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review

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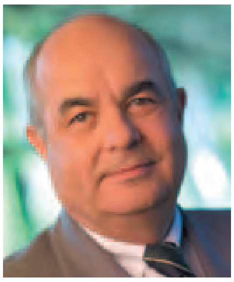
Foreword



Wilhelm Bonse-Geuking
Chairman, CONCAWE

When CONCAWE was established 43 years ago, the oil companies' objective was to create a framework within which they could jointly carry out technical studies in areas of common concern.

The sound technical analysis undertaken in such studies has provided the basis for maintaining an active dialogue with the Commission and other EU institutions, and for feeding into policy debates. CONCAWE's work over the years has acquired a great reputation for reliability and sound science, both within the industry and with the European stakeholders, in particular the European Commission. For addressing today's issues of climate, environmental and health impact of air and water pollution and waste disposal, it is more than ever essential to undertake in-depth technical and scientific work, and I am pleased that CONCAWE plays a key role in this respect.

Special recognition is to be given to the Member Company representatives for their highly important, excellent contributions through CONCAWE's working groups.

This *Review* once again illustrates the wide span of CONCAWE's activities, from water quality to chemicals legislation and from air quality legislation to marine fuels and pipelines. It shows how these activities further the knowledge base of our industry regarding its impact on environment and health, and how they contribute to the elaboration of relevant legislation.

On behalf of CONCAWE's members I congratulate the Secretary General and his staff for the excellent work they have delivered in the past year. The recognition that CONCAWE has gained across Europe is underlined by a number of oil companies seeking to become members of our association. CONCAWE's members represent more than 93% of the industry in Europe.

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Bruno Celard
Executive Officer, EUROPIA

Introduction

The development of Air Quality legislation involves an increasingly sophisticated use of science in a wide range of fields such as health impact assessment, modelling, emission control technologies and cost-benefit analysis. This poses a special challenge for advocacy organisations such as EUROPIA[1], whose role is to develop position proposals on policies and legislation initiatives for their membership and, once adopted, to represent them to the EU Institutions.

The purpose of this article is to provide an insight into the challenges of working with complex integrated assessment programmes such as CAFE, and to highlight the key contribution of CONCAWE to this process.

The CAFE Programme

The Clean Air For Europe (CAFE) Programme was launched by the European Commission in 2001, with the objective of developing strategic objectives for the EU environmental policy in 2020. These objectives were adopted by the Commission in 2005 in the Thematic Strategy on Air Pollution. Furthermore as the first major follow-ups to CAFE, the Commission developed a draft Ambient Air Quality Directive and launched a review of the National Emissions Ceilings Directive (NECD).

The approach chosen by the Commission for CAFE is known as 'effect-driven': it starts by assessing the effects of air pollutants on human health and ecosystems at each location inside the EU, and establishes their relationship with the emissions of each particular source or group of sources (industrial installations, domestic heating, transport, agriculture etc.). It then looks for the most cost-effective reduction of emissions to reach a given improvement in effects. This approach is to be contrasted with the so-called 'technology approach', which consists of simply reducing emissions without regard to the effective improvement that it may (or may not) generate.

It was the first time that the EU Commission decided to conduct such a wide-reaching programme and, indeed, CAFE was the first Thematic Strategy approved by the Commission.

The effects-driven approach is by nature complex and demands elaborate scientific support at each stage of the pollution analysis process, for example:

- modelisation of the pollutants generation and transport;
- establishment of relationship between health impact and exposure to each pollutant;
- integrated assessment on a multi-pollutant, multi-effect basis throughout the EU;
- monetisation of the effects and evaluation of the cost of measures;
- cost optimisation and cost/benefit analysis.

One of the greatest challenges is the handling of uncertainties. These are highly significant in all of these steps, either because of knowledge gaps (health effects), shortcomings in forecast assumptions (economic drivers, energy scenario), meteorology variability, inaccuracies in modelling or simply incomplete inventories of sources.

While these uncertainties cannot be eliminated, it is important that they be expressed in policy-relevant terms in order to inform the decision makers about their potential impact on policy decisions. Combining the complexity of science with the pragmatism of policy was an essential requirement in CAFE.

One of CONCAWE's activities was to develop sensitivity/alternative scenarios, an essential task to evaluate uncertainties. In this fashion, one can translate uncertain-

[1] *European Petroleum Industry Association*

ties into a range of variability for the key output parameters i.e. effects, benefits and costs. This provides an appropriate basis for the risk management process which underpins any policy decision.

Oil industry approach

The oil industry has always promoted the view that robust environmental policy should be based on the following principles:

- scientific, fact-oriented analysis;
- realisable benefits; and
- cost-effective solutions.

Consistent with these principles, EUROPIA supported the effects-driven approach as the only one capable of delivering cost-effective solutions.

EUROPIA strategy in CAFE was to:

- get involved as early as possible in the CAFE Consultation Process;
- participate actively in the various working groups set up by the Commission; and
- contribute positively by making proposals, in cooperation with the other industry sectors through UNICE.

As new issues were raised in the course of the programme, this required frequent evaluation and reorientation of the technical work to be done by CONCAWE in order to:

- understand the facts, including the knowledge gaps;
- understand the process by which the various options had been developed by the Commission;
- assess the robustness of the methodologies used, in particular those relative to the benefits evaluation;
- develop alternative perspectives on the analysis done at all levels; and
- offer proposals regarding the pursuit of optimum cost-effective strategies and solutions.

CONCAWE contribution

EUROPIA and CONCAWE have been involved in CAFE since the very beginning. Their respective roles were clearly defined:

- EUROPIA being in charge of developing the advocacy strategy and conducting it in the field; and
- CONCAWE being responsible for overseeing all technical aspects.

CONCAWE's contribution can be broken down into several categories:

Expertise

CONCAWE had several strengths at the outset:

- multi-disciplinary expertise in most areas relevant to CAFE (energy, air quality, transport, and health);
- in-depth knowledge and practical experience in modelling and data analysis techniques;
- sophisticated and efficient in-house modelling tools;
- a structure of working groups able to tap into the Member Companies' expertise.

Moreover, CONCAWE was able to pull together further expertise in health effects analysis (in the area of exposure evaluation and epidemiology) and to acquire new competences in techno-economic areas, such as benefit evaluation techniques and cost-benefit analysis, with the utilisation of advanced statistical methods.

Credibility and continuity

CONCAWE benefits from long experience in the air quality area since the Auto/Oil Programme carried out in the 1990s, and has participated in the technical debates in all the key legislative initiatives that followed, including the Air Quality Directive, Fuels Directive, Vehicle Emission Directive, NECD and IPPC—all of which relate to CAFE in some way.

During all those years CONCAWE gained the recognition of the scientific community as an authoritative technical

From science to advocacy

The CAFE experience

expert organisation, and built connections with a global scientific network thus facilitating exchange of information and cross-fertilisation of ideas.

Focused technical programme

Under a Steering Committee, Special Task Forces were assigned specific work areas:

- emissions inventories;
- modelling;
- health aspects;
- cost-benefit analysis;
- scenarios; and
- techno-economics.

A particular effort was devoted to scenarios, consistent with the view that these play a central role in the risk management process. It involved not only the analysis of the scenarios run by the Commission's contractor, but also the development of alternatives by means of CONCAWE's internal tools. This provided a useful input into the discussions held within the Commission Stakeholders' Working Groups.

In addition, CONCAWE participated directly, as a technical expert, in specific sub-projects within CAFE, together with other contractors and agencies working for the Commission. An important one, known as City Delta, aimed at developing the modelisation of urban area air pollution and incorporating it into the main Integrated Assessment Model used in CAFE.

Vision

The CONCAWE structure covers a wide range of issues and is flexible enough to allow exchanges that ensure it gets 'the broad picture'. In CAFE, this has been the case in terms of air quality, climate change, energy supply, vehicle emissions, and product availability and supply.

This broad coverage has, of course, been an essential element for EUROPIA in forming the vision from which it could define its positions and orient its advocacy on a consistent basis, both within and outside of CAFE itself.

Responsiveness

In an initiative like CAFE, the traditional view that there is research and science on the one side and advocacy on the other is not applicable. The intensive dynamics of CAFE translated into a huge amount of data and scenarios presented to stakeholders for review at very short notice. Complex analysis and simulations had to be carried out on a tight time schedule in order to allow meaningful and productive input into the stakeholders' debate. Turning back to the title of this paper, it is worth stressing that the transfer 'from science to advocacy' is not a one–way, linear process. On the contrary, it must be a fully interactive cooperative process in which the two organisations continue nevertheless to adhere strictly to their respective missions.

Conclusions

The oil industry assigned high priority to the CAFE programme. Significant resources were mobilised, not only for formulating a stakeholder opinion in the debate, but also for delivering substantial contribution to the technical work that prepared and underpinned the political decision making phase. The collaboration between CONCAWE and EUROPIA builds on the technical strengths of CONCAWE to support EUROPIA's advocacy in a programme of unprecedented technical sophistication and complexity. The main achievement which resulted from this work has been to demonstrate that the ambition levels initially chosen for the Thematic Strategy were too high to be cost-effective. The levels finally adopted by the Commission were reduced (although not enough in EUROPIA's view, but this is another debate).

This operating mode between EUROPIA and CONCAWE will be usefully continued in the NECD Review, with the additional value of the experience gained and improvements made during the four years of joint hard work on CAFE.

Registration of petroleum substances under REACH

How CONCAWE can support its Members in the registration process

Introduction

In 1993 the Council adopted Regulation (EEC) 793/93 or the 'ESR' (Existing Substances Regulation), thus introducing a comprehensive framework for the evaluation and control of 'existing' chemical substances. The ESR foresaw comprehensive risk assessments and, where necessary, risk reduction measures for priority substances. This Regulation complemented the existing rules governed by Directive 67/548/EEC for 'new' chemical substances, which required approval by the competent authorities of EU Member States prior to being put on the market. In the late 1990s legislators and industry alike concluded that chemicals safety legislation needed a fundamental overhaul. The notification of new substances within the European Community had declined, falling significantly below the number of new substances notified in the USA. The risk assessment programme for existing chemicals under Regulation 793/93, the 'Existing Substances Regulation', was disappointingly slow. Since the adoption of the Existing Substances Regulation by the Council in 1993, work had started on 141 of the 2,700 or so high production volume chemicals produced within, or imported into the Community at volumes above 1,000 t/a, and risk assessments were completed for only a fraction of these 141 chemicals. The comprehensive risk assessment approach had turned out to be too heavy and too slow. Moreover, since the Existing Substances Regulation had not foreseen an involvement of downstream users of chemical substances as such (or as used in preparations), it was notoriously difficult to obtain the use and exposure information needed to assess the risks over the full life cycle. In parallel, the view emerged among authorities that responsibility for demonstrating the safe use of chemical substances ought to be moved from governments to industry.

This was the backdrop against which the European Commission published, in February 2001, its 'White Paper on the Strategy for a Future Chemicals Policy'. The White Paper introduced 'a new system of chemicals control—the REACH system', where REACH stands for Registration, Evaluation and Authorisation of Chemicals.

The proposed REACH system foresaw the shift of responsibility from Member State governments to industry (manufacturers, importers and downstream users), often referred to as the 'paradigm shift'. REACH was intended to merge legislation for new chemicals and existing chemicals under a common registration scheme, and to maintain the possibility of restrictions of marketing and use. In addition it introduced the authorisation of certain chemicals of very high concern, for example carcinogens, mutagens and reprotoxins class 1 and 2. Implementation of REACH would be managed by a new Chemical Agency, located in Helsinki, but with a strong involvement of the Member States in the evaluation and authorisation process.

Industry noted the improvements for the notification of new chemicals but, on balance, was concerned about: the economic impact of the heavy REACH regime, particularly on small- and medium-sized enterprises (SMEs); the 'loss of chemicals' for applications as a consequence of the authorisation scheme; the possible negative effect on the innovation capability of manufacturers and downstream users; and the potential 'loss of market' as a consequence of relocating manufacturing to regions outside the EU.

In this debate the fact is often overlooked that REACH will stretch even the resources of big companies to the limit. SPORT, the Strategic Partnership on REACH Testing concluded that parallel work on the registration of a large number of chemicals within a relatively short period would be an unprecedented challenge to registrants (see www.sport-project.info). Moreover, a significant number of registrants produce large volumes of substances with a limited market share and limited human resources. Although they are not usually regarded as SMEs, they will find it as difficult as any 'low

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volume manufacturer' type of SME, if not impossible, to fully comply in time. Several players in the oil industry fall into this category of registrants.

After an internet consultation, the European Commission adopted, on 29 October 2003, its proposal for a new EU regulatory framework for chemicals, i.e. REACH, thus kicking off the legislative process which involves both the European Parliament (EP) and the European Council of Ministers (Council) in the co-decision procedure.

The first reading in the EP took place on 17 November 2005. The EP voted for a number of improvements in the registration scheme benefiting small and medium enterprises and giving the Chemical Agency an overall stronger role, but at the same time it voted for a drastic tightening of the authorisation scheme that foresees the substitution of authorised substances after the authorisation period has expired.

The Council reached a political agreement on 13 December 2005. Again there were improvements in the registration scheme, a stronger role for the Chemical Agency, and a tightening of the authorisation scheme. However, with respect to registration there were fewer improvements, while as regards authorisation there was less tightening than had been voted for by the EP in its first reading.

Both the EP and the Council extended the scope for collective sharing of information by registrants beyond vertebrate animal testing results under the slogan 'One Substance, One Registration' (OSOR).

The Council is expected to agree a 'common position' in May 2006 after which REACH will go through the second reading in the EP. Assuming that a compromise is reached between the EP and the Council, REACH could enter into force as early as April 2007. However, the new European Chemicals Agency is only expected to be fully operational in April 2008, 12 months after entry into force of the legislation.

How will petroleum substances be affected?

Refinery streams are regarded as substances. They will have to be registered if their annual production or import volume per manufacturer or importer is 1 t/a or more and if their manufacturers/importers wish to continue their business. Although the authorisation process may yield the most severe consequences, the bulk of the work for industry will most likely be related to registration.

There are only a few differences between the REACH versions of the EP and the Council as far as the basic principles of the future registration scheme are concerned, and the Commission has indicated that they support the Council position. The development of guidance and tools for both industry and authorities is in progress in the form of REACH Implementation Projects (RIPs) under the auspices of the Commission. Hence many details are still unclear and tools not yet ready, let alone tested and validated. Nevertheless, CONCAWE believes that its Members would be well-advised to prepare themselves without delay for the implementation of REACH. CONCAWE is supporting its Members in that preparation, in particular through the on-going programme of risk assessments of petroleum substances.

REACH foresees three phases for the registration depending on the volume band. Substances with a production/import volume of 1,000 t/a or more (and those classified as carcinogenic, mutagenic or reprotoxic) will have to be registered within three years after REACH enters into force. The deadline for registration could therefore be as early as April 2010. Lower production volume substances will have to be registered thereafter. The whole registration process for existing substances will be completed by 2018.

Practically all petroleum substances fall into the ≥1,000 t/a volume band and will therefore have to be registered during the first phase, i.e. before April 2010. Figure 1 illustrates the registration process.

Both the EP and the Council foresee that all registrants of a substance must collaborate for the preparation of certain elements of the registration dossier. These elements concern substance information, the testing proposal (where required) and the classification and labelling proposal[1]. A lead company is supposed to submit the documentation on behalf of all the other registrants.

This mandatory collaboration and sharing of information does not apply to use and exposure and thus risk-related elements of the registration dossier, although some of these elements, notably the Chemical Safety Report (CSR) may be submitted jointly by registrants.

In any event, any specific information will have to be prepared and submitted separately by each registrant.

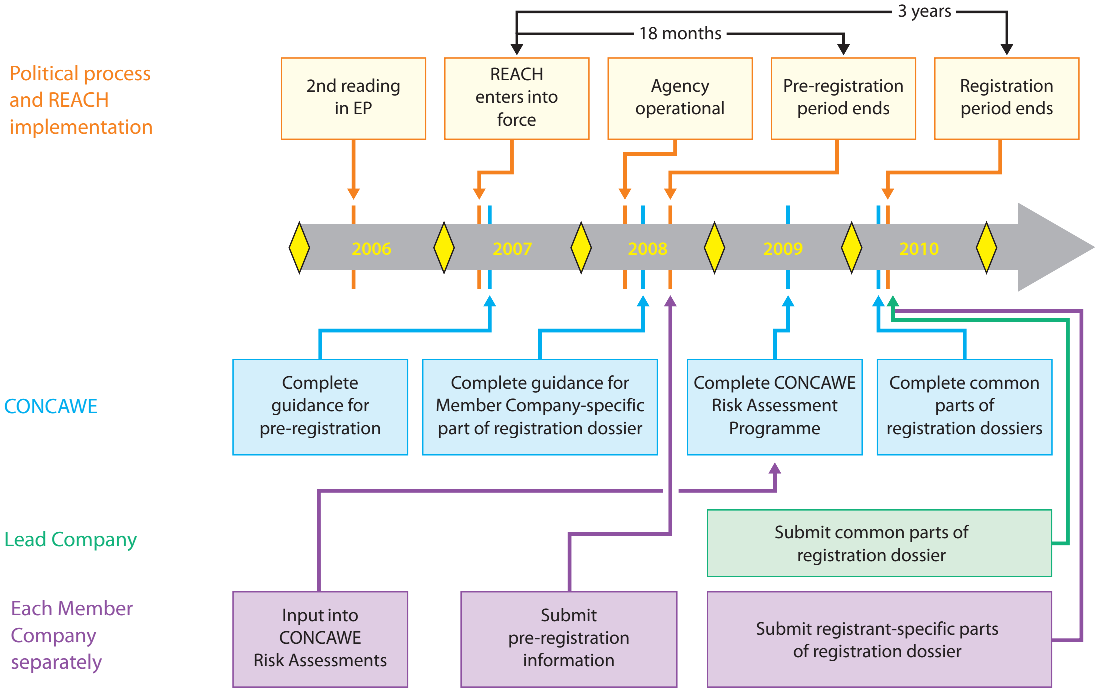
The registration process starts with a pre-registration step. Each individual registrant will have to submit its name and address and the CAS number of the substance. The Chemical Agency will inform other registrants for the same CAS number, to enable them to work collectively on the common elements of the registration dossier and to share the relevant information for these elements.

A period of 18 months is foreseen for the pre-registration process, beginning with the date when REACH enters into force. Since the Chemical Agency is actively involved in the pre-registration process, it is worrying that it will only become operational one year after REACH has entered into force.

At face value the registration of petroleum substances appears to be a straightforward task. However, the REACH system is designed for the vast majority of registration cases, i.e. for single substances, whereas practically all petroleum substances are process streams of varying composition containing many different constituents.

CONCAWE's voluntary risk assessment programme for petroleum substances will enable CONCAWE and its members to prepare for the registration and, if and when required, the authorisation of petroleum substances under a REACH regime in a proper and timely fashion. For the risk assessments to serve these purposes, it is critical that member companies ensure

Figure 1 REACH implementation timelines (≥1,000 t/a volume band) and CONCAWE activities/actions



Practically all petroleum substances fall into the ≥1,000 t/a volume band and will therefore have to be registered before April 2010 assuming that REACH comes into force in April 2007. Figure 1 illustrates the registration process.

[1] *The GHS, i.e. the Globally Harmonised System of Classification and Labelling of Chemicals, will be implemented in parallel with REACH and replaces existing legislation. For registrants under REACH this implies additional work as the GHS is not identical to the current regime.*

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that company-/site-specific information on manufacturing, storage and use is made available.

What will CONCAWE do to support its Members?

For classification and labelling of petroleum substances, as well as for its voluntary risk assessment programme, CONCAWE has developed a methodology that allows grouping of substances for two purposes:

a) to determine the inherent properties of refinery streams with a minimum of testing, vertebrate animal tests in particular; and
b) for a common risk assessment.

Using the risk assessment for gasoline as an example, the methodology has been presented to, and discussed with, the TCNES (Technical Committee for New and Existing Substances). The TCNES has supported the methodology in principle.

The CONCAWE risk assessments for petroleum substances will form the basis for the various elements of REACH registration dossiers.

Moreover, the Commission has invited CONCAWE to draft technical guidance for petroleum substances, which will then be incorporated in the overall technical guidance for industry currently developed as part of the Commission's REACH Implementation Projects.

In terms of specific work for its Members CONCAWE will prepare:

- the common dataset;
- the common classification and labelling proposal; and, if required
- the testing proposal.

Under OSOR these elements will have to be common to all registrants, so registrants that are not CONCAWE Members will also benefit from this work subject to agreement on cost-sharing.

CONCAWE will also prepare Chemical Safety Reports for its Members. OSOR does not require these to be shared among all registrants.

In addition CONCAWE will develop specific guidance (and, where appropriate, templates) on the pre-registration of petroleum substances[2]; and the registrant specific elements of the registration dossier.

In parallel CONCAWE will determine whether, and if so which, petroleum streams may become subject to the authorisation scheme of REACH.

Conclusion

It is essential to complete the CONCAWE Risk Assessments for Petroleum Substances within a time frame that allows for the preparation of registration dossiers well before the end of the registration period, currently expected to be spring 2010. This will be a major challenge but Members can contribute to a timely completion by providing the necessary information without delay. In view of the time pressure and the size of the task it will be impossible to adjust the risk assessments and to incorporate missing information at a later date.

Special Task Forces (STFs) have been formed in CONCAWE that will provide the input for the registration of petroleum substances and reclassify them in line with the Globally Harmonised System of classification and labelling as adopted by the EU. However, CONCAWE can only provide the input. Based on this input its member companies will have to prepare those elements of the registration that are specific for the registrant and they will have to carry out the registration.

It is therefore essential that all CONCAWE member companies fully understand their obligations under REACH and GHS, and that they proactively prepare the registrant-specific elements of the registration dossiers. Active participation in the CONCAWE Special Task Forces is the most efficient way to achieve this.

[2] *Determining the identity of substances is no trivial task. The Commission has recognised this and set up a specific REACH Implementation Project which has just completed draft guidance on substance identity.*

Groundwater and the groundwater daughter directive

Key features and potential impact on the downstream petroleum industry

The Groundwater Directive (GWD) is a daughter directive of the Water Framework Directive (WFD) and has the potential to significantly affect downstream petroleum operations. It is currently undergoing its second reading in the EU parliament and gives rise to very heated debates between MEPs, the Commission and stakeholders who will be subject to its provisions.

One key issue in this debate is whether or not all groundwater should be managed under drinking water quality standards. The science of hydrogeology teaches us that water interacts with the surrounding geological structures. By implication, achieving drinking water quality in all cases is not feasible from either a technical or an economic perspective. This is not only because of remediation issues but also because, in some locations, the volumetric yield will not be high enough to justify the economics. As a result, one should not manage all groundwaters in the same way. It is important for decision makers to be well informed of the scientific and economic aspects of groundwater if they are to create a pragmatic Directive that Member States can implement and industry can comply with technically and economically.

The WFD seeks to establish a consolidated and sustainable approach to water management throughout the European Community and it will ultimately result in the progressive repeal of a substantial number of existing Directives concerned with water.

The main objectives of the WFD are:

- Provision of a secure supply of drinking water in sufficient quantity and with sufficient reliability.
- Provision of water resources of sufficient quality and quantity to meet economic (e.g. industry, agriculture) and recreational requirements.
- Provision of water resources in appropriate quality and quantity to protect and sustain, in all but exceptional cases, the good ecological state and functioning of the aquatic environment.
- Assurance that water is managed so as to prevent or reduce the adverse impact of floods and minimise the impact of droughts.

The WFD requires Member States to achieve 'good chemical and ecological status' for surface waters and groundwaters by 2015. Where surface waters are concerned, good chemical status is defined as compliance with all the Environmental Quality Standards (EQS) established for chemical substances at the European level.

Within the WFD, there are 'daughter' or sub-directives that more specifically define quality standards, monitoring and other issues not dealt with directly in the WFD. The GWD will specifically:

- clarify the definition of groundwater bodies;
- set criteria for defining good chemical status within groundwater bodies;
- set criteria for defining significant and sustained upward trends in contaminant concentrations; and
- define the starting point for trend reversal.

The GWD will also require integration with several other Directives (Nitrates, Landfill, Soil, etc.), which address issues that are environmentally interrelated. As these Directives are developed and implemented, industry can expect that the WFD and GWD will require them to devote more resources to groundwater protection and remediation than they have done in the past. Historically, the focus for contaminated land has primarily been on human health, rather than water quality *per se*. The new focus on the ecological status will increase the attention that regulators pay to groundwater quality at those sites close to water bodies, and industry can expect to have to do more in order to demonstrate compliance with the WFD by 2015.

Basics

It is important to be aware of the basic principles of groundwater hydrology and the hydrologic cycle to

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properly understand the complexity of the topic. Groundwater is not a stand-alone entity, but part of an integrated natural cycle involving interaction between surface water (note: many surface waters are an outcrop of groundwater), vegetation, soil, and other natural components; and these in turn have an impact upon groundwater. As water evaporates from the earth's surface, the vapour collects in the atmosphere and eventually makes its way back to earth as precipitation. This precipitation then percolates through the soil surface and ends up in a saturation zone through gravity, and then flows terrestrially where it discharges into surface waters or is used for anthropogenic purposes (drinking water, industry, agriculture, etc.). The process is continuous and Figure 1 shows this cycle in more detail. While the principle is simple, individual processes and interactions can be complex.

Along with this cycle, hydrogeology has a critical part to play. As an example of how complex hydrogeology can be, consider the differences between The Netherlands and Austria. Underlying each area is a completely different set of rock and soil that dictates how groundwater is collected and stored. In The Netherlands groundwater tables can be very close to the surface lying less than a meter below ground. In the Austrian Alps, groundwater may not be found until 50 meters deep or more. What happens then, when one goes deeper into the earth and finds not one but several aquifers that are stratified in different layers and at different depths? Figure 2 illustrates a simplified cross sectional view of this stratification.

Each aquifer will have varying characteristics that could make one suitable for drinking water supply and the other one unsuitable. This is often a direct result of a water body's mineral concentrations, recharge rate (weeks, years, centuries or millennia), usage and flow characteristics. Some of these groundwater bodies are confined and will have very different attributes due to naturally protective barriers, for example clay or impervious rock, as compared to unconfined aquifers that are closer to the surface.

Additionally, the concentration of organic materials and minerals will often vary within the same aquifer. Due to different hydrogeology, it is possible to find a low concentration of a naturally occurring substance at one point and a very high concentration of the same substance some distance away. This is, for example, often the case with iron, one location requiring its removal prior to household use and another not. Such differing iron concentrations are by no means the exception, rendering a standardised approach to groundwater regulation quite impractical because hydrogeology makes all of the difference!

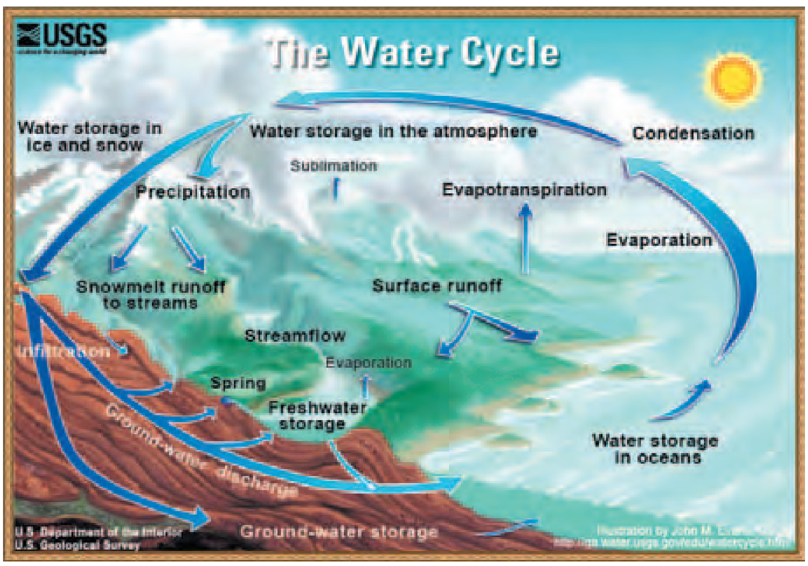

Figure 1
The water cycle is a continuous process. For further information see: http://ga.water.usgs.gov/edu/watercycle.html

Risk-based approach

Due to the complexities that surround the management of Groundwater, it is CONCAWE's recommendation to use a risk-based approach implemented at Member State level. At the heart of the process is the three-pillar concept of the source-pathway-receptor relationship. Simply put, this concept states that, for a risk to exist, there must be a source of potential harm, it must have a pathway to the receptor and a receptor must have an exposure. If one of these pillars does not exist, then there is no risk. Figure 3 illustrates this relationship in more detail.

The model is underpinned by the notion that no two risks are equal and each must be managed individually. The risk management methods for two groundwater

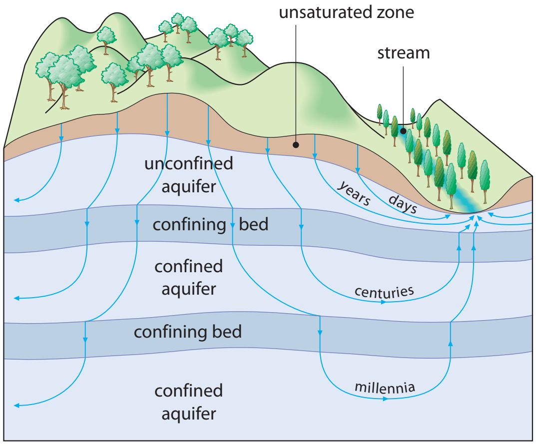

Figure 2
The stratification of aquifers at different depths

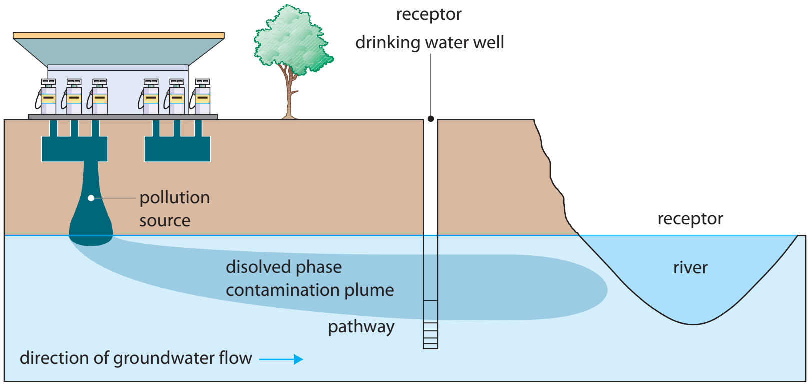

Figure 3
Soil and groundwater contamination: for a potential risk to exist there must be at least one complete source-pathway receptor linkage

bodies that have the same concentration of a substance may be quite different depending upon the location. Natural attenuation[1] is a viable approach to managing the risks associated with groundwater contamination but is affected by the surrounding hydrogeology. Parameters such as biodegradation, dilution and sorption, all of which contribute to natural attenuation of groundwater contamination plumes, vary by location and these processes dictate whether or not a substance degrades before it impacts a receptor. Therefore the surrounding hydrogeology and site specific characteristics will dictate a particular course of action.

Another key strength of this approach is that it enables the regulators and the site owners to identify and prioritise high risk sites. A 'one-size-fits-all' approach would call for action at all sites regardless of risk potential, leading to the danger of focusing on low risk sites while leaving higher risk locations unmanaged. This would allow real risks to actually increase and get worse over time.

Access to a polluted groundwater body located in a rural area might not be a problem and decontamination could be a feasible solution. Alternatively, it may be more economically and technically feasible to block the pathway to a receptor to provide effective protection against adverse effects. The situation may be very different in an urban landscape where decontamination might be infeasible due to the impossibility to access the water body. The preferred solution could be to protect the receptor by providing an alternative water supply and allow natural bioremediation to attenuate the contaminants over time.

If all locations are treated in the same way, there is a chance that the method used in one instance may over-protect or under-protect a receptor in another. This is why each location must be viewed independently of others and managed according to its specific characteristics and risk potential.

CONCAWE activities

To further support our risk-based methodology CONCAWE began a project in 2005 to review the petroleum industry's potential risk to groundwater across the EU-25. The project entails gathering and integrating digital data around petroleum sites and mapping this against aquifer type and their vulnerability to contamination. This is a risk assessment process that starts at a high

[1] *The naturally occurring chemical and biological processes that gradually renders a substance harmless*

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level to help manage multiple assets located in areas with varying geographic and hydrogeologic characteristics. The idea here is to first determine the risk potential for each location. Some sites have a higher risk potential than others but the risk only becomes real if there is a source of contamination, a pathway and an unacceptable impact at a receptor (or potential to cause unacceptable impact if no action is taken).

With this risk-based approach mindset, CONCAWE developed a risk criteria matrix to help categorise risk potential for petrol filling stations. In the environmental sensitivity criteria table below (Table 1), a Category 1 site is within a drinking water Source Protection Zone (SPZ) and carries a high risk potential from a leak at an underground storage tank. Conversely, at a site in Category 5 there would be no risk since there is no potential to impact drinking water, and therefore no receptor. This requires completely different approaches of how a regulator should view a site and its risk, as well as how the industry manages risk mitigation measures.

The specific case of the Czech Republic is described below. Figure 4 maps petrol stations against the groundwater and source protection zone data provided by the Member State, where the dots are sites and the colours indicate the category into which they fall.

Of the 1756 sites mapped against groundwater data, none are in Category 1 and only 17 fall within 100 meters of a source protection zone. Overall, there are few sites with high risk potential in the Czech Republic. This information is powerful because it provides a guide to initially focus activities on the most important locations (the 17 high risk sites in Category 2) and then move to the lower-risk sites in a methodical approach instead of trying to manage all 1756 sites in the same manner. This is more beneficial for the regulators, the industry and the public alike because effective action can then be taken in locations where it is warranted.

With regards to data capture and analysis, there are still hurdles to overcome. The major issue CONCAWE is dealing with is lack of consistent data across the EU. There are several reasons for this. Firstly not all Member States have information in digital form that will make it easy to map or study, precluding all EU-25 countries from being reviewed at this time. Secondly, much of the data is not collated on a country-wide basis and is often held by provincial government bodies in different formats. In several countries studied thus far, it has created visible gaps where one part of the country is analysed and other regions are left blank, making overall analysis difficult. We have also encountered several situations where the data are available in digital format, but the data holders have either requested an exorbitant price for the data or have flatly refused to provide data for our study. This is in no one's interest, since the data will be used to help identify possible risks to groundwater from petroleum sites and act as a first step at managing those risks.

For the above reasons, we currently have incomplete data for some countries and will only be able to identify

Table 1 Environmental sensitivity: provisional risk criteria

Groundwater category	Category 1	Category 2	Category 3	Category 4	Category 5
Principal criterion	SPZ1	Within 100 m of SPZ1	Other SPZ (2, 3 and 4)	Any other condition over minor aquifer	Non-aquifer, and not in SPZ

Groundwater sensitivity in the Czech Republic

Locations of petrol filling stations identified by environmental sensitivity

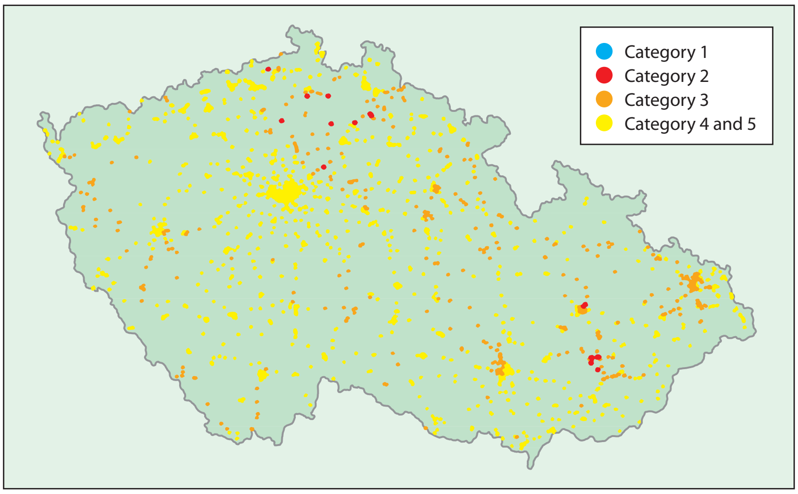


Figure 4

The locations of petrol filling stations were mapped against groundwater and source protection zone data throughout the Czech Republic; the dots are sites and the colours indicate the categories into which they fall.

Table 2 Provisional groundwater sensitivity of retail filling stations in the Czech Republic

Groundwater category	Category 1	Category 2	Category 3	Category 4	Category 5
Number of sites in each category	0	17	426	622	691

site-by-site risk as the data become available, in the required format, and at a reasonable cost. To compound the difficulty, countries do not use the same scale when they provide data, which prevents country-by-country comparisons. Therefore, an overall EU picture is currently not attainable and may not be in the near future.

Conclusion

CONCAWE strongly believes that groundwater should not be treated with a 'one-size-fits-all' approach. As illustrated above, creating EU-wide standards, methods and management practices for groundwater is neither pragmatic nor economically viable, and may lead to technically unachievable requirements due to hydrogeological variations and other issues. The lack of consistent data among Member States would, in any case, preclude an EU-level approach.

The recommended way forward is for a risk-based methodology that can be implemented by Member States according to their particular circumstances.

More information can be obtained at the following websites:

www.europa.eu.int/comm/environment/water/water-framework/groundwater.html

www.nicole.org

www.usgs.gov

The case for Gothenburg

The benefit of including all 'Gothenburg Protocol' countries in the scope of the National Emission Ceilings Directive Review

Introduction

The UN-ECE Convention on Long-Range Transboundary Air Pollution, which last year celebrated its 25th Anniversary, marked the first international response to the concerns over the impacts of long range transportation of air pollution on human health and the environment. This underlines the longstanding recognition that emissions from bordering countries can have potentially significant impacts on a given country's ecosystems and the health of its citizens.

This understanding underpins the more recent UN-ECE multi-pollutant, multi-effects 'Gothenburg Protocol' and the parallel European Union National Emission Ceilings Directive (NECD).

A key difference between these two initiatives is the number of countries included in their scope. The NECD was confined to the then 15 EU Member States, whilst the Gothenburg Protocol included in its scope some 34 European Countries.

Importantly, both initiatives were developed using the same Integrated Assessment Methodology (IAM), underpinned by the same models and databases, to determine the individual pollutant ceilings for each country. The key principle in this methodology is to achieve the agreed improvements at the lowest overall economic burden and to derive the individual national ceilings accordingly. In the case of the NECD the Integrated Assessment Modelling process emission changes beyond the 'business as usual' (or 'Current Legislation') case were limited to those of the then 15 EU Member States. Inevitably, this restriction resulted in higher burdens on EU Member States than their corresponding burden under the Gothenburg protocol, because the solution did not allow for potentially more cost-effective changes in non-EU countries. The EU political process of finalising the NECD legislation reflected an understanding of this situation, as the NECD ceilings finally adopted were close to those of the Gothenburg Protocol.

As the European Commission embarks on the National Emission Ceilings Review, will the recent EU enlargement by 10 more States solve the problems outlined above? As we shall see, current evidence suggests that, for the Member States bordered by non-EU countries, this will not be the case. This article explores the case for widening the scope of this process to more countries bordering the EU.

The approach to the analysis

To undertake this analysis, CONCAWE has been able to use the so-called 'functional relationships' which lie at the heart of IIASA RAINS[1] model and were developed by IIASA[1] within the scope of the European Commission's CAFE[1] Programme. These relationships, derived from multiple runs of the UN-ECE EMEP[1] model, link emissions from a given country to their impact on all related receptors.

To simplify the analysis, CONCAWE has focused on the priority concern in the CAFE programme (and the subsequent Thematic Strategy on Air Pollution) namely: human exposure to fine particulates. In this case, functional relationships were developed by IIASA for each 50 x 50 km EMEP grid in EU-25. Each individual relationship is a function of the emissions from each contributing EU country to both primary and secondary particulate concentration levels in that grid. The relationship also includes terms expressing the contribution from sea areas and an overall constant term (derived from the statistical fit of the data) which represents the non-EU or non-sea area contribution.

[1] *See 'Abbreviations and terms' on page 26 of this* Review

Contribution of $PM_{2.5}$ concentrations in ten highest populated EMEP grids for four countries which are not on the outer border of the EU (2020 TSAP scenario)

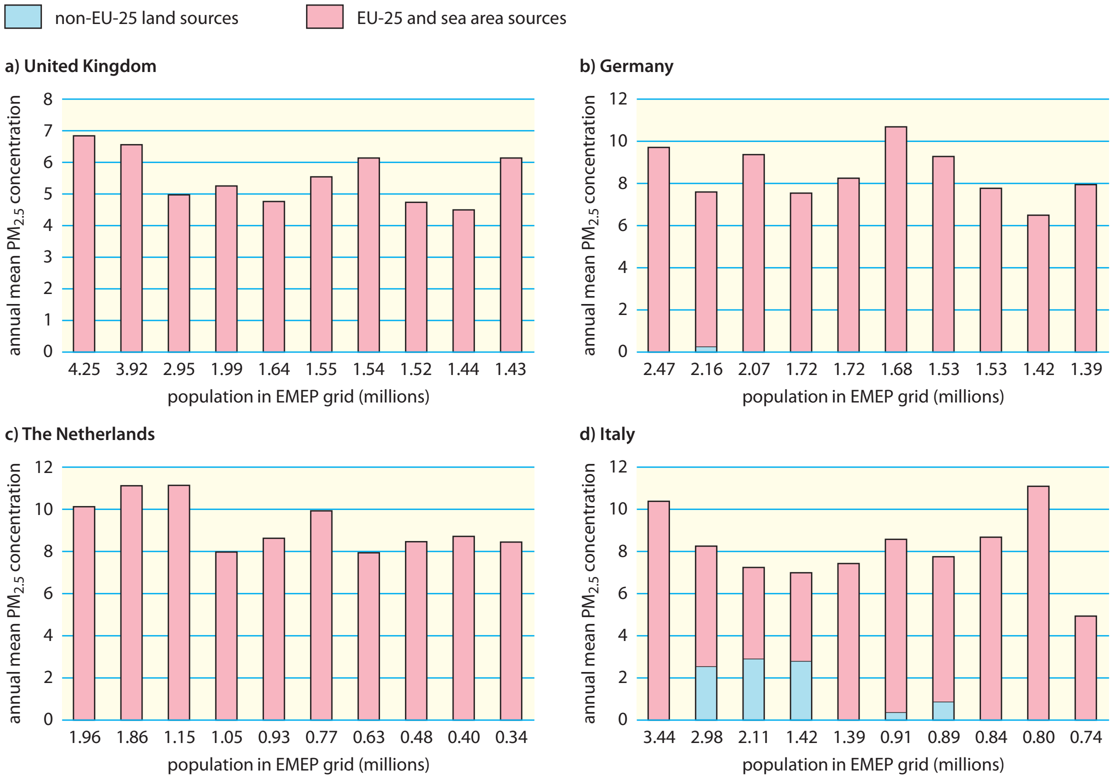


Figure 1

In the case of the UK, Germany and The Netherlands, $PM_{2.5}$ concentrations are essentially from EU-25 and sea area sources only. Italy is of course influenced both by bordering Adriatic non-EU countries and, importantly, by the significant volcanic source of sulphur oxides e.g., from Etna, which are also included in the EMEP inventory.

Results

It is this non-EU/non-sea area term that provides a perspective on the consequences of restricting the scope of 'emission changes' to EU-only countries in the NECD review process. In Figures 1a to 1d the relative contribution of this term is shown for four countries which are not on the outer border of the EU. The EMEP grids chosen in a given country are those with a significant human population.

In the case of the UK, Germany and The Netherlands, the 'as modelled' contribution to overall $PM_{2.5}$ concentrations are essentially from EU-25/sea areas only. Italy is of course influenced both by bordering Adriatic non-EU countries and, importantly, by the significant volcanic source of sulphur oxides from Etna, which are also included in the EMEP inventory.

Figures 2a to 2d show the corresponding plots for countries on the outer border of the EU. Beside the highest populated grid bars, an additional bar has been added to the series showing the maximum non-EU/non-sea area contribution.

Conclusions

It is clear from these figures that non-EU/non-sea area emission sources make a significant and, at times, dominating contribution[2] to overall concentrations of $PM_{2.5}$ in countries lying along the borders of EU-25.

An important question is whether the above findings could have any material impact on policy making in the context of the NECD. After all, the optimisation approach finally adopted by the Commission in their Thematic Strategy on Air Pollution was aimed at delivering the

[2] *Implied by the regression analysis of IIASA in developing their functional relationships.*

The case for Gothenburg

The benefit of including all 'Gothenburg Protocol' countries in the scope of the National Emission Ceilings Directive Review

Contribution of $PM_{2.5}$ concentrations in ten highest populated EMEP grids for four countries on the outer border of the EU (2020 TSAP scenario)

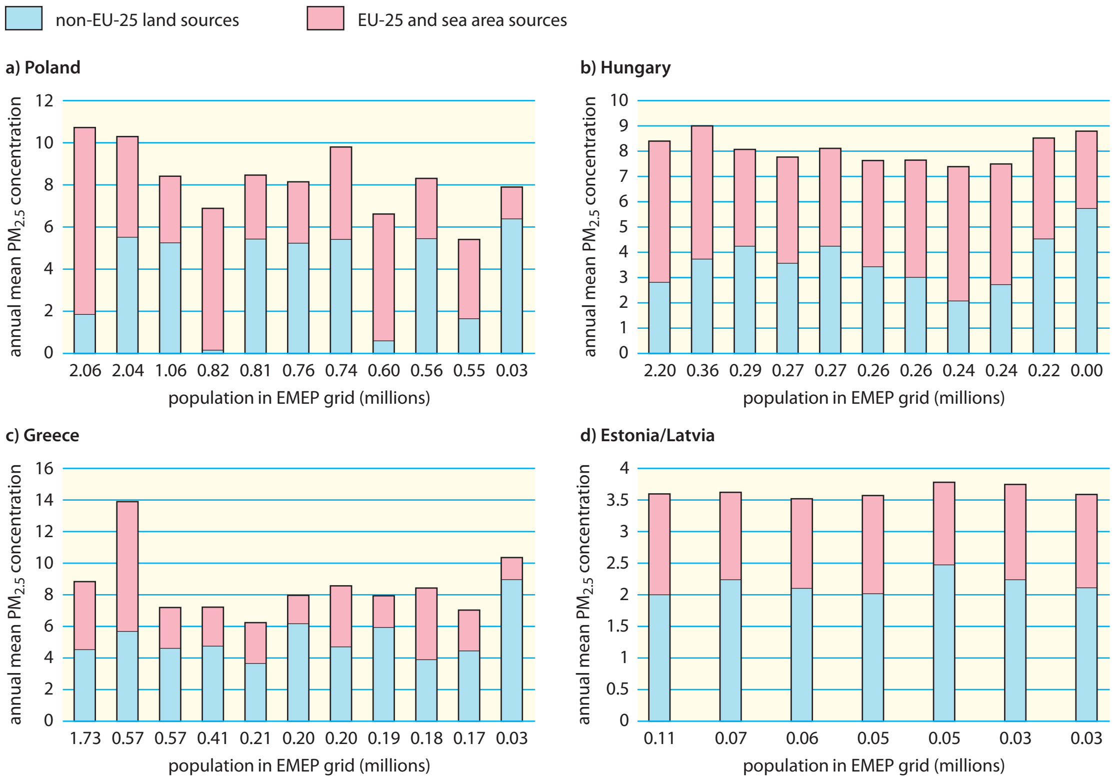


Figure 2

Non-EU/non-sea area emission sources make a significant, and at times, dominating, contribution to overall concentrations of $PM_{2.5}$ in these four countries, which are on the outer border of the EU.

desired reduction of the impact of exposure to $PM_{2.5}$ in EU-25 in the most cost-effective way. Individual country targets were not set as constraints but rather an overall EU target was established.

This does not mean that the exclusion of the significant 'uncontrolled' contributions depicted in Figure 2 is unimportant. Indeed, not allowing the IAM to look for cost-effective reductions in countries bordering the EU must, by definition, drive up the cost of delivering a given target for improvement, even if it is set only on an overall EU basis. The economic impact of this restriction will of course be more significant at higher ambition levels.

The analysis described above shows that we can learn helpful lessons from the original development of the NECD and the Gothenburg Protocols. The development of revised ceilings within the NECD review process would benefit from the inclusion of UN-ECE countries. At the very least the candidate countries to the EU should be included. This can only assist in ensuring the best alignment of two key EU goals: to be a leader in solving its environmental problems, a well as a strong competitor in the global market place.

Evaporative emissions and ethanol blends

Another technical contribution from the JRC/EUCAR/CONCAWE consortium

The JRC/EUCAR/CONCAWE consortium was set up in 2000 to carry out technical work of joint interest in the area of advanced fuels and vehicles. The first major output from the collaboration was the Well-to-Wheels analysis of future automotive fuels and associated power-trains, first published at the end of 2003 and updated version issued in May 2006.

The EU Fuels Directive Review, 2003/17/EC, provided a second major subject of common interest for all three consortium partners. This review included specific consideration of the current gasoline summer vapour pressure limits with respect to ethanol blending and technical data were needed. 'Splash'[1] blending of ethanol in standard gasoline would increase the vapour pressure by up to 10 kPa, potentially requiring an increase of the maximum specification from 60 kPa to 70 kPa, or the preparation of a special base fuel with lower vapour pressure for ethanol blending. The current summer limit of 60 kPa was set to control evaporative hydrocarbon emissions, and there is concern about the possible consequences of the increased vapour pressure of the ethanol/gasoline blends on evaporative emissions from gasoline cars.

In Europe, most of the data available on evaporative emissions had been obtained in studies carried out in the late 1980s on 'uncontrolled' vehicles and cars with first generation evaporative emission control systems. As fuels and vehicles have developed considerably since the late 1980s, there was a need for new data. For this reason CONCAWE, EUCAR and JRC decided to investigate the influence of vapour pressure and ethanol content on evaporative emissions from a range of current generation vehicle technologies. Representatives from the ethanol and ether producers were invited to join the programme as observers and provided input. This article is based on an interim report recently published (http://ies.jrc.ec.europa.eu/250.html). The full report, which will be available soon, will provide more in-depth information, in particular regarding the sensitivity of different cars to increased volatility.

[1] *Usual term to designate blending at a depot or terminal without quality adjustment.*

How are evaporative emissions controlled?

On-board evaporative emission control systems use carbon canisters to absorb gasoline vapours generated during normal running, 'hot soaks' after driving and 'diurnal losses' caused by daily temperature variation of the fuel tank. These vapours are then purged back to the engine during running conditions, with a complex control system also necessary for the whole system to function effectively. Although the vehicles are certified with a rigorous procedure, under extreme conditions such as extended high temperatures or exposure to high volatility fuels, it is possible that the carbon in the canister could become saturated and vapours could 'break through' and be emitted to the atmosphere.

Programme objectives and overview

The specific objectives of the joint JRC/EUCAR/CONCAWE programme were: to assess the effects of ethanol and vapour pressure on evaporative emissions from a range of latest generation canister-equipped gasoline cars; and to provide a firm technical basis for debates on gasoline vapour pressure limits in relation to ethanol blending for the Fuels Directive Review.

Seven vehicles of different sizes and makes, some of which were provided by the European Auto manufacturers and others hired, were tested on a fuel matrix consisting of fuels differing in ethanol content and vapour pressure (DVPE). All tests were carried out using the current regulatory evaporative HC emissions test procedure (see Directive 98-69-EC Annex VI, p. 27).

The test fuel matrix was composed of 60- and 70-kPa hydrocarbon base fuels with 5 and 10% ethanol splash blends as well as matched vapour pressure blends. The

Evaporative emissions and ethanol blends

Another technical contribution from the JRC/EUCAR/CONCAWE consortium

Table 1 Fuel properties

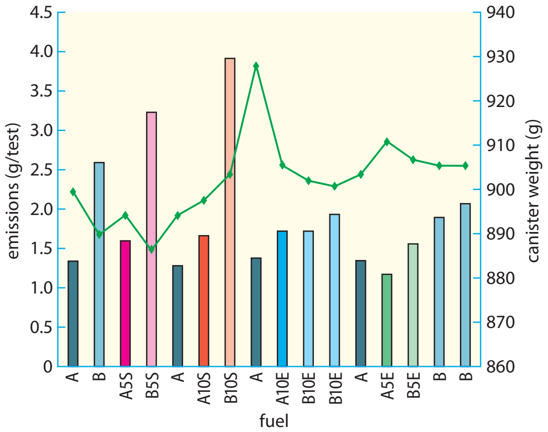
Fuel		A	A5S	A10S	A5E	A10E	B	B5S	B10S	B5E	B10E
DVPE	kPa	60.1	67.1	66.8	59.7	59.9	69.0	75.4	75.6	69.9	66.5
E70	%v/v	38.3	42.7	51.8	40.2	44.6	38.9	44.0	53.1	42.0	46.3
E100	%v/v	54.7	56.6	59.4	61.3	54.8	54.8	56.8	60.0	61.8	58.0
Ethanol	%v/v	0.0	4.5	9.5	4.7	10.3	0.0	4.7	9.8	4.9	9.7
Density	kg/m^3	755.5	757.2	758.7	747.1	756.0	753.3	754.3	756.0	747.1	750.0

two HC base fuels with DVPEs of 60 (fuel A) and 70 (fuel B) kPa represent (A) the current standard European summer grade gasoline and (B) summer grade gasoline specified in regions with 'severe winter conditions'. Based on these base fuels, blends with either 5% or 10% ethanol were prepared. The fuels with suffix 'S' were splash blends; those with suffix 'E' had their vapour pressure adjusted to match the DVPE of the base fuel. The fuel properties are shown in Table 1.

Key findings

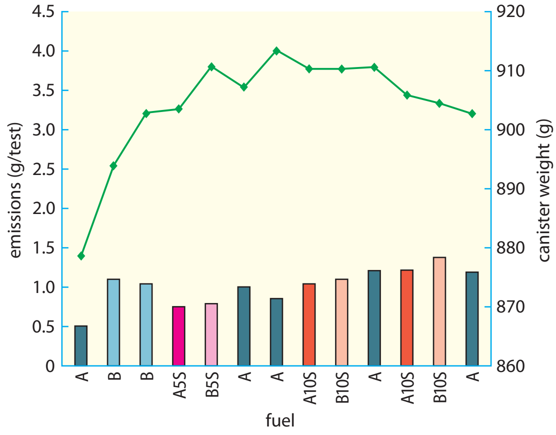
The vehicles tested differed in their level of evaporative emissions and in the extent of their response to fuel changes (see Figures 1 and 2). All cars met the regulated 2 g/test emission limit on the first test on fuel A, the evaporative emissions reference fuel with DVPE of 60 kPa. Some vehicles slightly exceeded the limit on subsequent tests on this fuel, probably as a result of increased canister loading in later tests, as shown by the line graphs on Figures 1 and 2.

Figure 1 [a]
Effects of fuel changes on vehicle emissions: Vehicle 1
Vehicle 1 showed significant response to fuel changes, in particular with the high volatility ethanol blends, B5S and B10S



[a] *Note on Figures 1 and 2: Bars = Total Evaporative Emissions; Line = canister weight before testing*

Figure 2 [a]
Effects of fuel changes on vehicle emissions: Vehicle 2
Vehicle 2 was less sensitive to fuel changes and stayed within the EU's 2 g/test emissions limit on all fuels tested.



The key fuel variable that affects evaporative emissions is vapour pressure (DVPE). In general, increasing fuel vapour pressure above that of the reference fuel used for system development increased evaporative emissions. The effect appeared to be non-linear (as expected for a canister breakthrough effect). The ethanol blends with DVPE around 75 kPa gave considerably higher evaporative emissions than the other fuels in several tests over most of the vehicles (see Figures 3 and 4). Differences between the other fuels with DVPE in the range 60–70 kPa were small (see Figure 4).

Due to the combination of DVPE variations, the presence or absence of ethanol, and to significant changes of canister weight (see below) it is difficult to draw any reliable conclusions on the influence of each single parameter. The engineering margin built into the system may also explain the reduced fuel effect in this volatility range.

This programme has also shown that the test protocol used was not able to return the vehicle's carbon canister

Figure 3
Effects of changes in vapour pressure (DVPE) on evaporative emissions: Vehicle 1

Vehicle 1 showed influence of increasing DVPE on total emissions. Ethanol blends at 75 kPa gave significantly higher emissions than the other fuels.

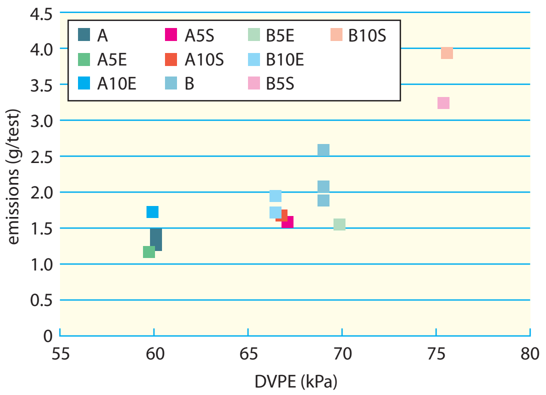
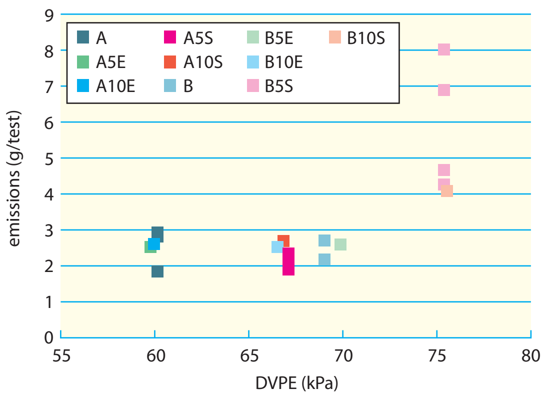


Figure 4
Effects of changes in vapour pressure (DVPE) on evaporative emissions: Vehicle 4

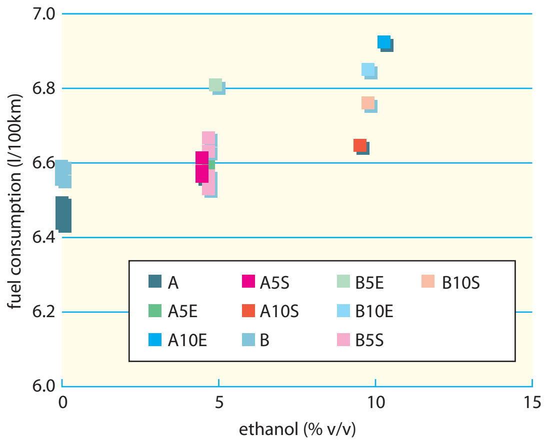
In Vehicle 4, ethanol blends at 75 kPa showed significantly higher emissions than the other fuels. Differences between fuels with DVPE <70 kPa were small.



system to a consistent condition at the start of each test. Repeating the test procedure without any additional driving between tests to purge the canister allows vapour to build up in the canister. This reduces its absorption capacity during the test and can increase emissions. This may not be representative of real-world operating conditions, but is a very severe test of the evaporative emission control system. Although the increase in emissions with repeated tests made it more difficult to discriminate fuel and vehicle effects, several clear conclusions could still be drawn from the results.

Volumetric fuel consumption (litres/100 km) increased with increasing ethanol content, as shown in Figure 5. This increase was roughly proportional to the oxygen content of the fuel. There was no clear effect on CO_2 emissions or energy consumption.

Figure 5
Observed increase in volumetric fuel consumption with increasing ethanol content: Vehicle 1



Application of results, limitations and potential further work

The test programme was designed to explore the effects of ethanol and fuel vapour pressure on evaporative emissions from a range of latest generation canister-equipped gasoline cars using the EU Evaporative Emissions test procedure. It has provided technical evidence on these effects, which should assist in the development of sound regulatory decisions under the EU Fuels Directive Review.

Not all aspects could be evaluated in this programme, e.g. parameters such as test temperature profile, presence of ethers in the fuel, fuel permeation and the long-term effect of ethanol and water on carbon canister working capacity could not be addressed due to limited experimental resources.

For any further work in this area, an improved canister conditioning procedure is needed to ensure that the canister system is properly conditioned to the new fuel at the start of each evaporative emissions test.

Reducing the sulphur content of residual marine fuels

What will be the consequences for refiners and for market prices?

The legislative context

Residual fuel is a commodity used by sea-going vessels the world over. The quality specifications of residual marine or 'bunker' fuels (RMF) result essentially from self-regulation of the industry and agreements between producers and consumers. Parameters such as carbon residue, density and stability are essential for the reliable and safe operation of ships.

The sulphur content of marine fuels is, however, regulated on a worldwide basis through the International Maritime Organization (IMO). The maximum allowable sulphur content of RMF is currently 4.5% m/m. An agreement under the International Convention for the Prevention of Pollution from Ships (MARPOL), known as MARPOL Annex VI, has introduced the concept of Sulphur Emission Control Areas (SECA) which are special sea areas where specific limits apply. The Baltic and North Sea have been designated as SECAs whereby emissions from ships sailing into these areas will be limited to a level consistent with a maximum fuel sulphur content of 1.5% m/m. Following its ratification in 2005, MARPOL Annex VI comes into force in May 2006 for the Baltic Sea and in November 2007 for the North Sea. A process for revision of that legislation was initiated by the IMO's Marine Environment Protection Committee in July 2005.

In addition, the EU has adopted Directive 2005/33/EC[1] (further referred to as 'the Directive') which extends the 1.5% m/m sulphur limit to all ferries operating from and to an EU port and which will also come into effect in August 2006. The Directive includes a review clause whereby the possibility can be envisaged of extension of the sulphur limit to all EU waters and its further reduction (levels of 0.5% m/m have been mentioned).

[1] *Directive 2005/33/EC of the European Parliament and of the Council of 6 July 2005 amending Directive 1999/32/EC as regards the sulphur content of marine fuels*

It has to be noted that the obligation under the Directive could also be met by appropriate reduction of the ship stack emissions. This can be achieved by sea water scrubbers, a number of which have been developed to full-scale demonstration stage.

In this context CONCAWE undertook a study focusing on the option of reduction of fuel sulphur content and aiming to:

- clarify the options open to European refiners facing these new constraints, including possible future ones; and
- analyse the impact of refiners' choices on the RMF market in terms of availability and prices.

The full results of the study will be published in a CONCAWE report. In this article we highlight the main findings and conclusions.

Refiner's business options

When faced with an additional constraint, a refiner will re-evaluate its entire operation to try to find the new economic optimum. Focusing on RMF sulphur reduction, the options would in principle be as follows:

Optimise residue streams segregation and residual fuel blending

This is a relatively soft option for the refiner, although it may require minor investments to make segregation possible. Clearly, however, the scope is limited to the volumes of low sulphur residual streams physically available and also by a number of practical considerations that could make segregation impossible. The current demand to cover the requirement of the Directive could partly be met through this mechanism.

Process more low sulphur crude

This option is of course in principle open to individual refiners. It must, however, be realised that the trend is for crude oil worldwide to become heavier and more sulphurous. Globally for Europe, it has been estimated that the current percentage of low-sulphur crudes (about 45%) can at best be maintained for the next 10–15 years but could not realistically be increased. From a European point of view this option is therefore not available.

Desulphurise residues

On paper, the simplest way to reduce sulphur in RMF is to desulphurise key residual components. Residue desulphurisation is technically feasible but is no trivial matter. It requires heavy processing, essentially high pressure/high temperature hydrotreatment. The processes involved are complex, the plants costly and delicate to operate. Blended fuel stability and mutual compatibility of finished fuels can cause problems, especially with the heavier, higher sulphur residues. The processes are similar in nature to hydroconversion (i.e. cracking to lighter material). They apply similar technologies but under somewhat milder conditions. Although several such processes are commercially proven, they are regarded as state-of-the-art technologies, particularly when it comes to treating heavy and high sulphur residues (e.g. from Middle Eastern crudes). None of the residue desulphurisation plants operating today actually produces low sulphur RMF components.

A significant reduction of the sulphur content of a large proportion of the residual fuels would therefore change their very nature. They would become manufactured products having to support complex and expensive processing equipment. As a result their production would be in economic competition with other manufactured products such as distillates, and so refiners would inevitably consider alternatives.

Convert residual streams to distillate products

As the market has gradually moved towards more distillates and less residual fuels (a 'whiter demand barrel') while the average crude oil barrel on offer is slowly becoming heavier, the refining industry has adapted by installing 'conversion' capacity, i.e. plants that can turn residues into distillates such as diesel fuel, kerosenes or gasolines. Such plants are in fact very similar to those required to desulphurise residues, the difference being more in the degree of severity applied than in the process principles used. Conversion is likely to be more expensive than desulphurisation but not by a large margin. As a result, partial or full conversion will always be an option when desulphurisation is considered.

The economics of desulphurisation would rely on an expected price differential between low and high sulphur RMF. The magnitude and evolution with time of such a differential would be crucially dependent on the supply/demand balance of low sulphur material and the evolution and application of the legislation that created the demand in the first place. Compared with these uncertainties, conversion relies on the continued prospect of sustained distillate growth and decreasing demand for residues, offering a more reliable basis for justifying what would in any case be major investment decisions.

It must be noted that conversion is not the only technological option available to the refiner for dealing with residual streams. Residue gasification for heat and power production offers a further alternative which may be attractive under certain circumstances and would also be in competition with the desulphurisation option. Although our model is able to represent such processes we have not included this option in our study, as consideration of the relative economics of conversion and gasification would have required discussion of relative electricity and oil prices that would be beyond our scope.

Export surplus high sulphur residual fuel

The worldwide RMF market is set to grow steadily and, with no immediate prospects of additional sulphur restrictions outside Europe and limited parts of the USA and Japanese coastal areas, export is likely to remain an option. There may also be opportunities for export of high-sulphur heavy fuel oil (HS HFO) for other uses. This option might be considered where funding for the large desulphurisation or conversion investments is not available.

Cost of residue desulphurisation

Starting from a pre-SECA 'business-as-usual' case, the study considered two scenarios based on enacted legislation (MARPOL legislation alone, MARPOL + EU

Reducing the sulphur content of residual marine fuels

What will be the consequences for refiners and for market prices?

Figure 1 Desulphurisation cost per tonne of low sulphur RMF under different scenarios

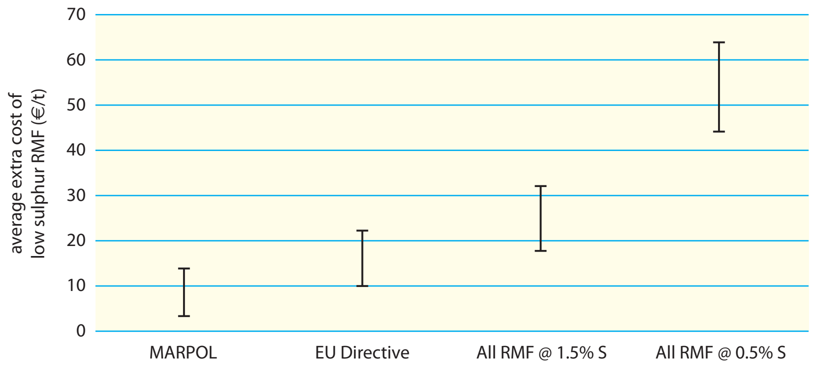


Figure 1
The average extra cost per tonne of LS RMF would be between 10 and 25 €/t to meet enacted legislation, increasing to 45 to 65 €/t in the 0.5% sulphur case.

Figure 2
Under both scenarios studied, conversion or export would be more attractive than desulphurization.

Directive) and two further prospective scenarios in which the sulphur content of all RMF sold in the EU would be limited to either 1.5 or 0.5% m/m. Demand figures were based on a 2015 forecast.

In a first part we estimated the cost to EU-27 (EU-25 + Norway and Switzerland) refineries of reducing RMF sulphur to the required level while meeting the RMF demand.

As already highlighted in studies by others, residue desulphurisation has a high cost. Meeting already enacted legislation will require investments of up to 2 G€ in EU-27 for an annual cost in the order of 0.5 G€. Reducing the sulphur content of all RMF sold in Europe to 0.5% m/m would require an additional investment of between 7 and 13 G€ for an annualised cost of 2.2–3.2 G€. The average extra cost per tonne of LS RMF (Figure 1) would be between 10 and 25 €/t to meet enacted legislation increasing to 45 to 65 €/t in the 0.5% sulphur case.

These costs, however, do not reflect the impact of the RMF sulphur limits on its likely market price. From an economic point of view desulphurisation relies on the price differential between low and high sulphur residual fuels, which is only the consequence of legislated sulphur limits. Conversion also requires complex and costly plants but delivers distillate products that are inherently more valuable than residues. Its economic prospects are therefore much better than desulphurisation.

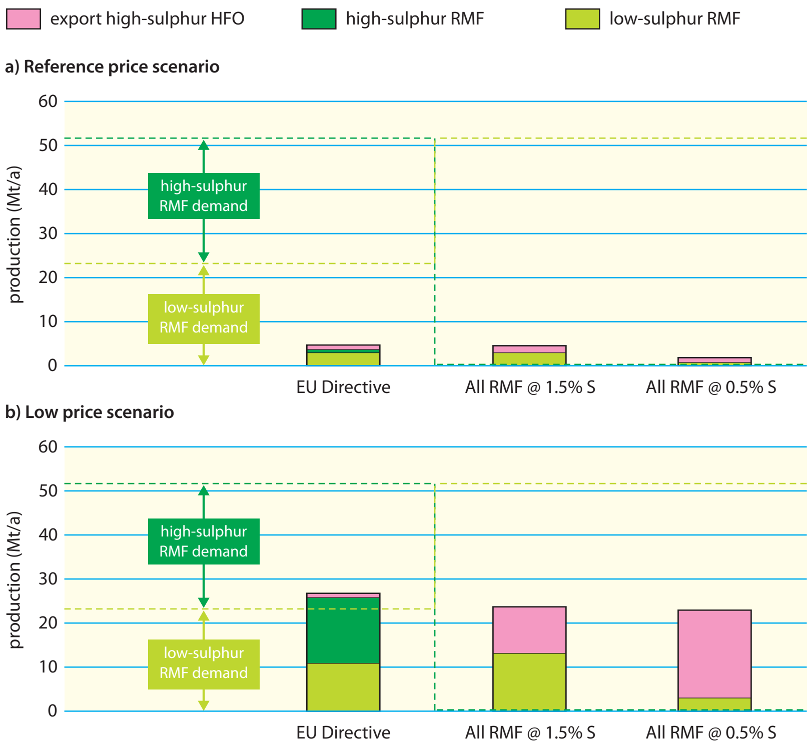
The consequences of realistic economic mechanisms

In reality refiners will always have the choice to supply only the portion of the market which is economically attractive. In a second part of our study we therefore considered the relative merits of residue desulphurisation (for LS RMF production), conversion to lighter products or export outside the EU. In addition to the reference price scenario (around 40 $/bbl) we also used a low price set (around 25 $/bbl) in order to test the sensitivity of the results to this essential economic driver.

As shown in Figure 2, our key finding is that, under both price scenarios **conversion or export would be more attractive than desulphurisation.**

The LS RMF price increase required to make desulphurisation attractive would be very high. In order to re-establish the full LS RMF production in our reference price scenario, differentials between HS and LS RMF in the order of 90 €/t would be required in the EU Directive case and up to 140 €/t in the 0.5% overall sulphur limit case. This would bring the price of LS RMF close to that of heating oil, which would then make LS RMF an unattractive customer choice.

Figure 2 Optimum economic production of RMF under two price scenarios



COPEX 2006

The oil pipeline community met in Brussels

The CONCAWE Oil Pipelines Operators Experience Exchange seminar (COPEX for short) that took place in Brussels on 30–31 March was continuing a long-established tradition. CONCAWE has been active in the field of oil pipelines since the early 70s and started organising regular seminars for pipeline operators during the 80s. The seminar has been run on a regular 4-yearly schedule since 1994. The principal aim of COPEX is to provide a forum for pipeline operators to update their knowledge of legislative, regulatory and technical developments in the field as well as exchange information in an informal environment and without commercial pressures. Although regulators and selected equipment suppliers are invited to give presentations, contributions are essentially provided by pipeline operators who also form the bulk of the audience. COPEX 2006 was attended by 115 delegates from 15 countries, together representing virtually all major oil pipelines in Europe.

The Seminar first considered the legislative and regulatory developments in the field of pipelines. In 2004 the EU Commission convened a group of experts to consider safety in all modes of transport. Sub-groups were formed for each mode including one on pipelines in which CONCAWE participated. A presentation outlined the content of the report of the sub-group to be published later this year, which points to third-party interference as the main hazard facing pipelines. Within the framework of the Conventions on the Transboundary Effects of Industrial Accidents and on the Protection and Use of Transboundary Waters and International Lakes, the UN-ECE began drafting, in 2005, safety guidelines covering design, operation and maintenance of pipelines. The content of the nearly final document, to which CONCAWE provided significant input, was highlighted. The Guidelines are due to be released later this year. A further presentation described the regulatory framework in place in one of Germany's States. The CONCAWE spillage statistics provided the material for an overview of the integrity performance of EU oil pipelines in the past four years and the circumstances of a number of recent incidents were explained in short presentations.

Pipeline integrity management systems provided the theme of the second session of the Seminar. These systems, based on the general principle of quality management, are today the backbone of pipeline operation. They are designed to ensure reliability, accountability, traceability and transparency in all aspects of the operation of pipeline systems, also providing the framework for a pathway towards performance improvement. Several presentations described the state of the art in terms of inspection systems (intelligence pigs) and leak detection, while the problems related to illegal tappings were also discussed. This was followed by a panel discussion on pipeline ageing, debating whether this issue should be considered as a problem and if so what should be done about it. The current EU pipeline inventory is about 40 years old on average, with a maximum of just over 60 years. The general opinion was that we are still far from having reached an age that would require large scale replacement. The situation is manageable with the appropriate state-of-the-art maintenance and inspection techniques.

The third session of the Seminar covered general operational matters including cost benchmarking and cost reduction programmes, capacity improvement with flow improvers and ultrasonic metering.

The Seminar was concluded by a panel session devoted to the all important issue of third party interference and, in particular, how this major threat to pipelines can be better tackled by both the industry and the authorities. Although no definite answer emerged from the debate it proved once again that this is the most serious issue in the field of pipeline safety. CONCAWE/OPMG intends to initiate an activity on this subject in the near future in order to fuel the reflection and make concrete proposals.

Abbreviations and terms used in this CONCAWE *Review*

CAFE	Clean Air For Europe
CAS	Chemical Abstracts Service (the CAS Registry is a database of chemical substance information, each substance in the database being identified by a unique number, the CAS Registry Number)
CSR	Chemical Safety Report
DVPE	Dry Vapour Pressure Equivalent
EMEP	UN-ECE's cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe
EP	European Parliament
EQS	Environmental Quality Standards
EUCAR	European Council for Automotive Research and development
E70	%v/v of gasoline evaporated at 70°C
E100	%v/v of gasoline evaporated at 100°C
GHS	United Nations Globally Harmonised System of Classification and Labelling of Chemicals
Gothenberg Protocol	Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (The eighth Protocol to take effect under the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (UNECE))
GWD	Groundwater Directive
HFO	Heavy Fuel Oil
IAM	Integrated Assessment Methodology
IIASA	International Institute for Applied Systems Analysis
IMO	International Maritime Organization
JRC	European Commission's Joint Research Centre
LS	Low sulphur
MARPOL	International Convention for the Prevention of Pollution from Ships
MEP	Member of the European Parliament
NECD	National Emissions Ceilings Directive
OSOR	One Substance, One Registration
$PM_{2.5}$	Particulate with an aerodynamic diameter less than or equal to 2.5 µm
RAINS	Regional Air Pollution Information and Simulation model (A tool developed by the International Institute for Applied Systems Analysis (IIASA) for analysing alternative strategies to reduce acidification, eutrophication and ground-level ozone in Europe)
REACH	Registration, Evaluation and Authorisation of Chemicals
RIP	REACH Implementation Project
SPZ	Source Protection Zone
RMF	Residual Marine Fuels
SECA	Sulphur Emission Control Area
SMEs	Small- and Medium-sized Enterprises
Splash blending	Usual term to designate blending at a depot or terminal without quality adjustment
SPORT	Strategic Partnership on REACH Testing
STF	CONCAWE Special Task Force
TCNES	Technical Committee for New and Existing Substances. Consists of technical experts of the Member States and the Commission (i.e. the European Chemicals Bureau)
TSAP	Thematic Strategy on Air Pollution
UN-ECE	United Nations Economic Commission for Europe
UNICE	Union des Industries de la Communauté Européenne (Confederation of Industries of the European Communities)
WFD	Water Framework Directive

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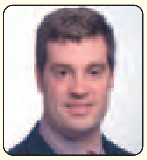

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