

ENVIRONMENT AND HERITAGE SERVICE

**GUIDANCE FOR PROCESSES PRESCRIBED FOR
AIR POLLUTION CONTROL
BY THE CHIEF INDUSTRIAL POLLUTION INSPECTOR**

**CHIEF INSPECTOR'S GUIDANCE
TO INSPECTORS
(PART B PROCESSES)**

PETROL STORAGE AT TERMINALS

B PROCESS GUIDANCE NOTE - GNB 1/2 VERSION 1

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1. INTRODUCTION

This Note is issued by the Chief Industrial Pollution Inspector as one of a series providing guidance for processes prescribed for Air Pollution Control (APC) by the Chief Inspector in Regulations made under the Industrial Pollution Control (Northern Ireland) Order 1997.

A further series of Notes is produced by the Department of the Environment (NI) for those processes prescribed for air pollution control and subject to regulation by the District Councils.

This Note provides a guide on standards and techniques to Inspectors in their assessment of an application for, or variation of, an APC authorisation under the Order.

This Note will also be of interest to operators of such processes, however it should be understood that whether an authorisation is granted, and on what conditions, will depend on the particular circumstances of each application. Parameters such as individual process characteristics and site location may influence the nature of the conditions that are included in an authorisation.

A key objective of the legislation is to ensure that, in carrying on a prescribed process, the best available techniques not entailing excessive cost (BATNEEC) will be used -

- (i) for preventing the release of prescribed substances into the air or, where that is not practicable by such means, for reducing the release of such substances to a minimum and for rendering harmless any such substances which are so released; and
- (ii) for rendering harmless any other substances which might cause harm if released into the air.

This Note comprises guidance in relation to new and existing processes and is based on an assessment of best available techniques as qualified by the requirement not to entail excessive cost. (Background guidance on the meaning of BATNEEC is contained in the General Guidance Note.)

The guidance contained in this Note is based on the current state of knowledge and understanding of these processes, their potential impact on the environment, and the available control techniques at the time of publication. The guidance will be updated regularly, (as a minimum the Note will be reviewed at not more than four yearly intervals from the date of publication), to reflect changes in knowledge and understanding. It will not always be possible to revise the Notes quickly enough to keep in absolute step with rapid changes. It is therefore recommended that operators and their advisors check with the Inspectorate as to whether there have been any changes before relying on this Note for the purpose of making an application or taking other significant action under the Order.

2. **PROCESS DEFINITION**

- 2.1 This Note applies to the storage, loading and unloading of petrol at petrol storage terminals as described in Schedule 1 - Section 1.4, Part B of Industrial Pollution Control Order (Prescribed Processes and Substances) Regulations (Northern Ireland) 1998. The Note is written so as to comply with the EC Directive 94/63/EC on the Control of Volatile Organic Compound (VOC) Emissions Resulting From the Storage of Petrol and its Distribution from Terminals to Service Stations. It should be noted that the constructional standards for mobile containers set out in the Directive (see 2.4 and Appendix 1 below) will not be controlled under the Industrial Pollution Control (NI) Order but instead will be dealt with by the Department of Economic Development's Health & Safety Inspectorate.

2.2 Storage of petrol is undertaken in fixed roof tanks, or tanks with either internal or external floating roofs. The petrol is loaded or unloaded from road tankers, rail tankers or vessels which may be top or bottom loaded. Petrol is also transported by pipe lines.

2.3 In this Note the words “shall” and “must” are used when describing requirements of EC Directive 94/63/EC on the Control of Volatile Organic Compound (VOC) Emissions Resulting From the Storage of Petrol and its Distribution from Terminals to Service Stations. The word “should” is used when giving guidance.

2.4 In the context of this Note:

“petrol”	means any petroleum derivative with or without additives, having a Reid vapour pressure of 27.6kPa or more, which is intended for use as a fuel for motor vehicles, except liquified petroleum gas (LPG).
“vapours”	means any gaseous compound which evaporates from petrol.
“storage installation”	means any stationary tank at a terminal used for the storage of petrol.
“terminal”	means any facility which is used for the storage and loading of petrol onto road tankers, rail tankers or vessels, including all storage installations on the site of the facility.
“mobile container”	means any tank, transported by road, rail or waterways used for the transfer of petrol from one terminal to another or from a terminal to a service station.
“service station”	means any installation where petrol is dispensed to motor vehicle fuel tanks from stationary storage tanks.
“existing”	means as defined in Schedule 3 ¹ of the Industrial Pollution Control (Prescribed Processes and Substances Regulations) (NI) 1998
“new”	means not “existing”

“throughput”	means the largest total annual quantity of petrol loaded from a storage installation at a terminal into mobile containers during the three years preceding the relevant date as detailed in this Note.
“vapour recovery unit” (VRU)	means equipment for the recovery of petrol from vapours including any buffer reservoir systems at a terminal
“vessel”	means a vessel, other than a sea-going vessel, having a total weight of 15 tonnes or more.
“target reference value”	means the guideline given for the overall assessment of the adequacy of technical measures in the Note and is not a limit value against which the performance of individual installations, terminals and service stations would be measured.
“intermediate storage of vapours”	means the intermediate storage of vapours in a fixed roof tank at a terminal for later transfer to and recovery at another terminal. The transfer of vapours from one storage installation to another at a terminal should not be considered as intermediate storage of vapour.
“loading installation”	means any facility at a terminal at which petrol can be loaded onto mobile containers. Loading installations for road tankers comprise one or more gantries.
“gantry”	means any structure at a terminal at which petrol can be loaded onto a single road tanker at any one time.
“approved bottom loading device”	means any vehicle complying with the constructional standards in Appendix 1.

3. **GENERAL REQUIREMENTS**

3.1 New processes must comply with the standards contained in this Note immediately.

3.2 It shall be the aim to bring existing processes up to current standards whenever the opportunity arises. Account should be taken of the plant's technical characteristics; its rate of utilisation and the length of its remaining life; the nature and amount of polluting emissions from it and the desirability of not entailing excessive costs for the plant concerned.

3.3 In any event, existing plant shall be upgraded with the aim of attaining the appropriate standards quoted in these notes by the dates indicated in the relevant sections.

4. **RELEASES INTO AIR**

The principal emissions to atmosphere are associated with the escape of petrol vapour from the storage and handing systems of the terminals.

5. **RELEASE ROUTES**

The principal release routes to air for petrol vapour are from:

- (i) storage vessel and mobile container displacement during loading operations,
- (ii) leaks at vapour collection systems and coupling operations, and
- (iii) general fugitive releases.

6. **TECHNIQUES FOR RELEASE MINIMISATION**

6.1 **Storage Installations**

6.1.2 Upgrading to 6.1.4 - 6.1.9 applies to new installations from the date of first authorisation and to existing facilities by the following dates:-

- (a) 31 December 1998 if the throughput loaded at a terminal is greater than 50,000 tonnes per year.
- (b) 31 December 2001 if the throughput loaded at a terminal is greater than 25,000 tonnes per year but less than or equal to 50,000 tonnes per year.
- (c) 31 December 2004 for other existing petrol storage installations at terminals.

6.1.3 The definition of throughput in Paragraph 2.4 above means that the compliance deadline will apply if the throughput figure is exceeded in any of the three immediately preceding years, which will always include the most recent year. For example, if the throughput at a petrol storage terminal exceeds 50,000 tonnes for the first time in 1999 then that petrol storage terminal should have "a throughput greater than 50,000 tonnes" in the year 2000. In practice this should mean that when the petrol storage terminal operator becomes aware that the throughput is likely to increase beyond the throughput threshold in any year after the relevant deadline in paragraphs a)-c) above, steps should be taken to comply in respect of storage by the end of the following year, and sooner if possible. There is however, no balancing provision in the case of decreasing throughput, so if the throughput is greater than 50,000 tonnes in 1996 the relevant requirements will apply as from 31 December 1998, irrespective of any reduction below that figure in the following years.

6.1.4 The provisions of Paragraph 6.1.5 to 6.1.9 are designed to reduce the total annual loss of petrol resulting from loading and storage at each storage installation at terminals to below a target reference value of 0.01% by weight of the throughput.

6.1.5 The external wall and roof of tanks above ground must be painted in a colour or colours with a total radiant or light reflectance of 70% or more, unless the tank is

linked to a vapour recovery unit which conforms to the standards in 6.2.7 of this Note. Repainting should be carried out within a period of three years after the dates mentioned in 6.1.2. 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.

Such painting should not be required where the tanks are situated in special landscape areas and Areas of Outstanding Natural Beauty or which are visible from such areas. In any event such matters should be discussed with the Planning Service.

6.1.6 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^{2,3} 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 2654 (Manufacture of Vertical Steel Welded Storage Tanks with Butt-welded shells for the Petroleum Industry) or equivalent.

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

6.1.7 All new storage installations at terminals, where vapour recovery is needed to comply with the provisions in 6.2.4 - 6.2.11 and 7.1.1 - 7.1.3 shall be either:

- (a) fixed roof tanks connected to a vapour recovery unit in conformity with the standards in 6.2.7 or
- (b) tanks designed with a floating roof, either external or internal, equipped with primary and secondary seals to meet the performance standards set down in 6.16 above³.

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^{2,3} if:

- the roof is fitted with both primary and secondary seals;
- the primary seal extends from the floating roof to the tank walls and the secondary seal is fitted above it;
- 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 complies with the requirements of BS 2654 or equivalent; and
- the roof and seal system are designed and installed as per the Institute of Petroleum “Internal Floating Roofs for Oil Storage Tanks Code of Practice”, August 1994⁴.

6.1.8 Existing fixed roof tanks must either:

- (a) be connected to a vapour recovery unit in conformity with the standards in 6.2.7, or
- (b) 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.

An internal floating roof and seal system should be deemed to achieve an overall containment of vapours of 90% or more compared to a 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 2654 or equivalent; and
- the roof and seal are designed and installed as per the Institute of Petroleum “Internal Floating Roofs for Oil Storage Tanks Code of Practice”, August 1994⁴.

The provisions of 6.1.8 should not be applied to existing horizontal tanks or to existing vertical tanks with a diameter less than 6 m at terminals with a throughput of less than 10,000 tonnes per year.

6.1.9 The standards for vapour containment controls in 6.1.7 and 6.1.8 shall not apply to fixed roof tanks at terminals where intermediate storage of vapours is permitted under 6.2.6.

The standards should also not be applied to interface tanks which receive dumped product mixtures. Such mixtures contain, but are not wholly comprised of, petrol.

6.2 **Loading and Unloading of Mobile Containers at Terminals**

6.2.1 6.2.3 - 6.2.11 and 7.1 - 7.3 apply to new terminals from the date of first authorisation and to existing terminals by the following dates:-

- (a) 31 December 1998 for existing terminals for loading onto road tankers, rail tankers and/or vessels if the throughput is greater than 150,000 tonnes per year.
- (b) 31 December 2001 for existing terminals for loading onto road tankers and rail tankers if the throughput is greater than 25,000 tonnes per year but less than or equal to 150,000 tonnes per year.

(c) 31 December 2004 for all other existing loading installations at terminals for loading onto road tankers and rail tankers.

Notwithstanding the above, these do not apply to existing terminals with a throughput of less than 10,000 tonnes per year or to new terminals with a throughput of less than 5,000 tonnes per year if located in a small remote island.

- 6.2.2 Advice on the practical application of the throughput criterion is contained in 6.1.3.
- 6.2.3 The provisions of 6.2.4 - 6.2.11 and 7.1.1 - 7.1.3 are designed to reduce the total annual loss of petrol resulting from the loading and unloading of mobile containers at terminals to below a target reference value of 0.005% by weight of the throughput.
- 6.2.4 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.
This provision does not apply to top loading tankers as long as that loading system is permitted.
- 6.2.5 At terminals which load petrol onto vessels, a vapour incineration unit may be substituted for a vapour recovery unit if vapour recovery is unsafe or technically unfeasible because of the volume of return vapour³. The standards concerning air emissions from vapour recovery units in 6.2.7 also apply to vapour incineration units.
- 6.2.6 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 Controls³.

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.

6.2.7 The mean concentration of vapours in the exhaust from the vapour recovery unit - corrected for dilution during treatment - must not exceed 35g/Nm^3 for any 1 hour.

6.2.8 All pollutant concentrations should be expressed at reference conditions 273K, 101.3kPa, without correction for water vapour content.

6.2.9 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.

6.2.10 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.

6.2.11 Operators of top loading systems for petrol must have written procedures instructing loading personnel to keep the outlet of the loading arm as near to the bottom of the mobile container as practicable during loading.

6.3 **Gantries**

6.3.1 6.3.5 - 6.3.16 apply to the extent and by the dates specified in 6.3.2. - 6.3.4.

6.3.2 All terminals with loading facilities for road tankers shall be equipped with at least one gantry which meets the standards for bottom loading equipment laid down in 6.3.5 - 6.3.16 by the dates expressed in 6.2.1.

6.3.3 By 31 December 2004 the standards for bottom loading equipment set out in 6.3.5 - 6.3.16 shall apply to all road tanker loading gantries at all terminals.

6.3.4 The provisions of 6.3.5 - 6.3.16 shall not apply to existing terminals with a throughput of less than 10,000 tonnes per year or to new terminals with a throughput of less than 5,000 tonnes per year if located in a small remote island.

6.3.5 The liquid coupler on the loading arm shall be a female coupler which should mate with a 4-inch API (101.6 mm) male adapter located on the vehicle⁵.

6.3.6 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 (101.6 mm) cam-and-groove adapter located on the vehicle⁵.

- 6.3.7 The normal liquid loading rate shall be 2,300 litres per minute (maximum 2,500 litres per minute) per loading arm.
- 6.3.8 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, and a maximum of 45 millibar at the interface between the adaptor and coupler.
- 6.3.9 The loading gantry shall be equipped with an overflow-detection control unit which, when connected to the vehicle, shall provide a fail-safe signal to enable loading, providing no compartment-overflow sensors detect a high level.
- 6.3.10 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.
- 6.3.11 The gantry Control Unit shall be suitable for both 2-wire and 5-wire vehicle systems.
- 6.3.12 The vehicle shall be bonded to the gantry via the common return wire of the overflow 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.
- 6.3.13 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:
- (a) maximum 1.4 metres (unladen); minimum 0.5 metres (laden), the preferred height being 0.7 to 1.0 metres;

- (b) the horizontal spacing of the adapters shall not be less than 0.25 metres (preferred minimum spacing is 0.3 metres);
- (c) all liquid adapters shall be located within an envelope not exceeding 2.5 metres in length; and
- (d) 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).

6.3.14 The earth/overflow 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).

6.3.15 Loading shall not be permitted unless a permissive signal is provided by the combined earth/overflow control unit.

In the event of an overflow condition or the loss of vehicle earth the Control Unit on the gantry shall close the gantry-loading control valve.

6.3.16 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.

6.4 **General Operations**

6.4.1 Effective control of emissions requires the maintenance and proper use of equipment, as well as prudent supervision of process operations. Effective preventive maintenance shall be employed on all plant and the equipment concerned with the control of emissions to the air. Essential spares and consumables shall be held or available at short notice.

- 6.4.2 Any malfunction or breakdown leading to abnormal emissions should be dealt with promptly and process operations adjusted until normal operations can be restored. The Inspector shall be informed without delay if there is likely to be any effect on the local communities such as odour affecting nearby inhabitants. All such malfunctions shall be recorded in a log book, retained by the operation for a minimum of 4 years and available for examination by the Inspectorate.
- 6.4.3 Staff at all levels should receive the necessary formal training and instruction in their duties relating to control of the process and emissions to air. Particular emphasis should be given to training for start-up, shut down and abnormal conditions.
- 6.2.4.4 A high standard of housekeeping shall be maintained.

7. **COMPLIANCE MONITORING PROGRAMME**

- 7.1 The operator must provide adequate facilities for sampling at each vapour recovery unit (VRU). The sampling positions for all monitoring instruments should be agreed with the Inspectorate. Care is needed in the design and location of sampling systems to obtain representative samples.
- 7.2 Emissions from each VRU should be measured at least every 3 years. The mass concentration of total organic compound (TOC) emissions should be determined by the test method in Appendix 2 or by a method approved by the Inspectorate and complying with Annex II of the EC Directive 94/63/EC.
- 7.3 The Inspectorate should be advised at least 7 days in advance of any periodic monitoring exercise to determine compliance with emission standards, as well as the provisional time and date of monitoring, pollutants to be tested and the methods to be used. The results of all the emission testing should be forwarded to the Inspectorate as soon as possible after completion of the sampling.

1 Paragraphs 5 and 6 of Schedule 3 of the Industrial Pollution Control (Prescribed Processes and Substances) Regulations (NI) 1998 state:

5. Subject to paragraph 6, references to an existing process are to a process --

(i) which was being carried on at some time in the 12 months immediately preceding 2nd March 1998;

(ii) which is to be carried on at a works, plant or factory or by means of mobile plant which was under construction or in course of manufacture or in the course of commission at that date, or the construction or supply of which was the subject of a contract entered into before that date; or

(iii) in respect of which the best practicable means which will be required to be used under section 2 or 7 (as applicable) of the Alkali, &c. Works Regulation Act 1906 (a), if that process is subsequently registered as a work under section 9 of that Act, have been notified in writing before the commencement date of these regulations by the chief inspector or an inspector to the person who intends to carry on that process.

6. A process shall cease to be an existing process if at any time between 2nd March 1998 and the last day by which an application is otherwise required to be made for authorisation for the carrying on of that process, the process ceases to be carried on and is not carried on again at the same location (or with the same mobile plant) within the following 12 months.

2 Advice on calculating evaporative losses may be found in :

- a. API No. 2517 Evaporative loss from External Floating Roof Tanks, 3rd Edition 1989 with 1994 Addendum, £44 net
- b. API No. 2518 Evaporative loss from Fixed Roof Tanks, 2nd Edition 1991, £35 net
- c. API No. 2519 Evaporative loss from Internal Floating Roof Tanks, 3rd Edition June 1983 (reaffirmed March 1990), £24 net

available from ILI Sales Department, Ascot, Berkshire.

3 Further advice may be found in "Guidelines for the Design and Operation of Gasoline Vapour Emission Controls", published by the Institute of Petroleum, 1992, ISBN 0 85293 105 0, £24 net.

4 Further advice may be found in "Internal Floating Roofs for Oil Storage Tanks - Code of Practice", published by the Institute of Petroleum, 1994, ISBN 0 85293 143 3, £28 net.

5 API Recommended Practice 1004 Seventh Edition, November 1988. Bottom Loading and Vapour Recovery for MC-306 Tank Motor Vehicles (Section 2.1.1.1 Type of Adapter used for Bottom Loading, and Section 4.1.1.2 - Vapour Recovery Adapter)

APPENDIX 1

STANDARDS FOR MOBILE CONTAINERS CONTAINED WITHIN ARTICLE 5 OF THE COUNCIL DIRECTIVE ON THE CONTROL OF VOLATILE ORGANIC COMPOUND EMISSIONS RESULTING FROM THE STORAGE OF PETROL AND ITS DISTRIBUTION FROM TERMINALS TO SERVICE STATIONS

These provisions of the Directive are to be dealt with by the Department of Economic Development's Health and Safety Inspectorate and not under the air pollution control system, except to the extent that they are addressed in the main body of this Note.

1. Mobile containers shall be designed and operated in accordance with the following requirements:
 - (a) mobile containers shall be designed and operated so that residual vapours are retained in the container after unloading of petrol;
 - (b) mobile containers which supply petrol to service stations and terminals shall be designed and operated so as to accept and retain return vapours from the storage installations at the service stations or terminals. For rail tankers this is only required if they supply petrol to service stations or to terminals where intermediate storage of vapours is used;
 - (c) except for release through the pressure relief valves, the vapours mentioned in sub-paragraphs (a) and (b) shall be retained in the mobile container until reloading takes place at a terminal.
If after the unloading of petrol the mobile container is subsequently used for products other than petrol, in so far as vapour recovery or intermediate storage of vapours is not possible, ventilation may be permitted in a geographical area where emissions are unlikely to contribute significantly to environmental or health problems;
 - (d) the Members States' competent authorities must ensure that road tankers are regularly tested for vapour tightness and that vacuum/pressure valves on all mobile containers are periodically inspected for correct functioning.
2. The provisions of paragraph 1 shall apply:
 - (a) from 31 December 1998 for new road tankers, rail tankers and vessels;
 - (b) 31 December 1998 for existing rail tankers and vessels if loaded at a terminal to which the requirement of the Directive applies;
 - (c) for existing road tankers when retrofitted for bottom loading in accordance with the specifications laid down in the Directive.
3. By way of derogation, the provisions of paragraph 1, sub-paragraphs (a), (b) and (c) shall not apply to losses of vapours resulting from measuring operations using dipsticks in relation to:
 - (a) existing mobile containers; and
 - (b) new mobile containers which come into operation before 31 December 1999.

APPENDIX 2

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 gasoline 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 7-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.

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.

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 7 hours during the course of a 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 7 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 or seven hours of filling where the time taken for tank filling is more than 7 hours.

During the test period there shall be at least one hour in which 4 or more measurements of TOC concentration are made. If this conditions is not met during a period of 7 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 (eg, a carbon adsorption type VRU with 2 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 measurements made of the TOC concentration in that common vent.

4.1.4 Vent Vapour Dilution

Where the VRU process results in exhaust vapour dilution, (eg, for systems using direct cooling by nitrogen), that 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 calculated for each hour of the test. It shall also give details 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. Typically this should be at least two pipe diameters upstream from the vent opening.

Where a VRU has more than one vent (eg, 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.

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 absorb 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, 3 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 shall 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 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 (eg, 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, recalibrate 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 specification 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. 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 (eg, 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 4 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) for each hour of the test during which 4 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 Inspectorate:

- 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.

TOC METER CALIBRATION

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

A1.1 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 (ie, containing <1% of emission limit TOC concentration) or inert gas should be used (see section A1.2).

Calibrations should be made at least at 2 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 $\pm 5\%$, (eg, 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 $\pm 1\%$.

A1.2 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 as may be used:

- purchased calibration standard mixtures;
 - dynamic volumetric mixtures blended using flow metres;
 - 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 2 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 metres.

MOLECULAR WEIGHT CALCULATION

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

Component	Vol % MW (Note)	Calculation [(Vol % ÷ 100) x MW]
C3 paraffins	6.7	44.1 0.067 x 44.1 = 3.0
C4 paraffins	65.2	58.1 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 = 0.4
C7 paraffins	0.3	100.2 0.003 x 100.2 = 0.3
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 = 1.9
C5 olefins	1.9	70.1 0.019 x 70.1 = 1.3
C6 olefins	0.1	84.2 0.001 x 84.2 = 0.1
C7 olefins	<0.1	98.2
C8 olefins	<0.1	112.2
C9 olefins	<0.1	126.2
C10 olefins	<0.1	140.3
C5 naphthenes	0.3	70.1 0.003 x 70.1 = 0.2
C6 naphthenes	0.3	84.2 0.003 x 84.2 = 0.3
C7 naphthenes	0.1	98.2 0.001 x 98.2 = 0.1
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 = 0.4
C7 aromatics	0.2	92.1 0.002 x 92.1 = 0.2
C8 aromatics	0.1	106.2 0.001 x 106.2 = 0.1
C9 aromatics	<0.1	120.2
C10 aromatics	<0.1	134.3

Average Molecular Weight = sum = 61.0

Note: Vapour composition, normalised to 100% TOC, obtained from analysis of composite sample taken over test period (see section 4.4.6)

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:

Component	Vapour Composition Vol % (Note)	Response Factor	Calculation [(% ÷ 100) x response factor]
C3 plus lighter components	7	0.8 (propane)	$0.07 \times 0.8 = 0.06$
C4 components	68	1.0 (n-butane)	$0.68 \times 1.0 = 0.68$
C5 plus heavier components	25	1.2 (n-pentane)	$0.25 \times 1.2 = 0.3$

overall response factor = sum = 1.04

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.

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 are between 0.9 and 1.1

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

where:

$$\begin{aligned} M &= \text{average TOC concentration in g/Nm}^3 \\ V &= 60 \text{ minute average TOC concentration in ppm} \end{aligned}$$

Equation 2

For all other TOC meters

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

where:

$$\begin{aligned} M &= \text{average TOC concentration in g/Nm}^3 \\ MW &= \text{average molecular weight of TOC in gas sample taken over test period} \\ &\quad \text{(see sections 4.4.2 and 4.4.6 and Annex 2)} \\ V &= 60 \text{ minute average TOC concentration in ppm.} \end{aligned}$$

MEASUREMENT DECISION TREE

