

WORLD WIDE TRENDS IN MOTOR VEHICLE EMISSION STANDARDS

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Presentation to the NATIONAL ASSOCIATION FOR CLEAN AIR
Annual Conference "CHARTING A COURSE FOR THE 90s"

ABSTRACT

The emissions from the combustion of fossil fuels are receiving greater attention now that they have for some years. Realisation that the standards designed to control emissions need to be continually reviewed to match the changing industrial environment is leading to much more concern over the issue. Measures which were thought to be sufficient to contain the problem, are now being shown in some cases, to be inadequate.

In order to meet the regulations being adopted throughout the world, engine manufacturers and fuel suppliers have been required to devise new technologies. This has led to a greater awareness, in both of these industries, of the effects that new technology can have on ambient air quality.

Experiences over many years in other parts of the world has provided this country with the opportunity to study the end result of different regulatory standards and their long term effects, and to draw meaningful conclusions when considering the directions which should be taken in order to ensure that our future generations do not suffer.

INTRODUCTION

There is no doubt that emissions from the combustion of fossil fuels are receiving greater than ever attention in today's world. The Greenhouse Effect, acid rain and photochemical smog are the resultant of man's development and a measure of the reliance that is placed on fossil fuels to power the world of convenience in which we live. Not so many years ago, a car was considered an absolute luxury. Even today it represents the second major item of expense for the private motorist, after the house purchase, but if we are honest with ourselves, how many of us could enjoy life without wheels? It would take a major undertaking in local transport development to persuade people that there is an alternative. Driving into and out of Cape Town on a business day can be a frustrating experience and calls for a good deal of self discipline. Thus we have to accept that road transport, in whatever form it takes, is here to stay.

On his inauguration as the forty first president, of the United States of America, President George Bush announced as one of his major objectives, "THE GREAT AMERICAN DREAM - CLEAN AIR", and immediately set about investigating ways to tighten the regulated emission standards in force in that country, claiming that he would halve the level of emissions during his term of office. The USA has led, and is still leading the world in measures to control emissions, perhaps because they appear to have some of the worst problems. We have all seen the famous Los Angeles smog depicted on television. The combination of the city's surrounding ring of hills, and its good weather, make a perfect trap for pollution. This city consumes more than 20 billion litres of petrol per year. Every day, more than 750 000 cars venture onto the roads and, it is estimated that by 2012, there will be 8 million more. One effect of this is to increase commuting time for the average motorist to more than two hours, about half of which will be spent at a dead stop. Another is to vastly increase the amount of exhaust pollution in

real terms that is emitted into an already overloaded atmosphere. It thus comes as no real surprise that strategies for air quality improvement are continually under discussion. One of the plans is to phase out the use of petroleum based fuels and solid fuels in industrial plants and replace them by natural gas and other "clean" fuels, such as methanol. As the vehicle population is considered to emit about 50% of the airborne pollutants, one may see this as the target for such alternative fuels. The technology is fairly well known today and it is not conceivable that this could be considered a viable alternative. Thus, in an area where catalytic converters and unleaded fuel were seen some years ago as the answer to their pollution problems, the sheer increase in numbers of cars on the road are causing plans to change, and a search for a more long term solution. This is, perhaps, an extreme case. Conditions in other parts of America are much less of a problem, but it serves to illustrate what can happen. American is, however not alone, Japan suffers almost as badly, and the problem is well known in Johannesburg, given the right ambient conditions.

Photochemical smog is caused by the interaction of hydrocarbons, nitrogen oxides, ozone and sunlight and thus is a symptom of modern society. The more vehicles that occupy the roads, the greater is the chance of this type of problem. If we consider the local scene, there are some 4,5 million vehicles on the roads of this country, just over 3 million of which are gasoline engined motor cars. With the prospects of transport deregulation, and the population expansion, these numbers could double in the next 15 or 20 years - one generation. If we consider the slogan used by the New Zealand Department of Lands and Survey, which reads "TRUE CONSERVATIONISTS ARE PEOPLE WHO KNOW THAT THE WORLD IS NOT GIVEN TO THEM BY THEIR PARENTS BUT IS BORROWED FROM THEIR CHILDREN", the evaluation of the future effects should not be a task that is put off for too much longer.

PROGRESS

Looking at progress throughout the world, America has undoubtedly set the standards for the rest of the world to follow. Many other countries have adopted American standards as a starting point leading to further study into their own, often unique, situations deriving tailor made standards. Outside America, Europe is attacking the effects of exhaust emissions in a progressive manner.

The concerns in Europe are no less important than in America, but maybe they have not till now been perceived to the same degree of seriousness. The EEC are continually reviewing their regulations on exhaust emissions levels and periodically issue standards. Up to now, the individual countries have not been obliged to follow these, but, in the main, have done so, adopting the regulation that seemed appropriate to their particular market. The current standard is EEC Directive 15.04, which was implemented in 1984 for new vehicle models and 1986 for those already existing. This directive is used mainly throughout Europe as a basis for the individual national regulations.

The events in Europe have, however, changed markedly this year. The original Luxemburg agreement has now been abandoned, as consensus could not be reached on standards applicable to small cars, and more severe limits adopted. A completely new emission directive is now being written which is expected to be adopted by the end of this year. This is likely to be implemented by 1992 and will be more comprehensive than the existing legislation.

The key features are:

- * Catalyst converters will be required on all new cars from the end of 1992.
- * Emission system durability will be specified.
- * Revised, more severe, evaporative emissions test procedures.
- * The directive will become compulsory for all EEC members.

This latter point is a significant change in EEC policy regarding exhaust emission regulations.

Non-European countries have tended to follow the American standards according to the state of maturity of their vehicle population and their manufacturing capability. The following is the up to date position:

- Austria : US 1983 standards were introduced in 1986 for diesel engined vehicles and from 1987 for gasoline engined vehicles.
- Sweden : US 1983 standards are to be adopted from 1989. For two years prior to this date, voluntary standards were encouraged by the use of tax incentives.
- Switzerland : Implemented US 1983 standards from 1987 for cars and from 1988 for light commercial vehicles.

Finland : Introduced ECE 15.04 in 1986 but is to change to US 1983 standard for new models from 1990, and all new cars from 1992. Again, tax incentives have been introduced for voluntary compliance ahead of these dates.

Norway : US 1983 standards have been introduced from 1989 for all new cars and taxis.

In America new standards were introduced in 1987 which, effectively, require gasoline engined vehicles to use catalyst technology. Diesel engined vehicles will find it difficult to achieve the new regulations without the use of particulate traps. Although such equipment is under development, a viable solution has yet to be found.

Canada has adopted the US standards, as has Mexico, Japan and South Korea. Singapore has adopted ECE 15.04 for its emission standard.

In Australia the Government does not have the authority over motor vehicle legislation, which power lies with the various State Governments. The Transport Advisory Council, which comprises Federal and State Transport Ministers meet biannually and can resolve the adoption of emissions standards, which, although not binding on the States, are usually adopted in State legislation.

Prior to 1986, emissions standards were based on those developed in America in 1973/4. From 1986, standards equivalent to the US 1975 requirements were required to be met, which has now led to the current situation based on standards developed by New South Wales and Victoria.

World wide, the standards for control of emissions have thus largely followed American practice. Undoubtedly, America has seen the exhaust pollution problem before any other country, probably because of the weight of numbers of vehicles using their highways, and the more advanced state of their economy. However, the EEC is now taking a much more positive stance with respect to this issue and being more directive in the application of emission standards.

TECHNOLOGIES FOR IMPROVEMENT

The general trend that such progress has taken has been to divide cars into three groups dependent on engine size with emission standards varying accordingly. These standards, to a large extent, have decided the engine technology which would be necessary to meet them. For instance, in the group with engine capacity up to 1,4 litres, lean burn engines have been considered as the answer. Beyond 2 litres engine capacity, lean burn has not considered as an option, and 3 way exhaust catalysts seem to be the only way to achieve the desired results. The 1,4 litres to 2 litres range, which probably represents the vast majority of cars on the road, has a choice of both technologies, or to restrict catalytic systems to oxidation catalysts only. However, the EEC proposals under discussion will make catalytic converters a compulsory requirement on all new cars from 1993 onwards. Thus development technologies may take a different path, particularly for the small engine range.

The development of 3 way catalytic converters, to provide the answer to meeting emission standards, has led to changes in the oil refining industry. The platinum catalysts which are in use today are poisoned, or plugged, by lead compounds in the exhaust system emanating from the antiknock additives used in the manufacture of gasoline. Thus, where such catalysts are used, unleaded gasoline is required. The use of unleaded gasoline throughout the world outside communist areas, as an example, now represents 60% of all gasoline sold, and is an indication of the direction that is being taken in engine technology. Japan, whose emission standards have been self generated and not directly comparable with those in Europe or America, sells only unleaded fuel, and in America all new cars have been required to be able to run on unleaded gasoline since 1975. Now, America is actively considering alternatives to unleaded fuel to assist their, somewhat unique situation in Los Angeles. The Australian position is such that manufacture of leaded regular gasoline is no longer permitted, and limits applied to the use of lead in premium gasoline. These limits vary widely across the States and are, in some way, similar to the levels permitted in this country. Unleaded gasoline is to be found in the metropolitan areas of New South Wales.

The programme in this country to reduce the lead content of our gasolines has entered the second phase this year. The permitted level was reduced from 0,836 grams per litre 0,6 grams per litre on 1st January 1986, and again to 0,4 grams per litre on 1st January 1989. It has been indicated that this level will be held for at least 5 years, and that if any further reductions are considered necessary for environmental reasons, the position of unleaded gasoline would be considered as an alternative to a further reduction to, say, 0,2 grams per litre. Thus the planning for our future is underway if it is considered that cleaner exhaust systems need to go hand in hand with lead free gasoline in order to make available vehicles which can operate with exhaust system catalysts.

GLOBAL EFFECTS

In Europe, a proposal was made at a meeting in May 1989 to create a European Environmental Agency, consisting of the environment ministers from the individual parliaments. Their brief would be to examine the effects of exhaust emissions on a continental level, rather than an individual country level. Pollution knows no boundaries, what happens in one country may not directly affect them, but can cause untold harm in another. Concern over the Greenhouse Effect prompted the formation of this high level body, but activities related to the control of vehicle emissions are also part of their brief. The acid rain damage to the Black Forest in Germany is not considered to be necessarily a home grown problem, but resulting from its industrialised neighbours. The same effects are noted in Canada, where much of the damage to their vegetation is generated in America, and has led to discussions between these two countries on ways to overcome the problem. There is also a proposal to form a Global Environmental Association the membership of which would be drawn from the environmental ministries of world governments. Thus, we may see much more stress in future on the wider aspects of emissions.

We are, perhaps, fortunate that we do not have any industrialised neighbours to pass on their problems to our country. This may be one of the reasons why emission standards in this country are not as well developed as the rest of the world. The prevailing winds tend to do a good job in keeping our atmosphere clean. The south easter which blows with monotonous regularity in the Cape summer, and about which we moan when we decide it is a good day for the beach, is not called the "Cape Doctor" for nothing. If we had a much more settled weather pattern, with fewer strong prevailing winds, I have no doubt that controls to regulate exhaust emissions would be far more advanced than they are at the moment.

South Africa is, however, a large country, resembling in size most of Europe. Thus a similar situation could develop where harmful emissions generated in one region may affect another. Controls to regulate emissions in, say, the Transvaal, may well avoid a future problem in the agricultural areas of the Orange Free State. It is unlikely, however, that there would be regional differences in any measures to control exhaust emissions with the same standards being applied country wide. We should, however, learn from the experiences in other parts of the world and be in a position to determine when such a problem is likely to occur here.

INFLUENCE OF SULPHUR ON DIESEL PARTICULATES

The discussion so far has addressed mainly gasoline engines, although the regulations that are in force do cover both gasoline and diesel engines. This latter group do, however, have particular considerations which must be addressed.

The one major area where diesel engines differ from gasoline engines is in the type and amount of particulate matter emitted from the exhaust system. Part of these particulates is considered to be carcinogenic, although they are present in very small quantities, and regulations for control of diesel emissions address this concern. Much research effort is going into the development of particulate traps to enable these emissions to be minimised. One area which is receiving attention is the level of sulphur in the fuel as this can contribute to particulate emissions. As a distillate hydrocarbon, diesel fuel does contain sulphur, the level of which is dependent on the type of crude oil being processed in a traditional refinery, and on the capacity of that refinery to desulphurise. Particulates are a mixture of carbon and heavy hydrocarbons with sulphuric acid, and result from incomplete combustion and condensation of sulphur oxides and water vapour. Although most of it is converted to gaseous oxides, the level of sulphur in the fuel thus does influence the type and amount of particulate emissions.

America is set to reduce their diesel fuel sulphur content from the present 0,3 per cent mass down to 0,05 per cent mass by 1993 in order to allow the engine manufacturers to meet more severe particulate emission limits. These are due to be enacted in 1994 covering heavy duty vehicles. In Europe, there is a requirement for a uniform standard to be proposed by the end of 1991. At present, the general

limit is a maximum of 0,3 per cent mass with member states, who consider they have a special need for protection, being allowed to institute a maximum on lower than 0,2 per cent mass. It seems likely that this latter figure will be the uniform standard as it is already in operation in many of the European and Scandinavian countries. Austria has had a limit of 0,15 percent mass in force since 1986.

The diesel fuel sulphur level in this country is controlled by an SABS specification to a maximum of 0,55 per cent mass, and is typically close to this figure for fuel produced from crude oil. The Sasol Oil form Coal plants produce a diesel fuel with a very low sulphur content. The development of Trackless Mining techniques in many of our gold mines has raised the concern over exhaust emissions in this environment of limited ventilation where increasing numbers of diesel powered vehicles are being used, particularly with reference to particulate emissions. A fuel specification is in the process of being developed, which may be well become an industry standard for such applications, and which limits the sulphur content of the fuel to 0,2 per cent mass.

Recent engine test work has shown that this does reduce particulates. It must, however, be stressed, that this was on an engine in good condition with correct ignition settings, and carried out on an engine dynamometer. In live situations, the correct maintenance of an engine is the key to a cleaner exhaust, and not only in the underground environment. We have all seen some horrific examples of poor maintenance on the roads and it is essential that controls be maintained to avoid such occurrences. As half of the particulate emissions from diesel engines come from the consumption of fuel and the other half from the consumption of lubricating oil, correct and effective maintenance cannot be over-emphasised.

The adjustment of fuel specifications to enable tighter control of exhaust emissions inevitably has lead to more costly refining techniques, whether it be the case of the reduction of lead antiknock additives in gasoline, or the reduction of sulphur in diesel fuel. Future planning for emission control, which will require attention to fuel specifications, must recognise that the lead time for the introduction of new refinery processes, or the upgrading of existing ones, is in terms of years rather than months. Many of these units have to be tailor made to suit a particular refinery and, as such, cannot be bought "off the shelf". The costs also have to be carefully planned as they can run into many millions of Rands. The same is largely true for the engine manufacturers. Developments to achieve future emission regulations have necessitated the introduction of new technologies.

Such changes can take many years of development work, and add significantly to costs.

CONCLUSION

There are many parties to the discussion of regulations to control vehicle emissions. The suppliers of the fuel, the manufacturers of the engines and vehicles, the vehicle users, the environmental authorities, and the Government and its agencies. It is an issue which cannot be solved overnight, but one which requires very careful deliberation and decision making. The effects of such decisions will be far-reaching and affect the world in which we live a long way into the future. The South African Wild Life Society has an expression which fits this issue extremely well:

"WE MUST LEARN TO PLANT TREES UNDER WHOSE SHADE WE KNOW WE WILL NEVER SIT".