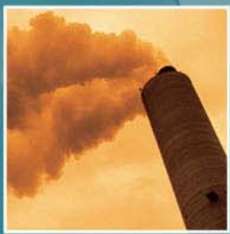
European Commission

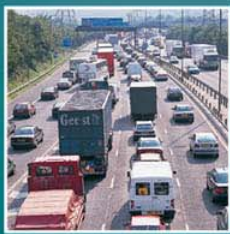
Assessment of the implementation of the VOC Stage I Directive (1994/63/EC)

Final Report

April 2009

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Assessment of the implementation of the VOC Stage I Directive (1994/63/EC)

Final Report

April 2009

Entec UK Limited in partnership with the Regional Environmental Centre for Central and Eastern Europe (REC)

Certificate No. FS 13881

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Executive Summary

Introduction

The VOC Stage I Petrol Vapour Recovery Directive (94/63/EC[1]) is intended to reduce emissions to atmosphere of volatile organic compounds (VOCs) from the operations, installations, vehicles and vessels used for storage, loading and transport of petrol from one terminal to another or from a terminal to a service station.

The overall purpose of this study was to assess the implementation status of the Stage I Directive with particular emphasis on the older Member States because of their greater experience of implementing this Directive since its adoption in 1994, as well as the fact that a previous Entec/REC study focussed on a selection of new Member States. The following tasks were undertaken and are described in the report and supporting appendices:

- Assessment of the status of implementation of the Stage I Directive for each Member State;
- Identification of any technical issues and problems of interpretation encountered by each Member State during implementation of the Directive;
- Assessment of the potential for simplification of the Directive; and
- Technical review of current "state-of-the-art" vapour recovery technologies.

The majority of the information presented in this report is derived from consultation with relevant organisations responsible for implementing the Directive (such as industry associations, Member State Government Departments and regulators). A review of relevant literature has also been undertaken.

Status of implementation

An extensive consultation has been undertaken with stakeholders in each of the Member States to investigate how the Directive has been implemented and whether or not the technical provisions are being applied correctly in practice. In addition, consideration has been given to whether or not Member States have correctly applied throughput thresholds for derogating service stations and terminals and/or whether they have granted any additional time periods beyond those stipulated in the Directive or, where relevant, the Accession Treaties.

Based on the information provided, it appears that most Member States (for which information was available) have implemented and applied the requirements of the Directive within the agreed timescales (in the Directive and, where applicable, in the Accession Treaties) including throughput thresholds for derogating service stations and terminals. However, in some instances, there appear to have been certain delays (Belgium, Cyprus and Greece)

1 OJ L 365, 31.12.1994, p. 24.

and/or issues (Finland and Sweden) with implementation. Details are provided in Section 3 of this report. It should be noted that the review and conclusions are based on information gathered from relevant stakeholders and associated literature rather than any specific checking of application of the technical provisions.

In addition, given that the provision of information by these organisations was voluntary, there are differences in the levels of information available for each of the Member States covered. In particular, some Member States have provided very limited or no information on the current status of implementation of the Directive. This includes Luxembourg, Malta, Netherlands, Portugal and Spain, although details of the national legislation transposing the Directive's requirements and information from previous studies has confirmed that the legislation appears to have been introduced in each of these Member States. However, it has not been possible to confirm if the technical provisions of the Directive are actually applied in practice.

Technical issues and problems of interpretation

A key element of this project was to identify, through consultation with Member State regulatory authorities, industry associations and economic operators (and any relevant literature), any technical issues or problems of interpretation which hinder an effective implementation of the Directive.

Based on the discussions held during the study, most Member States seem to have experienced few, if any, technical problems in implementing the Directive. However, there are specific issues for the Arctic Member States (Sweden and Finland) in that they do not fully comply with the requirements in Annex IV due to the nature of the pre-existing Stage I controls in place in these Member States.

Work by an Environmental Fuels Expert Group (EFEG) in the 1990s involved reviewing the technical provisions of the Directive. This led to a number of recommendations regarding possible changes to the Annexes to the Directive. It has been confirmed by a number of consultees (including Sweden, Finland and Concawe) that the rationale for all of the proposed changes still applies. These provisions, mainly aimed at encompassing the requirements applied in the Arctic Member States[2], do not appear likely to compromise the overall aims of Directive 94/63/EC in terms of control of VOC emissions (based on information available for this study). Given the relative geographic isolation of these Member States, the conclusions of the EFEG technical sub-group suggested that the provisions as recommended would be sufficient to avoid adverse effects upon cross-border trade (and information available for this study suggests that the Directive has been implemented in line with the EFEG recommendations in these Member States).

Some other technical issues have been encountered in implementing the Directive, although the practical effects these are likely to be relatively more minor. However, in any revision to the Directive, it may be appropriate to

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[2] There are slightly different technical provisions in these Member States for Stage I controls because of their geographical and climatic nature and because they had Stage I legislation in place prior to joining the EU, around the time that the Stage I Directive was adopted.

give consideration to clarifying provisions on, for example, what constitute “living quarters or working areas” and how ethanol blends should be treated under the provisions of the Directive, as these were issues highlighted by consultees.

In relation to VOC emissions from ship loading (future introduction of standards for vapour control and recovery is mentioned explicitly in the preamble to the Directive), a previous study for the Commission has concluded that measures in other sectors would be more effective in reducing VOC emissions in the context of national emission ceilings.

Potential for simplification

One aspect of this project was to identify, through consultation with Member State regulatory authorities, industry associations, economic operators and open literature, any potential to simplify the Directive’s provisions and technical annexes taking account of technical progress since the Directive was adopted in 1994. In particular, reference to relevant CEN standards was highlighted as a possible means of simplification at the start of the project.

When considering the potential for simplification of the Directive, three possible approaches have been identified within this study:

- Remove certain specific technical requirements in the Annexes (mainly Annex IV) and replace these with references to external documents such as CEN standards;
- Remove certain technical requirements and replace them with emissions limits to be met in a manner that the Member States are to determine independently;
- Retain the Directive in its present form, though potentially with adaptations to reflect the situation in the Arctic Member States.

Within the first approach there are a number of external documents that respondents have suggested could be referred to during consultation for this study. Based on a review of related legislation and international agreements, as well as consultation for this study, some Member States fulfil certain requirements of the Stage I Directive (for road tankers) through EU legislation (Directive 2008/68/EC) and/or UNECE agreements on the transport of dangerous goods (ARD, RID and ADN). Whilst some provisions of these rules cover some of the requirements of the Stage I Directive, it is unlikely to be appropriate to refer to these instead of retaining the current technical provisions of the Directive as they do not contain significant coverage of the requirements (those set out in Annex IV in particular).

On the other hand, the CEN standards and technical reports do cover all of the requirements of Annex IV with two exceptions, where the CEN documents would need to be amended should it be decided that it would be appropriate to replace the existing text of the Directive with reference to CEN standards. In addition, one of the CEN technical reports includes descriptions of technical variations applied in/required for Arctic Member States; these are in accordance with the situation in those countries. The main advantages of referring to CEN standards would be the simplification of the current regulatory system, through harmonisation with external bodies’ regulations and current procedures. The main disadvantage of this option is that the Commission would partially forgo the ability to positively influence the inclusion of technical requirements, although it would retain the ability to exclude any undesirable amendments from the Directive. This approach would also presumably require some of the information currently included in CEN Technical Reports to be incorporated into formal Standards as the former are of a less binding nature than the latter. Presumably the target emission levels within the main body of the Directive would need to be retained if such an approach were to be adopted.

The second approach, which was suggested by some organisations consulted during this study, is to remove the technical provisions of the Annexes (specifically Annex IV) whilst retaining the overall emissions target(s) and to allow the individual Member States to meet this target in whichever way was felt to be most appropriate. The advantage of this approach is that the Member States would be free to shape national regulations so that they are appropriate for the local conditions. The disadvantages of this method are that separate national regulations may create barriers to trade and that it may become more difficult to assess compliance with the Directive.

Lastly, the Directive could be left in its current form. The main advantage of this method is that industry and the regulatory authorities are familiar with the regulations in their current form and changing them may increase the regulatory burden. If the Directive were to be changed substantially, to include variations for the Arctic Member States or to improve standards, then this benefit could be reduced for those Member States (though this would not necessarily affect other Member States). Some consultees favour leaving the Directive in its current form.

Technical review of provisions

The final task for this project was, from a purely technical perspective, to briefly assess how the degree of VOC abatement stipulated in the Directive for the various activities (storage at terminals, loading at terminals, unloading at service stations) compares with that possible with the current state of the art. This covered all of the technical requirements specified in the Directive relating to storage of petrol in tanks at terminals, loading at terminals, non-road vessels and unloading at service stations.

The BREF for mineral oil and gas refineries under the IPPC Directive outlines a number of technical improvements to storage tanks at terminals that could, if implemented, achieve relatively minor reductions of VOC emissions compared to the existing provisions of the Stage I Directive. However, it is important to note that the BREF sets out emission levels associated with the use of best available techniques whereas the emission limit values and techniques set out in Directive 94/63/EC represent minimum standards (and also apply at installations that are not covered by the IPPC Directive).

No information has been identified during the course of this study regarding current state of the art techniques that could significantly reduce VOC emissions from road tankers and non-road vessels.

Perhaps, the greatest technical potential for reducing VOC emissions appears to be through improvements in vapour recovery units and lowering the legislative emission limit for these units (though it should be noted that a full investigation of total emissions from each stage in petrol storage and distribution has not been undertaken for this study). There are three types of technology employed in modern vapour recovery units (VRUs) that are capable of reducing emissions to significantly below the limit of 35 g/Nm^3 specified in the Directive, including: carbon adsorption, refrigeration and hybrid membrane/adsorption. Of the three types of VRU, the carbon adsorption type, sometimes in combination with a membrane unit, is currently the most prevalent of the VRU technologies capable of meeting the 150 mg/Nm^3 limit specified under German legislation; refrigeration units capable of meeting the lower limit are available but this is a relatively new technology. Several other Member States have national provisions that require emission limits stricter than the 35 g/Nm^3 specified in the Directive.

Lowering the current ELV for VRUs at terminals could result in net benefits for the EU27 as compared to emissions at the limit value included in the Directive. However, it is evident that emissions from many installations will already be substantially below the 35g/Nm^3 limit, due to differing national provisions or simply because actual performance of equipment will generally be somewhat better than the limit value. The total emissions reductions from lowering the ELV would also be relatively small in comparison to those already achieved by compliance with the current limit in the Directive, as compared to uncontrolled emissions.

It is also noted that those Member States that have implemented the provisions of the Gothenburg Protocol should already be applying a lower emission limit (10 g/Nm^3) for all new installations and for existing installations so far as it is technically and economically feasible, taking into consideration the costs and benefits.

There also exists some potential for achieving further emissions reductions at service stations, particularly through control/capture of emissions that would otherwise be released from pressure/vacuum relief valves (this is not covered by the Stage I Directive). It has not been possible within the time available or scope of the study to consider these in detail.

Contents

1. Introduction

1.1 Background

Directive 94/63/EC is intended to reduce emissions to atmosphere of volatile organic compounds (VOCs) from the operations, installations, vehicles and vessels used for storage, loading and transport of petrol from one terminal to another or from a terminal to a service station.

At the time that the 1994 Directive was introduced, emissions of volatile organic compounds (VOCs) from storage and distribution of petrol represented around 500,000 tonnes per year (5% of total anthropogenic VOC emissions in the Community).

The reductions of VOC emissions achieved by the Directive are warranted to reduce the levels of photochemical oxidants, such as ozone, for which the VOCs from petrol play an important role as precursor of pollution. The 'Stage I' control measures established in the Directive, set out actions to 'close' the system for storage and distribution of petrol by reducing breathing losses from storage tanks at terminals and by ensuring that the petrol vapours displaced during transport and loading operations from terminals to the service station are captured, contained and transported back 'upstream' to terminals, where the vapours can be regenerated into petrol.

Reduction in emissions from petrol storage and distribution also reduces exposure to substances that are carcinogenic, mutagenic and toxic for reproduction (such as benzene).

The requirements of the Directive were required to be implemented over the period 1996-2004[3] and are briefly summarised below:

- For storage at terminals:
  - Above ground tanks must be painted with high heat-reflectance paint (with derogations for the protection of special landscape areas designated by national authorities and exemptions where tanks are connected to a vapour recovery unit).
  - Tanks with external floating roofs must have primary and secondary seals between the tank wall and the floating roof.
  - Fixed roof tanks must either be connected to a vapour recovery unit or be fitted with an internal floating roof.

3 With certain derogations granted for some Member States, including older Member States (as set out in the Directive) and transition periods for some newer Member States (as agreed in the accession process).

  - Vapour containment efficiencies are specified for the above sealing systems (compared with a fixed roof tank with pressure/vacuum relief valve).

- When loading and unloading at terminals:

  - Displaced vapours must be returned through a vapour-tight connection line to a vapour recovery unit for regeneration at the terminal (this does not apply to top-loading tankers; all road tankers had to be bottom-loaded by the end of 2004) or intermediate storage.

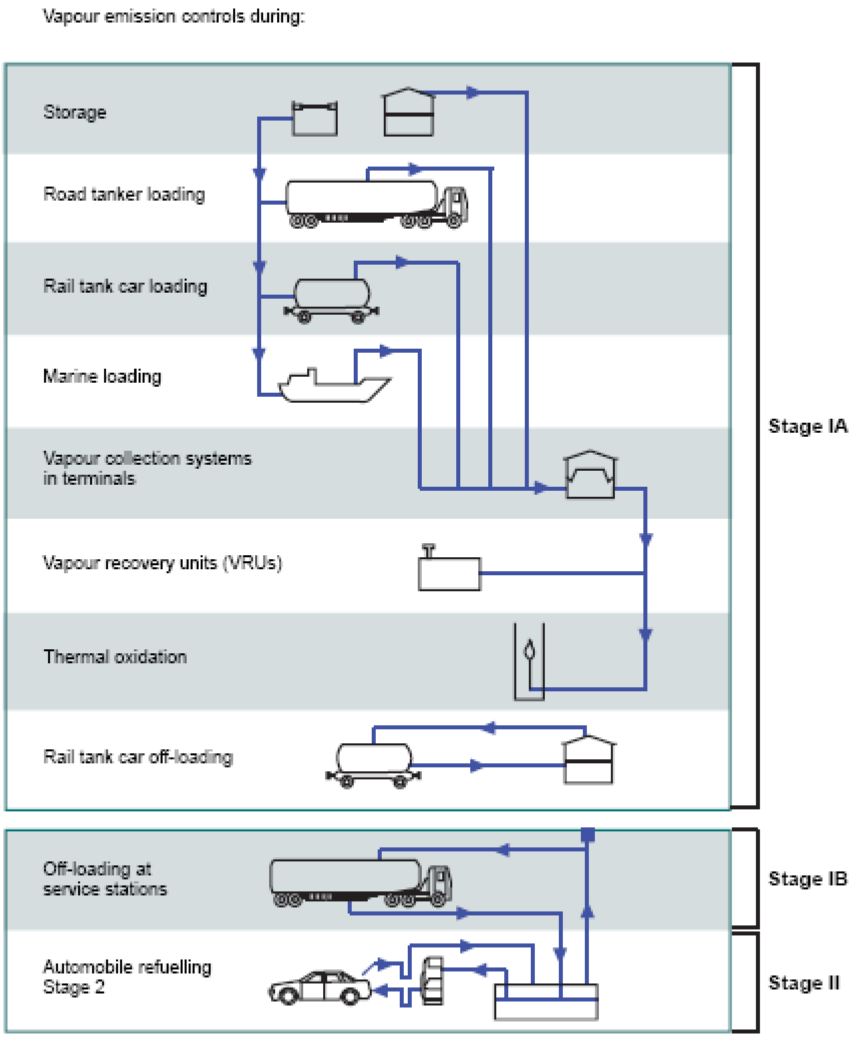
  - Vapours may be incinerated when loading onto vessels where vapour recovery is unsafe or technically impossible because of the volume of return vapour.

- Mobile containers need to be designed and operated so as to retain vapours returned from storage installations.

- Where intermediate storage of vapours is carried out at terminals and during unloading of petrol at service stations and terminals, displaced vapours must be returned through a vapour-tight connection line to the mobile container delivering the petrol.

Figure 1.1 provides a summary of the main stages where vapour emission controls can be applied. Those applied during loading, transport and terminal operations are generally referred to as Stage 1A controls; those during delivery to service stations as Stage 1B; and those during refuelling of vehicles as Stage 2 (the latter is not the subject of the current contract).

Figure 1.1 Stages for vapour emission controls (after Institute of Petroleum, 2000[4])



There are a number of time-limited derogations set out in the Directive related to specific Member States as well as derogations for smaller terminals and service stations. There also exists the possibility for Member States to grant a derogation from the requirements for petrol stations located such that emissions are unlikely to contribute significantly to environmental or health problems and where throughput is below a certain threshold[5].

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4 Institute of Petroleum (2000): Guidelines for the design and operation of gasoline vapour emission controls, second edition, October 2000.

5 For example, such a derogation has been implemented by the United Kingdom for existing petrol stations with a throughput less than 500m3/yr (since these are not expected to contribute significantly to environmental or health problems).

1.2 Aims and objectives

The overall purpose of this study is to assess the implementation status of the VOC Stage I Directive with particular emphasis on the older Member States because of their greater experience of implementing this Directive since its adoption in 1994 as well as the fact that a previous Entec/REC study focussed on a selection of new Member States[6]. To this end, the objectives of the contract are to:

- Undertake a consultation and literature review to identify any technical or interpretation issues which may hinder an effective implementation of the Directive and highlight any potential for the provisions of the legislation to be simplified.

- Undertake an assessment of the technical provisions of the Directive at all phases compared to current state of the art in terms of the degree of VOC abatement achieved.

- Assess the status of implementation in all Member States, with a particular focus on: (1) the extent to which the technical requirements of the Directive are applied in practice (if such information is available); (2) whether the throughput thresholds for derogating service stations and terminals are being applied correctly; and (3) whether additional time periods have been granted beyond those specified in the Directive and accession treaties.

In undertaking this study, consideration has been given to work undertaken by the Environmental Fuels Expert Group in the 1990s regarding potential revisions to the Annexes to the Directive (Article 7 of the Directive makes provision for adapting the Annexes to technical progress) to make various clarifications and to take into account the particular situation in the 'Arctic' Member States[7].

1.3 Purpose of this report

The purpose of this final report is to provide the Commission with an overview of the information gathered during this study to assess the implementation status of the VOC Stage I Directive (94/63/EC[8]) across the EU. A summary of the assessment of implementation for each Member State (MS) is provided with more detailed information available in the appendices. A summary of technical issues and problems of interpretation identified during the study is also presented as well as a review of current "state-of-the-art" vapour recovery technologies. The potential for simplification of the Directive is also considered.

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6 Entec (2005): Service contract to assist the Commission identify and assess obstacles and difficulties for the implementation of Directive 94/63/EC in new Member States and Candidate Countries. Final report for the European Commission, December 2005.

7 Environmental Fuels Expert Group (EFEG), Technical sub-group on the implementation of Directive 94/63 VOC Stage I, Minutes of the meeting of 20 October 1997.

8 OJ L 365, 31.12.1994, p. 24.

This report is submitted under specific contract 070307/2008/494894/MAR/C3 implementing framework contract ENV.C.5/FRA/2007/0071 and relates to an assessment of the implementation of the VOC Stage I Directive (94/63/EC).

1.4 Structure of this report

This report is structured according to the following sections:

- Section 2 provides a summary of the approach taken to data collection and progress achieved for each Member State;
- Section 3 presents a summary of the status of implementation of the Directive across the EU based on information returned during this study;
- Section 4 presents ideas on potential areas for simplification;
- Section 5 presents a review of the technical provisions of the Directive based on feedback received from stakeholder consultation and a review of relevant literature; and
- Section 6 presents conclusions and recommendations.

Detailed case studies relating to the situation in each Member State are provided in Appendix A.

2. Approach to data collection

2.1 Introduction

This section provides a summary of the approach taken to data collection including an overview of progress with consultation with relevant stakeholders and Member States that was undertaken by Entec and REC. The majority of the information presented in this report has been based on consultation with relevant organisations responsible for implementing the Directive (such as industry associations, Member State Government Departments, and regulators). Given that the provision of information by these organisations was voluntary, there are of course differences in the levels of information available for each of the Member States covered.

2.2 Data collection processes

2.2.1 Data collection proforma

As a first step, a data collection proforma was developed with the purpose of focusing data gathering on the key issues of interest so that the necessary information could be collected for each Member State. A draft of the proforma was developed and submitted to the Commission for comment. This was based on a similar proforma developed for the 2005 Stage I petrol vapour recovery (PVR) study. The proforma was based around the key issues of interest:

- Part 1: Current status of implementation of the Directive with particular focus on the technical requirements (Articles 3-6 and Annexes I-IV), application of derogations and timescales involved as well as any reasons why the technical requirements of the Directive are not being applied in practice (if relevant);
- Part 2: Any technical issues or problems of interpretation of the Directive;
- Part 3: Any potential for simplification of the provisions of the Directive and technical annexes (Annexes I-IV) based on experience of relevant stakeholders in the implementation of the Directive;
- Part 4: Information on current ‘state of the art’ on VOC abatement concerning the various activities covered by the Directive.

The proforma was sent out to a wide range of relevant contacts and used to help structure and focus discussions on the relevant issues (discussions were held with these contacts, either by telephone or face-to-face). Stakeholders also used the proforma as a basis for discussion with relevant colleagues. Information from the literature review was used to supplement data from consultation in order to address the issues covered by the proforma.

2.2.2 Literature review

A detailed literature review was undertaken of existing documents available including: legislation in the Member States; national and EU-level guidance documents; industry reports; and other relevant literature. The literature review has informed all aspects of the project.

2.2.3 Stakeholder Consultation

In order to assess the implementation status of the Directive, an EU wide consultation of relevant stakeholders has been undertaken, primarily focussed on Member States' Competent Authorities and industry representatives (e.g. trade associations). Initial contacts were identified from: existing studies and technical reports; the Environmental Fuels Expert Group (EFEG) which was active in reviewing the provisions of the Directive in the 1990s; and information/contacts provided by the Commission and the literature review.

Each of these individuals has been contacted by e-mail and telephone to request their involvement in their study and to arrange suitable times for discussions to take place. In many cases we have had to invest significant time in identifying and prompting suitable contacts as in several Member States there has been relatively high turnover of relevant staff, meaning that there is in some cases less institutional memory than others (particularly as the Directive was adopted in 1994). For some Member States, face-to-face interviews have taken place with the remainder being carried out by telephone.

The table below provides an overview of the consultation undertaken and data collected for each Member State and highlights data gaps. The appendices provide details of the organisations that have been consulted. Given that information collection is reliant on the participation and goodwill of the organisations consulted, it is perhaps inevitable that there are differences in the level of information available. The areas where there are data gaps may provide a focus for further investigation, if considered appropriate by the Commission.

Table 2.1 Summary of consultation and data collection for each Member State

MS	Current Status
Austria	Consultation with the relevant competent authorities (Federal Ministry of Agriculture, Forestry, Environment and Water Management, and the Federal Ministry of Economics and Labour) has been undertaken, gathering data and information on the implementation of the Directive 94/63/EC, including the provisions of national legislation.
Belgium	Relevant competent authorities have been consulted for Belgium and the three regions (Flanders, Walloon and Brussels). For the Flanders region consultation with the Flemish Environment, Nature and Energy Ministry (Flemish LNE) has been undertaken and some data had been gathered, including national legislation documents. For the Walloon region, some data (including national legislation documents) has been collated via consultation with relevant the competent authority. For the Brussels region, consultation with the 'Département Plan air, climat et énergie' has been undertaken and data has been gathered, including a regional law order document.

MS	Current Status
Bulgaria	An interview has been undertaken with the relevant Ministry and further information gathered on the legal background. Additional data have been provided on status of implementation.
Cyprus	Consultation with relevant competent authorities and industry representatives and data collection for the implementation of Directive 94/63/EC has been undertaken.
Czech Republic	Interviews have been held with the Ministry of Environment and Hydro Meteorological Institute and information gathered on the legal background. There are some gaps on processes for regulation and numbers of terminals and mobile tankers having implemented the legislation.
Denmark	An interview has been undertaken with the Danish Petroleum Industry Association. No information was received from the Danish regulatory authorities.
Estonia	A number of interviews have been undertaken with key stakeholders – some gaps remain regarding the processes for regulation and reporting.
Finland	The relevant contacts have been identified and interviews have been undertaken with representatives from the Ministry of Environment and the Ministry of Transport and Communications. A representative from the Finnish Oil & Gas Federation has been consulted.
France	An interview with the Ministry of Ecology, Energy, Sustainable Development and Spatial Planning has taken place. Other stakeholders have been contacted but without success.
Germany	Consultation has been undertaken at the national Government level (the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety), and at the national agency level (the Federal Environment Agency, UBA). Legislative documents have been obtained. Additional information has been gathered from literature search on emission factors and updated by the UBA. Contacts have collectively responded through written responses to a proforma. No Länder-specific information has been obtained via the UBA.
Greece	Consultation with relevant competent authorities and industry representatives and data collection for the implementation of Directive 94/63/EC has been completed. A site visit and meeting has been undertaken with industry (Association of Greek Oil Product Trading Companies) and competent authority (Ministry of Environment) representatives attending.
Hungary	Interviews have been undertaken with the relevant Government Ministry, regulatory authorities and trade associations.
Ireland	Consultation with the Irish Environmental Protection Agency and the Irish Petroleum Institute has been undertaken and data including the national legislation has been gathered. No contact with the local authorities responsible for inspection activities was possible.
Italy	National legislation with regards to Directive 94/63/EC has been provided. In addition, consultation with industry (Unione Petrolifera) has been undertaken. No other stakeholders have responded to our consultation.
Latvia	Interviews have been held with the Ministry of Environment, State Environmental Service, Greater Riga Regional Environmental Board and Latvian Fuel Traders Association.
Lithuania	Interviews have been undertaken with a number of key stakeholders (four national Government authorities, a regional authority and a trade association).
Luxembourg	No discussions have been possible due to lack of staff resources to participate.
Malta	Initial consultation with Malta Environment & Planning Authority (MEPA) has been undertaken. More detailed information on the Directive 94/63/EC has not been provided in time for inclusion in this report because of the need to obtain approval for the provision of this information (from the responsible minister). However national legislation with regards to Directive 94/63/EC has been provided.

MS	Current Status
Netherlands	A limited amount of information has been provided by the Directorate for the Environment, Division Climate & Air Quality.
Poland	Interviews have been undertaken with wide range of stakeholders (national Government departments, local authorities and national agencies). Some data gaps remain.
Portugal	It has not been possible to gather detailed data and information due to a lack of response from the relevant authorities.
Romania	Interviews have been undertaken with relevant stakeholders (responsible national Government department and national agency).
Slovakia	Interviews have been undertaken with some stakeholders (Ministry of Environment, hydrometeorological institute and Environmental Agency). Some data gaps remain.
Slovenia	Interviews have been undertaken with relevant Government and industry representatives.
Spain	It has not been possible to gather detailed data and information due to a lack of response from the relevant authorities.
Sweden	A meeting with Swedish Environmental Protection Agency (SEPA) and Swedish Petroleum Institute (SPI) was held in October 2008. National legislation, guidance documents and standards have been provided, as well as details of the status of implementation as compared to the Directive and EFEG recommendations from October 1997. Formal written responses to proforma questions have also been received, which included input from the Swedish Rescue Services Agency.
UK	A meeting with various relevant stakeholders has taken place and information has been provided during and after this meeting.

In addition to discussions with the Member States' Competent Authorities and national trade representatives, discussions have also taken place with Concawe/Europia in Brussels (September 2008). They provided insights into the issues raised by the EFEG in the minutes of the meeting of 20 October 1997 and a letter from CEN/Europia to the European Commission dated 15 May 2003.

Further discussions were held with other industry associations and companies involved in, for example, the supply of relevant equipment for VOC emissions abatement.

2.3 Summary

As Table 2.1 demonstrates, considerable progress was made with consulting with each Member State. However, some fairly significant data gaps still remain for some Member States, namely: Luxembourg, Malta, Netherlands, Poland, Portugal and Spain. To summarise:

- No data has been made available for five Member States;
- Limited information has been returned for eight Member States; and
- Significant information has been returned for fourteen Member States.

As significant information was already available for several Member States from previous studies, this has been used to provide an indication of implementation where no detailed information has been made available specifically for the purposes of the current study.

3. Status of implementation

3.1 Introduction

This section provides an overview of the status of implementation of the Directive across the EU based on information gathered during this study via a review of relevant literature sources and direct consultation with Member States' Competent Authorities and trade representatives.

Detailed individual Member State case studies are presented in Appendix A.

3.2 Overview of implementation

Table 3.1 provides a summary of the status of implementation of the Directive for each Member State against three main criteria:

- The extent to which the technical requirements of the directive are applied in practice (where information is available);
- Whether throughput thresholds for derogating service stations and terminals have been/are being correctly applied; and
- Whether additional time periods have been granted beyond those stipulated in the directive and accession treaties.

The indications provided in this table are based on information provided during the consultation process. They do not reflect the results of any physical checking of implementation by ourselves.

Table 3.1 Overview of status of implementation across the EU (based on information provided by stakeholders)

MS	Technical requirements applied in practice?	Throughput thresholds for derogating service stations/ terminals correctly applied?	No additional time periods granted beyond those in Directive and Accession Treaty?
Austria			
Belgium			
Bulgaria			
Cyprus			
Czech Republic			

MS	Technical requirements applied in practice?	Throughput thresholds for derogating service stations/ terminals correctly applied?	No additional time periods granted beyond those in Directive and Accession Treaty?
Denmark			
Estonia			
Finland			
France			
Germany			
Greece			
Hungary			
Ireland			
Italy	Note 1	Note 1	Note 1
Latvia			
Lithuania			
Luxembourg			
Malta			
Netherlands			
Poland			
Portugal			
Romania			
Slovakia			
Slovenia			
Spain			
Sweden			
UK			

Key:

	All technical requirements appear to be applied in practice	All throughput thresholds for derogating service stations/terminals appear to be correctly applied	No additional time periods granted beyond those in Directive and Accession Treaty

	Most requirements appear to be applied in practice	Most throughput thresholds for derogating service stations/terminals appear to be correctly applied	Additional time periods may have been granted beyond those in Directive and Accession Treaty
	Some requirements are not applied in practice	Throughput thresholds for derogating service stations/terminals appear to be not correctly applied	Additional time periods granted beyond those in Directive and Accession Treaty
	Insufficient information available to assess		
NR	Not Relevant		

Note 1: This is based on consultation with Unione Petrolifera and review of the national legislation that transposed Directive 94/63/EC. Consultation with the competent authorities (Ministry of Environment) was not possible with regards to the implementation of this Directive. It is also noted that Italy has implemented national legislation for Stage II vapour recovery as well.

Based on the information available from consultation and literature review, it appears that most Member States have implemented and applied the requirements of the Directive correctly within the agreed timescales (in the Directive and, where applicable, in the Accession Treaties) including throughput thresholds for derogating service stations and terminals. However, in some instances there appears to have been some delays and/or issues with implementation; these are outlined below:

- For the Flanders Region of Belgium, the Stage I VOC Directive was only transposed into national legislation in the Vlarem on 1st April 1999, hence suggesting a delay in the implementation of the Directive. For the Walloon region of Belgium, consultation has suggested that there are transitional periods for the application of the Directive to certain service stations. In particular, it is understood that AGW 4/03/1999 allows a transitional period up to 1 January 2010 for stations with storage tanks that were less than 20 years old in 2001. The practical implications of how this transitional period relates to the requirement to implement Stage I controls according to Directive 94/63/EC and AGW 23/05/1996 are not clear.

- For Bulgaria, there are various transition periods for compliance with the requirements of the Directive with a final deadline for implementation of 31st December 2009. As such, not all of the requirements have necessarily been implemented at this stage.

- For Cyprus, an extension was given with regards to compliance with the requirements of Directive 94/63/EC for five petrol stations (i.e. installation of Stage 1B vapour recovery equipment) until 2008 or when maintenance of the petrol stations was planned, whichever took place earlier. For these five petrol stations, installation of the Stage 1B vapour recovery equipment and full compliance with the requirements of Directive 94/63/EC is understood to have taken place by the end of 2007.

- For Finland and Sweden, the same issues exist for the regulations referring to the technical requirements set out in Annex IV, for rail and road transport tanks, as were raised at the

'Environmental Fuels Expert Group'[9] in 1997. Both Member States have implemented the Directive as if the amendments discussed by the EFEG had been made to the legislation and as such do not strictly comply with Annex IV of the Directive. This is described in greater detail in Section 3.3 of this report. The differences in implementation for these Member States are not expected to have significant implications for the level of environmental protection achieved or for intra-EU trade.

- For Greece, information provided by stakeholders indicates that a small number of road tankers do not currently comply with the requirements of the Directive (although steps are being taken to rectify this). In addition, whilst all service stations have Stage I controls fitted, in some cases they are reportedly not being used and/or operated correctly.

- For Ireland, some terminals have not have implemented the requirements of the Directive yet although it is unclear to the authorities if they have a throughput of less than 10,000 tonnes per year.

- For Romania, there are various transition periods for compliance with the requirements of the Directive with a final deadline for implementation of 31st December 2009. As such, not all of the requirements have necessarily been implemented at this stage.

3.3 Technical issues and problems of interpretation

3.3.1 Overview

A key element of this project was to identify, through consultation with Member State regulatory authorities, industry associations and economic operators (and any relevant literature) any technical issues or problems of interpretation which hinder an effective implementation of the Directive.

In addition to providing an improved understanding of the implementation of the Directive, the identification of such issues and problems also serves as a basis for identifying any potential to simplify the Directive's provisions (including the technical annexes) taking account of technical progress since the Directive was adopted in 1994 (e.g. reference to relevant CEN standards).

The following main sources of information have been used to inform this section:

- A review of the provisions of Directive 94/63/EC itself.

- Discussions with and information from certain Member States.

- Discussions with various industry associations (including European and national-level associations).

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9 Environmental Fuels Expert Group (EFEG) Technical sub-group on the implementation of Directive 94/63 VOC Stage 1: Meeting of 20th October 1997

- Review of relevant standards and technical documentation, including international standards and national guidance on implementation of the Directive.

In the following sections, information is provided in the form of context in order to understand changes made since the Directive was introduced (particularly conclusions reached in the Environmental Fuels Expert Group and development of CEN standards). Specific issues that have been identified are then treated in turn.

3.3.2 Context

Environmental fuels expert group (EFEG)

At its meeting on 20 October 1997, the EFEG's "technical sub-group on the implementation of Directive 94/63 VOC Stage I" (hereafter referred to as the EFEG technical sub-group) reached conclusions on a review of a number of proposed wording changes to the Directive[10]. These changes were to be submitted to the Committee foreseen under Article 8 of the Directive.

In particular, agreement was reached on amended text for inclusion in the Directive. A number of these text changes were proposed in order to clarify certain provisions of the Annexes of the Directive. Furthermore, several changes were proposed in order to take into account the specific circumstances of the "Arctic" Member States that were not part of the EU when the Directive was introduced[11].

It was concluded that certain provisions of the Directive did not account for the situation in these Member States where different specifications were in place for bottom-loading, vapour collection and overfill protection. These different standards were not considered to achieve a lower reduction in VOC emissions prior to introduction of the Directive. The specific changes proposed to the text of the Annexes of the Directive are outlined in the following sections.

Development of CEN standards

Directive 94/63/EC refers to certain standards with regard to specifications for equipment for loading and vapour collection (such as the American Petroleum Institute's Recommended Practice for liquid couplers on loading arms and vapour-collection couplers on loading gantries).

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[10] Environmental fuels expert group (EFEG), technical sub-group on the implementation of Directive 94/63 VOC Stage I, minutes of the meeting on 20 October 2007.

[11] These Arctic Member States include Finland and Sweden which joined the EU on 1 January 1995 (i.e. after the Directive was published in the Official Journal).

The European Committee for Standardization (CEN) contributes “to the objectives of the European Union and European Economic Area with voluntary technical standards which promote free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programmes, and public procurement.”[12]

In particular, one of the CEN Technical Committees, CEN 296, on tanks for transport of dangerous goods, has been set up and has been developing standards for design, construction, inspection and testing of metallic tanks intended for transport of dangerous goods of a capacity of more than 450 litres (this covers road tankers, tanks of rail-tank-wagons and tanks intended for multimodal transport)[13]. CEN Technical Committee 296 has developed a number of published standards related to various equipment and activities related to tanks for transporting dangerous goods. These are outlined in Box 1.

Box 1	**CEN/TC 296 – Published standards**
CEN/TR 15120:2005	Tanks for transport of dangerous goods - Guidance and recommendations for loading, transport and unloading
EN 12972:2007	Tanks for transport of dangerous goods - Testing, inspection and marking of metallic tanks
EN 13081:2008	Tanks for transport of dangerous goods - Service equipment for tanks - Vapour collection adaptor and coupler
EN 13082:2008	Tanks for transport of dangerous goods - Service equipment for tanks - Vapour transfer valve
EN 13083:2001	Tanks for transport of dangerous goods - Service equipment for tanks - Adaptator for bottom loading and unloading
EN 13094:2008	Tanks for the transport of dangerous goods - Metallic tanks with a working pressure not exceeding 0,5 bar - Design and construction
EN 13094:2008/AC:2008	Tanks for the transport of dangerous goods - Metallic tanks with a working pressure not exceeding 0,5 bar - Design and construction
EN 13308:2002	Tanks for transport of dangerous goods - Service equipment for tanks - Non pressure balanced footvalve
EN 13314:2002	Tanks for transport of dangerous goods - Service equipment for tanks - Fill hole cover
EN 13315:2002	Tanks for transport of dangerous goods - Service equipment for tanks - Gravity discharge coupler
EN 13316:2002	Tanks for transport of dangerous goods - Service equipment for tanks - Pressure balanced footvalve
EN 13317:2002+A1:2006	Tanks for transport of dangerous goods - Service equipment for tanks - Manhole cover assembly
EN 13922:2003	Tanks for transport of dangerous goods - Service equipment for tanks - Overfill prevention systems for liquid fuels
EN 14025:2008	Tanks for the transport of dangerous goods - Metallic pressure tanks - Design and Construction
EN 14116:2007	Tanks for transport of dangerous goods - Digital interface for the product recognition device
EN 14432:2006	Tanks for the transport of dangerous goods - Tank equipment for the transport of liquid chemicals - Product discharge and air inlet valves
EN 14433:2006	Tanks for the transport of dangerous goods - Tank equipment for the transport of liquid chemicals - Foot valves
EN 14512:2006	Tanks for the transport of dangerous goods - Tank equipment for the transport of liquid chemicals - Hinged manhole covers and neckrings with pivoting bolts
EN 14564:2004	Tanks for transport of dangerous goods - Terminology

[12] http://www.cen.eu/cenorm/aboutus/index.asp

[13] http://www.cen.eu/nr/cen/doc/PDF/6277.pdf

EN 14595:2005	Tanks for transport of dangerous goods - Service equipment for tanks - Pressure and Vacuum Breather Vent
EN 14596:2005	Tanks for transport of dangerous goods - Service equipment for tanks - Emergency pressure relief valve
EN 15207:2006	Tanks for transport of dangerous goods - Plug/socket connection and supply characteristics for service equipment in hazardous areas with 24 V nominal supply voltage
EN 15208:2007	Tanks for transport of dangerous goods - Sealed parcel delivery systems - Working principles and interface specifications

Source: http://www.cen.eu/CENORM/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Standards.asp?param=6277&title=CEN%2FTC+296.

One of the key publications in the context of the technical requirements of Directive 94/63/EC is the CEN Technical Report on "Tanks for transport of dangerous goods - Guidance and recommendations for loading, transport and unloading" (CEN/TR 15120). This provides guidance and recommendations to enable the transfer of product and vapour between the loading gantry, the tank truck and the service station. The recommendations and guidance are intended to assist users in meeting the requirements of Directive 94/63/EC.

One of the key issues covered in this report, particularly in the context of the EFEG conclusions referred to above, is that the report "acknowledges that, for climatic and logistical reasons, alternative technical solutions are commonly used in the Arctic Region".

3.3.3 Review of specific provisions

Introduction

This section provides a brief review of specific technical provisions in the Directive that have been identified as causing issues with implementation (or as having the potential to cause such issues). The provisions discussed are based on the conclusions of the EFEG technical sub-group[14] as well as specific issues raised based on discussions with Member States and industry associations.

Painting of storage tanks with heat-reflecting paint at terminals

Section 1 of Annex I of Directive 94/63/EC requires that: "The external wall and roof of tanks above ground must be painted in a colour with a total radiant heat reflectance of 70% or more".

Given that this provision only allows tanks to be painted in one colour and because the majority of solar heating of a tank occurs due to radiation upon the roof, the EFEG technical sub-group concluded that it would be appropriate

[14] Only a brief summary of the issues is presented here. The reader is referred to the specific conclusions agreed and supporting information for further details.

for tanks to be painted in a colour *or colours* with an average radiant heat reflectance weighted by area of 70% or more and that the roof must be painted in the colour with the highest radiant heat reflectance of the colours used.

Based on the discussions held as part of this study, it is evident that this provision has been interpreted in different ways in different Member States. For example:

- In Sweden, this was reportedly the requirement of the Directive that took longest to implement. The provisions of Annex I, point 1 concerning "colour" were interpreted as relating to painting of tanks in white at terminals, though not at refineries[15]. The Swedish EPA reserved the right in its transposition of the legislation to take alternative measures to obtain equivalent environmental outcomes. Many existing tanks in Sweden that previously stored heavy fuel oil have been converted to store petrol (instead of being scrapped). Due to the heavy insulation already provided by such tanks, the painting of these tanks in white was not considered necessary (see also Appendix A).

- In the UK, the relevant guidance[16] for authorities and operators states that "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."

Overall, the approach suggested by the EFEG technical sub-group would not be expected to lead to any increase in VOC emissions as compared to the approach set out in the Directive and would allow for the use of more than one colour (for example, this would allow for company colours to be incorporated).

Similarly, the approaches adopted in Sweden and the UK would not be expected to lead to any increase in VOC emissions compared to the approach in the Directive[17].

Shut-down of loading operations in the event of vapour leak

Section 4 of Annex II to Directive 94/63/EC requires that: "The Member States' competent authorities must ensure that loading operations are shut down at the gantry in the case of a leak of vapour. Equipment for such shutdown operations must be installed at the gantry."

In the EFEG technical sub-group's conclusions, it was argued that vapour leaks may occur during loading from the pressure relief valves of road tankers built before 1st January 1996 which do not need to meet the requirements of

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15 At refineries, vapour recovery units are generally in place and so do not necessarily need to be painted as such, as allowed for in the Directive.

16 Process Guidance Note 1/13 (04) – Secretary of State's Guidance for Storage, Unloading and Loading Petrol at Terminals, Department for Environment, Food and Rural Affairs, 2004.

17 Although in theory a tank could be painted in colours with a total average heat reflectance of 70% or more but the tank roof could be painted in a colour of lower reflectance (if the sides were painted with a higher reflectance paint, averaging 70% overall). There is no evidence to suggest that this occurs in practice.

Article 5 and Annex IV of the Directive. Therefore, the requirement to shut-down loading should only apply to leaks from tankers which conform with the requirements of Annex IV and carry an identification plate specifying the maximum number of loading arms which may be operated simultaneously to ensure that no vapours are emitted from the tanker pressure and vacuum relief valves.

This conclusion presumably reflects a view that the operator of the terminal should not be responsible for the compliance with the Directive (or otherwise) of road tankers that are not explicitly required to comply with the Directive. The overall number of road tankers that do not comply with the requirements of the Directive is unknown[18].

Note that the conclusions of the EFEG technical sub-group also make clear the distinction between a requirement to shut-down operations where the vapour leak occurs at the terminal vapour collection system and where the leak occurs from the road tanker; the former would not be affected by the proposed changes.

Title of Annex IV

Annex IV of Directive 94/63/EC is titled "specifications for bottom-loading, vapour collection and overfill protection of European road tankers."

The EFEG technical sub-group suggested that the title should be amended to "specifications for bottom-loading, vapour collection and overfill protection of road transport tank/gantry interface."

The rationale behind this is that the majority of the provisions of the Directive relate to the design of the loading gantry and its interface with the transport tank (with the exception of those that describe the requirement for a vehicle identification plate).

In addition, the suggested change of terminology from "road tankers" to "transport tanks" was suggested on the basis of achieving consistency with other regulations[19].

Couplings

Section 1 of Annex IV of Directive 94/63/EC requires that:

> *"1.1 The liquid coupler on the loading arm must be a female coupler which must mate with a 4-inch API (101.6 mm) male adapter located on the vehicle as defined by: API Recommended Practice 1004 Seventh*

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[18] Note that the European road tanker fleet includes approximately 60,000 units, with new vehicles representing around 5,000 units per year (http://www.cen.eu/nr/cen/doc/PDF/6277.pdf).

[19] For example, Directive 94/55/EC on the approximation of the laws of the Member States with regard to the transport of dangerous goods by road (the "ADR Framework Directive", as amended).

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)

"1.2 The vapour-collection coupler on the loading-gantry vapour-collection hose must be a cam-and-groove female coupler which must mate with a 4-inch (101.6 mm) cam-and-groove male adapter located on the vehicle as defined by: API Recommended Practice 1004 Seventh Edition November 1988 – Bottom loading and vapour recovery for MC-306 tank motor vehicles (Section 4.1.1.2 - Vapour-recovery adapter)."

The EFEG technical sub-group suggests that provision should be made to allow the use of 3 inch (76.2mm) liquid couplings and vapour collection couplers as an alternative in the Arctic Member States. According to their recommendation, at least one gantry at each terminal would be required to have the 4 inch liquid and vapour collection couplings in place, in order to permit cross-border trade.

The basis for this recommended change is that bottom loading equipment had been used in the Arctic Member States, but using 3 inch liquid and vapour collection couplings, for more than 20 years (as of 1997). It was estimated that modifying these to 4 inch would achieve no additional reduction in VOC emissions and would cost 400 million SEK to rebuild the 48 terminals in Sweden alone[20].

Additional information has been made available concerning the Arctic Member States for the purposes of this study.

In relation to the situation in **Sweden**[21], it has been clarified that bottom loading of road tankers was introduced in 1974 for occupational health reasons and for efficiency gains. The whole depot system was rebuilt approximately 10 years later.

The road tankers in Sweden are above average in size as compared to those in other Member States, because the population is spread over a large area. They are generally 60 tonne tankers, up to 25.25m long, typically comprising a standard tanker, with an additional trailer of variable length attached behind. This is highlighted in Figure 3.1.

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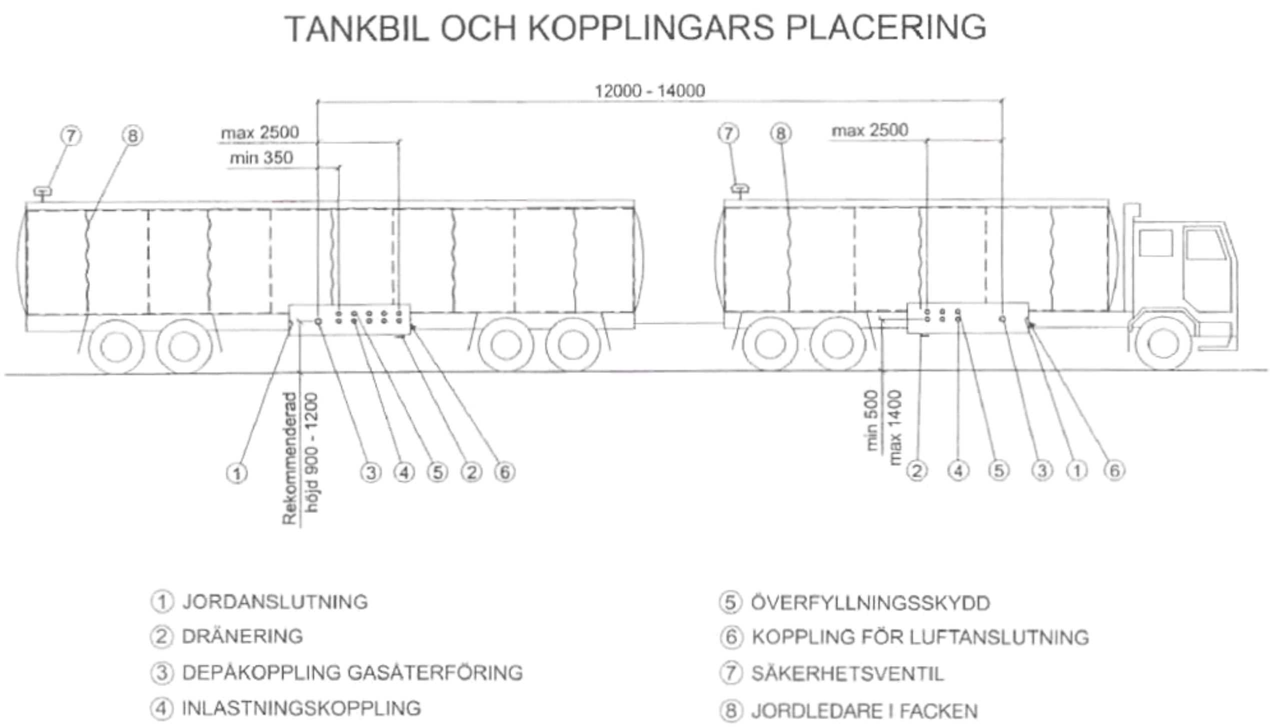
[20] This corresponds to €40 million at an exchange rate of €1 = 0.100 SEK (as of 10 November 2008, not taking into account inflation).

[21] The information presented on Sweden is based on a meeting between Entec and the Swedish EPA and the Swedish Petroleum Institute on 7 October 2008.

Figure 3.1 Typical Swedish road tanker including trailer (SPI, 2008)[22]



In order to fill both the tanker and the trailer at the same time, gantries were developed with two loading systems and two pumps in place. This necessitated the use of lengthy hoses in order to accommodate the variable trailer length (rather than fixed loading arms). As such, since 1985, 3 inch couplings have been in use as standard industry practice in Sweden on loading arms and loading gantries, with the standard formalised through the SPI in 2004.

It is understood that the 4 inch couplings prescribed by Annex IV of the Directive were trialled but were found to make the hoses too heavy to be easily lifted by the drivers, and so were not adopted (for this reason amongst others).

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[22] SPI (2008): SPI Lastningsstandard, Swedish Petroleum Institute, version 2, 1 January 2008 (in Swedish).

Figure 3.2 Loading hoses at terminals in Sweden

Source: Swedish Petroleum Institute

In order not to inhibit cross-border trade, adapters for 4 inch couplings are reported to be available on one gantry at each Swedish terminal. However, it is understood that these have very rarely been used given that the Arctic Member States are relatively isolated geographically as compared to other Member States (it has been suggested that some use may have occurred in southern Sweden where road tankers from other Member States, with 4 inch couplings, may visit).

Whilst an in-depth analysis of the vapour control afforded by the Swedish vapour collection systems has not been undertaken for the purposes of this study, the descriptions provided do not suggest that the level of VOC abatement would be less than that afforded through compliance with Directive 94/63/EC. The indication that at least one 4 inch coupling is in place at all terminals in Sweden would tend to suggest that issues related to cross-border trade have been addressed in Sweden.

In **Finland**, it has also been confirmed that alternative technology is still used to some extent in the road tanker fleet (3 inch vapour recovery couplings instead of the 4 inch couplings required by the Directive)[23].

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[23] Personal communication, Finnish Oil and Gas Federation, 30 October 2008.

Furthermore, in the **CEN** Technical Report referred to above (CEN/TR 15120:2005), it is explicitly recognised that, in the Arctic region, couplers for bottom loading with the same functionality but able to connect with an adaptor for bottom loading with a reduced diameter are commonly used; likewise, vapour collection couplers with the same functionality but with a reduced diameter are commonly used (corroborating the above information from Sweden and Finland).

Liquid loading rate

Section 2.1 of Annex IV of Directive 94/63/EC requires that: "the normal liquid-loading rate must be 2,300 litres per minute (maximum 2,500 litres per minute) per loading arm."

The EFEG technical sub-group concluded that this should be amended to indicate that the loading rate for design purposes should be 2,500 litres per minute per loading arm. This was on the basis that the loading rate varies from terminal to terminal depending upon factors such as pipe sizes and pump capacities, meaning that a specified normal liquid loading rate is unworkable. It is understood that the reason for this requirement is to enable the vehicle and the plant engineers to design their respective vapour collection systems.

Furthermore, it was suggested that a lower liquid loading rate for design purposes of 1,800 litres per minute should be allowed in the Arctic Member States, where a reduced diameter coupling is used (as described above).

It has been highlighted by the Swedish Petroleum Institute that the loading rates specified in the Directive are inconsistent with those in CEN/TR 15120:2005. This Technical Report provides details of the maximum loading rates per loading arm for diameters of pipe used in loading systems (including tank truck pipework) such that the accumulation of the electrostatic charge on the surface of the liquid does not exceed acceptable limits.

For example, this suggests maximum loading rates of 2,400 litres per minute for pipe of 100mm nominal diameter and 1,800 for pipe of 80mm diameter, though there are differences depending upon the loading conditions and the conductivity of the fuel. The Technical Report also suggests that loading rates may need to be reduced for safety reasons depending upon specific circumstances and that reduced flow rates are applicable in Arctic or severe winter conditions.

There is therefore an argument for amending the requirements of this part of the Directive to reflect the clarification that the maximum rates specified are for design purposes but also to recognise the variability depending upon conditions and the different equipment used in certain cases in Sweden and Finland.

Counter-pressure generated by vapour collection systems at terminals

Section 2.2 of Annex IV of Directive 94/63/EC requires that "when the terminal is operating at peak demand, its loading gantry vapour collection system, including the vapour recovery unit, is allowed to generate a maximum counter-pressure of 55 millibar on the vehicle side of the vapour collection adapter."

The EFEG technical sub-group suggested that the counter pressure should instead be referred to as being "at the interface between the vapour collection adapter on the vehicle and the vapour collection coupler on the loading gantry."

The basis for this would be to allow the designer of the vehicle to have a reference value against which to specify all of the components in the vapour collection system on the vehicle and the designer of the loading gantry vapour collection system to have a reference value against which to specify all of the components in that system, including the vapour recovery unit. The current wording means that the vehicle vapour adapter is included in the loading gantry vapour collection system, making design specification problematic.

According to Concawe[24], this was a real issue for people involved in design and specification. However, in practice, it is understood that most have assumed that the text in the EFEG technical sub-group agreement is how the requirements should be implemented.

Connection of vehicle earth/overfill detection

Section 3 of Annex IV of Directive 94/63/EC requires that the loading gantry must be equipped with an overfill-detection control unit which, when connected to the vehicle, must provide a fail-safe permission signal to enable loading, providing no compartment-overfill sensors detect a high level. The specific provisions include:

> *"3.1 The vehicle must be connected to the control unit on the gantry via a 10-pin industry-standard electrical connector. The male connector must be mounted on the vehicle and the female connector must be attached to a flying lead connected to the gantry-mounted control unit.*
>
> *"3.2 The high-level detectors on the vehicle must be either 2-wire thermistor sensors, 2-wire optical sensors, 5-wire optical sensors or a compatible equivalent, provided the system is fail-safe. (NB: thermistors must have a negative temperature coefficient.)*
>
> *"3.3 The gantry control unit must be suitable for both 2-wire and 5-wire vehicle systems.*
>
> *"3.4 The vehicle must be bonded to the gantry via the common return wire of the overfill sensors, which must be connected to pin 10 on the male connector via the vehicle chassis. Pin 10 on the female connector must be connected to the control-unit enclosure which must be connected to the gantry earth.*
>
> *"3.5 All approved bottom-loading vehicles must carry an identification plate (see 2.3) which specifies the type of overfill-detection sensors installed (i. e. 2-wire or 5-wire)."*

The EFEG technical sub-group suggested that a number of changes be made to this Section, including:

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24 Meeting between Entec and Concawe on 16 September 2008.

- The option to use individual compartment overfill detectors in the Arctic Member States (in 3.1).
- Removal of reference to the requirement for thermistors to have a negative temperature co-efficient (in 3.2).
- Provision for at least one gantry to be equipped with an overfill detection control unit suitable for both 2-wire and 5-wire vehicle systems as described in 3.2 and the option to use a unit suitable only for 2-wire thermistor sensors with a positive temperature coefficient in the Arctic Member States (in which cases, at least one gantry would need to be equipped with a control unit suitable for optical sensors) (in 3.3).
- The option to use a separate earth connection (in 3.4).

The rationale behind this is that the high level detectors used in the Arctic Member States were thermistors with a positive temperature coefficient, given that those with a negative temperature coefficient were considered less reliable in a cold climate and potentially unsafe. These existing systems in the Arctic Member States had individual connectors and a separate earth connection.

The Swedish EPA previously estimated the costs of bringing the Swedish network in line with the Directive at:

- 150m SEK (€15m excluding inflation) for retrofitting new overfill detectors and fittings in tankers and trailers in Sweden; and
- 1800m SEK (€180m excluding inflation) for retrofitting tanks at customers' premises to avoid use of two different overfill protection systems[25] (this is considered to be out of date now, and probably closer to 400-500m SEK (€40-50m excluding inflation) based on the 2008 network compared to the 1996 network).

The EFEG technical sub-group also indicated that the wording should reflect the possibility of requiring overfill detection control units compatible with all types of transport tank to be installed at one gantry in order to permit cross-border trade (as with the couplings referred to above).

Location of liquid adaptors (envelope)

Section 4.1.3 of Annex IV to Directive 94/63/EC requires "all liquid adapters to be located within an envelope not exceeding 2.5 metres in length."

The EFEG technical sub-group proposed that the length of this allowed "envelope" be extended to 2.8 metres for the Arctic Member States on the basis that larger vehicles are used (as outlined above).

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25 Given that a large number of tankers also deliver to customers whose tanks are also fitted with positive temperature coefficient thermistors which are linked to the tanker.

Based on discussions with the Swedish EPA and the Swedish Petroleum Institute, it is understood that there has been some ambiguity concerning the definition of "envelope" when applied to a road tanker with a trailer attached (as is commonly applied in Sweden). If the envelope is defined as the width of one set of adapters (i.e. on either the truck, or the trailer) then it is understood that this change would not be required for Swedish road tankers. However, if the "envelope" encompasses the distance between the furthest forward adapter on the truck and the furthest back adapter on the trailer, then obviously this will be a distance much more than 2.5m (see Figure 3.2). To encompass this in the Directive would require an alternative change in wording to that recommended by the EFEG technical sub-group.

It is unknown at present whether there are any vehicles where the vehicle-connection envelope is greater than the 2.5m specified in the Directive and the 2.8m recommended by the EFEG technical sub-group (notwithstanding the comments above regarding the situation in Sweden).

Location of earth/overfill connector

Section 4.2 of Annex IV to Directive 94/63/EC requires that "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)."

The EFEG technical sub-group recommendation included amending this to restrict the location of the earth/overfill connector only to being on the right of the liquid adapters (and not the vapour collection adapters). It was further recommended that the use of individual compartment overfill detectors and separate earth connectors – as is applied in the Arctic Member States – be explicitly recognised.

The implications of this proposed change are currently unclear.

Earth/overfill detection

Section 5.1 of Annex IV to Directive 94/63/EC requires that "loading must not be permitted unless a permissive signal is provided by the combined earth/overfill control unit. In the event of an overfill condition or a loss of vehicle earth, the control unit on the gantry must close the gantry-loading control valve."

The EFEG technical sub-group recommendation included amending this such that the use of separate earth and overfill control units – as is applied in the Arctic Member States – be explicitly recognised.

Definitions in Directive 94/63/EC

Also included in the minutes of the EFEG technical sub-group's meeting of 20 October 1997 are a number of proposed text changes, mainly related to definitions. These include:

- A proposal to amend Article 2(e) to refer to “transport tanks” as defined in relevant legislation on transport of dangerous goods (Directive 94/55/EC, Directive 96/49/EC, etc.) rather than “mobile containers”.
- Deletion of Article 2(k) which defines “vessels”.
- Reference to following the specifications laid down in Annex IV for road transport tank vehicles (see below) in Articles 5.2(a) and 5.2(c) in relation to tanks for road, rail and vessels, including those retrofitted for bottom loading.
- Two possible versions for a new Annex V aiming to establish the links between the vocabulary used in Directive 94/63/EC and that used in legislation regarding the transport of dangerous goods. A first step and second step were presented, the latter incorporating more of the wording from the ADR and RID Directives[26].

Other issues

A number of other technical issues and/or problems of interpretation have been identified which have (or had) the potential to hinder an effective implementation of the Directive. These include:

- In the UK and some other Member States, it has reportedly been difficult in some cases to determine what constitutes “living quarters or working areas” according to Article 6(2)(b) (in practice this has been done on a case by case basis e.g. on the location of the vent valve).
- How ethanol blends should be treated under the Directive. This issue has been raised through consultation with the UK authorities and industry. In addition, consultation with Sweden has suggested that increased use of ethanol blends may impair the performance of vapour recovery units, including the service life of carbon VRUs.
- A number of issues that mainly relate to implementation of the Directive rather than the provisions of the Directive itself have also been identified. These include, for example, people connecting to the wrong tanks (diesel rather than petrol); lack of documenting compliance; misconnection of fuel and vapour return lines; and in some cases many different inspections from different organisations.

Vapour recovery systems for loading installations and ships

The preamble to Directive 94/63/EC states that “whereas, on grounds of international standardization and of safety during the loading of ships, standards must be drawn up at International Maritime Organization level for vapour control and recovery systems to apply to both loading installations and ships; whereas the Community must therefore endeavour to ensure that the necessary provisions are introduced into the Marpol Convention during the

[26] The ADR Directive is Council Directive 94/55/EC with regard to the transport of dangerous goods by road (implementing the European Agreement concerning the international carriage of dangerous goods by road). The RID Directive is Council Directive 96/49/EC (regulation concerning international carriage of dangerous goods by rail).

current revision of Marpol due to be completed in 1996; whereas in the event that the Marpol Convention is not so revised, the Community, after discussion with its major trading partners, should propose appropriate measures to apply to ships and port installations servicing ships."

Article 9 also states that "the Commission is invited to accompany its first report where appropriate with proposals for the amendment of this Directive, including in particular the extension of the scope to include vapour control and recovery systems for loading installations and ships."

As was indicated by the Commission in 1997[27], at that time work was in progress "to finalise the new Annex VI to Marpol 73/78, dealing with restrictions on air pollutants (nitrogen oxides (NO_x), sulphur dioxide (SO_2) and VOCs) generated from ships. In the light of the final agreement on the revision of the Marpol convention, the Commission will decide whether it is appropriate to propose an amendment to Directive 94/63/EEC, in accordance with the provisions of Article 9 of that Directive, including an extension of the scope of the Directive to include vapour control and recovery systems for loading installations and ships."

A report for the Commission[28] considered a number of options for marine vapour emission control in the EU in the context of such a possible amendment to the Directive. This study concluded that: "the emissions resulting from the ship-loading of gasoline and crude oil in the EU represent 0.07% and 0.8% respectively of all VOCs emitted annually in the EU. In general, the costs per tonne abated of measures on ship-loading are higher than the most expensive measures that Member States are likely to implement in order to comply with national emission ceilings for VOCs arising from new Community legislation. In light of this relatively small potential for reduction in VOC emissions and relatively poor cost effectiveness, it would appear that measures in other sectors of the European economy would be more effective in reducing VOC emissions than measures applied to the ship loading of gasoline, crude oil and other petrol and chemical products. Emissions from crude oil loading offer the greatest potential for reduction, but since these are concentrated in the North Sea it would be preferable to assess the impact on ozone in ambient air before considering measures for their abatement."

3.4 Summary

Despite some data gaps, the vast majority of work by the Member States already seems to have been done and, with a few seemingly minor exceptions (based on the data available), the provisions seem to have been implemented. In addition, the majority of Member States do not seem to have introduced additional derogations or time limits for compliance with the Directive.

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[27] OJ C 45, 10.2.98, p. 75.

[28] Measures to reduce emissions of VOCs during loading and unloading of ships in the EU, AEA Technology, August 2001 (http://ec.europa.eu/environment/air/pdf/vocloading.pdf).

Based on the discussions held during the study, most Member States seem to have experienced few if any technical problems in implementing the Directive.

However, there are specific issues for the Arctic Member States (Sweden and Finland) in that they do not fully comply with the requirements in Annex IV due to the nature of the pre-existing Stage I controls in place.

In relation to the recommendations of the EFEG technical sub-group, it has been confirmed by a number of consultees (including Sweden, Finland and Concawe) that the basis for all of these proposed changes still applies. These provisions, mainly aimed at encompassing the requirements applied in the Arctic Member States, do not appear likely to compromise the overall aims of Directive 94/63/EC in terms of control of VOC emissions (based on information considered so far). Given the relative geographic isolation of these Member States, the conclusions of the EFEG technical sub-group suggested that the provisions as recommended would be sufficient to permit cross-border trade (and information available for this study suggests that the Directive has been implemented as such in these Member States).

4. Potential for simplification

4.1 Introduction

One aspect of this project is to identify, through consultation with Member State regulatory authorities, industry associations, economic operators and open literature, any potential to simplify the Directive's provisions and technical annexes taking account of technical progress since the Directive was adopted in 1994. In particular, reference to relevant CEN standards was highlighted as a possible means of simplification at the start of the project.

From the consultation undertaken for this study, two main areas of *potential* overlap with Annex IV of the Directive were identified:

- CEN standards and technical reports. Specifically, since the adoption of the Stage I Directive, a number of CEN standards and technical reports have been produced which cover some of the requirements of the Stage I Directive, particularly Annex IV.

- The transport of dangerous goods Directives. Specifically, in Austria, Greece and Sweden, the implementation of the ADR requirements is understood to also cover the requirements for road tankers in Directive 94/63/EC (for example, tankers are tested for leaks according to national ADR legislation)[29].

In the remainder of this section, the areas of overlap between the CEN standards, transport of dangerous goods directives and the VOC Stage I Directive are discussed and the merits of possible means of simplification with regard to these instruments considered.

4.2 Potential areas for simplification

4.2.1 Reference to the Transport of Dangerous Goods Directives (Directive 2008/68/EC)

The transport of goods by road and rail was first regulated by Directives 94/55/EC (road) and 96/49/EC (rail) and their subsequent amendments. However, on 24th September 2008, Directive 2008/68/EC ('Inland Transport of Dangerous Goods') was passed, which sets up a common regime covering all aspects of the inland transport of dangerous goods by road and rail and also lays down provisions in relation to inland waterways; this Directive replaces Directives 94/55/EC and 96/49/EC and their various amendments.

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29 Compare with Article 5(1)(d) of the Stage I Directive which requires regular testing for vapour tightness.

Directive 2008/68/EC is a wide reaching Directive and applies to the transport of goods, by road, by rail or by inland waterway within or between Member States, including the activities of loading and unloading; the transfer to or from another mode of transport; and the stops necessitated by the circumstances of the transport.

4.2.2 Reference to UNECE Agreements in Directive 2008/68/EC

A key element of Directive 2008/68/EC is that it should be possible to rapidly adapt the annexes to take into account the development of new technologies and in particular to take account of new provisions incorporated in the ADR, RID and ADN UNECE (United Nations Economic Commission for Europe) Agreements. Therefore Directive 2008/68/EC does not stipulate any technical requirements directly (unlike the previous ADR Directive, for example), but refers to the most recent UNECE Agreements in Annexes I, II and III:

- Annex I of Directive 2008/68/EC stipulates that Annexes A and B of the ADR 2009 shall apply from the 1st of January 2009 and allows certain existing derogations within Directive 94/55/EC to be continued. Here ADN refers to the European Agreement concerning the International Carriage of Dangerous Goods by Road, concluded at Geneva on 30th September 1957. The latest amendments entered into force on 1st January 2009 and the revised and consolidated version is published as document ECE/TRANS/202, Vol. I and II ('ADR 2009')[30] .

- Annex II stipulates that RID 2009 shall apply from 1st January 2009 and allows certain derogations from Directive 96/49/EC to be continued. Here RID refers to the Regulations concerning the International Carriage of Dangerous Goods by Rail, appearing as Appendix C to the Convention concerning International Carriage by Rail (COTIF) concluded at Vilnius on the 3rd June 1999; the most current version of which is from 2009[31].

- Annex III states that the ADN 2000 shall also apply from 1st January 2009 with some minor transitional provisions. Here ADN refers to the European Agreement concerning the International Carriage of Goods by Inland Waterways, concluded at Geneva on 26th May 2000[32] , as amended. At the time of writing, the 2000 version was still the most current text.

It should be noted that Directive 2008/68/EC refers to each UNECE document specifically by publication; therefore when a revised UNECE document is published, the annexes to the Directive will presumably need to be amended to refer to the new document[33]. This arrangement of the legislation allows the Directive to be rapidly updated through amending the annexes (as compared to amending the large amount of detailed provisions previously included in the ADR Directive), but also gives the Commission some control over which version of the

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30 http://www.unece.org/trans/danger/publi/adr/adr2009/09ContentsE.html

31 www.otif.org

32 http://www.unece.org/trans/danger/adnreg.html

33 Personal Communication, DG TREN, 30th January 2009.

UNECE documents to reference. It should be noted that, for the transport of dangerous goods, it is understood that the Commission would almost without exception update the annexes, as all vehicles within the Member States must comply with the UNECE Agreements in any case and common rules on cross-border trade in dangerous goods is considered necessary for the European transport market to function as a common market[33].

The main potential area for simplification as regards Directive 94/63/EC relates to harmonisation of terminology used with the system under the ADR, RID and ADN Agreements and Directive 2008/68/EC. This was highlighted by the EFEG Technical Subgroup in 1997. It is unknown what, if any, complications the differences in terminology cause in practice.

In addition, the ADR includes requirements for tankers carrying liquids such as petrol. For example, it includes a requirement for a leakproofness test and testing of the satisfactory operation of all relevant equipment (Chapter 6.8.2.4 of the ADR). There may be some overlap between this and the requirement of Article 5(1)(d) for competent authorities to ensure regular testing for vapour tightness and periodic inspection for correct functioning of vacuum/pressure values. Some Member States are understood to fulfil the requirements of Directive 94/63/EC through their national implementation of the ADR requirements.

4.2.3 Reference to CEN standards in the UNECE Agreements

All three UNECE Agreements cover the requirements for the design, construction, testing and operation of tanks suitable for the carriage of petroleum and diesel products in a similar way. Because the main areas for simplification identified during consultation for this study relate to Annex IV (Road Tankers), the discussion below focuses on the ADR. In the ADR Agreement there are two sections which are the most relevant for the carriage of petroleum and diesel products: Chapter 6.8 sets out the requirements for the design, construction and testing of tanks and tank-vehicles and Chapter 7.5 sets out the requirements for loading and unloading of tanks and tank vehicles, but does not specifically mention requirements to reduce emissions of VOCs.

The requirements in the ADR Directive are linked to CEN standards and in the ADR refer to CEN standards as a method of demonstrating compliance with the requirements. The ADR Agreement covers the transport of a wide spectrum of dangerous goods and rather than treating each product individually, covers types of requirements in a general manner before introducing product specific requirements through coded tables. Because of this, it is sometimes easier to ascertain what the precise requirements are by reference to the CEN documents. For this reason and to avoid covering the same ground twice, the cross-overs between the ADR and Directive 94/63/EC are explored in Section 4.2.4, where the third column of Table 4.1 indicates which standards are also referenced in the ADR.

4.2.4 Potential for simplification by reference to relevant CEN standards

It is evident from the information presented in Section 3.3 of this report and from the references to CEN standards in the ADR Directive that there already exists a wide range of standards developed by CEN, particularly in the context of tanks for transport of dangerous goods. Indeed, a number of consultees for this study (e.g. Finland, Sweden) have suggested that it is inappropriate for Directive 94/63/EC to provide the level of technical detail that is currently included and that it would be more appropriate to refer to relevant CEN standards rather than including the detailed provisions currently in Annex IV in particular.

There are a large number of CEN standards which are indirectly related to the Stage I VOC Directive, but are not directly relevant to the requirements set out in Annex IV; a table showing a summary of these standards is given in Appendix C.

There is an important difference between a CEN Standard and a CEN Technical Report (several of the provisions of Directive 94/63/EC are covered by a CEN Technical Report rather than a CEN Standard).

A standard is a technical document designed to be used as a rule, guideline, or definition. CEN produces European Standards which imply an obligation to implement as an identical national standard in CEN member countries. Standards are voluntary and as such do not impose any legislative requirements. However, laws and regulations may refer to certain European Standards and make compliance with them compulsory. European Standards are sometimes used to provide presumption of conformity with European Directives. By contrast, a Technical Report is a document produced within a CEN Technical Committee that provides background information, for example on how to implement standards in specific cases. Technical Reports may contain informative material not suitable to be published as a European Standard[34].

Table 4.1 below shows the requirements of Annex IV of the VOC stage I Directive against the CEN standards which cover the same or similar requirements in order to determine what cross-over there is between the two. The third column shows where the CEN standard has been referred to in the ADR Directive/Agreement.

[34] http://www.cen.eu/cenorm/faq.asp; http://www.bsi-global.com/en/Standards-and-Publications/About-standards/Glossary/.

Table 4.1 Comparison of the links between CEN standards and Directive 1994/63/EC (VOC Stage I)

Requirement from Directive 1994/63/EC, Annex IV	Equivalent CEN Standard	CEN Reference in ADR Directive	Comments (Note 1)
1. Couplings			
(1.1) The liquid coupler on the loading arm must be a female coupler which must mate with a 4” API (101.6mm) cam-and-groove male adapter located on the vehicle as defined by API recommended practice 1004 (Seventh Edition, November 1988)	EN 13083:2001 specifies the dimensions of the male bottom loading adaptor to be fitted to the tank; outside D = 161.5mm, inside D = 101.6mm (which is 4”) CEN/TR 15120:2005 (4.1.4) states that the loading arm coupler must be compatible with the bottom loading adaptor. (5.3.2) states that the male adaptor should be designed in accordance with EN 13083. Both (4.1.4) and (5.3.2) state that arctic states may use smaller diameter adapters.	N/A	EN 13083 does not specify the dimensions of the female coupler EN 13083 would need to be revised so that it is in line with CEN/TR 15120 for the diameter of couplers in arctic states (if the approach in these MSs is considered appropriate).
(1.2) The vapour-collection coupler on the loading-gantry vapour-collection hose must be a cam-and-groove female coupler which must mate with a 4” (101.6mm) cam and groove male vapour adapter located on the vehicle as defined by; API recommended practice 1004 (Seventh Edition, November 1988).	EN 13081:2001 specifies the dimensions of the male and female vapour collection couplers; the outside diameter of male coupler = 119.6mm CEN/TR 15120:2005 (4.1.5) (gantry) and (5.4.6) (tank) state that the coupler and adapter must be designed in accordance with EN 13081: 2001 and that arctic states may use smaller diameter adapters and couplers.	N/A	Although the diameters do not appear to match, it has been confirmed that the two documents refer to the same coupler[35]. EN 13081 would need to be updated to be in line with CEN/TR 15120 for the diameter of couplers in arctic states (if the approach in these MS is considered appropriate).
2. Loading Conditions			
(2.1) The normal liquid-loading rate must be 2,300 litres per minute (maximum 2,500 litres per minute) per loading arm.	CEN/TR 15120:2005 (4.2.1) Table 1 specifies maximum loading rates per loading arm for different diameter pipes, fuels and sulphur contents of the fuel. However, it does not specify the normal loading rate and the maximum loading rate given is 2,400 litres per minute, not 2,500. The maximum loading rates given are those that prevent the build up of static electricity.	N/A	The maximum loading rates given in CEN/TR 15120:2005 and the Directive are different. In order to prevent the build up of static electricity, it will not always to comply with the Directive’s ‘normal’ loading rate requirement. In addition, the EFEG document highlighted that specification of the maximum rate “for design purposes” may be more appropriate.

35 Personal Communication with one of the authors of TR15120 on 13th February 2009.

Requirement from Directive 1994/63/EC, Annex IV	**Equivalent CEN Standard**	**CEN Reference in ADR Directive**	**Comments (Note 1)**
(2.2) When the terminal is operating at peak demand, its loading gantry vapour collection system, including the vapour-recovery unit, is allowed to generate a maximum counter pressure of 55 millibar on the vehicle side of the vapour-collection adapter.	CEN/TR 15120:2005 (4.2.3) states that the maximum back-pressure created by the gantry vapour collection system should be 55 mbar.	N/A	Note the distinction as highlighted in the EFEG document (regarding where the back-pressure requirement applies).
(2.3) All approved bottom loading vehicles will carry an identification plate which specifies the maximum number of loading arms that may be operated simultaneously whilst ensuring that no vapours are released via the compartment P and V valves, when the maximum plant back pressure is 55 millibar.	CEN/TR 15120:2005 – Annex C (1) states that each tank shall carry an 'Information plate' which states the number of arms that may be loaded simultaneously. (5.4.1) states that the tank should be designed so that no vapours are released at this back pressure.	N/A	The Directive refers to an 'identification plate', while the CEN standard refers to an 'information plate'. The Directive varies between referring to back and counter pressure.
3. Connection of vehicle earth/overfill detection			
(3) The loading gantry must be equipped with an overfill-detection control unit which, when connected to the vehicle, must provide a fail-safe permission signal to enable loading, providing no compartment-overfill sensors detect a high level	CEN/TR 15120:2005 (4.1.3) states that the overfill prevention system should conform to EN 13922.	N/A	
(3.1) The vehicle must be connected to the control unit on the gantry via a 10-pin industry-standard electrical connector. The male connector must be mounted on the vehicle and the female connector must be attached to a flying lead connected to the gantry-mounted control unit.	EN 13922: 2003 specifies the design of the overfill detectors including the provision of a 10 pin socket for connection to the gantry. CEN/TR 15120:2005 specifies the location of the 10 pin socket on the vehicle.	N/A	
(3.2) The high level detectors on the vehicle must be either 2-wire thermistor sensors, 2-wire optical sensors, 5-wire optical sensors or a compatible equivalent provided the system is fail safe. NB: Thermistors must have a negative temperature coefficient (NTC)	EN 13922: 2003 (6.2.2) specifies design of the overfill detectors, which must be 2-wire thermistor sensors, 2-wire optical sensors, 5-wire optical sensors. Thermistors shall have a NTC. It also restricts the use of 2-wire sensors to vehicles with less than 8 compartments. CEN/TR 15120:2005 (4.1.3) states that overfill prevention system should conform to EN 13922, but that arctic states may use a positive temperature coefficient.	N/A	There is a discrepancy in terminology: CEN consistently refers to overfill detectors, while Stage 1 VOC refers to them here as 'high-level detectors' EN 13922 would need to be amended to be in line with CEN/TR 15120 in allowing PTC thermistors to be used in arctic states (if the approach in these MS is considered appropriate).
(3.3) The gantry control unit must be suitable for both 2-wire and 5-wire vehicle systems.	EN 13922: 2003 (6.1.1) states that the interface shall be suitable for 2-wire or 5-wire overfill prevention system and that the gantry based controller shall automatically detect the difference.	N/A	

Requirement from Directive 1994/63/EC, Annex IV	Equivalent CEN Standard	CEN Reference in ADR Directive	Comments (Note 1)
(3.4) The vehicle must be bonded to the gantry via the common return wire of the overfill sensors, which must be connected to pin 10 on the male connector on the vehicle chassis. Pin 10 on the female connector must be connected to the control-unit enclosure which must be connected to the gantry earth.	CEN/TR 15120:2005 does not state this requirement explicitly, but without connecting the two 10 pin sockets, the gantry will not receive a permissive signal and will not operate.	N/A	
(3.5) All approved bottom-loading vehicles must carry an identification plate (see 2.3) which specifies the type of overfill-detection sensors installed (i.e. 2-wire or 5-wire)	CEN/TR 15120:2005 – Annex C states that each tank shall carry an 'Information plate' which states the type of overfill-detection sensors installed.	N/A	
4. Location of the Connections			
(4.1) The design of the liquid-loading and vapour collection facilities on the loading gantry must be based on the following vehicle-connection envelope.			
(4.1.1) The height of the centre line of the liquid adapters must be: max 1.4m (unladen), min 0.5m (laden), the preferred height being 0.7 – 1.0m	CEN/TR 15120:2005 (Annex A) shows this diagrammatically.	N/A	
(4.1.2) The horizontal spacing of the adapters must be not less than 0.25m (preferred spacing is 0.3m)	CEN/TR 15120:2005 (Annex A) shows this diagrammatically.	N/A	
(4.1.3) All liquid adapters must be located in an envelope not exceeding 2.5m in length	CEN/TR 15120:2005 (Annex A) shows this diagrammatically. It does not mention any special allowance for arctic states.	N/A	CEN/TR 15120 could be amended to allow for arctic states to exceed the 2.5m envelope length (but see also the comments on use of tank trailers)
(4.1.4) The vapour-collection adapter should preferably be located to the right of the liquid adapters and at a height not exceeding 1.5m (unladen), and not less than 0.5m (laden)	CEN/TR 15120:2005 (Annex A) shows this diagrammatically.	N/A	
(4.2) The earth/overfill detector must be located to the right of the liquid and vapour-collection adapters and at a height not exceeding 1.5m (unladen) and not less than 0.5m (laden)	CEN/TR 15120:2005 (Annex A) shows this diagrammatically.	N/A	
(4.3) The connections referred to in 4.1-4.2 must be located on one side of the vehicle only	CEN/TR 15120:2005 (Annex A) shows this diagrammatically.	N/A	

Requirement from Directive 1994/63/EC, Annex IV	Equivalent CEN Standard	CEN Reference in ADR Directive	Comments (Note 1)
5. Safety Interlocks			
(5.1) Loading must not to be permitted unless a permissive signal is provided by the combined earth/overfill control unit. In the event of an overfill, the control unit on the gantry must close the gantry-loading control valve	EN 13922: 2003 specifies the conditions under which a permissive signal will be given.	N/A	Neither EN 13922 or CEN/TR 15120:2005 specifies the reaction of the gantry-loading control valve.
(5.2) Loading must not be permitted unless the vapour collection hose has been connected to the vehicle and there is free passage for the displaced vapours to flow into the collection system.	CEN/TR 15120:2005 (5.4.7) states that interlocks should be provided to ensure that the vapour collection coupler is connected and the vapour transfer valve is open before loading can commence.	N/A	

Notes

1. This column refers to changes to the CEN standards that would need to be made if Annex IV of the Stage I Directive were to be modified to refer to CEN standards instead of including the detailed technical provisions directly.

2. CEN/TR 15120:2005 (4.2.1) allows for maximum loading rates less than those specified in Directive 94/63/EC where there are specific safety concerns (e.g. arctic countries).

From Table 4.1 it can be seen that all of the requirements outlined in Annex IV of Directive 94/63/EC are covered by CEN Standards and/or Technical Reports, with two exceptions. For requirement 5.1 of Annex IV, the CEN Standard does not specify the reaction of the gantry-loading control valve. Requirement 2.1 of Annex IV specifies that the normal loading rate **must** be 2,300 litres per minute, while the CEN technical report only stipulates maximum loading rates in order to prevent the build up of static electricity.

There are also differences in the nomenclature used between the CEN standards and Annex IV of the Stage I Directive. For example, the CEN standards consistently refer to overfill detectors/prevention system, while Annex IV refers to high-level sensors in 3.2, but refers to overfill sensors/connection. Also, the CEN standards refer to an information plate, while the Directive refers to an identification plate; it is unclear whether these are the same object, but the information plate contains all of the detail specified in the Directive (and so there may not be any practical difference between the two). If Annex IV were to be adapted so as to refer to CEN standards, this may need to be taken into account.

A further difference between the CEN Standards/Technical Reports and Annex IV, is that the CEN Technical Report (which does not have the same standing as a Standard) includes deviations specifically for arctic countries. Of the amendments to the Directive suggested by the EFEG technical sub-group, only the deviation for a larger loading envelope was not mentioned in the CEN documents. It should be noted that EN 13922:2003 does not include a note for arctic countries to have a positive temperature coefficient thermistor, but that the relevant paragraph in the CEN Technical Report does.

Therefore if the CEN standards were amended to remove the differences highlighted above, Annex IV could be replaced by a reference to CEN Standards and Technical Reports, which would incorporate the amendments suggested by EFEG; the merits of this will be discussed in section 4.2.5. However, it is noted that several of the relevant provisions are currently included in CEN Technical Reports rather than full Standards and so could not presumably be referred to in the same way in any amendment to Directive 94/63/EC.

It can also be seen from Table 4.1 that none of the requirements of Annex IV of Directive 94/63/EC are directly covered by 'ADR 2009'; therefore there is no opportunity for simplification through referring to either ADR 2009 or Directive 2008/68/EC (though, as mentioned above, the ADR does appear to cover similar requirements to Directive 94/63/EC as regards testing for leakproofness – which may be considered to be the same as vapour tightness in the Directive – and for correct functioning of relevant equipment)..

4.2.5 Discussion of the merits of referencing external documents in EC Directives

As can be seen from the above, various CEN Standards and Technical Reports cover some of the requirements of Annex IV of the Stage I Directive.

There is therefore scope for simplifying the Directive (or at least removing some of the technical detail) through referring to such standards (though this would presumably require some of the requirements currently set out in Technical Reports to be included in formal Standards). Provided that provision were made to take into account updates to these standards, consistency with the current understanding of good practice in design and operation of relevant equipment could potentially be achieved without necessarily needing to adapt the Stage I Directive again in the future. There is also a precedent for this as the Directive already refers to API recommended practice[36] and Directive 2008/68/EC refers to the UNECE Agreements (which in turn refer to various CEN standards).

However, consultation has indicated some apprehension with regard to reliance upon such standards as this in effect removes some control from the authorities in terms of determining the way in which emissions are controlled. Although any new standards would have to be approved by the Commission before they are referred to in any revised appendices, which would effectively give the Commission the power of veto over amendments, the Commission would perhaps have less control in terms of being able to pro-actively influence the wording of such external documents. It is noted that the main part of the Directive covers the environmental objectives/targets to be achieved whereas Annex IV provides the detailed technical specifications.

Discussion with DG TREN[33] indicates that the driving factor in referencing the UNECE Agreements in Directive 2008/68/EC (as compared to the lengthy detail provided in the previous ADR Directive) was that it did not make sense to have separate legislation for the transport of dangerous goods across Member States and across borders.

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[36] For example, Annex IV refers to API Recommended Practice 1004 on bottom loading and vapour recovery for MC-306 tank motor vehicles, seventh edition, November 1998. The most recent version of this is RP 1004 on bottom loading and vapor recovery for MC-306 and DOT-406 tank motor vehicles, eighth edition, January 2003.

DG TREN indicate that, although duplicates of certain key documents must be sent to several authorities, the inspection and certification activities are only conducted once, which minimises administrative and compliance costs.

One possible approach, suggested during consultation for this study, would be for the Directive to specify the standards that are required in terms of the level of VOC abatement to be achieved (as is already done) and then to leave the detailed technical provisions as to how this is to be achieved to relevant standards.

Finally, it is worth bearing in mind that the Directive has already been implemented extensively for some time. Therefore, introduction of such changes to the provisions could entail a greater regulatory burden than not making any changes at all. However, as noted elsewhere in this report, there are some differences from Annex IV of the Directive in the technical provisions implemented in certain Member States (notably Sweden and Finland) which may need to be addressed by the Commission.

4.3 Summary

When considering the potential for simplification of the Directive, three possible approaches have been identified within this study:

- Remove certain specific technical requirements in the Annexes (mainly Annex IV) and replace these with references to external documents such as CEN standards;
- Remove certain technical requirements and replace them with emissions limits to be met in a manner that the Member State is to determine independently;
- Retain the Directive in its present form, though potentially with adaptations to reflect the situation in the Arctic Member States.

Within the first approach there are a number of external documents that respondents have suggested could be referred to during consultation for this study. As discussed in Section 4.2.2, it would probably not be appropriate to refer to Directive 2008/68/EC, as the ADR, RID and ADN documents to which this Directive refers for technical matters do not contain significant coverage of the requirements set out in Annex IV.

On the other hand, the CEN standards and technical reports do cover all of the requirements of Annex IV with two exceptions, where the CEN documents would need to be amended should this route be chosen. In addition, the CEN technical report includes technical variations for arctic states which are in accordance with the situation in those countries. The main advantages of referring to CEN standards would be the simplification of the current regulatory system, through harmonisation with external bodies' regulations and current procedures. The main disadvantage of this option is that the Commission would forgo the ability to positively influence the inclusion of technical requirements, but would retain the ability to exclude any amendments. It would also presumably require some of the information currently included in Technical Reports to be incorporated into formal Standards.

The second approach, which was suggested by some organisations consulted during this study, is to remove the technical provisions of the Annexes (specifically Annex IV) whilst retaining the overall emissions target(s) and to allow the individual Member States to meet this target in whichever way was felt to be most appropriate. The advantage of this approach is that the Member States would be free to shape national regulations so that they are appropriate for the local conditions. The disadvantages of this method are that separate national regulations may create barriers to trade and that it may become more difficult to assess compliance with the Directive.

Lastly, the Directive could be left in its current form. The main advantage of this method is that industry and the regulatory authorities are familiar with the regulations in their current form and changing them may increase the regulatory burden. If the Directive were to be changed substantially, to include variations for arctic countries or to increase standards, then this benefit could be reduced for those Member States (though would not necessarily affect other Member States).

5. Technical review of provisions

5.1 Introduction

One of the aims of this project is, from a purely technical perspective, to briefly assess how the degree of VOC abatement stipulated in the Directive for the various activities (storage at terminals, loading at terminals, unloading at service stations) compares with that possible with the current state of the art. This is to cover all of the technical requirements specified in the Directive relating to storage of petrol in tanks at terminals, loading at terminals, non-road vessels and unloading at service stations.

5.2 Technical review

5.2.1 Storage of petrol in tanks at terminals

A review of the provisions of the Directive against the BREF on storage[37] has not indicated any *significant* differences between what represents BAT for those activities covered by the 1994 Directive. However, there are some smaller changes that could potentially achieve greater emission reductions such as:

- BAT for external floating roof tanks represents a VOC emission reduction of 97% compared to 95% in the 1994 Directive and emission reductions of up to 99.5% can be achieved (compared to emissions from a fixed roof tank with no measures);
- BAT for fixed roof tanks with an internal floating roof can achieve over 97% emission reduction as compared to 90% in the Directive;
- Vapour recovery for fixed-roof tanks can achieve a BAT-associated emission level of 98%;
- Requirements related to installation and maintenance of pumps and compressors as well as sealing systems used can have implications for VOC emissions and these may need to be taken into account;
- Use of a “solar shield” on above ground storage tanks could potentially achieve higher emission reductions than painting tanks white, though the additional emission reductions may not be highly significant;
- Appropriate inspection and maintenance programmes and leak detection and repair programmes are also considered as BAT in this BREF document.

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[37] Integrated Pollution Prevention and Control, Reference Document on Best Available Techniques on Emissions from Storage, July 2006.

5.2.2 Loading at terminals

Summary of information from consultation with Member States and industry associations

Information from a number of sources suggests that the maximum level of VOC emissions in the exhaust gas from vapour recovery indicated in the Directive may be significantly higher – in some cases – than the levels that can be achieved and indeed higher than the levels specified in certain Member States' legislation[38]. In particular, indications from consultation are as follows:

- Concawe has suggested that, in the Germanic Member States, through the TA Luft, two-stage vapour recovery units have been required, achieving 99.95% emission reduction compared to 99.5% in the Directive. This was considered to be a relatively small additional reduction for relatively high cost. It was suggested that the VRUs already used are considered efficient and reliable and there have been no real changes in their design.

- Consultation with Germany has indicated that the mean concentration of vapours was determined to be 150 mg/Nm^3.

- Consultation with Sweden suggested that "first generation" VRUs using kerosene as a cooling agent typically achieved 35 mg/Nm^3. However, "second generation" VRUs, using carbon adsorption are now more commonly implemented and these can achieve typically less than 5 g/Nm^3 but occasionally have values of 5-10 g/Nm^3.

- The Flanders region of Belgium has reportedly introduced requirements (from 1st January 2008) to require a more stringent concentration limit for VOC emissions at VRUs at the terminals of 10 g/Nm^3 instead of 35 g/Nm^3. This limit was applied as it is included in the Gothenburg Protocol[39,40].

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38 According to Section 2 of Annex II, the mean concentration of vapours in the exhaust from the vapour recovery unit – corrected for dilution during treatment – must not exceed 35 g/Nm3 for any one hour. As set out in Article 4(1), the provisions of Annex II are designed to reduce the total annual loss of petrol resulting from loading and unloading of mobile containers at terminals to below the target reference value of 0.005 w/w % of the throughput.

39 Annex VI of the Gothenburg Protocol sets limit values for emissions of VOCs from stationary sources. For the storage and distribution of petrol, excluding the loading of seagoing ships, the use of a vapour recovery unit serving storage and distribution facilities at refinery tank farms or terminals (with a threshold of 5000m3 annual throughput of petrol is 10 g VOC/Nm3 including methane). It is further specified that, in the case of continuous measurements, as a minimum requirement, compliance with the emission standards is achieved if the daily mean does not exceed the limit value during normal operation and no hourly average exceeds the limit values by 150%. In the case of discontinuous measurements, as a minimum requirement, compliance with the emission standards is achieved if the mean value of all readings does not exceed the limit value and no hourly mean exceeds the limit value by 150%.

- Austria has introduced a requirement for a more stringent concentration limit for VOC emissions from VRUs at terminals of 10 g/Nm^3 instead of 35 g/Nm^3.

- Consultation with terminal operators in Cyprus revealed that the typical outlet concentrations from VRUs are usually about 2 – 5 g/Nm^3.

- Anecdotal information for Denmark indicates that the emission limit for VRUs is 0.15g/Nm^3.

Refinery BREF

The reference document on best available techniques (BREF) for the refineries sector under the IPPC Directive (2008/1/EC) provides information on vapour recovery units. As indicated in this document, emissions are directly related to VOC removal efficiency and can be as low as 10 mg/Nm^3 excluding methane. At an efficiency of 99.9%, 150 mg/Nm^3 (excluding methane) or 2.5 g/Nm^3 (including methane) can be achieved. Table 5.1 provides a summary of the abatement efficiencies of different VRU techniques based on this document.

Table 5.1 VOC removal efficiencies of different vapour recovery unit types

VRU technique	VOC removal efficiency (%)
Absorption	99 - 99.95
Adsorption	99.95 - 99.99
Membrane gas separation	99 - 99.9
Refrigeration/condensation	99.8 - 99.95 (This method can achieve low exit concentrations if the applied refrigeration temperature is low enough. A great advantage is that the vapours are recovered as pure liquids (no waste), which can easily be returned directly to the storage tank.)

Ranges are due to the use of 1 or 2 stages. Higher removal efficiencies are only reached with high inlet loads.

Source: Integrated pollution prevention and control – Reference document on best available techniques for mineral oil and gas refineries, February 2003[41].

It would, therefore, appear that there is some scope to reduce VOC emissions during loading at terminals through the introduction of more stringent requirements for emissions from vapour recovery units. Indeed, the

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40 According to Article 3(2) and 3(3), this limit applies to each *new* stationary source. As an alternative, a Party may apply different emission reduction strategies that achieve equivalent overall emission levels for all source categories together. For each *existing* stationary source, Parties are required to apply the limit value in so far as it is technically and economically feasible and taking into consideration the costs and advantages.

41 http://eippcb.jrc.ec.europa.eu/pages/FActivities.htm

requirements of the Gothenburg Protocol, go beyond the requirements of Directive 94/63/EC as regards the emission limit value applied for vapour recovery units (as described above).

The current VRU market and the practicality and costs associated with reducing the acceptable emissions limit from VRUs are discussed below.

Vapour recovery units – background

There are a number of different technologies that can be used in VRUs at storage terminals and at petrol stations, but most are of either the adsorption or the refrigeration type. Historically, almost all petrol terminals in the US used the 'refrigeration' type VRU, but these VRUs proved to be unreliable and had high operational and maintenance costs[42]. Also, this method lost favour in the US because it could not meet more stringent limits (10 mg/L of hydrocarbon), as the products could not cool the vapour to sufficiently low temperatures. Since then, the activated carbon adsorption/vacuum regeneration system has become increasingly popular due to lower operational costs and ability to meet more stringent emission limits. However, advances in refrigeration unit design, that allow the temperature to be reduced to –200^{0}F (-130ºC) through the use of modified mechanical design and the use of liquid nitrogen as the refrigerant have revived an interest in this method[43]. There also exist systems that combine a membrane system with a carbon adsorption/vacuum regeneration unit; membrane systems can also be retrofitted to existing carbon adsorption VRUs to increase their vapour flow capacity or to increase their efficiency[44].

Carbon Adsorption and Vacuum Regeneration VRUs

Currently this is the most popular method for vapour recovery and a majority of the major oil companies (BP, Total, Exxon, Kuwait Petroleum, Shell) use this in their terminals. In this system the vapour enters the VRU and flows through an activated carbon bed at atmospheric temperature and pressure. When the vapour comes into contact with the activated carbon, the hydrocarbon molecules are attracted to the internal structure of the carbon.

Once the carbon bed is saturated, or at a predetermined cycle time, the flow of vapour is blocked and a pump is used to generate a vacuum. Under a vacuum, the loading factor (quantity of hydrocarbons that attach to the carbon) of the activated carbon is much lower; the hydrocarbons are released from the surface of the carbon. The regeneration cycle concludes when a small quantity of air is bled over the top layer of the carbon bed to remove the

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42 Personal Communication, CarboVac, Environmental Service, 12th December 2008

43 Waste Compliance & Enforcement & Release Prevention: Bureau of Discharge Prevention, 'Guide to Vapor Recovery Units (VRU)'

44 Personal Communication, ARID Technologies Inc., 19th February 2009.

'heel'. It should be noted that fires may occur when using the carbon adsorption system; see Appendix B for more information.

Once the hydrocarbons have been removed from the carbon bed, the released vapours enter the atmospheric re-absorber column where they are returned to the liquid phase. The re-absorber is generally a simple 'wash-tower' where the highly concentrated hydrocarbons coming from the vacuum system are brought into contact with a counter flow of absorbent. For more information on technological advances in the design of carbon adsorption VRUs see Appendix B.

With these systems the energy consumption increases with lower emission requirements. A study on one such system determined the quantity of energy which is required for different emission limits; this is summarised in Table 5.2.

Table 5.2 Example of energy consumption with different emission limits for a carbon adsorption type VRU

Emission limit (Note 1) (g/m3)	35	20	10	1	0.15
Energy required (kWh/m^3)	0.08	0.09	0.09	0.1	0.2
g/m^3 recovered	1,179	1,188	1,194	1,199.4	1,199.9
Additional recovery compared to next highest limit in this table (g/m3)	0	9	6	5.4	0.5

Source: CarboVac, 'Technical Presentation – English'

Note 1: This emission limit is the outlet concentration that the VRU is designed to produce at a given inlet temperature; in operation because the inlet concentration will be less the outlet concentration will be less also.

The data in the table above shows that, for the emission rate to be reduced from 1 to 0.15 g/m^3 (in this case), the energy consumption doubles. Recovering the additional 0.5g/m^3 of product requires an additional 0.1 kWh/m^3, which is the equivalent of 75 times the energy recovered in the petrol vapours[45]. According to the manufacturers, there is a breakeven point where the energy consumed by the VRU will be equal to the 'surplus' energy recovered and beyond which it is financially and environmentally uneconomic to reduce emissions further. Representatives of the equipment supplier concerned indicate that the breakeven point is reached at an emission level of between 1 and 2g/m^3.

45 Though there are of course other benefits associated with reducing emissions.

Typical costs for a VRU of this type[46] when operating at a recovery rate of 99.7% on a typical inlet concentration of 1,160g/Nm^3, which gives an outlet concentration of 3.5g/Nm^3, are shown below in Table 5.3. It should be noted that systems recovery rates and outlet concentrations are theoretical and based on assumptions about the concentration at the inlet; in practice the recovery rate and outlet concentration are likely to be lower[47]. Because the inlet concentration and total annual volume treated are not known, the total volume of product reclaimed and therefore the monetary savings cannot be calculated; however from discussions with industry[48] it can be said that the value of reclaimed product will be several times greater than the cost of electricity.

Table 5.3 Typical costs for a carbon adsorption type VRU operating at a 3.5g/Nm^3 outlet concentration

	2 Lane VRU	8 Lane VRU
Maximum loading Rate (L/hr):	272,550	1,090,200
Capex (excl. installation) (U.S.$):	500,000	1,000,000
Capex (excl. installation) (€):	345,000 (Note 1)	690,000 (Note 1)
Annual electricity usage (kWh):	219,000	876,000
Annual Electricity costs (€):	20,500 (Note 2)	81,629 (Note 2)
Total Annualised costs (€) (Note 3):	53,547	147,900

Note 1: Prices quoted in 2008 US$ and converted to 2008 € at the average exchange rate for 2008 of €1 = $1.45

Note 2: The electricity price used was €0.093kWh (2008 prices)

Note 3: The annualised cost was calculated by assuming that the initial Capex had been paid for using a loan that was paid back over the life of the VRU (15 years) at a 6% interest rate in annual instalments and adding this amount to the annual electricity costs.

Note 4: The electricity costs stated in this table are from a different source and do not agree with the electricity consumption figures stated in table 5.2 and used later in this report.

Membrane/Carbon Adsorption Hybrid VRUs

For Stage I applications, membrane units may either be combined with a carbon adsorption unit in the original design or may be retrofitted to existing carbon adsorption units. The membrane referred to is an extremely thin,

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46 Personal Communication, Symex (TESCO Inc), 19th December 2008.

47 Personal Communication, Symex (TESCO Inc), 22nd January 2009.

48 Personal Communication, Covaltech, 26th November 2008.

selectively permeable, polymeric film attached to a porous structure; the membrane 'rejects' nitrogen and oxygen molecules while allowing hydrocarbons to pass through[49]. The combined unit functions in the following way:

- Vapour flows from the mobile tank into the membrane unit, where the majority of hydrocarbons pass through the membrane to form a concentrated hydrocarbon stream that is returned to the scrubber in the carbon adsorption unit. The hydrocarbons are drawn through the membrane by a vacuum pump.
- The remaining 'conditioned' vapour stream, flows to the carbon beds as normal in a carbon adsorption VRU.

The addition of a membrane unit to a carbon adsorption unit is beneficial in three ways[44]:

i. The maximum volume of vapours for a given carbon bed size can be increased.

ii. The energy consumption of the carbon adsorption VRU is decreased. This occurs because less carbon is adsorbed onto the carbon bed and therefore less energy is needed to remove it. It is unclear whether hybrid units have a lower overall energy consumption as the membrane unit uses energy to power the vacuum pump.

iii. When the membrane unit is retrofitted to an existing adsorption VRU it can reduce the outlet concentration as the vapour flows to the carbon beds at a lower concentration.

Refrigeration based VRUs

Vapours enter a 'knock-out' tank where condensate drops out and the vapours pass through; the condensate is returned to the storage tank. The vapours then enter the vapour recovery unit and are chilled to 0^0C to remove as much vapour as possible; glycol is the most common refrigerant used at this stage. The vapour then enters the top section of the condensate coil where moisture and hydrates are removed at a very low temperature. The 'cleaned' vapours are then allowed to vent to the atmosphere and the collected, condensed hydrocarbons are returned to the storage tank. Once every 24 hours, the main chilling coil must be defrosted to eliminate any icy build up which would otherwise impede the flow of VOCs across the coil. In these systems, the quantity of vapours removed is dependant on the temperature to which they are cooled.

In older systems, where the minimum temperature achieved was – 84^0C the emission level was above $10g/m^3$, but using nitrogen as a coolant, a temperature of – 120^0C and the EPA's standard can be met (10mg/L of hydrocarbon)[50]. For the Covaltech system, which is currently widely used in Europe, the temperature in the

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49 www.aridtech.com

50 Waste Compliance & Enforcement & Release Prevention Bureau of Discharge Prevention, 'Guide to Vapor Recovery Units'

condensate coil ranges from -44^{0}C in a petrol station to -60^{0}C in a small depot; at these temperatures no methane or ethane is recovered, but ~50% of propane, ~70% of butane and >99% of all heavier fractions are recovered. Typical cost information for Covaltech refrigeration systems is given below[51] in Table 5.4:

Table 5.4 Cost and Performance Information for Refrigeration VRU systems

	Petrol Station	Small Depot
Maximum Volumetric Flow (m^3 fuel/hour)	170	170
Recovery efficiency (w/w% NMVOC)	99.95 – 99.97	99.95 – 99.97
Cost of Unit (€)	41,000	220,000
Installation Cost €)	2,000 (new), 10-12,000 (retrofit)	Negligible
Daily Electricity Use (kWh)	10 (Note 1)	25 (Note 1)

Note 1: The difference in energy consumption between the two units is influenced by the actual volume of product recovered, design of the VRU and operating temperature of the unit.

Costs and Benefits of Introducing a lower ELV for VRUs

In this section the potential costs and benefits of further reducing emissions from loading of tankers at storage terminals where a vapour recovery unit is in place are considered. The implications of changes from the current emission limit value of 35g/Nm^3 to achieve lower levels of emissions is explored by calculating emissions for an example (hypothetical) terminal.

This example assumes that the hypothetical terminal is currently fitted with a carbon adsorption type VRU. It is understood that certain VRUs of this type are capable of meeting an ELV of 0.15mg/Nm^3; therefore the only additional costs occurred to meet the new limit are the costs of electricity, assuming an installation already has such a unit in place (in practice, it is recognised that not all VRUs in place will be able to meet such a low limit purely through increased operation of the equipment and that there may be other capital costs associated with meeting a lower limit; no data have been identified to evaluate such additional capital costs robustly).

Although there are many types of VRU currently in operation in the EU, this assumption is made as carbon adsorption type VRUs are installed by most of the major oil companies, are often currently operated to meet a lower ELV than that set out in the Directive[52] and are generally designed to be capable of meeting the lower ELVs. Lastly, it was assumed that any change to the legislative limit would allow a considerable time frame for

51 Personal Communication, Covaltech, 26th November 2008

52 Symex Americas Client List

implementation, so that VRUs would be replaced at the end of their life and therefore no additional replacement costs would be incurred. It should be noted by making these assumptions that the authors do not favour the use of carbon adsorption type over any other technology; these figures are purely intended to be illustrative.

Emissions at different ELVs and the unabated emissions for the example terminal were calculated using an approach developed by the Institute of Petroleum[53]. For this indicative assessment, it was assumed that actual emissions are at the legislative ELV; in practice, it is recognised that emissions at any individual compliant terminal may be substantially lower than the legislative ELV.

From these initial figures, the additional abatement achieved by requiring a lower ELV and the associated additional electricity costs have been calculated for the hypothetical terminal using the assumptions shown in Appendix D. Finally the cost of damages avoided from the additional abatement can be estimated using high and low estimates of damage cost functions[54]

The hypothetical terminal considered is assumed to have an annual throughput of 25,000m3. Based only on additional electricity costs and value of recovered petrol, lowering the emission limit from VRUs down to the lowest limit considered of 0.15 g/Nm^3 could have a net benefit to the installation, as the value of the total reclaimed product is greater than the cost of electricity used. However, the extent to which further, incremental, reductions in emissions would achieve a benefit is dependent upon how far emissions are reduced. Based on the information in Appendix D, the following illustrative conclusions can be drawn:

- By reducing the legislative emission limit, emissions could be further reduced. Reducing the ELV from 35 g/Nm^3 to 10 g/Nm^3 would reduce emissions from around 0.65t per year to around 0.2t per year compared to uncontrolled emissions of 14.7t per year (98.7% reduction compared to 95.6% at 35 g/Nm^3). Reducing emissions to 1 g/Nm^3 gives equivalent emissions of around 0.02t per year (99.9% reduction) and to 0.15 g/Nm^3 gives equivalent emissions of 0.003t per year (99.98%).

- There would be additional energy costs of achieving these emission reductions of around €20 per year to achieve 10 g/Nm^3, €50 per year to achieve 1 g/Nm^3 and €280 per year to achieve 0.15 g/Nm^3 (assuming actual emissions of 35g/Nm^3).

- These additional abatement (electricity) costs equate to around €50/t abated to achieve 10 g/Nm^3, €75/t abated to achieve 1 g/Nm^3 and €430/t abated to achieve 0.15 g/Nm^3.

- The incremental (electricity) costs of moving from an already low limit to one that is lower still become much higher as the lower emission levels are approached, for example:

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[53] Institute of Petroleum (2000).

[54] Damage cost functions are taken from: AEA Technology Environment, 'Damages per tonne of PM2.5, NH3, SO2, NOx and VOCs from each EU25 Member State (excluding Cyprus) and surrounding areas', March 2005.

- To go from 10 g/Nm^3 to 1 g/Nm^3 would achieve an additional emission reduction of 0.17t at an additional electricity cost of €23 (i.e. around €140/t);

- To go from 1 g/Nm3 to 0.15 g/Nm^3 would achieve an additional emission reduction of 0.016t at an additional electricity cost of around €230 (i.e. nearly €15,000/t).

- There would be benefits in terms of the value of the fuel recovered which would tend to offset the increased costs of electricity use in abatement for moderate emissions reductions. However, to achieve the highest emissions reductions (e.g. down to 0.15 g/Nm^3) it is likely that the additional *incremental* electricity costs would be significantly greater than the *incremental* value of the recovered product (for example, to move from 1 g/Nm^3 to 150 g/Nm^3 could cost around €14,000/t abated).

- There would also be benefits associated with reduced health and environmental damage. Based on the damage cost functions from the CAFE Programme, the damage costs avoided by moving from emissions of 35 g/Nm^3 to lower emissions could be around €440-1300 per year to achieve 10 g/Nm^3; around €600-1800 per year to achieve 1 g/Nm^3; and around €600-1800 per year to achieve 0.15 g/Nm^3.

- These *indicative* figures suggest that there is some potential for further reducing emissions where a vapour recovery unit is in place, through the operation of VRUs that are already available/used to achieve lower emissions concentrations. However, the additional emission reductions that could be achieved are relatively small compared to those already achieved (through compliance with the 35 g/Nm^3 emission limit). As terminal operators already operate VRUs at lower emissions levels (e.g. to meet a lower ELV in certain Member States or to achieve a margin of safety), the actual reductions in emissions will be much less than those described here.

- Further analysis of the level of the ELV that will deliver maximum benefit for an operator (installation costs and cost of recovered petrol) and the sensitivity of this figure to changes in the petrol price is included in Appendix D; the optimum economic level appears to lie between 1 and 2g/Nm^3 and is dependent on the relative prices of electricity and petrol.

- If scaled up to the EU27 as a whole (based on total EU27 petrol consumption as compared to the throughput of the hypothetical terminal), the maximum potential emission reduction through reducing emissions from VRUs from 35 g/Nm^3 to 10 g/Nm^3 would be around 3.6kt (or around 0.04% of total current VOC emissions) and to 1 g/Nm^3 would be around 5.0kt (or around 0.05% of the total)[55]. For comparison, the emission reductions already achieved by meeting 35 g/Nm^3 compared to uncontrolled emissions (around 110kt) are equivalent to approximately 1.2% of total EU27 VOC emissions). These figures are only intended to be illustrative, in providing a picture of the possible order of magnitude of potential emission reductions.

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55 This assumes that all loading operations are connected to a VRU and that actual emissions are equivalent to the limit value. Obviously this is not the case given that emissions are already significantly below the legislative ELV in a number of cases. As such, the actual emissions reductions (in absolute terms and as a percentage of total emissions) would be lower than the values quoted here.

5.2.3 Road tankers

No information has been identified during the course of this study regarding current state of the art techniques that could significantly reduce VOC emissions from road tankers. As with all other stages, it is assumed that appropriate inspection and maintenance programmes and leak detection and repair programmes would help to at least achieve the aims of the Directive and potentially to improve upon these.

5.2.4 Non-road vessels

No information has been identified during the course of this study regarding current state of the art techniques that could significantly reduce VOC emissions from non-road vessels. As with all other stages, it is assumed that appropriate inspection and maintenance programmes and leak detection and repair programmes would help to at least achieve the aims of the Directive and potentially to improve upon these.

5.2.5 Unloading at service stations

The Stage I Directive already introduces controls on emissions during unloading of petrol at service stations. This involves return of vapours displaced by the delivery of petrol into storage installations at service stations and in fixed-roof tanks used for the intermediate storage of vapours through a vapour-tight connection line to the mobile container delivering the petrol (Article 6 and Annex III).

According to the Directive, this is intended to reduce the total annual loss of petrol from loading into storage installations at service stations to below 0.1% w/w of the throughput. As compared to uncontrolled emissions, this technique is assumed to be around 95% efficient in reducing emissions[56].

Whilst not directly reducing overall emissions, some techniques have been developed to reduce the generation of vapour in the storage tank and hence the amount of vapour recovered back to the road tanker. These include:

- A system whereby the fuel delivered through the pipe into the tank is dispersed through a series of smooth apertures, leading to a calmer delivery, resulting in less vapour generation in the storage tank. This reduces the effect of turbulence in the tank caused by air in the delivery pipe being forced into the tank and fuel hitting the bottom of the tank, which can cause vapour generation, through reducing the effect of turbulence in the tank. Investment costs are understood to be around €4,000 per tank[57].

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56 Institute of Petroleum (2000): Protocol for the estimation of VOC emissions from petroleum refineries and gasoline marketing operations.

57 £2,450 in 2004, converted using an exchange rate of £0.68 per €, in 2008 prices (ECB) according to the Euro Area harmonised index of consumer prices (epp.eurostat.ec.europa.eu).

- A venturi system involving a reduced cross-sectional area of the filling pipe which operates when fuel is being delivered, creating a vacuum which pulls vapour back into the liquid flow, reducing the volume of vapour in the tank and thus reducing the vapour pressure. This is understood to cost around €5,000 per tank and is understood to be suitable for larger service stations (with over 3,000m^3 annual throughput)[58].

These techniques will serve to reduce the vapour generation and hence petrol losses for the retailer (which would otherwise be recovered in the road tanker), though it is unknown whether there will be a reduction in overall VOC emissions through use of such techniques.

5.2.6 Releases from storage tanks at service stations

Introduction

The Stage I Directive covers emissions during the unloading of petrol into storage tanks at service stations. The Commission has proposed a Directive that would introduce Stage II controls to reduce VOC emissions during refuelling of vehicles[59] (and such controls are already in place in several Member States). Whilst the latter proposal includes provisions to reduce potential emissions through over-pressurisation of underground storage tanks[60], neither the Stage I Directive nor the proposed Stage II Directive include controls on emissions from underground storage tanks.

In the underground storage tank, a vent is required to allow "breathing" of the underground storage tank and also as a safeguard in case the vapour balancing system back to the road tanker becomes inoperable[61]. This also provides a

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58 Sources: (1) www.petroman.ltd.uk, accessed 23 March 2009; (2) *Wetstock* management, Forecourt Trader, 1 August 2008, page 30; (3) *Vapour recovery systems in a storage tank filling pipe*, US Patent No 7368001, May 6 2008.

59 Proposal for a Directive of the European Parliament and of the Council on Stage II petrol vapour recovery during refuelling of passenger cars at service stations, COM(2008) 812 final, 4.12.2008.

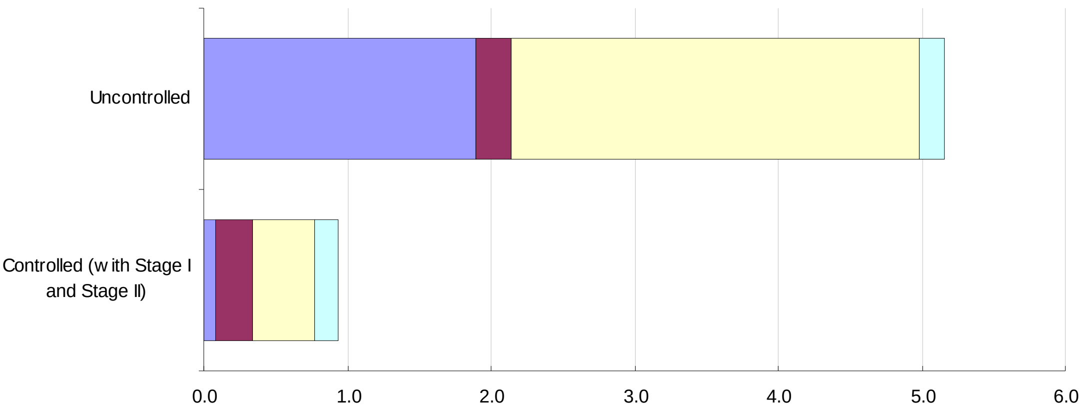
60 Limiting the ratio of vapour recovered to the amount of petrol dispensed (to no more than 1.05) reduces the potential increase in pressure due to recovery of petrol vapour and air into the underground storage tank. If the pressure increase is too great, petrol vapour will be released through the pressure/vacuum (PV) valve (where applicable) connected to the storage tank.

61 Institute of Petroleum (2000): Guidelines for the design and operation of gasoline vapour emissions controls.

safeguard against any over-pressurisation from excessive return of petrol vapours/air during Stage II petrol vapour recovery[62].

Emissions from tank breathing are lower than uncontrolled emissions during unloading into storage tanks and vehicle refuelling. However, they may be a significant proportion of remaining emissions (where Stage IB and Stage II controls are in place) and are not controlled through the existing or proposed legislation. Whilst actual emissions will vary according to environmental conditions and the types of vapour recovery controls in place[63], it is possible to provide an estimate of emissions from tank breathing as compared to other losses at service stations, as outlined in the figure below for a hypothetical service station.

Figure 5.1 VOC emissions from a hypothetical service station without controls and with Stage I/II controls (t/yr)[64]



	Controlled (w ith Stage I and Stage II)	Uncontrolled
Drips and spillage	0.17	0.17
Refuelling	0.43	2.84
Tank breathing	0.26	0.26
Filling of tanks	0.09	1.89

62 And excessive amounts of air returned to the underground storage tank during vehicle refuelling with the petrol vapour will lead to increased vapour generation in the storage tank (additional vapour from the liquid petrol will evaporate into the tank ullage as the system tends towards the saturated vapour concentration).

63 As well as temperature differentials between fuel delivered and in the storage tank; diurnal and seasonal temperature variations; amongst others.

64 Emissions based on Institute of Petroleum (2000): Protocol for the estimation of VOC emissions from petroleum refineries and gasoline marketing operations. Assuming petrol with a reid vapour pressure of 60kPa, temperature of 10ºC and annual petrol throughput of 3,000m^3. Efficiency of Stage II controls assumed to be 85%.

Based on the above, the emissions from tank breathing could be around 0.012% of throughput for this hypothetical service station and, for service stations with both Stage I and Stage II controls installed, these could be a significant proportion of the remaining VOC emissions.

There are a number of techniques that have been developed that could be used to control emissions from tank breathing, as outlined below.

Membrane technology

Membrane technology has been used in a new application that reduces emissions from pressure vents in storage tanks at service stations. Here a membrane recovery unit treats vapours that would otherwise be emitted through the storage tank's pressure-vacuum relief valve; a vacuum pump 'pulls' hydrocarbons through a selectively permeable, polymeric film and returns them to the storage tank head space, while the 'conditioned' vapour stream is released to the atmosphere.

This reduces the emissions from venting and helps to regulate the hydrocarbon concentration in the head space so that less vapour evaporates when the concentration is low[65].

One example of such a technique involves maintaining a negative pressure in tank ullage space. When the pressure becomes slightly positive the system turns on and pulls in petrol vapour to reduce the pressure. The extracted petrol vapour is then separated into hydrocarbons and air with a reported efficiency of 99%, with clean air released to atmosphere and hydrocarbons returned to the storage tank both as liquid petrol and as super-saturated vapour[66].

Although this technology may not reduce emissions during unloading, as vapour should flow back to the tanker during balancing and not through the pressure relief valve, it is mentioned here as a technology that is capable of reducing emissions from the pressure vent valve, which are not currently regulated.

Condensation of petrol vapours

Another system, similar to the membrane technology described above, can be mounted on the service station forecourt and involves converting evaporated petrol vapour from the storage tanks (when stored passively), plus vapour created during petrol deliveries or Stage II vapour recovery, back into petrol for re-sale.

The system has a pipe from the underground storage tank to a heat exchanger which condenses liquid petrol from the vapour (the refrigerant is then converted back to a liquid for re-use by an integral compressor unit). The liquid

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65 Personal communication, ARID Technologies Inc., 19th February 2009.

66 Vaporsaver, OPW chemicals.

petrol is returned to the storage tank and "vapour-free" gases are vented to atmosphere[67]. Again, this reduces emissions releases of petrol vapours from the service station PV valve.

5.3 Summary

The BREF for refineries outlines a number of technical improvements to storage tanks at terminals that could if implemented achieve relatively minor reductions of VOC emissions. However, it is important to note that the BREF sets out emission levels associated with the use of best available techniques whereas the emission limit values and techniques set out in Directive 94/63/EC represent minimum standards (and also apply at installations that are not covered by the IPPC Directive).

No information has been identified during the course of this study regarding current state of the art techniques that could significantly reduce VOC emissions from road tankers and non-road vessels.

The use of a membrane unit to control emissions from the pressure vent in storage tanks at petrol stations could be investigated further, as it may reduce emissions during unloading at service stations and has the potential to reduce emissions from pressure vents that are currently unregulated.

Perhaps, the greatest potential for reducing VOC emissions appears to be through improvements in vapour recovery units and lowering the legislative emission limit for these units. There are three types of technology employed in modern VRUs that are capable of reducing emissions to the TA Luft limit of 150mg/Nm^3: carbon adsorption, refrigeration and hybrid membrane/adsorption. Of the three types of VRU, the carbon adsorption type, sometimes in combination with a membrane unit, is currently the most prevalent of the VRU technologies capable of meeting the 150mg/Nm^3 limit; refrigeration units capable of meeting the lower limit are available but this is a fairly new technology[68].

Lowering the current ELV for VRUs at terminals could result in net benefits for the EU27, if it is assumed that all terminals have installed VRUs capable of meeting lower limits during the natural replacement cycle. However, it is evident that emissions from many installations will already be substantially below the 35g/Nm^3 limit set out in the Directive. The total emissions reductions from lowering the ELV are also expected to be relatively small when compared to those already achieved by introducing the current limit, as described above.

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67 Sources: (1) www.coolfuel.net, accessed 23 March 2009; (2) Recovering petrol vapour at a filling station, Patent Application GB 2451340, published 28 January 2009.

68 Waste Compliance & Enforcement & Release Prevention: Bureau of Discharge Prevention, 'Guide to Vapor Recovery Units (VRU)'

It is also noted that those Member States that have implemented the provisions of the Gothenburg Protocol should already be applying a lower emission limit (10 g/Nm^3) for all new installations and for existing installations so far as it is technically and economically feasible, taking into consideration the costs and benefits.

There is also some potential to achieve further reductions in emissions at service stations through controlling emissions that would otherwise occur through a storage tank's PV valve. Emissions during storage (through tank "breathing") are not directly covered by the existing Stage I Directive or the proposed Stage II Directive. Whilst such emissions are likely to be a relatively small proportion of *uncontrolled* emissions, they become *proportionately* more important for service stations with both Stage I and Stage II controls in place. Various techniques to control such emissions are available, as described above, with abatement efficiencies up to 99% quoted.

6. Conclusions and Recommendations

6.1 Status of Implementation

An extensive consultation has been undertaken with stakeholders in each of the Member States to investigate how the Directive has been implemented and whether or not the technical provisions are being applied correctly in practice. In addition, consideration has been given to whether or not Member States have correctly applied throughput thresholds for derogating service stations and terminals and/or granted any additional time periods beyond those stipulated in the Directive or, where relevant, the Accession Treaties.

Based on the information provided, it appears that most Member States (for which information was available) have implemented and applied the requirements of the Directive correctly within the agreed timescales (in the Directive and, where applicable, in the Accession Treaties) including throughput thresholds for derogating service stations and terminals. However, in some instances there appear to have been some delays (Belgium, Cyprus and Greece) and/or issues (Finland and Sweden) with implementation. Details are provided in Section 3 of this report. It should be noted that our review and conclusions are based on information gathered from relevant stakeholders and associated literature rather than any specific checking of application of the technical provisions.

Given that the provision of information by these organisations was voluntary, there are of course differences in the levels of information available for each of the Member States covered. In particular, some Member States have provided very limited or no information on the current status of implementation of the Directive. This includes Luxembourg, Malta, Netherlands, Portugal and Spain, although details of the national legislation transposing the Directive's requirements and information from previous studies has confirmed that the legislation appears to have been introduced in each of these Member States. However, it has not been possible to confirm if the technical provisions of the Directive are actually applied in practice.

6.2 Technical issues and Problems of Interpretation

Based on the discussions held during the study, most Member States seem to have experienced few if any technical problems in implementing the Directive. However, a number of technical revisions to the Directive, according to the provisions of Article 7, were discussed and agreed by the EFEG technical working group. Many of these proposed changes still appear to be relevant and our consultation suggests that the provisions of the Directive often seem to have been implemented as if these revisions had been agreed; for example in relation to the application of provisions on back-pressure when loading at the gantry/tank interface and the proposed provisions to take into account the situation for the Arctic Member States.

Many of the provisions that were subject to review by the EFEG technical sub-group related to the requirements applied in the Arctic Member States (Sweden and Finland). Whilst there are some differences in their implementation from the provisions of Directive 94/63/EC, the way in which Stage I controls have been applied in these Member States[69] does not appear likely to compromise the overall aims of the Directive in terms of control of VOC emissions (based on the information and stakeholder views received). Given the relative geographic isolation of these Member States, the conclusions of the EFEG technical sub-group suggested that the provisions as recommended would be sufficient to permit cross-border trade (and information available for this study suggests that the Directive has been implemented according to the EFEG conclusions in these Member States).

Some other technical issues have been encountered in implementing the Directive, although these are likely to be relatively more minor. However, in any revision to the Directive, it may be appropriate to give consideration to clarifying provisions on what constitute "living quarters or working areas" and how ethanol blends should be treated under the provisions of the Directive (as these were issues highlighted by consultees).

In relation to VOC emissions from ship loading (which is mentioned explicitly in the preamble to the Directive), a previous study for the Commission has concluded that measures in other sectors would be more effective in reducing VOC emissions in the context of national emission ceilings.

6.3 Potential for Simplification

With regard to the potential for simplification of the Directive, a number of the requirements of the Directive in relation to road tankers appear to be covered by the provisions of the ADR. Indeed, some Member States (e.g. Austria, Greece and Sweden) have indicated that the requirements of the Directive for road tankers are covered by the national implementation of the ADR Directive/Agreement. In particular, it is understood that these relate to the leakproofness test and test for operation of equipment (Chapter 6.8.2.4 of the ADR and Article 5(1)(d) of the Directive).

The majority of the requirements of Annex IV of the Directive are now covered by relevant CEN Standards and/or Technical Reports (with a small number of minor exceptions). As such, there does exist some potential to simplify the provisions of this part of the Directive through reference to CEN Standards. However, a number of the provisions of the Directive – and also provisions relating to the specific situation in the Arctic Member States – are covered in CEN Technical Reports, which do not have the same standing as CEN Standards. In addition, the Commission would forgo the ability to positively influence the inclusion of technical requirements, but would retain the ability to exclude any amendments.

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69 Sweden and Finland have Stage I requirements which differ from the requirements of the Directive in a number of ways, taking into account the specific situation in these countries. In particular, the fact that Sweden for example had Stage I legislation in place before the introduction of the Directive; that the colder temperatures require different types of equipment to that specified in the Directive (e.g. temperature coefficient of thermistors) and that the road tankers used in the Arctic Member States are different from other Member States (e.g. have different sized fuel and vapour return lines and often have trailers in addition to the main tanker) amongst others.

6.4 Technical Review of Provisions

With regard to current state of the art in abatement of VOC emissions for the activities covered by the Directive, the main area where there appears to be potential for further emission reduction relates to the emission limit values specified for vapour recovery units. Based on information from consultation with the Member States and various industry organisations (trade associations and companies), it is evident that vapour recovery units are available that could allow emissions to be reduced well below the current limit of 35 g/Nm^3. Indeed, emission limits in several Member States are already lower than those set out in the Directive (in some cases due to implementation of the requirements of the Gothenburg Protocol, where a 10 g/Nm^3 limit is specified, though in some cases still lower limits are included). Actual operational emissions of vapour recovery units will also generally achieve emissions well below the limit value set out in the Directive. It should also be noted that the additional emissions reductions that could be achieved through requiring a more stringent emission limit value would be relatively small in comparison to those already achieved through implementation of the existing Directive.

There also exists some potential for achieving further emissions reductions at service stations, particularly through control/capture of emissions that would otherwise be released from pressure/vacuum relief valves (this is not covered by the Stage I Directive). It has not been possible within the time available or scope of the study to consider these in detail.