A PHILOSOPHY FOR CLEAN AIR

H I Fuller, MA.
Principal Environmental Scientist
Esso Petroleum Company Limited, Abingdon, Oxon, UK.

OPSOMMING:

Stygende lewenstandaarde wat deur wetenskaplike en nywerheidsontwikkelinge veroorsaak is, het gelei tot 'n toenemende bewustheid onder die publiek van die waarde van skoon lug vir beide gesondheid en welsyn. Wetgewing word in baie lande gebruik om die meer sigbaar besoede lende vrylating te beheer. Saam met skoner lug egter, het die druk vir verdere beheer toegeneem. Toenemende pogings word gewy aan navor sing, epidemologie, tegnologie, beplanning, modellering en verdere wetgewing vir die beheer van subtiele gevolge van spoorsmetstowwe. Onder soeke, vermindering en wetstoepassing vereis die nodige middele, waarvan party skaars is. Hierdie referaat stel moontlike oorsake vir die huidige besorgdheid oor die omgewing voor en beskou sommige van die meer belangrike implikasies vir die moderne samelewing. Daar word voorgestel dat daar 'n toenemende behoefte vir 'n omvattende filosofie is, waarin sosiale verwagtinge in die tegniese vermoë om skoon lug te verkry hul regte perspektief in die spektrum van maatskaplike verbetering vind.

Praktiese aspekte van die opleiding van Munisipale Lugbesoedelingspersoneel en invoering van lugbesoedelingsbeheer deur N. Burgess.

SYNOPSIS:

Rising standards of living, brought about worldwide by scientific and industrial advances, have led to increasing popular awareness of the value of clean air for both health and welfare. Legislation in many countries is used to control the more evidently polluting emissions. With cleaner air, however, pressures have come for further controls. Increasing efforts are being devoted to research, epidemiology, technology, planning, modelling and further legislation for the control of subtle effects of trace contaminants. Investigation, abatement and enforcement all demand resources, some of them scarce. The paper suggests possible reasons for this present preoccupation with the environment and considers some of the more significant implications for modern society. It is suggested that there is a growing need for a wide-looking philosophy in which social expectations and technical capability for achieving clean air find their proper perspective in the spectrum of social improvement.

Thirty years ago it seemed we were concerned only with smoke from open coal fires and fumes from overworked diesel vehicles, with maybe a thought for sulphur dioxide and carbon monoxide. Today, we have progressed until every conceivable aspect of air pollution seems to be under debate. Medical experts argue over exposure and the sub-clinical effects of trace materials on 'sensitive' groups in the population. Scientists attempt to assess the reaction kinetics of transient radicals in the stratosphere. Industry disputes the workability of emission standards set by authorities who appear not to understand the limitations of economics and chemical engineering. And political leaders, aiming to establish socially equitable policies as well as clean air, struggle with both the demands of national productivity and the ideals of environmentalists. We have moved from an age of seemingly simple problems. Now, under the pressures of public awareness – part apprehension, part genuine – we are beset on all sides by complex questions demanding simple answers.

Much progress has, of course, been made. Action in most industrial countries has brought cleaner air to areas once notorious for their fogs and fumes. In the UK, the 'Digest of Pollution Statistics' published last year paints a clear picture of the improvements in the quality of the air achieved in the years since the Clean Air Act of 1956. Concentrations of smoke in urban areas have fallen by nearly four-fifths since 1960, and average UK sulphur dioxide levels are down by a half or more. Much of this quite remarkable improvement is due to the introduction of Smoke Control Orders requiring the use of solid smokeless fuels or gas/electricity/oil in domestic and other premises. As a result, the hours of winter sunshine in Central London now virtually equal those in the countryside around the metropolis. Similar great improvements in air quality have also been achieved in urban areas throughout Europe, the USA, and other parts of the world.

All the same, there is considerable political momentum throughout the world to introduce further controls. The EEC Commission is proposing air quality standards for sulphur dioxide and smoke in order to protect public health, and would like to see limits set for the sulphur content of fuels, as in the USA. The UN Economic Commission for Europe is following the US lead in wanting stricter limits on the emission of carbon monoxide, unburned hydrocarbons and nitrogen oxides from vehicles. In Germany, where the TALuft already sets limits for a wide range of air pollutants, attention is turning to emissions of nitrogen oxides and certain trace metals. In the UK there is continuing concern about lead in the environment, and studies are in hand to relate the significance of lead from petrol to that from other sources such as food and drink, especially for small children.

Clean Air Regulations – In principle, setting up a system of clean air regulations looks pretty straightforward. You determine your air quality health criteria, usually on the basis of a range of epidemiological studies, you set air quality standards that will meet those criteria and also be politically satisfactory, and then you require suitable reductions to be made in emissions from the various sources. With a bit of monitoring and some enforcement of the regulations, you perhaps feel the system will then give the clean air everybody wants. But, of course, it's not that simple. One has only to glance through the literature to see the extraordinarily diverse and formidable amount of research that is going on to quantify the many links between emissions from a source and their possible effects on the environment and on us.

I believe many of our current difficulties arise from the policy – popular in some countries – of seeking uniform reductions in emissions from all sources contributing to the pollution in an area. The belief seems to be that this approach is, by definition, equitable. But of course it ignores technical feasibility : what is easy for one plant may be very difficult for another, and clearly improvement should be more pressing where emissions have a special impact on the environment. Such a policy may also ignore national priorities for the goods or services being produced along with the emissions.

However, once such a policy has been adopted, it becomes politically necessary to be seen to be equitable, which means identifying the contribution from each source, and this in turn leads inevitably to a search for reliable source dispersion formulae and area modelling techniques. The ultimate situation is surely that obtaining in the USA. There, under the Clean Air Act Amendments of 1970, individual States were supposed to meet the national Air Quality Standards by 1977 but no further industrial developments were permitted in the "non-attainment areas". Recognising the effect this would have on the national economy, the Environmental Protection Agency modified the rules so that new sources could be allowed in those areas, provided that their emissions were more than offset by "trade offs" from existing sources in the area.

Bedevilled by these complexities, however, and by endless debates about 'no significant deterioration' in rural areas, industry has become understandably reluctant to install new plant in practically all parts of the USA. In another attempt to ease the burden, the EPA has recently put forward its 'air bubble' proposal. This is intended to assist complex industrial sites by giving them the opportunity of effecting internal trade-offs. EPA say this will allow industry to cut back more severely on those emissions of a pollutant which are easier and cheaper to control, rather than having to achieve equal reductions in all types of emissions, including those which are difficult to find and expensive to control.

The OECD, reporting earlier this year on the rolé of technology in clean air regulations, concluded that uniform emission standards are generally suitable only for a homogeneous group of sources. They said Air Quality Objectives (AQO's) are to be preferred, for both economic and environmental reasons, to take account of the specific environments of the sources and the availability of suitable control technologies. Thus the AQO approach allows control strategies to be developed to suit the particular circumstances of climate, topography and urbanisation of an area, and also to take recognition of national or regional economic policies, fuel supplies and so on. It is very interesting to note that the US 'bubble' proposal in fact follows the philosophy recommended by OECD – as does the UK's often-maligned but pragmatic policy of relying on Best Practicable Means to achieve reductions in emissions. The BPM system takes into account factors such as the age of the plant, the process it uses and, most important, the financial burden involved in making changes. Although a great deal of criticism has been levelled at the BPM approach, investigations show it to be more effective in practice than imposing absolute standards of control because it achieves a balance between what can be done and what should be done.

Health Criteria – Most air pollution research so far has looked at the behaviour and effects of the inorganic gases – carbon monoxide, sulphur dioxide, and so on – generally one at a time, and this has been moderately successful in providing a basis for today's regulations. However, most polluted air in fact contains a very wide range of substances, almost any of which might have deleterious effects and each with its own dose-response relationship. It is the practice of studying pollutants individually (and, moreover, often ignoring the effects of other environmental factors) that has undoubtedly led to much of the current controversy over the setting of criteria and standards. This has certainly been the case with the 'sulphur' story. First it was sulphur dioxide. Then it was synergism with particulate matter. When the evidence remained inconclusive, despite years of study, attention was turned to sulphates – with no better evidence. The discussion continues.

Uncertainty is also to be seen in the current debate about the proper way to measure and limit suspended particulate matter. There are those who believe all airborne particulates are suspect; they propose controls based on the high-volume sampler. Others are convinced that only small respirable particles are significant, and would introduce measures based on cascade sampling. Yet others point to an apparent correlation of biological activity with the carbon content of suspended particulates and support air quality standards based on the 'sootiness' of filters, emphasising that most of the long-term epidemiological evidence is related to filter stains.

Fortunately, there is a good deal of evidence – negative though most of it may be – that the reduction of air pollution to the levels now being achieved in many areas has eliminated the adverse health effects, both acute and chronic, that were so evident in the industrial towns of the 1950's and earlier. For instance, in a four-day episode in London in December 1975, although smoke and sulphur dioxide levels rose six-fold over the current winter average, there was no discernible effect on the morbidity or mortality statistics – certainly less than a cold spell a few weeks earlier and vastly less than an outbreak of influenza a month or so later. In fact, the main factors now seen in most epidemiological studies are cigarette smoking and the history of respiratory infections.

With falling levels of many pollutants, it is more difficult to find 'populations' that are sufficiently exposed to be significant for epidemiological study. Since artificial exposures pose ethical problems, it will become increasingly difficult in the future to get realistic evidence for defining health criteria.

Thanks to advances in analytical techniques, our ability to detect low concentrations of airborne substances has improved by orders of magnitude in the last few years. At parts per trillion sensitivity in several instances, it now greatly exceeds our ability to assess toxic potential and to keep it in perspective. The identification of a threshold is difficult because, by definition, effects are marginal at this level of exposure. They become lost in the 'background' responses to a host of natural variables or to compensations for life styles and habits. Smokers may have as much as 15% carboxyhaemoglobin in their blood and yet apparently not suffer the effects of such chemical anaemia. Where does healthy adaptive response to a changed environment become actual ill-effect? In setting air quality criteria or objectives, how should we allow for natural variability, the effects of age, poor diet, illness?

Control Priorities – Clean air regulations need to have a certain degree of social efficiency. They have necessarily to concentrate on those pollutants which affect a significant proportion of the population. For instance, it would seem to be right to reduce the exposure of the public to harmful emissions from motor vehicles in urban areas, where both people and cars gather together. On the other hand, a highly toxic substance which could affect only a few individuals who could readily be protected may well deserve a much lower priority for control. In trying to define "sensitive groups" in the population that deserve special protection, should we include merely the young, also the disadvantaged such as asthmatics, or those even at death's door too? Some research studies already make impact assessments based on population distribution statistics. Could these be linked with pollutant distribution data to identify areas deserving priority?

Because it is difficult to define sound health protection criteria, even for the much-studied 'classical' pollutants, there has to be scope for reappraisals. Thus a recent review of the toxicology of the sulphur oxides has concluded, like others before it, that there are no important long-term effects from exposure to this group of pollutants, and that there is certainly no supporting evidence for more stringent standards. On the other hand, public apprehension about 'dirty air' and political momentum based on this will undoubtedly impede many attempts to relax standards. Take the recent case of the oxidant standard in the USA. This was originally set at 0.08 ppm but subsequent research failed to confirm the evidence on which the criteria were based. Later studies indicated that photochemical smog causes only temporary discomfort and affects the ability to do heavy work only at levels of 0.25 ppm or more. Yet the administration felt unable to relax this costly standard beyond 0.12 ppm – and even this relaxation went further than some felt was safe. Since it is known that several standards were set with wide margins of safety at a time when better data were not available, does not this problem of relaxation as later information de-emphasises a pollutant need attention if society is not to expend resources on unnecessary controls?

Minimal Risk – Most of the remaining problems with the 'classical' pollutants are associated with local or specific emitters, the industrial 'hot-spots'. However, the increasing cleanliness of our cities has raised expectations. Whereas the industrial fogs of the past were often seen as the price of prosperity, now there are demands for ever more improvement – towards still lower concentrations, for the control of more esoteric substances, and for protection from ever more subtle effects.

This concern about trace pollution by exotic chemicals seems to be part of a general desire these days for greater personal security. It is almost as if the very success of modern technology, of modern medicine above all, has encouraged us to believe that everything is now possible. So the search is on to identify and eliminate all risks, all contamination. In the words of James P. Lodge : "Our success has led to a crisis of expectations that will not be met this century".

This attitude to risk is echoed in the rapid recent growth of health and safety legislation and of consumer protection laws in Europe and the USA. Public apprehension about air pollution is leading to demands to review exposures whose effects may be sub-clinical or are to be found in intangibles such as a shortening of lifetime or a reduced capability for dealing with stresses in old age. Behind these concerns lie the great modern fears of cancer and foetal damage.

No longer are we concerned with pollutants that are supposed to produce a more or less immediate response. Instead we are dealing with materials which, from a single exposure, may possibly produce an effect far into the futre. In this area of scant knowledge, moreover, most individuals who come into contact with typically moderate amounts of a recognised carcinogen do not develop cancer, while those who do get cancer have invariably been exposed to a wide range of other potentially carcinogenic agents. Few epidemiological studies of human exposures to any of these pollutants can be wholly convincing, yet problems are unavoidable in trying to define human risk from animal studies, usually made with high concentrations of a single substance.

If a pollutant is any substance that, in some concentrations or other, may be hazardous (EPA's definition), clearly there is no end to the number of substances that will have to be identified, measured and controlled. But there are limits of finance and skills that can or should be devoted to studying these trace components of our environment. The range of concern is very wide. It includes arsenic and cadmium, dry-cleaning fluids and benzene, and even secondary pollutants such as nitrosamines formed in the air from reactions between nitrogen oxides from combustion and amines from decaying protein. It would be impossible to sample and analyse every possible emission from every industrial or other activity. Yet, in the pursuit of consumer protection, the US Toxic Substances Control Act of 1976 (ToSCA) requires listing of all manufactured chemical substances that may be harmful, and EPA can limit the manufacture or use of any that do not pass stringent tests for toxicity. There are 10 000 chemicals on the list so far, and it is ultimately expected to include more than 500 000, but the toxicity testing is imposing such a load that a priority list of only a few hundred substances has had to be developed and even this is running well behind schedule. Because other countries face similar problems, several international information systems are emerging : eg UNEP's International Register of Potentially Toxic Chemicals ('IRPTC') and the EEC's 'ECDIN'.

Abatement Costs – No amount of research, or of modelling and monitoring, provides a solution without effective abatement measures. The first steps are often simple, requiring little more than good housekeeping or better maintenance; this is the case, for instance, in reducing exhaust emissions emissions from vehicles. When, however, more elaborate technological arrangements are needed – for large reductions in automotive pollution, or for reducing dust emissions from coke ovens or cement plants – then large expenditures are involved. For example, Swedish authorities estimate a recurring cost of more than R4 500 million ($5 bln) each year to halve European sulphur dioxide emissions, which could put up electricity generating costs by 25–30%. While "the polluter pays", as EEC policy requires, it is inevitable that these costs must eventually be passed on to the consumer and to society as a whole.

The improvements that are being achieved have been expensive. In the Federal Republic of Germany, industrial investments for environmental measures are currently running at more than R900 million (DM 2 bln) a year. In the USA, such expenditure absorbs some 2% of the GNP. It is common in large new industrial developments to devote 15% of the investment to environmental protection.

Abatement is, in fact, often technically difficult, and always involves the expenditure of additional manpower, finance, and material resources – of which, energy must be regarded as the most important. The energy cost of pollution abatement cannot be ignored. Electrostatic dust-precipitators and flue-cleaning processes consume sizeable amounts of energy, quite apart from the energy needed to make the materials of construction. For the reduction of sulphur in industrial fuel oil, 8–10% of the feedstock is consumed in keeping the process going. The next stage of European vehicle emissions control will worsen fuel consumption by 3–5%.

Social Priorities – Because resources of energy and of other materials are becoming increasingly scarce and expensive, it is becoming increasingly important to consider what proportion of our limited resources we should devote to a cleaner environment, in competition with demands from perhaps even more worthy causes. From all points of view, therefore, clean air and other environmental regulations should conform to certain basic criteria : the need for the controls should be firmly established, the controls should be practicable, there should be enough lead time to implement them, and they should be worth more to society than they cost. These criteria are fundamental, and failure in any aspect will eventually bring the regulations into disrepute. The danger is that regulatory agencies, under criticism for inaction by some pressure group or a politician seeking votes, may prefer a popular 'safe' action over considerations of product cost and availability or energy economics and national productivity.

Fortunately there are several signs of a changing emphasis in overall policies and strategies. On to the growing legislative and administrative framework designed to provide for a wide protection of the environment is being grafted a growing recognition of the importance of planning to reconcile the whole range of social objectives. It is an area where long lead-times are unavoidable, and where the state of world and national economics plays a key role in determining the achievable balance between a clean environment and other valid aims, constraints and opportunities.

It has been said we are now in the third phase of environmental development. By the end of the last century, great improvements were being made in housing, sanitation and public health generally. In the middle of this century, efforts were directed towards solving the major problems of air and water pollution – work which is becoming more specific and specialised as it progresses. But now attention is turning to questions about the 'quality of life'. We need to consider not merely protection of our immediate environment but also its creation, with due concern for the proper conservation of material and energy resources. This will necessarily involve careful consideration of our attitudes to all aspects of community living. The debate will have a long future!