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WHO

REGIONAL OFFICE FOR EUROPE

AIR QUALITY GUIDELINES IN THE EUROPEAN REGION

Report on two workshops

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EUR/HFA TARGET 21

This document presents the findings, conclusions and recommendations of two workshops held in Athens from 13 to 16 December 1988 and in Warsaw from 20 to 22 June 1989.
They were convened by the Regional Office for Europe to promote work aimed at achieving the following target in the health for all strategy.[a]

TARGET 21

PROTECTION AGAINST AIR POLLUTION

By 1995, all people of the Region should be effectively protected against recognized health risks from air pollution.

Index terms

AIR QUALITY
AIR POLLUTION - prevent/control
EUR

[a] *Targets for health for all.* Copenhagen, WHO Regional Office Europe, 1985 (European Health for All Series, No. 1).

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FOREWORD

This report is based on discussions at meetings held in Athens in December 1988 and in Warsaw in June 1989 as follow-up action to the WHO Air Quality Guidelines project. Participants, as listed in Annex 5, came from Mediterranean and East Europe countries respectively, presenting a cross section of the types of air pollution problems currently experienced in the European Region, together with approaches for their control. A WHO team comprising experts who had been closely connected with the Air Quality Guidelines project also attended on each occasion. The meetings were held, and the joint report drafted, prior to the sweeping economic and political changes that have been taking place in some of the countries concerned, opening up new prospects of international collaboration on pollution control. In particular it should be noted that German unification, as from 3 October 1990 nullifies many of the comments and regulations on pages 14-15, 53 and 61. This material is retained as a matter of history, but henceforth the environmental requirements of the Federal Republic of Germany will be applicable, with the aim of achieving "environmental union" by the year 2000.

The contents of this report are put forward now as a contribution to further discussions in the Region on sharing experiences on the role of air quality guidelines and standards in developing control procedures to protect public health.

4 October 1990

1 INTRODUCTION

One of the targets set out in the WHO's European regional strategy for health for all (1) was that "by 1995, all people in the Region should be effectively protected against recognized health risks from air pollution" and accordingly "the achievement of this target will require the introduction of effective legislative, administrative and technical measures for the surveillance and control of both outdoor and indoor air pollution, in order to comply with criteria to safeguard human health".

Subsequently over the four year period 1984-87 a project was carried through to develop air quality guidelines for the European Region. It covered a group of 28 air pollutants considered to be of special environmental and health significance within the region and following a series of Working Group meetings the conclusions were published in a single volume (2). The nature and purpose of the guidelines was explained in detail there, the main points being:

> "The primary aim of the air quality guidelines is to provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and wellbeing.
>
> The guidelines are intended to provide background information and guidance to governments in making risk management decisions, particularly in setting standards, but their use is not restricted to this. They also provide information for all who deal with air pollution. The guidelines may be used in planning processes and various kinds of management decision at community or regional level. When guideline values are indicated, this does not necessarily mean that they must take the form of general countrywide standards, monitored by a comprehensive network of control stations. In the case of some agents, guideline values may be of use mainly for carrying out local control measures around point sources.

> It should be emphasized that when air quality guideline values are given, these values are not standards in themselves. Before standards are adopted, the guideline values must be considered in the context of prevailing exposure levels and environmental, social, economic and cultural conditions. In certain circumstances there may be valid reason to pursue policies which will result in pollutant concentrations above or below the guideline values."

It was also noted that in general no distinction was made between outdoor and indoor exposures, and while occupational exposure had been considered in the evaluation process it was not the main focus of attention since the guidelines related to the general population. In the case of pollutants with at least limited evidence of carcinogenicity to humans (IARC classification 1 or 2A) only risk estimates were formulated rather than air quality guidelines. The summary section of the Air Quality Guidelines (AQG) volume is reproduced as Annex 1.

Following the publication of the guidelines the Regional Office had been concerned to encourage and assist Member states in using these public health oriented values for the implementation at national level of relevant standards or regulations as appropriate. A number of earlier WHO publications, including one on urban air quality management (3), another on air pollutants from industrial sources (4) and one on environmental standard setting (5) provide additional information for that purpose.

The present report summarizes the discussions that took place subsequently in Athens (December 1988) and Warsaw (June 1989), examining a cross-section of the types of air pollution problems encountered within the Region, and approaches currently used for their control.

2 AIR POLLUTION PROBLEMS IN INDIVIDUAL COUNTRIES

2.1 General Situation

Throughout the European Region the most widespread problems are those associated with emissions from motor vehicles and with fuel usage in power stations, industrial, commercial and residential buildings. In each country some action has already been taken to establish guidelines or standards for control purposes, protection of health being an important determinant. In general attention has been given primarily to the major urban air pollutants, sulfur dioxide, particulates, oxides of nitrogen, carbon monoxide and ozone that had featured in one of the AQG Working Groups, but in several countries a wider range of pollutants as emitted from specific industrial sources or found in indoor (non-occupational) environments has been considered. For some of the countries, existing European Community (EC) Directives, as set out in Annex 2, provide the principal control measures, the AQG being analogous with guide values within those directives rather than with the limit values. There are already examples of the AQG being used to reconsider or extend the development of national standards, and it is anticipated that they will be of increasing value in providing a uniform basis for action within Europe.

2.2 Greece

Attention has been focussed on the problems of Athens resulting from rapid growth in the post-war years coupled with its limited air-shed. Not only has the population in the Greater Athens area increased greatly, but improved living standards have led to disproportionate increases in energy and car transport requirements. While a series of abatement measures had been taken in a developing crisis situation, the need for a systematic analysis of the problems became evident by the mid 1970s, and with advice and assistance from WHO and other organizations a rapid emission inventory was done, followed by the development of an abatement strategy based on health and amenity criteria, but taking costs into account (6).

In respect of industrial sources, there are minimum emission standards applied across the country, and the best control technology consistent with moderate cost is required to be used. There is some overlap of responsibilities between the Ministries of Environment, Health and Industry, together with local authorities. Licences are required for major new industrial plants, and for existing plants there is some financial assistance towards environmental control.

In the Greater Athens area more widespread action has been required, including sharp reductions in the sulfur content of residual fuel oil and the lighter distillate fuels used for space heating or diesel vehicles. There are also maintenance and inspection requirements for space heating equipment and for vehicles. To reduce emissions from the large numbers of taxis in the city, the introduction of liquid petroleum gas (LPG) powered vehicles has been encouraged, though changes in fuel price differentials have led to a switch back to diesel fuels in recent years.

The basic air quality standards are those required under EC directives (Annex 2) but WHO guidelines are referred to also, and they are regarded as the longer-term targets. In general there is compliance with EC limit values, though with some exceedances in Athens of the short-term figures for smoke and NO_2. There are monitoring networks in Athens and in 11 other large city/industrial areas, covering SO_2/smoke, NO_2 and lead to meet EC directive requirements, together with some 24 hour Total Suspended Particulate (TSP) sampling and monitoring of carbon monoxide, hydrocarbons and ozone to produce hourly mean values.

Because of the topographical situation, with liability to temperature inversions and stable air conditions, there are risks of episodes of relatively high pollution in Athens, and to minimise the impact emergency levels have been defined (Annex 4), with provision for restrictions on activity as pollution threatens to build up. The action can be triggered by smoke, SO_2, NO_2 or CO rising towards the specified figures, with weather forecasts conducive to accumulation, but in practice it is more usually smoke, and sometimes NO_2 that acts as the trigger. The first step in the restrictive measures involves a reduction in traffic of 50%, with a 30% reduction in industrial activity. The second step has never been reached, but would involve a complete ban on traffic. While the basic rationale for action is protection of health, general amenity aspects are relevant, and public perception is determined largely by visibility reductions, attributable to smoke.

At present ozone levels are not incorporated in the alert system, though there are episodes of photochemical pollution during the summer months in which WHO guidelines for ozone are exceeded. While general reductions in hydrocarbon emissions could reduce formation of this secondary pollutant, it is not easily dealt with in emergency situations, since a temporary reduction in traffic could increase rather than decrease ozone levels locally (the nitric oxide in vehicle emissions reacts with ozone).

2.3 Israel

Most of the population and industrial activity is concentrated along the coastline, the main air pollution problems being from the use of heavy oil in power stations, refineries and other industries. There are contributions to NO_2 from traffic, and lead levels in petrol have remained at 0.4g/l until recently, dropping in 1988 to 0.3g/l and then in 1989 to 0.15g/l. Sandstorms can affect concentrations of suspended particulates, since some fine components are present in them. Concern has been expressed about emissions of specific industrial pollutants, including some with carcinogenic properties, such as asbestos, benzene or vinyl chloride.

Existing air quality standards, as defined in 1971, together with proposals for revisions and additions, are shown in Annex 3. The WHO AQG have been helpful in efforts towards the revisions, though in the case of carcinogenic substances a need is seen for guideline values rather than the unit risk concept.

The Ministry of Health issues guidelines for minimum distances between industrial and residential areas and is the main authority concerned with licences for new developments and with standard setting. There is an environmental protection service, within the Ministry of the Interior, that has an advisory and technical role. Implementation of air pollution control is largely the responsibility of local authorities, who also operate monitoring networks, and further measurements are made by electric power companies and the Ministry of Health. SO_2, NOx, CO and O_3 are measured on 6 minute cycles, together with particulates (TSP) on a 24 hour basis. Although there is no formal "emergency" procedure, there is provision for some large fuel oil users to switch to lower sulfur oil when SO_2 monitoring data and forecasts of inversions indicate risks of high pollution. In general there is compliance with the whole range of standards.

In December 1988 the government created a Ministry of the Environment and transferred to it all the responsibility of the Ministries of Health and of the Interior concerning air pollution control.

2.4 Malta

Though small in area and population there are problems of current concern regarding air pollution in the Maltese islands, including power station emissions, notably from an old coal/oil fired station in a densely populated area where dispersion is poor, traffic pollution and local problems around lime-kilns, stone quarries, ship repair yards and uncontrolled refuse burning dumps. An existing Clean Air Act covers emissions of dark smoke (primarily from ships in harbour), but new broader legislation to protect and conserve air quality is in preparation, under which the Ministry of Health will be responsible for setting air quality standards.

In 1983/1984 there was a monitoring programme on lead and cadmium in air as part of a UNEP/WHO project. However the lead and cadmium concentrations were found to be well below the current EC guidelines even when the lead in petrol was at that time relatively high (over 0.4g/l).

2.5 Portugal

Industrial development and growing concern with environmental questions, together with the need to comply with EC directives have led to the development of a coherent policy on air quality management, under powers provided by a Government Decree of 1980. There are now requirements for optimum control in new industrial activities, and emission limits are being defined for major installations, such as power and cement plants, steel mills and chemical industries. Licences for new developments are issued through the Ministry of Industry and Energy, in consultation with the General Directorate for Environmental Quality. Several urban and industrial areas have been defined where air quality management falls directly under the latter authority. Emissions from new motor vehicles are now subject in EC requirements, and the present level of lead in petrol is 0.4g/l, to be reduced to 0.15g/l.

The EC air quality standards (Annex 2) are being adopted, and there are guidelines for a wider range of pollutants, similar to the WHO AQG values. There are monitoring networks operated by national, regional and municipal bodies as well as by some industries, covering continuous measurements of SO_2, NO_2, CO and O_3, with additional 24 hour sampling for SO_2/smoke and for TSP. There are also some continuous hydrocarbon measurements in the more polluted areas. In most of the country there is compliance with EC limit values though at a few sites in Lisbon and the main industrial area there are some exceedances for SO_2 and smoke.

2.6 Spain

Air quality standards are set by the government in accordance with European Community requirements (Annex 2), with advice from the Department of Environmental Health. In addition, emergency levels have been defined at national and local level to combat risks of high pollution episodes occurring in combinations of meteorological and topographical situations unfavourable for dispersion. There have in the past been such problems in Madrid during the winter months, with high concentrations of

SO_2/particulates from heating sources. Action taken to reduce emissions on approaching the defined emergency levels has included limitations on major industrial sources, a ban on traffic in certain areas and avoidance of heating before noon and after 7pm. The situation has however improved now through changes in domestic heating, mainly towards the use of gas. Pollution from traffic continues to create problems, more particularly in the summer months, exacerbated by poor dispersion in the narrow streets.

In the South and East of the country there are areas with refineries and other industries where SO_2 and NO_2 concentrations are relatively high.

Monitoring is carried out by local authorities and industry, with observations in 28 localities covering SO_2, smoke, NO_2, lead, CO, fluoride and ozone. There are currently some exceedances of the shorter-period (24 hour) EC limit values for SO_2 and smoke.

2.7 Turkey

Historically there have been major problems of air pollution, particularly in Ankara, associated with the use of low quality lignite for heating purposes, and rapid economic development in more recent years has brought increasing and more widespread problems. Rising oil prices in the 1970s led to a conversion of power stations from oil to lignite and currently there is a move to restrict the use of lignite to power stations, but with the addition of flue gas desulfurisation. In Ankara the use of high sulfur lignite is now prohibited, with coke, other manufactured solid fuels and natural gas imported from the USSR being introduced in its place.

There are regulations on air quality implemented through the Ministry of Health and Social Welfare together with local environment councils. Assessments of emissions from new industrial plants are made by the General Directorate of Environment who also set air quality standards, following advice from other ministries, universities and international organisations: the standards currently in force are shown in Annex 3. Monitoring is the responsibility of the Ministry of Health and Social Welfare, with a basic network of semi-automatic SO_2/smoke samplers covering 50 provinces, together with 10 fully automatic stations and two telemetric systems in Ankara. A need is seen for further development of monitoring resources, including technical training for staff and the establishment of a central calibration unit.

In view of the risk of episodes of high pollution occurring in the particular circumstances of Ankara, warning levels have been established for taking emergency measures to limit emissions. These are set out in Annex 4: to date, the third warning level has been reached on two occasions.

In respect of pollution from motor vehicles, control is through vehicle type emission standards. Steps are being taken to reduce lead-in-petrol levels and generally to conform with European agreements on the whole range of emissions.

2.8 Yugoslavia

The basic standards for a wide range of pollutants were originally based on sensory effects, being taken over from USSR literature and sanitary legislation. Since 1972 however regulations for protecting air quality and the setting of standards have been devolved mainly to the individual republics, only a few issues, such as emissions from motor vehicles and the sulfur content of oils being controlled at federal level. The range of pollutants covered varies between the republics: air quality standards adopted for the more common pollutants are set out in Annex 3. In some cases control is through emission limits, taking into account technical feasibility of abatement measures.

Monitoring networks are organised through health and meteorological services, including continuous instruments for CO and NO_2, and SO_2/smoke sampling over 1 to 24 hr periods. There are some occasions when current standards are exceeded. Emergency procedures are operated at local level in a number of areas, an example of the warning levels (for Belgrade) being shown in Annex 4.

2.9 Bulgaria

There is wide-ranging legislation for environmental protection in Bulgaria that requires the setting of standards for maximum permissible concentrations of harmful substances in ambient air, through the Ministry of Health and Social Welfare, with the advice of the Institute of Hygienic and Occupational Health. Over 150 substances are covered, ranging from those associated with combustion sources to a variety of industrial process emissions. The system is dynamic, allowing revisions as required in the light of new knowledge, the last review having been done in 1984. Work related to the setting of standards for the ambient air is integrated with that concerned with occupational environments. Values for common urban air pollutants such as sulphur dioxide, nitrogen dioxide and lead are similar to the WHO air quality guidelines, and they are shown in Annex 3.
Regional programmes have been developed to reduce concentrations of harmful pollutants in large industrial centres, and there are proposals to set special air quality standards for selected areas.

A national air pollution monitoring system was introduced in 1970, operated through the Hygiene and Epidemiology Inspectorates within the Ministry of Public Health and at district level through the Committee for Environmental Protection and the Institute of Hydrology and Meteorology. Currently, there are 105 sampling sites. SO_2, total suspended particulates and lead are measured at all sites. In addition there are measurements of a range of other pollutants, including NO_2, H_2S, CS_2, phenol, Mn, As, H_2SO_4, HF and HCL, where appropriate, depending on the presence of specific sources. Observations are made periodically, on 10 days each month. There are exceedances of existing standards, up to about twice the values in the case of SO_2 and total suspended particulates. No emergency procedures have been established for dealing with occasional peak values in adverse weather conditions.

A national air pollution monitoring system was introduced in 1970, operated through the health services. Sulfur dioxide, suspended particulates and lead are determined at all sites, while other specific industrial pollutants are monitored where appropriate.

2.10 German Democratic Republic

Air quality standards are defined in terms of "maximum immission concentrations" and these MIK values (Annex 3) form an important part of national environmental legislation. Since 1980 there has been an advisory body supporting the Minister of Health in periodic reviews of the values. There has however to date been no fundamental work within the GDR. In general the MIK values have been based on the experimentally-determined hygienic standards that are in force in the USSR. Limiting values are set for carcinogenic substances also (IARC classification groups 1, 2A and 2B). Accepting a no-threshold approach they are set as "technical immission limitation" (TIB) values, intended to keep health risks as low as possible, using the best available control technology. Relationships between the MIK or TIB values and WHO air quality guidelines or risk estimates, respectively, have been examined in a recent publication (7).

The control of emissions in order to meet MIK or TIB values is operated through a State Environmental Inspectorate. There is a high stack policy for dispersing fuel combustion products and other pollutants from industry. Limited availability of control equipment has however hindered other efforts to reduce pollution at source. There are particular problems with SO_2 emissions, which are among the highest in Europe, with domestic heating sources accounting for the major part during the winter months. Monitoring of concentrations is carried out through the State Hygiene Inspectorate, that is also involved in the licensing of new sources.

Air quality standards are defined in terms of MIK values linked with percentiles of the frequency distribution of observed values and three approaches are used to check compliance. In five counties there is a continuous automated network on an on-line telemetric basis covering 40 sites for SO_2 and a smaller number for suspended particulates, CO and H_2S. There are plans to extend this. Secondly, half-hour grab samples for SO_2, H_2S, NO_2 and sometimes other pollutants are taken on a regular basis over a defined grid network covering all 15 county hygiene inspectorates. Finally, there are special programmes for determining deposited dust, total suspended particulates, heavy metals and asbestos as required. Observations on a range of the commoner pollutants are also made at background sites by the Meteorological Service.

There are some "hot spots" where current standards are exceeded, particularly for SO_2 during years when meteorological conditions relating to emission or dispersion have been extreme. New regulations on lines similar to those in the Federal Republic of Germany, are being introduced in respect of emergency "smog" procedures, operating in 20 cities or industrial localities, and these are outlined in Annex 4.

2.11 Hungary

Following a statement of principles for achieving clean air by the Ministry of Health in 1954 and a subsequent Order issued by the Council of Ministers in 1973, new comprehensive rules were introduced in 1986 under a Clean Air Protection Order. Under this three levels of protection are defined: I for inhabited (residential) areas, II for industrial (non-residential) areas and III for clean areas such a nature reserves, accorded high priority for protection. Different air quality thresholds are applied for these three categories, each expressed in terms of half-hour, 24 hour and annual averages. The short-term (half-hour) values are aimed at preventing the onset of acute illnesses or ecological effects. Longer-term (annual) values provide the targets for control measures and the prevention of chronic health risks and environmental damage.

The Order includes air quality thresholds for 327 air pollutants divided into two classes, the first subject to detailed control, with the inclusion of annual averages, and the second for other substances, for which only half-hour and 24 hour values are specified. Further, the pollutants are divided into four categories depending on their toxicity : extremely, less severely, moderately and hardly hazardous. Examples of the air quality thresholds for some of the commoner pollutants are shown in Annex 3. These are not exactly air quality standards as understood in some other countries, since exceedances are related to the level of protection and hazard categories.

In territories belonging to the category "protected with high priority", all activities are forbidden that would lead to the emission of air pollutants in the most hazardous class. The extent to which threshold values may be exceeded depends on the hazard class, for example while substances in the fourth category are allowed to reach 2.5 times the threshold up to seven times a year, no substance in the first category is allowed to reach even 1.1 times the threshold value, on any occasion. Implementation of the regulations is through local organizations of the Ministry of Health or Ministry of Environmental Protection.

A monitoring network was established in 1974, under the supervision of the National Institute of Public Health in Budapest (Ministry of Health). Measurements carried out by Hygiene and Epidemiology stations are based mainly on 24 hour off-line automatic equipment at sites defined on the basis of the WHO/GEMS system, at city centres, busy traffic junctions, industrial zones and green belt areas. There are at least three sampling sites of each type in every town and more in the larger cities.

Deposited dust is measured at 550 sites, with SO_2, NO_2 and suspended particulate matter (as smoke) at 450. The deposited dust is collected over successive 30 day periods, every second day, and smoke is measured as a weekly average. Other pollutants, including total suspended particulates, benzo(a)pyrene, Pb, Cd, fluoride and ammonia are measured as and when required, according to local sources. The data, amounting to more than 200,000 observations a year, are used directly by local authorities to guide control measures and by the National Institute of Hygiene for long-term evaluations and epidemiological studies. The required criteria for air quality are not always met, and there are instances of deposited dust, total suspended particulates, CO, Pb and benzo(a)pyrene rising to several times the prescribed limits.

It is only in Budapest that an on-line telemetric network exists, that comprises eight sampling sites, measuring SO_2, NO_2 and CO continuously, providing the basis for emergency action in three stages, up to limitations of industrial emissions and of traffic movements. This latter step has not however been reached since 1986.

As regards general reductions in industrial emissions, the United Kingdom "best practicable means" approach is favoured. Deposited dust remains a major problem, calling for improved filtration equipment on industrial installations. To reduce pollution by common urban air pollutants such as smoke as SO_2 from heating sources, changes in fuel are required, for which there are economic and technical limitations. Meanwhile, NO_2 is becoming a more significant problem, due to the increasing volume of traffic.

2.12 Poland

There are major problems of air pollution in many parts of Poland, particularly in the highly industrialized area of Upper Silesia. Adverse effects on health are recognised and for some pollutants there is a need to consider exposure through water and food as well as air. Air quality standards (Annex 3) have been set by the Council of Ministers, with advice from the Medical and Environmental Protection Institutes. There are two levels of protection, one for residential areas and the other for specially protected regions such as national parks. The MAC (maximum allowable concentration) values for the former are similar to the WHO Air Quality Guidelines, and carcinogenic substances are included in the list. Values for specially protected regions are related to ecological effects, and are lower. New regulations introduced in February 1990 by the Ministry of Environmental Protection, natural resources and Forestry include MAC values for 44 ambient air pollutants, most being consistent with WHO Guidelines.

Monitoring is carried out mainly by the staff of the Sanitary Epidemiologic Stations, and sometimes by the Environmental Protection Inspectorate or research institutes. There are about 700 sites in all, chiefly in the larger towns, with 40 of them covering the Upper Silesia area (in and around Katowice). The principal pollutants measured are deposited dust (monthly averages) suspended particulates (24 hour, gravimetric) and SO_2 usually with manually operated equipment. Other substances, including NO_2, Pb, Cd, formaldehyde, phenol and fluoride, are determined at a limited number of sites, though procedures vary from one to another. In the highly polluted Katowice area regular measurements extend to some 20 pollutants. Although a large amount of data has been assembled from all this monitoring activity, collation on a national scale has hitherto been inadequate and it has not been used effectively to guide control measures.

New initiatives include the development, in collaboration with the Institute of Hygiene, of a revised monitoring system operating at three levels, background, small to medium cities (with manual equipment) and major cities (with automatic equipment, suitable for emergency alert procedures). The Committee of Environmental Toxicology the Polish Academy of Sciences has prepared a priority list of harmful chemicals in the environment (in air or other media), based on adverse effects on man or on other biological or non-biological receptors in order to accord priority for preventive action. The first 10 substances in the list are SO_2 and related compounds, dust, PAH's NOx and related compounds, fluorine, Pb, Cd, nitrogenous fertilizers, pesticides and CO.

While it is anticipated that the WHO Air Quality Guidelines will be very helpful in any revision of existing national MAC values, one question that remains is how to deal with mixtures of pollutants such as occur in Upper Silesia, with a great range of specific industrial emissions as well as those from fuel combustion and traffic. Other matters to be considered include combined exposures in occupational and general environments and multi-media exposures (for example to lead). There is also the question of how best to use the unit risk estimates for carcinogens, as given in the WHO Air Quality Guidelines in establishing or revising MAC values (a point raised also in 2.10 above).

2.13 Romania

When maximum allowable concentrations for air pollutants were first introduced in 1973, they were based on hygienic standards established in the USSR, but in 1987 the matter was reconsidered through the Institute of Hygiene and Public Health (Ministry of Health). Air quality standards were then defined for 28 substances, as shown in Annex 3, applicable to defined protected zones (residential areas). Information from WHO publications was drawn on, though the Air Quality Guidelines volume was not available at the time. The latter recommendations will be taken into consideration in the next revision, scheduled for 1990-91, and it is planned to add standards for carcinogenic substances then.

A range of monitoring activities is carried out in 94 communities, each with a number of sampling sites. Many of these are confined to monthly assessments of deposited matter, with analyses for heavy metals and sulfate ion. Observations on concentrations of suspended particulate matter and sulfur dioxide are made at 85 of the sites, with additional pollutants such as NO_2, ammonia, fluoride, chloride, hydrogen chloride, aldehydes, phenols, mercaptans, Pb, Cr, Ni, Cd, sulfate and PAH's at some, according to local circumstances. Data are collated centrally on an annual basis at the Institute of Hygiene and Public Health and made available to groups concerned with environmental management and public health surveillance. In this way areas of possible health risk have been identified and epidemiological studies have been done in them to investigate relationships between air pollution levels and health status, providing further information on control measures needed to improve the situation. Decisions on whether to continue monitoring at particular sites or to add new ones are also made in the light of results. Current air quality standards are generally met, but there are occasional exceedances in industrial areas or in particular meteorological conditions. There is no general emergency alert system, but local short-period control in industrial areas can be imposed in response to excessive concentrations or complaints. Pollution by SO_2 and smoke from fuel burning is not a major problem in Romania, since natural gas and oil are quite widely used for heating purposes, though there is a tendency for higher sulfur oils to be used now.

2.14 USSR

Hygienic standards have been established for many years in the USSR, covering air quality in occupational and environmental circumstances as well as water quality and food contamination. These standards are set by the Ministry of Health, with advice from hygiene research institutes, and values have been set for more than 350 air pollutants: those for the common air pollutants are shown in Annex 3. To date the assessments have been based mainly on experimental toxicological work, examining reflex action in biological systems and/or systemic effects from absorption of the pollutants, with subsequent follow-up through epidemiological studies. These procedures differ from the risk assessments made in some other countries: for some substances they lead to values similar to those adopted elsewhere but for others substantial differences emerge. The assembly of data on a wide range of effects of relevance to health, including irritation, reflex action, acute and chronic morbidity, mutagenesis and carcinogenesis is seen as a valuable step in unifying approaches in the future. In the USSR a new centre for prophylactic toxicology is being set up as a focal point for information on the contamination of air, soil and water, with a view to filling gaps in the toxicological base for controlled substances.

Monitoring of air pollutants is carried out through the Public Health Sanitary Service, the State Committee of Hydrometeorology and the State Committee of Environmental Protection. There are sampling sites in 427 towns, SO_2, particulate matter, Pb, CO, hydrocarbons, formaldehyde and H_2S being the principal pollutants examined, with others included where appropriate according to the nature of local sources. Compliance with existing standards is achieved for areas covering some 60% of the population of the country. There is no established emergency alert system, but there are instances of concentrations of pollutants greatly exceeding the standards and measures are being developed to deal with each specific type of situation.

3 AIR QUALITY MANAGEMENT: SUMMARY OF PROCEDURES

Despite a wide disparity in the nature of current air pollution problems between the countries contributing to the present report, arising from contrasts in types of fuels used, the balance between space heating, industrial and traffic sources, climatic and topographical factors influencing liability to temperature inversions and stable air conditions there are a number of common features in the procedures adopted for abatement. Similarly there are also disparities in the way in which air quality guidelines, standards or other criteria for effects on health and/or the environment are developed and implemented, but again some common threads are evident. Procedures reported for the management of air quality generally and the role seen for the WHO AQG in promoting control for the protection of public health are outlined below.

3.1 Departmental responsibilities

In general air quality management at national level involves ministries concerned with health, environment and planning, in various combinations in the different countries. Some decision-making, and much of the implementation is shared with regional or local authorities. Increasingly a need is being seen to assess overall health/environmental effects of new industrial, housing or transportation developments, through the application of environmental impact analysis. For some pollutants, for which multi-media exposures are relevant (lead being a prime example) there is also a need to integrate management of air, water and soil contamination, extending sometimes to food and various consumer products.

The more severe air pollution problems, at least in relation to human exposures and risks to public health, are concentrated in certain cities or industrial regions and are related primarily to local emissions. Thus efforts towards assessment of effects, monitoring, and abatement procedures have often been directed mainly towards such areas, though setting a pattern for other parts of each country. The long-distance transport of pollutants does however create more widespread problems, both within and beyond national boundaries. These are generally of greater concern in relation to ecological than to direct health effects, and the production of secondary pollutants such as ozone or acid sulphates by photo-chemical or other atmospheric reactions is important in this connection. Discussion of these aspects is beyond the scope of the present report, but there are implications in respect of control strategies, for some local abatement activities such as dispersal from tall stacks can increase long-distance transport effects, and there is a need to bring other government departments and international authorities into discussions on control procedures.

3.2 Advice on health effects

Where air quality standards or guidelines have been defined, protection of health has generally been the basic criterion, though the more easily perceived effects such as visibility reduction, dirtying or erosion of buildings and vegetation damage have been important, often promoting public concern in improving air quality.

Historically the most powerful stimulus has been the occurrence of episodes of high pollution in areas with a high source density, as in the case of the millions of chimneys serving coal fires that gave rise to major smogs in London up to the 1960's, or the similarly large numbers of motor vehicles contributing to the photochemical smogs in Los Angeles. Throughout Europe there have been further instances of massive emissions of pollution from domestic heating sources, industry or traffic, sometimes compounded, as in Athens, by poor natural ventilation. The obvious adverse effects on amenity and wellbeing in such circumstances have created the public and political will to consider effects on health more seriously and to develop control measures.

In a number of countries direct information on health effects has been obtained through specially designed epidemiological studies, and in Eastern Europe in particular there are routine health surveillance systems that can provide pointers to possible adverse effects. In general, however, reliance has been placed, at least in respect of quantitative assessments, on experience in other countries as assembled and reviewed by international organisations. For those countries falling within the European Community existing directives provide common limit and guide values for a number of pollutants (Annex 2). Assessments by WHO Expert Groups (8,9,10) contributed to the development of those directives, and there have been further publications (11,12) providing background information in respect of other pollutants. Similarly there has been a common basis for standards adopted in a number of countries in Eastern Europe (Annex 3) based largely on the experimental toxicological work carried out in the USSR. For further guidance now the WHO AQG volume is seen to be very helpful, particularly for the range of pollutants considered in terms of non-carcinogenic endpoints, for which guideline values were specified. They cover the more commonly occurring urban or industrial pollutants in Europe, though for the future consideration might be given to some additional pollutants from industrial sources, such as hydrochloric acid and fluorides.

A major gap still exists in respect of effects of mixtures of pollutants. Apart from the joint consideration of SO_2/particulates, the AQG dealt with pollutants singly, but in practice there will usually be many different pollutants present. This is a particular problem in highly industrialized areas such as Upper Silesia where a wide range of pollutants from fuel burning and from industrial processes occur simultaneously. No satisfactory formula for assessing the combined effects of such mixtures has been put forward, and indeed it would be difficult to construct a basis for one in the case of pollutants exerting different types of effect on health. As a broad guide it has been recognised that for a number of pollutants having similar effects, for example on the respiratory system, the combined effect is likely to be additive or more than additive.

The manner in which data for compounds considered in the AQG project in terms of carcinogenic end-points, namely as lifetime risks of cancer corresponding with a unit concentration (1ug/m^3) of the pollutant, still leaves decisions to be made individually by any national or local authorities wishing to establish guidelines or standards. Any of the data can readily be transcribed into concentrations corresponding with a given level of risk, say 1 in 10^4, but choice of an "acceptable" risk is to some extent arbitrary and has to be seen against the background of an overall lifetime risk of cancer (all forms) in populations in Europe in the region of 1 in 5. The carcinogenic risk estimates presented in the AQG are to be regarded as upper limits, and new developments in modelling such risks support a view that they may be over - rather than under-estimates. Alternative approaches to the establishment of guidelines for carcinogenic substances have been used in a number of European countries, and some of the values are shown in Annex 3.

3.3 Monitoring

In section 2 above the scope of monitoring is seen to vary widely between countries according to the severity of their air pollution problems, ranging from limited special-purpose surveys around industrial sources to the intensive automated monitoring set up in large cities subject to episodes of high pollution. In most of the countries there is a basic network of manual or semi-automatic samplers for the measurement of SO_2 and suspended particulates. The latter comprise either measurements of black smoke or of TSP, but it has to be recognised that such observations are largely separate from one another, reflecting different characteristics of the pollution, and that in the case of direct gravimetric measurements (such as TSP) there is generally a need to limit the particle size range collected. The matter is discussed in the AQG volume (2), and for routine purposes the type of measurement required is dictated by the form of any guidelines or standards that are in force.

In some countries a large part of the monitoring activity is devoted to monthly dust-fall measurements, with analyses for components such as lead or sulphates. Insofar as such particulate matter is beyond the respirable range it is of limited relevance to any direct effect on health. Such observations are valuable in identifying dust problems close to specific industrial sources, high values indicating needs for improved control, but they do not necessarily contribute much to long-term monitoring for health-related purposes.

A general comment can be made that monitoring of any kind is not a substitute for action. On the one hand obvious pollution problems do not need substantial monitoring efforts to underline the need for action to restrict emissions at source, and on the other hand, once it is evident that there is little or no problem in a given area, monitoring can generally be discontinued there. Networks need to be flexible, reducing as well as increasing them as circumstances dictate.

Continuous recording instruments are in use at many sites across Europe, SO_2 being the commonest pollutant measured in this way. Others include CO, NO_2 and in some cases total hydrocarbons and ozone (or total oxidants) are included in a number of networks, usually where traffic pollutants are important. Lead concentrations are often monitored, using filter samples running for 24 hr periods or longer, principally in busy streets or near specific industrial sources.

Observations on pollutants beyond those mentioned above are mainly limited to special surveys or to investigations around point sources. There is scope for making increased use of dispersion modelling techniques as an aid to monitoring in assessing compliance with standards or to predict concentrations of less common pollutants from industrial sources.

3.4 Assessment of exposures

In general the monitoring activities are related primarily to needs for defining pollution problems, observing long-term trends or assessing compliance with standards. They do not provide adequate information on the actual exposure of population groups. This does not necessarily impair the application of the WHO guidelines, since they were in general derived from epidemiological studies using results from monitoring networks as indices of exposures. However, great care is needed in considering situations where the circumstances of exposure, for example time spent indoors as opposed to outdoors, the extent to which people are in or close to busy streets, or the mixture of pollutants differ from those in the original studies. Thus in Southern areas of Europe there are locations where windows and doors can be open much of the time and the population leads a largely outdoor life, and others where there are large differences in temperature between summer and winter, leading to contrasts in the way people are exposed to pollution problems with seasonal characteristics (pollution by smoke/SO_2 usually being highest in the winter, and by photochemical pollutants highest in the summer). Indoor locations offer some protection against reactive pollutants such as sulfur dioxide or ozone, but on the other hand where there are indoor sources, for example of NO_2 derived from unflued gas or kerosene appliances, exposure can be enhanced.

There are quite important reservations for some short-term AQG values that have been derived from clinical studies involving controlled exposures to single pollutants, sometimes with defined exercise regimes. In applying those the local circumstances relating to indoor/outdoor activity and the simultaneous presence of other pollutants need to be considered carefully. Physical activity is a factor to bear in mind more generally, for the effective exposure to inhaled pollutants increases sharply with vigorous exercise, due to the combined effect of increased minute-volume and deeper penetration of the pollutants. This is particularly important in the case of ozone (13), and those at greatest risk tend to be young active people out of doors rather than elderly people who may have more respiratory impairment, but remain relatively protected while sedentary indoors.

3.5 Emergency Action

In a number of localities there has been concern over the accumulation of pollutants during periods when weather conditions are unfavourable for dispersion, leading to exceptionally high concentrations liable to have adverse effects on health. In some cases criteria have been defined for issuing warnings to the public about possible risks and/or for action to limit the emission of pollutants temporarily. Information available at present is drawn together in Annex 3, but there is a case for separate discussions on this topic, to establish the relevant criteria in respect of effects on health and to consider the most appropriate action to reduce emissions from heating/industrial sources or from traffic without causing undue disruption. Fuel switching or short-term bans on heating, industrial activity or traffic can avert locally high levels of primary pollutants such as SO2 or smoke, but it is more difficult to secure an immediate impact on the build-up of secondary photochemical pollutants such as ozone.

While the introduction and operation of emergency alert schemes can offer some temporary protection of public health and at the same time contribute to the general awareness of air pollution problems, the long-term objective must always be to curb emissions at all times sufficiently to avoid risks of high pollution episodes.

3.6 Abatement

Measures required to limit emissions in order to secure satisfactory air quality clearly depend on the nature of local problems, but they can be considered under a number of broad headings, as follows:

(a) Home heating. Needs for home heating are very variable across the European Region and there are many localities where, in the winter months, home heating is the dominant source of air pollution. Problems are most severe where poor quality coal or lignite is the principal fuel. Action being taken includes the introduction of alternative fuels, such as natural gas, the development of processed solid fuels with reduced pollution potential or of more efficient stoves capable of eliminating most of the smoke. Other problems arise where oil is used for domestic heating, the sulfur content then determining SO2 emissions. There are examples, for example in Athens, of stringent limits being placed on the sulfur content of such fuels.

(b) Power stations and other large fuel-burning installations. Again the type of fuel has an important bearing on emissions. Both oil and coal are used in Europe, the oil sometimes having a relatively high sulfur content. In general there are regulations to control smoke and other particulate emissions, and in some cases there are limits on sulfur content to minimise SO2 problems. Location and stack height are factors taken into account in ensuring that ground level concentrations are kept within required guidelines or standards, and the more persistent problems are related to old, badly located plants. In some cases there is still inadequate control of the coarse particulate matter arising from the combustion of coal in large plants, creating much local nuisance from deposited dust.

Strategies for control need to take into account not only the achievement of satisfactory air quality close to the sources, but also avoidance of adverse health or environmental effects at greater distances. Special problems are created through the formation of secondary pollutants during the long-distance transport of emissions, one example being the formation of aerosols and acid rain from SO_2 and NO_2 in the plumes from tall stacks at power stations or other industrial installations. To deal with the widespread regional effects linked with long-distance transport, which in Europe often means trans-boundary too, large air pollution control regions are often needed, requiring co-operation between neighbouring local or national authorities.

(c) Industrial sources in general. In many European countries there are regulations, often operating through a licencing system, to control either fuel-burning or process emissions from new industrial installations beyond some specified size. Action on existing older plant depends largely on requiring the best available technology to be used to limit emission, sometimes in accordance with fixed standards.

The extent to which ambient air quality standards have been established in respect of specific substances from industrial sources varies widely. Where such standards exist they provide targets to be met through control measures, though currently there are many examples of failure of compliance in the vicinity of sources. Not only is there great variation in the numbers of substances covered by standards in different countries, but also in the actual values adopted. There has been general agreement that the WHO Air Quality Guidelines provide a valuable step in unifying the criteria for effects on health while still leaving the setting of standards to be considered within each country according to local circumstances.

(d) Motor vehicles. As control of the more "traditional" pollutants from domestic heating and industrial sources has improved, in may localities potential benefits in terms of overall improvement in air quality have been offset to some extent by substantial increases in the numbers of motor vehicles. Though the types of pollutants emitted from them differ from those emitted by stationery sources, there is some overlap, for example with the black smoke from diesel vehicles boosting any still derived from inefficient coal or oil burning and with the volatile hydrocarbons and oxides of nitrogen from traffic playing a major part together with refinery and other industrial emissions in the formation of photochemical pollutants.

The latter tend to reach maximum concentrations some distance from the sources, but more generally the primary pollutants from motor vehicles create highly local problems, since emission is within the breathing zone and maximum exposures of the population occur in busy streets, close to traffic, before there has been adequate time for dilution.

The severity of the problem in different countries of Europe is affected by a number of factors, including traffic densities, particularly as experienced in the large cities, the age and condition of the vehicle stock, liability to stable air conditions leading to the accumulation of pollutants and the intensity and duration of sunshine, in relation to the development of secondary photochemical pollutants. In such situations control measures relevant to direct exposures of the population within cities have to be considered in the light of local circumstances, but there is a pressing need also to limit emissions on a much more widespread regional scale to minimize photochemical pollution problems arising from long-distance transport. International co-operation on this matter is channelled through the United National Economic Commission for Europe, setting out proposals for limits on the emission of hydrocarbons, NOx and CO, together with particulates in the case of diesel engined vehicles. These are carried through via the European Community or other national or international authorities, and they apply to the approval of new vehicle types from specified dates.

The more immediate problem in most European countries is however control over existing vehicles, in some cases often in poor repair and emitting excessive pollution. At present the extent to which this is dealt with, though annual checks or otherwise varies widely and there is scope for improvement, particularly in respect of excessive smoke emission from poorly maintained diesel vehicles. In cities with acute traffic problems, such as Athens, further control measures, including switches to alternative fuels (LPG) and restrictions on the numbers of vehicles allowed in central areas have been tried.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

1 The AQG are very useful for the preparation of national air quality standards. They provide a valuable basis for the development of a wide range of strategies needed for control purposes. The choice of substances given priority in the Air Quality Guidelines project is considered to be an appropriate selection of those pollutants likely to be encountered in the European Region, but some other pollutants (such as ammonia, phenol, fluorides and hydrogen chloride) may need consideration in future.

2 The relative importance of different types of source varies widely between countries in the region, and between different localities in any one country. Common types range from the sulfur dioxide and particulate matter associated with the use of poor quality lignites for domestic heating and industrial purposes, through emissions from power stations burning coal or relatively high sulfur oils, metallic oxides and other inorganic dusts from steel-works or the release of organic compounds from refinery and other chemical industries, to primary or secondary pollutants (carbon monoxide, oxides of nitrogen, hydrocarbons, ozone and diesel soot) associated with motor vehicles.

3 The AQG values are considered to provide a valuable basis for the development of the wide range of strategies needed for control purposes. However, the approaches needed in particular countries and areas depend very much on the local conditions. The objective of such strategies is to achieve maximum effectiveness, while considering the economic and administrative constraints that may exist. Air quality guidelines are essential in the strategy formulation process, because they help to define the goals and serve as a basis for assessing the effectiveness of control measures.

4 In accordance with WHO policy, air pollution is always to be kept to a minimum: the AQG are not to be taken as a licence to pollute in areas that are currently below the guidelines.

5 The published guidelines may need to be supplemented by further guidance to deal with "episodes", the occasions on which exceptionally high levels of pollutants are likely to arise locally in meteorological or topographical situations unfavourable for dispersion.

6 For countries within the European Community (EC) a uniform set of standards is already in force for a limited range of pollutants, and the AQG would be of value in any subsequent revisions or extensions of the EC directives. Also, in a number of Eastern European countries uniform hygienic standards have been defined for a much larger number of substances, though they are not in general subject to statutory control.

7 Further guidance is sought on the establishment of monitoring approaches suitable for assessment of population exposures and related health effects, in addition to monitoring for compliance with standards.

8 Health statistics data and routine health observations are necessary for surveillance, but they are of limited value for establishing relationships between health effects and air pollutants. To establish such relationships, specially designed epidemiological studies are more appropriate.

9 The results of studies on the health effects of air pollutants tend to be less and less conclusive. Where the concentrations of pollutants are lowered through control, the power of epidemiological studies to detect their effects is decreased. Nevertheless, confidence in the relationships between air pollution and health might be increased by bringing together information from similar population-based studies in a number of countries, and by evaluating preclinical signs of intoxication and/or biological exposure indicators.

10 In the AQG, the risk associated with lifetime exposure to carcinogens is expressed as the incremental unit risk estimate, avoiding any reference to the acceptability of a given risk. The decision on the acceptability of a certain risk needs to be taken by national authorities in the context of a broader risk management process. In this process, health risk assessment is usually used together with technological, socioeconomic and other considerations which may differ widely.

11 Definitive results from studies to interpret the effects of exposure to mixtures of air pollutants are not likely to be available in the near future. It will therefore be difficult to set priorities for the control of mixtures of air pollutants exclusively on the basis of scientific evidence; judgement and consensus will be required.

12 In dealing with complex mixtures of air pollutants, the summing of irritants, systemic toxicants and genotoxic carcinogens each in their own group seems to be appropriate, but the summing of such groups together does not have a sound basis. If indices are constructed, then the only factors that should be summed together are those that have the same target and similar toxicological action.

4.2 Recommendations

1 An extension of the AQG should be pursued by including additional pollutants, such as fluorides. New developments in pertinent areas should be incorporated in any subsequent updating of the AQG.

2 When establishing new national air quality standards or revising existing ones, consideration should be given to the use of the AQG values as a means of providing a common basis for standards across Europe.

3 A common approach should be developed for the evaluation of relationships between air pollution monitoring, population exposures, and health effects.

4 Control strategies should entail the development of detailed and pragmatic action programmes. As a first step towards the successful implementation of such programmes, emphasis should be placed on securing their widest possible acceptance by all interested groups.

5 In the development of strategies for the control of air pollution, the public should be informed about the problems; its input in the decision-making could also be sought.

6 Especially in the case of volatile organic compounds, the contribution of indoor air to total exposure may be large. Therefore, indoor air pollution levels should be considered in the design of an overall control strategy.

In some countries, a great part of ambient air pollution results from combustion processes using coal. The reduction of air pollution caused by domestic heating is of especially high importance. Measures such as energy conservation and switching to the use of clean fuel should be given high priority.

Adequate monitoring with appropriate quality control and assurance should be made an integral part of an effective air pollution control strategy.

Strategies on indoor pollution should include guidance on policies for restricting smoking in public places.

Guidance should be provided to deal with air pollution episodes, when exceptionally high levels of pollutants arise locally owing to geographical and meteorological circumstances that are unfavourable to dispersion.

The development of control strategies should take into account the fact that ambient air pollutants can cause several types of effect that require attention, such as irritation, odour, annoyance, acute and long-term health effects, indirect pathway effects and ecological effects. The assignment of priorities for undertaking control actions should likewise take into account the nature and relative severity of the types of effect associated with specific pollutants of concern.

Best available control technologies should be employed whenever new industrial installations are built, obtaining advice when necessary from appropriate national and international bodies.

As no safe guidelines can be established for carcinogenic substances, strategies should be considered for the minimisation of population exposure.

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Annex 1

SUMMARY OF THE GUIDELINES[a]

The term "guidelines" in the context of this book implies not only numerical values (guideline values), but also any kind of guidance given. Accordingly, for some substances the guidelines encompass recommendations of a more general nature that will help to reduce human exposure to harmful levels of air pollutants. For some pollutants no guideline values are recommended, but risk estimates are indicated instead. Table 1 summarizes the different endpoints on which guideline values and carcinogenic risk estimates have been based for organic and inorganic substances, showing that all relevant biological effects (endpoints) were evaluated and sometimes more than one endpoint was considered for guideline recommendations.

The numerical guideline values and the risk estimates for carcinogens (Tables 2–5) should be regarded as the shortest possible summary of a complex scientific evaluation process. Scientific results are an abstraction of real life situations, and this is even more true for numerical values and estimates based on such results. Numerical guideline values, therefore, are not to be regarded as separating the acceptable from the unacceptable, but rather as indications. They are proposed in order to help avoid major discrepancies in reaching the goal of effective protection against recognized hazards. Moreover, numerical guidelines for different substances are not directly comparable. Variations in the quality and extent of the scientific information and in the nature of critical effects result in guideline values which are only comparable between pollutants to a limited extent.

Owing to the different bases for evaluation, the numerical values for the various air pollutants should be considered in the context of the accompanying scientific documentation giving the derivation and scientific considerations. Any *isolated* interpretation of numerical data should therefore be avoided and guideline values should be used and interpreted in conjunction with the information contained in the appropriate sections.

It is important to note that guidelines are for individual chemicals. Pollutant mixtures can yield differing toxicities, but data are at present insufficient for guidelines relating to mixtures (except that of sulfur dioxide and suspended particulates) to be laid down.

[a] Air quality guidelines for Europe. Copenhagen, WHO Regional Office for Europe, 1987 (WHO Regional Publications, European Series, No. 23).

Guideline Values based on Effects other than Cancer

The guideline values for individual substances based on effects other than cancer and odour are given in Table 2. Guideline values for combined exposure to sulfur dioxide and particulate matter are indicated in Table 3.

The emphasis in the guidelines is placed on exposure, since this is the element that can be controlled to lessen dose and hence lessen response. As stated earlier, the starting-point for the derivation of guideline values was to define the lowest concentration at which adverse effects are observed. On the basis of the body of scientific evidence and judgements of protection (safety) factors, the guideline values were established.

However, compliance with the guideline values does not guarantee the absolute exclusion of undesired effects at levels below the guideline values. It means only that guideline values have been established in the light of current knowledge and that protection factors based on the best scientific judgements have been incorporated, though some uncertainty cannot be avoided.

For some of the substances, a direct relationship between concentrations in air and possible toxic effects is very difficult to establish. This is especially true of those metals for which a greater body-burden results from ingestion than from inhalation. For instance, available data show that the food chain is, for most people, the critical route of nonoccupational exposure to lead and cadmium. On the other hand, airborne lead and cadmium may contribute significantly to the contamination of food by these metals. Complications of this kind were taken into consideration and an attempt was made to develop air quality guidelines which would also prevent those toxic effects of air pollutants that resulted from uptake through both ingestion and inhalation.

For certain compounds, such as organic solvents, the proposed health-related guidelines are orders of magnitude higher than current ambient levels. The fact that existing environmental levels for some substances are much lower than the guideline levels by no means implies that pollutant burdens may be increased up to the guideline values. Any level of air pollution is a matter of concern, and the existence of guideline values never means a licence to pollute.

The approach taken in the preparation of the air quality guidelines was to use expert panels to evaluate data on the health effects of individual compounds. As part of this approach, each chemical is considered in isolation. Inevitably, there is little emphasis on such factors as interaction between pollutants that might lead to additive or synergistic effects and on the environmental fate of pollutants (e.g. the role of solvents in atmospheric photochemical processes leading to the formation or degradation of ozone, the formation of acid rain and the propensity of metals and trace elements to accumulate in environmental niches). These factors militate strongly against allowing a rise in ambient pollutant levels. Many uncertainties still remain, particularly regarding the ecological effects of pollutants, and therefore efforts should be continued to maintain air quality at the best possible level.

Unfortunately, the situation with regard to actual environmental levels and proposed guideline values for some substances is just the opposite.

Table 1 Established guideline values and risk estimates

Substance	IARC Group classification	Risk estimate based on carcinogenic endpoint	Guideline value(s) based on		
			toxicological endpoint	sensory effects or annoyance reaction	ecological effects
Organic substances					
Acrylonitrile	2A	x			
Benzene	1	x			
Carbon disulfide	–		x	x	
1,2-Dichloroethane	—[a]		x		
Dichloromethane	—[a]		x		
Formaldehyde	2B		x		
Polynuclear aromatic hydrocarbons (Benzo[*a*]pyrene)	—[b]	x			
Styrene	3		x	x	
Tetrachloroethylene	3		x	x	
Toluene	–		x	x	
Trichloroethylene	3		x		
Vinyl chloride	1	x			
Inorganic substances					
Arsenic	1	x			
Asbestos	1	x			

Inorganic substances (contd)					
Cadmium	2B		x		
Carbon monoxide	...		x		
Chromium (VI)	1	x			
Hydrogen sulfide	—		x	x	
Lead	3		x		
Manganese	—		x		
Mercury	—		x		
Nickel	2A[c]	x			
Nitrogen dioxide	—		x		x
Ozone/photochemical oxidants	—		x		x
Radon	—	x			
Sulfur dioxide and particulate matter	—		x		x
Vanadium	—		x		

[a] Not classified but sufficient evidence of carcinogenicity in experimental animals.

[b] Not classified but sufficient evidence of carcinogenicity of PAH in humans in some occupational exposures (*IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*, Vol. 34). Sufficient evidence of carcinogenicity for benzo[a]pyrene in animal studies. Benzo[a]pyrene is present as a component of the total content of polycyclic aromatic hydrocarbons in the environment (*IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*, Vol. 32).

[c] Exposures from nickel refineries are classified in Group 1.

Table 2. Guideline values for individual substances based on effects other than cancer or odour/annoyance[a]

Substance	Time-weighted average	Averaging time	Chapter
Cadmium	1- 5 ng/m³ 10-20 ng/m³	1 year (rural areas) 1 year (urban areas)	19
Carbon disulfide	100 µg/m³	24 hours	7
Carbon monoxide	100 mg/m³[b] 60 mg/m³[b] 30 mg/m³[b] 10 mg/m³	15 minutes 30 minutes 1 hour 8 hours	20
1,2-Dichloroethane	0.7 mg/m³	24 hours	8
Dichloromethane (Methylene chloride)	3 mg/m³	24 hours	9
Formaldehyde	100 µg/m³	30 minutes	10
Hydrogen sulfide	150 µg/m³	24 hours	22
Lead	0.5-1.0 µg/m³	1 year	23
Manganese	1 µg/m³	1 year[c]	24
Mercury	1 µg/m³[d] (indoor air)	1 year	25
Nitrogen dioxide	400 µg/m³ 150 µg/m³	1 hour 24 hours	27
Ozone	150-200 µg/m³ 100-120 µg/m³	1 hour 8 hours	28
Styrene	800 µg/m³	24 hours	12
Sulfur dioxide	500 µg/m³ 350 µg/m³	10 minutes 1 hour	30
Sulfuric acid	—[e]	—	30
Tetrachloroethylene	5 mg/m³	24 hours	13
Toluene	8 mg/m³	24 hours	14
Trichloroethylene	1 mg/m³	24 hours	15
Vanadium	1 µg/m³	24 hours	31

[a] Information from this table should *not* be used without reference to the rationale given in the chapters indicated

[b] Exposure at these concentrations should be for no longer than the indicated times and should not be repeated within 8 hours

[c] Due to respiratory irritancy, it would be desirable to have a short-term guideline, but the present data base does not permit such estimations

[d] The guideline value is given only for indoor pollution, no guidance is given on outdoor concentrations (via deposition and entry into the food chain) that might be of indirect relevance

[e] See Chapter 30

Note When air levels in the general environment are orders of magnitude lower than the guideline values, present exposures are unlikely to present a health concern. Guideline values in those cases are directed only to specific release episodes or specific indoor pollution problems.

Table 3 Guideline values for combined exposure to sulfur dioxide and particulate matter[a]

	Averaging time	Sulfur dioxide ($\mu g/m^3$)	Reflectance assessment black smoke[b] ($\mu g/m^3$)	Gravimetric assessment: Total suspended particulates (TSP)[c] ($\mu g/m^3$)	Gravimetric assessment: Thoracic particles (TP)[d] ($\mu g/m^3$)
Short term	24 hours	125	125	120[e]	70[e]
Long term	1 year	50	50	—	—

[a] No direct comparisons can be made between values for particulate matter in the right- and left-hand sections of this table, since both the health indicators and the measurement methods differ. While numerically TSP/TP values are generally greater than those of black smoke, there is no consistent relationship between them, the ratio of one to the other varying widely from time to time and place to place, depending on the nature of the sources.

[b] Nominal $\mu g/m^3$ units, assessed by reflectance. Application of the black smoke value is recommended only in areas where coal smoke from domestic fires is the dominant component of the particulates. It does not necessarily apply where diesel smoke is an important contributor.

[c] TSP: measurement by high volume sampler, without any size selection.

[d] TP: equivalent values as for a sampler with ISO-TP characteristics (having 50% cut-off point at 10 μm), estimated from TSP values using site-specific TSP/ISO-TP ratios.

[e] Values to be regarded as tentative at this stage, being based on a single study (involving sulfur dioxide exposure also).

i.e. guideline values are below the existing levels in some parts of Europe. For instance, the guideline values recommended for major urban air pollutants such as nitrogen oxides, ozone and sulfur oxides point to the need for a significant reduction of emissions in some areas.

For substances with malodorous properties at concentrations below those where toxic effects occur, guideline values likely to protect the public from odour nuisance were established; these were based on data provided by expert panels and field studies (Table 4). In contrast to other air pollutants, odorous substances in ambient air often cannot be determined easily and systematically by analytical methods because the concentration is usually very low. Furthermore, odours in the ambient air frequently result from a complex mixture of substances and it is difficult to identify individual ones; future work may have to concentrate on odours as perceived by individuals rather than on separate odorous substances.

Table 4. Rationale and guideline values based on sensory effects or annoyance reactions, using an averaging time of 30 minutes

Substance	Detection threshold	Recognition threshold	Guideline value
Carbon disulfide in viscose emissions			20 $\mu g/m^3$
Hydrogen sulfide	0.2–2.0 $\mu g/m^3$	0.6–6.0 $\mu g/m^3$	7 $\mu g/m^3$
Styrene	70 $\mu g/m^3$	210–280 $\mu g/m^3$	70 $\mu g/m^3$
Tetrachloroethylene	8 mg/m^3	24–32 mg/m^3	8 mg/m^3
Toluene	1 mg/m^3	10 mg/m^3	1 mg/m^3

Guidelines based on Carcinogenic Effects

In establishing criteria upon which guidelines could be based, it became apparent that carcinogens and noncarcinogens would require different approaches. These are determined by theories of carcinogenesis which postulate that there is no threshold for effects (i.e. that there is no safe level). Therefore, risk managers are faced with two decisions: either to prohibit a chemical or to regulate it at levels that result in an acceptable degree of risk. Indicative figures for risk and exposure assist the risk manager to reach the latter decision. Therefore, air quality guidelines are indicated in terms of incremental unit risks in respect of those carcinogens for which at least limited evidence of carcinogenicity in humans exists (Table 5).

Table 5. Carcinogenic risk estimates based on human studies[a]

Substance	IARC Group classification	Unit risk[b]	Site of tumour
Acrylonitrile	2A	2×10^{-5}	lung
Arsenic	1	4×10^{-3}	lung
Benzene	1	4×10^{-6}	blood (leukaemia)
Chromium (VI)	1	4×10^{-2}	lung
Nickel	2A	4×10^{-4}	lung
Polynuclear aromatic hydrocarbons (carcinogenic fraction)[c]		9×10^{-2}	lung
Vinyl chloride	1	1×10^{-6}	liver and other sites

[a] Calculated with average relative risk model.

[b] Cancer risk estimates for lifetime exposure to a concentration of 1 µg/m³.

[c] Expressed as benzo[a]pyrene (based on benzo[a]pyrene concentration of 1 µg/m³ in air as a component of benzene-soluble coke-oven emissions).

Separate consideration is given to risk estimates for asbestos (Table 6) and radon daughters (Table 7) because they refer to different physical units and are indicated in the form of ranges.

Unfortunately, the recent reclassification of dichloromethane by IARC has not allowed sufficient time to publish a detailed risk estimate which takes into account important information on the metabolism of the compound. The risk estimate for cancer from the animal bioassay is not used for this reason in the guidelines.

Table 6. Risk estimates for asbestos[a]

Concentration	Range of lifetime risk estimates	
500 F*/m³ (0.0005 F/ml)	10^{-6} - 10^{-5}	(lung cancer in a population where 30% are smokers)
	10^{-5} - 10^{-4}	(mesothelioma)

[a] See Chapter 18 for an explanation of these figures.

Note. F* = fibres measured by optical methods.

Table 7. Risk estimates and recommended action level[a] for radon daughters

Exposure	Lung cancer excess lifetime risk estimate	Recommended level for remedial action in buildings
1 Bq/m³ EER	$(0.7 \times 10^{-4}) - (2.1 \times 10^{-4})$	≧ 100 Bq/m³ EER (annual average)

[a] See Chapter 29 for an explanation of these figures and for further information.

Formaldehyde represents a chemical for which cancer bioassays in rats have resulted in nonlinear exposure response curves. The nonlinearity of the tumour incidence with exposure concentrations led Starr & Buck[a] to introduce the "delivered dose" (amount of formaldehyde covalently bound to respiratory mucosal DNA) as the measure of exposure into several low-dose extrapolation models. Results showed considerable differences in the ratio between risk estimates based on the administered dose and those based on the delivered dose, with a great variance of ratios between models. Since estimates vary because of the inherent differences in approach, cancer risk estimates are referred to but not used for the guidelines. In addition, such estimates should be compared with human epidemiological data when an informed judgement has to be made.

The evidence for carcinogenicity of 1,2-dichloroethane in experimental animals is sufficient, being based on ingestion data. No positive inhalation bioassays are available. Consequently, an extrapolation from the ingestion route to the inhalation route is needed to provide a cancer risk estimate from the bioassay data. Such extrapolations are best conducted when detailed information is available on the kinetics of metabolism, distribution and excretion. Two estimates calculated from data on oral studies are provided for the risk of cancer through inhalation of 1,2-dichloroethane, but they lack detailed data for the route-to-route extrapolation and are not used in the guidelines.

It is important to note that quantitative risk estimates may give an impression of accuracy which in fact they do not have. An excess of cancer in a population is a biological effect and not a mathematical function, and uncertainties of risk estimation are caused not only by inadequate exposure data but also, for instance, by the fact that specific metabolic properties of agents are not reflected in the models. Therefore, the guidelines do not indicate that a specified lifetime risk is virtually safe or acceptable.

[a] **Starr, T.B. & Buck, R.D.** The importance of delivered dose in estimating low-dose cancer risk from inhalation exposure to formaldehyde. *Fundamental and applied toxicology*, 4: 740–753 (1984).

Table 8 Guideline values for individual substances based on effects on terrestrial vegetation

Substance	Guideline value	Averaging time	Remarks
Nitrogen dioxide	95 $\mu g/m^3$ 30 $\mu g/m^3$	4 hours 1 year	In the presence of SO_2 and O_3 levels which are not higher than 30 $\mu g/m^3$ (arithmetic annual average) and 60 $\mu g/m^3$ (average during growing season), respectively
Total nitrogen deposition	3 g/m^2	1 year	Sensitive ecosystems are endangered above this level
Sulfur dioxide	30 $\mu g/m^3$ 100 $\mu g/m^3$	1 year 24 hours	Insufficient protection in the case of extreme climatic and topographic conditions
Ozone	200 $\mu g/m^3$ 65 $\mu g/m^3$ 60 $\mu g/m^3$	1 hour 24 hours averaged over growing season	
Peroxyacetylnitrate	300 $\mu g/m^3$ 80 $\mu g/m^3$	1 hour 8 hours	

The decision on the acceptability of a certain risk should be taken by the national authorities in the context of a broader risk management process. Risk estimate figures should not be applied in isolation when regulatory decisions are being made; combined with data on exposure levels and individuals exposed, they may be a useful contribution to risk assessment. Risk assessment can then be used together with technological, economic and other considerations in the risk management process.

Guidelines based on Ecological Effects on Vegetation

Although the main objective of the air quality guidelines is the direct protection of human health, it was decided that ecological effects of air pollutants on vegetation should also be considered. The effects of air pollutants on the natural environment are of special concern when they occur at concentrations lower than those that damage human health. In such cases, air quality guidelines based only on effects on human health would allow for environmental damage that might indirectly affect human wellbeing.

It should be understood that the pollutants selected (SO_x, NO_x and ozone/photochemical oxidants) (Table 8) are only a few of a larger category of air pollutants that may adversely affect the ecosystem. Furthermore, the effects which were considered are only part of the spectrum of ecological effects. Effects on aquatic ecosystems were not evaluated, nor were effects on animals taken into account. Nevertheless, the available information indicates the importance of these pollutants and of their effects on terrestrial vegetation in the context of the European Region.

Annex 2

AIR QUALITY LIMITS AND GUIDELINES: EUROPEAN COMMUNITY[a]

COUNCIL DIRECTIVE

of 15 July 1980

on air quality limit values and guide values for sulphur dioxide and suspended particulates

(80/779/EEC)

ANNEX I

LIMIT VALUES FOR SULPHUR DIOXIDE AND SUSPENDED PARTICULATES

(As measured by the black-smoke method)

TABLE A

Limit values for sulphur dioxide expressed in µg/m³ with the associated values for suspended particulates (as measured by the black-smoke method [1]) expressed in µg/m³

Reference period	Limit value for sulphur dioxide	Associated value for suspended particulates
Year	80 (median of daily mean values taken throughout the year)	> 40 (median of daily mean values taken throughout the year)
	120 (median of daily mean values taken throughout the year)	≤ 40 (median of daily mean values taken throughout the year)
Winter (1 October to 31 March)	130 (median of daily mean values taken throughout the winter)	> 60 (median of daily mean values taken throughout the winter)
	180 (median of daily mean values taken throughout the winter)	≤ 60 (median of daily mean values taken throughout the winter)
Year (made up of units of measuring periods of 24 hours)	250 [2] (98 percentile of all daily mean values taken throughout the year)	> 150 (98 percentile of all daily mean values taken throughout the year)
	350 [2] (98 percentile of all daily mean values taken throughout the year)	≤ 150 (98 percentile of all daily mean values taken throughout the year)

[1] The results of the measurements of black smoke taken by the OECD method have been converted into gravimetric units as described by the OECD (see Annex III).

[2] Member States must take all appropriate steps to ensure that this value is not exceeded for more than three consecutive days. Moreover, Member States must endeavour to prevent and to reduce any such instances in which this value has been exceeded.

[a] Extract from Official journal of the European Communities, Nos. L229/35, L378/15, L87/5.

TABLE B

Limit values for suspended particulates (as measured by the black-smoke method [1]) expressed in $\mu g/m^3$

Reference period	Limit value for suspended particulates
Year	80 (median of daily mean values taken throughout the year)
Winter (1 October to 31 March)	130 (median of daily mean values taken throughout the winter)
Year (made up of units of measuring periods of 24 hours)	250 [2] (98 percentile of all daily mean values taken throughout the year)

(1) The results of the measurements of black smoke taken by the OECD method have been converted into gravimetric units as described by the OECD (see Annex III).

(2) Member States must take all appropriate steps to ensure that this value is not exceeded for more than three consecutive days. Moreover, Member States must endeavour to prevent and to reduce any such instances in which this value has been exceeded.

ANNEX II

GUIDE VALUES FOR SULPHUR DIOXIDE AND SUSPENDED PARTICULATES

(as measured by the black-smoke method)

TABLE A

(Guide values for sulphur dioxide expressed in $\mu g/m^3$)

Reference period	Guide value for sulphur dioxide
Year	40 to 60 (arithmetic mean of daily mean values taken throughout the year)
24 hours	100 to 150 (daily mean value)

TABLE B

Guide values for suspended particulates (as measured by the black-smoke method [1]) expressed in $\mu g/m^3$

Reference period	Guide value for suspended particulates
Year	40 to 60 (arithmetic mean of daily mean values taken throughout the year)
24 hours	100 to 150 (daily mean value)

(1) The results of the measurements of black smoke taken by the OECD method have been converted into gravimetric units as described by the OECD (see Annex III).

ANNEX IV

LIMIT VALUES FOR SULPHUR DIOXIDE AND SUSPENDED PARTICULATES (AS MEASURED BY A GRAVIMETRIC METHOD) APPLICABLE WITHIN THE CONTEXT OF ARTICLE 10 (2)

1. Table A shall be replaced by the following: (1989 revision)

"TABLE A [(1)]

Limit values for sulphur dioxide expressed in ug/m3, and associated values for suspended particulates (measured by the gravimetric method) expressed in ug/m3

Reference period	Limit values for sulphur dioxide	Associated value for suspended particulates
Year	80 (median of daily mean values taken throughout the year)	> 150 (median of daily mean values taken throughout the year)
	120 (median of daily mean values taken throughout the year)	≤ 150 (median of daily mean values taken throughout the year)
Winter (1 October to 31 March)	130 (median of daily mean values taken throughout the winter)	> 200 (median of daily mean values taken throughout the winter)
	180 (median of daily mean values taken throughout the winter)	≤ 200 (median of daily mean values taken throughout the winter)
Year (made up of units of measuring periods of 24 hours)	250 (i) (98th percentile of all daily mean values taken throughout the year)	> 350 (98th percentile of all daily mean values taken throughout the year)
	350 (i) (98th percentile of all daily mean values taken throughout the year)	≤ 350 (98th percentile of all daily mean values taken throughout the year)

(i) Member States must take all appropriate steps to ensure that this value is not exceeded for more than three consecutive days. Moreover, Member States must endeavour to prevent and to reduce any such instances in which this value has been exceeded."

TABLE B

Limit values for suspended particulates (as measured by the gravimetric method described in (ii) below) expressed in µg/m³

Reference period	Limit value for suspended particulates
Year	150 (arithmetic mean of daily mean values taken throughout the year)
Year (made up of units of measuring periods of 24 hours)	300 (95 percentile of all daily mean values taken throughout the year)

COUNCIL DIRECTIVE

of 3 December 1982

on a limit value for lead in the air

(82/884/EEC)

Article 1

1. This Directive shall fix a limit value for lead in the air specifically in order to help protect human beings against the effects of lead in the environment.

2. This Directive shall not apply to occupational exposure.

Article 2

1. For the purpose of this Directive, 'limit value' means the concentration of lead in the air which, subject to the conditions laid down hereinafter, must not be exceeded.

2. The limit value shall be 2 micrograms Pb/m^3 expressed as an annual mean concentration.

3. Member States may, at any time, fix a value more stringent than that laid down in this Directive.

COUNCIL DIRECTIVE

of 7 March 1985

on air quality standards for nitrogen dioxide

(85/203/EEC)

ANNEX I

LIMIT VALUE FOR NITROGEN DIOXIDE

(The value limit shall be expressed in µg/m³. The volume must be standardized at the following conditions of temperature and pressure: 293° K and 101,3 kPa)

Reference period (1)	Limit value for nitrogen dioxide
Year	200
	98th percentile calculated from the mean values per hour or per period of less than an hour recorded throughout the year (2)

ANNEX II

GUIDE VALUES FOR NITROGEN DIOXIDE

(The value limit shall be expressed in µg/m³. The volume must be standardized at the following conditions of temperature and pressure: 293° K and 101,3 kPa)

Reference period	Guide values for nitrogen dioxide
Year	50
	50th percentile calculated from the mean values per hour or per period of less than an hour recorded throughout the year
	135
	98th percentile calculated from the mean values per hour or per period of less than an hour recorded throughout the year

Annex 3

AIR QUALITY STANDARDS AND GUIDELINES: OTHER COUNTRIES

(a) **Proposed New Air Quality Standards in Israel**

Part 1: Gaseous Pollutants

Pollutant	Threshold Value mg/m³	Averaging Time
Ozone	0.230 0.065	30 min 24 hours
Sulphur Dioxide	0.780 0.280 0.060	30 min 24 hours 1 year
1,2 Dichloro-ethane	6.0 2.0	30 min 24 hours
Dichloro-methane	6.0 3.0	30 min 24 hours
Toluene	10.0	24 hours
Tetrachloro-ethylene	5.0	24 hours
Trichloro-ethylene	1.0	24 hours
Hydrogen Sulfide	0.045 0.015	30 min 24 hours
Styrene	0.1	30 min
Formal-dehyde	0.1	30 min
Carbon Monoxide	35.0 11.0	30 min 8 hours
Nitrogen Oxides (as NO_2)	0.940 0.560	30 min 24 hours

Part 2: Suspended Particulate Pollutants

Pollutant	Treshold Value mg/m³	Averaging Time
Suspended Particulate Matter	0.300 0.200 0.075	3 hours 24 hours 1 year
Respirable Part. Matter	0.150 0.060	24 hours 1 year
Vanadium (in SPM)	0.001	24 hours
Sulfate Salts	0.025	24 hours
Phosphate (in SPM)	0.250 0.100 0.040	30 min 24 hours 1 year
Lead (in SPM)	0.0050 0.0015 0.0005	24 hours 30 days 1 year
Cadmium (in SPM)	0.0020 0.0006 0.0001	24 hours 30 days 1 year

Part 3: Settling Particulate Pollutants

Pollutant	Threshold Value t/km²	Averaging Time
Settling Dust	20	30 days
Phosphate	0.25 0.05	24 hours 30 days

(b) Turkey

Pollutant	1 hr	24 hr	Annual mean
CO mg/m3	-	10	-
SO_2 µg/m3	450	150	60
Smoke µg/m3	-	150	60
O_3µg/m3	240	-	-

(c) Yugoslavia

Separate figures are given for:

1 Serbia and Macedonia
2 Slovenia
3 Montenegro

Standards applicable to half hour periods

Pollutant	1	2	3
COmg/m3	3	30	30*
NO_2µg/m3	85	300	300*
SO_2µg/m3	500	-	360*
Smoke µg/m3	150	-	-
Oxidants µg/m3	125	-	125

Standards applicable to 24 hr periods

Pollutant	1	2	3
CO mg/m3	1	10	10
NO_2µg/m3	85	100	-
SO_2µg/m3	150	300	300*
Smoke µg/m3	50	150	160*

* 95 percentile values

There is a 3 hr standard for SO_2 in Slovenia, 300 µg/m3. Standards are designated for a further 109 substances in Serbia and Macedonia, for 9 more in Slovenia and 107 in Montenegro.

(e) Bulgaria

Pollutant	1 hour	24 hour
CO mg/m^3	5	3
NO_2 ug/m^3	85	40
SO_2 ug/m^3	500	50
TSP ug/m^3	500	150
O_3 ug/m^3	160	30

(f) German Democratic Republic

Pollutant	1 hour	Annual Mean
CO mg/m^3	5	3
NO_2 ug/m^3	100	40
SO_2 ug/m^3	500	150
TSP ug/m^3	500	150

This table show the MIK_k and MIK_d "immision" (ambient air quality) standards for 1 hour and annual mean values respectively. Corresponding values have been defined for a range of about 150 other chemicals.

(g) Hungary

Pollutant	30 min	24 hour	Annual Mean
CO mg/m^3	10	5	2
NO_2 ug/m^3	100	85	70
SO_2 ug/m^3	500	150	70
Smoke ug/m^3	150	50	25
TSP ug/m^3	200	100	50
O_3 ug/m^3	200	100	-

These standards apply in protected areas category I (residential areas). In addition there are standards for other types of areas, technical limit values for carcinogens and "planning values" for about 320 other contaminants.

(h) Poland

Pollutant	30 min	24 hour	Annual Mean
CO mg/m^3	5	1	0.12
NO_2 µg/m^3	500	150	50
SO_2 µg/m^3	600	200	32
TSP µg/m^3	-	120	50
O_3 µg/m^3	100	30	-

These standards apply in protected (residential) areas. There is a second list, with lower values, for specially protected areas. Standards have also been defined for a further 39 substances.

(i) Romania

Pollutant	30 min	24 hour	Annual Mean
CO mg/m^3	6	2	-
NO_2 µg/m^3	300	100	40
SO_2 µg/m^3	750	250	60
Smoke µg/m^3	150	50	-
TSP µg/m^3	500	150	-
O_3 µg/m^3	100	30	-

Standards have also been defined for about 25 other substances.

(j) USSR

Pollutant	30 min	24 hour
CO mg/m^3	5	3
NO_2 µg/m^3	85	40
SO_2 µg/m^3	500	50
TSP µg/m^3	500	150
O_3 µg/m^3	160	-

In all, standards have been defined for about 360 substances.

Annex 4

EMERGENCY LEVELS AND PROCEDURES

(a) Greece (Athens)

	SMOKE $\mu g/m^3$	SO_2 $\mu g/m^3$	NO_2 $\mu g/m^3$	CO mg/m^3
A. ACCEPTABLE LEVELS (if these levels are exceeded the Environmental Pollution Control Directorate is on the alert)	24 hour		Hourly	Running 8 hour average
	250	200	200	15
B. RESTRICTIVE MEASURES (step A)	400	400	500	25
C. EMERGENCY CONDITION (step B)	600	500	700	35

Note: 1. There are no corresponding levels for O_3.

2. Measures are taken before exceeding the levels, having as a criterion the meteorological forecast.

Alerts operate when any one monitoring station in the city is at risk of exceeding levels as specified in the table above (but revision to two under consideration).

Step A 30% reduction in industrial activity 50% reduction in traffic (operated on basis of odd or even numbers of vehicle registration)

Step B Complete ban on traffic

(b) Turkey (Ankara)

Warning Levels of Pollutants for Emergency Measures

Warning level	SO_2 ($\mu g/m^3$)	PM ($\mu g/m^3$)
1st level	700	400
2nd level	1,000	600
3rd level	1,500	800
4th level	2,000	1,000

Note : Figures listed above indicate the 24-hour concentration values. When prevailing relative humidity exceeds 90%, the values shown above are to be cut by 100%.

Emergency measures at the warning levels

Warning Level		Emergency Measures
		In addition to the regular measures,
1st	(i)	Soot and smoke emissions from the non-sanitary installations belonging to the 2nd and 3rd classes shall be reduced by 50%
	(ii)	Stoves and central heating boilers shall not be used for more than 4 hours each in the morning and afternoon and in total 8 hours per day.
		In addition to the measures taken at the 1st level:
2nd	(i)	Soot and smoke emissions from the 1st class non-sanitary installations shall be cut by 50%.
	(ii)	Stoves and central heating boilers shall not be used for more than 3 hours each in the morning and afternoon and in total 6 hours per day.
		In addition to the measures taken at the 2nd level:
3rd	(i)	Passengers cars having even number plates can be used only on the even days and those with odd number can be used only on the odd days.
	(ii)	Elementary schools and junior high schools shall be closed.
	(iii)	All the non-sanitary installations shall not be operated.
	(iv)	Stoves and boilers shall be used for no more than 3 hours per day continuously

		In addition to the measures to be taken at the 3rd level
	(i)	All the schools and public and private offices shall be closed.
	(ii)	All the motor vehicles except those of the Government, military, firestation and diplomatic corps and those transporting necessities, ambulance and taxis, shall not be used.
	(iii)	All work activities except production of necessities and those directly related to public health shall be stopped.
4th	(iv)	All the stoves and boilers shall not be used. Hospitals and buildings related to public health may use electric heaters with necessary precautions.
	(v)	Hospitals shall secure the necessary number of beds, medicines and materials for the treatment of patients.
	(vi)	All the ambulances within the metropolitan municipality area shall be placed under the control of the Department of Health of the Provincial Government of Ankara.

(c) Yugoslavia

Examples of proposals for emergency levels

For Belgrade

For Belgrade	SO_2	Smoke
	ug/m^3	ug/m^3
1st stage	800	300
2nd stage	1600	600
3rd stage	2400	900

Based on 24 hr average concentrations, with forecast of stable air conditions for next day or so.

Action

1st stage Recommendation to susceptible people st stay indoors

2nd stage Restrictions on industrial emissions and on some traffic

3rd stage A ban on all energy use other than gas or electricity, and a traffic ban.

For Lublana

	SO_2 ug/m^3	NOx ug/m^3
1st stage	1,000	1,000
2nd stage	1,600	1,600
3rd stage	2,400	2,400

Action

1st stage Recommendation to people to stay indoors, advice for reduction of motor vehicle use and suggestions for controlling heating systems.

2nd stage Restrictions on use of coal and oil and on some traffic.

3rd stage A ban on heating systems and on traffic, and other measures as determined by the Executive Council of the city.

(d) German Democratic Republic

Smog Alert Ordinance of the GDR

The German Democratic Republic (GDR) published the first Smog Ordinance (1) on 2 November 1989. This Ordinance defines twenty smog areas in the districts Berlin, Potsdam, Magdeburg, Halle, Leipzig, Dresden, Karl-Marx-Stadt, Gera, Suhl, Erfurt and Cottbus. The smog alert criteria are given by measured values of sulphur dioxide. For this pollutant a monitoring network was established in the last years. The table contains three smog alert stages, corresponding SO_2 concentrations and measures. The defined smog stages are comparable to the Smog Ordinances of Federal Republic of Germany which additionally include levels of nitrogen oxide, carbon monoxide and suspended particulates. Unfortunately, the Smog Ordinance does not demand practical measures because operational plans have not yet been formulated.

As a consequence of the recent political changes in the GDR the Ordinance on Environmental Data (2) was entered on 13 November 1989. Therefore, all environmental measuring data can now be published. The Governmental Inspectorates of Hygiene that are located in the capitals of districts are responsible for carrying out measurements and publication of data in the field of air pollution control.

(1) Vierte Durchführungsbestimmung zur Fünften Durchführungsverordnung zum Landeskulturgesetz - Reinhaltung der Luft - Smogordnung - vom 2.11.1989. Gesetzblatt der Deutschen Demokratischen Republik Teil I, Nr.21.

(2) Verordnung über Umweltdaten vom 13.11.1989. Gesetzblatt der Deutschen Demokratischen Republik Teil I, Nr.22.

Smog Alert Stages

<table>
<tr><th></th><th>Stage of Information</th><th>Stage I</th><th>Stage II</th></tr>
<tr><td rowspan="2">SO_2 concentration</td><td>600 $\mu g/m^3$
3 hours at 2 measuring stations</td><td>1200 $\mu g/m^3$
3 hours at 2 measuring stations</td><td>1800 $\mu g/m^3$
3 hours at 1 measuring and 1200 $\mu g/m^3$
at another station</td></tr>
<tr><td colspan="3">When the meteorological conditions are stable over 24 hours</td></tr>
<tr><td rowspan="3">Measures</td><td colspan="3">Information of public through press, radio and television, recommendations, alert of public health facilities</td></tr>
<tr><td rowspan="2">Information of factories with operational plans</td><td colspan="2">Coming into force of operational plans by the authorities
Call to reduce room temperature and avoidance additional air pollutions</td></tr>
<tr><td>It is recommended not to use private cars</td><td>Autority can restrict the use of motor vehicles and carrying out of open air meetings</td></tr>
</table>

Annex 5

LIST OF PARTICIPANTS

MEETING IN ATHENS, 13-17 DECEMBER 1988

GREECE

Mr K. Bourkas
Secretary in charge of the Environment, Ministry of the Environment, Physical Planning and Public Works, Athens (*Senior delegate*)

Dr A.P. Economopoulos
Research Scientist, Institute of Nuclear Technology, National Centre for Physical Sciences "Democritos", Attiki

Mr N. Manalis
Air Quality Department, Division of the Environment, Ministry of the Environment, Physical Planning and Public Works, Athens

Dr A. Pantazoplou-Fotinea
Medical Oficer on Health Impact Assessment, Head, Division of the Environment, Ministry of the Environment, Physical Planning and Public Works, Athens

Mr M. Sambatakakis
Head, Environmental Pollution Control Department, Division of Environmental and Sanitary Protection, Ministry of Health, Welfare and Social Security, Athens

Mr K. Stamelos
Environmental Protection Sector, Organization of the Master Plan and Environmental Protection of Thessaloniki. Thessaloniki

ISRAEL

Dr S. Brenner
Director, Research Institute for Environmental Health, Ministry of Health, Tel Aviv (*Senior delegate*)

Mr M. Tal
Regional Office of Haifa, Ministry of Health, Haifa

MALTA

Mr L. Vella
Occupational Hygiene Office, Department of Health, Valletta

PORTUGAL

Ms E. Coragem
Sanitary Engineer, Directorate-General of the Primary Health Service, Lisbon

Mr J. M. de Tavora
Head of Qir Quality Division, Regional Directorate for Environment and Natural Resources, Lisbon (*Senior delegate*)

SPAIN

Dr E.B. Gil
Head, Air Pollution Control Section, Ministry of Health and Consumer Affairs, Madrid

TURKEY

Mrs Z. Yöntem
Chemical Engineer, Directorate General of Environment, Ankara

YUGOSLAVIA

Dr V. Damjanov
Chief, Hygiene Section, Institute for Public Health of Serbia, Belgrade

Dr M. Hiti
Chief Sanitary Inspector of Slovenia, Republic Sanitary Inspectorate, Ljubljana

Dr V. Radmilovic
Group Chief , Department of Sanitary Control and Preventive Health Care, Federal Committe for Labour, Health and Social Policy, New Belgrade (*Senior delegate*).

MEETING IN WARSAW, 20-23 JUNE 1989

BULGARIA

Dr P. Kazasov
Senior Officer, Ministry of Public Health and Social Care, Sofia (*Senior delegate*)

Dr S. Tabacova
Associate Professor and Senior Research Scientist, Air Pollution Control Laboratory, Institute of Hygiene and Occupational Health, Sofia

GERMAN DEMOCRATIC REPUBLIC

Dr H.J. Discher
Head of Department, Ministry of Environment and Water Management, Berlin

Dr A. Hellwig
Head, Environmental Hygiene Inspection, District Hygiene Institute, Magdeburg

Dr H. Werner
Head, Air Hygiene Inspection, Ministry of Health, Berlin (*Senior delegate*)

HUNGARY

Dr J. Molnär
Head, Department of Toxicology, National Institute of Hygiene, Budapest (*Senior delegate*)

Dr T. Varkonyi
Adviser, Department of Air Hygiene, National Institute of Hygiene, Budapest

POLAND

Dr T. Dutkiewicz
Professor, Institute of Environmental Protection, Katowice (*Senior delegate*)

Mr S. Kaminski
Department of Air Protection Systems, Ministry of Environmental Protection and Natural Resources, Warsaw

Dr J. Majka
Institute of Occupational Medicine, Lodz

Dr S. Maziarka
Department of Communal Hygiene, State Hygiene Institute, Warsaw

Dr M. Nowicki
Department of Atmosphere Protection, Institute of Environmental Protection, Warsaw

ROMANIA

Dr C. Petre
Sanitary Inspector and Chief, Ministry of Health, Bucharest (*Senior delegate*)

Dr C. Manole
Head, Environmental Health Department, Institute of Hygiene and Public Health, Bucharest

Dr M. Anca
Medical Specialist on Air Pollution Epidemiology, Institute of Hygiene and Public Health, Bucharest

USSR

Dr S.L. Avaliani
Laboratory Chief, Sysin Institute of General and Communal Hygiene, Moscow

Dr V.I. Chyburaev
Chief, Sanitary Protection Board, Ministry of Health of the USSR, Moscow (*Senior delegate*)

Dr Y.I. Prokopenki
Director, Research Institute of Disinfection and Sterilization, Moscow.

MEMBERS OF WHO TEAM PRESENT AT BOTH MEETINGS

Dr A.P. Economopoulos[a]
Research Scientist, Reactor Division, National Centre for Physical Science "Democritos", Attiki, Greece

Dr L.D. Grant
Director, Environmental Criteria and Assessment Office MD-52, US Environmental Protection Agency, Research Triangle Park, NC, USA

Dr K.R. Krijgsheld
Coordinator, Air Pollution Effects, Ministry of Housing, Physical Planning and Environment, Leidschendam, Netherlands

Dr B. Seifert
Professor and Deputy Director, Air Hygiene Department, Institute of Water, Soil and Air Hygiene, Berlin

Dr J.A. Sokal
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