CONCAWE Review

Volume 10 • Number 2 • October 2001

CONCAWE *is the oil companies' European organization for environment, health and safety. The emphasis of its work lies on technical and economic studies relevant to oil refining, distribution and marketing in Europe.*

CONCAWE *was established in 1963 in The Hague, and in 1990 its Secretariat was moved to Brussels.*

Photographs: cover, Digital Stock Corporation;
page 20, by permission of BP Grangemouth

*This publication was designed and produced by Words and Publications,
Oxford, United Kingdom • www.words.co.uk*

Foreword

For nearly forty years, CONCAWE has endeavoured to provide the Community with technically-sound information and studies in the field of environment and health related to the downstream oil industry. We firmly believe that the principles of sound science, transparency and cost-effectiveness must be at the root of all environmental and health legislation. Indeed the application of these principles requires up-front studies, discussions and exchange of views, that is to say time and money. In the final analysis, however, this approach is the only way to ensure that the large sums of money spent on improving our environment are effective in doing so. The Auto/Oil programmes bear witness to the energies that can be harnessed through adhering to these principles and the synergies that can be built as a result.

We have recently observed, with some concern, a tendency for legislation to be proposed on the basis of beliefs, opinions and incomplete evidence rather than science. The proposal to reduce road fuels sulphur content to 10 ppm and the revision to the LCPD are such examples. The sulphur issue was the subject of an article in an earlier CONCAWE Review (Vol. 9 No. 2) while the latter is further developed in this issue.

Through the Chemicals White Paper and the CAFE programme, we are in the early stages of development of two pieces of legislation that can have a positive impact on our environment, but which will also have far-reaching consequences for industry in general and the downstream oil industry in particular. We do hope that, for these major initiatives, the legislator will heed the principles that have so far ensured that environmental and health protection money is well spent.

Jean Castelein
Secretary-General, CONCAWE

Contents

4
Future EU air legislation
Target or technology driven?

Historically, environmental legislation has been driven either by the desire to take advantage of the best available technology or by fixing environmental quality objectives. Using the examples of the revised Large Combustion Plant Directive and the National Emissions Ceilings, this article illustrates how the former approach can lead to very high costs that cannot be justified on environmental grounds.

Enquiries to: Henk Schipper

8
The revised Large Combustion Plant Directive
A major challenge

The so-called 'Large Combustion Plant Directive' is in the last stages of a major revision that imposes stringent restrictions on the operation of both new and existing plants. This article briefly reviews the key implications for the EU refining industry.

Enquiries to: Henk Schipper

13
Automotive particulate emissions
Growing knowledge in a complex area

A recently issued report of the UK DETR/SMMT/CONCAWE particulates consortium extends knowledge on particulates measurement methodologies and levels of particulate emissions across a range of vehicle technologies and fuels.

Enquiries to: Neville Thompson

16
Hydrogen
A CO_2-free fuel?

A promising fuel for the long term, hydrogen is a carrier rather than a source of energy. A realistic estimate of the CO_2 emissions associated to its production requires careful analysis of the production path. This article explores two examples where 'more hydrogen' is not necessarily synonymous with 'less CO_2'.

Enquiries to: Jean-François Larivé

19

The potential of Whole Effluent Assessment

The Whole Effluent Assessment concept, which calls for testing of the toxicity of effluents, provides an alternative to traditional chemical analysis as a means of controlling the discharge from an industrial site. Although agreeing that it is a useful tool, CONCAWE believes that, in its current state of development, it would not be suitable as the only method of control for site effluents.

Enquiries to: Eric Martin

22

Downstream oil industry safety statistics

CONCAWE has been collecting downstream oil industry safety statistics for the past eight years. The 2000 figures broadly confirm earlier trends showing that safety in the industry is gradually improving. Fatalities from road accidents remain a problem area.

Enquiries to: Eric Martin

23

CEC reorganization

Additional role for CONCAWE

The Coordinating European Council (CEC) is the inter-industry body in charge of developing standardized European performance tests for fuels and lubricants. Following a detailed review, it will now be managed through the European industry associations rather than via national bodies as in the past. This brings an additional role for CONCAWE and a new challenge to coordinate oil industry input on CEC fuels test developments.

Enquiries to: Neville Thompson

24

CONCAWE news

25

CONCAWE publications

Future EU air legislation

Target or technology driven?

Historically, environmental legislation has been driven by either 'available technology' or 'environmental quality'. In the former approach, available technology is applied to progressively reduce emissions of the pollutants of concern. It implies that a common solution is required within the geographical scope of the legislation (e.g. the EU). The process involves an assessment of the capability of available abatement technologies to derive an emission limit which is then enshrined in legislation. In effect this emission limit becomes a surrogate for the chosen technology or technologies. Since, in this case, the only definition of 'clean' is zero emissions, progressive updates of the legislation, with tougher emission limits, are made at regular intervals to reflect the developments in available technology. Concepts like the application of Best Available Techniques, sometimes embracing the notion of 'Not Entailing Excessive Costs', are derived from this approach.

In the alternative environmental quality driven approach, the starting point is the establishment of environmental targets. For air-related legislation this could be air quality standards, based on human health concerns, or critical loads/levels, based on ecological concerns. The vulnerability of ecosystems varies significantly in the EU territory so that, in the latter case, the targets may differ from region to region.

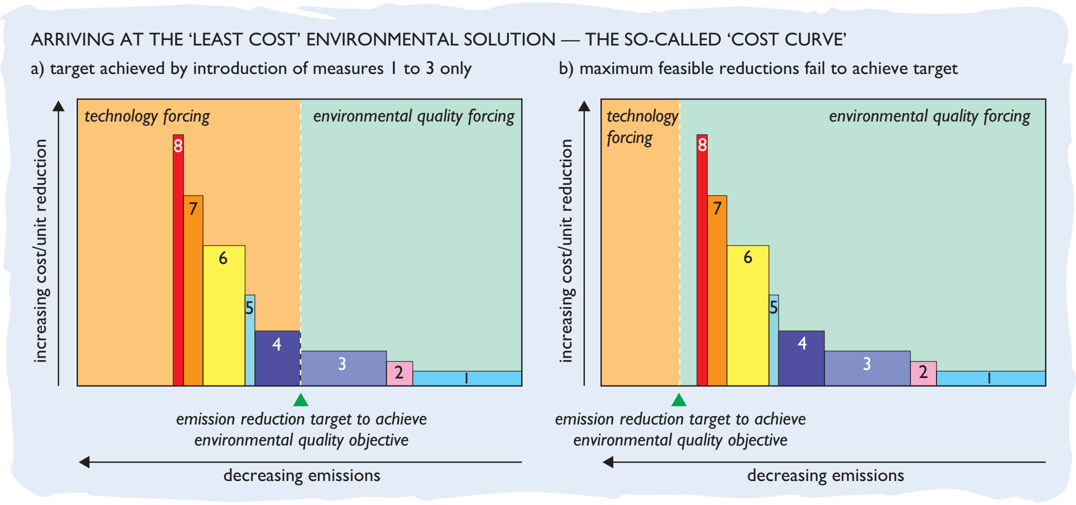
The appropriate use of urban scale and regional scale modelling allows the relationship between emission sources and their contribution to the environmental concern to be established. Using these relationships within an 'Integrated Assessment Modelling' (IAM) framework then allows the determination of the least-cost mix of measures required to deliver the target(s). In this case, 'clean' is the point at which the environmental targets are achieved. This approach accounts for the variation in the intensity of environmental problems across a geographical area and indeed, in the case of ecological concerns, the variations in environmental targets.

This environmental quality driven approach has dominated the development of both EU and UN-ECE air related legislation over the past decade. Examples of this are the European Auto/Oil programmes, the second UN-ECE sulphur protocol, the UN-ECE Gothenburg Protocol and the parallel EU National Emission Ceilings Directive (NECD). While advocating the need for appropriate processes for setting environmental targets and the need to account for uncertainties that influence policies, the European oil industry strongly supports this 'rational approach' that seeks to solve environmental problems in the most cost-effective way.

The benefits of the major environmental initiatives mentioned above are already emerging. All indications are that air quality targets will be attained in most of the EU during the next few years. But what about the future? Will new programmes such as Clean Air For Europe (CAFE) maintain the focus on environmental quality? While the 6th Environment Action Programme of the European Community, 'Environment 2010: Our Future, Our Choice', affirms such a commitment there are some worrying signals in recent developments, such as the revision of the Large Combustion Plant Directive (LCPD), of a shift towards a more 'technology driven' approach.

In this article we briefly explore why the oil industry is concerned over the potential of such a shift by comparing the NECD with the LCPD revision. We focus on sulphur since this avoids the complexities associated with NO_x, which contributes not only to acidification but also to ozone.

The simplified ‘cost curves’ shown in Figure 1a and 1b illustrate how the process of Integrated Assessment can be used to arrive at the ‘least-cost’ environmental solution. The width of the bar represents the emission reduction capability of a given measure (e.g. tonnes of SO_2 reduction) while the height of the bar represents the marginal cost of that measure (e.g. EUR/t). The measures are ranked from lowest marginal cost to highest marginal cost.


ARRIVING AT THE ‘LEAST COST’ ENVIRONMENTAL SOLUTION — THE SO-CALLED ‘COST CURVE’

a) target achieved by introduction of measures 1 to 3 only

b) maximum feasible reductions fail to achieve target

Figure 1a
The emission reduction target is achieved by implementing measures 1 to 3; additional measures are not justified on either cost or environmental grounds.

Figure 1b
The emission reduction target cannot be achieved, even if maximum feasible reductions (MFR) are mandated.

The green arrow shows the emission reduction required to achieve the environmental target, as would be determined by modelling. Figure 1a indicates the target can be achieved by introducing measures 1 to 3. Since measures are ranked from least to highest marginal costs, this represents the least-cost solution. Introducing additional measures beyond ‘measure 3’ moves away from an environmental quality driven regime (the green area) to a technology forcing regime (orange area) with attendant additional costs that are not justified on environmental grounds.

Of course the emission reduction required to deliver the environmental target can vary significantly across a geographical area (or over a range of urban environments). Figure 1b illustrates a situation where the required reduction cannot be achieved even if all feasible measures (maximum feasible reductions or MFR) were mandated. Driving EU-wide legislation according to 1b would result in significant unnecessary expenditure in geographical areas that are more akin to the situation described in 1a.

When it comes to addressing the concern over acidification in the EU, Figures 1a and 1b are respectively typical of southern and northern Europe. While such differences were accounted for in the establishment of the sulphur ceilings associated with the NECD, they were ignored in the setting of EU-wide emission limits in the revision of the LCPD.

Figure 2a shows the large variation in critical loads for acidification across Europe. The very sensitive areas of northern Europe have critical loads up to two orders of magnitude lower than much of southern Europe. Figure 2b clearly illustrates the consequential ‘north-south’ divide in

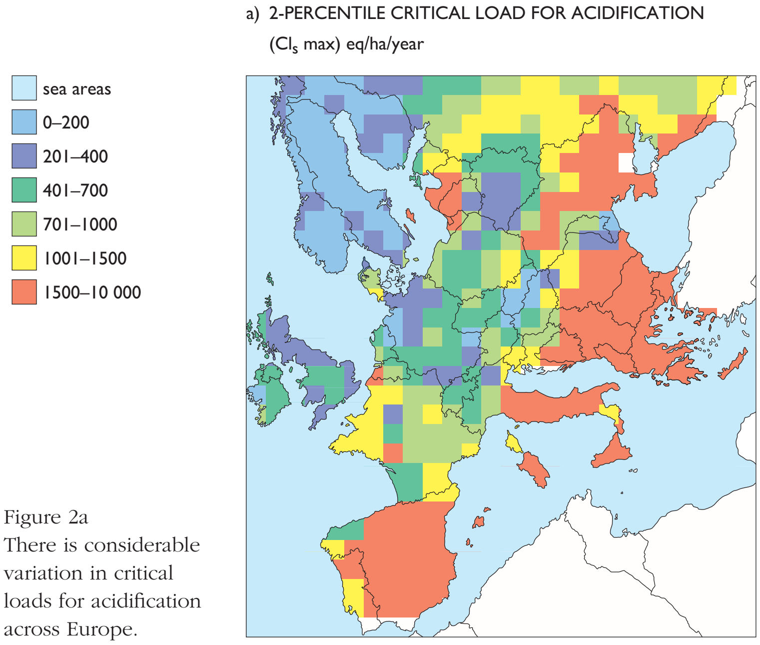


Figure 2a
There is considerable variation in critical loads for acidification across Europe.

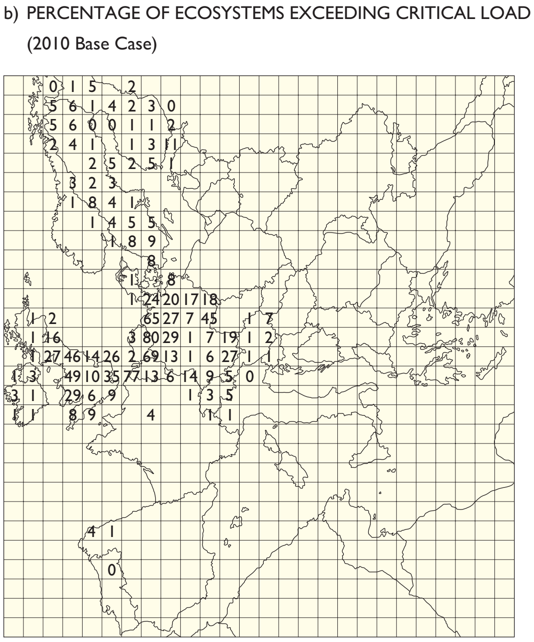
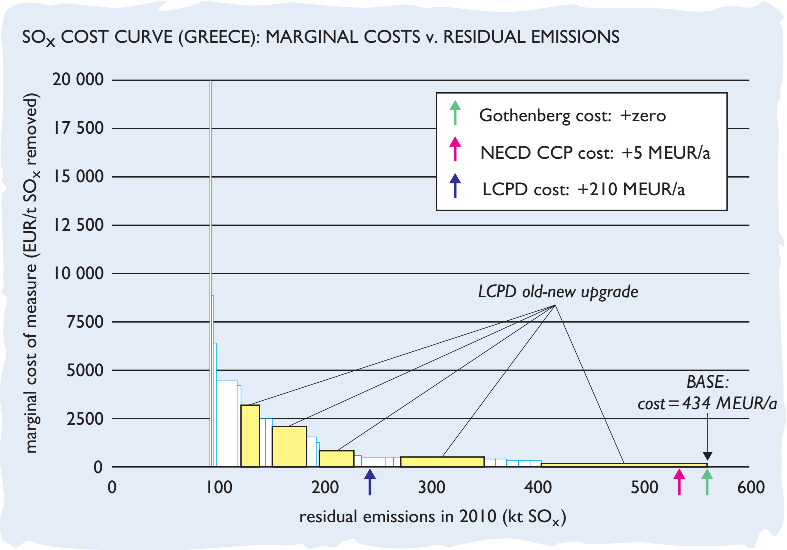


Figure 2b
Zero exceedances of critical loads in Southern Europe contrast with significant exceedances in parts of central EU in 2010 (after application of already-agreed measures).

terms of the percentage of ecosystems anticipated to exceed their critical loads in the EU in 2010 after application of the already agreed measures (i.e. prior to the Gothenburg protocol, the NECD and the revision of the LCPD). Southern Europe is already expected to meet the long-term goal of 'zero exceedances' of critical loads. In contrast, significant residual exceedances are anticipated in parts of central EU (e.g. Belgium, Germany, The Netherlands). This explains why the national ceilings for these EU Member States (or those contributing significantly to deposition in these areas), are generally much more demanding than those of the southern Member States.

The particular situation for Greece will serve to illustrate this. As seen in Figure 2b, no exceedance of critical loads is anticipated in Greece after application of already mandated measures. Accordingly the IAM work that underpinned the Gothenburg protocol and the NECD determined that virtually no further sulphur emission reduction was required for Greece. This is illustrated by the actual sulphur cost curve for Greece shown in Figure 3[1]. Of course Greece will still need to continue to spend more than 400 MEUR/a on sulphur reduction measures to achieve the base case.

Figure 3
The cost of EU-wide 'existing plant' upgrades required by the revised Directive would not be justified on the basis of attaining critical loads.



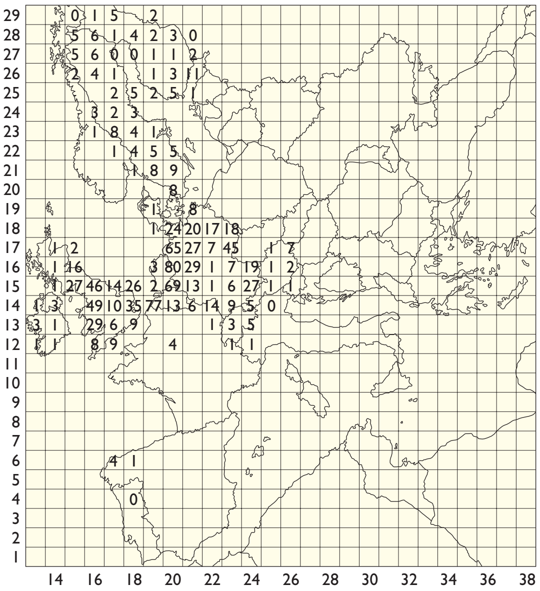
However, applying the 'existing plant' upgrading requirements of the revision of the LCPD drives sulphur emissions much further down in Greece. The measures that reflect these upgrading requirements are highlighted in yellow on the cost curve. Such further reduction, costing an additional 200 MEUR/a, is not justified on the basis of attaining critical loads but arises simply from the revised LCPD requirement for uniform EU-wide upgrading of existing plants.

---

[1] *IIASA 6th Interim Report on the NECD (October 1998)*

SO_2 EMISSION REDUCTIONS FOR NECD v. REDUCTION FROM 'OLD PLANT' LCPD REQUIREMENTS (IIASA 1/01)

Figure 4
The LCPD 'existing plant' upgrade requirements result in SO_2 reductions which greatly exceed those required to meet the obligations of NECD and the Gothernberg protocol.



	CCP	Kt/year EP	LCPD
Denmark	39	39	45
France	73	230	23
Finland	45	45	0
Germany	61	118	0
Greece	23	23	274
Italy	92	92	163
Netherlands	23	23	0
Portugal	14	33	63
Spain	396	396	657
Sweden	0	0	0
UK	501	585	312

The IIASA analysis shown in Figure 4[2] confirms that such a picture is not confined to Greece. All the SO_2 reductions shown in this table are additional reductions beyond those achieved by 'Base Case' measures[3]. These data clearly highlight the fact that the LCPD 'existing plant' upgrading requirements for southern European countries drive sulphur emission reductions well beyond those required to meet the obligations of NECD and the Gothenburg protocol. It also shows that EU Member States with the most significant residual exceedances have already upgraded, or will upgrade, their LCPs as part of the base case since they are not affected by the revised LCPD (i.e. zero further reductions).

The fact that these Member States have already had to invest to upgrade or replace existing plants in response to their more severe acidification problems has every potential to generate a political incentive for them to support EU-wide adoption of a technology-driven approach. With attendant common EU-wide emission limits this 'levels the playing field' for their indigenous industries that would otherwise have to bear higher financial burdens than those in southern Europe. Clearly such a stance is not driven by environmental need but rather by national competitiveness and the concern that less stringent emission reduction requirements in southern Europe might lead to preferential investment in this region.

How this dynamic will play itself out in the recently launched CAFE programme remains to be seen. The environmental quality driven approach clearly remains the most efficient route to achieving the EU environmental goals. The technology-driven approach would result in unnecessary and very significant environmental expenditure. For the EU in total, the additional costs (beyond the base case) of achieving the emission requirements for all the pollutants covered by the Gothenburg protocol would be about 1.5 billion euro per annum while the 'ultimate' technology forcing to MFR would drive the cost to as much as 42 billion euro per annum[4].

---

[2] *IASA 'Emission Reductions from Existing Large Combustion Plants Resulting From Amendments of the LCPD', January 2001*

[3] *The base case includes measures already mandated but not the further reductions stemming from the Gothenburg protocol, the NECD and the revised LCPD.*

[4] *IIASA 7th and 8th interim reports for the NECD January 1999/January 2000*

The revised Large Combustion Plant Directive

A major challenge

Following the completion of the formal 'conciliation procedure' of the EU Institutions, a joint text for the revision of the 1988 Directive (88/609/EEC) on 'the limitation of emissions of certain pollutants into the air from Large Combustion Plants' was approved by the Conciliation Committee on 2 August 2001.

While maintaining many of the structural elements of the original Directive, this revision includes an important and fundamental change, in that it prescribes the upgrading of existing plants (built before 1 July 1987) to meet the same requirements as new plants (as defined in Directive 88/609/EEC).

Such a requirement, while founded on the principles of Best Available Techniques (BAT) enshrined in the IPPC Directive[1], removes the inherent flexibility provided by that Directive through its site-specific and integrated provisions. As discussed in the previous article it also results, at least for SO_2, in emission reductions (and attendant costs) significantly beyond those required to achieve the associated environmental objective in most southern EU Member States.

Based on an assessment of developments in pollution abatement technologies since the adoption of Directive 88/609/EEC, the revised Directive also mandates more stringent emission limits for 'new new' plants[2].

In this article we briefly review some of the key implications for the EU refining rector of this revision to the original Directive.

SO_X EMISSIONS

The emission limits for SO_x in the revised Directive are shown in Figure 1 for 'old', 'new' and 'new new' combustion plants as a function of thermal capacity. As in the original Directive, two alternatives are possible for refineries, viz. emission limit values (ELV) for individual combustion plants or an overall average 'refinery bubble concentration'. In both cases, the requirements for 'new new' plants are much tougher than those for 'old' and 'new' plants. To enable the impact of these two alternatives on existing refineries to be more readily seen, Figure 2 expresses the limit values from Figure 1 in terms of the equivalent level of sulphur in the refinery fuel oil that can be used. This maximum sulphur level is plotted as a function of the percent fuel oil fired in a given unit or, in the case of the bubble, the refinery as a whole. Only the case of 'old' and 'new' units or existing refineries are covered in this figure.

---

[1] *Council Directive 96/61/EC on Integrated Pollution Prevention and Control*

[2] *Plants for which a full construction licence is issued 12 months or later after the entry into force of the Directive or that are brought into operation 24 months or later after entry into force*

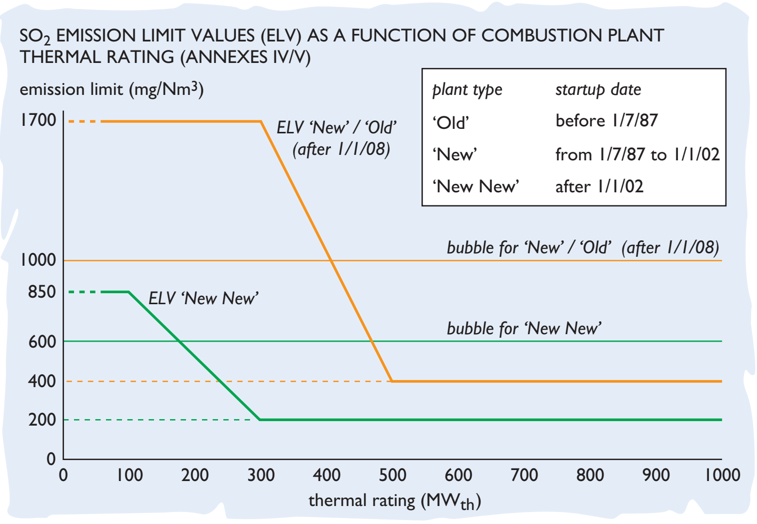


Figure 1
SO_x emission limits are much tougher for 'new new' plants than those for 'old' and 'new' plants.

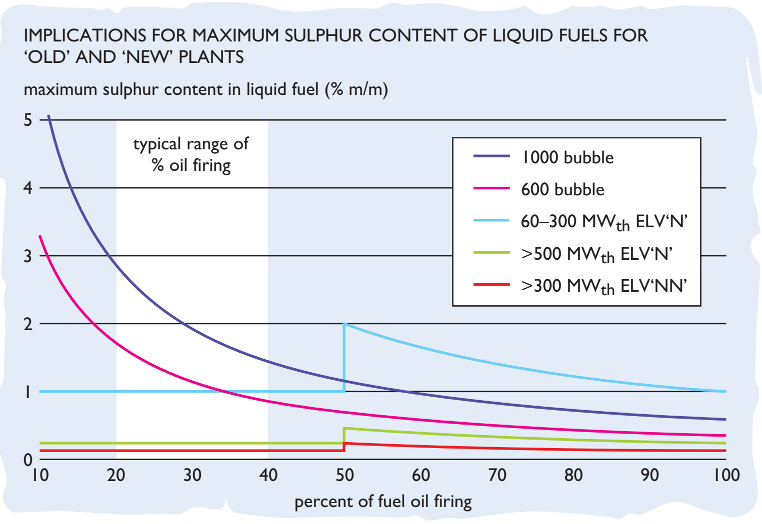


Figure 2
The limit values in Figure 1 are expressed here in terms of the equivalent level of sulphur in the refinery fuel oil that can be used.

For the alternative where emission limit values are set for individual plants, the 'majority fuel' concept—a specific provision for refineries—is preserved in the revised Directive. This important provision results in an emission limit for mixed oil and gas firing equivalent to the 'oil only' emission limit, provided the percentage of fuel oil firing is 50% or more on a thermal basis. The effect of this provision is clearly seen in Figure 2. For combustion units up to 300 MW_{th}, the emission limit is 1700 mg/Nm^3 and is equivalent to an average sulphur content in the liquid fuel of 1% m/m[3]. This jumps to 2% m/m at 50% fuel oil firing as a consequence of the majority fuel concept.

Figure 2 also shows that the second alternative, which specifies a refinery bubble concentration, clearly provides for a greater flexibility in fuel usage in the refinery. For 'old' and 'new' refineries, at the typical overall range of oil to gas firing in EU refineries, the bubble limit of 1000 mg/Nm^3 would allow the firing of 1.5 to 3% m/m sulphur fuel oil regardless of thermal capacity. For a grass roots refinery ('new new'), the bubble limit of 600 mg/Nm^3 would make it very difficult to fire any high sulphur residual fuel oil, although the alternative individual plant emission limit value would be even more restrictive. In this case, with an emission limit of 200 mg/Nm^3, 'new new' plants over 300 MW_{th} would, even under the majority fuel concept, only be able to burn 0.25% m/m sulphur fuel oil.

Clearly, the revision to emission limits on SO_x outlined in the revised Directive will, in the medium/longer term, make it difficult for refineries to continue to burn residual fuel oil. With even higher downward pressure on the sulphur level of marketed heavy fuel (via the 'Sulphur in Liquid Fuel' Directive) this will make significant further investment demands upon the EU refining sector, particularly in southern Europe with its dependence on higher sulphur crude sources.

NO_X EMISSIONS

Figure 3 shows the emission limits for NO_x in the revised Directive. For NO_x the Directive makes no provision for an alternative average bubble concentration. This means that the special 'majority fuel' provision for refineries is particularly important. This is seen more clearly in Figure 4. This provision will have significant implications for the refinery's fuel management strategies on individual units. Maintaining the proportion of fuel oil firing above 50% on individual units has clear advantages in terms of the emission limit.

---

[3] *Assuming the sulphur content in the other fuels is negligible*

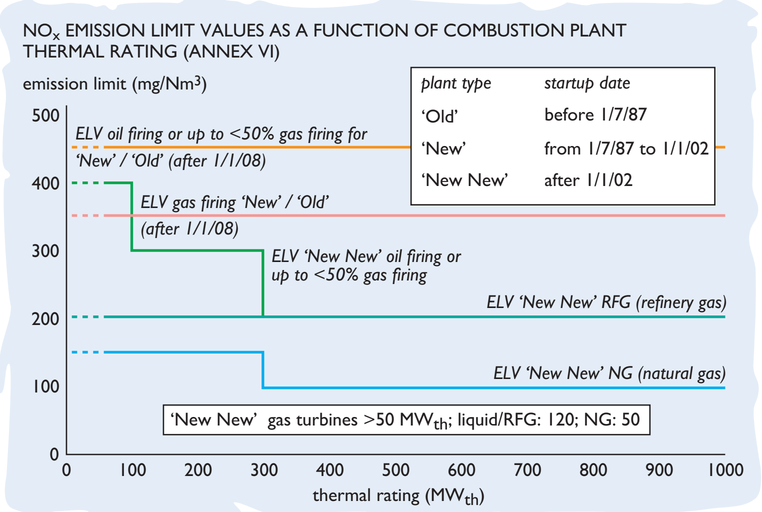


Figure 3
The Directive makes no provision for an alternative average bubble concentration for NO$_x$.

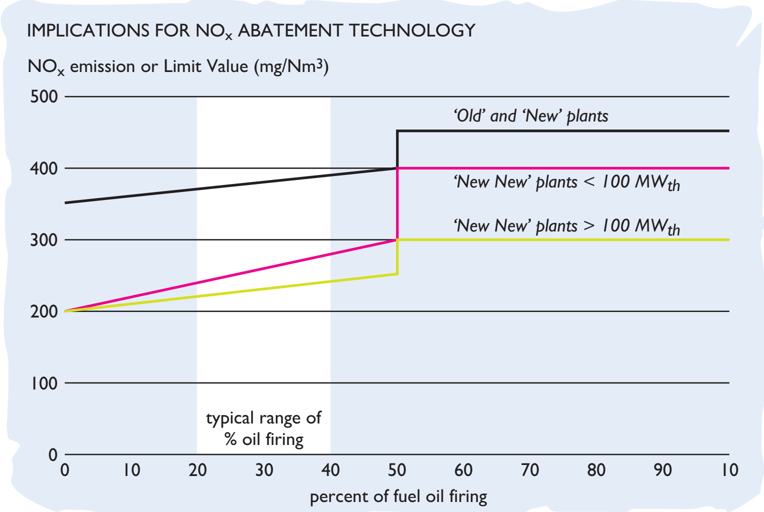


Figure 4
Maintaining the proportion of fuel oil firing above 50% has clear advantages in terms of the emission limit.

The NO$_x$ emission limits are in themselves extremely challenging, especially for high nitrogen content residual fuels and/or units where investment in energy conservation has resulted in high levels of combustion air preheat. In some situations it may be impossible to maintain current levels of air-preheat and comply with the new emission limits. This illustrates the potential for 'environmental tensions' (energy efficiency v. NO$_x$ emissions) when the 'integrated' aspects of the IPPC Directive are jeopardized by the application of fixed emission limits for a single *pollutant*. The requirement for compliance with the emission limit value over a 48/24 hour averaging period will effectively increase the stringency of the new limits since these limits will need to be met for the 'worst' set of operating conditions over the year.

PARTICULATE OR DUST EMISSIONS

Figure 5 shows the emission limits for particulates as a function of plant thermal rating. As for NO$_x$, there is no provision for an average bubble concentration for particulates. Hence the special 'majority fuel' provision for refineries again provides a much-needed flexibility. The advantage of maintaining fuel oil firing in a given unit just above 50% is clearly seen in Figure 6. Maximizing gas firing whilst staying within the requirements of oil being the 'majority fuel' will help to minimize the formation of carbonaceous particles. However, particularly for 'new new'

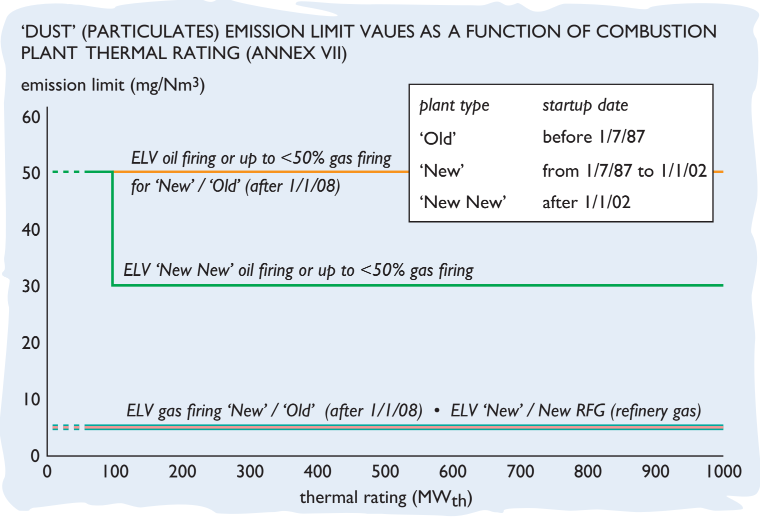


Figure 5
As with NO$_x$, there is no provision under the Directive for an alternative average bubble concentration for particulates.

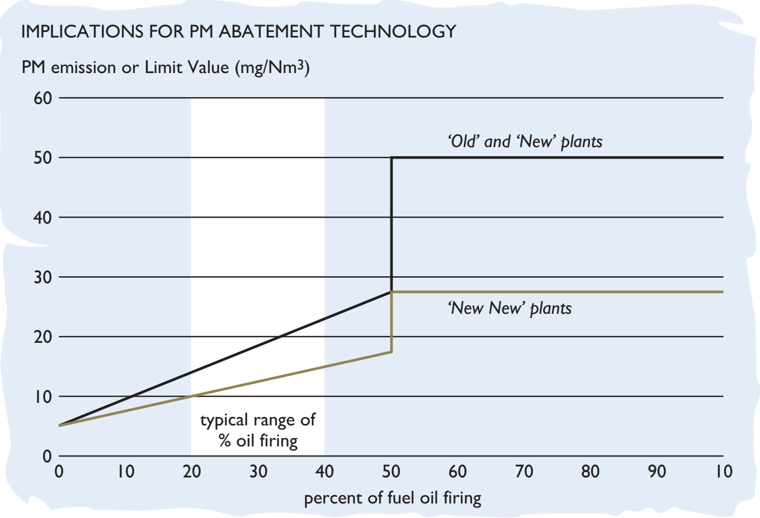


Figure 6
The advantages of maintaining fuel oil firing at just above 50% are clear; but for many plants this may be difficult to achieve given the stringent limit on PM emissions.

plants, the stringent limit on PM emissions is likely to seriously restrict the firing of heavy residual fuel oil in refineries, especially those with high Conradson Carbon Ratios/high ash contents. Complying with both the NO_x and PM emission limits, given the potential of primary control measures, will also be a significant challenge.

A SPECIAL PROVISION FOR ADDING NEW PLANT TO REFINERIES

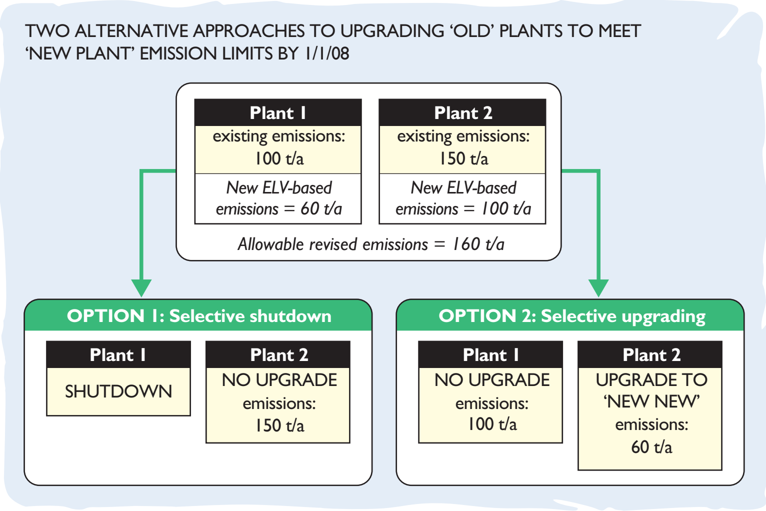
An important provision of the Directive, is the determination of the emission limit value for 'extensions' to existing refineries. The limit value for a 'new new plant', added to an existing refinery, is based on the thermal rating of the additional plant alone and not on the whole site after the new plant has been added. The significance of this provision can be seen by reviewing Figure 3. If a 60 MW_{th} plant is added to a refinery which has an original thermal rating of 400 MW_{th} then the emission limit for the additional plant is 400 mg/Nm^3. Without the special refinery provision the limit would have been 200 mg/Nm^3.

AN IMPORTANT FLEXIBILITY FOR UPGRADING 'OLD' TO 'NEW'

One further important flexibility in the revised Directive is the provision of an alternative approach to the upgrading of 'old plants' to meet 'new plant' emission limits. This is based on the concept of a national 'old plant emissions bubble'. The provision is clearly aimed at providing a cost-effective route to delivering the overall emissions reduction achieved by upgrading 'old plants' to meet 'new plant' emission limits. The way it is designed to operate is best illustrated by a simple example of two 'old plants'.

Plant 1 emits 100 t during the 'accounting year[4]' while Plant 2 emits 150 t during the same period. When the upgrading requirements of the revised Directive are applied to these two plants, the allowable emissions are 60 t/a for Plant 1 and 100 t/a for Plant 2. Figure 7 illustrates how the flexible provision of the Directive would allow two basic means of achieving the overall goal of the 'national ceiling' of 160 t/a. One route would be to shut down Plant 1 and, without any upgrade, continue to operate Plant 2. This would result in emissions of 150 t/a, which is within the target of 160. However, a special restriction within the revised Directive does not permit the emission of Plant 2 to be increased above its original 'accounting year' level so that Plant 2 could not, with the same fuel, be operated at a higher capacity than in the accounting year.

Figure 7
Upgrading 'old plants' to meet 'new plant' emission limits may provide a cost-effective route to achieving an overall reduction in emissions.



The other route to achieving the 'national ceiling' is 'selective upgrading'. This would be based on the notion that Plant 2 represents a more cost-efficient route for upgrading than Plant 1. In this case Plant 2 would be upgraded to meet more stringent emission limits than required for 'new plants' (perhaps close to 'new new' emission limits) so that its emissions were no more than 60 t/a. As a consequence, Plant 1 would be able to continue to emit its original base emissions of 100 t/a.

Such a provision at the national level will undoubtedly be difficult to implement, espe-

---

[4] *In the revised Directive this is set as year 2000*

cially if attempts are made to ensure a cost-effective flexibility across industrial sectors. However, within the context of an individual refinery or within a refining company with several refineries in a country, such a provision offers a significant potential for optimizing, from a cost point of view, the attainment of the overall environmental goal.

This brief review of the key implications of the revision to the Large Combustion Plant Directive demonstrates that it presents a major challenge to the EU oil refining industry. In particular it will significantly curtail the use of heavy residues from the refining process for which alternative disposal routes are already either closed or in the process of being closed. Such an outlook suggests further significant investment pressures on the downstream sector as well as additional CO_2 emissions associated with energy-intensive residue upgrading processes.

Furthermore, the new emission limits for both NO_x and particulates represent a significant challenge to combustion control technology. The prospect of these limits resulting in a need to retrofit high cost, end-of-pipe technologies, for an industry which is only a minor (<2%) contributor to both NO_x and particulate emissions in the EU is a major concern.

Automotive particulate emissions

Growing knowledge in a complex area

Particulate matter (PM) in the air continues to be the focus of increased attention due to concerns over potential health effects. Under the EU Air Quality Framework Directive an air quality standard has been defined with respect to PM_{10}[1] with a review planned in 2003.

Legislation to control the overall mass of automotive particulate emissions has been progressively tightened over the years. While there is evidence that adverse health effects are associated with current ambient PM concentrations, it is as yet uncertain which feature of the particulate matter, chemical or physical, has the most relevance for health. Further work is needed to understand health effects. In the automotive area, extensive studies have been carried out on the number-based size distribution of particulate emissions. This article provides an update on recent activities and CONCAWE's current understanding on automotive particulate emissions.

SCOPING STUDIES ON AUTOMOTIVE PARTICLES COMPLETED

CONCAWE embarked early on the study of automotive particulate emissions by mass, number and size. Initially a thorough literature survey was carried out to identify suitable measurement methodologies for both mass and number distributions of particles[2]. This work was followed by a scoping exercise to improve the understanding of particulate emissions using a range of light-duty diesel and gasoline vehicle technologies with a wide range of market fuels[3]. A heavy-duty engine test programme was then carried out covering two engine technology levels (Euro 2 and 3) and using a fuel matrix similar to that used for the light-duty diesel vehicle study[4]. More recently the final reports from the collaborative work between the UK DETR[5], SMMT[6] and CONCAWE have been published[7]. The major findings from this latest study are reviewed below and put into context with CONCAWE's current understanding on automotive particulate emissions.

UK DETR/SMMT/CONCAWE STUDY HAS BROADENED THE KNOWLEDGE BASE

The DETR/SMMT/CONCAWE Particulate Research Programme investigated the effect of engine technologies and fuel specifications on regulated PM emissions, as well as particle number, mass and size distribution. Emissions from a range of light-duty vehicles (diesel, gasoline and LPG), a range of heavy-duty diesel engines and one heavy-duty CNG engine were characterized. Euro 1, 2 and 3 engine and vehicle technologies were tested with a range of market fuels. The

---

[1] *Particulate with an aerodynamic diameter less than or equal to 10 µm*

[2] *CONCAWE report 96/56, SAE 982602*

[3] *CONCAWE report 98/51, SAE 982600*

[4] *CONCAWE report 01/51, SAE 2000-01-2000*

[5] *DETR: Department of the Environment, Trade and the Regions*

[6] *SMMT: Society of Motor Manufacturers and Traders*

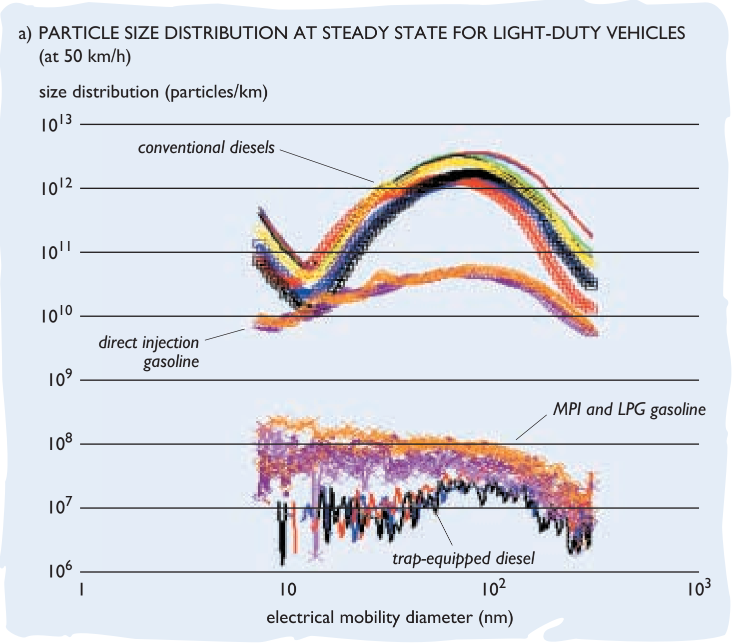
[7] *May 2001, www.ricardo.com*

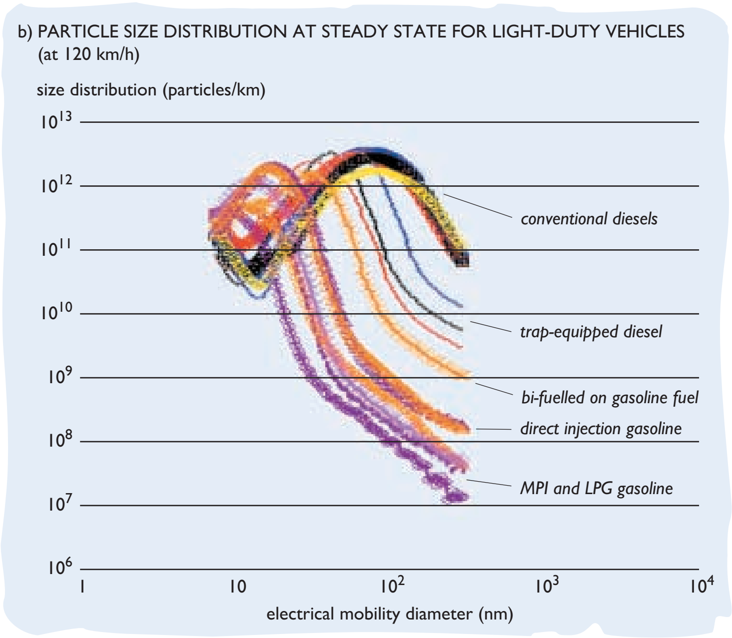
study also addressed the application and limitations of current sampling and measurement techniques and led to recommendations regarding instrumentation and sampling methods.

Two distinct particle types were observed: solid, carbonaceous (accumulation mode) particles and volatile (nucleation mode) particles. It was shown that good repeatability can be achieved for measurements of both accumulation and nucleation mode particles. However, nucleation mode particles were confirmed to be highly sensitive to sampling conditions, dilution parameters and pre-conditioning of engines/vehicles. Limitations inherent to the instrumentation used to measure particle size and number highlighted the difficulties in comparing data derived from different studies. The importance of standardized and representative sampling and measurement methodologies was highlighted.

The study showed that both fuel and engine technology influence particle number emissions. Stricter emission standards have resulted in reductions in particulate mass and this is generally reflected in reductions of accumulation mode particles. However, none of the fuel or engine technologies tested reduced all nucleation and accumulation mode particles as well as particle mass under all operating conditions.

Figure 1
Trends in particle size distribution for light-duty vehicles at:
a) 50 km/h; and
b) 120 km/h


a) PARTICLE SIZE DISTRIBUTION AT STEADY STATE FOR LIGHT-DUTY VEHICLES (at 50 km/h)


b) PARTICLE SIZE DISTRIBUTION AT STEADY STATE FOR LIGHT-DUTY VEHICLES (at 120 km/h)

Diesel particulate filters (DPFs or traps) showed the largest effect of a single technology in both light- and heavy-duty applications, reducing particle mass and number by several orders of magnitude. At high exhaust temperature conditions, however, trap-equipped diesel engines produced significant numbers of nucleation mode particles.

In the light-duty fleet, the highest particle numbers were emitted from conventional diesel vehicles. Particle number emissions from conventional MPI gasoline vehicles, the LPG vehicle and the diesel vehicle fitted with a particulate filter system were several orders of magnitude lower than those from conventional diesel. Gasoline direct injection vehicles gave particle number emissions between the conventional gasoline and conventional diesel vehicles. The heavy-duty CNG engine produced significantly lower particle mass and number emissions compared to the heavy-duty diesel engines. Examples of the trends in the light-duty fleet are illustrated in Figure 1.

Fuel effects were small compared to the effects of engine technologies. Swedish Class 1 diesel fuel showed a small but significant reduction in particle mass and number compared to the other diesel fuels tested. Gasoline quality effects were minimal in conventional engines, while UK specification ultra low sulphur fuel reduced particulate mass in direct injection engines.

CONCAWE'S CURRENT UNDERSTANDING ON MEASUREMENT METHODOLOGY

The science surrounding the measurement of automotive particle size and number emissions and their potential health effects is still under development. Generically, automotive particle emissions can be classified into two types:

- accumulation mode, solid carbonaceous particles, representing most of the particulate mass and found mainly in the size range 30 to 1000 nm; and
- nucleation mode, volatile particles, generally smaller than ca. 30 nm.

Instrumentation and measurement techniques are still being developed and it remains difficult to compare data from different instruments and studies. With due care and attention, measurements of the accumulation mode particles can be relatively robust and repeatable. On the other hand, measurements of the nucleation mode particles are very sensitive to exhaust gas dilution conditions, such as temperature, humidity and dilution ratio, as well as to engine/ vehicle pre-conditioning.

Recent studies continue to provide evidence of the complexity of sampling and measuring the full range of particles. There is a greater understanding of the measurement of accumulation mode particles, while more research is needed to understand the complex nucleation processes and the resulting nucleation mode particles. A key challenge remains to develop consistent, practical measurement methodologies which are representative of real-world operating conditions.

MEMBER STATES NOW FOCUSING ON DEVELOPMENT OF TEST SUITABLE FOR TYPE APPROVAL USE

Member States have initiated a new two-year programme under the GRPE[8] to develop a test to measure particulate size and number emissions that is suitable for future type approval testing. A practical test procedure is required for use in routine regulatory emissions testing. It is expected that such procedure will focus on the measurement of the accumulation mode particles, with the ultimate objective of controlling diesel particulate emissions at a level currently achievable by trap-equipped vehicles.

CONCAWE is also participating in work in the DG TREN[9] particulates consortium which aims to further extend knowledge on automotive particulates and should include the development of a representative, harmonized sampling and testing methodology as well as the establishment of emissions factors for current and future vehicles and fuels.

Through its continued involvement in automotive particulate emissions CONCAWE is committed to assisting in the development and application of sound science in a complex and rapidly developing area.

---

[8] *Groupe des Rapporteurs pour Pollution et Energie*

[9] *EU Commission's Directorate General for Transport and Energy*

Hydrogen

A CO_2-free fuel?

The concerns about global warming and greenhouse effect have, quite justifiably, fuelled the search for 'carbon-free' energy sources to curb CO_2 emissions. Road transport is a major user of energy and virtually all of it is based on relatively 'carbon-intensive' fossil fuels. It is therefore the subject of much attention as more 'greenhouse-friendly' alternatives are being considered. Using hydrogen is heralded as such an alternative, with visions of the world gradually converting to the 'hydrogen economy'.

The greenhouse effect is a truly global i.e. worldwide issue and the location where greenhouse gases (GHG) emissions occur is immaterial. The analysis of the impact of any measure, event etc. on the GHG balance must therefore also be truly global if it is to serve a purpose and have credibility.

Pure hydrogen is the cleanest of fuels, as it obviously contains no carbon and produces only water when burned. In addition pure hydrogen can be fed to fuel cells, which are considerably more energy-efficient than internal combustion engines. With regard to conventional hydrocarbon-based fuels, a higher hydrogen content is regarded as 'CO_2-friendly' as, besides containing less carbon, the fuel also has a higher heating value per unit of mass.

Hydrogen, however, is not a primary energy source but rather an energy carrier. Indeed it does not occur as such in nature and has therefore to be manufactured from something else. In its natural state, hydrogen is usually to be found bound with oxygen in water or with carbon in hydrocarbons. Releasing molecular hydrogen requires breaking these (very stable) bonds and is therefore an energy-intensive process. In practice this is done either by partial oxidation or steam reforming of light hydrocarbons, or by electrolysis of water. In the former case, the bulk of the energy required is hydrocarbon-based. In the latter case, the primary energy source used to produce the electricity has to be considered.

The overall picture only emerges when the complete cycle is considered in a so-called 'cradle-to-grave' or, as appropriate for fossil-based road fuels, 'well-to-wheels' analysis. Many well-to-wheels pathways have been proposed and are being actively studied in order to make hydrogen a truly attractive alternative. Amongst them the combination of hydrogen production from natural gas associated to fuel cell vehicles appears to be the most promising even though many technical challenges remain.

The purpose of this article is not to deny the potential of hydrogen as a future fuel but rather to highlight the pitfalls of a superficial analysis and to illustrate how it can lead to the wrong conclusions. In the following lines we consider two situations where the apparent CO_2 emission reduction may be turned into an increase when looking at the complete well-to-wheels balance.

THE C/H MIRAGE: THERE IS NO SUCH A THING AS A FREE LUNCH!

Hydrocarbons, essentially in the form of crude oil, come as a cocktail of molecules, both saturated and unsaturated. Generally there is not enough light material in the native crudes to meet demand, so heavy molecules have to be cracked into smaller unsaturated ones. Starting from a given hydrocarbon source, decreasing the C/H ratio of the fuel pool therefore requires hydrogen to be added. Although some of the energy required for doing so is recovered in the form of increased energy content of the fuel, the global energy balance is invariably negative because of practical and thermodynamic limitations of heat recovery.

The net result is that adding hydrogen to a fuel for the sole purpose of increasing its heat content is always a net CO_2-producing endeavour. This can be illustrated by a simple, if somewhat theoretical and extreme example. Let us consider benzene and its fully saturated equivalent hexane. The relevant data is shown in Figure 1.

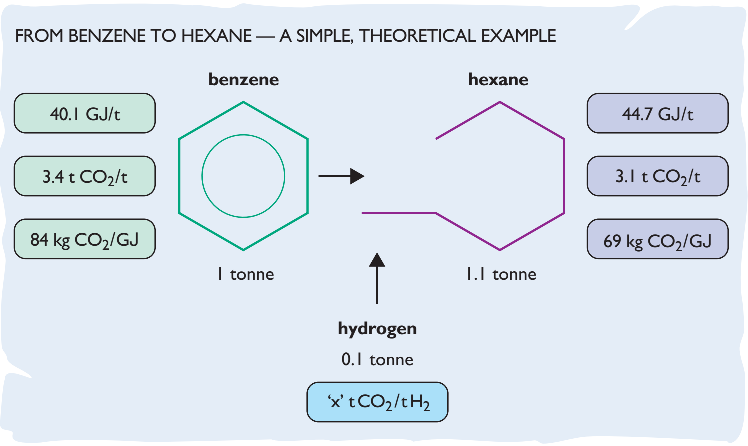


Figure 1
From benzene to hexane (heating values from Phillips databook)

On a 'CO_2-friendliness' basis hexane would obviously always be preferred to benzene as a fuel. However, if only benzene was available in the first place, hexane would need to be made. Turning 1 tonne of benzene into hexane requires approximately 0.1 tonne of hydrogen. Manufacturing this hydrogen causes the release of a number of tonnes of CO_2, the actual number depending on the feedstock, the process used and its energy efficiency. The most widespread hydrogen production route is steam reforming of light paraffins, mainly methane, which typically generates between 8.5 and 9 tonnes of CO_2 per tonne of hydrogen. Processes using heavier feeds, such as partial oxidation of heavy residues or coal, generate much more, up to 15 tonnes of CO_2 per tonne of hydrogen. As we will discuss in the next section, even 'renewable' hydrogen can hide significant CO_2 emissions.

The calculation is easy to complete. About 1.1 tonnes of hexane are produced for a combined potential CO_2 emission of (3.4 * 1 + x * 0.1) per tonne of hexane. The results are shown graphically in Figure 2. Within the realistic range of CO_2 emissions from hydrogen production, the CO_2 balance is clearly always negative.

As a more practical example, we have estimated that adding 0.8% m/m of hydrogen to diesel[1] would result in a net increase of about 2% of the CO_2 emissions associated with this fuel (assuming hydrogen is made with natural gas). With a forecasted diesel demand well in excess of 150 Mt/a in the EU, this would correspond to some 10 Mt/a of additional CO_2 or 10% of the current total emissions from EU refineries. It also has to be said that this level of hydrogenation requires dedicated plants, very few of which exist at the moment.

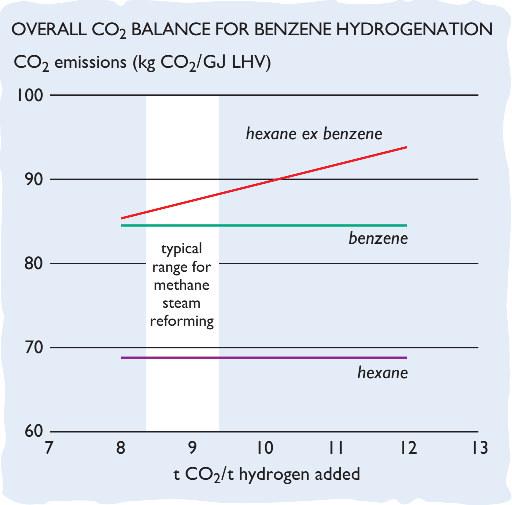


Figure 2
CO_2 emissions in benzene hydrogenation: these can only be justified if they are more than compensated for by the increase in fuel efficiency.

Clearly such increases of CO_2 emissions can only be justified if they are more than compensated by genuine increases in fuel efficiency. This is normally only the case when the envisaged fuel quality change enables a novel, fuel-efficient engine technology to emerge. In the case of diesel, efficiency gains are unlikely to materialize as a result of changes in fuel quality, so the cost of such changes, both in financial and in CO_2 terms, may be an inevitable corollary to achieving the desired targets for air pollutant emissions.

---

[1] *This is roughly the amount of hydrogen that would be required to saturate the bulk of the aromatics in diesel*

HOW ‘RENEWABLE’ CAN HYDROGEN BE?

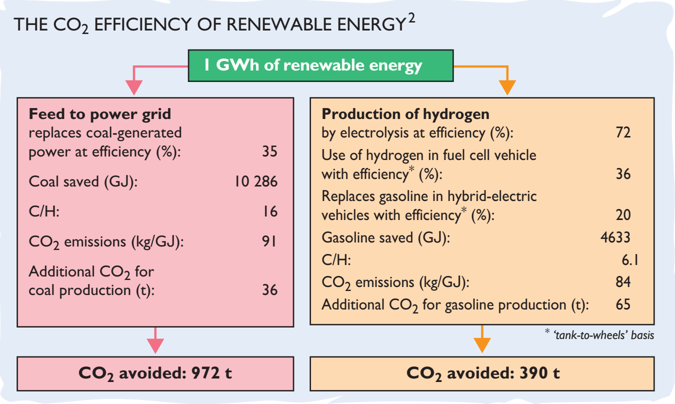
Many well-to-wheels analyses compare an existing situation, or a future situation based on a ‘do-nothing’ or ‘business-as-usual’ scenario, with an alternative view for the future involving novel technologies, mode shifts etc. In most cases, the envisaged changes are gradual and partial, as evolution is generally more likely than revolution. As the changes are marginal, so are the effects. Average values are therefore rarely usable.

Production of hydrogen by electrolysis immediately raises the question of the source of electricity. Enthusiasts will mention renewable energy such as wind or hydropower, raising the prospect of CO_2-free hydrogen. Reality is, however, likely to be somewhat different.

Electricity generation accounts for the largest share of the energy consumed worldwide, and demand for electricity as such is increasing. There certainly are prospects for generating increasing amounts of electricity from renewable sources, but a large part of the balance will continue to be supplied by fossil fuels (coal and gas essentially) for a number of decades to come. As renewable sources (as well as nuclear energy) are most likely to be favoured (on the basis of low variable costs or through political will) they will probably provide the base load (even in off-peak periods). Any additional electricity required to produce hydrogen would therefore effectively be generated by the marginal, least efficient plants. In many parts of the world this means coal-fired power plants.

From a global point of view, hydrogen would therefore be effectively produced from coal, through the rather inefficient process of electricity production followed by electrolysis of water. The only exception to this would be production of hydrogen in remote areas with a dedicated renewable power plant (e.g. solar) that could not practically be connected to a power grid. As transport and storage is one of the major problems associated with hydrogen, this is unlikely to occur on a large scale.

Figure 3
Using electricity from renewable sources to replace coal-based electricity is more CO_2-efficient than using it to produce hydrogen for use as an alternative road fuel.



Independently of economic considerations, and from a pure CO_2 balance point of view, one would wish to select the most CO_2-efficient way to make use of the limited amount of renewable electricity. Figure 3 provides a comparison of two possible routes.

1 GWh of renewable electricity may be used as such through the common grid. It will then displace the same amount of marginal electricity, likely to be coal-based. Alternatively it can be used to produce ‘renewable’ hydrogen by electrolysis. Assuming we are in the future, say 2015, this hydrogen is used in efficient fuel cell vehicles. This displaces other fuels such as gasoline, by then somewhat more efficiently used than today in hybrid-electric vehicles. The balance clearly shows that replacing coal-based electricity is much more CO_2-efficient than producing hydrogen to be used as alternative road fuel. The production of ‘renewable’ hydrogen effectively results in an almost three-fold global decrease of the CO_2-effectiveness of the renewable energy.

The ratio of CO_2 avoided between the two options is of course heavily affected by the assumptions. The same calculation for marginal electricity based on natural gas still shows a 25% increase of CO_2 avoided compared to the hydrogen route.

---

[2] *Electrolysis and vehicle efficiency figures from ‘Well-to-Wheels Energy Use and Greenhouse Gas Emissions of Advanced fuel/Vehicle Systems’. General Motors Corporation, Argonne National Laboratory, BP, Exxonmobil, Shell*

The potential of Whole Effluent Assessment

To date effluent discharges have largely been assessed and regulated on the basis of physical and chemical properties, such as chemical oxygen demand (COD), biological oxygen demand (BOD), suspended solids, pH and concentrations of specific hazardous substances. These properties provide a sound basis for controlling effluents containing relatively few well-characterized contaminants with well-defined and understood toxicological properties. However it is sometimes difficult to assess the environmental significance of complex and variable effluents on the basis of their composition and physico-chemical properties alone.

As an alternative, the Whole Effluent Assessment (WEA) concept proposes the direct measurement of eco-toxicity of effluents as part of an integrated approach to protecting and improving surface water quality. Work is in hand in a number of international bodies to develop an internationally harmonized approach to bioassay requirements, which would be recognized by national agencies and supported by industry. The approach has also recently been recognized by its inclusion in the BAT[1] Reference Document for waste water and waste gas treatment in the chemical industry.

Eco-toxicity assessment provides an additional and perhaps more direct means of assessing the potential impact of effluents on the aquatic environment. It is likely to play an increasing part in the regulation of discharges, supplementing and possibly replacing the traditional yardsticks of effluent quality in environmental monitoring and risk assessment. Cooperation and mutual understanding between the regulators and the industries concerned will be essential to ensure that control of chemically complex discharges remains cost-effective and meets the relevant environmental objectives.

In developing and establishing such an approach it is important to recognize that the choice of bioassay methods depends on the application, i.e. whether results are to be used for risk assessment, monitoring or compliance. Bioassay methods for different applications will have different requirements.

Risk assessment is concerned with evaluating the potential effects of a specific discharge to a receiving environment. Assessment should commence with standardized laboratory bioassays to determine the acute toxicity of the effluent to a range of relevant species. The species should be selected on the basis of existing knowledge of their susceptibility to known toxic effluent components or as representative of important functional groups in the receiving environment. The bioassay results can then be combined with predicted or measured dilution patterns in the receiving water to assess potential risk. In cases where this assessment shows that the expected effluent concentration in the receiving water is close to the no-effect level, further work may be required to assess the level of risk posed by a discharge. This may also be the case when there are concerns over the potential for longer-term effects resulting from the presence of persistent and toxic effluent components.

---

[1] *BAT: Best Available Technique*

Bioassay methods for monitoring effluents differ from those used in risk assessment in that they should provide a convenient mechanism for assessing the variability of effluents being discharged and give a warning if the effluent toxicity has altered significantly. Monitoring techniques need not be the most sensitive, but they have to be capable of detecting changes in relative toxicity which can be correlated with the results of assessment or compliance tests. To be useful these test methods need to be inexpensive, fast, relatively portable and easy to conduct. Field monitoring studies can be used to provide a mechanism for checking that discharge consent parameters are achieving the degree of control and protection envisaged. Monitoring studies should, where possible, include pre- and post-discharge assessments (in both time and space). These will ensure that changes in status attributable to the effluent can be confidently identified.

Bioassays conducted for compliance purposes need to be of a statistically robust design, yield unambiguous results and be reproducible and robust to the closest scrutiny. Without this, site operators risk finding themselves quite unjustifiably liable to legal penalties when it is the test method rather than their performance which is at fault. Such tests should always be carried out by approved laboratories with quality control accreditation. Tests used for this purpose need to have proven test performance criteria and be based on methods that are applicable internationally. The most likely tests for adoption will be adaptations of methods currently required for regulatory chemical hazard assessment.

Both chemical analysis and ecotoxicity assessment of effluent have their own relative merits and disadvantages.

In principle, chemical analytical methods allow calculation of total pollutant load per substance and show whether any particular problem-substance is present. This is, however, only true if all components are measured, which is rarely the case. The presence or absence of any listed substance can be confirmed. Data can also be provided for calculating regional and national contaminant loads, e.g. for monitoring progress towards reduction targets for discharges into a body of water such as the North Sea. The disadvantages of analytical methods are that they are time-consuming and increasingly expensive for effluents containing large numbers of substances. Even with full chemical analysis adequate toxicological data on all the substances is usually not available to allow a reliable assessment of the environmental hazard of the effluent.

The advantages of ecotoxicity assessments are firstly that they provide a measure of the combined effects of all the components in a complex effluent, thereby taking account of any additive or synergistic effects. Secondly they add a degree of biological relevance which can help public understanding of the impact of an effluent and demonstrate the distinction between contamination (substances present at concentrations too low to cause harm) and pollution (substances present at concentrations likely to cause harm). Ecotoxicity assessment provides a mechanism for evaluating the environmental significance of a complex effluent that is usually quicker and cheaper than extensive chemical characterization. Bioassay methods can also be used to assess the quality of receiving waters and for identifying toxic components of an effluent and tracking their origins within a multi-plant site by carrying out the tests on samples taken from various points in the sewer system.

It is widely recognized, however, that there are currently considerable difficulties and limitations in the application of ecotoxicity testing. Perhaps the greatest difficulty is deciding which bioassays are appropriate for each situation. Consideration must always be given to probable differences between environmental effects indicated by laboratory bioassays and the subsequent effect of an effluent in the aquatic environment. Natural degradation processes cannot be simulated reliably in the laboratory without elaborate and expensive test procedures. There is great uncertainty about the precision of results. These are influenced by effluent sampling methods, sample storage conditions, time between sample collection and biological testing, inter- and intra-laboratory variability, effluent variability, level of understanding of the local receiving water conditions, and the influence of the latter on effluent toxicity to resident organisms. These aspects must be carefully examined to ensure that any ecotoxicity assessment scheme is both scientifically sound and practicable.

Research is currently being undertaken to develop reliable and cost-effective methods for the toxicity assessment and monitoring of effluents. Some of the techniques (e.g. bio-sensors) have considerable potential, but they are not currently at an advanced stage of development.

The limited state of development of bioassay methods and the inherent variability of biological testing indicates that ecotoxicity assessment methods currently available are not sufficiently reliable to be used as a compliance criterion in terms of a limit in a discharge permit which triggers legal action if exceeded. Ecotoxicity assessment can be used most effectively as an action level to initiate investigation, identify sources of toxic discharges, prioritize toxicity reduction measures, plan toxicity reduction programmes and monitor improvements both at the end-of-pipe and in the quality of the receiving water. However, it is costly and time-consuming and should be applied only when appropriate to the risk, and the results used only if unambiguous.

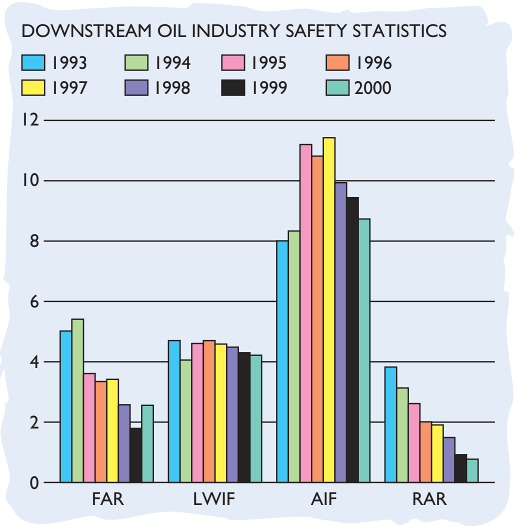
Downstream oil industry safety statistics

CONCAWE has now been collecting data on the safety performance of the downstream oil industry in Europe for eight years. A complete report for the year 2000 will be published shortly. For that period returns were received from all CONCAWE Member Companies who operate refineries which together represent more than 90% of the oil refining capacity in Europe.

Figure 1 summarizes the survey results for all years in terms of four indicators: Fatal Accident Rate (FAR)[1]; Lost Workday Injury Frequency (LWIF)[2]; All Incident Frequency (AIF)[3]; and Road Accident Rate (RAR)[4]. The statistics include own employees as well as contractors.

A notable feature of the surveys has been the decreasing number of fatalities in the industry. Although, with 12 fatalities, 2000 was not as good as 1999 (8 fatalities), the last two years are the best on record in this respect. What is more, of the 20 fatalities recorded over these two years, no fewer than 17 were caused by road accidents. The remaining 3 fatalities occurred during maintenance and construction activities, mainly from collapsing equipment. It is noteworthy that not one fatality resulted from fire or explosion, which is often regarded as the major hazard for the oil industry. Member Companies clearly have to pay even more attention to improving road safety. Efforts in the area have already paid off as the RAR has declined significantly over the years of these surveys. It must be noted, however, that only a minority of companies reports the latter indicator.

The LWIF has been fairly constant with only a slight reduction over the last five years. The AIF figures are more random but have been decreasing over the last four years. Comparison of these figures from year to year is complicated by the fact that not all companies record AIF and that the number of companies that do has increased over the period. Further complications arise from the fact that restricted working is not allowed in some countries and there are differences between what is classified as Medical Treatment and First Aid (which is not included). The ratio of AIF to LWIF has always been lower than expected. It is quite possible that as the reporting of incidents improves, the AIF will rise again. Paradoxically, this may be a positive sign in that one of the basic steps to improving safety performance is to ensure that all incidents are reported so that they can be studied and any weaknesses identified and corrected.



These statistics confirm that safety is improving in the European downstream oil industry. In the past, comparisons with the general situation in European industry have shown that our industry has a good record. This year CONCAWE Member Companies have been compared with the European chemical industry and the upstream oil industry. The figures are of the same order of magnitude although the chemical industry has a higher LWIF and lower fatalities while the opposite is true for the upstream oil industry. All CONCAWE Member Companies are however committed to reducing the number of accidents involving both their own employees and their contractors to as low a frequency as possible.

[1] **FAR**: the number of fatalities per 100 million hours worked

[2] **LWIF**: the number of incidents involving injury severe enough for the worker to miss one or more days work per million hours worked

[3] **AIF**: the number of incidents which cause a worker to seek medical treatment or to be put onto lighter duties per million hours worked (includes lost-time incidents)

[4] **RAR**: the number of road accidents per million kilometres travelled.

CEC reorganization

Additional role for CONCAWE

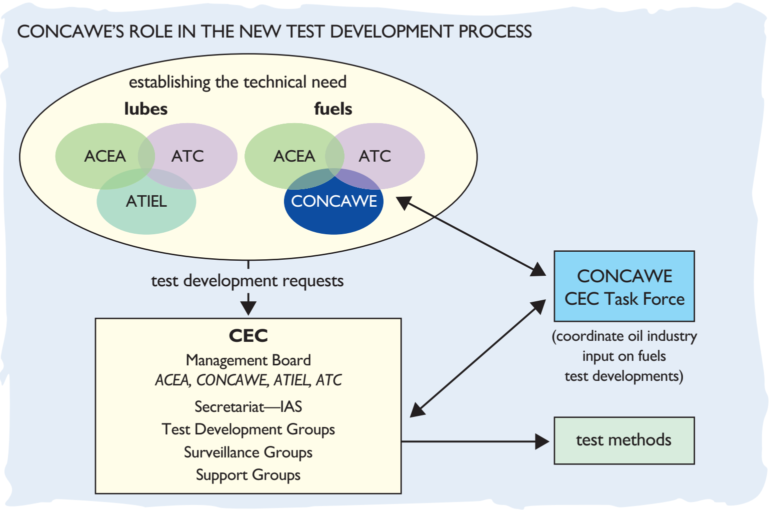
The Coordinating European Council (CEC) is the inter-industry body in charge of developing standardized European performance tests for fuels and lubricants. A detailed review of CEC operations, carried out in response to industries' demands for a more efficient mechanism for European test developments, has resulted in a change of the structure of CEC from management by national industry bodies to management through European associations. Consequently, ACEA, ATIEL, ATC[1] and CONCAWE formed the Management Board of the new CEC in July 2001.

The core mission of CEC remains the same as the industry associations recognize the continuing need for such a standardization body. The new organization is expected to provide a more efficient European-focused forum for relevant test developments.

The new CEC has contracted Interlynk Administrative Services (IAS) to operate CEC's administration from an office based in the UK. CEC itself remains registered in Brussels. The first test development under the new CEC regime, a lubricant fuel economy longevity test, is already under way and has attracted an encouraging number of sponsors.

CONCAWE's role will be to coordinate the oil industry's input on fuels related issues and a new CONCAWE Task Force has been established for this purpose. In the new organization, the definition of the need for tests should be done outside CEC, so that CEC can focus specifically on test developments. To this end, CONCAWE will work with ACEA and ATC to establish the needs for fuels test developments. In the lubricants area, such a mechanism already exists via the 'AAA' forum (ACEA, ATC, ATIEL) and it is expected that a similar mechanism will be established to handle fuels issues. CONCAWE's expectation on the future mode of operation is shown below.

Over the coming months, the new CEC management team will review the existing CEC working groups and determine how best to proceed across the range of activities. In the meantime, the Chairmen of the existing working groups have been requested to continue with their current tasks. Although a lot of work remains to be done to complete the transition to an effective new CEC organization, CONCAWE welcomes the challenge and is looking forward to a fruitful cooperation with the other industry association partners and IAS in establishing the new CEC.


CONCAWE'S ROLE IN THE NEW TEST DEVELOPMENT PROCESS

---

[1] *ACEA is the Association des Constructeurs Européens d'Automobiles; ATIEL is the Association Technique de l'Industrie Européene des Lubrifiants; and ATC is the Technical Committee of Petroleum Additive Manufacturers in Europe.*

CONCAWE news

If you are a fan of CONCAWE reports or a regular visitor to our website you will be familiar with our 'yellow' (general interest) and 'white' (special interest) reports as well as our 'blue' product dossiers. The distinction between 'yellow' and 'white' reports was originally introduced to better target the audience for each series. Partly as a result of the internet era whereby our reports can be downloaded from our website, we have recently reviewed our publication policy and have come to the conclusion that this distinction is no longer justified. Accordingly, from the beginning of 2002 all CONCAWE reports will be 'yellow'. The product dossiers will remain unaltered. The report catalogues will be merged in due course.

As a recipient of the *Review*, you should also have received a short questionnaire designed to inform us whether you prefer to receive our reports in electronic or in printed format. It will also help us to update our 'customer' database by asking you to confirm and complete your contact details. We thank you for your cooperation in completing this questionnaire.

Finally you will find below an updated table of our contact details. Those of you who knew her will notice that Laurence Evrard is no longer with us, having left CONCAWE in August for the exciting environment of a theatre company. You can, of course, also find our details on our website.

SECRETARIAT STAFF

		Telephone	Mobile phone	e-mail
General	www.concawe.be	+32-2 566 91 60		info@concawe.be
Secretary-General	Jean Castelein	+32-2 566 91 61		jean.castelein@concawe.be
Technical Coordinators:				
Petroleum products	Bo Dmytrasz	+32-2 566 91 65	+32-485 54 41 12	bo.dmytrasz@concawe.be
Automotive emissions	Neville Thompson	+32-2 566 91 69	+32-485 54 39 75	neville.thompson@concawe.be
Safety management, water and soil protection and waste management, oil pipelines	Eric Martin	+32-2 566 91 83 or +44-1372 45 23 53		eric.martin@concawe.be
Air quality	Henk Schipper	+32-2 566 91 71	+32-485 75 73 70	henk.schipper@concawe.be
Health	Jan Urbanus	+32-2 566 91 63	+32-485 75 72 31	jan.urbanus@concawe.be
Refinery technology and publications	Jean-François Larivé	+32-2 566 91 67	+32-485 75 73 73	jeanfrancois.larive@concawe.be
Documentation and library	Annemie Hermans	+32-2 566 91 80		annemie.hermans@concawe.be
Secretariat	Sandrine Faucq	+32-2 566 91 75		sandrine.faucq@concawe.be
	Elfriede Geuns	+32-2 566 91 76		elfriede.geuns@concawe.be
	Barbara Salter	+32-2 566 91 74		barbara.salter@concawe.be

CONCAWE PUBLICATIONS, RECENT REPORTS

General circulation (yellow cover) reports:

1/00	European downstream oil industry safety performance—statistical summary of reported incidents—1999
2/00	A review of European gasoline exposure data for the period 1993–1998
3/00	Performance of cross-country oil pipelines in Western Europe—1999 survey
1/01	Motor vehicle emission regulations and fuel specifications—Part 1 summary and annual 1999/2000 update
2/01	Motor vehicle emission regulations and fuel specifications—Part 2 detailed information and historic review (1996–2000)

Special interest (white cover) reports

00/51	The occurrence of selected hydrocarbons in food on sale at petrol station shops and comparison with food from other shops—a literature survey
00/52	Management of occupational health risks during refinery turnarounds
00/53	An assessment of the reproductive toxicity of gasoline vapour
00/54	Impact of a 10 ppm sulphur specification for transport fuels on the EU refining industry
00/55	A review of trends in hearing thresholds of European oil refinery workers
00/56	Revised Dangerous Preparations Directive (1999/45/EC)—implications for petroleum products
01/51	Measurement of the number and mass weighted size distributions of exhaust particles emitted from European heavy-duty engines
01/52	A noise exposure threshold value for hearing conservation
01/53	Classification and labelling of petroleum substances according to the EU Dangerous Substances Directive (CONCAWE recommendations—August 2001)*
01/54	Environmental classification of petroleum substances—summary data and rationale*
01/55	Nickel in oil products and ambient air*
01/56	An assessment of occupational exposure to noise in the European oil industry (1989–1999)*

Up-to-date catalogues of CONCAWE reports are available via the CONCAWE website at www.concawe.be
New reports are generally also published on the website.

* *available shortly*

CONCAWE
Boulevard du Souverain 165
B–1160 Brussels
Belgium

Telephone: +32-2 566 91 60
Telefax: +32-2 566 91 81
E-mail: info@concawe.be
World Wide Web: www.concawe.be