapours	Connect to vapour recovery unit (or hold vapour)
Loading mobile tanks	Petrol vapours	Connect to vapour recovery unit (or hold vapour)

Techniques to control emissions from contained sources

Storage installations

- 5.2 The external wall and roof of tanks above ground must be painted in a colour or colours with a total radiant heat or light reflectance of 70% or more, unless the tank is linked to a vapour recovery unit. This paragraph should not require the replacement of tanks with internal or external floating roofs with fixed roof tanks connected to a vapour recovery unit.
- 5.3 Such painting should not be required where the tanks are situated in special landscape areas such as national parks, the Broads, the New Forest and Areas of Outstanding Natural Beauty or which are visible from such an area. In any event, a close liaison with the local planning authority responsible for development control should be maintained.

- 5.4 Tanks with external floating roofs must be equipped with a primary seal to cover the annular space between the tank wall and the outer periphery of the floating roof and with a secondary seal fitted above the primary seal. The seals must be designed to achieve an overall containment of vapours of 95% or more as compared to a comparable fixed roof tank with no vapour containment controls (that is a fixed roof tank with only vacuum /pressure relief valve).

An external floating roof and seal system should be deemed to achieve an overall containment of vapours of 95% or more compared to a comparable fixed roof tank solely fitted with pressure/vacuum relief valves if:

- the roof is fitted with both primary and secondary seals;
- the primary seal extends from the floating roof to the tank wall and the secondary seal is fitted above it; **and**
- the seal system is designed to accommodate variations in the gap between the floating roof and the tank wall, and the tank and the roof comply with the requirements of BS EN14015 (Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above) or equivalent.

Floating roofs should be landed as infrequently as possible to avoid vapour release on recommissioning.

- 5.5 All new storage installations at terminals where vapour recovery is needed to comply, shall be either:

- tanks designed with a floating roof, either external or internal, equipped with primary and secondary seals; **or**
- fixed roof tanks connected to a vapour recovery unit.

- 5.6 An internal floating roof and seal system installed in a new tank should be deemed to achieve an overall containment of vapours of 95% or more compared to a comparable fixed roof tank solely fitted with pressure/vacuum (P/V) relief valves if:

- the roof is fitted with both primary and secondary seals;
- the primary seal extends from the floating roof to the tank wall and the secondary seal is fitted above it;
- the seal system is designed to accommodate variations of the gap between the floating roof and the tank wall, and the tank and the roof complies with the requirements of BS EN14015 or equivalent; **and**
- the roof and seal system are designed and installed as per as per the API Standard 620: Design and construction of large, welded, low-pressure storage tanks.”

5.7 Existing fixed roof tanks must either:

- be connected to a vapour recovery unit; **or**
- have an internal floating roof with a primary seal which should be designed to achieve an overall containment of vapours of 90% or more in relation to a comparable fixed roof tank with no vapour controls.

5.8 An internal floating roof and seal system should be deemed to achieve an overall containment of vapours of 90% or more compared to comparable fixed roof tank solely fitted with pressure/vacuum (P/V) relief valves if:

- the roof is fitted with a primary seal;
- the seal extends from the floating roof to the tank wall;
- the seal is designed to accommodate variations in the gap between the floating roof and the tank wall, and the tank and the roof complies with the requirements of BS EN14015 or equivalent; **and**
- the roof and seal are designed and installed as per the API Standard 620: Design and construction of large, welded, low-pressure storage tanks.”

The provisions of this paragraph should not be applied to existing horizontal tanks; they should also not be applied to existing vertical tanks with a diameter less than 6m at terminals with a throughput of less than 10,000 tonnes per year.

5.9 The standards for vapour containment controls shall not apply to:

- fixed roof tanks at terminals where intermediate storage of vapours is permitted;
- tanks which receive dumped product mixtures, such as interface tanks and slop tanks. Such mixtures contain, but are not wholly comprised of, petrol.

Loading and unloading of mobile containers at terminals

5.10 Displacement vapours from the mobile container being loaded must be returned through a vapour tight connection line to a vapour recovery unit for recovery at the terminal.

5.11 At terminals with a throughput of less than 25,000 tonnes per year, intermediate storage of vapours may be substituted for immediate vapour recovery at the terminal.

Vapour balancing systems should be designed in accordance with the Institute of Petroleum's Guidelines for the Design and Operation of Gasoline Vapour Emission Controls.

Operators of terminals with intermediate vapour storage systems should have written procedures for the operation of such systems including instructions on the connection of vapour hoses or arms to mobile containers prior to the off-loading of petrol from them into any tanks used for intermediate vapour storage, and their subsequent disconnection at the completion of off-loading.

5.12 Vapour collection pipework, except for flexible hoses, should be tested prior to initial commissioning as follows:

- where systems are made up of prefabricated lengths joined together mechanically, each length (including any permanent attachment of the jointing mechanism) should be tested to a minimum pressure of 1 bar for a period of one hour. Assembly of mechanical joints should be subject to inspection;
- where the systems are assembled with permanent joints (for example, welded, cemented) they should be tested to the above requirement on completion.

In-service monitoring should comprise an annual visual examination of the system to check for integrity and alignment of the pipework and the joints.

An annual visual examination of bellows and flexible hoses used to connect mobile containers to the vapour collection pipework should be undertaken to check for integrity; wear and security of connections.

5.13 If a leak occurs in the vapour collection system (including the vehicle) at a gantry during loading of an approved bottom loading vehicle, operations at that gantry shall be shut down until the leak is sealed. Equipment to facilitate such shut down operations shall be installed at the loading gantry. Operating instructions to loading personnel shall include provisions regarding the detection of leaks and reporting and shut down procedures.

Gantries

5.14 The liquid coupler on the loading arm shall be a female coupler which should mate with a 4-inch API (101.6mm) male adapter located on the vehicle.

5.15 The vapour-collection coupler on the loading-gantry vapour-collection hose shall be a cam-and-groove female coupler which should mate with a 4-inch (101.6mm) cam-and-groove male adapter located on the vehicle.

5.16 The normal liquid-loading rate shall be 2,300 litres per minute (maximum 2,500 litres per minute) per loading arm.

5.17 When the terminal is operating at peak demand, its loading gantry vapour collection system, including the Vapour Recovery Unit, shall be allowed to generate a maximum counterpressure of 55 millibar on the vehicle side of the vapour collection adapter, (This is equivalent to a maximum counterpressure of 45 millibar at the interface between the adaptor and coupler).

- 5.18 The loading gantry shall be equipped with an overfill-detection control unit which, when connected to the vehicle, shall provide a fail-safe signal to enable loading, providing no compartment-overfill sensors detect a high level.
- 5.19 The vehicle shall be connected to the Control Unit on the gantry via a 10-pin industry-standard electrical connector. The male connector shall be mounted on the vehicle and the female connector shall be attached to a flying lead connected to the gantry-mounted Control Unit.
- 5.20 The gantry Control Unit shall be suitable for both 2-wire and 5-wire vehicle systems.
- 5.21 The vehicle shall be bonded to the gantry via the common return wire of the overfill sensors, which shall be connected to pin 10 on the male connector via the vehicle chassis. Pin 10 on the female connector shall be connected to the Control Unit enclosure which shall be connected to the gantry earth.
- 5.22 The design of the liquid-loading and vapour collection facilities on the loading gantry shall be based on the following vehicle-connection envelope:
- The height of the centre line of the liquid adapters shall be:
 - maximum 1.4 metres (unladen); minimum 0.5 metres (laden), the preferred height being 0.7 to 1.0 metres;
 - the horizontal spacing of the adapters shall not be less than 0.25 metres (preferred minimum spacing is 0.3 metres);
 - all liquid adapters shall be located within an envelope not exceeding 2.5 metres in length;
 - the vapour-collection adapter shall be located preferably to the right of the liquid adapters and at a height not exceeding 1.5 metres (unladen) and not less than 0.5 metres (laden).
- 5.23 The earth/overfill connector must be located to the right of the liquid and vapour-collection adapters and at a height not exceeding 1.5 metres (unladen) and not less than 0.5 metres (laden).
- 5.24 Loading shall not be permitted unless a permissive signal is provided by the combined earth/overfill control unit.
- 5.25 In the event of an overfill condition or the loss of vehicle earth the Control Unit on the gantry shall close the gantry-loading control valve.
- 5.26 Loading shall not be permitted unless the vapour-collection hose has been connected to the vehicle and there is a free passage for the displaced vapours to flow from the vehicle into the vapour-collection system.

Air quality

Ambient air quality management

5.27 In areas where air quality standards or objectives are being breached or are in serious risk of breach and it is clear from the detailed review and assessment work under Local Air Quality Management that the permitted process itself is a significant contributor to the problem, it may be necessary to impose tighter emission limits. If the standard that is in danger of being exceeded is not an EC Directive requirement, then industry is not expected to go beyond BAT to meet it. Decisions should be taken in the context of a local authority's Local Air Quality Management action plan. For example, where a permitted process is only responsible to a very small extent for an air quality problem, the authority should not unduly penalise the operator of the process by requiring disproportionate emissions reductions. Paragraph 59 of the [Air Quality Strategy 2007 \[Volume 1\]](#) gives the following advice:

“...In drawing up action plans, local authority environmental health/pollution teams are expected to engage local authority officers across different departments, particularly, land-use and transport planners to ensure the actions are supported by all parts of the authority. In addition, engagement with the wider panorama of relevant stakeholders, including the public, is required to ensure action plans are fit-for-purpose in addressing air quality issues. It is vital that all those organisations, groups and individuals that have an impact upon local air quality, buy-in and work towards objectives of an adopted action plan.”

Management

Management techniques

5.28 Important elements for effective control of emissions include:

- proper management, supervision and training for process operations;
- proper use of equipment;
- effective preventative maintenance on all plant and equipment concerned with the control of emissions to the air; **and**
- ensuring that spares and consumables - in particular, those subject to continual wear – are held on site, or available at short notice from guaranteed local suppliers, so that plant breakdowns can be rectified rapidly. This is important with respect to arrestment plant and other necessary environmental controls. It is useful to have an audited list of essential items.

Appropriate management systems

- 5.29 Effective management is central to environmental performance; it is an important component of BAT and of achieving compliance with permit conditions. It requires a commitment to establishing objectives, setting targets, measuring progress and revising the objectives according to results. This includes managing risks under normal operating conditions and in accidents and emergencies.

It is therefore desirable that installations put in place some form of structured environmental management approach, whether by adopting published standards (ISO 14001 or the EU Eco Management and Audit Scheme [EMAS]) or by setting up an environmental management system (EMS) tailored to the nature and size of the particular process. Operators may also find that an EMS will help identify business savings.

- 5.30 Regulators should use their discretion, in consultation with individual operators, in agreeing the appropriate level of environmental management. Simple systems which ensure that LAPPC considerations are taken account of in the day-to-day running of a process may well suffice, especially for small and medium-sized enterprises. Regulators are urged to encourage operators to have an EMS for all their activities, but it is outside the legal scope of an LAPPC permit to require an EMS for purposes other than LAPPC compliance. For further information/advice on EMS refer to the appropriate chapter of the appropriate Guidance Manual for [England and Wales](#), [Scotland](#) and [Northern Ireland](#).

Training

- 5.31 Staff at all levels need the necessary training and instruction in their duties relating to control of the process and emissions to air. In order to minimise risk of emissions, particular emphasis should be given to control procedures during start-up, shut down and abnormal conditions. Training may often sensibly be addressed in the EMS referred to above.
- All staff whose functions could impact on air emissions from the activity should receive appropriate training on those functions. This should include:
 - awareness of their responsibilities under the permit;
 - steps that are necessary to minimise emissions during start-up and shutdown;
 - actions to take when there are abnormal conditions, or accidents or spillages that could, if not controlled, result in emissions.
 - The operator should maintain a statement of training requirements for each post with the above mentioned functions and keep a record of the training received by each person. These documents should be made available to the regulator on request.

Maintenance

5.32 Effective preventative maintenance plays a key part in achieving compliance with emission limits and other provisions. All aspects of the process including all plant, buildings and the equipment concerned with the control of emissions to air should be properly maintained. In particular:

- The operator should have the following available for inspection by the regulator:
 - a written maintenance programme for all pollution control equipment; **and**
 - a record of maintenance that has been undertaken.

6. Summary of changes

The main changes to this note, with the reasons for the change, are summarised in **Table 6.1**. Minor changes that will not impact on the permit conditions e.g. slight alterations to the Process Description have not been recorded.

Table 6.1 - Summary of changes			
Section/paragraph/row	Change	Reason	Comment
Throughout	There are no regulatory changes but the note is in the newer format	New format is shorter and more simple to follow	

7. Further information

Sustainable consumption and production (SCP)

Both business and the environment can benefit from adopting sustainable consumption and production practices. Estimates of potential business savings include:

- £6.4 billion a year UK business savings from resource efficiency measures that cost little or nothing;
- 2% of annual profit lost through inefficient management of energy, water and waste;
- 4% of turnover is spent on waste.

When making arrangement to comply with permit conditions, operators are strongly advised to use the opportunity to look into what other steps they may be able to take, for example, having regard to the efficient use of auxiliary fuels, such as gas and electricity. Regulators may be willing to provide assistance and ideas, although cannot be expected to act as unpaid consultants.

Health and safety

Operators of installations must protect people at work as well as the environment:

- requirements of a permit should not put at risk the health, safety or welfare of people at work or those who may be harmed by the work activity;
- equally, the permit must not contain conditions whose only purpose is to secure the health of people at work. That is the job of the health and safety enforcing authorities.

Where emission limits quoted in this guidance conflict with health and safety limits, the tighter limit should prevail because:

- emission limits under the relevant environmental legislation relate to the concentration of pollutant released into the air from prescribed activities;
- exposure limits under health and safety legislation relate to the concentration of pollutant in the air breathed by workers;
- these limits may differ since they are set according to different criteria. It will normally be quite appropriate to have different standards for the same pollutant, but in some cases they may be in conflict (for example, where air discharged from a process is breathed by workers). In such cases, the tighter limit should be applied to prevent a relaxation of control.

Further advice on responding to incidents

The UK Environment Agencies have published [guidance](#) on producing an incident response plan to deal with environmental incidents. Only those aspects relating to air emissions can be subject to regulation via a Part B (Part C in NI) permit, but regulators may nonetheless wish to informally draw the attention of all appropriate operators to the guidance.

It is not envisaged that regulators will often want to include conditions, in addition to those advised in this PG note, specifying particular incident response arrangements aimed at minimising air emissions. Regulators should decide this on a case-by-case basis. In accordance with BAT, any such conditions should be proportionate to the risk, including the potential for harm from air emissions if an incident were to occur. Account should therefore be taken of matters such as the amount and type of materials held on site which might be affected by an incident, the likelihood of an incident occurring, the sensitivity of the location of the installation, and the cost of producing any plans and taking any additional measures.

Appendix 1 - Compliance test method for vapour recovery units

1. Test applicability

This method applies to performance testing of any vapour recovery unit (VRU), installed at any petrol terminal, as required to demonstrate that the unit is in compliance with legislation governing atmospheric emissions from such units.

2. Principle

During the compliance test, total organic compound (TOC) vapour concentration in the VRU vent line is measured at regular intervals when there is vapour flow into the VRU. The test is conducted over at least a seven-hour period during the course of a normal working day. The mean TOC concentration in the vent line is reported for each 60-minute period of the test as mass per normal unit volume. Compliance is confirmed if the mean TOC concentration for each of the 60 minute periods reported is below the emission limit applicable to the VRU as stated in **Table 4.1** of PGN.

3. Inspection of vapour collection system

Prior to any compliance test, a visual inspection of the integrity of the vapour collection system shall be carried out to check for damage or misalignment of the pipework and the joints. Any damage shall be rectified before the test is undertaken.

4. Compliance test

4.1 General

4.1.1 Measurement frequency

Direct measurements of TOC concentration in the VRU vent (or vapour sampling for subsequent TOC measurement) shall be made at regular intervals, but at least once every 15 minutes, when there is vapour flow into the VRU. For VRUs which operate in batch mode (e.g. carbon adsorption type VRUs) the interval should be set so that at least two measurements are made (or samples are collected) within each VRU 'batch' cycle time (e.g. carbon bed cycle times).

The measurement frequency used should reflect the typical number and length of periods when there is vapour flow into the VRU during normal operations at the terminal. Measurements should be made during as many periods of vapour flow as is practical.

If on review of the terminal records at the end of the test it is found that measurements were made when there was no vapour flow into the VRU, for example because there was no loading at that time, those measurements shall be disregarded.

4.1.2 Duration

The duration of the test shall be at least seven hours during the course of normal working day, except for the following types of installation:

- (i) Where a vapour holding tank (VHT) is installed, the duration of the test shall be the time taken for the VRU to process the vapours generated and fed to the VHT during at least seven hours of normal operations at the terminal.
- (ii) Where a VRU is connected to storage tank vapour spaces, the duration of the test shall be a typical tank filling period of seven hours of filling where the time taken for tank filling is more than seven hours.

During the test period there shall be at least one hour in which four or more measurements of TOC concentration are made. If this condition is not met during a period of seven hours, then the test shall be extended until it is met.

4.1.3 VRU with multiple vents

Where a VRU has more than one vent, but vapours are emitted from only one vent at any one time (e.g. a carbon adsorption type VRU with two carbon beds operating on a cyclic basis), a similar number of TOC concentration measurements should be made from each of the vents during the test period.

Where a VRU has more than one vent emitting vapours simultaneously then the vents should be linked into a common vent and measurement made of the TOC concentration in that common vent.

4.1.4 Vent vapour dilution

Where the VRU process results in exhaust vapour dilution, (e.g. for systems using direct cooling by nitrogen), the flowrates of the inlet vapours and the dilution medium shall be measured at the same time as the TOC concentration. Flow should be measured according to BS 3405 or a similar method of equivalent accuracy. Each TOC concentration measurement shall then be corrected for dilution using inlet and diluent volumes.

4.1.5 Test report

The compliance test report shall state the average vent TOC concentration in g/Nm^3 calculated for each hour of the test. It shall also give detail of the test method and measurement equipment used.

4.2 Apparatus

If electrical equipment is to be used within a hazardous area, either suitably certified equipment should be used, or the test should be carried out under an appropriate hazardous operations "hot work" permit scheme.

The essential components of the measurement system are:

4.2.1 Sampling point

A sampling point must be located at a position from which a representative sample of emitted vapour can be drawn (see Paragraph 4.12 of PGN).

Where a VRU has more than one vent (e.g. a carbon adsorption type unit with carbon beds operating on a cyclic basis), separate sampling points should be provided in each vent line.

4.2.2 Sample line

The sample line used to connect between the sampling point and the TOC meter or sample gas bag should consist of metal, or other suitable non-permeable and non-adsorbent material. The sample line should have adequate electrical conductivity to prevent the build up of static electric charge. The sample line and the TOC meter should be earthed.

4.2.3 TOC meter

The total organic compounds (TOC) meter must be capable of measuring the concentration of TOC vapour in air without interference from any other gases which may be present in air. It should be noted that although use of oxygen deficiency instruments is a valid and well established technique to determine the total hydrocarbon concentration at the VRU inlet, this technique cannot be used to derive VRU vent emissions. The measurement cannot provide sufficient accuracy, due to the fundamental limits of resolution and repeatability achievable. For activated carbon adsorption systems, there is also the further possibility of oxygen depletion by the carbon causing erroneous measurements.

If battery powered, the meter should be capable of at least 8 hours continuous operation.

The meter should be calibrated in units of ppm of n-butane.

The meter should have a measuring range from 1000 ppm up to at least twice the expected vent TOC concentration. If this is not known, the range should be up to at least 1.5 times the emission limit.

The response of the meter to propane and n-pentane relative to that of n-butane must be known (see **Annexes 3 and 5**).

The overall measurement uncertainty due to the TOC meter and the calibration method must not exceed 10% of the emission limit. In order to achieve this the calibration gas should be specified as in **Annex 1** and the TOC meter specification should be:

- repeatability should not exceed 3% of the emission limit;
- linearity of response should not exceed 5% over the measuring range;
- zero drift during use should not exceed 5% of the emission limit per hour once the meter has stabilised at its operating temperature;
- the TOC meter calibration stability should be such that calibrations made before and after measurements do not differ by more than 5%.

4.2.4 Gas sampling pump

A gas sampling pump is required to draw gas from the sampling point to the TOC meter or gas sampling bags. The sampling pump may be separate or an integral part of the TOC meter.

The pump should be capable of pumping at a rate which will result in the sample line volume being displaced within at least 30 seconds.

If battery operated, the pump should be capable of at least 8 hours continuous operation.

4.2.5 Gas sampling bags

Gas sampling bags must be made from a material which is impermeable to hydrocarbons and does not adsorb hydrocarbons onto its surface. Tedlar or similar fluorocarbon polymer is recommended. The bags should be strong enough to withstand physical handling without cracking and leaking. The filling/emptying valve should be made from inert material.

Bags should be cleaned before use by flushing with clean dry air then evacuating, three times.

4.3 Test preparation

4.3.1 Safety

The person(s) undertaking the test must be conversant with the Health, Safety and other appropriate regulations pertaining at the site and should comply with those regulations.

An appropriate hazardous operations "hot work" permit must be obtained if electrical equipment that is not suitably certified is to be used within a hazardous area.

4.3.2 Connection of sample line

Connect the sample line to the sampling point (or on-stream sampling point where the VRU has more than one vent).

Ensure that all pipe joints and connections in the sample line are leak tight.

Ensure that the sample pump flowrate is such that the sample line volume displacement time is less than 30 seconds. Where a separate pump is used, the outlet may need to be connected to a tee-piece to prevent pressurisation of the meter inlet, with one branch connected to the TOC meter and the other to a vent in a safe location.

Ensure that the TOC measurement system vent is located where the vapours can be safely dispersed. Flush the sampling line for at least 5 minutes with vapour from the VRU vent prior to the start of the compliance test.

4.3.3 Pre-test measurement system preparation

A decision tool for determining which measurement technique should be used, depending upon the type of TOC meter, is given in Annex 5.

Set Up the TOC meter according to the manufacturers' instructions.

Switch on all equipment and allow this to stabilise for the minimum period recommended by the manufacturers.

4.3.4 Pre-test measurement system zero setting

When the measurement system has stabilised, but prior to the start of the compliance test, zero the TOC meter. This should be carried out according to the manufacturers' instructions.

4.3.5 Pre-test measurement system calibration

Calibrate the TOC meter according to the manufacturers' instructions; in units of ppm of n- butane (see also **Annex 1**).

4.4 Emission measurement test procedure

4.4.1 TOC concentration measurement

Connect the TOC meter to the sampling system. If gas bag sampling is used, refer to section 4.4.5.

Record the location, date and start time of the test.

Take readings of TOC concentration from the meter at regular intervals, but at least once every 15 minutes, when there is vapour flow into the VRU.

Record time of each TOC concentration measurement.

Where a VRU has more than one vent, ensure that the sampling line is connected to the vent on-stream. Change the sampling point used as appropriate, depending upon the operation of the VRU, so that samples are always taken from the on-stream vent. Take measurements from all on-stream sampling points in approximately equal numbers over the test period.

At the end of the test, if necessary, compare the times that TOC concentration measurements were made with the terminal records. If a measurement was made when there was no vapour flow to the VRU (e.g. no loading was taking place), then that measurement should be disregarded.

If any measurement of TOC concentration is outside of the range of the TOC meter, the test must be invalidated.

4.4.2 Sampling for measurement of vapour composition

A composite sample of vapour must be collected over the test period if the response factors of the TOC meter to propane and n-pentane relative to n-butane in mass concentration units are outside of the range 0.9 to 1.1 (see **Annexes 3 and 5**).

Collect a composite sample of vapour in a gas sampling bag over the test period by:

- either continuously pumping sample gas into the bag at a low steady flowrate over the entire test period. Sampling should be interrupted during lengthy periods when there is no vapour flow to the VRU;
- or by transferring set volumes of sample gas into the bag every 15 minutes over the test period, when there is vapour flow to the VRU.

4.4.3 TOC meter zero adjustment

Immediately before starting measurements and at regular intervals throughout the test, but at least once every hour, disconnect the TOC meter from the sample line and re-introduce zero gas to the meter. When the reading has stabilised, record the reading and re-adjust the instrument to read zero.

If the zero has drifted by more than 5% of the emission limit (expressed as ppm n-butane) since the previous zero adjustment, discard all readings since the previous adjustment.

4.4.4 Post-test calibration drift determination

At the end of the test period, disconnect the TOC meter from the sample line and re-introduce zero gas. Record the reading when it has stabilised.

If the zero has drifted by more than 5% of the emission limit (expressed as ppm n-butane) since the previous zero adjustment, discard all readings since the previous adjustment.

Within 24 hours of the end of the test, set the zero and recalibrate the meter as specified in **Annex 1**. If the calibration drift value exceeds the limit specified in section 4.2.3, re-calibrate the measurement system as specified in **Annex 1** and report the results using both sets of calibration data.

4.4.5 Measurement of TOC concentration using gas bags (where taken)

The TOC meter, sample line, sampling pump and gas bags should meet the specifications in section 4.2.

The gas bags should be suitably cleaned (see section 4.2.5) and clearly marked before use. If bags are reused during the test they must be evacuated before each reuse.

Connect the gas bag to the sample line via a sampling pump.

Record the location, date and start time of the test.

Take samples in gas bags at regular intervals, but at least once every 15 minutes, when there is vapour flow into the VRU. For VRUs which operate in batch mode (e.g. carbon adsorption type VRUs) the interval should be set so that at least two samples are collected within each VRU 'batch' cycle time (e.g. carbon bed cycle times).

The bag samples should contain sufficient vapour to permit the measurement of TOC concentration to be repeated if necessary.

Record the time of each sampling and the sample gas bag identification.

At the end of the test, if necessary, compare the times that vapour samples were taken with the terminal loading records. If a sample was taken when there was no vapour flow to the VRU (e.g. there was no loading taking place), then that sample should be disregarded.

If the reliable bag storage time is not known, measurements should be undertaken within 2 hours of the sample being taken.

Prior to measurements being made, zero and calibrate the meter as in sections 4.3.4 and 4.3.5.

At regular intervals between gas bag sample measurements, but at least once per hour, re-zero the TOC meter as in section 4.4.3.

Following the completion of measurements on all the gas samples, recalibrate the meter and determine the drift as in section 4.4.4.

If any measurement of TOC concentration is outside of the range of the TOC meter, the test must be invalidated.

4.4.6 Analysis of vapour composition sample (where taken)

If a composite sample was taken over the test period (section 4.4.2), obtain an analysis of the sample TOC vapour composition from a suitably accredited laboratory which should use a validated procedure meeting the following requirements:

- identification of the carbon number and the type (paraffin, olefin, naphthene, aromatic) of major components (those which make up more than 95% of the total TOC mass) either individually or by carbon number groups;
- measurement of major components with an accuracy of at least 5% of the concentration of each component.

If the reliable bag storage time is not known, undertake this analysis within 24 hours from the end of the test.

[Typically, analysis will be by gas chromatography (GC) using a temperature programmed capillary column and a flame ionisation detector].

Express results in volume % of components, normalised to 100% TOC.

Calculate the molecular weight of the TOC. An example of this calculation is given in **Annex 2**.

4.5 Calculations

4.5.1 Calculation of mean hourly vent TOC concentrations

Calculate the mean TOC concentration for each hourly period of the test (from the start time) from each of the readings taken from the TOC meter during that hour (or from the TOC measurements of the samples taken in gas bags during that hour) if four or more measurements have been made in that hour.

4.5.2 Concentration correction for TOC meter response factor

Divide the hourly mean TOC concentrations by the meter overall response factor. Guidance on the calculation of the factor is given in **Annex 3**.

4.5.3 Conversion of TOC volume concentrations to mass concentrations

Convert the hourly mean TOC volume concentrations to mass concentrations as specified in **Annex 4**.

5. Reporting

Report the results of the compliance test as average mass TOC per normal unit volume vented (g/Nm^3) for each hour of the test during which four or more TOC concentration measurements were made.

The report should include the following:

- Location of VRU;
- Site operator;
- Date of test;
- Start time of test,
- Who undertook test;
- A sketch of the sampling point location;
- A copy of the test method used;
- Type, make and serial number of TOC meter used;
- Uncertainty of test results;
- Hourly mean TOC concentration in g/Nm^3 for each hour of the test;
- Emission limit applicable to the VRU.

The following information should be made available on request from the local enforcing authority:

All TOC concentration measurements (in ppm) or one minute average TOC concentration data where the frequency of measurement is in excess of once per minute;

Where vent vapour dilution occurred, all the measurements of VRU inlet vapour and diluent gas flows;

Example of a typical calculation to derive hourly mean TOC mass concentration.

Test method Annex 1

TOC meter calibration

Appropriate care must be taken during the handling of compressed and liquefied gases.

A1 Calibration procedure

The concentration of the calibration gas should be reported in ppm.

The TOC meter should be calibrated at least before and after use. Mixtures of n-butane, having a purity of at least 99%, and clean air (i.e. containing <1% of emission limit TOC concentration) or inert gas should be used (see **section A2**).

Calibrations should be made at least at two concentrations, aimed at covering the highest expected measurement concentration and half that concentration. If the highest expected measurement concentration is not known, then this should be assumed to be equal to the emission limit. A zero setting should also be made.

Calibrations made before and after measurements must not differ by more than $\pm 5\%$, (e.g. for a meter calibrated prior to the test with 10,000 ppm n-butane, the results of the calibration after the test should not differ by more than 500 ppm).

Meters should be calibrated at a similar temperature to the measurement conditions. The pressure at the sample inlet should also be similar to measurement conditions. If practical, the meter should be calibrated via the same sample connection tubing that is used for measurements. Otherwise, tubing of the same type and dimensions used to make the measurements should be employed during calibration.

Calibration should be carried out as follows, taking account of the manufacturers' instructions:

- (i) Switch the TOC meter on and allow to stabilise;
- (ii) Set the meter zero using clean air or other suitable gas containing no TOCs;
- (iii) Introduce the calibration standards, one at a time, starting with the lowest concentration, allowing the meter reading to stabilise each time and recording each stable reading;
- (iv) Following calibration with the standard having the highest concentration, repeat the calibration with the lowest concentration standard. The repeat readings should not differ by more than $\pm 3\%$ of reading.

Where measurement calculations are made manually, a calibration graph should be constructed. The graph should be a smooth curve or straight line. Where measurement calculations are made electronically, a suitable curve fitting equation should be derived that fits the calibration points within $\pm 1\%$.

A2 Calibration gas mixtures

The gas mixture used for meter calibration should be traceable to a national standard, or a certified flow meter or an absolute volumetric measurement, such that the uncertainty in the stated concentration of the gas mixture does not exceed $\pm 5\%$.

Three types of calibration gas may be used:

- purchased calibration standard mixtures;
 - dynamic volumetric mixtures blended using flow meters;
 - static volumetric mixtures in a container such as a gas bag.
- (i) The suppliers of calibration standard mixtures in compressed gas cylinders should provide suitable certification stating the gas composition, its accuracy and details of traceability on the method of determination of composition. It should also state a shelf life within which the composition does not vary by more than 5% of the certified value. Compressed calibration gas standards should be stored, handled and used according to the supplier's instructions.
- (ii) Dynamic calibration standard mixtures can be generated using calibrated flow meters, with flow controllers, fed from compressed clean dry air and liquefied n-butane. Flow meters should be operated within their calibrated range and temperature and pressure specifications and should be re-calibrated at least annually against a certified flow meter or an absolute volumetric measurement.
- (iii) Static volumetric mixtures can be prepared, typically in suitable gas bags having sufficient capacity to make at least two calibrations. If the reliable bag storage time is not known, the contents should be used within 2 hours. Bags can be filled using a dynamic mixture generated as described in ii) above or by introducing measured volumes into the bag from large gas syringes (available in volumes up to a few litres) or wet test meters.

Test method Annex 2

Molecular weight calculation

The Molecular Weight (MW) of the TOC should be calculated as in the following example:

Table A - Molecular weight calculation					
Component	Vol%	MW		Calculation (Vol% 100) x MW	
C3 paraffins	6.7	44.1		0.67 x 44.1 =	03.0
C4 paraffins	65.2	65.2		0.652 x 58.1 =	37.9
C5 paraffins	20.5	72.1		0.205 x 72.1 =	14.8
C6 paraffins	0.5	86.2		0.005 x 86.2 =	00.4
C7 paraffins	0.3	100.2		0.003 x 100.2 =	00.3
C8 paraffins	0.1	114.2			
C9 paraffins	<0.1	128.2			
C10 paraffins	<0.1	142.3			
C3 olefins	<0.1	42.1			
C4 olefins	3.3	56.1		0.033 x 56.1 =	01.9
C5 olefins	1.9	70.1		0.001 x 70.1 =	01.3
C6 olefins	0.1	84.2		0.001 x 84.2 =	00.1
C7 olefins	<0.1	98.2			
C8 olefins	<0.1	112.3			
C9 olefins	<0.1	126.2			
C10 olefins	<0.1	140.3			
C5 naphthenes	0.3	70.1		0.003 x 70.1 =	00.2
C6 naphthenes	0.3	84.2		0.003 x 84.2 =	00.3
C7 naphthenes	0.1	98.2		0.001 x 98.2 =	00.1
C8 naphthenes	<0.1	112.2			
C9 naphthenes	<0.1	126.2			
C10 naphthenes	<0.1	140.3			
C6 aromatics	0.5	78.1		0.005 x 78.1 =	00.4
C7 aromatics	0.2	92.1		0.002 x 92.1 =	00.2
C8 aromatics	0.1	106.2		0.001 x 106.2 =	00.1
C9 aromatics	<0.1	120.2			
C10 aromatics	<0.1	134.3			
		Average Molecular Weight = sum =			61.0

Test method Annex 3

Response factor correction for TOC meters

The response of the meter to propane and n-pentane relative to n-butane should be known.

If these response factors in either mass or volume units are between 0.9 and 1.1 relative to n-butane, a meter overall response factor of 1.0 should be used (see **Annex 5**).

If any response factor is outside of the range 0.9 to 1.1, the meter overall response factor should be calculated based on the average vapour composition. Composition is determined as described in section 4.4.6 (normalised to 100%) from analysis of a sample collected over the measurement period.

An example of the calculation of overall response factor is given below:

Table B - Calculation of overall response factor				
Component	Vapour composition Vol% (Note)	Response factor	Calculation (% / 100) x response factor	
C3 plus lighter components	7	0.8 (propane)	0.07 x 0.8 =	0.06
C4 components	68	1.0 (n-butane)	0.68 x 1.0 =	0.68
C5 plus heavier components	25	1.2 (n-pentane)	0.25 x 1.2 =	0.30
Overall response factor = sum =				1.04
<p>Note: Vapour composition, normalised to 100% TOC, obtained from analysis of composite sample taken over test period (see section 4.4.6) If the calculated overall response factor is between 0.9 and 1.1, a factor of 1.0 should be used.</p>				

Test method Annex 4

Conversion from TOC volume concentration to TOC mass concentration

The mean hour TOC volume concentration in ppm should be converted to mass per normal unit volume concentration using the following equations:

Equation 1

Where TOC meter responses to propane and n-pentane relative to n-butane in g/Nm^3 are between 0.9 and 1.1

$$M = (25.9 \times V) \div 10,000$$

where:

M = average TOC concentration in g/Nm^3

V = 60 minute average TOC concentration in ppm

Equation 2

For all other TOC meters

$$M = (0.446 \times MW \times V) \div 10,000$$

where:

M = average TOC concentration in g/Nm^3

MW = average molecular weight of TOC in gas sample taken over test period (see sections 4.4.2 and 4.4.6 and **Annex 2**)

V = 60 minute average TOC concentration in ppm

Test method Annex 5

Measurement decision tree

The procedure to measure TOC varies with the equipment used and when it is used

In this decision tree a TOC meter response is linear if both

TOC meter volume response factor for C3 is >0.9 relative to n-C4 and

TOC meter volume response factor for n-C5 is <1.1 relative to n-C4.

Otherwise the TOC meter response is non-linear

A TOC meter can be used on site as the process happens i.e. in realtime, or the TOC meter can be used at a later time.

