HEALTH AND AIR POLLUTION-
A DEVELOPING COUNTRY'S PERSPECTIVE

by

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Air pollution in general and indoor air pollution in particular have been associated in many people's mind with industrialization and urbanization and thus with the cities in developed countries where most of the measurements of ambient and indoor air pollution have been made. Although most studies rely on ambient air pollutant concentrations as a measure of public exposure, and studies of indoor air quality have been mostly carried out in developed-country buildings, the greatest concentrations of suspended particulate matter are found in both rural and urban households of developing countries (Smith, 1996; WHO 1997a).

The potential hazards of substances in the ambient and indoor environment of developed countries is well known Epidemiology and toxicology has provided us with information on a multitude of chemicals and other substances producing adverse health effects. This research has allowed to identify the hazards and to propose the actions reducing the probability of population exposure to high air pollutant concentration and preventing the most obvious adverse health effects of the exposure WHO and other international organizations have reviewed and summarized the accumulated evidence on ambient and indoor air quality and its health aspects (WHO, 987; WHO, 1994; WHO, 1995b; WHO, 1995c; WHO, 1995d; WHO 1996).

Of major support to countries in risk assessment and national standard setting have been WHO's Air Quality Guidelines for Europe, WHO, 1987. Between 1993 and 1996 they were updated (WHO, 1994; WHO, 1995a; WHO, 1995b; WHO, 1995c; WHO, 1996; WHO, 1998a) and extended to become globally applicable in a recent meeting (WHO, 1998b) taking into account factors which might be influential for the health outcome in other regions, and issues of air quality monitoring and management.

Under the umbrella of the Healthy Cities Programme (WHO, 1995c) the Air Management Information System (AMIS) was set up in 1996 by WHO as a successor of the UNEP/Global Environmental Monitoring System/Air (GEMS/AIR, (UNEP/WHO, 1993)) AMIS has the objective to transfer information on air quality management (air quality management instruments used in cities, indoor and ambient air pollutant concentrations, noise levels, health effects, control actions, air quality standards, emission standards, emission inventories, dispension modelling tools) between countries and cities (WHO, 1997b) AMIS data can be used for a comparison of the air pollutant situation in various urban areas of the World, as a means to estimate the exposure of the urban population to air pollutants, and to inform on the approaches in air quality mangement used in different urban environments.

While in developed countries the evaluation of the exposure and the assessment of the impact of air pollution on the health of the population has been attempted e.g. in the WHO project "Concern for Europe's Tomorrow" (WHO, 1995b) similar projects for developing countries have not yet been performed AMIS has been created to facilitate such assessments.

The objectives of this address are the delineate the air pollution situation in developing countries, to discuss the health effects of air pollution, to present and discuss the updated and revised air quality guidelines of WHO, to describe the frame of the Air Mangement Information System AMIS and to elaborate on the disease burden caused by ambient and indoor air pollution.

HEALTH EFFECTS OF AIR POLLUTION

The health impacts of air pollutants are manifold and can become manifest in any compartment of the human body, compartments affected include the respiratory system, immune system, skin and mucosal tissues, sensory system, central and peripheral nervous system, cardiovascular system.

Health effects of air pollution on the respiratory system (lower airways) include acute and chronic changes in pulmonary function, increased incidence and prevalence of respiratory symptoms, sensitizastion of airways to allergens present in the indoor environment, and exacerbation of respiratory infections such as rhinitis, sinusivitis, pneurmonia, alveolitis, legionnaires' disease Principal agents for these health effects are the combustion products sulphur dioxide, nitrogen dioxide, suspended particulate matter with a mean aerodynamic diameter below 10 µm, and carbon monoxide. In addition indoor air pollutants - fine suspended particulate matter, formaldehyde, and infectious organisms - can also act as important agents.

Health effects of air pollution on immune system allergies manifest themselves in exacerbation of allergic asthma, allergic rhinoconjunctivits, extrinsic allergic alveolitis / hypersensitivity pneumonitis, and can produce permanent lung damage in sensitized individuals including pulmonary insufficiency Principal agents are known to be outdoor allergens and indoor air agents such as house mite dust, cockroaches, organisms living in the pelt of pets, insects and moulds in high humidity environments.

Health effects of air pollution on the skin and on mucosal tissues (eyes, nose, throat) are mostly irritating effects. Primary sensory irritations include dry - sore - throat, tingling sensation of nose, and watering and painful eyes. Secondary irritation is characterized by edema and inflammation of the skin and mucous membranes up to irreversible changes in these organs Principal agents include volatile organic compounds, formaldehyde and other aldehydes (e.g. acetaldehyde, acrolein) and environmental tobacco smoke.

Sensor effects of air pollution include nuisance and annoyance reactions caused by perception of air pollutants through sensory organs. As principal agents can act volatile organic compounds, formaldehyde and environmental tobacco smoke.

Effects of air pollution on the central nervous system manifest themselves in damage of the nerve cells, either toxic or hypoxia/anoxia. Principal Agents are volatile organic compounds (acetone, benzene, toluene, formaldehyde), carbon monoxide and pesticides. In infants and young children neurophysiological changes caused by lead can result in developmental retardation and irreversible deficiencies.

Effects of air pollution on the cardiovascular systems develop through reduced oxygenation and result in increased incidence and prevalence of cardiovascular diseases, myocardial infarction, and consequent increase in mortality caused cardiovascular diseases Principal agents are carbon monoxide suspended particulate matter and environmental tobacco smoke.

Carcinogenic effects of air pollution are associated with lung cancer, skin cancer, and leukemia Principal agents for lung cancer have been identified as arsenic, asbestos fibers, chromium, nickel, cadmium, polveyelic aromatic hydrocarbons, trichloroethylene, environmental tobacco smoke, and radon Benzene is known to produce leukemia and ultraviolet radiation is a causative agent of skin cancer. A difficult question is that of synergism among the different carcinogens compounds and been carcinogenic and non carcinogenic agents. The question of synergism is largely unresolved. Also other carcinogenic effects might also exist by are not well assessed.

WHO GUIDELINES FOR AIR QUALITY

The Air Quality Guidelines for Europe have been published by the WHO Regional Office for Europe, EURO in 1987 (WHO, 1987). Since 1993 they were reviewed and updated (WHO, 1994; WHO, 1995a; WHO, 1995b, WHO, 1996). In a recent expert meeting the new Air Quality Guidelines for Europe (WHO 1998a) were extended to become globally applicable through consideration of findings in non European regions. The globally applicable guidelines for air quality will constitute a publication in which also the issues of air quality monitoring an mangement and indoor air problems are being addressed (WHO, 1998b).

Air quality guidelines have several objectives, including the protection of public health from adverse effects of pollutants, elimination or reduction to a minimum of air contaminant concentrations, provision of background information for making risk management decisions, provision of guidance to governments in setting standards, and assistance in implementing local, regional, national action plans.

Air quality guidelines (AQG) should be clearly distinguished from air quality standards AQG are derived from purely epidemiological andtoxicological (or environment-related) data while in contrast, AQS are values limiting air pollutant concentration which are promulgated through legislation in a country or community. In the process of promulgation issues of technological feasibility, costs of compliance, prevailing exposure levels, social, economic and cultural conditions are possibly taken into consideration.

Two different concepts are applied for deriving air quality guidelines for compounds with non-carcinogenic and carcinogenic health endpoints, respectively. For non-carcinogenic endpoints the concept relates to either a lowest-observed-effect-level (LOEL), lowest-observed-adverse-effect level (LOAEL), no-observed-effect-level (NOEL), or no-observed-adverse-effect-level (NOAEL). For these compounds the existence of a threshold for the onset of health effects is assumed or established Using any of these levels and applying uncertainty factor to cover our ignorance about the entity of effects, extrapolation from animal experiments to man, and the existence of sensitive groups, fixed values are derived as air quality guidelines. If these guidelines are complied with, the risk of any health effect is considered to be negligibly small Tables of the updated and revised, globally applicable air quality guidelines are given in Annex 1. The values fixed in these tables are considered to be "safe levels" of air pollutant concentrations for which the risk of a health effect is negligibly small.

For carcinogenic compounds it is not possible to give such "safe levels" Rather, the quantitative risk assessment of carcinogenic compounds employs the notion of unit risk which is defined as the additional lifetime concern risk occurring in a hypothetical population in which all individuals are exposed continuously from birth throughout their lifetimes to a concentration of 1 μg m^{-3} of the agent in the air they breath. With this notion a linear risk-concentration model in assumed for a carcinogenic compound which allows to estimate the risk of cancer cases in a fictitious population at various concentration of the compound. The unit risk is estimated by extrapolation from high exposure levels as observed in occupational and animal studies to low exposure levels which are representative of the pollutant burden of the general population. This extrapolation is dependent on the extrapolation model. A tables for the unit risks of carcinogenic compounds is presented in Annex 2. The interpretation of unit risk estimates has to consider the fact that unit risk estimates are not equivalent to the true cancer risk. But unit risk estimates provide policy maker with rough estimates which may serve as a basis for setting priorities, balancing risks and benefits, and establishing the urgency of public health problems among sub-populations inadvertently exposed to carcinogens.

The tables in Annex I do not include guidelines for suspended particulate mater. It was argued that a threshold for this compound including the size-dependent fractions PM_{10} and $PM_{2.5}$ could not be established and consequently no guideline be given (WHO, 1995a). Rather it is recommended to use percent-change-concentration relationships such as indicated in figure 1 for fixing a acceptable percent change for some kind of effect (e.g. in the case of figure 1 of mortality) in the sense of a risk consideration. It should be noted that the linear relationships of figure 1 are only valid up to concentrations of 200 μg/m³ in the PM_{10} concentration. Above that value the relationships are expected to level off in a way not established up to now. This procedure is new and comparable to that for carcinogenic compounds. An interpretation of this concept with respect to standard derivation is being contributed by Schwela and Junker (1998)

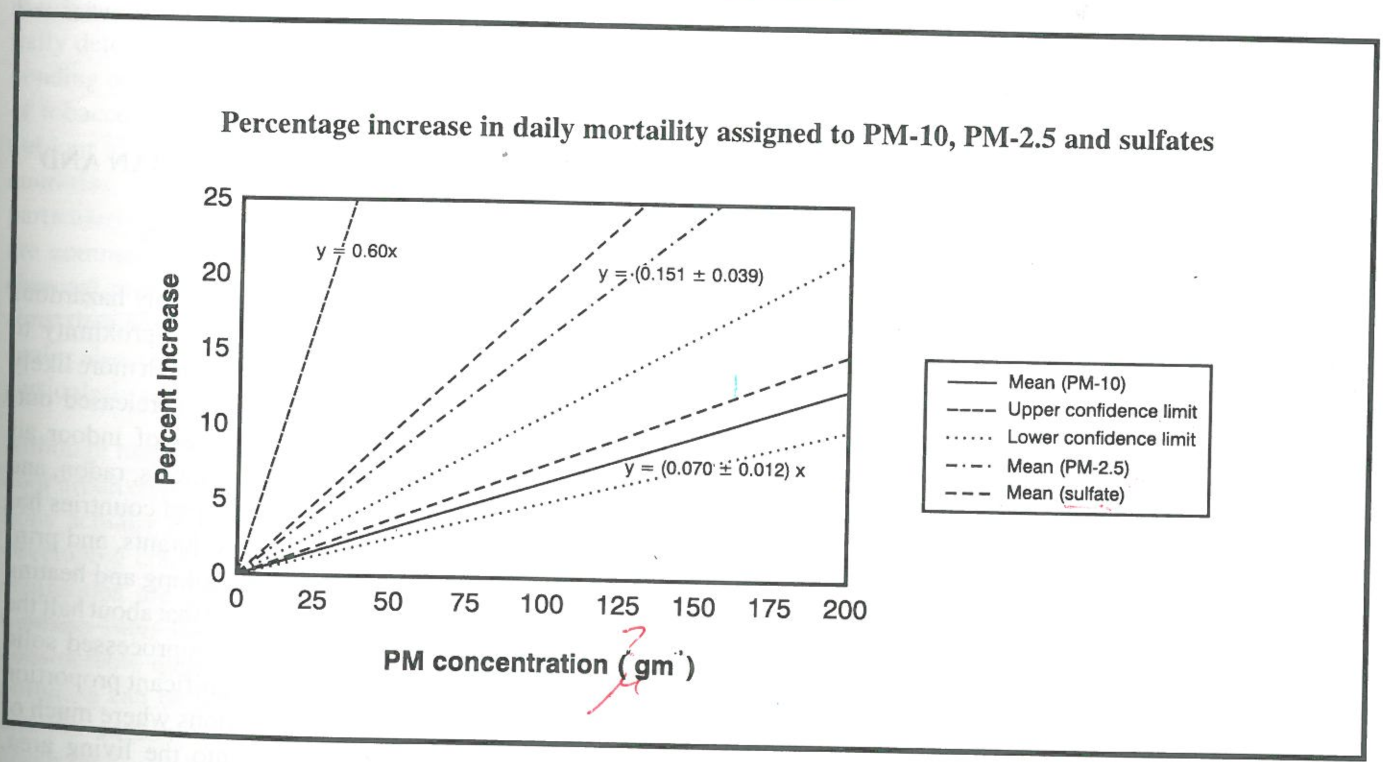

Figure 1. Percen-concentraito relationship for daily mortality according to the air quality guidelines.

AIR POLLUTION IN URBAN AREAS OF DEVELOPING COUNTRIES

Global trends of air pollution in the urban areas can be inferred from the data of the Air Management Information System (AMIS. (WHO. 1997b)), AMIS is configured to act as a global air quality information exchange system. AMIS Programme activity areas include:

- Coordinating data bases with information on air quality issues in major and megacities;
- Acting as an information broker between countries, cities, national environmental protection agencies, funding agencies, international organizations, and other interested participants in the frame of Global Air Quality Partnership;
- Providing and widely distributing technical documents on air quality management;
- Publishing and widely distributing annual trend reviews on air pollutant concentrations on a CD ROM and on the Internet;
- Developing further databases and characterization of emissions of major and megacities, reference to other air quality databases, air quality management capabilities and procedures of cities, control actions and magnitude of their cost, adverse effects of air pollution on health and magnitude of their costs.

AMIS is a set of user friendly MS ACCESS based databases. A core database contains summary statistics of air pollution data like annual means, 95 percentiles, and the number of days on which WHO guidelines are exceeded. Any compound for which WHO air quality guidelines exist can be entered into the open-ended database. Data handling is easy and data validation can be assured with relatively little means. In the existing version data (mostly from 1986 to 1996) from about 100 cities in 40 countries are represented. All these items are made available to AMIS participants. For the core database it is intended to increase the number of contributing cities 300 by the end of the millennium. Cities can easily compare their data with the data of all other participants in the system. Another database that has been realized is the database on air quality standards. Standards from about fifty countries are incorporated and can be seen in comparison with the WHO air quality guidelines. A database with the names and addresses of the AMIS focal points allows direct communication between the participants. A CD ROM with air pollutant concentration data from sixty cities was published in 1997 and is being widely distributed (WHO ,1997b). It is planned to bring the database to the Internet accessible through the WHO homepage. The framework of the databases on indoor air and on noise levels were realized. these databases are to be filled with data in the near future. The other databases, in particular the database on air quality management instruments used in the different cities are planned to exhibit a similar user friendly structure as the core database.

The global air pollution trends in urban areas as they can be inferred from the AMIS database are characterized as follows. In developed countries the concentration of the compounds SO_2, SPM, PM_{10}, Smoke are decreasing and often below WHO guidelines (for SPM, PM_{10} those of the 1987, (WHO. 1987)). For the compounds NO_2, O_3 concentrations are constant or increasing and often above WHO guidelines. Developing countries and countries in transition exhibit increasing concentrations of SO_2, SPM, PM10, which are often above WHO guidelines (SPM, PM10 those of 1987). Concentrations of NO_2, O_3, are increasing but often below WHO guidelines. Figure 2 shows typical annual means of pollutant concentrations for suspended particulate matter in cities of various countries. It is to be noted that very high concentrations are observed for this compound. It is possible that corresponding PM_{10} concentrations are also much higher than those that are monitored in developed countries and used to derive the relationships for figures 1.

INDOOR AIR POLLUTION IN URBAN AND RURAL AREAS OF DEVELOPING COUNTRIES

Indoor air pollution can be particularly hazardous to health because it is realized in close proximity to people. A pollutant released indoors is much more likely to reach peoples lungs than a pollutant released outdoors. Of the four principal categories of indoor air pollution - combustion products, chemicals, radon, and biological agents - research in developed countries has focused on combustion-generated pollutants, and principally those from solid-fuel-fired cooking and heating stoves. On a global basis it is estimated that about half the worlds households cook daily with unprocessed solid fuels, ie. biomass fuels or coal. A significant proportion of this activity takes place in conditions where much of the airborne effluent is released into the living area. Although ventilation rates are often relatively high, the emission factors for such fuels are so great that indoor concentrations and exposures can be quite significant. It has been shown that indoor air pollution in developing countries plays a much more important role due to the fact that ovens and braziers used for cooking and heating in households lead to much higher air pollutant concentrations indoors than those observed in developed countries (Smith, 1987. Smith, 1988. Smith, 1993. Smith, 1996). The resulting human exposures to suspended particulate matter, carbon monoxide, nitrogen oxides often exceed WHO guidelines by factors of 10, 20 or even more (WHO, 1992).

For health risk assessment, the duration of exposure is as important as the level of air pollution. If the total exposure of the world's population to air pollution is estimated by relating total person time spent in different types of settings (i.e. developed or developing country, rural or urban setting, indoor or outdoor) to the average air pollutant concentration of these settings, a comparison of total population exposures in different settings can be made, and the populations and settings with the highest risks identified. By using the percentage of the population involved in agricultural activities in developing countries, it has been estimated that more than 70% of person-time is spent indoors in those countries (Smith, 1993. WHO 1997a), in developed countries about 90% of the person-time is spent indoors. In order to estimate human exposure to air pollutants the relationship between outdoor and indoor air pollution is important since in urban areas urban indoor concentration are substantially determined by outdoor levels. Consequently, depending on the kind of household fuel used and amount of tobacco smoke present, they are often higher than outdoor concentrations, sometimes even in developed countries. In many developing country urban areas, particularly in South Asia and East Asia, biomass fuels are commonly used. In Africa, many households use charcoal, producing substantially lower particulate emissions than wood, but still high CO levels. Use of smoky coal is also a major source of urban indoor air pollution, particularly in China.

Although many people associate air pollution with outdoor urban environment, some of the highest concentrations actually occur in rural, indoor environments in developing countries (WHO, 1997a). These high concentrations are often due to burning of unprocessed biomass fuels (wood, crop residues, dung) that emit considerable quantities of pollutants. Indeed, so much pollution can be produced by indoor biomass fuel use that the outdoor air quality of entire local neighbourhoods and adjoining areas may be highly polluted. Indoor air pollutant concentrations can be high even if ventilation is relatively good.

INCREASE IN DISEASE BURDEN CAUSED BY AMBIENT AND INDOOR PARTICULATE POLLUTION

In recent years a large number of studies of the health impacts of suspended particulate air pollution have been undertaken in developed country cities (WHO, 1998a). Some data are also available for South American and Chines cities (Hong, 1995; WHO, 1998b). These studies show remarkable consisteney in developed countries in the relation ship between changes in daily ambient suspended particulate matter levels and changes in daily mortality. Global annual deaths assigned to indoor and outdoor particulate exposure have been estimated using tow different models (Schwela, 1996c; Smith, 1996; WHO, 1997a). Following the method of Smith about 3 million deaths are due to suspended particulate air pollution globally each year 2.8 million due to indoor exposures and 0.2 million due to outdoor exposures (Smith, 1996; WHO, 1997a). In developing countries about 1.9 million deaths each year may be due to indoor exposures in rural areas and 0.6 million to indoor exposures in urban areas. Estimates based on the second method arrive at similar total figure of 2.7 million premature deaths due to suspended particulate matter (Schwela, 1996; WHO, 1997a). Rural indoor premature deaths amount to about 1.8 million per year while urban indoor and urban ambient excess deaths are about 400 000 and 500 000 per year, respectively. The largest number of deaths is estimated to occur in India, followed by sub-Saharan Africa. The uncertainty of these estimates is probably a factor of 2.

Using similar considerations and methods, the exposure data of the Air Mangement Information System AMIS, and the percent increase of diseases with unit increase of particulate pollution concentration, estimates on the annual incidence of respiratory disease, asthma, chronic obstructive pulmonary diseases (COPD), and croup have been performed (Hong, 1995: Schwela, 1998). According to these estimates between 18 and 50 million incidences per year of respiratory diseases due to particulate matter in the ambient air have to be expected globally. For asthma incidence in children younger than 15 years the corresponding estimates range form 1.9 to 5.5 million incidences per year, for COPD in 45-60 years old adults between 850 000 and 2.1 million incidences per year are estimated to be due to exposure to suspended particulate matter. The incidences per year are estimated to be due to exposure to suspended particulate matter. The incidences for croup in children below the age of 5 years have a lower estimate of 1.3 million and 2.8 million cases per year. The bulk of this disease burden with about 2/8 of these incidences to be found in China, India, South-East Asia and Latin America developing countries.

CONCLUSIONS

The above considerations indicate the magnitude of an pollution problems in developing countries. Serious ambient air pollution is prevalent in many urban areas, in particular for suspended particulate matter where the 1987 air quality guidelines of WHO are exceeded. In view of the fact that for inhalable and fine particles a threshold for the onset of health effects could not be derived the reduction of emissions of this compound is particularly important. Indoor air pollution due to biomass fuel and coal use appears to be an even more serious problem. However indoor air pollutant monitoring has been much less intensive than ambient air monitoring. Therefore, indoor air pollution monitoring should be intensified in order to be able to reliably and in a representative way assess how it affects public health in developing countries. Rough model estimation of the disease burden due to ambient and indoor air indicate a substantial increase in premature deaths, incidence of respirable diseases, asthma and DOPD cases. These estimations need further refinement by assessing values for the basic parameters used in these models.

The instruments for the management of ambient air quality are well known in developed countries and the procedures developed can, in principle and in a simplified manner, be applied in developing countries through appropriate legislation and enforcement. The mangement of indoor air problems is left primarily to the building occupants, in developing countries as well as in developed countries. Their decisions will more often be driven by the household economy, convenience or habits, and the time proportion spent indoors than by minimal health risk considerations with respect to activities, facilities, and material used indoors. Regulations with respect to private and public buildings, material labelling and other means will alleviate these kinds of decisions. It is, however, unrealistic to expect that adverse health impacts can be avoided only through optimal individual decisions. An important task of the public health sector is to identify the most prevalent conditions adversely affecting health in a population and to propose efficient ways of health risk reduction. Individuals should be encouraged to manage the indoor environment in a health promoting way by legislative and economic mechanisms.

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ANNEX 1

Table 1. WHO air quality guidelines for "classical" compounds

Compound	Annual ambient air concentration ($^{\mu}g/m^3$)	Health endpoint	Observed effect level ($^{\mu}g/m^3$)	Uncertainty factor	Guideline value ($^{\mu}g/m^3$)	Averaging time
Carbon monoxide	500-700	Critical level of COHb < 2.5%	n.a.	n.a.	100 000 60 000 30 000 10 000	15 minutes 30 minutes 1 hour 8 hours
Lead	0.01-2	Critical level of Pb in blood < 25µg Pb/1)	n.a.	n.a.	0.5	1 year
Nirogen dioxide	10-100	Slight changes in lung function in asthmatics	365-565	0.5	200 40	1 hour 1 year
Ozone	10-100	Respiratory function responeses	n.a.	n.a.	120	8 hours
Sulphur dioxide	5-400	Changes in lung function in asthmatics Exacerbations of respiratory symptoms in sensitive individuals	1000 250 100	2 2 2	500 125 50	10 minutes 24 hour 1 year

Table 2. WHO air quality guidelines for non-carcinogenic compounds

Compound	Annual ambient air concentration ($\mu g/m^3$)	Health endpoint	Observed effect level ($\mu g/m^3$)	Uncertainty factor	Guideline value ($\mu g/m^3$)	Averaging time	Source
Acetaldehyde	5	Irritancy in humans Carcinogenicity related irritation in rats	45 (NOEL)	20	2 000	24 hours	EHC 167, 1995
Acrolein	15	Eye irritation in humans	130	2.5	50	30 min	EHC 127, 1992
Acrylic acid	No data	Nasal lesions in mice	15(LOAEL)	50	54		ECH 191, 1997
Cadmium	$(0.1\text{-}20).10^3$	Renal effects in the population	n.a.	n.a.	5x103	1 year	EURO, 1997
Carbon disulphide	10-1500	Functional CNS changes in workers	10 (LOAEL)	100	100	24 years	EURO, 1987
Chloroform	0.3-110	Hepatoxicity in heagles	from TDI	1 000	from TDI		ECH 163, 1994
1,2 Dichloroe-thane	0.2-6	Inhalation in animals	700 (LOAEL)	1 000	700	24 hours	EURO, 1987
Dichloromethane	<5	COHb formation in normal subjects		n.a.	3 000	24 hours	EURO, 1997
Diesel exhaust	1.0-10.0	Chronic alveolar inflammation in humans Chronic alveolar inflammation in rats	01.139 (NOAEL)* 0.23 (NOAEL)	25 100	5.6 2.3		EHC 171, 1996
Di-n-butyl Phthalate	$(3\text{-}800).\ 10^3$	Developmental/Reproductive toxicity	from ADI	1 000	14	24 hours	EHC 189, 1997
Ethythenzene	1-100	Biological significance criteria in animals	2 150 (NOEL)	100	22 000	1 week	EHC 186, 1996
Hunrides	0.5-3	Effects on livestocks	n.a.	n.a.	1	1 year	EURO, 1997
Formaldehyde	$(1\text{-}20).10^3$	Nose, throat irritation in humans	0.1 (NOAEL)	n.a.	0.1	30 minutes	EURO, 1997
Hydrogen sulphide	0.15	Eye irritation in humans	15 (LOAEL)	100	150	24 hours	EORO, 1987
Hydrogen sulphide	0.15	Odour annoyance	n.a.	n.a.	7	30 minutes	EURO, 1987
Managanese	0.01-0.07	Neurotozic effects in workers	0.03 (NOAEL	200	0.15	1 year	EURO, 1997
Mercury, inorganic	$(2\text{-}10).10^3$	Renal tubular effects in humans	0.020 (LOAEL)	20	1	1 year	EURO, 1997
Styrene	1.0-20.0	Neurological effects in workers	107 (LOAEL)	40	260	1 week	EURO, 1997
Styrene	1.0-20.0	Odour annoyance	n.a.	n.a.	70	30 minutes	EURO, 1997]
Tetrachloroethylene	1-5	Kidney effects in workers	102 (LOAEL)	400	250	24 hours	EURO, 1997
Toluene	5-150	Effects on CNS in workers	332 (LOAEL)	1 260	260	1 week	EURO, 1997
Toluene	5-150	Odour annoyance	n.a.	n.a.	1 000	30 minutes	EURO, 1997
Vanadium	0.05-0.2	Respiratory effects in workers	0.02 (LOAEL)	20	1	24 hours	EURO, 1987
Xylenes	1-100	CNS effects in human volunteers	304 (NOAEL)	60	4 800	24 hours	EHC 190,1997
Xylenes	1-100	Neurotoxicity in rats	870 (LOAEL)	1 000	870	1 year	EHC 190, 1997
Zylenes	1-100	Odour annoyance	n.a.	n.a.	4 000	30 minutes	EHC 190, 1997

ANNEX 2

Table 1. WHO air quality guidelines for carcingenic compounds

Compound	Annual ambient air concentration tion ($^{\mu}g/m^3$)	Health endpoint	Unit risk ($^{\mu}g/m^3)^{-3}$	IARC classification	Source
Acctaldehyde	5	Nasal tumours in rats	(1.5.9 x 10-7	2B	EHC 167, 1995
Acrylonitrile	0.01-10	Lung cancer in workers	2 x 10-3	2A	EURO, 1987
Araenic	(1-30), 10^{-3}	Lung cancer in exposure humans	1.5 x 10^{3}	1	EURO, 1997
Benzene	5.0-20.0	Leukenis in exposed workers	(4.4-7.5) x 10^{-6}	1	EURO, 1997
Chromium^{VI}	(5-200),10^{-3}	Lung cancer in exposed workers	(1.1-13) x 10^{-2}	1	EURO, 1997
Diesel exhaust	1.0-10.0	Lung cancer in rats	(16-7.1) x 10^{5}		EHC 171, 1996
Nickel	1-180	Lung cancer in exposed humans	3.8 x 10^{4}	1	EURO, 1997
PAH (BaP)	(1-10), 10^{3}	Lung cancer in exposed humans	8.7 x 10^{1}	1	EURO, 1997
Trichloreothylene	'1-10	Cell tumours in testes of rats	4.3 x 10^{-7}	2A	EURO, 1997
Vinychloride	0.1-10	emanglosarkoma in exposed workers Liver cancer in exposed workers	1x10-6	1	EURO, 1987

EURO, 1987, 1987 refers to the Air Quality Guidelines for Europe (WHO, 1987.

EHC 'n fefers to the WHO Environmental Health Criteria publication number n.