

MTBE and the Requirements for Underground Storage Tank Construction and Operation in Member States

A Report to the
European
Commission

Notice

This report was commissioned by the European Commission. Our conclusions are the results of the exercise of our best professional judgement, based in part upon materials and information provided to us by European Member States and others. Use of this report by any third party for whatever purpose should not, and does not, absolve such third party from using due diligence in verifying the report's contents.

Any use which a third party makes of this document, or any reliance on it, or decisions to be made based on it, are the responsibility of such third party. Arthur D. Little Limited accepts no duty of care or liability of any kind whatsoever to any such third party, and no responsibility for damages, if any, suffered by any third party as a result of decisions made, or not made, or actions taken, or not taken, based on this document.

Case Manager: John Barker

Date: 19-Apr-01

Case Director: Alan Marples

Date: 19-Apr-01

Final Report to European Commission

March 2001

Your reference number:
ENV.D.1/ETU/2000/0089R

Arthur D. Little Limited
Science Park, Milton Road
Cambridge CB4 0DW
Telephone 01223 392090
Fax 01223 420021

Reference 73488

Table of Contents

Table of Contents	i
List of Tables	iii
List of Figures	iv
Glossary of Abbreviations	vi
1. Executive Summary	1
2. Study Background	3
2.1 Chapter Introduction.....	3
2.1.1 United States Regulation of Gasoline and UST Systems.....	3
2.1.2 European Regulation of Gasoline and UST Systems	4
2.1.3 Predicted Use of Oxygenates in the EU	6
2.2 Study Scope	6
2.2.1 Study Objectives.....	7
3. Requirements for Underground Storage Tanks in the USA	9
3.1 Chapter Introduction.....	9
3.2 Underground Storage Tanks: The Regulatory History.....	9
3.2.1 Leak Detection.....	10
3.2.1.1 Financial Responsibilities.....	12
3.2.1.2 California Requirements	12
3.2.1.3 Complications of the California UST Programme	15
3.3 Underground Storage Tanks: Current Requirements	18
3.3.1 Corrosion Protection.....	18
3.3.2 Spill and Overfill Protection	19
3.3.3 Leak Detection.....	19
3.3.4 Construction Certification	20
3.3.5 Future Initiatives.....	21
4. Regulation of Groundwater Protection and Water Quality	24
4.1 Chapter Introduction.....	24
4.2 United States Groundwater Regulations	24
4.2.1 The Safe Water Assessment Programme	26
4.2.2 The Underground Injection Control Programme	26
4.2.3 State Legislation	27
4.2.3.1 California Regulations	28
4.3 United States Water Quality Regulations.....	30
4.3.1 Federal Drinking Water Standards	30
4.3.2 Drinking Water Programmes.....	31
4.3.3 California Regulations.....	32
4.3.3.1 Californian Drinking Water Programme	33
4.4 EU Water Quality Regulations	35
4.4.1 Prevention of Groundwater Contamination	35
4.4.2 Preservation of Water Quality.....	36
4.4.2 Water Quality Framework Directive	36
4.4.3 Comparison of United States and EU Legislation.....	38
4.5 Chapter Summary	42
5. Member State Survey Information	43
5.1 Chapter Introduction.....	43
5.2 Member State Requirements for UST systems.....	44
5.2.1 Benchmarking of Standards for UST Systems	44
5.2.2 Summary of Requirements	45
5.2.3 Dates of Enforcement.....	46
5.2.3 Member State Summaries.....	46
5.2.4 Austria	47

5.2.5	Belgium	47
5.2.5.1	Brussels	48
5.2.5.2	Flanders	48
5.2.5.3	Wallonia	49
5.2.6	Denmark	50
5.2.7	Finland	51
5.2.8	France	52
5.2.9	Germany	53
5.2.10	Greece	54
5.2.11	Republic of Ireland	54
5.2.12	Italy	55
5.2.13	Luxembourg	57
5.2.14	Netherlands	58
5.2.15	Portugal	58
5.2.16	Spain	59
5.2.17	Sweden	61
5.2.18	United Kingdom	61
5.2.18.1	England, Wales and Scotland	61
5.2.18.2	Northern Ireland	63
5.3	Monitoring of Groundwater Contamination	63
5.3.1	Denmark	64
5.3.2	Finland	65
5.3.3	France	65
5.3.4	Germany	65
5.3.5	Sweden	66
5.3.6	United Kingdom	66
5.3.6.1	Scope and Objectives of the Survey	66
5.3.6.2	Data on Retail Sites and Depots	67
5.3.6.3	Monitoring of Groundwater Quality	67
5.3.7	Study Conclusions	68
5.4	Chapter Summary	68
6.	Study Findings	69
6.1	Chapter Introduction	69
6.2	Main Findings	69
6.2.1	Member States Requirements for UST Systems	69
6.2.2	Water Quality Legislation	71
6.2.3	Monitoring of Groundwater Contamination	71
6.3	Additional Findings for Consideration	72
6.3.1	Pattern of MTBE consumption	73
6.3.2	Geology	75
6.3.3	United States Economy	75
6.4	Chapter Conclusions	76

List of Tables

Table 1: Changes in Fuel Specification in the EU.	5
Table 2: Report Outline.....	8
Table 3: UST Requirements.....	11
Table 4: Date for Release Detection Requirements Under Different Systems.	11
Table 5: Corrosion Requirements for Different Systems.....	18
Table 6: Spill and Overfill Protection Methods.....	19
Table 7: Leak Detection Requirements.....	20
Table 8: Requirements for Leak Detection on Piping.....	20
Table 9: WQFD environmental objective deadlines.....	38
Table 10: Comparison of legislation.....	40
Table 11: Dates of Adoption and Revision of UST Requirements.....	45
Table 12: Latest Date Requirements Come into Force.	46
Table 13: Member State Groundwater Monitoring Data.	64
Table 14: Summary of Member State Requirements.....	70

List of Figures

Figure 1: Penetration of Unleaded Fuel in Member States	4
Figure 2: Estimated European Supply and Demand for MTBE.....	74

Glossary of Abbreviations

EU

CPR	Commission for the Prevention of Calamities by Dangerous Products
DOC	Dissolved Oxygen Content
DWD	Drinking Water Directive
EA	Environment Agency
EFOA	European Fuel Oxygenates Association
EQS	Environmental Quality Standard
ETBE	Ethyl Tertiary Butyl Ether
GWR	Ground Water Rule
IPPC	Integrated Pollution, Prevention and Control
MTBE	Methyl-tertiary-butyl-ether
PPP	Polluter Pays Principle
PWS	Public Water Supply
UST	Underground Storage Tank
WQFD	Water Quality Framework Directive

USA

AL	Action Level
CCL	Contaminant Candidate List
CERCLA	Comprehensive Environmental Response, Compensation And Liability Act
CUPA	Certified Unified Programme Agency
CWA	Clean Water Act
DHS	Department Of Health Services
DWSRF	Drinking Water State Revolving Fund
DWTPB	Department Of Water Technical Programs Branch
EPA	Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide And Rodenticide Act
GWR	Ground Water Rule
LG	Local Guidance
LIA	Local Implementing Agencies
MCL	Maximum Concentration Level
ML	Maximum Limit
NDWAC	National Drinking Water Advisory Council
NPDWR	National Primary Drinking Water Regulation
NSDWR	National Secondary Drinking Water Regulation
RWQCB	Regional Water Quality Control Board
SDWA	Safe Drinking Water Act
SIR	Statistical Inventory Reconciliation
SSA	Sole Source Aquifer
SWAP	Source Water Assessment Protection
SWRCB	State Water Resources Control Board
TSCA	Toxic Substances And Control Act
TT	Treatment Technique
UCWR	Unregulated Contaminant Water Regulation
UIC	Underground Injection Control
WHC	Water Hazard Class

1. Executive Summary

Increasing environmental concern over the last decade regarding pollution of water has led to significant revisions in environmental regulations. One pollutant in particular – methyl-tertiary-butyl-ether (MTBE) – has been responsible for significant litigation in the USA after several reported incidents of groundwater contamination caused by leaking gasoline Underground Storage Tanks. Subsequent revisions to California state legislation has seen the phase-out of MTBE, and a tightening of construction and operational requirements for gasoline Underground Storage Tanks (UST) has been addressed by changes in federal regulations.

The present study assesses whether groundwater within the European Union (EU) faces a similar potential for widespread contamination by MTBE as has already occurred in the USA, and whether this risk is mitigated by controls or obligations present in Member States that may or may not exist in the USA. Three factors were considered as part of this assessment:

1. **UST Construction, installation and operation.** What are the key differences between requirements for UST systems in the USA and those in the Member States?
2. **Regulation of Water Quality.** How does the United States Safe Drinking Water Act (SDWA) and associated water quality legislation compare to the equivalent EU Groundwater (80/68/EEC) and Drinking Water (98/83/EC) Directives?
3. **MTBE monitoring programmes.** Does information from EU groundwater monitoring programmes suggest widespread groundwater contamination by MTBE is already occurring throughout Member States?

Legislative information was collated from the USA and compared with data gathered from government ministries and environment agencies within the EU. Analysis of these data suggested that:

Widespread MTBE contamination on the same scale as in the USA (especially California) is unlikely. The risk of groundwater contamination is unlikely to increase, given important differences between the USA and the EU, although robust enforcement of the existing Member State regulatory framework is required to ensure this risk remains low in the future.

Three findings supported this conclusion:

1. **Standards of UST construction and operation.** Our survey revealed that Member State requirements for the construction and operation of UST systems generally met or exceeded the new United States requirements revised under Subtitle I of the Resource Conservation and Recovery Act (RCRA), although it should be noted that many of these requirements have only been adopted or revised within the last five years.

2. **Water Quality Legislation.** Many of the regulatory controls mandated in the US under the SDWA and RCRA can also be found in the equivalent European Directives. The new ‘combined approach’ used under the Water Framework Directive now integrates a number of Directives regulating water quality that were established during earlier tranches of environmental legislation.
3. **Monitoring of Groundwater Contamination.** Although there is little publicly available information within the EU on groundwater contamination by MTBE, none of the existing reports suggest widespread or serious groundwater contamination by this gasoline component. It is likely that monitoring of groundwater contamination by MTBE will increase as the river basin management systems are established by Member States, especially where responsibility for water quality within a given river basin is shared by more than one Member State. Identifying the sources of pollution will facilitate the use of economic instruments by Member States to recover the cost of water services, an approach that forms part of the polluter-pays principle integrated under the Framework.

Adequate enforcement of Member State requirements for the construction and operation of UST systems is the key to safeguarding water quality in the EU.

Three additional findings were considered of relevance to this study:

1. **Pattern of MTBE consumption.** The 2 percent minimum oxygen content mandated under the United States Clean Air Act represents a significant driver for increased usage of MTBE in gasoline. Changes in fuel specification in the EU adopted out of the Auto Oil II programme are not anticipated to generate equivalent demand for fuel oxygenates.
2. **Geology.** California represents a ‘special case’ where a technologically advanced economy with a high per-capita water consumption is reliant on shallow aquifers to abstract water from a depressed water table. It is difficult to find an equivalent set of circumstances within the EU, given that arid regions such as the interior of Spain and Greece support lower populations than California.
3. **United States economy.** The USA has traditionally enjoyed at-the-pump gasoline costs of up to one quarter of those found in EU Member States. These low costs encourage high levels of car ownership and use in the United States, where the fuel of choice for private users is unleaded gasoline. This contrasts with the situation in Member States, where the high cost of fuel makes diesel a popular second choice after unleaded gasoline for private motor vehicles on grounds of fuel efficiency. This reduces the quantity of MTBE-containing fuel sold across Europe by virtue of the fact that diesel does not contain MTBE.

2. Study Background

2.1 Chapter Introduction

This study concerns the regulation of UST systems and the pollution of groundwater by ether oxygenates (particularly MTBE) that have leaked from these systems. Historical contamination of groundwater by UST systems that leaked MTBE-containing gasoline blends have proved very litigious in the United States, and concern has been expressed that this pattern of groundwater contamination could be repeated in the EU. This study tackles these concerns by undertaking an analysis of the regulatory situation in the United States regarding UST systems and groundwater protection, and comparing this to what is known about equivalent regulations in Member States.

The use of fuel oxygenates and regulation of UST systems in the EU and the USA have different regulatory histories, a consequence of differences in environmental regulation and the choices made in fuel specification. These differences are briefly discussed in this chapter to provide background for the remainder of the report.

2.1.1 United States Regulation of Gasoline and UST Systems

The US Clean Air Act Amendments of 1990, implemented in 1995, stipulated a minimum oxygen content for gasoline of 2% by mass. In order to meet these minimum requirements, petroleum refiners turned to oxygenates to provide the mandated oxygen content. This resulted in the reformulated gasoline that was produced to comply with the Act having an oxygenate content of between 10 and 15 percent. Of the various oxygenates available to refiners, MTBE has always been favoured over alternatives, such as ethanol, which is hygroscopic and hence has a tendency to introduce water and other impurities into gasoline.

Given the early phase-out in the USA of lead in gasoline and the relative unpopularity of diesel amongst car owners, unleaded gasoline was already established in 1990 as the predominant fuel sold at the pump. The introduction of the Clean Act Amendments meant that, not only was MTBE the principle constituent of oxygenates in unleaded gasoline, it was present in the bulk of gasoline sold on American forecourts – up to 85 percent of all reformulated fuels on sale.

Prior to the early 1980's there was little regulation of UST systems in the United States. The discovery of gasoline and components of gasoline in groundwater such as ether oxygenates (which have very low taste and odour thresholds) led to an amendment of the RCRA in 1984 to add Subtitle I. This required all UST systems to be installed to certain standards aimed at minimising the risk of gasoline leaking into groundwater. Existing UST systems were given 10 years to comply from the date the amended Act came into force on December 22, 1988.

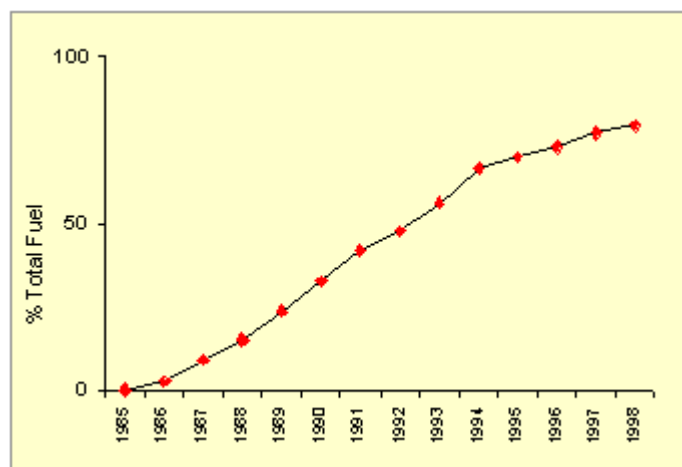
The detection of MTBE in potable water supplies generated significant environmental concerns, and resulted in litigation in a number of states. To date, lawsuits have been filed against oil companies by citizen groups in North Carolina, Maryland, Virginia, California and Texas and in at least one case litigation has resulted in a settlement in favour of the plaintiffs. Leaking UST systems at gasoline forecourts were widely implicated, although it is likely that incidental spills of gasoline at the point of sale also contributed to the ingress of MTBE into potable water. A second significant source of MTBE pollution reported by the Blue Ribbon Panel on Oxygenates in Gasoline (who presented their final report into these issues on July 27, 1999) was from recreational craft on various lakes and rivers. Outboard engines typically discharge exhaust gases into the water. Incomplete combustion of gasoline means that the fuel (including oxygenates) will enter the watercourse directly.

Although California has now mandated a complete phase-out of MTBE, companies such as Chevron have already decided to voluntarily stop using MTBE in reformulated gasoline ahead of the time-scale proposed for California.

2.1.2 European Regulation of Gasoline and UST Systems

In Europe there has traditionally been greater concern over the environmental impact of lead, nitrogen oxide (NO_x), and aromatics. This has been reflected in the pattern of legislation introduced in Member States. While the EU Directive 85/210/EEC introduced a specification for unleaded gasoline in 1985, the changes in fuel composition in accordance with the EU Fuels Directive 98/70/EC only came into force relatively recently. The relatively slow uptake of unleaded gasoline grades (illustrated below as a percentage of total fuel consumption in Member States) meant that, as late as 1995, unleaded fuel had not achieved 100 percent penetration in many Member States.

Figure 1: Penetration of Unleaded Fuel in Member States



As part of these specification changes maximum allowable concentration of ether oxygenates were set for premium unleaded gasoline (95 octane) at 10 percent by volume. With Directive 98/70/EC the allowable concentration of ether oxygenates has increased to 15 percent, and limits for sulphur (150 ppm), aromatics (42 percent), benzene (1 percent) and oxygen (2.7 percent) introduced for gasoline sold after 1st January 2000.

These data are summarised in the table below (the grey shading indicating the future adopted limits).

Table 1: Changes in Fuel Specification in the EU.

Date / Component	1985	1998	2000	2005
Sulphur (mg/kg)	-	500	150	50
Ethers (% v/v)	10	10	15	- ¹
Oxygen (% m/m)	-	-	2.7	- ¹
Benzene (% v/v)	5	5	1	- ¹
Aromatics (% v/v)	-	-	42	35
Lead (g/l)	0.013	0.013	0.005	0.005

Although the current allowable concentration of ether oxygenates is similar to that used in reformulated gasoline in the USA, European fuel blends (with the exception of Finland) still actually contain much lower concentrations of ether oxygenates, typically less than 5 percent and often less than 1 percent by volume². This is because the current allowable limits of benzene, aromatics and sulphur allow refiners to maintain specified octane without addition of expensive ether oxygenates. These compounds – including MTBE – therefore have traditionally been used as ‘octane trim’ rather than to meet air emissions standards set across Member States³.

In contrast to the United States, there has been little reporting within the EU to-date of groundwater contamination by these fuel additives. Consequently, there has been the same drive in Member States to develop a common standard for the construction, installation and operation of UST systems. Such specification standards vary across Member States, and have different technical specifications as well as different dates for the enforcement of any changes to those specifications. The risk to groundwater posed by fuel additives is therefore different from one Member State to another, and will be sensitive to any changes in fuel specification that may occur across the EU.

1. These values have yet to be decided and will be the subject of a new Commission proposal, based on the conclusions reached by the Auto-Oil II programme.

2. These data were corroborated by petroleum companies contacted during this study, who indicated that at various refineries ether oxygenates constituted less than 5 percent by volume, and of this MTBE constituted less than 1 percent. Arthur D. Little were asked by the companies contacted not to indicate which refineries these data related to.

3. The percentage MTBE content of 98 RON or ‘Super Unleaded’ may be greater than the typical figures quoted here, which refer to the mean concentration of MTBE across all unleaded grades. Sales of super unleaded account for a small proportion of total gasoline sales and hence have a lower impact on the mean value of MTBE component concentration.

2.1.3 Predicted Use of Oxygenates in the EU

Directive 98/70/EC specified a further reduction in the sulphur content to 50 ppm and aromatics to 35 percent, which will enter into force in 2005. Although the remaining parameters have yet to be decided by European Parliament, it is possible that these changes will require an increased use of oxygenates to meet any octane deficit, although these increases depend on any new refining technologies introduced by petroleum companies.

2.2 Study Scope

Given the environmental concerns raised by groundwater contamination from high-oxygenate fuel blends used in the United States, and the forthcoming changes in fuel specifications, this study asks:

Does a potential for the contamination of groundwater by ether oxygenates (as has already occurred in the USA) exist in the EU, and is this mitigated by existing controls or obligations in Member States that may or may not exist in the USA?

By way of possible mitigation, we have considered three factors:

1. UST Construction, installation and operation.

Prior to the early 1980s there was little regulation of UST systems in the USA at either the federal, state or local levels. Operational and technical deficiencies such as a lack of regular testing of tank integrity have been widely acknowledged as being responsible for much of the resulting groundwater contamination by ether oxygenates. Regulation in force in the USA prior to the 1984 amendment of the RCRA therefore provides a useful reference point for European systems in assessing whether there are similar deficiencies in UST regulation across Member States.

2. Regulation of Water Quality.

Water purveyors, states, and the United States Environmental Protection Agency (EPA) each have a role in monitoring and assuring drinking water quality. The most prominent US federal legislation passed to ensure that the goals are met is the SDWA. The SDWA uses an integrated approach to drinking water protection, which includes assessing and protecting drinking water sources; protecting wells and collection systems; making sure water is treated by qualified operators; ensuring the integrity of distribution systems, and making information available to the public on the quality of their drinking water.

Similar provisions for water quality exist in Europe as part of the newly adopted Water Framework Directive, which includes a requirement for water quality monitoring under Article 7 of Directive 98/83/EC. The SDWA, which was last amended in 1996 and Californian state legislation concerning the Maximum Contaminant Levels (MCL) for groundwater pollutants are used to assess whether the Water Quality Framework Directive, Directive 80/68/EEC and Directive 98/83/EC meet or exceed the equivalent federal legislation, or whether there are any deficiencies in the EU regulations which may need to be addressed.

3. MTBE monitoring programmes.

There are several reported studies within the EU into the contamination of groundwater by ether oxygenates. The most recent and comprehensive of these was published by the UK Environmental Agency (EA) and the Institute of Petroleum (IP) in November 2000. Current levels of ether oxygenate contamination are a useful indication of whether current UST and water quality regulations are providing sufficient protection against groundwater pollution.

2.2.1 Study Objectives

The objectives of this study are as follows:

- 1. Describe the current (post-1998) federal requirements (post-December 1998) for the construction, installation and operation of UST systems in the USA;**
- 2. Describe the previous requirements (pre-December 1998) for the construction, installation and operation of UST systems in the USA and for California in particular;**
- 3. Describe the current requirements for the construction and operation of UST systems in the Member States of the Community. Highlight any substantial changes to these requirements in the last five years;**
- 4. Describe any relevant US federal legislation (or State legislation particularly in respect of California) regarding the prevention of contamination of groundwater and compare with the Council Directive 80/68/EEC and the provisions of the newly adopted Water Quality Framework Directive;**
- 5. Describe any relevant US federal legislation (or State legislation particularly in respect of California) regarding the quality requirements of water intended for human consumption and compare this to Directive 98/83/EC in the EU.**
- 6. Describe any Member State programmes designed to monitor the levels of MTBE (and other oxygenates used in gasoline blending) in ground and potable water, and report any monitoring results that are available; and**
- 7. Ascertain whether any surveys or inspections of underground gasoline storage tanks have been undertaken in the Member States, and report any publicly available survey results.**

8. Conclude whether the risk of groundwater pollution by ether oxygenates is mitigated by these findings and any differences between the water quality regulatory framework established in the EU as compared to the USA.

Table 2 shows how each of the objectives identified above fit into the report.

Table 2: Report Outline.

Number	Objective	Section
1.	Current US requirements for UST systems	3.3
2.	Previous US requirements for UST systems	3.2
3.	Current EU requirements for UST systems	5.2
4.	Current US groundwater legislation	4.2
5.	Current US water quality legislation	4.3
4 / 5.	Comparison of US and EU legislation	4.4
6.	EU Member State MTBE monitoring	5.3
7.	EU Member State UST monitoring	5.2 / 5.3
8.	Study Findings	6.1

3. Requirements for Underground Storage Tanks in the USA

3.1 Chapter Introduction

This chapter describes the regulatory framework in the USA for the construction and operation of UST systems. The reporting of groundwater contamination by ether oxygenates in the USA has had a significant impact of the development of this framework, both through the revised specifications for UST systems and monitoring programmes set up to safeguard against future contamination incidents.

This chapter is divided into two sections. Section 3.2 describes the regulatory history for the construction and operation of UST systems prior to the federal deadline of 22nd December 1998 for implementation of the revised system requirements. Section 3.3 describes the current requirements for the construction and operation of UST systems, standards that approximately 85 percent of all systems are now in compliance with.

3.2 Underground Storage Tanks: The Regulatory History

Prior to the early 1980's, there was little regulation of UST systems at the federal, state, or local levels. With the discovery of gasoline, and components of gasoline, in groundwater sources of drinking water in several areas throughout the United States, the federal RCRA was amended in 1984 to add Subtitle I. The new amendment was designed to require UST systems to be installed in accordance with standards that mitigate against future leaks. This law formed the basis of the UST programme and became effective immediately. Implementation of this law required all new UST systems do the following:

- Prevent releases due to corrosion or structural failure for the operational life of the UST;
- Cathodically protect against corrosion, use system components constructed of non-corrosive materials, use steel clad with non-corrosive materials, or design the system in a manner to prevent the release or threatened release of any stored substance;
- Use materials in the construction or lining of the tank that are compatible with the substance stored.

Following an intense period of rulemaking, the United States EPA established a nationwide UST system notification programme; system monitoring requirements; and several other specific system upgrade requirements including spill, overfill, and corrosion protection. The upgrade standards were applied to all new UST systems installed on or after December 22, 1988. All existing UST systems installed prior to December 22, 1988 were allowed ten years to upgrade. For all new and existing fuel-related UST installations, the federal programme required single-walled UST systems to meet uniform system monitoring and leak prevention standards.

As stated in the RCRA regulations, federal law required notification for all gasoline UST systems that had been used since January 1, 1974, that were in the ground as of May 8, 1986, or that were brought into use after May 8, 1986. The law required that the owner or operator of the tank contact State or local agencies. Notification was required within 30 days after the tank was brought into service. Some of the information that had to be provided to the agency included the following:

- Tank ownership information;
- Type of tank;
- Whether the tank is in or out of service;
- Estimated age of tank;
- Estimated total capacity of tank;
- Description of the material used to construct the tank;
- Description of internal protection and external protection;
- Description of associated piping; and
- Description of the substance stored in the tank.

Owners and operators were also required to submit to the implementing agency reports of all releases including suspected releases, spills and overfills, and confirmed releases; corrective action planned or taken; and notification before permanent closure or of a change-in-service. Likewise, owners and operators were required to maintain information including documentation on UST system repairs or upgrades, results of the site investigation conducted at permanent closure, recent compliance with release detection requirements, etc. It was required that the information be readily available at the UST site or alternative site for immediate review by the implementing agency.

3.2.1 Leak Detection

Owners and operators of UST's were required to have a system installed that could detect the release of the regulated substance. The leak detection system implemented must have been able to detect a leak from any portion of the tank or piping that routinely contained petroleum and must have been installed, calibrated, operated, and maintained in accordance with the manufacturer's instructions. Generally, the tanks had to be monitored on a monthly basis using secondary containment with interstitial monitoring, automatic tank gauging, monitoring for vapours in the soil, monitoring for liquids on the groundwater surface, statistical inventory reconciliation (SIR), or other methods given that they were approved by the implementing agency. The tank could also have been monitored using monthly inventory control and annual tank testing, but only for ten years after adding corrosion protection or until December 22, 1998, whichever was the later date. Likewise the tank could have been monitored using monthly inventory control and tank testing every five years, but this could only have been performed for ten years after installation and then monthly monitoring was required. The table below summarises the requirements.

Table 3: UST Requirements.

Equipment	Leak Detection Method
UST System (3 Choices)	1. Monthly Monitoring ⁴
	2. Monthly Inventory Control and Tank Tightness Testing Every 5 Years ⁵
	3. Monthly Inventory Control and Annual Tank Tightness Testing ⁶

Pressurised piping in UST systems also had to be equipped with an automatic line leak detector and had to have an annual line tightness test or monthly vapour monitoring, groundwater monitoring, interstitial monitoring, or other monitoring approved by the implementing agency. Suction piping in UST systems had to have a line tightness test conducted every three years or monthly vapour monitoring, groundwater monitoring, interstitial monitoring, or other monitoring approved by the implementing agency. However, no release detection was required for suction piping that was below-grade (i.e. below ground surface) and operating at less than atmospheric pressure, that had below-grade piping that was sloped so contents drain back into the tank, or only had one check valve in the suction line. The table below summarises the requirements.

Table 4: Date for Release Detection Requirements Under Different Systems.

Year System Was Installed	Year When Release Detection Is Required				
	12/22/89	12/22/90	12/22/91	12/22/92	12/22/93
Unknown Date	RD ⁷	P ⁸			
Before 1965					
1965-1969		P/RD			
1970-1974		P	RD		
1975-1979		P		RD	
1980-1988		P			RD

4. Monthly monitoring includes secondary containment with interstitial monitoring, automatic tank gauging, monitoring for vapours in the soil, monitoring for liquids on the groundwater, SIR, or other methods approved by the implementing agency.

5. This option could only be used for ten years after installation and then monthly monitoring was required.

6. This option could only be used for ten years after adding corrosion protection or until December 22, 1998, whichever was the later date.

7. Must begin release detection for tanks and suction piping.

8. Must begin release detection for all pressurised piping

3.2.1.1 Financial Responsibilities

In order to operate a petroleum UST, the owner or operator had to show that they have the financial resources to clean up a site if a release occurred, to correct environmental damage, and to compensate third parties for injury to their property or themselves. The amount of coverage required depended on the type and size of the business.

Owners and operators had several options to demonstrate financial responsibility. They included obtaining commercial environmental impairment liability insurance; demonstrating self-insurance; obtaining guarantees, surety bonds, or letters of credit; placing the required amount into a trust fund administered by a third party; or relying on coverage provided by a state financial assurance fund. Local governments had four additional compliance mechanisms tailored to their special characteristics: a bond rating test, a financial test, a guarantee, and a dedicated fund.

3.2.1.2 California Requirements

The California UST programme actually predates the federal UST programme and became effective January 1, 1984. UST's first came to the attention of Santa Clara County in northern California with the discovery of groundwater contamination by solvents used in the electronics industry. Following the discovery of extensive contamination, California passed state legislation in 1983 that was far more stringent than the federal laws operating at that time, requiring all UST systems to be double-walled throughout the state.

In 1983, California legislature enacted the Sher Bill which, for the first time, stated that California had the right to specifically govern the construction, maintenance, testing, and use of UST's used to store hazardous substances. The law required that before January 1, 1985, any UST's storing hazardous substances and installed on or before January 1, 1984 must have a monitoring system capable of detecting unauthorised releases. The owner or operator had to monitor the tank at least monthly with a method specified in the UST permit and maintain detailed records. If the UST was installed after January 1, 1984, it was required to be double-walled. This law also required all owners and operators to obtain a permit from the local agency to operate the UST systems. Additionally, the law required that owners and operators of the UST system notify the local agency if any changes "in the usage" of the UST were to occur, including if there were any releases of hazardous substances.

The Sher Bill also established closure guidelines, requiring that owners and operators of UST systems demonstrate to the local agency that residual amounts of hazardous substances that were stored in the tank were properly removed, disposed of, and neutralised. Furthermore, the owner or operator had to demonstrate that no significant soil contamination occurred as a result of the UST operations.

In 1985, the Sher Bill was implemented by the State Water Resources Control Board (SWRCB) when it adopted regulations establishing detailed monitoring requirements for the UST's. These laws are located in the California Health and Safety Code, Chapter 6.7. The regulations adopted by the SWRCB are currently located in Title 23, Division 3, Chapter 16 of the California Code of Regulations. Specifically, the law required visual monitoring to be the principal leak detection monitoring method for all tanks installed before January 1, 1984. Where visual monitoring was not possible, the regulation called for the implementation of an alternative method, approved for the particular UST system by the local agency. They included one or a combination of the following:

- Tank testing
- Vadose (i.e. unsaturated ground) zone monitoring
- Groundwater monitoring
- Soil sampling
- Inventory reconciliation
- Pipeline leak detectors
- Tank gauging
- Other monitoring method approved by the local agency.

These laws also required that the UST systems have a leak detection device to monitor for leaks in the piping if a pressurised pump system was connected to the UST. This leak detection device also had to be tested on an annual basis. The regulations allowed for alternative monitoring methods for UST systems located on farms to store motor vehicle or heating fuels used primarily for agricultural purposes. If the tank was between 1,100 gallons⁹ (4165 litres) and 5,000 gallons (18931 litres) in capacity, it was subject to a tank integrity test at least once every three years and tank gauging on a monthly basis or more frequent if requested by the local agency. If the tank was greater than 5,000 gallons (18931 litres) in capacity, the tank was subject to the previously mentioned monitoring requirements.

The law also stated that all UST systems were required to be replaced or upgraded to prevent releases due to corrosion, spills, or overfills by December 22, 1998. Additionally, all existing underground pressurised piping was required to be equipped with an automatic line leak detector by December 22, 1990 and be retrofitted with secondary containment by December 22, 1998 with tightness testing being performed on an annual basis. However, piping did not have to be retrofitted if the existing pressurised piping contained motor vehicle fuel and was constructed of glass fibre reinforced concrete, cathodically protected steel, or steel clad with glass fibre reinforced plastic; was equipped with an automatic line leak detector; and was tightness tested on an annual basis.

9. Throughout this report gallons refers to US gallons. 1 US Gallons equals approximately 3.8 litres.

For tanks installed after 1984, it was required that the UST system and piping be double-walled. The double-walled tanks had to contain a continuous leak detection system with an alarm which was capable of detecting the entry of hazardous substances from the inner container into the interstitial space and detecting water intrusion from the outer shell into the interstitial space. In addition, the tanks had to be equipped with spill and overflow protection. The law also required that underground pressurised piping associated with the tank had to be equipped with an automatic line leak detector and tightness tested on an annual basis. For tanks installed before 1997, the tanks did not have to have primary and secondary levels of containment as long as the following requirements were met:

- The primary containment was constructed of glass fibre reinforced plastic, cathodically protected steel, or steel clad with glass fibre reinforced plastic.
- The primary containment was installed in a way that would direct any leak encountered directly to a monitoring well to detect the release of motor vehicle fuels.
- The UST system was designed to provide early leak detection and response, and to protect the groundwater from releases.
- The UST system and piping were gauged daily, along with performing inventory reconciliation.

Furthermore, these SWRCB regulations slightly changed the reporting requirements originally stated in the Sher Bill. Releases that occurred from new UST systems that were cleaned up in eight hours and did not escape secondary containment were to be recorded on the operator's monitoring reports. Releases that occurred and escaped secondary containment had to be reported to the local agency within 24 hours followed up by submittal of a written report.

Closure requirements were also expanded under this legislation. Prior to closure, the UST owners or operators had to submit to the local agency a proposal describing how they intend to comply with the closure requirements. Owners and operators also had to demonstrate that no unauthorised release had occurred by performing ongoing leak detection monitoring immediately following removal of the UST. Additionally, the regulations provided for compliance with the reporting requirements if any unauthorised release was detected during closure.

The California Uniform Fire Code also required that a permit be obtained when removing, abandoning, or closing an UST system containing a flammable or combustible liquid (e.g., gasoline).

Similar to the federal laws in force at that time, California regulations required owners or operators of UST systems containing petroleum product to show that they had the financial resources to clean up a site if a release occurred, to correct environmental damage, and to compensate third parties for injury to their property or themselves. The amount of coverage required depended on the type and size of the business.

The California UST Cleanup Fund was approved by the EPA as a mechanism for meeting the federal financial responsibility requirements for UST's containing petroleum in the state of California. The UST Cleanup Fund Programme was created to help owners and operators of UST's satisfy federal and state responsibility requirements and to assist with the cost of cleanup of contaminated soil and groundwater in California. The fund pays for corrective action and third party liability costs up to \$1 million per occurrence. The state board collects approximately \$0.006 for each gallon of petroleum delivered to a UST in California to finance this fund.

3.2.1.3 Complications of the California UST Programme

When California laws were first passed, the UST programme became very complicated due to the way the programme was administered within the State of California. California law allowed local implementing agencies (LIA's), operating under the oversight of the SWRCB and its nine Regional Water Quality Control Boards (RWQCB), to administer and enforce the UST programme. However, because the LIA's were allowed to promulgate requirements that went beyond the state and federal requirements, it resulted in a lot of complexity, overlaps, confusion, and inefficiencies in implementing and enforcing the UST programmes. Additional problems arose when the SWRCB began to issue Local Guidance (LG) letters to LIA's to facilitate the interpretation of the laws. Many of these LG letters had to be revised, corrected, or even cancelled due to the regulated communities and LIA's questioning their content, and to the lack of assurance that the interpretations made by the SWRCB were consistent for each programme in place. As a result of this confusion, the California UST programme did not receive and has still not received the EPA's approval due to their lack of confidence in California's segmented local agency approach to enforce even the basic federal requirements.

In order to improve the state UST programme, the Senate passed a bill in 1993 (Senate Bill 1082), which established the Certified Unified Programme Agency (CUPA). The CUPA Programme was intended to consolidate, co-ordinate, and standardise the administrative requirements, permits, inspection activities, enforcement activities, and fees associated with hazardous waste and hazardous materials regulatory programmes. The CUPA Programme includes the following six environmental protection programmes and allows a regulated facility to have a single point of contact for each of these six issues:

- Hazardous waste generators and hazardous waste onsite treatment;
- UST systems;
- Hazardous material release response plans and inventories;
- Accidental release prevention programme;
- Aboveground storage tanks (SPCC plan only); and
- Uniform Fire Code hazardous materials management plans and inventories.

The California Legislature proposed and passed another law (AB 1491) in October 1998 that required all UST's to be "certified" by their respective LIA's in order to continue receiving fuel. This law was enacted due to a large number of UST systems remaining that were not upgraded to meet the December 22, 1998 deadline of enforcement of Subtitle I of the RCRA. The individual UST LIA's were responsible for verifying the upgrades and issuing Upgrade Certificates, UST fill tags, and placards to complying UST facilities. However, due to the fear that local agencies might not have enough time to assess the compliance of all UST systems, another law was passed (SB 913) allowing a local agency to petition to the SWRCB before December 1, 1998 for a 90-day extension to meet its upgrade compliance certification requirements. During this the time, UST owners could "self-certify" their UST's if they met the specified design and construction requirements until the local agency could officially inspect the tank. Owners who self-certified their UST systems, but did not actually meet the requirements were subjected to a civil penalty up to \$25,000 per each day of violation.

In addition to the federal requirements, some local agencies required additional upgrades such as retrofitting the dispenser pans beneath the dispensers¹⁰ and replacing the fibre trenches along the product lines with double-walled line. These additional requirements were very expensive and disruptive to the owner and resulted in increased difficulty when it came time to inspect the UST systems.

Since the implementation of CUPA, many studies have been conducted evaluating the effectiveness of California's programme. These studies have been especially important with the increasing detection of MTBE in the groundwater throughout California due to leaking UST's. Studies have been performed by various organisations including the SWRCB, Lawrence Livermore National Laboratory, California Energy Commission, University of California, California Bureau of Audits, California UST Advisory Panel, and EPA Blue Ribbon MTBE Panel. In regards to the UST programme, the general consensus is that UST systems are still leaking because of the lack of agency enforcement and inspection procedures to prohibit the use of faulty or uncertified tanks. Many of the sites that are leaking were not monitored consistently, had UST systems that were not properly installed, or were not compliant in their reporting requirements. The following recommendations have been made as a result of these studies.

- Improve the UST programme enforcement inspection procedures.
- Include the intents and purposes of UST testing and monitoring, alarm response procedures, and spill response/reporting procedures when training UST owners and operators.
- Improve public awareness of how fuel dispensing can impact the environment, air, and water quality.
- At UST remediation sites, implement procedures to investigate the exact source/cause of a release and document the information in a state-wide database.
- Improve UST installation, maintenance, and repair contractor training and certification.

10. Dispenser pans are equivalent to the oil and water traps widely used in Europe to collect and retain spills during UST operation.

- Begin working toward the establishment of standard protocols for UST system/equipment materials compatibility testing.
- Develop and issue appropriate and feasible corrective action guidelines for MTBE contaminated sites.
- Improve UST information management and data transfers between agencies.
- Update the Leaking Fuel Tank Manual, which was last updated in 1989, to address MTBE.

Furthermore, regulatory and/or legislative actions will be needed in order to:

- Require enhanced UST installation, maintenance, and repair contractor training and certification.
- Increase the required frequency of LIA UST facility inspections to at least once a year.
- Require UST owner or operator training relative to UST monitoring, testing, and response to system alarms as well as reporting requirements.
- Require the eventual upgrade of single-walled and hybrid UST systems to full double-walled UST systems (already enforced in California).
- Replace all fibre-trench systems with double-walled piping (already enforced in California).
- Require the phase-in of under-dispenser containment.
- Require environmental assessment borings or groundwater monitoring wells at each UST site.
- Authorise greater SWRCB oversight powers to include UST facility inspection and enforcement.
- Increase penalties associated with flagrant and/or repeated non-compliance.
- Authorise SWRCB oversight and enforcement authorities over fuel delivery operations and operators.
- Adopt regulations to reduce fraud and false reporting associated with UST inspections, monitoring, testing, and services/repairs.
- Consider more protective measures for UST sites identified through GIS mapping to be high-risk sites relative to drinking water.
- Consider the development of penalties on or retraction of authorities from LIA's that have not adequately enforced the UST programme.
- Require the thorough investigation of UST leak cause and sources.
- Require evaluation of UST system compatibility during deliberation by the California Air Resources Board regarding fuel specification regulations leading to reformulation.

3.3 Underground Storage Tanks: Current Requirements

Federal law requires that as of December 22, 1998, all underground storage tank (UST) systems must include corrosion, spill, and overflow protection [United States Code of Federal Regulations, Title 40 (40 U.S.C.), §280 et seq.]. The legislation also outlines certain requirements when installing, inspecting, and certifying any UST. The purpose of the updated regulations is to prevent releases of product due to structural failure, corrosion, spills, and overfills for as long as the UST system is used to store regulated substances.

3.3.1 Corrosion Protection

The onset of the new corrosion protection requirements for UST systems was developed because unprotected steel UST's and piping were corroding, resulting in the release of product through the corroded holes. The regulations now require that the tanks and piping constructed and installed must be designed so they are protected from corrosion in areas where the tank or piping routinely contains regulated substances. Tanks and piping may be constructed of the following materials: fibreglass-reinforced plastic, steel, and steel-fibreglass-reinforced-plastic composite (for the tanks only). Other metals may also be used to construct the tanks and piping, but only following approval from the implementing agency. The laws require that existing steel UST systems be constructed with interior lining, cathodic protection, or interior lining combined with cathodic protection. Interior lining is defined as a tank with an interior that is constructed of a thick layer of non-corrodible material, which is installed in accordance with applicable industry codes. Cathodic protection systems are not required for fibreglass-reinforced plastic and steel-fibreglass-reinforced-plastic tanks and piping. Refer to the table below for a summary of the new corrosion protection requirements necessary for existing or new tanks and piping.

Table 5: Corrosion Requirements for Different Systems.

Equipment	Corrosion Protection Method
New Tanks (3 choices)	1. Coated and Cathodically Protected Steel
	2. Fibreglass-Reinforced Plastic
	3. Steel-Fibreglass-Reinforced-Plastic Composite
Existing Tanks (4 choices)	1. Same Options for New Tanks
	2. Add Cathodic Protection System
	3. Interior Lining
	4. Interior Lining and Cathodic Protection
New Piping (3 choices)	1. Coated and Cathodically Protected Steel
	2. Fibreglass-Reinforced Plastic
	3. Another Approved Material
Existing Piping (2 choices)	1. Same Option as for New Piping
	2. Cathodically Protected Steel

3.3.2 Spill and Overfill Protection

The new regulations also require that as of December 22, 1998, UST systems that transfer regulated substances (i.e., gasoline) are constructed with spill and overfill prevention equipment. As part of the spill protection, the UST's must have catchment basins to contain spills. As part of the overfill protection, the UST's must have automatic shutoff devices, overfill alarms, or ball float valves.

Spill and overfill prevention equipment is not required for UST's where transfers of product do not exceed 25 gallons (94 litres) at one time. Furthermore, spill and overfill prevention equipment is not required when the implementing agency determines that alternative equipment is adequate.

Table 6: Spill and Overfill Protection Methods

Equipment	Spill/Overfill Protection Method
All Tanks	Catchment Basins –and–
	Automatic Shutoff Devices –or–
	Overfill Alarms –or–
	Ball Float Valves

3.3.3 Leak Detection

The regulations associated with UST systems having leak detection systems were also made more stringent as of December 22, 1998. All existing and new UST systems had to detect a leak from any portion of the tank or piping that routinely contains petroleum and must be installed, calibrated, operated, and maintained in accordance with the manufacturer's instructions. Generally, the laws require that new and existing tanks be monitored on a monthly basis using secondary containment. Monitoring can be performed using one of the following methods: interstitial monitoring, automatic tank gauging, monitoring for vapours in the soil, monitoring for liquids on the groundwater surface, SIR, or other methods given that they are approved by the implementing agency. New and existing tanks could also be monitored using monthly inventory control and annual tank testing for existing tanks and every five years for new tanks. However, this method can only be used for 10 years after installation of the tanks. Following 10 years, monthly monitoring is required. The requirements are summarised below.

Table 7: Leak Detection Requirements.

Equipment	Leak Detection Method
New Tanks (2 Choices)	1. Monthly Monitoring ¹¹
	2. Monthly Inventory Control and Tank Tightness Testing Every 5 Years ¹²
Existing Tanks (3 Choices)	1. Monthly Monitoring
	2. Monthly Inventory Control and Tank Tightness Testing Every 5 Years
	3. Monthly Inventory Control and Annual Tank Tightness Testing ¹³

Leak detection for piping depends on the type of piping (pressurised or suction). The table below summarises the requirements for each.

Table 8: Requirements for Leak Detection on Piping.

Equipment	Leak Detection Method
New and Existing Pressurised Piping (Choice of one from each set, A & B)	A-1. Automatic Shutoff Device –or-
	A-2. Flow Restrictor –or-
	A-3. Continuous Alarm System
	-AND-
	B-1. Annual Line Testing –or-
	B-2. Monthly Monitoring* (except automatic tank gauging)
New and Existing Suction Piping (3 Choices)	1. Monthly Monitoring* (except automatic tank gauging)
	2. Line Testing Every 3 Years
	No Requirements Given: Below-ground piping is sloped so contents drain back into storage tank if suction is released. Each suction line has only one check valve which is located directly below suction pump.

3.3.4 Construction Certification

Finally, the new regulations require that as of December 22, 1998, UST's must be installed in accordance with a code of practice developed by a nationally recognised association or independent testing laboratory and in accordance with the manufacturer's instructions. In order to ensure that the UST has been installed in compliance to the regulations stated above, the owners and operators of the UST must have the tank certified by providing a certification of compliance on the UST notification form.

11. Monthly monitoring includes secondary containment with interstitial monitoring, automatic tank gauging, monitoring for vapours in the soil, monitoring for liquids on the groundwater, SIR, or other methods approved by the implementing agency.

12. This option can only be used for 10 years after installation and then monthly monitoring is required.

13. This option can only be used for 10 years after adding corrosion protection or until December 22, 1998, whichever is the later date.

UST systems can be certified by installers if they have been certified by the tank and piping manufacturers or have been certified or licensed by the implementing agency. The tank can also be inspected and certified by the implementing agency or by a registered professional engineer with education and experience in UST system installations. Finally, the tank can be certified if the work listed on the manufacturer's installation checklist as been completed.

Throughout the installation procedures numerous checks are required to document installation in accordance with the manufactures and local agencies requirements. These included but are not limited to the following:

- Holiday testing of coated steel tanks prior to placement in the ground
- Delivery and placement of UST's under a vacuum applied at the manufacturer
- Hydrostatic testing of the UST containment sumps after completion of piping penetrations
- Pressure testing of primary lines and external leak assessment using soapy water
- Pressure testing of secondary containment
- Testing and verification of sensors and probes
- Final volumetric testing of fuelling system prior to initial fuel delivery

3.3.5 Future Initiatives

The EPA has identified various UST programmes which, when implemented, will guide the future for UST work that remains to be completed across the nation. Many of these initiatives were introduced in October 2000 with expectations for them to be implemented immediately. These include the following:

- **The UST field Initiative** is designed to assess and clean up abandoned or closed underground storage tanks at Brownfield sites. The EPA plans to give grants to 50 areas where there are problems caused by MTBE. Specifically, the grants will provide states with money for community pilot projects to plan cleanups, stop contamination of groundwater, protect public health, and allow for future economic development of the sites.
- **Improving Compliance.** Although approximately 85 percent of all tanks are in compliance with spill, overfill, and corrosion protection requirements, the EPA is actively working to bring the remaining 15 percent (approximately 100,000 tanks) into compliance. Furthermore, states estimate that only 60 percent of all UST systems are in compliance with the leak detection requirements. The initiative will include improving the quality of operating compliance data so the EPA, states, and public have an accurate and consistent measure of compliance. It will set national and regional targets through 2005 in bringing tanks into compliance as well as improving the implementing agencies inspection and enforcement practices. Furthermore, the initiative will obtain commitments from states to increase their inspection and enforcement presence if state-specific targets are not met.

The EPA also plans to provide tools, such as technical assistance, improved guidance, and training, which will provide owners, operators, and inspectors with accurate information about the operation and maintenance of UST systems and foster improved operational compliance.

- **Faster Cleanups.** The EPA is working to increase the pace of UST site cleanups (totalling approximately 160,000) by setting national and regional target goals through 2005. The EPA hopes to explore the use of a federal audit policy and other approaches to promote multi-site cleanup agreements between the EPA and multi-site owners to clean up releases.

- **Evaluating UST System Performance.** Because there is evidence that releases still occur from compliant UST systems, the EPA is looking to evaluate the effectiveness of current leak detection requirements, systems, and their operation to determine if the new regulations are really working and if any changes should be made. Various aspects of the UST system performance are being evaluated by several organisations, which the EPA will use to assess the issues. Some evaluation projects include:
 - Survey of Current UST Management and Operation Practices (Lead Organization, Alpine Environmental).
 - Leaking UST's as Point Sources of MTBE to Groundwater and Related MTBE-UST Compatibility Issues (Lead Organization, University of California – Davis).
 - Advisory Panel on the Leak History of New and Upgraded UST Systems: Leak Source and Leak Detection Data Collection and Analysis (Lead Organization, California State Water Resources Control Board).
 - An Evaluation of MTBE Occurrence at Fuel Leak Sites with Operating UST's (Lead Organization, Santa Clara Water District).
 - Field Verification of UST System Leak Detection Performance (Lead Organization, University of California – Davis).
 - Analysis of UST System Environmental Performance (Lead Organization, ICF, Inc.).
 - Field Investigation of Leak Prevention and Detection (Lead Organization, Levine Fricke).

In addition to the initiatives proposed by the EPA, several bills have been proposed regarding UST systems and clean ups associated with UST releases, specifically in regards to MTBE. Many of the bills presented to Congress are, for the most part, similar to one another, but with minor changes. Proposed legislation includes the following:

- Amend the Solid Waste Disposal Act to allow funds from the Leaking UST Trust Fund to be used for corrective actions resulting from releases of MTBE from UST's. Other bills include proposals to use the funds for conducting inspections, issuing orders, and carrying out actions under the UST regulation programme.

- Amend the Solid Waste Disposal Act to require owners and operators of UST's to conduct monitoring and report results for MTBE for ten years following the detection of the first release or three years after the date on which with last release was detected. In addition, require the implementing agency for UST's to focus enforcement on areas where MTBE is leaking into the groundwater or surface water.
- Amend the Safe Drinking Water Act to allow the implementing agencies of UST's to declare drinking water emergencies in areas where the county or municipality water supplies become contaminated with MTBE.
- Allocate funds to study the long-term effects of MTBE in drinking water resulting from UST releases.
- Allocate additional funds for the Leaking UST Trust Fund to take action to protect human health and the environment from releases of MTBE from UST's.

These proposed amendments represent significant activity in the field of groundwater protection, and are envisaged to continue pushing forward the development of associated water quality regulations for the foreseeable future.

4. Regulation of Groundwater Protection and Water Quality

4.1 Chapter Introduction

This chapter concerns the regulatory framework in the USA for the prevention of groundwater pollution and preservation of water quality, and the equivalent regulations that have been adopted by the EU. A number of significant revisions to these regulations have been adopted in recent years.

In the USA these complement changes in the requirements for UST systems described in the previous chapter, for example the 1998 amendments to the Safe Drinking Water Act and the establishment of a source water assessment protection (SWAP) programme designed to build on existing wellhead protection programmes. The assessments should be completed for all public water systems in each state by 2003.

In the EU the most significant change to legislation in recent years has been the adoption of the Water Quality Framework, which is expected to be finalised in 2002. This incorporates a number of existing European Directives, and will eventually result in Directive 80/68/EEC (concerning groundwater protection) being repealed. This chapter discusses these revisions in the context of existing United States legislation, and finishes with an assessment of the key similarities and differences between these two sets of regulations.

The chapter is divided into three sections. Sections 4.2 and 4.3 describe regulations preventing groundwater pollution and preserving water quality respectively in the United States. Section 4.4 introduces the equivalent EU Directives on groundwater protection (80/68/EEC) and the quality requirements for water intended for human consumption (98/83/EC), as well as the new adopted Water Framework Directive.

4.2 United States Groundwater Regulations

The United States EPA is responsible for federal activities relating to the quality of groundwater. EPA's groundwater protection activities are authorised by a number of laws including the following:

- The SDWA, which authorises the EPA to set national health-based standards for maximum levels of contaminants in drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water. In addition, the SDWA allows the EPA to regulate underground disposal of wastes in deep wells, designate areas that rely on a single aquifer for their water supply, and establish a nation-wide programme to encourage the states to develop programmes to protect public water supply wells (i.e., wellhead protection programmes). This law was enacted in 1974 and was amended in 1986 and 1996. [United States Code of Federal Regulations, Title 42 (42 U.S.C.) Chapter 6a, §300f et seq.]

- The RCRA, which regulates the storage, transportation, treatment, and disposal of solid and hazardous wastes to prevent contaminants from leaching into the groundwater from municipal landfills, underground storage tanks, surface impoundments, and hazardous waste disposal facilities. RCRA originated from the Solid Waste Disposal Act enacted in 1965, which was amended in 1970 by the Resource Recovery Act, and amended again in 1976 to become RCRA. [42 U.S.C. Chapter 82, §6901 et seq.]
- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), which authorises the government to clean up contamination caused by chemical spills or hazardous waste sites that could (or already do) pose threats to the environment, and whose 1986 amendments include provisions authorising citizens to sue violators of the law and establishing “community right-to-know” programmes (Title III). This law was enacted in 1980. [42 U.S.C. Chapter 103, §9601 et seq.]
- The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which authorises the EPA to control the availability of pesticides that have the ability to leach into groundwater. This law was enacted in 1972. [7 U.S.C. Chapter 6, §136 et seq.]
- The Toxic Substances Control Act (TSCA) which authorises the EPA to control the manufacture, use, storage, and distribution, or disposal of toxic chemicals that have the potential to leach into groundwater. This law was enacted in 1976. [15 U.S.C. Chapter 53, §2601 et seq.]
- The Clean Water Act (CWA), which authorises the EPA to make grants to the states for the development of groundwater protection strategies and authorises a number of programmes to prevent water pollution from a variety of potential sources. The law was originally enacted in 1972 as the Federal Water Pollution Control Act and was amended in 1977 to become the Clean Water Act. [33 U.S.C. Chapter I, §1251 et seq.]

In many instances, federal legislation requires each state to implement their own groundwater programme based on the federal law. Examples of this include the requirements in the 1986 amendments to the SDWA, which established the wellhead protection programme. As part of the programme, each state was required to develop a comprehensive programme to protect public water supply wells from contaminants that could be harmful to human health. Wellhead protection is simply protection of all or part of the area surrounding a well from which the well’s groundwater is drawn, otherwise known as the wellhead protection area. This law specifies the following minimum components for each state’s wellhead protection programme:

- The roles and duties of state and local governments and public water suppliers in the management of wellhead protection programmes must be established.
- The wellhead protection area for each wellhead be delineated.
- The contamination sources within each wellhead protection area be identified.

- Approaches for protecting the water supply within the wellhead protection area from contamination sources be developed.
- Contingency plans for use if public water supplies become contaminated be developed.
- Provisions for the proper siting of new wells to produce maximum water yield and reduce the potential for contamination as much as possible be established.
- Provisions to ensure public participation in the process be developed.

4.2.1 The Safe Water Assessment Programme

Another example of where federal law require states to implement their own programmes is with the 1996 amendments to the SDWA. These amendments established the Source Water Assessment Protection (SWAP) programmes that are designed to build on existing wellhead protection programmes. The assessments, which should be completed for all public water systems in each state by 2003, will identify the most significant potential sources of contamination for each public water system whether served by groundwater or by surface water. These assessments will provide valuable information for communities on priority drinking water protection needs. This law specifies the following minimum components for the SWAP programme:

- The identification of areas in each state that supply public tap water.
- The completion of a contaminant source inventory.
- The determination of susceptibility of the public water supply to contamination from the inventoried sources.
- A release of the results of the assessment to the public.

Source water assessments and protection measures are eligible to receive funding from the Drinking Water State Revolving Fund (DWSRF). The DWSRF was also established to assist communities in installing and upgrading safe drinking water treatment facilities. Furthermore, the DWSRF emphasises providing funds to small and disadvantaged communities and to programmes that encourage pollution prevention as a tool for ensuring safe drinking water.

4.2.2 The Underground Injection Control Programme

The Underground Injection Control (UIC) Programme was also created as part of 1996 amendments to the SDWA. This Programme established safeguards so that injection wells do not endanger current and future underground sources of drinking water. States choose to apply to be the primary enforcement responsibility for this programme, share the primacy with the EPA, or allow the EPA to run the programme. The goals of the UIC Programme are to prevent contamination by keeping the injected fluid from directly or indirectly entering into an underground source of drinking water and to require that injected fluids not cause a public water system to violate drinking water standards or otherwise adversely affect public health. As part of the programme, the EPA grouped underground injection wells into five classes for regulatory control purposes, with Class I wells being the most heavily regulated.

The UIC Programme prevents contamination of the underground sources of drinking water by setting minimum requirements, such as the siting of the injection wells, the construction, operation, maintenance, monitoring, testing, and finally, the closure of the wells.

Other programmes associated with the SDWA include the Sole Source Aquifer (SSA) programme. This programme is designed to further protect aquifers that are recognised as being the sole source of a community's drinking water. Once a petition is submitted and approved that recognises an aquifer as being SSA, all proposed federally financially-assisted projects which have the potential to contaminate the SSA are subject to regional EPA review. Ultimately, SSA designation help increase public awareness on the nature and value of local groundwater resources.

4.2.3 State Legislation

The federal laws tend to focus on controlling potential sources of groundwater contamination on a national basis. Where federal laws have provided for general groundwater protection activities such as wellhead protection programmes or development of state groundwater protection strategies, the actual implementation of these programmes must be by the states in co-operation with local governments. States are also allowed to enforce their own requirements given that the laws are at least as stringent as the federal laws. Each state has passed some form of groundwater policy. State groundwater legislation can be divided into the following subject categories.

- **State-wide Strategies.** This requires the development of a comprehensive plan to protect the state's groundwater resources from contamination.
- **Groundwater Classification.** This identifies and categorises groundwater sources by how they are used to determine how much protection is needed to continue that type of use.
- **Standard Setting.** This identifies levels at which an aquifer is considered contaminated.
- **Land-Use Management.** This develops planning and regulatory mechanisms to control activities on the land that could contaminate an aquifer.
- **Groundwater Funds.** This establishes specific financial accounts for use in the protection of groundwater quality and the provision of compensation for damages to underground drinking water supplies (e.g., reimbursement for groundwater cleanup, provision of alternative drinking water supplies).
- **Agricultural Chemicals.** This regulates the use, sale, labelling, and disposal of pesticides, herbicides, and fertilisers.

- **Underground Storage Tanks.** This establishes criteria for the registration, construction, installation, monitoring, repair, closure, and financial responsibility associated with tanks used to store hazardous waste or materials.
- **Wastewater Management.** This includes groundwater quality protection in the criteria used to justify more stringent water allocation measures where excessive groundwater withdrawal could cause groundwater contamination.

In order for these programmes to be successful, all levels of government must participate. The federal government is responsible for approving the protection programmes and for providing technical support to state and local governments. State governments must develop and implement programmes that meet the requirements set forth in regulations such as the SDWA and RCRA. Although the responsibilities of local governments depend on the specific requirements of their state's programme, these governments often are in the best position to ensure proper protection of the source waters.

4.2.3.1 California Regulations

California has developed its own set of regulations over the years intended to protect groundwater from contamination. California's first move in this direction occurred with the enactment of the Dickey Water Pollution Act of 1949, which created nine Regional Water Quality Control Boards. Responsibility for both water quality and water rights was given to the State Water Resources Control Board by the Legislature in 1967. However, the Porter-Cologne Water Quality Control Act (Porter-Cologne) is the principal law governing the water quality regulation in California. This act was established in 1969 and was a comprehensive programme designed to protect water quality and the beneficial uses of water. It applies to surface waters, wetlands, and groundwater. This statute can be found in the California Water Code beginning with Section 1300. In addition, Title 23 of the California Code of Regulation (CCR) contains administrative and regulatory elements of water quality and quantity management in California.

Porter-Cologne also required the adoption of Water Quality Control Plans that contain the guiding policies of water pollution management in California. There are a number of state-wide water quality control plans adopted by the SWRCB; and regional water quality control plans, known as Basin Plans, adopted by the RWQCB's. All water quality control plans identify the existing and potential beneficial uses of waters of the State and establish water quality objectives to protect these uses. They also contain implementation surveillance and monitoring plans. Water quality control plans include enforceable prohibitions against certain types of discharges.

California is also one of 20 states with an environmental impact assessment law modelled after the National Environment Policy Act. The California Environmental Quality Act (CEQA) applies to discretionary activities proposed to be carried out by government agencies, including approval of permits and other entitlements. CEQA has six objectives including the following:

- To disclose to decision makers and the public the significant environmental effects of proposed activities.
- To identify ways to avoid or reduce environmental damage.
- To prevent environmental damage by requiring implementation of feasible alternative or mitigation measures.
- To disclose to the public reasons for agency approvals of projects with significant environmental effects.
- To foster interagency co-ordination.
- To enhance public participation.

Numerous other State programmes have been enacted to protect both surface and groundwater. These include the following:

- **Water Quality Assessment.** Biannually, the State and Regional Boards evaluate California's water quality to decide where the State's water quality efforts should be directed.
- **Waste Disposal to Land Regulations.** These are waste discharge requirements issued by the RWQCB's to control the discharge of hazardous and non-hazardous wastes to the land.
- **Toxic Pits Cleanup Act.** This regulates surface impoundments containing liquid hazardous wastes and requires double-lining and monitoring.
- **Solid Waste Assessment Testing (SWAT).** This programme detect hazardous waste leakage from solid waste disposal sites.
- **Spills, Leak, Investigation, and Cleanup Programme (SLIC).** This programme manages sites with pollution from recent or historic surface spills, subsurface releases (such as pipelines), complaint investigations, and all other unauthorised discharges that pollute or threaten to pollute the surface or groundwater.
- **Aboveground Petroleum Storage Act.** This programme protects the public and the environment from spillage or petroleum-derived chemicals stored in thousands of aboveground storage tanks.
- **Department of Defence and Department of Energy Programme.** These programmes were created to establish procedures to clean up pollution at federal military sites and federal energy sites.

- **RCRA.** The State Board plays an important role implementing this programme through its own authority in the areas of land disposal and groundwater monitoring. It also performs water quality-related review work to provide the California Department of Toxic Substance Control, the programme's lead agency, with information to guide it in issuing permits to land disposal facilities.

4.3 United States Water Quality Regulations

Water purveyors, states, and the United States EPA each have a role in monitoring and assuring drinking water quality. The most prominent US federal legislation passed to ensure that the goals are met is the SDWA. The SDWA, originally passed in 1974 and amended in 1986 and 1996, gives the EPA the authority to set drinking water standards. These standards are part of the SDWA's "multiple barrier" approach to drinking water protection, which includes assessing and protecting drinking water sources; protecting wells and collection systems; making sure water is treated by qualified operators; ensuring the integrity of distribution systems; and making information available to the public on the quality of their drinking water. The EPA has set standards for 90 contaminants, seven of which are new standards that will be enforceable January 1, 2002. Under the SDWA, states that meet certain requirements, including setting regulations that are at least as stringent as the EPA's may apply for, and receive primary enforcement authority, or primacy. All states and territories except Wyoming and the District of Columbia have received primacy.

4.3.1 Federal Drinking Water Standards

The EPA sets national standards for drinking water based on sound science to protect against health risks, considering available technology and costs. Two categories of drinking water standards are established.

National Primary Drinking Water Regulation (NPDWR) – This is a legally enforceable standard that applies to public water systems (e.g., municipal water companies, homeowner associations, schools, businesses, campgrounds, shopping malls, etc.) by limiting the level of contaminants that can be present in the water. These standards are enforced using MCL's or TT's.

The EPA sets primary drinking water standards using a three-step process. First, the EPA identifies contaminants that may adversely affect public health and occur in drinking water with a frequency and at levels that pose a threat to public health. Following a comprehensive study on the contaminant, the EPA determines a maximum contaminant level goal (MCLG), which is a concentration in drinking water where there is no known expected risk to health. These goals allow for a margin of safety. Finally, the EPA specifies an enforceable MCL, which is the maximum permissible level of a contaminant in drinking water which is delivered to any user of a public water system.

These MCL's are chosen at a level where they can be achieved with the use of the best technology, treatment techniques, and other means which the EPA finds are available, taking cost into consideration. When it is not economically or technically feasible to set an MCL, or when there is no reliable or economic method to detect contaminants in the water, the EPA instead sets a required TT, which specifies a way to treat the water to remove contaminants.

National Secondary Drinking Water Regulation (NSDWR) – This is a non-enforceable guideline regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odour, or colour) in the drinking water. EPA recommends secondary standards to water system operators but does not require the water systems to comply. However, many states have chosen to adopt them as enforceable standards.

The EPA considers input from many individuals and groups throughout the rulemaking process, including a 15-member committee called the National Drinking Water Advisory Council (NDWAC) which advises all of the EPA's activities related to drinking water.

4.3.2 Drinking Water Programmes

The EPA also provides grants to implement safe drinking water programmes, and to help each state set up a special fund to assist public water operators in financing the costs for improvements (called the Drinking Water State Revolving Fund). Small water systems are given special consideration, since small systems may have a more difficult time paying for system improvements.

The EPA recognises that everyone has the right to know what is in the drinking water. Therefore, all water suppliers must notify consumers quickly when serious problems arise with water quality and must provide annual summary reports of water compliance with drinking water safety standards.

The SDWA 1996 amendments now require the EPA to establish a list of contaminants to aid in the priority-setting for the Agency's drinking water programme. Using this list, the EPA generated the National Drinking Water Contaminant Candidate List (CCL), which lists contaminants that are not already regulated on SDWA, may have adverse effects, are known to be in public water systems, and may require regulations under SDWA. Based on the amount of research performed on each of the contaminants, the EPA divides them into categories. By August 2001, the EPA will select five contaminants from the CCL and determine whether to regulate them. If the EPA determines that regulations are necessary, they must be proposed by August 2003 and finalised by February 2005. EPA also picks 30 contaminants from the CCL and requires public water systems serving at least 100,000 people to monitor them, as part of the Unregulated Contaminant Water Regulation (UCMR) in order to gather data about the occurrence and concentrations for future evaluations.

The EPA is also very active in finding solutions for recent problems encountered in the groundwater. For example, the EPA has proposed a rule, known as the Ground Water Rule (GWR), which specifies the appropriate use of disinfection in groundwater to assure public health protection. The GWR establishes multiple barriers to protect against bacteria and viruses in drinking water from groundwater sources and will establish a targeted strategy to identify groundwater systems at high risk for faecal contamination. Likewise, the EPA has proposed rules to revise the drinking water standards and rules of arsenic, radon, lead and copper, and radionuclides in order to ensure protection of public health. In addition, the EPA placed MTBE on the CCL and included it in the UCMR. Similar evaluations are also being conducted for sulphate and perchlorate in the drinking water.

Other agencies and organisations within and outside of the EPA including the United States Geological Survey, the EPA Office of Enforcement and Compliance Assurance – Water Enforcement Division, the EPA Office of Groundwater and Drinking Water, and the Bureau of Reclamation work together to monitor and evaluate groundwater issues and enforce rules established to protect the public health and environment.

4.3.3 California Regulations

California has developed its own set of regulations over the years in respect to the quality requirements of water intended for human consumption. Various divisions of the California Department of Health Services (DHS) are responsible for establishing criteria and ensuring that the public water systems are safe for use. One of the primary responsibilities of DHS is to set the MCL's, the enforceable concentration limits allowed to be present in drinking water. Primary MCL's are established for 78 chemical contaminants and six radioactive contaminants. Primary MCL's can be found in Title 22 of the California Code of Regulations for inorganic chemicals, trihalomethanes, radioactivity, and organic chemicals. Furthermore, various other updated California requirements can be found in the California Safe Drinking Water Act & Related Laws, 7th Edition. Secondary MCL's are established for 17 chemicals or characteristics. DHS has also set action levels (AL's) for approximately 44 chemicals. Although the AL's are not enforceable standards, exceedances do prompt statutory requirements and recommendations by DHS for consumer notices and, at high level, recommendations for source removal. Chemicals for which AL's are established may eventually be regulated by MCL's, depending on the how extensive the contamination is observed. An example of this is with the chemical MTBE, which proceeded from having an advisory AL in 1991 to a primary MCL of 0.013 milligrams per litre (mg/L) in 2000. DHS also list 52 chemicals, which require monitoring, in the unregulated chemical list.

4.3.3.1 Californian Drinking Water Programme

The Department of Water Technical Programmes Branch (DWTPB) of DHS is responsible for maintaining the scientific expertise of the drinking water programme and carrying out its administrative functions. The branch is composed of the Technical Operations Section and the Technical Programmes Section. The Technical Operations Section administers its programmes through the following units to ensure that drinking water standards are met.

- **Certification Unit.** This unit includes the Water Treatment Operator Certification Programme and the Water Treatment Device Programme. The Water Treatment Operator Certification Programme is responsible for ensuring that individuals certified as drinking water treatment operators meet the educational competence required by law. The programme administers a licensing programme for the State's approximately 9,000 water treatment plant operators and examines approximately 2,000 applicants each year. The Water Treatment Device Certification Programme is responsible for ensuring that devices sold for purifying water meet the standards set by government and fulfil their claims of effectiveness.
- **Standards and Technology Unit.** This unit maintains expertise on state-of-the-art technology in order to develop monitoring and water quality regulations and conduct special studies on contaminants in drinking water.
- **Reclaimed Water Unit.** This unit is responsible for developing water reclamation criteria and regulations, evaluating water reclamation projects, and making recommendations to the Regional Water Quality Control Boards regarding the public health implications of the projects.
- **Monitoring & Evaluation Unit.** This unit collects, compiles, evaluates, and reports drinking water quality data from large and small drinking water systems in the State. It is also responsible for developing and maintaining the database systems to manage the data; disseminating the data to branch, field, and management staff for administration of the SDWA; conducting health impact evaluations of water quality findings on a local, regional, and state-wide basis; preparing reports on findings and evaluations; and carrying out special studies related to drinking water quality. The unit is responsible for meeting the federal government's data reporting requirements under primacy, is the focal point for all data processing activities, and serves as the liaison with the Department's Data Systems Branch for the drinking water programme.
- **Programme Support Unit.** This unit provides general administrative support to both drinking water branches, by processing personnel transactions, administering sub-delegated examinations, tracking expenditures, and preparing budget reconciliation documents and reports.

- **Drinking Water Policy Development Unit.** This unit manages and co-ordinates all activities related to the EPA grant and the Drinking Water Treatment and Research Fund Programme. Staff is responsible for preparing and implementing the federal work plan pursuant to the SDWA, preparing reports to EPA per primacy requirements and SDWA, reviewing and analysing federal regulations to ensure the State remains in compliance with SDWA and primacy requirements, acting as a liaison to the Department's Office of Legislative Liaison, and analysing legislation and draft legislative concepts and legislative proposals for the drinking water programme.

The following programmes are administered by the Technical Programmes Section:

- **Safe Drinking Water State Revolving Fund (SDWSRF).** The SDWSRF administers the California DWSRF programme. The staff conducts many of the activities associated with implementation of the DWSRF programme. The DWSRF programme goals reflect both federal and state legislative intent to provide funding to correct public water system (PWS) deficiencies based upon a prioritised funding system.
- **Small Water System Unit.** This unit administers the Technical, Managerial, and Financial Capacity programme and the Local Primacy Delegation Programme. DHS, under the provisions of Section 116330 of the California Health and Safety Code, has delegated primacy for the regulation of PWS's serving less than 200 service connections to 34 local primacy agencies (LPA's).
- **Field Operations Branch.** In addition to the Department of Water Field Operations Branch (DWFOB) Headquarters, there are 17 district offices distributed widely throughout the State. DWFOB is responsible for the inspection and regulatory oversight of approximately 8500 public water systems to assure delivery of safe drinking water to all California consumers.

DHS is also responsible for proposing and creating many regulations specific to drinking water including the 7th Edition of the California Safe Drinking Water Act and Related Law, effective January 1, 2000. New laws have also been passed creating a primary MCL for MTBE and a best available technology for Fluoride. Both of these laws were effective May 17, 2000.

4.4 EU Water Quality Regulations

Water quality is one of the most rigorously regulated areas of European environmental legislation. The first tranche of legislation following the 1973 European Environmental Action Plan included the 1980 Drinking Water Directive 80/68/EEC. After a period of review and identification of deficiencies in existing legislation, a second series of Directives were introduced during the 1990s, which included the Drinking Water Directive 98/83/EC.

As the second tranche of water legislation was being introduced it became apparent that efficient protection of water quality required the inclusion of pollutant emission limits in addition to the existing water quality standards legislation, a strategy that has become popularly known as the ‘combined approach’. The latter was established by the European Commission in the late 1990s as the Water Quality Framework Directive.

Each of these legislative instruments is discussed in the following sections.

4.4.1 Prevention of Groundwater Contamination

The Groundwater Directive 80/68/EEC, now forming part of the Water Framework Directive, concerns the pollution of groundwater by prescribed substances described as either List I or List II, commonly referred to as ‘black’ and ‘grey’ lists respectively. The Directive requires Member States to prevent List I substances from entering groundwater and to limit as far as practicable the contamination of groundwater by substances under List II.

Although the Directive allows indirect discharge of List I substances under certain circumstances (for example when groundwater has been identified as unsuitable for other use), the Directive requires that any disposal or tipping of List I substances are subject to prior investigation. Any authorisations (which may require the implementation of specific technical controls) for discharge of these substances are required to be reviewed every four years, and Member States are required to keep an inventory of these authorisations.

MTBE is not specifically mentioned as either List I or II. However, List I does include ‘mineral oils and hydrocarbons’. Given that the predominant use of MTBE is as a petroleum additive and given that it is generally found in association with petroleum hydrocarbons, discharge into groundwater is effectively prohibited under the Directive. Given their very low taste and odour thresholds, MTBE is also implicitly included under List II, which requires Member States to limit the discharge of substances ‘...which have a deleterious effect on the taste and/or odour of groundwater, and compounds liable to cause the formation of such substances in such water and render it unfit for human consumption’.

4.4.2 Preservation of Water Quality

The Drinking Water Directive (DWD) 98/83/EC, which came into force on 3rd November 1998, replaced the original Directive 80/778/EEC introduced with the first tranche of environmental legislation. The new Directive introduced a number of revisions made in light of scientific and technical progress in the field of water quality assessment, and also reduced the number of parameters for which Member States were required to set water quality objectives.

The Directive applies to all water intended for human consumption, and has the objective of protecting human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is 'wholesome and clean'. Towards this objective, the Directive sets various microbial and chemical parameters for drinking water, and minimum monitoring requirements which must be reported by Member States to the European Commission. The first three-yearly report required under the latter is for the years 2002-2004, with the deadline for submission of the report at the end of 2005.

Although ether oxygenates are not specifically mentioned in revised Drinking Water Directive, the indicator parameters given in Annex I, Part C include odour, which must be 'acceptable to consumers'. Again this implicitly includes MTBE, given its strong taste and odour which is detectable¹⁴ at concentrations above 5-15µg.l⁻¹.

4.4.2 Water Quality Framework Directive

The Water Quality Framework Directive (WQFD) was adopted by European Parliament on July 18th 2000. The Directive establishes a management structure for future European water policy, based on river basins identified within and across Member States. The WQFD integrates a number of directives established during earlier tranches of environmental legislation, and will eventually repeal some of these – including the Groundwater Directive 80/68/EEC to be repealed within seven years of the date of entry into force of the WQFD.

The WQFD places three principal obligations on Member States, which are required to:

- Prevent the deterioration of groundwater status by implementing the necessary measures to prevent or limit the input of pollutants into groundwater;
- Protect and restore all bodies of groundwater with the aim of achieving 'good status' within 15 years; and
- Implement measures to reverse any sustained upward trend in groundwater pollution arising from human activity.

Hence the directive places an emphasis on the assessment of human activity and the environmental impacts on water quality that arise from that activity.

14. There is some variation in the concentration of MTBE reported as being detectable by the consumer. The 15µg.l⁻¹ value is reported in a study completed by the UK Environment Agency (discussed here in Section 5.3.6). This value has also been taken as an advisory guideline by the United States EPA for taste and odour. However, the actual detection limit may be considerably higher than this, depending on the specific characteristics of the potable water.

The directive establishes a number of important principles for the management of water quality, representing a significant step forward in associated legislation. These include:

- **Management by river basin.** The directive requires Member States to manage water quality for each river basin falling within sovereign territory, and for this management to be shared where the river basin crosses national boundaries.
- **Scope of protection.** The scope of the directive is extended to all waters (i.e. both surface and groundwater), which were previously considered under separate directives. The Framework requires that common definitions of water quality status are established by Member States to ensure that good status of both surface and groundwater is achieved throughout the EU.
- **Groundwater monitoring.** The directive requires that Member States establish groundwater monitoring programmes for each river basin, and that these schemes identify and reverse any sustained upward trend in the concentration of groundwater pollutants.
- **Combined approach.** Member States are required by the directive to base community water policy on a combined approach, using the control of pollution at source through the setting of emission values, and the use of environmental quality standards (EQS) to establish good status for bodies of water.
- **Polluter-pays principle.** The directive requires Member States to set prices for water services that accurately reflect the environmental and resource associated with provision of those services. In particular the polluter-pays principle (PPP) is to be taken into account when apportioning these costs between the consumer and industry.

As part of these obligations the Member States are to establish a programme of measures to meet the environmental objectives established under the WQFD; this includes the application of Best Available Techniques to reduce or eliminate the production of waste. The deadlines for the various environmental objectives include the following listed in Table 9.

Table 9: WQFD environmental objective deadlines.

Deadline / years¹⁵	Objective	Article
4	Conduct a technical and economic assessment of each river basin falling within national territory, and review the impact of human activity on the status of all waters.	5
4	Establish a register of protected areas requiring either special protection of ground or surface water, or protection of species depending directly on water.	6
6	Establishment of programmes for the monitoring of ground and surface water status.	8
9	Publication of the river basin management plan.	11
12	Control of all discharges into surface waters are controlled according to the 'combined approach'.	10
12	Establishment of all measures under the river basin management scheme .	11
13	First review of the technical and economic assessment of each river basin.	5
15	Achieving 'good status' for all waters.	4
2010 ¹⁶	Incentives for the efficient use of water are provided by water pricing policies, and that the cost of services are recovered according to the polluter-pays principle.	9

By virtue of the environmental measures required under each river basin management plan, the WQFD has some important implications for the enforcement of UST regulations and monitoring of groundwater contamination by MTBE. Most importantly, the directive requires that Member States 'reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity' (WQFD, Article 4). Given the implicit inclusion of MTBE both as a List II substance under the Groundwater Directive, and the basis of taste and odour under the Drinking Water Directive, it is envisaged that monitoring for this substance will increasingly form part of the programme of measures implemented by Member States.

Adoption of the WQFD has a second important impact on industry sectors with a potential to pollute water bodies, such as the gasoline distribution network. Article 10 obliges Member States to use the Best Available Techniques for the control of pollution originating from point sources, and it is envisaged that this will lead to more rigorous enforcement of UST requirements, given the potential for point-course contamination of groundwater caused by failure of these systems. In many Member States the Best Available Techniques are already being applied to the construction and operation of UST systems. Where these techniques have yet to be established, it is envisaged that the WQFD will act as an additional incentive to revise national legislation.

4.4.3 Comparison of United States and EU Legislation

Much of the United States legislation on groundwater protection and preservation of water quality has comparable legislation within the EU – particularly the regulations mandated under the SDWA and Resource and Conservation Recovery Act (RCRA).

15. Each deadline is expressed as number of years after the date of entry into force of the WQFD.

16. The deadline for this obligation is given as a specific year rather than time elapsed after the date of entry into force.

In addition to the EU Groundwater and Drinking Water Directives, there are four other Directives whose remit is comparable to the equivalent United States legislation¹⁷:

- **Landfill of Waste 99/31/EC.** The main aim of this Directive is prevent or reduce the negative effects on the environment and the risks to human health from waste landfill. It requires Member States to take on a number of measures to achieve this aim, including treating waste before landfill and exercising controls over site closure and after-care.
- **Prohibition of Certain Active Substances in Pesticides 79/117/EEC.** This Directive provides for the prohibition of the marketing and use of certain produces containing active substances recognised as causing harmful effects on human or animal health, or their unacceptable adverse effects on the environment.
- **Integrated Pollution, Prevention and Control 96/61/EC.** This Directive, adopted as part of the Fifth Environmental Action Plan, established significant changes in the permitting system for certain prescribed processes. IPPC requires that all appropriate measures against pollution are taken by a given process, and that the waste management hierarchy introduced under the Waste Framework Directive 75/442/EEC is followed when deciding on the Best Available Technique employed to prevent pollution.
- **Waste Framework Directive 75/442/EEC (as amended by Council Directive 91/156/EEC).** This Directive sets out the framework for the management of waste and its production in the EU. It requires Member States to avoid the production of waste and, where this is not possible, consider recycling, reuse, reclamation and the use of waste as a source of energy. Waste disposal must be conducted in such a way that environmental impacts are reduced or avoided. The waste management hierarchy included under the Directive has been adopted as one of the basic principles of IPPC.

17. This study has concentrated on the Groundwater (80/68/EEC), Drinking Water (98/83/EC) and Water Quality Framework Directives. These four additional Directives are described here briefly to draw attention to other EU legislative instruments which are comparable in some aspects to other components of the United States RCRA and SDWA.

The table below lists various aspects of the RCRA and SDWA, indicating which EU Directive offers equivalent legislation.

Table 10: Comparison of legislation.

Legislative area	Water Framework Directive	Groundwater Directive 80/68/EEC	Drinking Water Directive 98/83/EC	Landfill of Waste 99/31/EC	Pesticides 79/117/EEC	IPPC 96/61/EC	Waste Framework Directive 75/442/EEC
SDWA : Human health-based approach to the categorisation of contaminants, setting maximum permissible levels in drinking water.			✓				
RCRA : Regulation of hazardous wastes that may contaminate groundwater by controlling the disposal of waste and setting the maximum permissible levels of certain contaminants in groundwater		✓		✓			✓
FIFRA : Control of listed substances with the ability to leach into groundwater that have known adverse effects on human or animal health, or the environment.		✓			✓		
TSCA : Control of various toxic chemicals that have the potential to leach into groundwater, including process emissions of chemicals with recognised toxicity.		✓				✓	
SDWA : Use of Environmental Quality Standards to set general criteria for the quality of all bodies of surface and groundwater.	✓						

As indicated in Table 10, both the SDWA and the EU Drinking Water Directive use a similar approach to the categorisation of contaminants based on their assessed risk to human health, setting their maximum permissible levels in drinking water. The SDWA gives states discretion in setting the levels of these contaminants in drinking water, provided that the level set is at least as stringent as the limit mandated under the SDWA. A similar approach is used by the DWD, which allows Member States to set their own contaminant limits as long as they meet or exceed those specified in the Directive.

The United States RCRA, as discussed previously, regulates hazardous wastes that may contaminate groundwater. The controls of this Act are covered in EU legislation via the provisions of the GWD, the Directive on the Landfill of Waste 99/31/EC and the Waste Framework Directive 75/442/EEC, which established the hierarchy of waste management practices from reduction of waste at source (most favourable) to waste disposal (least favourable).

The United States EPA has the power to control the availability of pesticides that have the ability to leach into groundwater under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), which was enacted in 1972. The equivalent controls in the EU are provided via the Groundwater Directive and the Directive on the Prohibition of the Use of Certain Active Substances in Pesticides 79/117/EEC.

The United States EPA is also authorised under the Toxic Substances Control Act (TSCA) to order various controls on toxic chemicals that have the potential to leach into groundwater. The law was enacted in 1976 and again the EU equivalent is found in the Groundwater Directive. Additional obligations are also placed on Member States by the Directive on Integrated Pollution, Prevention and Control 96/61/EC, requiring certain prescribed processes to adopt the Best Available Technology to minimise the production of waste.

Notwithstanding these similarities between the two regulatory frameworks, there are two important differences between the approach taken by the SDWA and RCRA in the USA and the equivalent EU legislation. The most significant differences relate to the use of EQSs, an approach which has been established by United States federal legislation for some time as part of the ‘multiple barrier’ approach taken by the SDWA. Prior to the adoption of the WQFD in the EU, Member States had a choice of two regimes to adopt as part of national legislation on water quality. These were:

- A limit value (LV) approach consisting of uniform fixed emissions limits which industry sectors have to comply with, irrespective of the quality of the receiving environment within which they were operating; or
- An EQS approach setting concentration limits that are location-specific, and which depend on the level of protection assigned to a particular receiving environment.

From the outset, all Member States - with the exception of the UK – favoured the LV approach. However, in reality a combination of the two approaches is now being adopted in line with requirements of the WQFD. So, although many Member States are already practising variations of the ‘combined approach’, adoption of the WQFD places an obligation on Member States to adopt both approaches as part of national legislation.

A second important approach taken by the United States with no equivalent in the EU is the CERCLA or ‘Superfund’, which authorises the government to clean up contamination caused by chemical spills or waste sites posing a threat to the environment. At present, the EU has no equivalent legislation that require Member States to operate the equivalent of a Superfund. However, the Water Framework Directive will raise some additional revenues for the improvement of water quality via the imposition of penalties for non-compliance, once the Directive is finalised. Although this revenue will provide additional financial assistance for remediation efforts, it is unlikely that the penalties will generate revenues equivalent those raised under the Superfund.

4.5 Chapter Summary

This chapter has reviewed the current United States regulations regarding groundwater protection, and the preservation of water quality to protect human health. Much of the legislation has been established in equivalent EU Directives adopted during the first and second tranches of environmental legislation introduced since 1973. The use of EQS's for all water bodies is one approach under the SDWA that, prior to the Water Framework Directive, was not used in the EU. These have now been adopted as part of the 'combined approach' taken by the Framework, and represents an important step forward in water quality management within Europe.

5. Member State Survey Information

5.1 Chapter Introduction

This chapter describes a survey conducted by Arthur D. Little amongst Environment Agencies, Directorates of Energy and other competent authorities to gather information relevant to this study. Information was requested on:

- Current requirements for the construction and operation of UST systems, and whether these requirements had changed significantly during the past five years;
- Whether surveys of UST systems had been conducted, and if so whether the information was publicly available;
- Whether monitoring programmes were in place for groundwater contamination of ether oxygenates; and
- Whether survey results from these monitoring programmes were publicly available.

The survey revealed that:

- **The Member States' requirements for UST systems generally met or exceeded the revised corrosion, spill and overfill protection specified in the United States Federal Regulations after December 22, 1998;**
- **Many of these Member State requirements have been adopted or significantly revised in the last five years;**
- **Little national survey data for UST systems is available within the EU, although the majority of Member States anticipate data will become available in the near future; and**
- **Limited information is publicly available on MTBE monitoring programmes currently in place in Member States¹⁸; although none of the data published so far point to widespread or increasing contamination of groundwater by MTBE.**

This chapter is divided into two sections. The first describes the Member State requirements for UST systems, comparing these requirements to the standards of Best Practice in the United States. The second reports on Member State monitoring programmes for MTBE, and discusses the significance of reported incidents of groundwater contamination by ether oxygenates.

18. These programmes are described in Section 5.3.

5.2 Member State Requirements for UST systems

Although individual European standards exist for component design and construction of, for example, corrosion-protective coatings, no European legislation exists for the construction and operation of the UST system itself. National standards are therefore expected to vary for these systems from country to country. This section reports on information gathered about these standards from each Member State.

5.2.1 *Benchmarking of Standards for UST Systems*

The revised requirements for the construction, installation and operation of UST systems in the United States are used here as a benchmark for Member State requirements. As discussed previously, the lack of regulation in the USA prior to 1988 meant that many systems in use throughout the gasoline supply network were not correctly maintained. The major deficiencies in these systems were:

- Structural failure caused by material choice or deficient maintenance programmes;
- Corrosion of tanks caused by either substandard protective coatings or a lack of cathodic protection; and
- Bad management practices, for example uncontrolled overfilling of the tank.

These deficiencies were instrumental in the subsequent episodes of groundwater pollution reported during the 1990s.

Title 40 of the United States Code of Federal Regulations required that, as of December 22, 1998 all UST systems must have corrosion, spill and overfill protection, and comply with certain requirements set during installation and inspection. This marks the expiry date of the ten-year period during which existing systems had to be upgraded to meet the revised requirements. Title 40 therefore provides a useful benchmark against which Member States requirements can be assessed.

From Title 40 (and the more stringent California UST legislation), this study considers the following requirements to be Good Practice¹⁹:

- Specification of double-walled systems, or if single walled contained within a secondary containment system;
- Specification of material choice appropriate to the substance stored in the tank, or where there is a risk of corrosion the use of cathodic protection to mitigate this risk;
- Specification of leak detection systems alerting the owner or tank operator to a release of inventory;
- Regular monitoring of the tank, including any secondary containment, and regular monitoring of local soil and groundwater conditions; and
- Registration of UST systems with the relevant federal environment agency or energy directorate.

Requirements for each Member State were checked against this set of good practices, and are reported in the following section.

19. It should be noted that this term is taken from the UK legislative system to indicate a given technology or operating procedure that is recognised to support compliance with the relevant regulations. Good practices may be site-specific and therefore cannot always be nationally applied. There may also be more than one recognised good practice that may be used by any given site.

5.2.2 Summary of Requirements

The requirements for each Member State are listed in Table 11, with the equivalent regulations for the USA highlighted at the top.

Table 11: Dates of Adoption and Revision of UST Requirements.

	Country	Requirements	Date of adoption	Revision in the last five years
	USA	Code of Federal Regulations, Title 40	1988	NO
1	Austria	Regulations on Inflammable Liquids	1991	NO
2a	Belgium, Brussels	Regulations for Petrol Filling Stations	1999	YES
2b	Belgium, Flanders	General and Specific Considerations for Environmental Hygiene	1995	YES
2c	Belgium, Wollonne	General Regulations for the Protection of Work	1999	YES
3	Denmark	Petrol Station Order	2000	YES
4	Finland	Department of Trade and Industry Decision regarding the Handling and Storage of Dangerous Chemicals at Distribution stations	1998	YES
5	France	Decision of 22 nd June 1998	1998	YES
6	Germany	Federal Water Act	1991	NO
7	Greece	Ministerial Decision 34458	1990	NO
8	Ireland	Dangerous Substances (Retail and Private Petroleum Stores) Regulations	1999	YES
9	Italy	Ministerial Decree, 246	1999	YES
10	Luxembourg	Act on Classified Establishments	1999	YES
11	Netherlands	Decree for the storage of fluid fuel products in underground storage tanks	1998	YES
12	Portugal	Ministerial Act on Petrol Filling Stations	1992	NO
13	Spain	Royal Decree 1523	1999	YES
14	Sweden	National Inspectorate of Explosives and Flammables rules regarding tanks and pipes for flammable liquids.	1997	YES
15	United Kingdom	The Petroleum (Consolidation) Act.	1928	NO ²⁰

The table shows that the majority of regulations have been revised or adopted during the last five years. Five Member States (Austria, Germany, Greece, Portugal and the UK) have not introduced new regulations for UST systems, although in the UK the guidance given to site owners and operations that is considered good practice was revised in 1999.

20. Although the Act has not been revised in the last five years, the guidance notes describing good practice were revised in November 1999.

5.2.3 Dates of Enforcement

The situation regarding the implementation and enforcement of these requirements is more complex. A number of Member States have a staggered phase-in of the requirements, depending on the original date the UST system was installed. The date from which these requirements come into force is indicated below in Table 12. More than one entry for a country indicates different dates of enforcement for different UST systems. These data are described in more detail under the Member State summaries.

Table 12: Latest Date Requirements Come into Force.

	Country	Applies < 2000	Applies < 2005	Applies > 2005
	USA	✓		
1	Austria	✓		
2a	Belgium, Brussels		✓	
2c	Belgium, Flanders		✓	
2b	Belgium, Wollonne			✓
3	Denmark		✓	
4	Finland		✓	
5	France			✓
6	Germany	✓		
7	Greece	✓		
8	Ireland		✓	
9	Italy			✓
10	Luxembourg	✓		
11	Netherlands		✓	
12	Portugal		✓	
13	Spain	✓		
14	Sweden	✓		
15	United Kingdom	✓		

The majority of Member States have set deadlines for compliance with the relevant legislation within the next five years. Four countries have latest dates for compliance of within the next ten years, although in each case the deadline concerns a subset of the regulatory measures adopted. These are as follows:

- In the Wollonne region of Belgium, UST systems built later than 1975 and not within a zone of identified groundwater vulnerability must comply with the relevant construction and operation requirements by January 1st, 2010;
- In Italy the latest date for improvements to be implemented on single-walled UST systems installed up to July 1978 is 30 years after installation, or July 2008; and
- In France under Article 12 of the regulations, single-walled UST systems must comply with the adopted standards or be decommissioned by 31st December 2010 at the latest.

5.2.3 Member State Summaries

The requirements under each Member State are summarised in the following sections.

5.2.4 Austria

The requirements for UST construction and operation are governed in Austria by the Work and Social Regulations on the Storage and Filling of Combustible Liquids (or Regulations on Combustible Liquids). The revised regulations, adopted in 1991, require owners and operators of premises storing combustible liquid (including gasoline) to satisfy the general requirements of the regulations, and to hold a current inspection certificate indicating that their premises meet these requirements.

Paragraph II of the regulations concerns the various technical requirements for the construction of storage vessels, the alarms and monitoring equipment required during operation and the procedures for filling and emptying the vessels, specifically that:

- Corrosion-susceptible materials must have additional protection from corrosion such as a protective coating or connection to a sacrificial anode, and this system of protection must be able to withstand penetration of moisture or other liquids (Section 1);
- The vessel must be installed in such a way to ensure that the vessel tightness is not compromised by system movement during filling, or by subsidence of underlying ground (Section 2);
- Vessels not at atmospheric pressure must be equipped with measuring instruments and other safety devices to ensure that the safe operating pressure is not exceeded;
- Both double and single-walled tanks must have leak detection devices installed which are capable of continuously monitoring the system for leaks, and these devices must be installed according to the guidelines provided by the manufacturer; and
- Leak detection equipment must be corrosion and frost-resistant, maintaining their operability throughout the equipment life specified by the manufacturer.

The Regulations require regular inspections of the gasoline storage facilities in order for the operator to be granted a license to conduct their business. This includes regular checks for system integrity and for correct functioning of the associated monitoring and leak detection equipment.

No publicly available data were available for Austria on surveys or inspections of UST systems.

5.2.5 Belgium

The legislative autonomy across the three regions of Belgium is reflected in the different approach to requirements for UST construction and operation. Although no publicly available data were available for Belgium on the current status of UST systems, the regional authority that we spoke to for Wallonia indicated that surveys were currently being undertaken and that data would be published in the future.

The requirements for each region are summarised in the three sections below.

5.2.5.1 Brussels

Regulations in Brussels for petrol filling stations were recently revised on 21st January 1999, and include general standards for the construction and operation of UST systems, wet-stock monitoring systems and procedures to be followed in the event of a leak occurring.

Standards for the construction and, transport, siting and connecting of tanks fall under Article 3 of the requirements. These refer to the national Belgium standards for tanks (as for Flanders), which are as follows:

- NBN 1-03-001 for single walled metal tanks;
- NBN 1-03-004 for double walled metal tanks; and
- NBN T41-013 for underground thermo-hardening plastic tanks (built on the basis that they are reinforced and measures are taken so that the contained liquid does not corrode the material of construction).

Articles 5 and 6 establish standards for tanks which are installed below ground-level, or which have secondary containment beneath the tank which is below ground-level. This includes:

- Lining of the tank and associated containment with an impermeable material to minimise the risk of groundwater contamination;
- Secondary containment within which any tanks are installed is required to have a total capacity 25% greater than the capacity of associated tanks;
- Underground tanks constructed of material vulnerable to corrosion (such steel) must be coated by an corrosion-resistant coating;
- Associated connecting pipes must either: (a) be constructed of a corrosion-resistant material, or (b) protected by corrosion by a protective coating or connection to a sacrificial anode; and
- Installation of a monitoring system for the detection of leaks.

The operating procedures for filling and servicing of the tanks are established under Article 14 of the Act. This requires that the filling process is overseen by a trained operator, who is responsible for the reporting of fuel spills that occur during the process. The Act requires that accidental overfill of the tank is protected against by an overfill device, which shuts off the fuel supply once the tank capacity has been reached.

5.2.5.2 Flanders

Regulations for UST construction and operation were introduced for Flanders on 1st June 1995 under General and Specific Considerations for Environmental Hygiene as a Decision Regarding Environmental Protection (VLAREM II). This Decision adopted technical guidelines established in a Belgium Code of Practice concerning corrosion protection and control.

Three dates of compliance with these requirements are given, depending on the throughput of gasoline in the tanks:

- Those with a throughput greater than 50,000 tonnes per year must comply by 1st January 1999; and
- Those with a throughput of less than 25,000 tonnes per year must comply by 1st January 2002.

The requirements established various standards for UST systems concerning the construction of the tank, leak protection devices and wet-stock monitoring equipment (under Section 5.17.2 of the requirements). These are as follows:

- Underground tanks constructed of material vulnerable to corrosion (such steel) must be coated by an corrosion-resistant coating;
- The walls of any secondary containment system must be coated using an impermeable material to prevent leaks;
- Associated connecting pipes must either: (a) be constructed of a corrosion-resistant material, or (b) protected by corrosion by a protective coating or connection to a sacrificial anode; and
- UST systems must have some form of wet-stock monitoring system for the detection of leaks, and consider installing some form of permanent leak detection system.

The requirements note that a number of pollution incidents in Flanders have been caused by spills, and therefore under Section 5.17.7 establish requirements for the filling of the system and overfill protection. Filling operations are required to be conducted under the supervision of a trained operator. In the event of the tank being overfilled, automatic overfill protection is required that stops the operation once the tank is at 98 percent of capacity.

5.2.5.3 Wallonia

Wallonia adopted the General Regulations for the Protection of Work on June 11th 1999. Article 681 of these regulations concerns the construction and operation of UST systems, referring to three Belgium standards for these systems:

- NBN 1-03-001 for single walled metal tanks;
- NBN 1-03-004 for double walled metal tanks; and
- NBN T41-013 for underground thermo-hardening plastic tanks (built on the basis that they are reinforced and measures are taken so that the contained liquid does not corrode the material of construction).

The General Regulations apply immediately to all new gasoline filling stations, and to all existing filling stations which must comply by one of three deadlines:

- By 1st January 2003 for all stations with single walled tanks situated in groundwater zones identified as being 'at risk';
- By 1st January 2005 for all other stations older than 1975; and
- By January 2010 for the remainder of stations built more recently than 1975 and not within an 'at risk' groundwater zone (Part 74).

The General Regulations require that:

- A safety device should be fitted so that the feed is cut when the tank is 98% full (Part 4);
- An optical or sound alarm is be fitted and connected to a leak detection device, to alert the owners or operators to leaks occurring from the system (Part 5);
- Tanks are not allows to be built or situated under buildings (Part 7);
- All pipes must be adequately sealed to prevent leaks during use (Part 29);
- Pipes carrying fuel from a tank should: (a) be positioned in a drain leading to secondary containment, or (b) laid underground within secondary containment, protected against corrosion and fitted with leak detection (Part 29);
- A waterproof area (with a minimum area of 4x2m) is provided for drainage around the end of the pipes connected to a tank, and that a oil / water trap collects any residue leaking from the pipes (Part 38);
- External metal walls are protected from corrosion by a coating of electrical resistance (Part 43); and
- Cathodic protection is provided for any metal pipes or other tank components that are situated underground (Part 43).

In the event of a leak, the Regulations require (Part 48) that the tank should not be used and emptied as soon as is practicable, and that a study is carried out to determine the scope of pollution. After repair UST systems should only be brought back into service once they have passed a leak detection test. If they fail the test the tank is required to be decommissioned.

All tanks are required to be checked at least every ten years for tightness and for integrity of the associated pipe-work, and an expert from a recognised competent authority is required to check the leak detection devices annually.

5.2.6 Denmark

Given the heavy reliance on groundwater abstraction from boreholes and the reported incidents of groundwater contamination by MTBE, Denmark has introduced strict requirements for the construction and operation of UST systems. To operate, businesses require approval under Chapter 5 of the Danish Environmental Protection Act. As part of the revisions made to decisions under the Act, the Order on the Prevention of Soil and Groundwater Pollution from Petrol Sales Outlets (or the Petrol Station Order) was drafted on November 7, 2000; this enters into force on March 1, 2001.

The order makes a distinction between businesses established before 1st March, 2001 and those established after the Order enters into force. The order requires that businesses established after 28th February 2001 consider Sections 4-11 of the Order to be the minimum requirements. This includes the following:

- Tanks must be secured against overfilling by installation of either an electronic or mechanical overfill device (Chapter 2, Section 4);
- Manual checks for leaks from tanks must be made at weekly intervals, or in the case of automatic leak detection the system should be checked that it is functioning correctly annually (Chapter 2, Section 7);

- Pipes carrying liquids from tanks to distribution points must be constructed as a double-walled system with leak control (Chapter 2, Section 8); and
- Drainage from the filling area must be routed to a gasoline and oil separator via a sand catcher and storage well with a total capacity of not less than 1000 litres (Chapter 2, Section 10).

For existing businesses Section 12-14 of the Order are considered the minimum requirements. This includes:

- Fitting of electronic or mechanical overfill devices to all non-double-walled tanks;
- Fitting of overfill and viscosity alarms to all gasoline and oil separators;
- Galvanising of all liquid-carrying pipes made of materials at risk of corrosion (such as iron and steel); and
- Fitting of non-return valves to suction pipes.

The latest deadline for these requirements to be implemented under the Order is given as December 31, 2004.

No publicly available information was available on the status of existing UST regarding these regulations. However, since 1997 the Danish Oil Industry's Association for Remediation of Retail Sites has been conducting tests on selected gasoline filling stations. It is envisaged that more data will become available as this programme proceeds.

5.2.7 Finland

A Department of Trade and Industry Decision regarding the Handling and Storage of Dangerous Chemicals at Distribution Stations came into force in Finland on July 1st, 1998, establishing requirements for the construction and operation of UST systems. The Decision replaced Section 14 of previous regulations concerning flammable liquids, which were established by the Department of Trade and Industry on April 15th, 1985.

The decision recommends the placement of all new distribution centres outside regions identified as being sensitive to groundwater pollution (Section 2), and requires that new distribution centres take special precautions if placement within one of these regions is unavoidable. This includes mandatory double-wall construction of the tank itself, and an accompanying leak-detection system.

The decision requires that all tanks must have a protective coating or plating to prevent corrosion and some form of volumetric measurement to prevent overfilling. The decision also makes a number of requirements of the associated piping used during tank filling and gasoline delivery. Piping placed underground has to be protected from mechanical damage, and pressurised pipes must be contained within a second protective pipe or canal with at least one inspection well or leak detection system.

The decision affected all new UST systems with a gasoline capacity of more than 10m³; systems with a lower capacity are exempt. Existing systems have been given until 31st December 2002 to comply with the new requirements.

No information was available on the status of existing UST systems in Finland; these data are anticipated later this year as the survey on groundwater contamination by MTBE is completed.

5.2.8 France

The revised government Decision on standards for the construction and operation of UST systems was adopted by France on June 22nd 1998. It introduced two sets of standards for UST systems built before 18th July 1998 and those built on or after this date.

New (i.e. built after July 1998) systems are dealt with under Title II of the Decision, which requires that all new UST systems are double-walled and fitted with either: (a) a leak detection system to monitor leaks into the interstitial space, or (b) optic and acoustic alarms to alert site operators of leaks. Title II also requires that secondary containment be used with additional leak detection to monitor liquid ingress into the containment (Article 5).

Under the Decision new single-walled steel connecting pipes are prohibited, and must instead be double-walled with the external wall constructed from plastic. The exception to this is pipes that circulate gasoline by gravity or suction, in which case single walled pipes are acceptable. Pipes fitted to new tanks that are buried underground must be angled down towards the tank, and double-walled pipes must be fitted with a drain at the lowest point so that product can be recovered in the event of a leak (Articles 6 & 7).

Title II requires that all filling operations are controlled by a safety device that will stop the filling of the tank automatically when the maximum filling level is reached. As part of the overfill protection, devices are required for all tanks that indicate the liquid volume (Articles 8 & 9).

Existing UST systems come under Title II of the Decision, which requires that existing single-walled UST systems must comply with the new standards or be decommissioned by 31st December 2010 at the latest (Article 12).

New and existing systems must pass a tightness test every five years which must be conducted by a competent authority. The first date of the test must be 15 years after the date of commissioning at the latest (Article 13).

The Decision also requires tightness testing of the associated pipe-work, depending on the date the pipes were installed. Systems installed before 18th July 1998 and not conforming to Article 6 of the decision must be checked for tightness every 10 years.

For older systems where the date of installation was prior to 31st December 1977, and for pipes connected to single-walled tanks, the first tightness check must be carried out by 31st December 2002 at the latest.

No publicly available information was available on surveys or monitoring of UST systems in France.

5.2.9 Germany

Authorisations or consents are required in Germany under the Federal Water Act for virtually all activities that may influence the quality of surface, coastal or groundwater. Authorisations for the storage of substances are only permitted under German law if it can be demonstrated that there is little or no risk to underlying groundwater systems. The requirements for gasoline UST systems, which potentially pose one of the greatest threats to groundwater, are therefore rigorous and comprehensive.

The requirements under the Act are adopted by each Bundesland into equivalent sets of local regulations that must be at least as stringent as the federal regulations. The specific regulations that apply depend on where the UST is situated. For example, in an area where groundwater is vulnerable to pollution the operator may be required (depending on the Bundesland responsible for regulating the area) to:

- register the UST with the local Environment Agency;
- complete a risk assessment on it;
- implement certain maintenance activities; and
- have the tank and associated equipment tested by authorised inspectors on an annual basis.

The ‘Standard Ordinance on Facilities for Handling Substances Constituting a Hazard to Water and on Specialist Firms of the Länder Working Group on Water’ applies to facilities designed for handling substances which constitute a hazard to water, pursuant to Article 19 paragraphs 1 and 2 of the Federal Water Act. The Ordinance sets out the requirements for, and provides guidance on, the standards required for the construction and operation of UST systems. The general requirements under Article 3 of the Ordinance are as follows:

- Facilities are to be designed and constructed in such a way as to prevent the escape of any substance posing a risk to local water bodies;
- Single-walled underground tanks are not permitted;
- Leaking substances must be recognised, retained and recycled or properly disposed of in a quick and reliable way; and
- Operating instructions, which must include a monitoring, maintenance and alarm plan, shall be set up and observed by the site operator.

Each Bundesland is required to interpret the Ordinance to produce region-specific requirements for UST systems, giving the Bundesland some discretion over the interpretation of the federal requirements, although in practice there is little regional difference in the interpretation of these requirements.

No publicly available information was available on surveys or monitoring of UST systems in Germany.

5.2.10 Greece

The Greek regulations concerning UST systems are found under Ministerial Decision 34458, which was adopted on 31st December 1990. Greece regulates the construction and operation of UST systems as part of the technical standards for the construction and operation of systems at petroleum refineries. These standards are therefore guided by requirements for fire protection rather than specific measures aimed at the prevention of groundwater pollution by fuel components.

The Greek regulations form part of the technical standards of construction and fire protection for petroleum refineries, and are entitled 'The determination of the technical construction parameters for the design, construction, safe operation and fire protection for oil refineries and other oil industries'. Petrol station forecourts are included in this Decision under 'other oil industries'.

Given that the bulk of the regulations concentrate on safe construction minimising the risk of fire and explosion, little information is contained within the regulations on standards specifically designed to prevent and detect leaks of gasoline. For example, while wet-stock management systems would be expected to form part of the refinery management system, there is no requirement for these systems at gasoline retail outlets provided that the operator can demonstrate safe operating practices minimising the risks of fire or explosion.

No publicly available information was available from either surveys or current monitoring programmes of UST systems in Greece.

5.2.11 Republic of Ireland

The regulatory control of the distribution and sale of gasoline in the Republic of Ireland is administered through two Government Departments, namely the Department of the Environment and Local Government and the Department of Enterprise, Trade and Employment. These Departments respectively hold responsibility for ensuring the protection of the environment and for the control of the storage of dangerous substances.

The current safety controls for the storage and dispensing of gasoline were originally introduced under the Dangerous Substances (Retail and Private Petroleum Stores) Regulations in 1979, and are now enforced by the National Authority for Occupational Safety and Health. Businesses had to meet the requirements of these regulations in order to qualify for a licence under the Dangerous Substances Act, 1972. The purpose of these regulations was to put in place uniform standards by which licensing authorities could decide on applications from owners of 'retail stores' (gasoline filling stations) and 'private stores' for a licence to keep petroleum. The standards chosen in the 1979 regulations were designed to minimise the risk of injury to both the public as well as property.

The regulatory safety requirements that businesses should observe in order to be eligible for a Dangerous Substances Act licence allowing the storage of gasoline are currently undergoing comprehensive revision in order to take into account the significant technological advances made towards the construction and operation of petroleum storage systems.

A permit system in relation to the control of petroleum vapour emissions from petrol stations was introduced in 1997 giving effect to EU Directive 94/63/EEC. These regulations are legislated for by the Department of the Environment and Local Government and administered by local authorities.

The new storage safety standards are described in the new Draft Code of Practice for the Design, Construction and Operation of Petrol Stations which is under development by the National Authority for Occupational Safety and Health and which will support the revised Dangerous Substances (Petrol Stations) Regulations. The Code is split into five parts, which concern the following areas:

- Design and Layout of Petrol Stations;
- Equipment for Use in Petrol Stations;
- Petrol Station Construction;
- Electrical Installations at Petrol Stations; and
- Petrol Station Operations.

Failure to observe any provision of this Code of Practice will not in itself render a person liable to any criminal proceedings. However, where a business or individual is alleged to have breached the proposed Dangerous Substances (Petrol Stations) Regulations, the Code and compliance with will be admissible in evidence. The Code will be published at the same time as the revised Dangerous Substances (Petrol Stations) Regulations are signed into law.

No publicly available information was available on surveys or monitoring of UST systems in the Republic of Ireland, although authorities contacted during this study envisage this information will become more widely available in the future.

5.2.12 Italy

Requirements for the management of fuel storage tanks were established in the Ministerial Decree number 246 of May 24th, 1999. This governs the construction and operation of both Aboveground Storage Tank (AST) systems and UST systems. Prior to the decree the only storage tank regulations that existed related to Liquid Petroleum Gas (LPG); this led to soil and groundwater contamination at many industrial sites where these systems were in use, due to deficient standards of construction and operation.

Article 7 of the Decree establishes the requirements for design and installation of new UST systems. These are required to be double-walled, or in the case of single-walled systems, constructed within secondary containment systems in case of tank wall failure.

Article 9 establishes rules for the proper management of the tanks and installation of leak detection systems. Remediation of existing soil contamination is governed by Ministerial Decree number 22, 1997, commonly known as the 'Ronchi Law' after the Italian minister responsible for its inception. The Decree requires notification of contamination incidents with the local environment agency within 48 hours of incident occurring, and submission of a remediation plan by the site owners.

The dates given for compliance with Decree 246 depend on the original installation date of the system, and are as follows:

- For single-walled UST systems installed before 1963 or with an unknown date of installation, a tightness test to check for potential leakage is to be completed annually, commencing 2001 and finishing 2003. The UST must undergo the necessary technical improvements by July 2004 or be taken out of service.
- For single-walled UST systems installed between 1963 and 1973, a tightness test is required by July 2002 with the same final date for technical improvements to be made by July 2004.
- For single-walled UST systems installed between 1973 and 1978, the first tightness test must be completed by July 2002. Further tightness testing is to be conducted every two years to check whether the system is up to standard. Technical improvements are to be implemented by the 30th year of installation or alternatively the tank is to be taken out of service. This gives the latest date for improvements to be implemented for this class of tank as July 2008.
- For single-walled UST systems installed after 1978, tightness testing is required on an annual basis, starting 25 years after the date of installation. Technical improvements need to be implemented by the 30th year after installation or the tank must be taken out of service.

For all improved UST systems, the first tightness test is required by the 5th year after the technical improvements were completed and further tightness testing is required every three years. All tanks are required to be decommissioned 10 years after the date improvements were completed. The technical improvements stipulated, as a minimum, are:

- Wall thickness test;
- Internal application of anti-corrosion material with a minimum thickness of 2.5mm;
- Production of a compliance certificate; and
- Manufacturer's 10 year guarantee.

The final requirements under the Decree relate to leak protection systems. Systems installed before July 1999 with leak control systems require an annual check of this system. Those systems installed before July 1999 with no leak control system require a leakage control system to be installed by July 2009, and an annual check of that system by July 2009.

The Decree requires all UST systems to be registered with the Local Environment Agency within 18 months of the Decree entering into force (November 2000). It is envisaged that the national registration scheme will lead to surveys of UST system being undertaken, although as yet no survey data have been published.

5.2.13 Luxembourg

An Act of 10th June 1999 established the requirements for the construction and operation of UST systems in Luxembourg. The objective of the Act was to ensure the integrated prevention and reduction of pollution from establishments. Gasoline filling stations fall under this Act and therefore became subject to the requirements laid out in AUTSTAS 1.2.1, which established the General Conditions for Gasoline Filling Stations.

The Act established a number of general requirements for new and existing gasoline filling stations, which are as follows:

- Single-walled UST systems are forbidden under Act [Section 4.4.1.2.1], and all UST systems must now be double-walled cylindrical tanks [Section 4.4.1.2]. The space between the two walls must be filled with either a gas or an anti-freeze agent, both of which must be non-corrosive;
- All UST systems must be equipped with automatic protection against accidental overfill, and an adequate electrical safety device. These two devices must stop automatically the filling operation before maximum level is reached [Sections 4.4.1.2 and 4.4.5];
- All tanks must be equipped with a leak detection device, which must trigger optical and acoustic alarms [Section 4.4.1.2.2];
- All joints and openings must be located above the level of the liquid in the tank [Section 4.4.1.2.2];
- Pipes for decanting of flammable liquids must be double-walled continuous pipes with a leak detection system (although suction pipes can be single walled) [Section 4.4.2]; and
- All vents and manholes must be equipped with devices that will ensure their automatic closure after filling [Section 4.4.2];

The Act also requires the following checks to be undertaken:

- The leak detection systems of double-walled UST systems must be checked every five years [Section 10.6];
- Separators, pipes and joints in the filling areas must be checked every five years [Section 10.5]; and
- Decommissioned UST systems must be removed after complete emptying [Section 11.3.2].

No information was available on either surveys or monitoring of UST systems that had been undertaken in Luxembourg.

5.2.14 Netherlands

The Dutch Environmental Protection Act includes two Decrees regarding the construction and operation of underground storage tanks. These are:

- The Decree for the storage of fluid fuel products in underground storage tanks, which became effective in 1993 and was revised in 1998; and
- The Decree for gasoline stations, which became effective in 1994.

The requirements for UST construction and operation are based on two guidelines produced by the Commission for the Prevention of Calamities by Dangerous Products (CPR). Guideline CPR 9-1 concerns the storage of gasoline products in underground metal tanks, and guideline CPR 9-5 the storage of gasoline in underground plastic tanks. These guidelines establish a minimum set of standards under the Decree that new and existing UST system must comply with (a similar arrangement to the guidance notes published in the UK), which are as follows:

- Tanks used as part of UST systems must be either double-walled with leak detection alarms fitted to the interstitial space, or single-walled with secondary containment and monitoring of leaks within the containment;
- Electronic or mechanical overfill devices must be fitted to UST systems, automatically shutting off the fuel flow in the event that the liquid volume reaches the capacity of the tank;
- All liquid-carrying pipes made of materials susceptible to corrosion must be protected, either by galvanising the vulnerable surfaces or by connecting the system to a sacrificial anode;
- Audible alarms must be fitted to all gasoline and oil separators; and
- Manual checks must be made for leaks from tanks at regular intervals, and the leak detection system should be checked to ensure that it is functioning correctly.

The revised Decree came into immediate effect for new UST systems; existing systems have been given until December 31st 2001 to comply with the requirements of the Decree.

No information was publicly available regarding surveys or monitoring of UST systems currently being undertaken in the Netherlands.

5.2.15 Portugal

The requirements for filling stations in Portugal were established by Decree 248/92, adopted on the 30th October 1992. These standards were an important step towards harmonising Portuguese national regulation with that in other Member States, and incorporated various good practices identified in other national requirements.

The requirements came into immediate effect for all new filling stations. Existing filling stations – and those for which approval had already been granted – were given until November 1997 to meet the new requirements. In some regions of Portugal this deadline was extended by Decree 302/95 to 23rd November 2002.

Articles 4 to 6 concern the safety and protection areas for gasoline. The requirements state that:

- A safety zone must be defined around each area of gasoline storage and dispensing equipment; and
- The safety zone must extend 0.5 m around the equipment, or 1.5 m for the tank vent and filling pipe.

Article 11 concerns the general requirements for construction of UST systems. These are as follows:

- Single-walled tanks are not allowed under buildings, or in areas with a history of soil subsidence or known sensitivity to water pollution;
- Where conditions are such that a single-walled system is prohibited, the tank must be reinforced or replaced with a double-walled steel tank;
- A minimum 2m distance is required between any gasoline storage system and buildings forming part of the filling station;
- There must be a minimum 10m distance between any gasoline storage system and public buildings; and
- All the distances are reduced to half if a UST is used to store the gasoline.

Articles 14 to 28 concern the construction and operation of the UST system itself. The tank must be able to withstand variations in temperature and pressure normally encountered during operation without deforming, and without this deformation resulting in the contents leaking. The tank must be constructed from steel or another material considered suitable for the storage of gasoline, and equipped with a level indicator.

Article 15 concerns the periodic testing of UST systems required under the Decree. Single-walled systems must be tested at least once every 10 years. The test is not compulsory for double-walled UST systems with an approved leak detection device fitted. Tightness testing is also required after any repair, or period when the tank is not in use that exceeds two years.

No information was available from Portugal on surveys or monitoring of UST systems completed to date.

5.2.16 Spain

The key legislative text in Spain concerning Petroliferous Installations, Regulations and Technical Instructions is the Royal Decree number 1523/1999. It supersedes two previous decrees:

- Royal Decree 1427/1997, applicable to installations where gasoline is stored for personal use only; and
- Royal Decree 2201/1995, application to installations that supply gasoline for sale.

The Decree requires that all new installations supplying gasoline to vehicles must use underground tanks for storage of the petroleum (Annex II, Chapter 3), and must be equipped with drainage leading to a trap which separates the petroleum from any storm-water. For new and existing tanks the main requirements are that:

- Tanks whose nominal capacity is above 3000 litres must be fitted with a device to prevent overfilling (Chapter 2, Section 8.1);
- All UST systems must be fitted with a leak detection system, for example monitored secondary containment, interstitial detection of leaks from a double-walled tank or any other authorised device (Chapter 3, Section 3.1);
- Tanks can be made of steel, high density polyethylene, glass fibre reinforced plastic or any other material which maintains tightness and integrity of the tank (Chapter 2, Section 6);
- Steel or cast iron underground pipes associated with the UST system must be protected against corrosion, either with a corrosion- and gasoline-resistant coating or with active protection, for example using a sacrificial anode (Chapter 2, Section 9); and
- Pipes used for extraction should be fitted with non-return valves to prevent the contents of the pipe from leaking into the surrounding environment.

The Decree specifies when and how UST systems must be checked for integrity. An annual check is required - although the tank does not need to be emptied for this check - and every five years the checks must be carried out with the tank emptied. There is no requirement for checks to be carried out on double-walled tanks fitted with leak detection, or for single-walled tanks fitted with secondary containment and leak detection.

Tanks storing gasoline for personal consumption are required to be tested for tightness every five years, with the tank emptied and tested every ten years.

Various deadlines for compliance with Decree 1523 are given depending on the date the UST system was originally installed. Firstly, installations authorised under the original Decree 1427/1997 (superseded by Decree 1523) have been given two years to implement the new requirements, making the latest date for compliance as being October 2001. Secondly, deadlines for tightness checks for all tanks installed before the adoption of Decree 1523 are given as follows (from Article 2):

- Before October, 2001 for UST systems installed before October 1979;
- Before October, 2002 for UST systems installed between October 1979 and October 1993; and
- Before October 2009 for all other installations.

Checks are also required for tanks storing gasoline for personal use; the latest date for these checks to be carried out is given as October 2001 and October 2002 for systems installed prior to 1992 and 1997 respectively.

5.2.17 Sweden

The National Inspectorate of Explosives and Flammables is responsible for the production of rules regarding the construction and operation of UST systems in Sweden. The relevant standards entitled 'Regulations on atmospheric pressure tanks and pipes for flammable liquids' were published by the Inspectorate on December 11th, 1997 (SAIFS 1997:9); at the same time the Inspectorate also published 'General advice on how flammable gases and liquids should be handled' (SAIFS, 1997:8).

The general requirements under the Rules for tanks with a volume greater than 1m³ are that:

- Tanks should be manufactured from material with properties suitable for storing flammable liquid;
- Have adequate protection against fire;
- Have adequate protection against corrosion;
- Built to withstand the thermal and physical shock;
- Include all the equipment required to operate safely; and
- Include instructions on the premises for safe operation of the equipment.

The Rules have specific requirements for the positioning of tanks, which must be placed on a stable, even surface away from areas of the facility where they may be exposed to accidental damage. During operation, regular controls are required to ensure that the tank has not been damaged.

The Rules have specific requirements for the connecting pipes used for filling and emptying of the tank. The pipes must be constructed from material able to withstand corrosion, and include vents to regulate changes in pressure occurring inside the system. The filling system must be connected to an overflow protection system which prevents filling from continuing once the liquid volume has reached capacity. If during filling the protection system is found to be malfunctioning, the Rules require that the operator takes additional steps to prevent overfilling, and that the system is repaired as soon as is practicable.

5.2.18 United Kingdom

Although there is a measure of legislative autonomy between the four countries forming the United Kingdom, for the purposes of this study the applicable regulations in force are the same across England, Wales and Scotland, with minor differences for Northern Ireland that are explained below.

5.2.18.1 England, Wales and Scotland

Although the licensing scheme introduced under the Petroleum (Consolidation) Act, 1928 and enforced under the Petroleum (Consolidation) Act 1928 (Enforcement) Regulations 1979 has not been revised during the last five years, the guidance notes supporting good practice have been recently revised. The technical content of the original guidance note HS(G)41: *Petrol filling stations: Construction and operation* has now been largely superseded by a publication jointly prepared by the Institute of Petroleum (IP) and the Association for Petroleum and Explosives Administration (APEA).

The publication, entitled *Guidance for the Design, Construction, Modification and Maintenance of Petrol Filling Stations*, describes good practice for gasoline filling stations and is aimed at:

- those involved in the planning, design and construction of installations;
- those involved in the Maintenance of existing installations;
- minimising the risks from fire and explosions; and
- minimising the risks to health and the environment.

Guidance on the construction and operation of UST systems forms an integral part of the guidance note and is dealt with at various points throughout the document, indicated below:

- **Chapter 3** describes hazardous area classification and the safe operation of the filling station. The chapter includes zoned classification for each of the filling station components, including UST systems, the manhole covers providing access to the tank, the tank filling connections and the vent pipes required for tanks with no vapour recovery system.
- **Chapter 4** concerns the planning and design of the filling station, describing the recommended minimum distances between tank components and the gasoline dispensing equipment.
- **Chapter 7** contains the bulk of guidance provided on the essential requirements for the construction of different types of USTs. The chapter describes the different types of tank currently in use in the UK and, based on material choice, the specific considerations for each type of tank. Steel, glass reinforced plastic and composite materials are covered in the chapter, with an additional section on corrosion protection technologies for materials vulnerable to corrosion.
- **Chapter 10** concerns vapour emission control systems, describing the different techniques used to recover vapour during filling operations. The chapter also includes a description of automatic overfill protection devices and the signage required to be displayed under UK Health and Safety Regulations.
- **Chapter 11** provides guidance on the main types of leak detection systems available, and some of the considerations necessary when deciding on the type of leak detection being installed at a filling station. The chapter divides recommended systems into seven classes, the choice of which depends on the severity of the potential leak and the type of equipment being protected by the leak detection device.
- **Chapter 13** concerns drainage systems and hydrocarbon separators required to contain spills during operation of the station. The chapter describes the different considerations for tanker delivery areas, drainage pipe-work and the discharge of surface runoff collected by the system.
- **Chapter 15** describes maintenance and in-service test of tanks and association systems.
- **Chapter 16** concerns the procedures to be followed for repair and modification of filling station equipment, including UST systems.
- **Chapter 17** describes the decommissioning of UST systems, dividing the decommissioning process into permanent (removal of the tank or filling with inert material) and temporary (making the tank safe by filling with an inert liquid).

The publication was drafted by working groups acting on behalf of the Technical Co-ordinating body, an association of interested bodies representing all branches of the industry and enforcement authorities. This included many of the petroleum companies operating in the EU via the membership of the Petroleum Retailers Association (PRA). Failure to observe any provision of either HS(G)41 or the new IP / APEA publication does not render a person liable to criminal proceedings. However, where a business or individual is alleged to have breached a the conditions of a petroleum license issued by the Act by the local authority, the guidance note and compliance with it is admissible in evidence. This is analogous to the draft standards of good practice currently be issued in under the Dangerous Substances (Retail and Private Petroleum Stores) Regulations, 1999 in the Republic of Ireland.

5.2.18.2 Northern Ireland

Relevant legislation in Northern Ireland is broadly similar to the rest of the UK, with the key Acts replicated as Orders for Northern Ireland and the same good practice recognised as applying within the country. The Health and Safety at Work Act 1974 is replicated as the Health and Safety at Work (Northern Ireland) Order 1978, and the Petrol (Consolidation) Act 1928 replicated as the Petrol (Consolidation) (Northern Ireland) Order 1929.

5.3 Monitoring of Groundwater Contamination

The study gathered information throughout Member States on two aspects of groundwater contamination by MTBE:

- Monitoring programmes currently in place; and
- Publicly available data from groundwater surveys that have been completed to investigate MTBE contamination.

Whilst contamination of groundwater by MTBE has been monitored extensively in the USA, there have been few formal studies completed in the EU. What data are available relates to studies that have been completed relatively recently, and therefore do not give much indication of changes in groundwater contamination with time.

The majority of Member States indicated that MTBE contamination of groundwater was either: (a) a compound they were currently monitoring for in groundwater, or (b) an issue they were aware of and hence envisaged conducting surveys to check for contamination in the near future. However, at the time of writing this study, data were only publicly available for six Member States. It is understood that more detailed information will be published by Finland in the next few months.

The following table lists the countries for which monitoring information was available and summarises the type of data collected.

Table 13: Member State Groundwater Monitoring Data.

	Country	Potable water	Soil	Groundwater	Survey	Incidents²¹
1	Austria	-	-	-	-	-
2a	Belgium, Brussels	-	-	-	-	-
2c	Belgium, Flanders	-	-	-	-	-
2b	Belgium, Wallonia	-	-	-	-	-
3	Denmark	✓	✓	✓	186 abstraction wells, 479 sites	5
4	Finland	-	-	✓	-	10
5	France	✓	-	-	37000 samples	1
6	Germany	✓	-	-	180 wells	3
7	Greece	-	-	-	-	-
8	Ireland	-	-	-	-	-
9	Italy	-	-	-	-	-
10	Luxembourg	-	-	-	-	-
11	Netherlands	-	-	-	-	-
12	Portugal	-	-	-	-	-
13	Spain	-	-	-	-	-
14	Sweden	-	-	✓	-	1
15	United Kingdom	✓	✓	✓	2069 sites, 940 boreholes	4

Of the six Member States, the study completed in June 2000 for England and Wales by the National Groundwater and Contaminated Land Centre, Environment Agency, and the Institute of Petroleum's Soil, Waste and Groundwater Working Group represents one of the most comprehensive reports currently available. Data are also available from surveys completed for Denmark, Germany and France, while more limited data are available for groundwater contamination only in Sweden and Finland.

These programmes and survey results are reported on in the following sections.

5.3.1 Denmark

In 1998 approximately 200 groundwater abstraction wells across Denmark's 16 counties were tested for MTBE, which was subsequently found in 19 of them. The Geological Survey of Greenland and Denmark (GEUS) re-examined these 19 incidents and found that 14 of the 19 findings had negligible levels of MTBE, leaving only five that tested positive a second time for the presence of the ether oxygenate. Of these, only one had MTBE at a concentration close to the 0.03 mg.l⁻¹ – the preliminary threshold set by Denmark for MTBE in drinking water. These data were published in a report on groundwater contamination completed by GEUS, Ministry of Environment and Energy in 1999.

Since the reported contamination, Denmark has been conducting a nation-wide groundwater monitoring programme, which has found no further traces of MTBE.

21. The term 'significant' is a relative term applied here to the findings reported, and therefore varies between Member States. Actual concentrations of MTBE reported as 'significant' are reported in the text.

However, tests of decommissioned gasoline filling stations indicate that MTBE contamination on such sites has been widespread. Between 1997 and 2000, the Danish Oil Industry's Association for Remediation of Retail Sites tested at selected stations where gasoline contamination had been remediated. The tests were conducted on stations that had been in operation after 1985 (when MTBE had first been used in gasoline blends in Denmark) and where gasoline contamination had already been found. This amounted to a total of 479 sites, of which 102 (21 percent) tested positive for MTBE contamination. Of the contaminated sites, 34 (7 percent) exceeded the threshold level of 0.03 mg.l^{-1} – the most heavily contaminated site containing MTBE at nearly 100 mg.l^{-1} .

In April 2000 MTBE was added to the Danish EPA's list of undesirable substances. This indicates that, in the view of the EPA, alternative suitable replacements should be considered and that the use of the substance should be limited as much as possible. This may lead to an eventual phase-out of MTBE across Denmark, mirroring developments in California.

5.3.2 Finland

Studies are current underway in Finland to assess the extent to which groundwater contamination by MTBE has already occurred. The results from these studies will be published later this year. To date, only limited information is available regarding the incidents of groundwater contamination that have occurred; this indicates 10 significant separate incidents where groundwater has been contaminated at concentrations exceeding taste and odour thresholds.

Initiatives being taken by government and industry are now assessing soil and groundwater pollution at those decommissioned petrol retail stations where contamination has been suspected. Of the 1800 sites in Finland, approximately 200 (11 percent) are being assessed under the programme. Of these, remedial measures have been proposed for the sites with most significant contamination, which number approximately 90. The data from these sites will form the basis of information published later this year.

5.3.3 France

Although currently there is no publicly available information on the contamination of groundwater by gasoline and gasoline components, France does have a comprehensive monitoring programme for MTBE in drinking water. Throughout France the concentration of MTBE is monitored in drinking water before and after treatment, and these data are recorded in a national database of chemicals recorded in drinking water. The database contains information on approximately 37,000 ground and surface water samples, although the lower detection limits are not available for all of the samples.

5.3.4 Germany

There is little publicly available information on the extent of groundwater contamination by MTBE in Germany. Only three incidents of significant pollution by MTBE have been reported (at a conference of the European Geophysical Society, Nice, France), and all of these were attributed to leaking UST systems. No data are available on the subsequent levels of contamination.

There is one reported survey of potable water completed in the south-east of Germany, which investigated samples taken from 180 wells supplying potable water to urban and rural districts. Although few samples taken in rural areas exceeded 0.5 g.l^{-1} , 15 percent of samples taken in urban areas showed concentrations above this level. No data were available on the sources attributed to the contamination in these districts.

5.3.5 Sweden

Sweden is currently undertaking a comprehensive assessment of soil and groundwater contamination by gasoline and gasoline components at filling stations throughout the country in order to assess what remedial measures are required. Data are expected to be published from the programme later this year. Until these data are released, there is little publicly available information on the extent to which groundwater has been contaminated by MTBE. Data are only available for one incident in the country of Gothenburg, Southern Sweden, where a leaking gasoline supply station contaminated groundwater and private supply wells. Concentrations of MTBE in groundwater near the site are still reported at exceeding $20 \mu\text{g.l}^{-1}$.

5.3.6 United Kingdom

The joint Environment Agency/Institute of Petroleum study completed in June 2000 contained comprehensive data gathered from regional water authorities, the Environment Agency's own records and data provided by owners and site operators of petrol forecourt stations.

5.3.6.1 Scope and Objectives of the Survey

The survey had three objectives:

- To collate information on the contamination of groundwater by MTBE in England and Wales²²;
- Assess the behaviour of MTBE in groundwater; and
- Make recommendations for the future monitoring and analysis of MTBE contamination in groundwater.

The survey was completed between November 1999 and June 2000, and data were collated from two different sources:

- Eight major oil companies, who provided information on 2069 retail, depot and terminal sites that have been investigated for soil and groundwater contamination; and
- Environment Agency regions, and regional water authorities, who provided data on existing MTBE monitoring programmes and 2864 groundwater samples from 940 observation and Public Water Supply (PWS) boreholes.

Not only did this provide a picture of aquifer contamination by MTBE, but also data on point sources of MTBE that could have potentially contributed to the levels found in groundwater samples.

22. The survey was not extended to Scotland or Northern Ireland.

5.3.6.2 Data on Retail Sites and Depots

Data were provided by major oil companies on 2069 petrol retail sites and distribution centres, which represents 46 percent of the 4500 retail filling stations and 200 oil distribution terminals and depots in the UK. Of the sites investigated, 837 (40 percent) were analysed for ether oxygenate contamination, given that MTBE was not anticipated at sites which:

- Had never handled petrol (given that MTBE is used exclusively in petrol);
- Had not shown any soil or groundwater by petroleum products during initial screening; and
- Had not sold petrol after fuel oxygenates were introduced (which was during the mid-1980's).

Of the 837 sites, approximately 29 percent were found to contain MTBE in groundwater and 25 percent contain MTBE in perched water. Of these, 40 sites (14 percent) were located above aquifers identified by the Environment Agency as 'high vulnerability', or at risk from MTBE leaching from the source of contamination.

Although oil companies did not provide location information, further analysis of the petrol distribution network demonstrated that six of the 40 sites (approximately 2 percent) were likely to be situated within a catchment zone for a public water supply (PWS). Further investigation of specific sites would be required to determine whether this is actually the case.

It is important to note that these data cannot be extrapolated across all sites in the UK, given the targeting of sites with a known history of petroleum contamination. This means that the results from the investigation are likely to paint a gloomier picture with greater groundwater contamination by MTBE than is actually the case amongst the remainder of the sites.

5.3.6.3 Monitoring of Groundwater Quality

Awareness of MTBE contamination of groundwater was raised during the 1990s following two incidents of MTBE at concentrations above taste and odour thresholds at Public Water Supply (PWS) boreholes. These incidents were followed by increased monitoring of groundwater for MTBE by regional water companies and the Environment Agency, programmes which were scaled down as little contamination of groundwater by MTBE was found in subsequent years.

The data analysed in the UK study are from current monitoring programmes run by the Environment Agency and regional water companies. Data were supplied on 2864 groundwater samples at 940 locations across England and Wales, which showed the following:

- 804 (13 percent) of the samples had detectable levels of MTBE;
- 19 percent of these sites had MTBE present in concentrations above the threshold taste and odour concentration of $5 \mu\text{g.l}^{-1}$; and
- 69 percent of the wells with detectable MTBE concentrations were located within 250 metres of a major aquifer identified as ‘high vulnerability’, and a further 20 percent within 250 metres of a ‘high vulnerability’ minor aquifer.

Of the locations not sampled prior to collection of the data analysed in the study, approximately seven or eight percent of the previously unsampled wells contained detectable MTBE. However, the study noted that this figure was skewed by the practice of sampling wells with known contamination problems.

5.3.7 Study Conclusions

The study concluded that no consistent or significant trends of groundwater contamination by MTBE in either Wales or England had been revealed by analysis of the data. Given the size of the data sample and the known bias within the sample toward sites with a history of contamination, the data were considered a representative picture of MTBE contamination that could be extrapolated to the rest of England and Wales. Although no data for either Scotland or Ireland were used in the study, a similar picture is envisaged for these countries; indeed the concentration of PWS boreholes in the south east of the UK means that the areas of greatest risk from MTBE contamination were included in the study.

5.4 Chapter Summary

This chapter has shown that the regulatory framework for the construction and operation of UST systems within Member States is in place, although the adoption of this framework has occurred relatively recently for the majority of Member States. However, there is still little information to date on Member State surveys of UST systems, or of groundwater monitoring programmes undertaken to assess the presence of MTBE in potable water supplies. Acquiring this information will add significantly to understanding of how effective these regulations have been at improving the standards of UST construction and operation.

6. Study Findings

6.1 Chapter Introduction

This chapter sets out the study findings, based on data gathered throughout the EU and legislative information on UST systems from the USA. Additional information of relevance to this study will become available when the MTBE risk assessment being completed under the Existing Substances Regulations 793/93/EEC is published later this year, but at this time, the data gathered supports the following main conclusion.

Widespread MTBE contamination on the same scale as in the USA (especially California) is unlikely. The risk of groundwater contamination is unlikely to increase, given important differences between the USA and the EU, although robust enforcement of the existing Member State regulatory framework is required to ensure this risk remains low in the future.

The findings supporting this conclusion are discussed in the following sections.

6.2 Main Findings

The risks to groundwater presented by MTBE use in Member States is influenced by two different sets of mitigating factors. The first set, discussed in the following sections, concerns the objectives of this study which were outlined in Section 2.2.1.

The second set concerns important underlying differences between the pattern of MTBE usage in gasoline in the USA and that in the EU, and differences in the geology of areas affected by MTBE contamination.

6.2.1 *Member States Requirements for UST Systems*

Information presented in this report showed that requirements for the construction of UST systems in Member States generally meet or exceed the equivalent federal or state legislation in the United States in four important areas:

- **Specifications for the construction of the tank**, which were typically either single-walled with additional containment or double-walled;
- **Specification of corrosion-resistant material** or cathodic protection of materials prone to corrosion;
- **Specification of leak detection systems**, regular monitoring of this system and regular monitoring of tank integrity; and
- **Specification of corrosion and leak-resistant connecting pipes**, with traps to separate spills from site groundwater.

The adoption of these requirements is summarised for each Member State in the table below. For each area, more than one technical solution may have been adopted by different Member States. For example, a statutory Member State requirement noted under the column 'use of corrosion-resistant materials' may be met by cathodic protection in one country and the application of UST coatings in another. The table therefore provides a broad picture of requirements rather than a checklist of specific technologies adopted as part of those requirements.

Table 14: Summary of Member State Requirements.

	Country	Double walled or single + containment	Use of corrosion- resistant materials	Leak Detection systems	Specifications for pipes and hydrocarbon separators
1	Austria	S	S	S	S
2a	Belgium, Brussels	S	S	S	S
2c	Belgium, Flanders	S	S	S	S
2b	Belgium, Wallonia	S	S	S	S
3	Denmark	R	S	S	S
4	Finland	R	S	R	S
5	France	S	S	S	S
6	Germany	S	S	S	S
7	Greece	N	R	R	N
8	Ireland	S	S	G	G
9	Italy	S	S	S	N
10	Luxembourg	S	S	S	S
11	Netherlands	S	S	S	S
12	Portugal	S	S	R	R
13	Spain	S	S	S	S
14	Sweden	R	S	R	N
15	United Kingdom	G	G	G	G

The following key is used in Table 14:

- **S** – primary or statutory requirement under national legislation for all systems;
- **R** – required for specific situations or recommended wherever practicable by national legislation;
- **G** – good practice cited by competent authorities; and
- **N** – no information available at time of study.

As indicated in the table, all Member States now have some form of published requirement for UST systems, whether issued as part of the sovereign legislation (for example, Italy or Portugal) or as guidelines for good practice (for example, the UK and the Republic of Ireland). There are very few gaps in these requirements when assessed against the four keys areas of construction and operation listed above, indicating a level of national awareness of the problems associated with gasoline UST systems and groundwater contamination.

It should be noted that, given the relatively recent adoption of these requirements in many Member States, existing UST construction standards may not yet meet those required under sovereign legislation. In addition, the final dates for enforcement of these requirements have yet to be reached in a number of Member States, which typically range from this year (2001) to 2005²³. Until this period has elapsed (and until such time that the relevant authorities have enforced these requirements) existing UST systems may be in operation with recognised technical and operational deficiencies.

It is important to emphasise that although the regulatory framework is in place across Member States, it is the effectiveness of this framework that is key to preventing groundwater contamination by MTBE if usage of this fuel component increases in the future. Complacency caused by having apparently robust regulations, coupled with a history of neglected UST systems has the potential to create similar conditions as has prevailed in the USA.

Strong enforcement of the UST system specifications is essential for this source control program to be effective, ensuring that the potential for UST systems to cause groundwater contamination remains low in the future.

6.2.2 Water Quality Legislation

The relationship between United States federal and state legislation can be considered analogous to the adoption of EU Directives and implementation of these Directives in Member States' national legislation. A comparison of the two legislative frameworks demonstrated many similarities between the United States SDWA and RCRA, and the equivalent EU Drinking Water (98/83/EC) and Groundwater (80/68/EEC) Directives.

One area unique to United States legislation is the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or 'Superfund'; at present the EU does not have any Directives that require Member States to operate the equivalent of the fund. While the newly adopted Water Framework Directive will impose penalties for non-compliance with the established water quality standards, it is unlikely that the penalties will generate anywhere near the revenue raised under the Superfund.

Strong enforcement of water quality legislation is essential for these penalties to prove an effective deterrent.

6.2.3 Monitoring of Groundwater Contamination

Although little public information is available across Member States regarding the monitoring of groundwater contamination by MTBE, correspondence with environmental agencies, competent authorities and petroleum companies indicated to us that this was not a true reflection of work currently being undertaken in Member States.

23. It is important to note that the dates for enforcement of requirements in some Member States are later than 2005, for example Italy and the Wollonne region of Belgium. Refer to Table 12 for the latest date of enforcement in each Member State.

For example, the major petroleum companies have indicated that they have been monitoring soil and groundwater pollution at gasoline station forecourts since the early 1990s. However, these data are not always available; one of the few reports to draw on data provided by industry is the report into groundwater contamination by MTBE in the UK published last year²⁴.

Of the six Member States for which monitoring and survey information were available (Denmark, Finland, France, Germany, Sweden and the UK), none of the findings indicated widespread or serious groundwater contamination by MTBE on the same scale as the USA. Given the recent adoption of new standards for UST systems, this contamination appears largely to be either: (a) historic contamination, or (b) isolated incidents where there was a recognised failure in either construction or operational standards. This contrasts with the USA where blended gasoline containing a high percentage of MTBE was being distributed in the 1980s and 1990s via UST systems with recognised construction or operational deficiencies.

Given the significantly lower concentrations of ether oxygenates used in European fuel blends to-date, it is envisaged that this situation is unlikely to change in the short to medium term.

Preliminary findings also indicate this for Finland, although more comprehensive data are expected to be published in the near future; these data are important given that Finland is the only EU Member State using higher levels MTBE in gasoline equivalent to that used in California. Given that Finnish requirements for the construction and operation of UST systems have only been recently introduced, these data will be an important indicator of what effect the higher usage of MTBE has had on groundwater contamination in Finland.

The monitoring of groundwater for water soluble components such as benzene and MTBE following known UST leaks is essential for remedial efforts, and the development of trends in groundwater contamination across the EU.

6.3 Additional Findings for Consideration

In support of the main conclusion reached by this study are the following additional findings that are considered here of significance when considering the threat to groundwater pollution posed by MTBE.

24. 'A review of current MTBE usage and occurrence in groundwater in England and Wales' (R & D Publication 97) was published by the UK Environment Agency, and can be ordered from HMSO.

6.3.1 Pattern of MTBE consumption

By far the most important additional finding concerns the differences between gasoline formulation in the EU and the USA, discussed in Section 2.1, which result from the different regulatory approaches adopted by the USA and EU.

Given the high cost of adding ether oxygenates to gasoline blends, the extent to which MTBE is added to fuel is determined primarily by economics; where possible petroleum refiners will use low concentrations of MTBE unless this is over-ridden by policy or legislation which sets minimum oxygen or oxygenate component concentrations. This was the case in the United States prior to the introduction of the Clean Air Act; ether oxygenates – including MTBE – were used at significantly lower concentrations.

After introduction of the Clean Air Act the minimum 2 percent oxygen content mandated by the Act required significantly higher concentrations of MTBE to be added to the fuel blend; the concentrate of oxygenates in reformulated gasoline is now an order of magnitude greater in the United States than before the adoption of the Act.

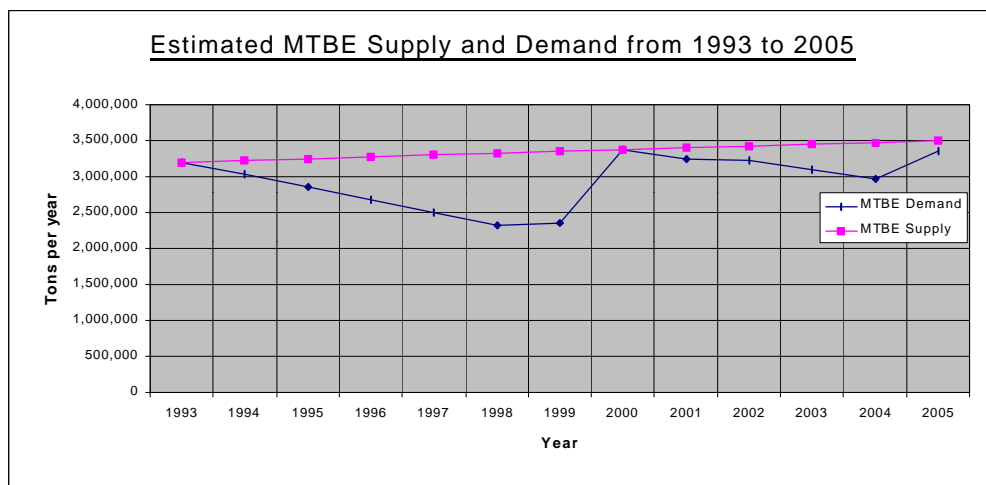
While the price of gasoline and gasoline components is essentially the same on both sides of the Atlantic, the regulations governing fuel specification in the EU currently give petroleum companies greater discretion over which gasoline components are used to meet the required fuel octane. MTBE is not used in preference to other gasoline components because octane specifications can be met without expensive additions of the former. This is the case at various refineries contacted during the study that supply gasoline to Member States who reported periods when no MTBE was being added to the gasoline blends.

As the new gasoline specifications adopted from Auto Oil II come into force, the choice of components that petroleum companies can use to reach the required octane specifications are reduced. For example, the maximum permissible level of sulphur will be cut to one third of the 2000 specifications. The new gasoline specifications which enter into force in January 2005 may result in an octane deficit at the refinery.

When the new specifications are introduced, increased concentrations of ether oxygenates may be required to meet any octane deficit. However, as new refining technologies are introduced to meet the tougher fuel specifications it is envisaged that MTBE component concentration will again drop, eventually to concentrations similar to those in gasoline prior to introduction of the 2005 specifications.

This change in MTBE demand is reflected in data provided by the European Fuel Oxygenates Association (EFOA), whose estimates are based on a mass balance of market capacity and demand. These data are illustrated in Figure 2.

Figure 2: Estimated European Supply and Demand for MTBE.



The EFOA data show fluctuations in demand as new fuel specifications are introduced, for example during 2000 when Directive 98/70/EC specified a reduction in the maximum limits for various fuel components. As new refining technologies better able to meet octane requirements are brought on-line, EFOA forecast further reductions in demand for MTBE.

Analysis of MTBE markets by Arthur D. Little²⁵ also supports a European scenario which sees a modest increase in MTBE demand over the next five years. While MTBE demand is specific to each Member State, we feel that – overall – any increase in demand will translate into a small increase in the percent volume of MTBE used in European fuel blends.

We envisage that ‘trim’ MTBE octane requirements will settle out in the 1-4 percent volume range, depending on the available octane, and still well below the 10-15 percent currently used in reformulated gasoline in the USA.

The Finnish petroleum company Fortum represents one important exception to the current trends in gasoline blending within Europe, using around 10 percent MTBE component concentration in fuels blended to reduce emissions of vehicle pollutants. This concentration is nearer to that used in California than the EU. As the former has demonstrated, high MTBE concentrations significantly increase the risk of ether oxygenates contaminating groundwater at concentrations that exceed taste and odour thresholds.

25. Confidential client report, 2000.

6.3.2 Geology

It is important to recognise the unique combination of geological factors present in California, and not shared by Member States, that led to incidents of groundwater contamination by MTBE. In contrast with much of Europe, California has little precipitation and therefore a low rate of aquifer replenishment. The predominant use of shallow aquifers for water abstraction leaves potable water susceptible to contamination by pollutants, a situation further compounded by the low levels of precipitation leaving the water table depressed. Although arid regions of Europe (for example, Greece and the interior of Spain) have similar levels of precipitation to California, the lack of industrialisation to the extent of that found in California means that these areas are less susceptible to water table depression caused by high rates of abstraction.

In many Member States the abstraction of water, predominantly from rivers, reduces the risk of MTBE contamination exceeding the taste and odour thresholds, given that MTBE is degraded more rapidly in water on account of its high Dissolved Oxygen Content (DOC). Boreholes abstracting water from deep and concealed aquifers are also at less risk of contamination by MTBE which has to travel further to pollute potable water.

6.3.3 United States Economy

The USA has traditionally enjoyed at-the-pump gasoline costs up to one quarter of those found in EU Member States. This is less a consequence of production costs (fuel traded at, for example, Rotterdam and New York fetches a similar per-barrel price), and more a result of the taxation levied by Member States governments. These low at-the-pump costs in the USA encourage higher levels of car ownership, production of vehicles with larger engines (though not necessarily less fuel-efficient) and greater car use on a daily basis.

The greater throughput of gasoline in the United States fuel distribution network and lower per-unit cost of product sold makes the financial incentives for spill control less than those in the EU, where fuel is typically taxed on delivery from the refinery rather than the forecourt pump.

The low cost of gasoline in the United States also means that fuel efficiency is less important to the consumer (notwithstanding regulations on air emissions that may require vehicles to be less polluting). This makes diesel less attractive to the consumer, in contrast to European consumers where the greater efficiency of diesel engines - combined with lower price compared to unleaded grades of gasoline - makes diesel a popular choice amongst private owners with a high annual mileage.

Given that diesel does not contain MTBE, this means that a lower proportion of motor fuels sold in the EU contain MTBE. Hence a lower proportion of forecourt station storage capacity is used to store fuels containing MTBE meaning that, in the event of a leak, MTBE is less likely to be released into the environment.

6.4 Chapter Conclusions

This study has demonstrated that requirements governing the construction and operation of UST systems are in place across much of the EU, and that these requirements compare favourably with the equivalent revised regulations in the United States. So far, given the important differences between fuel specifications in the USA and Europe, these requirements have not been tested by widespread storage of gasoline containing high concentrations of MTBE.

Adequate enforcement of these requirements is the key to safeguarding water quality in the EU.