COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 04.11.1996
COM(96) 540 final

FUTURE NOISE POLICY

European Commission
Green Paper

EXECUTIVE SUMMARY

Environmental noise, caused by traffic, industrial and recreational activities is one of the main local environmental problems in Europe and the source of an increasing number of complaints from the public. Generally however action to reduce environmental noise has had a lower priority than that taken to address other environmental problems such as air and water pollution.

The 1993 Fifth Environmental Action Programme started to remedy this and included a number of basic targets for noise exposure to be reached by the year 2000, while the recent proposal on the review of the Fifth Action Programme (COM(95)647) announces the development of a noise abatement programme for action to meet these targets.

This Green Paper is the first step in the development of such a programme and aims to stimulate public discussion on the future approach to noise policy. It reviews the overall noise situation and Community and national action taken to date followed by the outline of a framework for action covering the improvement of information and its comparability and future options for the reduction of noise from different sources.

The Noise Situation in the European Union

The data available on noise exposure is generally poor in comparison to that collected to measure other environmental problems and often difficult to compare due to the different measurement and assessment methods. However it has been estimated that around 20 percent of the Union's population or close on 80 million people suffer from noise levels that scientists and health experts consider to be unacceptable, where most people become annoyed, where sleep is disturbed and where adverse health effects are to be feared. An additional 170 million citizens are living in so-called 'grey areas' where the noise levels are such to cause serious annoyance during the daytime.

A wide variety of studies have examined the question of the external costs of noise to society especially transport noise. The estimates range from 0.2% to 2% of GDP. The Commission's Green Paper 'Fair and Efficient Pricing in Transport' used the lower estimate of 0.2% of GDP which represents an annual cost to society of over 12 billion ECU.

Analysis of Existing Noise Abatement Actions in the European Union

For more than twenty years Community environmental noise policy has essentially consisted of legislation fixing maximum sound levels for vehicles, aeroplanes and machines with a single market aim, or to implement international agreements in the case of aircraft, linked to certification procedures to ensure that new vehicles and equipment are, at the time of manufacture complying with the noise limits laid down in directives.

Thanks to this legislation and technological progress significant reductions of noise from individual sources have been achieved. For example the noise from individual cars has been reduced by 85% since 1970 and the noise from lorries by 90%. Likewise for aircraft the noise footprint around an airport made by a modern jet has been reduced by a factor of 9 compared to an aircraft with 1970s technology.

However data covering the past 15 years do not show significant improvements in exposure to environmental noise especially road traffic noise. The growth and spread of traffic in space

and time and the development of leisure activities and tourism have partly offset the technological improvements. Forecast road and air traffic growth and the expansion of high speed rail risk exacerbating the noise problem. In the case of motor vehicles other factors are also important such as the dominance of tyre noise above quite low speeds (50 km/h) and the absence of regular noise inspection and maintenance procedures.

For some sources such as railways and a wide range of noisy equipment used outdoors there are no Community or international standards setting emission limits. A number of Member States are planning national legislation for these products, which could cause problems for the functioning of the single market.

Most Member States have adopted legislation or recommendations setting immission limits for noise exposure in sensitive areas. These are often integrated into national abatement laws and used in land use plans especially for new infrastructure developments. A survey done for the Commission has shown a considerable degree of convergence between Member States in the establishment of such quality criteria for road, rail and industrial noise. The situation for aircraft noise indices and exposure levels is more divergent.

A New Framework for Noise Policy

In the light of the poor state of data on noise exposure and the shortcomings identified in the analysis of existing policy measures, the Commission believes that changes in the overall approach are required if a noise abatement policy is to be successful. This requires a framework based on shared responsibility involving target setting, monitoring of progress and measures to improve the accuracy and standardisation of data to help improve the coherency of different actions.

The local nature of noise problems does not mean that all action is best taken at local level, as for example generally the sources of environmental noise are not of local origin. However effective action is very dependent on strong local and national policies and these need to be more closely related to the measures to be decided at Community level. In this context there is scope for cooperation across the Community to improve the data situation and the comparability of information and in addition the Community could assist in the exchange of experience in noise abatement between Member States. The main area for Community involvement will remain linked to the reduction of noise from products. Here the Commission will be looking to broaden the range of instruments applied and paying particular attention to the potential of economic instruments, whose use to date is not widespread in noise abatement.

The proposed new framework outlines options for future action :

1. A proposal for a directive providing for the harmonization of methods of assessment of noise exposure and the mutual exchange of information. The proposal could include recommendations on noise mapping and the provision of information on noise exposure to the public. In a second stage consideration could be given to the establishment of target values and the obligation to take action to reach the targets.

2. The next phase of action to reduce road traffic noise will address tyre noise and look at the possibilities of integrating noise costs into fiscal instruments, amending Community legislation on road-worthiness tests to include noise and at the promotion of low noise surfaces through Community funding.

3. More attention needs to be paid to rail noise where some Member States are planning national legislation and where there is considerable opposition to the expansion of rail capacity due to excessive noise. In addition to supporting research in this field the Commission will investigate the feasibility of introducing legislation setting emission limit values, negotiated agreements with the rail industry on targets for emission values and economic instruments such as a variable track charge.

4. In air transport the Commission is also looking at a combination of instruments. These would include greater stringency in emission values and the use of economic instruments to encourage the development and use of lower noise aircraft, as well the contribution local measures such as land use planning could make. A specific framework directive on airport charges is planned for 1996. A consultation paper on stringency in emission values is to be presented in the near future.

5 The Commission plans to simplify the existing legislation setting emission limits for a limited range of outdoor equipment and will propose a framework directive covering a wider range of equipment including construction machinery, garden equipment and others and incorporate the existing seven directives. The principal feature of the new legislation will be the requirement to label all equipment with the guaranteed noise level. Limit values will only be proposed for equipment for which there is already noise legislation and a limited range of highly noisy equipment.

Conclusion

One of the main aims of this paper is to help to give noise abatement a higher priority in policy making. It is focusing on the areas where Community action in cooperation with Member States and local authorities can be of added value. The options for action on measurement methods and exchange of information cover important steps for the establishment of an overall framework for action. More work is required to assess the best combination of instruments to be applied to the different modes of transport.

1. INTRODUCTION

Many Europeans consider environmental noise, caused by traffic, industrial and recreational activities as their main local environmental problem especially in urban areas. It has been estimated that around 20 percent of inhabitants in western Europe suffer from noise levels that scientists and health experts consider to be unacceptable, where most people become annoyed, sleep is seriously disturbed and even adverse effects on the cardiovascular and psychophysiological systems are to be feared. The increasing number of complaints from the public about noise is evidence of the growing concern of citizens. For example the 1995 Eurobarometer environment survey showed that noise was the fifth most important area of complaint about the local environment (after traffic, air pollution, landscape and waste) but was the only issue about which the public's complaints had increased since 1992. The same survey showed a significant rise in the public's willingness to take action to reduce noise. A number of recent publications on the problem - such as those by WHO, EEA,and the Nordic Council show that greater attention is being paid to noise issues at international level.

European Community measures to address environmental noise problems have been in existence for over twenty five years and have essentially consisted of legislation fixing maximum sound levels for vehicles, aeroplanes and machines with single market aims and as such have not been conceived as part of an overall environmental noise abatement programme. The Member States have enacted a multitude of supplementary regulations and other measures aiming to reduce environmental noise problems and although there is some evidence to show that noise levels in the worst 'blackspots' have been reduced, recent data show that the overall noise problem is worsening and the numbers of people living in so-called 'grey areas' has increased. In particular the continuing growth in traffic volume in all modes coupled with suburban development have led high levels of noise exposure to be spread ever wider over both space and time and are part of the reason for this worsening. In addition over the past two decades leisure activities and tourism have created new spots and new sources of noise. As a result of these developments the impact of the policy measures implemented to date to address the noise problem are being offset.

Generally action by the Community and the Member States on environmental noise has had a lower priority than that taken to solve other problems such as air and water pollution despite the fact that opinion polls show that noise is considered one of the main causes of declining quality of life. Some of the reasons may be that decision makers are not aware of the problems or familiar with the effects of noise, which are unspectacular: noise is insidious not catastrophic. As far as the Community is concerned, the lower priority accorded to noise has in part been due to the fact that noise is very much a local problem with very varied perceptions in different parts of the Community as to the acceptability of the problem. However the sources of many of the causes of environmental noise are not of local origin. In addition despite the local dimension to environmental noise problems there is a general international consensus on the levels of unacceptable noise to which the public should not be exposed in order to protect health and quality of life.

In 1993 the European Community announced the beginings of a change to environmental noise policy in line with the major changes to Community environment policy included in the Fifth Environmental Action Programme. For noise the Programme established as a basic objective the situation where no person should be exposed to noise levels which endanger health and quality of life. It puts forward a a number of targets for noise exposure levels to be reached by the year 2000 (see annexe 1).

In order to meet the targets the Fifth Action Programme lists a number of measures for implementation by the different actors in the Community, depending on their responsibilities and competencies, covering information, technological, planning, economic and educational issues. There is a clear recognition as in other areas of environment policy that the Community needs to broaden the range of instruments to be applied, rather than relying solely on legislation of emissions at source if progress is to be made in protecting people from increasing noise exposure.

The recent progress report on the Fifth Action Programme (COM(95)624) called for more intensified efforts. Following on from the progress report, the proposal on the review of the Programme (COM(95)647) announces that particular attention will be given to the development of a noise abatement programme, which will address comprehensively the provision of information to the public, common noise exposure indices, targets for noise quality and noise emission from products.

To this end the Commission's 1996 work-programme announces the first step in the development of such a programme through a Green Paper to stimulate public discussion on future noise policy. It is focusing on the areas where the Commission believes the Community's involvement in cooperation with Member States and local authorities can bring added value and be of particular benefit for the public at large.

The Green Paper includes in Chapter 2 some basic information on the problem of environmental noise and its effects followed by a brief review of the noise situation in the Community and estimates of external costs to society of noise pollution. Chapter 3 analyses the approach taken to noise abatement to date in the Member States and the Community. Chapter 4 outlines options for action covering a framework for the assessment and reduction of noise exposure and future action to reduce noise from different sources.

This paper is addressing noise as an environmental problem and therefore does not directly deal with the issue of noise control in workplaces for which legislation has been in place since 1986 (Directive 86/188/EEC) and whose revision is pending at Council level. Furthermore it does not deal with neighbourhood noise. Here the provisions of the Construction Products Directive (89/106/EEC) can be of relevance as far as technical solutions are concerned. A large part of the solutions for such 'social' noise however are educational and these problems are generally regulated locally.

2. THE ENVIRONMENTAL IMPACT OF NOISE AND THE NOISE SITUATION IN THE EUROPEAN UNION

Noise is often defined as 'unwanted sound' or 'sound that is loud, unpleasant or unexpected'. Its origins are in human activities and it is especially associated with the process of urbanization and the development of transport and industry. Although primarily an urban problem, due to topographic conditions it can also be a source of annoyance in rural areas.

Annex 2 describes the main indices used in this paper for the measurement of noise, namely the decibel (dB), the most commonly used index to express noise exposure the 'A' weighted sound pressure level dB(A) and the method of averaging results over time the so-called equivalent continuous sound pressure level L_{Aeq}.

The Sources of Environmental Noise

All the Member States have similar classifications of the sources of environmental noise related to the different human activities: road traffic, rail traffic, air traffic, industry, civil engineering and building site activities, recreational activities, outdoor equipment (such as gardening equipment). These classes differ from a phenomenological point of view and as the public's attitudes to noise from the different sources vary, are perceived differently. (Annex 3 describes the nature of noise in more detail).

Effects of noise

The effects of noise are difficult to quantify as people's tolerance to noise levels and different types of noise vary considerably. However there is a large amount of scientific literature analysing and assessing the effects of noise on human beings. The most recent and most comprehensive is the WHO report (soon to be published) 'Community Noise - Environmental Health Criteria' which points out that environmental noise may have a number of direct adverse effects on exposed people including disturbance of sleep, auditory and non-auditory physiological - basically cardiovascular - effects, interference with communication and general annoyance (more details are included in annex 4). Environmental noise exposure does not normally cause noise induced hearing loss except where exposure is exceptionally high over a long period.

Magnitude of the environmental noise problem

Exposure

Generally data on the overall exposure of the population of European countries is patchy and often difficult to compare due to the use of different methods of obtaining the data and different descriptors. The most comprehensive data on exposure to noise in Europe has been collated by the OECD in 1993 and includes data from 14 European countries.

A variety of studies carried out recently have built on this work and estimate that between 17 and 22% (close on 80 million people) of the Union's population are exposed to continuous day-time outdoor noise levels caused by transport above what are generally considered to be acceptable - more than 65 dB(A) (INRETS 1994, von Meier 1994, INFRAS/IWW 1994). An additional 170 million citizens are exposed to noise levels between 55-65 dB(A), which is the level at which people become seriously annoyed during the daytime.

Road transport noise is the dominant source accounting for nine tenths of the proportion of the Union's population exposed to levels of noise over 65 dB(A). As for rail 1.7% of the population and air transport a further 1% of the population are exposed to these high levels.

Annoyance

Data for expressed annoyance are even more insufficient than those for exposure. National surveys do not always use the same wordings of questions to enable assessment of the way in which noise is perceived (disturbed, annoyed or affected). Comparable data are only available for four countries - Germany, France, Netherlands, United Kingdom. This shows that road traffic seems to annoy between 20 and 25% of the population and railway noise between 2 and 4%. Data from a number of countries indicate that people have a greater tolerance of rail noise than road noise and in some countries this is taken into consideration

in the setting of standards, guidelines or recommendations, which are set around 5 dB(A) higher for rail than for roads.

Recently investigations have started looking at the effect-dose relation, whereby a certain percentage of the annoyed population is related to a given noise exposure. The effect-dose relation will depend on the noise source causing the exposure and it should make it possible to compare the annoyance caused by different noise sources. Another aim of this research is to investigate the cumulative effects of exposure to different noise sources.

Trends:

Data over the past 15 years do not show significant improvements in exposure to environmental noise especially road traffic noise. Although exposure levels remained fairly stable at beginning of 1980s and action on 'black spots' over 70 dB(A) has been successful, as indicated above the proportion of the population exposed to levels above 65 dB(A) remained high and increases have been experienced by the end of the decade in many western European countries in the range 55-65 dB(A) the so-called 'grey' zone apparently as the result of fast growing volume of road traffic (INRETS 1994). The data show that the numbers of those acutely exposed are decreasing but the overall problem is getting worse. In many urban areas, traffic noise peaks are not increasing but the period of high noise exposure is increasing. Whereas in the past the day-time period between 800 and 1800 was the noisiest time, now the night-time period is also becoming more and more noisy (CEST 1993).

In the case of air traffic, there is some evidence of improvements in exposure to aircraft noise since the 1970s. This is due largely to the introduction of stricter noise certification standards but also due to other non technical measures (restrictions on night time movements, controlled take-off and landing flight paths, air traffic control procedures). For example the population around Heathrow exposed to noise levels above 60 dB(A) has more than halved between 1975 and 1989, when there has been a significant growth in traffic over the same period. Large decreases have also been experienced at Copenhagen, Schipol (Amsterdam).

Noise emissions from individual trains have also fallen and is associated with the changeover from diesel to electrically powered passenger trains, the gradual introduction of welded rails to replace jointed rail and the greater use of disc braked rolling stock.

The development of high speed rail is an issue of particular concern as far as future railway noise is concerned and is the main subject of complaint from the public, when new lines are under discussion. Current practice is to include noise abatement measures in the planning and construction of such lines.

Available data on the current state and forecasts of the noise environment, which have serious shortcomings, show that in the absence of ambitious abatement policies, the noise environment risks remaining unsatisfactory or even deteriorating especially exposure to road traffic noise. The main general trends influencing the current and future situation are:

- The increase in vehicles and vehicle mileage; the forecasts to 2010 indicate a near doubling of road freight transport (in tonne-kilometres) and an increase in aviation traffic by over 180%;
- The development of high speed rail;
- The spread of traffic noise spatially to affect rural and suburban areas;
- The spread of noise over time as the period of annoying levels of transport noise

expands with 24 hour freight distribution.

Estimates of the external costs of noise

The economic costs of noise have been examined in numerous different ways and there are no benchmarks for standardised evaluation of costs. Almost all this research is limited to transportation noise. The most common methods used have been (INFRAS/IWW 1994):

- Willingness to pay based on surveys
- Change of the market value of properties; hedonic pricing
- Cost for abatement measures
- Cost of avoidance or prevention
- Cost of medical care and production losses

An overview of these studies produced in 1993 (Quinet 1993) found that the estimated costs of noise pollution vary between 0.2% and 2% of GDP. Generally studies based on the avoidance cost approach give low values for noise costs - below 0.1% of GDP, while studies using the willingness to pay approach give higher values. All the studies on willingness to pay have been carried out in countries with a high per capita income. Willingness to pay is undoubtedly dependent on the ability to pay and therefore noise would probably not be valued so high in less rich countries.

In Germany a number of studies have been based on the willingness to pay for a better noise environment approach and show that on average an individual would be prepared to pay around 10 ECU per 1 dB(A) improvement per person per year if the noise levels exceed 43 dB(A). On this basis the annual costs of traffic noise in Germany were estimated to be 7.8 - 9.6 Billion ECU.

The study carried out for the UIC by IFRAS/IWW (1994) made an overall estimate for 17 European countries based on the willingness to pay approach which shows the total cost of transport noise to be 38 billion ECU per year (EUR15 plus Norway and Switzerland) or 0.65% of GDP. The cost figures for each country were adjusted to individual national situations using purchasing power parities.

These annual costs related to transport volume break down as follows:
Passenger transport - cars 4.5 ECU/1000 passenger kilometre compared to 4.2 ECU/1000 pkm for buses, 3.1 ECU/1000 pkm for rail and 3.0 ECU/1000 pkm for air transport. The figure calculated for two wheelers gave the highest cost coefficient of all modes of 60.3 ECU/1000 pkm.
Freight transport - 12.7 ECU/1000 tonne kilometre for road transport and 4.7 ECU/1000 tkm for rail transport.

Studies into the decrease in housing value depending on noise exposure for a variety of countries over the past 25 years have shown that in the 1980s the average rate of depreciation can be estimated at approximately 1% per dB(A) if the noise exceeds 55 dB(A), whereas the studies covering the 1970s show a depreciation rate of 0.3 to 0.8% per dB(A) (INRETS 1994). On the basis of these depreciation rates global evaluations of total damage caused by road traffic noise have been undertaken for cities and countries. For France this was estimated to be 800 million ECU per year or an average of around 30 ECU per inhabitant exposed to over 55 dB(A).

Data on the noise costs caused by aviation noise often relate to the costs of insulation schemes in properties around airports. These costs vary widely depending on local labour and materials costs, the scope of the insulation scheme, the actual indoor noise level to be reached and the technical measures used. This is illustrated by the following data: for Schipol the average cost per apartment is around 23650 ECU, for Frankfurt around 3800 ECU, Köln/Bonn 6600 ECU (for 3 bedrooms) and Manchester 2300 ECU.

There is little data on actual damage costs of noise in terms of monetary estimates of health costs. Some work in Germany has estimated that the annual cost of noise on public health is of the order of 500 to 1900 million ECU per annum for road noise and 100 million ECU for rail noise.

3. EXISTING POLICIES TO REDUCE NOISE EXPOSURE AND THEIR APPLICATION

3.1 Methods and Instruments for Reducing Noise Exposure

There are three basic approaches to reducing environmental noise exposure:

i. Reducing noise at source - from machines, engines, tyres and surface, reducing speeds and reducing traffic volume and use of equipment.
ii. Limiting the transmission of noise by placing barriers between the source and people affected.
iii. Reducing noise at the reception point such as through noise insulation of buildings.

The policy instruments developed to implement these methods include: Emission standards for individual sources generally laid down in legislation, immission standards based on noise quality criteria, land use planning, infrastructure measures, economic instruments, operational procedures, research and development and education and information actions. Annex 5 contains a more detailed outline of the different policy instruments.

Analysis of Existing Noise Abatement Actions in the European Union

The following sections of this chapter analyses use of these policy instruments in the European Union and briefly assesses the impact their application has had on the noise situation. Most of these instruments have been developed and implemented at the national and local level. The European Community and international involvement has essentially been in the establishment of emission standards to control noise from individual sources although there is increasing cooperation at the Community and at international level in research into the effects of noise, noise abatement methods and in the determination of noise exposure levels.

3.2 Legislation on Emission Standards

For more than twenty years Community environmental noise policy has essentially consisted of legislation fixing maximum sound levels for vehicles, aeroplanes and machines with a single market aim linked to third party certification procedures to ensure that new vehicles and equipment are, at the time of manufacture complying with the noise limits laid down in directives. The evolution of the emission limits over time is shown in tables in annex 6.

Transport sources

Road Transport

Motor Vehicles: The original legislation governing sound levels for motor vehicles (Cars, Lorries and Buses) was adopted in 1970 (directive 70/157/EEC) and has since been amended nine times. The latest amendment by directive 92/97/EEC comes into force in 1996. The type approval test for this directive seeks to limit noise produced in a typical urban traffic situation. All vehicles must meet the limits and therefore production models need to be designed to -1dB(A) below the limits to allow for production tolerances. As the limits have fallen, tyre noise has become more significant and with the new limits will be the main source at speeds above 50 km/h.The point has now been reached where without action to address tyre/road noise, a further lowering of the limits would not be effective. The 1992 amendment therefore calls on the Commission to present a proposal to address the problem of tyre/road noise.

Two and Three Wheelers: Legislation setting limits for the permissible sound level of motorcycles has been in existence since 1978 (78/1015/EEC) and since amended on several occasions in order to introduce lower limit values, the latest being in 1989 (89/235/EEC). In 1993 the Commission proposed a draft amendment to the directive as part of an overall proposal concerning type approval of two and three wheel vehicles (COM(93)449). This would make the optional second stage limit values set out in the 1989 amendment mandatory as of 1 January 1997 and would also introduce provisions concerning anti-tampering of silencers. The Council reached a common position on this proposal in November 1995 and final adoption is expected in 1996.

Assessment of the impact of the legislation

Following implementation of the latest amendment this year, the legislation will have resulted in a reduction of noise of 85% for individual cars (8 dB(A)) and over 90% for individual heavy lorries (11 dB(A)). However studies have shown that the reduction in actual road traffic noise levels thanks to this legislation has been much less: only 1-2 dB(A). The reasons for this low level of effectiveness have been identified as: relaxed limits in the early years, a slow replacement of older noisier vehicles, significant growth in traffic and a lower threshold to achievable noise reductions caused by the interaction of tyre and road (Sandberg 1993). In addition the test procedure (ISO R 362) doesn't reflect realistic driving conditions and without a regular inspection procedure to ensure maintenance of the acoustical design features the noise levels of the vehicle may increase over time. For example tampering with the exhaust silencers on motorcycles can increase noise levels by 10 dB(A).

Directive 77/143/EEC sets out the basic provisions for roadworthiness tests and includes noise as one of the items to be part of the test. However this is generally only a subjective check to ensure that the exhaust silencers are intact and there is no specific legislation as there is for air pollution. Some countries outside the Union have had success with roadworthiness testing for noise. In Japan for example there are periodic noise inspections for in-use vehicles in the street, while in some Australian states vehicles are subject to on-road 'spotting and subsequent testing (OECD 1991). In New South Wales thousands of vehicles are tested each year and average reductions of emission of 9 dB(A) have been achieved at a relatively low cost.

Rail Transport

In 1983 the Commission proposed a directive relating to maximum permitted noise emission levels of rail-mounted vehicles. This proposal, although approved by the European Parliament was withdrawn by the Commission in 1993. The withdrawal was partly due to unresolved technical issues but mainly related to the unrestricted access of third country rail vehicles, which would not have been subject to the European Community emission levels.

In the meantime a number of Member States have started to consider introducing their own controls on railway noise emissions. In 1993 Austria enacted legislation on the admittance of rail wagons for use by Austrian railways which require as of 1995 a noise reduction of 5 dB(A) for freight wagons.

Air Transport

Directive 92/14/EEC , which came into force in April 1995, is the latest in a series of legislative measures begun in 1979 (Directives 80/51/EEC and 89/629/EEC) aimed at limitation of aircraft noise. These directives, like broadly similar legislation in other 'noise restrictive states' (most of non-EU Europe, Japan, Australia and New Zealand, and the USA), use the benchmark standards specified by the International Civil Aviation Organisation (ICAO) in the Environmental Protection Annexe (Annex 16, Volume I) to the Chicago Convention, to which most countries in the world adhere. The limit values for individual aircraft types during take-off and landing are specified in terms of Effective Perceived Noise Levels (EPNL) in dB(A), and depend on the aircraft weight and number of engines. The oldest, noisiest jet transport aircraft are 'non noise certificated' (NNC), the second generation's characteristics are reflected in Chapter 2 of Annex 16, and the most modern, quietest aircraft meet Chapter 3 standards.

Subsonic non noise certificated (NNC) aircraft have been excluded from airports for several years and under the terms of Directive 92/14 Chapter 2 aircraft over 25 years old have been banned from European Community airports since April 1995 unless granted exemptions designed to avoid unreasonable economic hardship to the airlines of developing nations for instance. Chapter 2 aircraft are being systematically phased out over the 1995 to 2002 period, and as of 1 April 2002 only Chapter 3 aircraft will be allowed to use Community airports. Meanwhile, increased stringency is being considered in international fora such as ICAO's Committee on Aviation Environmental Protection (CAEP) and the European Civil Aviation Conference (ECAC).

Assessment of the impact of the legislation

Like individual motor vehicles, individual aircraft, when comparing those of the same size, have become much quieter over the past twenty years. The noise footprint area around an airport made by a modern jet aircraft has been reduced by a factor of 9 compared to an aircraft with 1970s technology. In the turboprop segment the noise footprint has been reduced by a factor of 4.5 over the past twenty five years. In Europe the changeover to an all Chapter 3 fleet has advanced steadily but at the same time the average size of individual aircraft is increasing. These developments coupled with the high growth in the past and projected high growth for the future may mean that only short to medium term benefit will be gained from the phase out of chapter 2 aircraft and that after 2002 the overall noise emissions and

consequently the overall noise footprints may not be contained within the reduced boundaries expected to be achieved by that date.

Construction Plant and Equipment, Lawnmowers

The Community's policy towards the control of noise from a limited number of types of equipment used outdoors has consisted of directives relating to permissable noise emission values, noise test codes and the labelling of equipment with its guaranteed noise emission values. Most noise emission values have been strengthened in a second step and since entry into force of the various pieces of legislation noise emission levels of the types of machine covered has been reduced by 1 to 5 dB(A).

This approach has resulted in 6 directives relating to noise of individual types of construction plant and equipment (compressors; tower cranes; welding generators; power generators; hand-held concrete breakers and picks; hydraulic excavators, rope-operated excavators, dozers, loaders and excavator-loaders), and one relating to noise from lawn mowers.

Directive 89/392/EEC commonly known as the Machinery Directive lays down provisions on health and safety concerning the design and construction of machinery including noise emissions . It states that machinery be designed and constructed so that risks resulting from the emission of airborne noise are reduced to the lowest level taking account of technical progress and the means available to reduce noise, in particular at source. As the emphasis is on the workplace it does not deal directly with environmental noise.

Assessment of the impact of the legislation

These directives only cover a very small range of noisy outdoor equipment and in recent years there have been calls from several Member States to extend the legislation to cover other products in particular to ensure that national legislation that has developed on noise emissions from outdoor equipment does not lead to restrictions on trade and cause problems for the functioning of the single market. For example there is legislation in France controlling the noise of construction machines, in Germany governing concrete pumps and mixers and controls in the Netherlands on motor chain saws.

In order to address the noise problem of outdoor equipment in an integrated manner the Commission together with experts from the Member States have been developing a new framework directive to bring together the machinery already covered by EC noise legislation and a wide range of other products. The outline of the new proposal is presented in Chapter 4.

Industrial Noise

There is no Community legislation laying down noise emission limits from industrial installations. However, the proposed directive on Integrated Pollution Prevention and Control (IPPC) on which the Council reached a common position in 1995 is relevant for noise reduction. It provides for the control of emissions including noise by means of a permit, taking into account local circumstances. The permit application must include a description of the likely effects and both the application and the final permit are subject to public scrutiny. In issuing the permit the competent authority ensures, that any relevant environmental quality standards are observed. Thus the IPPC will form a framework in which

the emissions of noise from industry can be controlled if the local circumstances require such control. It also provides that the Council shall adopt emission limits at European level if the need arises.

3.3 Immission Standards and Planning Procedures: Noise Quality Criteria

International Work on Noise Quality Criteria

As mentioned in the introduction, a large degree of international consensus has emerged over the years as what constitute unacceptable levels of noise exposure and what should be the maximum levels of exposure for certain specific situations. At the international level the World Health Organization together with the OECD are the main bodies that have collected data and developed their own assessments on the effects of exposure to environmental noise. On the basis of these assessments guideline values for different time periods and situations have been suggested.

In the mid 1980s the OECD (OECD 1986) reported the thresholds for noise nuisance as follows (in day-time L_{Aeq}):

- at 55-60 dB(A) noise creates annoyance;
- at 60-65 dB(A) annoyance increases considerably;
- above 65 dB(A) constrained behaviour patterns, symptomatic of serious damage caused by noise arise.

The World Health Organization has suggested a standard guideline value for average outdoor noise levels of 55 dB(A), applied during normal daytime in order to prevent significant interference with the normal activities of local communities. Additional guideline values are suggested for specific environments (WHO 1996 forthcoming):

All figures are in LAeq

	Daytime		Nighttime	
	Inside	Outside	Inside	Outside
Dwellings	50 dB(A)	55 dB(A)		
Bedrooms			30 dB(A)[1]	45 dB(A)[1]
			45 dBLAmax	
Schools	35 dB(A)	55 dB(A)		
Hospitals				
general	35 dB(A)		35 dB(A) 45 dB(A)max	
ward rooms	30 dB(A)		30 dB(A) 40 dB(A)max	
Concert Halls	100 dB(A) for 4h period		100 dB(A) for 4h period	
Discotheques	90 dB(A) for 4h period		90 dB(A) for 4h period	

The Fifth Environmental Action Programme established a number of broad targets on which to base action up to the year 2000 in night-time L_{Aeq} :

- to phase out average exposure above 65 dB(A);
- to ensure that at no point in time a level of 85 dB(A) should be exceeded coupled with the aim of ensuring that the proportions of the population exposed to average levels between 55 and 65 dB(A) should not increase
- exposure in quiet areas should not increase beyond 55 dB(A).

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[1] even lower sound pressure levels may disturb sleep depending on the noise source and the overall noise situation

Noise Quality Criteria applied in the Member States

A survey of the situation in Community countries has shown that most Member States have adopted legislation or recommendations aiming for immission limits in noise sensitive areas similar to these guideline values. (INRETS 1994). The national regulations were initially developed in the 1970s and 1980s in northern Member States and somewhat later in southern Member States. Generally the limits are more detailed and specific about the noise sources, the current noise situation, the kind of living area than the WHO guideline values.

Increasingly these regulations are being integrated into national abatement laws and are used in land use plans. Noise immission standards for new developments are normally set by local authorities as part of planning policy and are used as a reference in environmental impact assessments. They serve as a means of ensuring that appropriate measures are taken to minimize the noise impact of a site. Where an acceptable level of noise cannot be achieved, planning permission may be refused or action may be required to improve insulation from the noise sources.

As far as road traffic noise is concerned the limits generally apply to new roads and major modifications to existing roads in national road networks. Communal and urban roads are rarely covered by limit values, the decision being left up to the local authority to apply the limit or not. Only a few countries have adopted measures to improve existing critical noise problems along existing roads. The problems of funding for these actions has limited their adoption. On a technical level the L_{Aeq} (equivalent noise level) index has been almost universally adopted for road noise assessment.

The immission limits are generally applied to daytime and night-time periods, although the definitions of day and night vary. The most common definition is 6-22h for daytime and 22-6h for night time. Sometimes the evening is added as a third period as it is an extremely sensitive period for local residents. The Nordic countries use a single 24 hour period, the night-time values being raised by 10 dB(A) in order to calculate the daily average. Apart from the daytime period noise immission limits depend on the sensitivity of the areas where they apply: hospitals, schools, residential areas, industrial areas and commercial areas as well as the development phase of infrastructure and buildings. Differences of 10 to 15 dB(A) are frequently found in the limits between the most and least sensitive areas. The situations in the different Member States are diverse and difficult to compare. However the survey of the situation in the Community done for the Commission showed that the 58 to 62 dB(A) limit measured in L_{Aeq} by day at the facades of buildings and 48 to 55 at night-time seem to be ranges of the basic limits applied to zones bordering new roads in residential areas. Differences of 5 to 10 dB(A) are also commonly observed between the limits applied to new developments and those for the correction of existing situations.

The limits applied to railway noise are similar to those for road noise in that they generally aim to protect people living near new lines, are applied for similar periods of the day and are by and large based on the L_{Aeq} index. Some countries use L_{Amax}, particularly at night-times to limit the effects of noise on sleep. Other countries such as Germany, Austria and Switzerland use a rating value L_r, that is calculated from L_{Aeq} by subtracting the so-called railway bonus that has been given to railway noise on the basis of surveys that show that railways noise at a given L_{Aeq} is considered less annoying than road noise. Again the limits often depend on the sensitivity of the area affected. For new railway lines in residential areas the limits surveyed are in the 62 to 69 dB(A) range for daytime and 53 to 62 dB(A) for night-time.

Noise limits have been fixed for aircraft noise to ensure that rules are followed when building new dwellings and other noise sensitive installations close to existing airports and to be taken into consideration for airport capacity expansion. Zones are generally designed to separate land uses and is done by mapping noise contours and relating permissible land use to ambient noise levels. Unlike road and rail noise, there is a wide variety of noise indices for such rules or guidelines. Two basic approaches are generally followed. One uses the L_{Aeq} as for road and rail, the other uses indices that consider the number of aircraft movements and the peak noise level of each movement, with weightings for different periods of the day. In view of the diversity of the indices, it is difficult to compare immission limits.

Most Member States apply noise limits for noisy industrial establishments using the L_{Aeq} index. Sometimes 'penalties' are added to take into account the particular character of the noise. As for road and rail noise these apply to day and night time periods and sometimes the evening period, and vary depending on the sensitivity of the zone. In residential areas the limits range from 45 to 55 dB(A) by day and 35 to 45 dB(A) at night.

This survey done for the Commission and other similar surveys show a considerable degree of convergence between Member States in the establishment of quality criteria with immission limits related to sources and locations. While there are differences between the Member States in the levels of the limits applied, the ranges of the limits especially those for road traffic and industrial noise for new developments are relatively small. On a technical level the virtually universal adoption of the L_{Aeq} index for road, rail and industrial noise is an important element in convergence. There are however wide differences between Member States in the methods used to assess noise exposure, which greater hampers making comparisons between the data.

3.4 Infrastructure Measures

Road Surfaces

Low-noise porous road surfaces have been the subject of much research. These porous road surfaces reduce both the generation and propagation of noise by a range of mechanisms which can be related to the open structure of the surface layer. Results have shown that the emission noise levels can be reduced from levels generated on equivalent non-porous road surfaces by between 3 to 5 dB(A) on average and by optimising the surface design larger noise reductions are feasible. At present the cost of porous asphalt surfacing is higher than conventional surfaces, by around 4.5 ECU per m2 (for resurfacing, for new roads the increased cost is marginal) but they may fall as contractors gain experience with laying surface. The material is also less durable. However improvements are being made to durability and already in many countries these materials are being used as part of normal road construction in noise sensitive areas (INRETS 1994).

The Commission has been involved in some of the research activities for low noise surfaces and at present in cooperation with the Federation of European Road Research Laboratories is undertaking research on road design and construction techniques which may form the basis of future standards and includes noise generation. Also the CEN standardisation organisation is working on a standard for porous asphalt which will include noise criterion.

3.5 Use of Economic Instruments

Use of economic instruments for noise abatement is not widespread in Europe. The OECD in its report "Fighting noise in the 1990s" (OECD 1991) concluded that economic incentives for noise reduction have shown their effectiveness in relation to road vehicles in the few cases where they have been used and argued for much more general use. Noise charges - except in the field of aircraft noise - have been used even less than incentives and where these have been used have generally been set too low to encourage noise reduction. Their main function has been to raise funds for noise control measures such as insulation of buildings.

Taxes and Charges

The inclusion of a noise charge component as part of the landing fee for aircraft is a relatively widely used economic instrument. Their use was first introduced in Europe in 1970s and is growing. Recently 29 out of 99 surveyed airports in Europe reported having noise related charges and some 27 more indicated that such charges were planned in the near future as an instrument to influence the use of aircraft (ACI Europe 1995).

In most countries the proceeds of the noise charge go to finance insulation programmes round the airport. The impact of these charges on reducing noise has been mixed with the OECD's 1990 evaluation arguing that the efficacy had been low and not influenced airlines choice of aircraft, whereas reports from Germany indicate that charges have helped accelerate the changeover to Chaper 3 aircraft (Umweltbundesamt 1996).

In 1996 Austria is planning to introduce a road user charge that differentiates according to the noise and air pollution emissions of the vehicle.

Economic incentives to encourage noise reductions

Incentives in the form of grants to purchase low noise goods vehicles have been in operation in Germany and the Netherlands but are currently not in use. In 1981 in the Netherlands operators of heavy goods vehicles are offered a two tier subsidy if they purchase and use vehicles fitted with 'hush kits' which result in specified lower noise levels. Subsidy levels were 7.5% and 5% for noise reductions of 6dB(A) and 3dB(A) respectively. The costs of the quietening measures are borne by the operators. In 1988 because of reduced availability of funds, only heavy vehicles (over 12 tonnes) with drive-by noise levels of 79 dB(A) or less were eligible, receiving a maximum subsidy of 4.5%. More than 60% of the lorries now in use in the Netherlands have noise levels 5dB(A) below current standards.

3.6 Operational Procedures

Restrictions on the use of noisy vehicles and products

The most widely practised restriction of this type has been limits on lorries, especially at night, in numerous towns in Europe. The bans have been total or partial. Examples include the French quiet town scheme of the 1980s, a night time lorry ban with exemptions for low noise vehicles operates in German spa towns, a lorry ban in Salzburg, again with exemptions for low noise vehicles, the Greater London night time and weekend lorry ban again associated with incentives, and a night-time ban on lorries on the Tauern autobahn in Austria.

The OECD (OECD 1991) assessed a number of these schemes and concluded that a number

of conditions are necessary for a scheme to be successful:

- a legal framework which does not conflict with supranational legislation including a definition of low-noise vehicles;
- clear delineation of the restricted zone and identifiable exempted vehicles;
- a means of policing and enforcing the bans, where the public is an important actor;
- co-operation from manufactures and operators;
- public awareness of the noise issue, which can help operators of low noise vehicles perceive the benefits gained from enhanced public relations.

3.7 Community support for research into noise abatement

Through actions under the Community's 3rd and 4th Framework Programmes for Research and Technological Development, an increasing number of projects have been supported, aimed either at understanding fundamental concepts or developing solutions to technological problems relating to noise.

More specifically the following research activities have been supported:

- measurements of noise and vibration in the Standards, Measurements and Testing programme;

- reduction of noise from equipment in the Industrial and Materials Technologies programme especially noise from motor vehicles, railways and aircraft.

- research in the telematics applications programme, testing the effects of advanced road traffic management strategies on noise levels, and supporting pilot projects providing environmental information on noise levels in urban areas.

Assessment of the impact

Although there has been considerable Community input into noise research in the past many of the actions were scattered across various specific programmes and not sufficiently geared to environment policy objectives. However under the 4th Framework Programme efforts have been made to achieve better coordination between specific programmes. Task Forces gathering views from operators, legislators and users have helped further identify RTD needs in areas of importance for industry. In particular, the Task Forces on the aircraft of the future and trains and railway systems of the future are giving research on noise reduction a high priority. A close coordination of Community research on noise abatement based on a clear noise policy can benefit European industry in generating momentum to exploit potentially large markets in quieter products, instrumentation, sensors, actuators and other materials. A shift in emphasis could permit a strong European leadership with mass production facilities and with potential for job creation and export outside the EU.

3.8 Information and Education

Information and education programmes have long been an important instrument in Member States noise policies. The OECD in 1991 reported that experience in several countries showed that ongoing campaigns of a limited scope related to advances of noise abatement were more effective than major but occasional and short lived national campaigns, unrelated

to progress achieved and also that awareness campaigns undertaken locally were more effective than national campaigns.

4. TOWARDS A NEW FRAMEWORK FOR EC NOISE POLICY

Based on the analysis of the noise situation and the implementation of current policies in the previous two chapters the following section discusses the options for future policy measures. As a first step however it is important to set out clearly what the Commission sees as the Community's role in noise abatement.

4.1 The future European Community role

Perhaps to a greater extent than in any of the other environmental themes included in the Fifth Action Programme shared responsibility is the key to an effective noise policy. The local impact of noise means that proposing and implementing solutions are essentially local responsibilities. The sources of the noise problems are however diverse and often not of local origin. Therefore there has been a long involvement of international organizations in product standard setting and increasingly in cooperation in R&D related to noise abatements for products and the effects of noise exposure.

However to date this shared responsibility, which requires all actors to be working towards a common goal has not functioned effectively. There is evidence of a lack of overall coherency in the multitude of actions developed to reduce noise. The work done at the Community level is somewhat hampered in this respect as there is no overall noise abatement programme. Responsibilities for environmental noise actions are dispersed in the Commission and in different instances in the Council. The legislation on noise standards for cars, lorries, buses and motorcycles have been dealt with by the Economic Affairs/Internal Market Council, legislation on aircraft noise is decided by the Transport Council, while noise from construction machinery has been addressed in the Environment Council. In addition the effectiveness of noise abatement measures has been reduced by a lack of reliable and comparable data on the overall noise situation against which progress can be monitored and also by insufficient integration between action taken at the Community level and action taken at national and local levels.

The Commission believes that it is necessary to reassess the current approach to noise policy in order to increase its effectiveness by improving the coherency of the multitude of actions being undertaken for the different sources. Furthermore greater integration and coordination is necessary to ensure that the actions proposed under Community policies, which can directly or indirectly influence the noise environment, will make a positive contribution to noise abatement.

The reassessment and any changes in approach would not mean extending Community responsibilities to include actions best decided at national and local level. There are however a number of areas in noise abatement where a consensus is emerging across the Union on the need of a common approach in order to achieve more effective action. These include the establishment of common noise assessment methods and the determination of common exposure indices as necessary steps to improve the currently poor data situation on environmental noise and the exchange of information on noise exposure. The provision of information to the public in order to raise awareness and involve citizens more closely in abatement actions is another potential area of cooperation. Over the medium term there could also be agreement on a limited number of minimum noise quality target values.

The main area for Community involvement will continue to be action linked to the reduction of noise from different sources. Chapter 3 has shown some of the limitations of relying principally on legislation on emission limits and the potentials of some other instruments. The Commission therefore will look in detail at options for cost effective combinations of instruments consistent with the provisions of the Treaty and the principles of the Single Market to be applied to the different sources. The potential for using economic instruments to address noise problems from transport sources has been addressed in the Commission's 1995 Green Paper 'Towards Fair and Efficient Pricing in Transport'. The paper suggested that for road noise incentive schemes based on annual taxes or road pricing could be a way forward, while for railways a modulation of track charges to take account of noise should be investigated. The paper also announced a Commission initiative on airport charges.

Another area where there is scope for the Community to play a greater role is through encouraging exchanges of experience in noise abatement which can assist Member States and local authorities in the implementation of actions.

The remainder of the chapter outlines the actions that are proposed for discussion. It is divided into three parts, the first covering options for an overall framework for the reduction of noise exposure and the second options for future action on the key priority noise sources and the third areas where the Community could assist Member States and local authorities in the implementation of policies.

4.2 A Framework for Noise Exposure Assessment

> *'Compared to the measurements made and data available for some components of the environment which directly affect man, such as air or water, observation of the noise environment is still highly inadequate'.*

This statement which appeared in the OECD report 'Fighting Noise in the 1990s' published in 1991 is still very true five years later. The measurements of noise exposure levels and the exposure of populations remain far from comprehensive and the data are infrequently updated often using simplistic models. Without better information it is impossible to measure to what extent progress is being made towards the overall targets such as those set out in the 5th Environmental Action Programme. This was made clear in the 1995 state of the environment report of the European Environment Agency. In addition without better information choices about the most cost effective instruments for future action are made much more difficult i.e. whether to continue strengthening the Community wide emission limits or to rely more on local actions.

The Commission believes that improvements in noise data, its comparability and monitoring and the provision of information to the public are the main priorities for short and medium term action and is considering proposing legislation in the form of a directive to establish a framework for such actions. The results could help overcome the shortcomings mentioned above and can assist national and local authorities and the Community to take more informed decisions about the noise measures for which they are responsible. The Commission would therefore like to launch a debate on the scope of any legisation.

The types of measures that could be included in a directive proposal include:

- The establishment of a common 'EC' noise exposure index to ensure that data on environmental noise exposure are made available using the same noise units.

The Commission believes that the A-weighted equivalent continuous sound pressure level $L_{Aeq,T}$ in dB(A) (as defined in annex 2) should be the 'EC' index. This is already the most commonly used exposure descriptor and is gaining world wide acceptance as the scale for long term noise exposure.

- Provisions for the development and use of harmonized prediction and measurement methods for assessing environmental noise from different source categories.

Cooperation on the development of common methods is already underway between a number of European countries and would need to be taken into account.

- Provisions for the exchange of comparable information on noise exposure between Member States.

The data could be collected and made available by the European Environment Agency.

- Assessment of environmental noise exposure by the competent authorities in the Member States and provision of the information on exposure to the public.

The Commission believes that noise mapping has the potential to be an effective and relatively inexpensive method for the assessment of noise data and for presentation to the public and to serve as a basic planning tool. Such maps present ranges of noise exposure for a particular area in for example 5 dB(A) steps by the use of different colours. They make it easy to recognise the noise exposure and thereby identify areas where action is required and other quiet areas where exposure should not increase.

These measures could be proposed together with the data harmonization actions as part of a directive or presented separately in the form of recommendations to Member States.

Alternatively the requirement to inform the public on noise exposure could form part of a second phase of action depending on an assessment of the outcome of the first phase. The second phase could also include the establishment of a limited number of minimum target values and to the obligation to take action at the most appropriate level to meet these targets.

4.3 Action on the different sources

The following section outlines briefly the options that the Commission is considering for the future for the main priority noise sources for which there is already Community legislation. In assessing the options the Commission will focus on broadening the range of instruments, cost effectiveness/cost benefit and the polluter pays principle. The framework for the improvement of data will assist the identification of the best options.

i) Future options for road traffic noise

The setting of noise emission limit values for vehicles is the main area of EC involvement in environmental noise abatement to date due to the importance of road noise with the limit values being revised every five or so years. Studies have estimated that the new 1996 limit values will lead to an average reduction of noise levels of road traffic in urban areas of 2 dB(A) compared to the previous 1988 limit values. Such reductions are dependent on the complete replacement of the vehicle park and therefore would take 10-15 years and the growth of vehicles over this time may therefore partly offset this reduction. There would be

no reduction in rural areas and where speeds are over 60 km/h due to importance of tyre/road noise. The additional costs of vehicles associated with the introduction of these limits are estimated to be 3% for cars, 2% for buses and 4% for lorries.

Further reductions in limit values of 2 dB(A) are technically feasible but likely to be costly. One estimate forecast that such limit values, which would require increased use of acoustic shields could add 5% to cost of cars, 4% to buses and 7% to lorries (Favre and Tyler 1987), which could represent an annual cost of the order of 5-6 billion ECU to industry. This could also have implications for the weight of vehicles and thereby fuel economy and CO_2 emissions.

The Commission has been asked to come forward with a proposal on tyre noise and Commission services are currently working on the preparation of such a proposal. In addition to focusing on tyre/road noise, which will have to take into account the balance between reducing tyre noise and maintaining wet adhesion, the Commission believes that future action to reduce vehicle noise needs look for a cost/effective combination of instruments and in particular to address the weaknesses in the current approach identified in chapter 3.

To this end for the next phase of action to reduce road traffic noise the Commission will focus on cost/effectiveness assessments of a variety of options and in addition to addressing tyre/road noise and whether any new emission limit values are appropriate, will consider:

- in the context of the current review of vehicle taxation, whether more differentiation in existing annual vehicle and fuel taxes to take account of noise costs could be an effective instrument.
- a technical revision of the test procedure (ISO R362) to make it better reflect realistic driving conditions
- amending Community legislation on road-worthiness tests to include specific noise testing of in-use vehicles.
- actions to promote the use of low noise surfacing. As indicated in chapter 3 the Community is supporting research in this area and CEN is working on surface standards . This work should be accelerated. In addition the Community is an important source of finance for road building through the Structural and Cohesion Funds and the Trans-European Networks budget line, which should be built to the highest environmental and safety standards possible. The Commission will therefore promote the use of low noise surfaces for road projects in noise sensitive areas receiving Community funding, where this is feasible and cost-effective and where such surfacing can offer the same level of safety and durability.

ii) Options to reduce railway noise

A priority for Community transport policy is to achieve a better balance between different modes, which will mean achieving a greater role for rail. This in turn will require increasing capacity and more infrastructure in certain areas. However as the public's main criticism of rail transport is the excessive noise level, which could be exacerbated with the growth of high speed rail, there is considerable opposition in many areas to the expansion of infrastructure or capacity. Therefore increased noise abatement efforts are required if the expansion of traffic is to gain wider acceptance.

Two areas are of particular concern: high speed rail and freight wagons.

The problem of noise from high speed rail is being addressed in Council Directive 96/48/EC of 23.7.96 (OJ No. L 235) on interoperability on the high speed network. This Directive includes a specification that 'operation of the trans-European high speed rail network must remain within the statutory noise nuisance limits'. It sets up a joint body representing infrastructure managers, the railway companies and industry , amongst whose task will be to propose noise emission limits to be met by trains on the high speed network for a decision by the committee of Member States set up by the Directive.

In the area of freight less progress has been made compared to passenger wagons. The international railway industry organisation (UNIFE) has established a medium term target of reducing noise emissions from freight wagons by 8-10 dB(A), which it regards as feasible although with significant cost implications. As mentioned in Chapter 3, some Member States are considering national legislation to fix emission levels and there have been calls from industry and railway operators for international action.

Noise abatement has long been an important subject of research supported by the railway industry and the Community which is making an increase effort through the 'Trains and Railway Systems of the Future' programme for both freight and passenger systems.

In parallel to supporting the research efforts, the Commission in cooperation with the interested parties and other international organisations will investigate the possibilities of introducing other instruments. Among these possibilities are economic instruments such as a variable track charge which would enable the infrastructure fee for the use of track to be differentiated according to the noise levels of the wagons, legislation on emission limits, a negotiated agreement between the railways industry and the Community on targets for noise reductions and measures to ensure maintenance of in-use equipment. The assessment will look at the possibilities of using a mix of these instruments. Agreement on harmonised methods of assessment and prediction of railway noise would greatly facilitate the introduction of such instruments.

iii) Future options to reduce aircraft noise

In air transport, as for the other modes, the Commission is looking to develop an integrated approach to noise reductions based on an assessment of a combination of instruments. The assessment will include greater stringency in emission values and the use of economic instruments to encourage the development and use of lower noise aircraft, as well the contribution local measures such as land use planning could make.

As for emission limits, greater stringency has been under study for several years at international level by the Committee on Aviation Environmental Protection (CAEP), which has the task of making recommendations to the International Civil Aviation Council. The latest session of CAEP held at the end of 1995 failed to agree on a recommendation for increased noise stringency for aircraft, although there was a majority of countries on the Committee in favour of greater stringency. Following the failure of CAEP, the Commission aims to issue a consultation paper in the near future and to continue to work for agreement within international bodies on more stringent emission standards and harmonised measurement. .

The consultation paper will also include consideration of the contribution land use planning around airports could make in line with the provision in the Common Transport Action Programme (COM(95)302)) for the development of a common framework for land use rules.

In the air transport sector, economic instruments in the form of airport charges are already widely used to promote environmental aims as well as for other purposes. An analysis of airport charging systems in airports in the Community by the Commission has shown that many of the existing systems do not ensure fair and equal treatment of users as required in the Single Market. Therefore in the course of 1996 a specific Commission proposal is planned on airport charges in general, based on the principles of non-discrimination, cost-relatedness, transparency and will include provisions for modulation of charges to contribute to environment improvements such as noise abatement.

An acoustic classification of aircraft types in accordance with actual operational noise rather than the criteria of the Annex 16 to the Chicago Convention on certification noise could make the introduction of such modulations easier in practice and contribute to the overall transparency of charging systems. The Commission together with airports and manufacturers will study such a classification.

iv) Outdoor machinery

As indicated in chapter 3 in recent years there have been calls on the Commission to extend the noise legislation currently applying to a limited number of types of outdoor equipment. However, if the Community were to embark on the same approach to controlling the noise emissions from other types of machinery as for the seven existing directives, it would mean a vast increase in legislation, which would be time consuming and not cost effective in terms of its impact on industry and in the use of man-power. In addition there is no guarantee that such an approach would bring about the environmental improvements that the Community is seeking. The Commission services have therefore been working together with experts from the Member States on a new approach to control noise emissions of a much wider range of outdoor equipment, which will extend but at the same time simplify the legislation.

In 1997 the Commission intends to propose a framework directive to cover more than 60 types of equipment used outdoors, not only construction plant, but also garden equipment, equipment used on specific vehicles (such as refuse collection vehicles and glass containers) and which would incorporate the existing seven directives for noise from outdoor equipment. The principal feature of the new directive will be a requirement for manufacturers to label all equipment to be placed on the market with the guaranteed noise emission level. The OECD reported in 1991 that labelling products with standardized information on noise emission levels has attracted interest as an inexpensive means of creating a market for low noise products (OECD 1991). Noise limit values will be proposed only for the equipment already covered by noise legislation and a limited range of highly noisy equipment on the basis of appropriate cost effectiveness analyses. The draft directive will include provisions for the addition of other pieces of equipment at a later date. Another important feature will be the collection of information on the range of noise emission values of equipment on the market, their populations and contribution to noise exposure. This would make it possible if necessary to take other measures at a later stage such as additional limit values, criteria for eco-label awards or economic incentives. In addition the labelling could assist those at the local level in decisions on the use of certain equipment in noise sensitive areas.

4.4 Contributions from the Community to Noise Abatement Action in the Member States -Promoting exchanges of experience

Land use planning, education and awareness raising are instruments of noise policy where the Community can play a role in assisting Member States and local authorities in the

implementation of abatement actions essentially by promoting exchanges of experience and dissemination of good practice. In comparison with other environmental issues, there seems to have been less exchange of experience on noise actions among local authorities in Europe. However, the many initiatives for cooperation on urban transport issues between local authorities in Europe will have a beneficial impact on noise abatement.

As part of the review of the Fifth Environmental Action Programme, the Commission in cooperation with experts from the Member States and associations of local authorities, is intending to prepare a guide concerning the implementation of the Programme at the local level and its implications for local authorities. Noise abatement will be an important feature in this guide.

The Community also has several financial instruments through which cooperative ventures between Member States and particularly local authorities are supported and where noise abatement could be given a higher priority.

These include:

the *LIFE* programme, the Community's financial instrument for environmental protection, where assistance can be requested for demonstration, promotion and technical assistance actions for local authorities in order to encourage the integration of environmental considerations in land use development and planning. Noise along with air, water and waste are the priority themes.

Assistance for environmental awareness measures, from the financial resources available for environment policy.

the Telematics Applications Programme, Sector Environment, where pilot projects to improve environmental information systems for the public and environmental managers on topics such as noise are supported.

Assistance for networking and cooperation projects between urban areas and urban pilot projects provided for under article 10 of the European Regional Development Fund regulation, where noise abatement could be part of integrated projects for urban areas.

5. CONCLUSION

In this Green Paper the Commission is outlining a possible step by step approach to the development of a new framework for Community noise policy, which up to now has been a part of environment policy that has perhaps not been given the priority it deserves. The problem of noise is complex and action to reduce noise needs to be set within a long-term context. One of the aims of this paper therefore is to contribute to the efforts being made elsewhere to give noise abatement a higher priority in environment policy making.

The paper does not attempt to present in detail the complete range of the solutions to environmental noise problems but rather is focusing on the areas where it is appropriate and seems cost effective for the Community to be involved in cooperation with Member States and local authorities.

The options for action on measurement methods, monitoring and exchange of information and its provision to the public cover important steps for the establishment of an overall

framework for action. In particular providing better information to the public will help raise awareness about the real extent of the problem and can thereby influence changes in behaviour and is an area where cooperation across the Community can be of significant added value.

In addition these actions could assist the Community, Member States and local authorities to evaluate the optimal combination of instruments to apply to the different sources of noise. As is pointed out in Chapter 4 there is work to be done to evaluate the optimal combinations of instruments.

The Commission invites comments on these ideas from the Council, Parliament, the Economic and Social Committee and the Committee of Regions and other interested parties by 31 March 1997. Observations should be submitted to:

The European Commission
Directorate General for Environment, Nuclear Safety and Civil Protection
"Green Paper on Future Noise Policy"
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ANNEXES

1 Table on Noise from the Fifth Environmental Action Programme

Table 12: Noise

Objective	EC targets up to 2000	Actions	Time-frame	Sectors/actors
No person should be exposed to noise levels which endanger health and quality of life	Night-time exposure levels in leq dB(A)			Transport and industry
	exposure of the population to noise levels in excess of 65 should be phased out; at no point in time a level of 85 should be exceeded	Inventory of exposure levels in the EC	before 1994	EEA + MS + LAs
		Noise abatement programme to be set up	before 1995	MS + LAs
	proportion of population at present exposed to levels between 55-65 should not suffer any increase	Further reductions of noise emissions (cars, trucks, aircraft, cranes, mowers, etc). Directives to be presented progressively, aiming at implementation not later than 2000	before 1995	EC + MS + industry
	proportion of population at present exposed to levels less than 55 should not suffer any increase above that level	Standardization of noise measurement and ratings	continuous	EEA + EC + MS
		measures to influence behaviour, such as driving cars, flight procedures, industrial processes operating at night time	idem	MS + LAs + EC
		measures related to infrastructure and physical planning, such as better zoning around airports, industrial areas, main roads and railways	idem	MS + LAs

2 The Measurement of Noise

To a large extent **Noise** is determined by the subjective perception of people which is varying from one individual the other and often even for one individual depending on its current attitude. Because of its subjective nature it **cannot be measured by objective units.**
But in order to classify and compare different noise events it is necessary to give at least an approximate description by quantitative values. For this purpose the **"sound"**, that is the physical part of noise, **is described by quantitative values** concerning

o its **strength**

The strength of a sound is expressed in terms of the mean amplitude of the sound pressure waves p and is usually stated as sound pressure level L_p in decibels (dB) determined by the following equation (p_o being the reference sound pressure of 20 μ Pa):

$$\mathbf{L_p = 10 \log (p/p_o)^2 \text{ in dB}}$$

The decibel scale ranges from $-\infty$ to $+\infty$, but the human ear can only perceive sound pressure levels from 0 dB (the threshold of normal human audibility) to about 130 dB (the threshold of

pain). The way in which the dB scale corresponds to everyday noises in the outdoor environment is shown in figure 1 where it can be seen that this range varies from roughly 35 dB to about 110 dB.
Because of the logarithmic nature of sound pressure level values the addition of sound pressure levels is different from the usual way of addition: adding 2 (10, 20, 100) equal sound pressure levels results in an increase of 3 (10, 13, 20) dB.
Corresponding to the subjectively perceived loudness of sounds of different strength an increase of sound pressure level of 10 dB of a steady state pure tone will result in a twofold change in loudness.

o its **frequency or frequency composition**

Most sounds consist of a mixture of tones with various pitches and frequencies, the frequencies being measured in Hertz (Hz). The human ear has got a different sensitivity for tones of different frequency: it is most sensitive for tones between 1kHz and 5kHz, less sensitive for higher frequencies and even more less for lower frequencies. Therefore for most purposes the measured sound pressure level is weighted with the so called 'A'-weighting and transformed in the 'A'-weighted sound pressure level L_{pA}

$$\mathbf{L_{pA} = 10 \log (p/p_o)^2 \text{ in dB (A)}}$$

o its **time history**

Mostly sound is fluctuating with time, it may fluctuate in a very small range (in some distance of a motorway) or in a very wide range (near to an airport). All these different sound events should be described by one unit. The description of all the different noises is based on the hypothesis that equal noise doses (that means sound energy times exposure-time) result in equal noise burdens. This method of time averaging results in the so called

equivalent continuous sound pressure level L_{Aeq} in dB(A).

The equivalent continuous sound pressure level is gaining widespread acceptance as a scale for the measurement of long-term noise exposure. It is used in most of the legislation in the Member States and on the international level. It has been adopted by the ISO for the measurement of both environmental noise exposure and hearing damage risk. But there are still problems concerning the description of very fast fluctuating sound and of sound events that occur rarely by L_{Aeq}. To overcome these problems several (supplementary) units to describe the time history are used: e.g. the maximum sound pressure Level L_{max}, the statistical noise levels L_n (indicating the level that is exceeded in (100-n)% of time), the noise and number index NNI (taking into account also the number of noise events), and 'penalties' added to the L_{Aeq}. Research is going on trying to improve the current averaging method.

o its **particular character**

If sound contains single tones or very low frequencies this may be perceived as very annoying. Therefore sometimes 'penalties' are added to the L_{Aeq} in order to consider this annoyance.

Figure 1:
Noise levels of different noise sources

	A-weighted sound pressure level (dB(A))
Auditory threshold at 1000hz	0
Felt as complete quietness	0-20
Slight rising of leaves	25-30
Calm urban area in a city between 2 and 4 am	35-45
Normal conversation (indoor)	45-55
Passenger car, idling 7.5m (Otto engine)	45-55
Passenger car 50 km/h, 7.5m	60-80
Heavy goods vehicle 50 km/h, 7.5m	80-95
Motorcycle 50 km/h, 7.5m	75-100
Peak level of a passing freight train 100 km/h, 7.5m (diesel engine)	95-100
Discotheque (indoor, Leq)	85-100
Peak level of a passenger train (Intercity, 200 km/h, 7.5m)	95-100
Peak level of a passenger train (ICE, 250 km/h, 7.5m)	95-100
Peak level of a high-speed train (TGV, 300 km/h, 7.5m)	105-110
Jet aeroplane (>100 t, take off, 100 m)	110-115
Military low-level flights	105-120
Hearing damage possible even for short-term noise exposure	> 120

Source: Europe's Environment 'The Dobris Assessment' European Environment Agency (Box 16B from Müller, DGXI, CEC, personal communication based on US EPA, 1979)
Note: For modes of transport, the speed, distance from source and weight of carrier are indicated

3. The Nature of Environmental Noise

Road and rail traffic are considered as line sources with the area of noise impact parallel to the routes. The radiated noise can be related to traffic parameters and to the acoustically relevant properties of the surface or superstructure. The assessment of air traffic noise is more complicated as the impact depends on the height of the aircraft, the noise emission characteristics of the engines and its track. It is generally presented in the form of noise exposure contours around airports.

Road noise, especially at some distance from the road can be described as a steady state noise that does not fluctuate much. In contrast to road noise, rail and aircraft noise are acoustically characterized by high noise levels of relative short duration.

Noise from industrial installations, construction sites and fixed recreation facilities radiates from a point source and the shape of the exposure area is generally a circle. The radiated noise is generally related to the installed power of the installation and other acoustically relevant parameters. Depending on the nature of the installation noise from these sources may be steady for long periods or fluctuate considerably and then rise for a certain time.

The noise caused by outdoor equipment such as that used on construction sites is not related to a fixed piece of infrastructure like road or industrial noise. The equipment may be used in different places and at different times by different people all of which makes regulation of the noise caused by these products more difficult.

The basic level of road traffic noise emissions is determined by engine noise and the exhaust system. The noise produced in the contact between tyres and the road surface increases rapidly with higher speeds and with light vehicles tyres and the surface are the dominant source at speeds above 60 km/h. This threshold is likely to fall to 50 km/h and even lower, when more stringent vehicle emission limits are enforced. In future therefore tyre to surface noise will become an important issue to be addressed in noise abatement strategies. In urban areas behaviour behind the wheel is an important factor influencing noise emissions. Fast acceleration and revving the engine in traffic may result in emissions up to 15 dB(A) higher than the normal levels of emission resulting from smooth driving.

Road infrastructure is used equally by passenger and freight transport, although the percentage of heavy goods vehicles tends to vary considerably: it can represent up to 45% of traffic at night on a national motorway and less than 10% of traffic during the day in urban areas. Whereas assessing the shares of lorries and cars as far as their physical noise impact is concerned poses no problem, it is difficult to apportion the effects between both sources. However studies have shown that people perceive the noise emitted by one heavy lorry to be as loud as that of seven light goods vehicles and in urban areas where speeds are not constant to that of at least 10 cars.

At low speed the main source of railway noise is the engine, while at travelling speed the noise produced by the interaction of the track and the wheels exceeds that of the engine. The level of this noise is dependent on factors such as the condition of the wheel, its characteristics, the construction of the rolling stock, speed plus the condition of the track. The emissions of freight trains at travelling speeds of 100 km/h are about 4-5 dB(A) higher than that of passenger trains at speeds of 200 km/h. At very high speeds aerodynamic noise will be the most important problem and will require particular measures.

Aviation noise, whose main source is aircraft engines, has the most impact during take-off and landing, and is generally recognised to be a significant source of annoyance at relatively low operating heights. Therefore aviation noise is generally related to movements around airports.

Examples of comparisons between different stationary and mobile sources:

the sound power output from a modern 300 MW electrical power plant is more than three times less than that of one low noise heavy goods vehicle (measured under a type approval test code), while the noise of a large waste incineration plant is equivalent to 3 passenger cars accelerating from a green traffic light.

4. Effects of Noise

Sleep disturbance

Sleep disturbance starts at noise levels of 30 dB(A) for steady state continuous noise at the sleeper's ear. In special situations even lower levels may disturb sleep. The most important noise exposure parameter for sleep disturbance however is the maximum peak level of the exposure, which points to the importance of avoiding noise from lorries and aircraft in residential areas at night. From study findings the general conclusion can be drawn that to ensure undisturbed sleep the maximum sound pressure level should not exceed 45 dB(A). Field studies indicate deterioration in mood or symptoms such as tiredness, headache and nervous stomach where heavy traffic occurs at night and the recommended values are exceeded.

Extra-auditory effects

A great number of these mainly psycho-physiological effects of noise have been reported in the subject literature. The most important of them manifest themselves in physiological stress responses and, particularly at higher levels, in cardio-vascular reactions. But also mental health effects and influences on performance and productivity have been observed and documented. Intensive research on these subjects is still ongoing. It can be generally concluded from the present state of knowledge that exposure to environmental noise acts as a stressor to health as it may lead to measurable changes in e.g. blood pressure, heart rate, vasoconstriction, endocrine excretion levels and admission rates to mental hospitals.

Interference with Communication

Noise levels frequently attained in streets, gardens and on balconies interfere with speech. Noise levels inside buildings usually cause occupiers to close windows if they wish to hold a conversation once the external continuous noise level reaches 70 dB(A). It is generally accepted that noise levels in homes should not exceed 40-45 dB(A), levels that are often exceeded by traffic noise even with the windows closed.

General Annoyance

A less specific, but nevertheless serious effect of environmental noise is that it simply disturbs and annoys people. The feeling of annoyance results not only from sleep disturbance and interference with communication, but also from less well defined feelings of being disturbed and affected during all kinds of activities as well as during periods of rest. Because of the subjective nature of annoyance, evaluation must be carried out using survey techniques such as questionnaires. Studies to date show the importance of traffic noise as an annoyance factor in the general population.

5. Instruments for Reducing Noise Exposure

Emission Standards

These are generally laid down by governments and consist of emission limit values applicable to individual sources and included in type approval procedures to ensure that new products are at the time of manufacture complying with the noise limits.

Immission Standards

Immission standards are based on noise quality criteria or guideline values for noise exposure to be applied to specific locations and are generally built into planning procedures.

Planning Measures

Land use planning procedures are one of the means of putting immissions regulations into practice and are a key tool for noise abatement to ensure separation of dwellings and other noise sensitive buildings from noise sources. Over the long term land use planning is one of the most efficient ways of reducing noise as it can be used to prevent new problems occurring. In particular noise abatement through land use planning can include: restricting the use of land that

is already subject to high levels of noise, restricting the siting of new noise generators such as traffic routes or industrial installations in order to protect existing developments and encouraging noise generating activities to cluster together in order to preserve other low noise areas. Noise is one of the considerations to be dealt with in environmental statements for developments requiring an environmental impact assessment.

Infrastructure Measures

There are essentially two broad categories of infrastructure measures to abate noise: those that limit the transmission of noise: noise protection walls, tunnels, cuttings, noise attenuation dams, passive protection of buildings through insulation; and those that can contribute to the reduction of noise at source through for example the design of road surfaces and railway tracks.

Economic instruments

The types of economic measures that are and could be used in noise abatement policy include taxes and charges on noise emissions, economic incentives to encourage noise reductions and the development of low noise products, and the payment of compensation to people affected by noise.

Operational Procedures

Among the widely used measures are speed limits on sensitive road and rail sections, enforcing operational flight take-off-landing procedures for aircraft and noise preferential routes, as well as restrictions on the use of noisy products and vehicles in sensitive areas and during sensitive times.

Research and Development

Scientific research into the effects of environmental noise, the methods of noise abatement and low noise technologies and the development of special low noise products are a vital supporting instruments and often initiate improvements in the state of art of noise reduction. Financial support to pilot projects are useful in showing the advantages of technical and planning measures to reduce the noise exposure of citizens.

Information and Education

Education and information activities are important in promoting acceptance of and compliance with noise regulations and to encourage changes in behaviour. They can also be used in their own right to encourage noise abatement and awareness raising amongst decision makers and the general public.

6. EC noise emission limits for selected vehicles and products

Motor Vehicles

Vehicle Category	**1972**	**1982**	**1988/90**	**1995/96**
Passenger Car	82 dB(A)	80 dB(A)	77 dB(A)	74 dB(A)
Urban Bus	89 dB(A)	82 dB(A)	80 dB(A)	78 dB(A)
Heavy Lorry	91 dB(A)	88 dB(A)	84 dB(A)	80 dB(A)

Two and three wheelers

Motorcycles and Three Wheelers	1980	1989	Proposal
<80 cm3	78	77	75
>80<175 cm3	80-83	79	77
>175 cm3	83-86	82	80

Construction machinery and lawnmowers

Type of Equipment	classification	1986	1987	1991
compressors	nominal airflow in m^3/min			
	$Q \leq 5$	101		100
	$5 < Q \leq 10$	102		100
	$10 < Q \leq 30$	104		102
	$Q > 30$	106		104
tower cranes		102		100
welding generators	maximum welding current			
	≤ 200 A	104		101
	> 200 A	101		100
power generators	electric power in kVA			
	$P \leq 2$	104		102
	$2 < P \leq 8$	104		100
	$8 < P \leq 240$	103		100
	$P > 240$	105		100
hand-held concrete-breakers and picks	mass of appliance in kg			
	$m < 20$	110		108
	$20 \leq m \leq 35$	113		111
	$m > 35$	116		114
lawnmowers	cutting width in cm			
	$L \leq 50$		96	
	$50 < L \leq 120$		100	
	$L > 120$		105	

Earth-moving machinery < 500 kW

(noise limits existed since 1986; 1996 legislation has enacted a new approach that reduced old limits by approximately 3 dB(A))

type of equipment	classification	1997	2001
tracked machines (except excavators)	$P \leq 65$	107	104
	$P > 65$	$L_{WA} = 87 + 11 \log P$	$L_{WA} = 84 + 11 \log P$
wheeled dozers, loaders, excavator-loaders,	$P \leq 55$	104	101
	$P > 55$	$L_{WA} = 85 + 11 \log P$	$L_{WA} = 82 + 11 \log P$
excavators	$P \leq 15$	96	93
	$P > 15$	$L_{WA} = 83 + 11 \log P$	$L_{WA} = 80 + 11 \log P$

ISSN 0254-1475

COM(96) 540 final

DOCUMENTS

EN 14

Catalogue number : CB-CO-96-548-EN-C

ISBN 92-78-10730-1

Office for Official Publications of the European Communities

L-2985 Luxembourg