The Strategic Centre for Science, Technology and Innovation for Energy and Environment, CLEEN Ltd

Research Program

Measurement, Monitoring and Environmental Assessment (MMEA)

WP 4: Particles and Emissions

4.1. State of the Art and Future Trends

4.1.1. Environmental Legislation - Air Quality Monitoring

Air Quality Guidelines and Standards

Project Report

Virpi Tarvainen
Tuija Ruoho-Airola
Maija Parviainen

Finnish Meteorological Institute, Air Quality Research
Helsinki 06.04.2011

Contents

1 Introduction

This report presents an overview of air quality legislation and management systems in different countries. The study is focused on air quality standards, thus their application in e.g. air quality assessments or environmental impact assessments and permitting is not considered. Air quality measurement techniques are also outside the scope of the report.

In the following, the existing international recommendations and guidelines are introduced, and the national legislation in selected countries is surveyed, based on information available in literature and web site searches. Due to the time frame of the study and the limited resources, the countries included in the survey were mostly those for which information was readily available in English. Conclusions and recommendations for further studies are presented in the Summary.

2 International air quality objectives and guidelines

2.1 UNECE

The United Nations Economic Commission for Europe (UNECE) is one of the five regional commissions of the United Nations. Its region of influence covers 56 countries located in the European Union, non-EU Western and Eastern Europe, South-East Europe, Commonwealth of Independent States, and North America. In addition, over 70 international professional and other non-governmental organizations take part in its activities. UNECE seeks to advance pan-European economic integration by providing analysis, policy advice and assistance to governments. It promotes sustainable development through policy dialogue, negotiation of international legal instruments, development of regulations and norms, exchange and application of best practices, economic transition and technical expertise, as well as technical cooperation for countries with economies in transition. One of its sectors of expertise is environmental policy, where its aim is to reduce pollution in order to minimize environmental damage and avoid compromising environmental conditions for future generations. UNECE has negotiated five environmental treaties which address transboundary issues such as air pollution, environmental impact assessment, protection and use of watercourses and lakes, industrial accidents, and public participation.

As a result of active international collaboration to combat acidification one of the environmental treaties, the Convention on Long-range Transboundary Air Pollution (LRTAP) was signed in November 1979 in Geneva by 34 governments and the European Community (EC). It was the first international legally binding instrument to deal with problems of air pollution on a broad regional basis. The Convention lays down the general principles of international cooperation for air pollution abatement and sets up an institutional framework, bringing together research and policy. It has substantially contributed to the development of international environmental law and has created the essential framework for controlling and reducing the damage to human health and the environment caused by transboundary air pollution.

The Convention entered in force in 1983 and it currently has 51 Parties. It has been extended by eight protocols that identify specific measures to be taken by Parties to cut their emissions of air pollutants (Table 2.1).

The first Protocol of the Convention, the 1984 Geneva Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), which entered into force in 1988, established the EMEP monitoring programme as the backbone for review and assessment of air pollution in Europe. The main objectives of EMEP are:

- To provide observational and modelling data on air pollutant concentrations, deposition rates, emissions and transboundary fluxes on the regional scale and identify the trends in time;
- To identify the sources of the pollution concentrations and depositions and to assess the effects of changes in emissions;
- To improve our understanding of chemical and physical processes relevant to assessing the effects of air pollutants on ecosystems and human health in order to support the development of cost-effective abatement strategies;
- To explore the environmental concentrations of new chemical substances that might require the attention of the Convention in the future.

To fulfill its obligations EMEP collects emission data of relevant air pollutants, measures air and precipitation quality, and carries out modelling of atmospheric dispersion.The programme initially focused on assessing the transboundary transport of acidification and eutrophication. The scope of the programme has since been widened with the advance of scientific understanding on emerging air pollution issues, such as ground level ozone, persistent organic pollutants, heavy metals, and particulate matter. EMEP maintains a monitoring strategy, which is regularly reviewed, and the Parties are urged to make resources available for the full implementation of the strategy at national level within the geographic scope of EMEP. The monitoring requirements according to the EMEP monitoring strategy 2010-2019 are presented in Appendix A.

The most recent Protocol of the LRTAP Convention, the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, which entered into force in 2005, sets emission ceilings for 2010 for pollutants such as sulphur, NOx, VOCs and ammonia. It also sets tight limit values for specific emission sources (e.g. combustion plant, electricity production, and vehicles) and requires best available techniques to be used to keep emissions down.

Table 2.1: Protocols to the Convention on Long-range Transboundary Air Pollution.

Year	Protocol	Entry into force	Parties
1984	Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)	28 Jan 1988	43
1985	Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent	2 Sep 1987	25
1988	Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes	14 Feb 1991	34
1991	Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes	29 Sep 1997	24
1994	Protocol on Further Reduction of Sulphur Emissions	5 Aug 1998	29
1998	Protocol on Heavy Metals	29 Dec 2003	30
1998	Protocol on Persistent Organic Pollutants (POPs)	23 Oct 2003	30
1999	Protocol to Abate Acidification, Eutrophication and Ground-level Ozone	17 May 2005	26

Note: Information in this table is based on situation in January 2011. Up-to-date status of the Convention and its Protocols is available on the UNECE web pages (http://www.unece.org).

Currently, the Convention's priority activities include review and revision of its most recent protocols. The upcoming revisions will focus upon establishing new targets and including new pollutants in light of recent scientific findings. In the twenty-eight meeting of the Executive Body of the Convention in Geneva on 13-17 December 2010, decisions were made which will significantly expand the scope of the LRTAP Convention. For instance, black carbon, which is both an important air pollutant and a short-lived climate forcer, will be included in the revision of the Gothenburg Protocol as a component of particulate matter. The Convention will also investigate more closely tropospheric ozone and its precursors, including methane and carbon monoxide, which also act as greenhouse gases. The LRTAP Convention will thus become the first international agreement to tackle short-lived climate forcers in the context of air pollution on a policy level. The Convention aims at combating climate change, a global and long-term problem, on shorter time scales and through implementing abatement policies on a regional scale, first in Europe and Asia and then in other regions.

A second priority of LRTAP is the implementation of the Convention and its protocols across the entire UNECE region, with special focus on Eastern Europe, Caucasus and Central Asia (EECCA) and South-East Europe, and sharing its knowledge and information with other regions of the world. To advance this objective it has assessed the air quality monitoring networks in EECCA (ref. ECE/CEP/AC.10/2006/3) and prepared guidelines for developing national strategies to use air quality as an environmental policy tool which targets EECCA and South-East European countries (ref. ECE/CEP/2009/10).

Sources:

UNECE, http://www.unece.org (accessed January 2011).

EMEP, http://www.emep.int/ (accessed January 2011).

ECE/CEP/AC.10/2006/3, http://www.unece.org/env/documents/2006/ece/cep/ac.10/ece.cep.ac.10.2006.3.e.pdf (accessed January 2011).

ECE/CEP/2009/10, http://www.unece.org/env/documents/2009/ECE/CEP/ece.cep.2009.10.e.pdf (accessed January 2011).

2.2 WHO

The World Health Organization (WHO) was established in 1948 as a specialized agency of the United Nations (UN) serving as the directing and coordinating authority for international health matters and public health. The current membership of WHO comprises 193 countries and two associate members. WHO works together with other UN agencies, nongovernmental organizations, WHO collaborating centres, donors, and the private sector.

One of WHO's constitutional functions is to provide objective and reliable information and advice in the field of human health. To fulfill this obligation the WHO experts produce health guidelines and standards, helping countries to address public health issues. WHO also supports and promotes health research. Today WHO's work on environmental health provides the basis for global standards in environmental quality.

Clean air has been in the focus of WMO activities for more than 50 years. As a result of these activities, the first edition of the WHO Air Quality Guidelines for Europe (WHO 1987) was published in 1987. It comprised health risk evaluations for 28 pollutants. The aim of the Guidelines was to provide a basis for protecting public health from adverse effects of air pollutants, to eliminate or reduce exposure to hazardous air pollutants, and to guide national and local authorities in their risk management decisions. Although health effects were the major consideration in establishing the Guidelines, ecologically based Guidelines for preventing adverse effects on terrestrial vegetation were also considered, and guideline values for the protection of vegetation from nitrogen- and sulphur oxides and ozone were established. The guideline values for the evaluated 28 pollutants are presented in Appendix B.

The Guidelines were eagerly adopted by authorities and applied widely in environmental decisionmaking in the European region as well as in other parts of the world. After ten years, the Guidelines were updated and revised on the basis of new scientific data and new developments in risk assessment. In the revision process, health risks of 35 pollutants were considered (Table 2.2). The revised guidelines were accepted in 1997, and the Second Edition of WHO Air Quality Guidelines for Europe (WHO 2000) was published in 2000. The guideline values are presented in Appendix C.

During the preparation of the Second Edition, the Directorate-General for Environment, Nuclear Safety and Civil Protection (DGXI) of the European Commission developed the Air Quality

Table 2.2: Pollutants evaluated for the Air Quality Guidelines for Europe, Second edition (WHO 2000).

Organic air pollutants	Inorganic air pollutants
Acrylonitrile**	Arsenic*
Benzene*	Asbestos**
Butadiene	Cadmium*
Carbon disulfide**	Chromium*
Carbon monoxide*	Fluoride
1,2-Dichloroethane**	Hydrogen sulfide**
Dichloromethane*	Lead*
Formaldehyde*	Manganese*
Polycyclic aromatic hydrocarbons (PAHs)*	Mercury*
Polychlorinated biphenyls (PCBs)	Nickel*
Polychlorinated dibenzodioxins and dibenzofurans (PCDDs/PCDFs)	Platinum
Styrene*	Vanadium**
Tetrachloroethylene*	
Toluene*	
Trichloroethylene*	
Vinyl chloride**	
Classical air pollutants	**Indoor air pollutants**
Nitrogen dioxide§	Environmental tobacco smoke
Ozone and other photochemical oxidants*	Man-made vitreous fibres
Particulate matter*	Radon
Sulfur dioxide§§	

* included in the 1987 Guidelines, re-evaluated in the Second Edition
** included in the 1987 Guidelines, not re-evaluated in the Second edition
§ 1987 Guideline for nitrogen oxides
§§ 1987 Guideline for sulfur oxides

Framework Directive (Directive 96/62/EC) and several Daughter Directives for individual pollutants. It was agreed with the Commission that the final drafts of the revised WHO guideline documents would provide a starting point for discussions by the Commission's working groups aiming at setting legally binding limit values for air quality in the European Union.

In 2006, after careful considerations of the latest scientific findings, WHO published its first global air quality guidelines (WHO 2005), presenting revised values for the four most common air pollutants – particulate matter, ozone, nitrogen dioxide and sulfur dioxide (Table 2.3). For all other pollutants, the conclusions presented in the Second Edition of Air Quality Guidelines for Europe (WHO 2000) remained in effect.

Key findings in the Air Quality Guidelines, Global Update 2005 were:

- There are serious risks to health from exposure to PM and O3 in many cities of developed and developing countries. It is possible to derive a quantitative relationship between the pollution levels and specific health outcomes (increased mortality or morbidity). This allows invaluable insights into the health improvements that could be expected if air pollution is reduced.

Table 2.3: Air Quality Guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide according to the WHO Global Update 2005 (Krzyzanowski and Cohen, 2008).

Pollutant	**Averaging time**	**Guideline value ($\mu g\ m^{-3}$)**
Particulate matter $PM_{2.5}$	1 year	10
	24 h (99th percentile)	25
Particulate matter PM_{10}	1 year	20
	24 h (99th percentile)	50
Ozone O_3	8 h, daily maximum	100
Nitrogen dioxide NO_2	1 year	40
	1 h	200
Sulfur dioxide SO_2	24 h	20
	10 min	500

- Even relatively low concentrations of air pollutants have been related to a range of adverse health effects.
- Poor indoor air quality may pose a risk to the health of over half of the world's population. In homes where biomass fuels and coal are used for cooking and heating, PM levels may be 10–50 times higher than the guideline values.
- Significant reduction of exposure to air pollution can be achieved through lowering the concentrations of several of the most common air pollutants emitted during the combustion of fossil fuels. Such measures will also reduce greenhouse gases and contribute to the mitigation of global warming.

As with the previous update, the recommendations of the Global Update played a role in the revision of European air quality legislation and the preparation of the CAFÉ Directive (Directive 2008/50/EC) which replaced the Air Quality Framework Directive and its three Daughter Directives (1999/30/EC, 2000/69/EC, and 2002/3/EC) in 2008.

In addition to guideline values, interim targets are given for levels of PM, ozone and sulfur dioxide. These are proposed as incremental steps in a progressive reduction of air pollution, and are intended for use in areas where pollution is high. These targets aim to promote a shift from high air pollutant concentrations, with acute and serious health consequences, to lower concentrations. If these targets were to be achieved, one could expect significant reductions in risks for acute and chronic health effects from air pollution. Progress towards the guideline values should, however, be the ultimate objective of air quality management and health risk reduction in all areas. The interim targets are presented in Tables 2.4(a-c).

Table 2.4: Air quality guidelines and interim targets for particulate matter (a), ozone (b) and sulfur dioxide (c).

(a) Particulate matter

Annual mean level	**PM_{10} (μg m^{-3})**	**$PM_{2.5}$ (μg m^{-3})**	**Basis for the selected level**
WHO interim target 1 (IT-1)	70	35	These levels are estimated to be associated with about 15% higher long-term mortality than at AQG levels.
WHO interim target 2 (IT-2)	50	25	In addition to other health benefits, these levels lower risk of premature mortality by approximately 6% (2–11%) compared to IT-1.
WHO interim target 3 (IT-3)	30	15	In addition to other health benefits, these levels reduce mortality risk by approximately another 6% (2–11%) compared to IT-2 levels.
WHO AQ Guidelines	20	10	These are the lowest levels at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to PM2.5 in the ACS study (323). The use of the PM2.5 guideline is preferred.
24-hour mean level [a]	**PM_{10} (μg m^{-3})**	**$PM_{2.5}$ (μg m^{-3})**	**Basis for the selected level**
WHO interim target 1 (IT-1)	150	75	Based on published risk coefficients from multicentre studies and meta-analyses (about 5% increase in short-term mortality over AQG)
WHO interim target 2 (IT-2)	100	50	Based on published risk coefficients from multicentre studies and meta-analyses (about 2.5% increase in short-term mortality over AQG)
WHO interim target 3 (IT-3) [b]	75	37.5	About 1.2% increase in short-term mortality over AQG
WHO AQ Guidelines	50	25	Based on relation between 24-hour and annual PM levels

[a] 99th percentile (3 days/year).

[b] For management purposes, based on annual average guideline values, the precise number to be determined on the basis of local frequency distribution of daily means.

(b) Ozone

	Daily maximum 8-hour mean (μg m^{-3})	**Effects at the selected ozone level**
High level	240	Significant health effects; substantial proportion of vulnerable population affected.
WHO interim target 1 (IT-1)	160	Important health effects; an intermediate target for populations with ozone concentrations above this level. Does not provide adequate protection of public health.
WHO AQ Guideline	100	This concentration will provide adequate protection of public health, though some health effects may occur below this level.

(c) Sulfur dioxide

	24-hour average (μg m^{-3})	**10-min average (μg m^{-3})**
WHO interim target 1 (IT-1) (2000 guideline level)	125	-
WHO interim target 2 (IT-2)	50 Intermediate goal based on controlling either (a) motor vehicle (b) industrial emissions and/or (c) power production; this would be a reasonable and feasible goal to be achieved within a few years for some developing countries and lead to significant health improvements that would justify further improvements (such as aiming for the guideline).	-
WHO AQ guidelines	20	500

Sources:

http://www.who.int/ (accessed January 2011)

WHO 1987. Air quality guidelines for Europe. Copenhagen, World Health Organization Regional Office for Europe, 1987 (WHO Regional Publications, European Series, No. 23)

WHO 2000. Air quality guidelines for Europe, 2nd ed. Copenhagen, World Health Organization Regional Office for Europe, 2000 (WHO Regional Publications, European Series, No. 91)

WHO 2005. WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global update 2005, World Health Organization 2006.

Krzyzanowski M. and Cohen, A., Update of WHO air quality guidelines. Air Quality and Atmospheric Health 1:7-13, 2008. DOI 10.1007/s11869-008-0008-9.

3 European Union

Since the early 1970s, the European Union (EU) has been working to improve air quality by controlling emissions of harmful substances into the atmosphere, improving fuel quality, and by integrating environmental protection requirements into the transport and energy sectors. Over recent decades, EU has introduced and implemented various legal instruments aiming at the harmonization of air quality management in the Member States. Limit and target values have been set for for several air pollutants which are to be achieved by a certain period of time. The standards are regularly reviewed and updated, usually resulting in stricter standards.

The EU air quality management regime started in 1980 with Directive 80/779/EEC, which set air quality limit values and guide values for SO2 and suspended particulates (SP). This relatively late date in comparison with legislation in some other countries is explained by the evolution of the EU itself. The European Economic Community formed in 1956 only began to take specific actions with respect to environmental protection in the early 1970s, and in fact did not get a constitutional basis for acts with respect to environmental protection until the 1986 Single European Act, signed in Luxembourg and The Hague in July 1987. In the meantime, a number of Member States had already taken steps towards setting up national air quality management systems. Part of the challenge for the EU has therefore been to harmonize not only the European AQ standards, but also the national systems in place for assessing and monitoring AQ.

The 1996 Air Quality Framework Directive (96/62/EC), its four Daughter Directives and related Council Decisions (Table 3.1) were aimed at establishing this harmonized structure for assessing and managing AQ throughout the EU. The Daughter Directives set limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter, lead, benzene, carbon monoxide, ozone,

Table 3.1. EU air quality legislation under the 1996 Air Quality Framework Directive (96/62/EC).

Council Directive 96/62/EC on ambient air quality assessment and management	Air Quality Framework Directive, replaced by the CAFÉ directive
Council Directive 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air	First Daughter Directive, replaced by the CAFÉ directive
Directive 2000/69/EC of the European Parliament and of the Council relating to limit values for benzene and carbon monoxide in ambient air	Second Daughter Directive, replaced by the CAFÉ directive
Directive 2002/3/EC of the European Parliament and of the Council relating to ozone in ambient air	Third Daughter Directive, replaced by the CAFÉ directive
Directive 2004/107/EC of the European Parliament and of the Council relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air	Fourth Daughter Directive
Council Decision 97/101/EC establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States	EoI Decision, replaced by the CAFÉ directive
Commission Decision 2004/461/EC laying down a questionnaire for annual reporting on ambient air quality assessment under Council Directives 96/62/EC and 1999/30/EC and under Directives 2000/69/EC and 2002/3/EC of the European Parliament and of the Council	
Commission Decision 2004/224/EC laying down the obligation of Member States to submit within two years so-called Plans and Programmes for those air quality zones where certain assessment thresholds set in the Directives are exceeded.	

arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons (PAHs) in ambient air. The new limit values were developed concurrently with the revision of the WHO Air Quality Guidelines for Europe, and the revised recommendations were taken into account when drafting the Daughter Directives. In addition to the Directives, a Council Decision (EoI Decision, 97/101/EC) established a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States.

Within the EU AQ management framework, the Member States were given considerable discretion to determine what actions to take in order to achieve the AQ standards within their territories. However, the Member States were at the same time obliged to implement the other EU-level measures that comprise the overall EU air quality management system. These included controls over stationary sources of polluting emissions to air, such as large combustion plants, industrial installations, and facilities using solvents. Other EU-level measures aim to reduce emissions from mobile sources, such as road traffic, and include technical requirements to limit air emissions from various types of motor vehicles as well as fuel quality standards. Finally, the NEC Directive establishes national emissions ceilings for SO2, NOx, VOCs and NH3.

The Sixth Environment Action Programme (6th EAP) of EU, running from 2002 to 2012, aims to achieve levels of air quality that do not result in unacceptable impacts on, and risks to, human health and the environment. The Clean Air for Europe (CAFÉ) programme which was established

Table 3.2. EU air quality standards ([1]).

Pollutant	Protecting	Period of analysis	Value	Status
Nitrogen dioxide (NO_2)	Human health	Annual mean	40 $\mu g\ m^{-3}$	Limit value; valid from 2010
	Human health	Hourly mean; exceedances may occur for a maximum of 18 hours per year	200 $\mu g\ m^{-3}$	Limit value; valid from 2010
Nitrogen oxides (NO_X)	Vegetation	Annual mean	30 $\mu g\ m^{-3}$	Critical level
Particulate matter (PM_{10})	Human health	Annual mean	40 $\mu g\ m^{-3}$	Limit value; valid since 2005
	Human health	Daily mean; exceedances may occur for a maximum of 35 days per year	50 $\mu g\ m^{-3}$	Limit value; valid since 2005
Particulate matter ($PM_{2.5}$)	Human health	Annual mean	25 $\mu g\ m^{-3}$	Target value, to be reached in 2010; limit value, enters into force in 2015
	Human health	Annual mean	20 $\mu g\ m^{-3}$	Indicative limit value; valid from 2020, to be reviewed by the Commission in 2013
Ozone (O_3)	Human health	Maximum daily 8 hour mean; exceedances may occur for a maximum of 25 days per calendar year, averaged over three years	120 $\mu g\ m^{-3}$	Target value; to be reached in 2010
	Vegetation	AOT40, accumulated over May to July, averaged over five years	18 000 ($\mu g\ m^{-3}$)·h	Target value; to be reached in 2010
Sulphur dioxide (SO_2)	Human health	Hourly mean; exceedances may occur for a maximum of 24 hours per calendar year	350 $\mu g\ m^{-3}$	Limit value; valid since 2005
	Human health	Daily mean; exceedances may occur for a maximum of 3 days per calendar year	125 $\mu g\ m^{-3}$	Limit value; valid since 2005
	Vegetation	Annual / Winter (1 October to 31 March) mean	20 $\mu g\ m^{-3}$	Critical level
Benzene	Human health	Annual mean	5 $\mu g\ m^{-3}$	Limit value; valid from 2010
Carbon monoxide (CO)	Human health	Maximum daily 8 hour mean	10 $mg\ m^{-3}$	Limit value; valid since 2005
Lead (Pb)	Human health	Annual mean	0.5 $\mu g\ m^{-3}$	Limit value; valid since 2005
Arsenic (As)	Human health	Annual mean; for the total content in the PM_{10} fraction	6 $ng\ m^{-3}$	Target value; to be reached in 2013
Cadmium (Cd)	Human health	Annual mean; for the total content in the PM_{10} fraction	5 $ng\ m^{-3}$	Target value; to be reached in 2013
Nickel (Ni)	Human health	Annual mean; for the total content in the PM_{10} fraction	20 $ng\ m^{-3}$	Target value; to be reached in 2013
Benzo(a)pyrene (as a marker for the carcinogenic risk of PAHs)	Human health	Annual mean; for the total content in the PM_{10} fraction	1 $ng\ m^{-3}$	Target value; to be reached in 2013

([1])For specific conditions and notes, see Appendix D.

Table 3.3: EU alert thresholds for sulphur dioxide and nitrogen dioxide (a) and information and alert thresholds for ozone (b).

(a)

Pollutant	Alert threshold ([1])
Sulphur dioxide	500 $\mu g\ m^{-3}$
Nitrogen dioxide	400 $\mu g\ m^{-3}$

([1]) To be measured over three consecutive hours at locations representative of air quality over at least 100 km^2 or an entire zone or agglomeration, whichever is the smaller.

(b)

Purpose	Averaging period	Threshold
Ozone information	1 hour	180 $\mu g\ m^{-3}$
Ozone alert	1 hour ([1])	240 $\mu g\ m^{-3}$

([1]) For the implementation of short-term action plans (Article 24 of the CAFÉ Directive) the exceedance of the threshold is to be measured or predicted for three consecutive hours.

under the 6th EAP and launched in March 2001, provided long-term, strategic and integrated policy advice concerning air pollution. Following on from the work carried out under the CAFÉ Programme, the Commission set new targets for reducing certain pollutants (SO2, NOx, VOCs, ammonia and PM2.5). To supplement legislation, it also established a Thematic Strategy on Air Pollution which sets out ambitious but cost-effective objectives and measures for European air quality policy to 2020. The Thematic Strategy was adopted in September 2005.

3.1 EU air quality standards

EU's new air quality directive, the Directive on Ambient Air Quality and Cleaner Air for Europe (CAFÉ Directive, 2008/50/EC), was one of the key measures in place to address air pollution under the Thematic Strategy on Air Pollution. Similarly to the Air Quality Framework Directive and its Daughter Directives, the preparatory work leading to the CAFÉ Directive was carried out in concert with the concomitant development of the Global Update of the WHO Air Quality Guidelines. The CAFÉ Directive was the first EU directive to include air quality objectives for ambient concentrations of PM2.5 (fine particles). It also consolidated most of existing air quality legislation (except the Fourth Daughter Directive) into a single directive. The directive entered into force on 11 June 2008. A summary of the existing limit and target values according to the CAFÉ Directive and the Fourth Daughter Directive is presented in Table 3.2. Information and alert thresholds are given in Tables 3.3(a-b).

Table 3.4. EU air quality limit (a) and target (b) values, data quality objectives, reference methods, and EN standard methods according to *Guide to the demonstration of equivalence of ambient air monitoring methods, Report, EC Working Group on Guidance for the Demonstration of Equivalence, January 2010*.

(a)

Compound	**Limit value ($\mu g\ m^{-3}$)**	**Reference period**	**Data quality objective**		**Principles of reference method as specified by Directives**	**EN standard method**
			Expanded uncertainty (%)	**Data capture (%)**		
Sulphur dioxide	350	1 h	15	90	Ultraviolet-fluorescence	EN 14212
	125	24 h	15	90		
	20	1 y	15	90		
Nitrogen oxides	200 (NO_2)	1 h	15	90	Chemiluminescence	EN 14211
	40 (NO_2)	1 y	15	90		
	30 (NO_X)	1 y	15	90		
Carbon monoxide	10 000	8 h	15	90	Non-dispersive infrared spectrometry	EN 14626
Benzene	5	1 y	25	90	Pumped sampling + analysis by gas chromatography	EN 14662 parts 1-3
PM_{10}	50	24 h	25	90	PM_{10} reference sampler (EN 12341)	EN 12341
	40	1 y	25	90		
Lead	0.5	1 y	25	90	PM_{10} reference sampler + analysis by atomic spectrometry	EN 14902
$PM_{2.5}$	25 (per 1/1/2015)	1 y	25		$PM_{2.5}$ reference sampler (EN14907)	EN 14907

(b)

Compound	**Target value ($\mu g\ m^{-3}$)**	**Reference period**	**Data quality objective**		**Principles of reference method as specified by Directives**	**EN standard method**
			Expanded uncertainty (%)	**Data capture (%)**		
Ozone	120	8 h	15	90/75	Ultraviolet photometry	EN 14625
Benzo[a]-pyrene	0.001	1 y	50	90	PM_{10} reference sampler + analysis by liquid chromatography-fluorescence or gas chromatography-mass spectrometry	EN 15549
Arsenic Cadmium Nickel	0.006 0.005 0.020	1 y	40	90	PM_{10} reference sampler + analysis by atomic absorption spectrometry or inductively-coupled plasma –mass spectrometry.	EN 14902
$PM_{2.5}$	25 (per 1/1/2010)	1 y	25		$PM_{2.5}$ reference sampler (EN 14907)	EN 14907

Notes:

1. Limit/target values are in $\mu g\ m^{-3}$ unless otherwise stated, expressed at 20 °C and 101.3 kPa for gases and vapours; for PM, metals and benzo[a]pyrene they are expressed at ambient conditions.
2. The expanded uncertainty is defined at the 95% confidence level.
3. The uncertainty of the reference method, which is derived for a shorter averaging period used during laboratory and field validation trials, appliles to the longer averaging times specified in the directives (CR 14377).

3.1.1 Reference methods and data quality objectives

One of the objectives of the European legislation on ambient air quality is to “assess the ambient air quality in Member States on the basis of common methods and criteria”. Thus, in addition to limit and target values the air quality directives also specify the reference methods to be used for the measurement of the concentrations of the air pollutants and data quality objectives that have to be met in the measurements. These data quality objectives include minimum requirements for:

- expanded uncertainties of measurement results in the region of the limit or target value(s) set for each pollutant
- time coverage of the measurements in relation to the reference period of the limit or target values
- data capture when using the measurement method, i.e., effective measurement time.

When implementing the directives a Member State should use the reference methods. However, the directives also allow a Member State to use any other method which it can demonstrate gives results equivalent to the reference method.

The reference methods and data quality objectives for the limit and target values specified in the CAFÉ Directive and the Fourth Daughter Directive are presented in Table 3.4(a-b).

Sources:

Assessment of the Effectiveness of European Air Quality Policies and Measures, Case study 2, Comparison of the EU and US Air Quality Standards & Planning Requirements, 4 October 2004. (http://ec.europa.eu/environment/archives/cafe/activities/pdf/case_study2.pdf, accessed January 2011)

CAFÉ Directive 2008/50/EC. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDFEEA (accessed January 2011).

Report No 8/2010, Impact of selected policy measures on Europe's air quality, ISSN 1725-2237, European Environment Agency.

The Sixth Environment Action Programme of the European Community 2002–2012. (http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:242:0001:0015:EN:PDF, accessed January 2011)

Guide to the demonstration of equivalence of ambient air monitoring methods, Report, EC Working Group on Guidance for the Demonstration of Equivalence, January 2010.

http://europa.eu/legislation_summaries/environment/air_pollution/l28159_en.htm (accessed January 2011)

http://europa.eu/legislation_summaries/environment/air_pollution/index_en.htm (accessed January 2011)

http://ec.europa.eu/environment/air/index_en.htm (accessed January 2011)

http://ec.europa.eu/environment/air/legis.htm (accessed January 2011)

http://ec.europa.eu/environment/air/quality/standards.htm (accessed January 2011)

http://ec.europa.eu/environment/policyreview.htm (accessed January 2011)

3.2 Finland

Finland has incorporated the EU Air Quality Directives into national legislation. Most recently, the CAFÉ Directive was implemented in January 2011 when the Government Decree on Air Quality (38/2011) entered into force on January 25th. The Fourth Daughter Directive was implemented in February 2007 with a Government Decree (164/2007). The limit and target values of pollutant concentrations, as well as the critical levels and information and alert thresholds in effect in Finland thus correspond to the EU air quality standards presented above in Tables (3.2) and (3.3). The only exception is the EU target value for the annual mean PM2.5 concentration which was immediately set as a limit value in the Air Quality Decree (38/2011) while according to the CAFÉ Directive it would only enter into force in 2015.

In addition to the EU standards, Finland has set national guideline values for certain pollutants (Government Decision 480/1996). The guideline values are nonbinding and their main objective is to steer environmental decision making in order to maintain good air quality and prevent significant deterioration. The guideline values must be taken into account e.g. in land use and traffic planning and the environmental permitting of activities that cause emissions. The Finnish national air quality guideline values are presented in Table 3.5. In addition to the guideline concentrations, for the protection of ecosystems the long term target value of sulphur deposition is 300 mg m^{-2} a^{-1}.

Sources:

Government Decree on Air Quality, 38/2011 (in Finnish).

Government Decree on arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons, 164/2007 (in Finnish).

Government Decision on air quality guidelines and target value for sulphur deposition, 480/1996 (in Finnish).

Table 3.5. Finnish national air quality guideline values.

Pollutant	Period of analysis	Guideline value (20°C, 1 atm)	Statistical definition
Carbon monoxide (CO)	Hourly mean	20 mg m^{-3}	Hourly mean
	8 hour mean	8 mg m^{-3}	Moving average
Nitrogen dioxide (NO_2)	Hourly mean	150 $\mu g\ m^{-3}$	99. percentile monthly
	Daily mean	70 $\mu g\ m^{-3}$	Second largest daily mean monthly
Sulphur dioxide (SO_2)	Hourly mean	250 $\mu g\ m^{-3}$	99. percentile monthly
	Daily mean	80 $\mu g\ m^{-3}$	Second largest daily mean monthly
Total suspended particles (TSP)	Daily mean	120 $\mu g\ m^{-3}$	98. percentile annually
	Annual mean	50 $\mu g\ m^{-3}$	Annual mean
Particulate matter (PM_{10})	Daily mean	70 $\mu g\ m^{-3}$	Second largest daily mean monthly
Total reduced sulphur (TRS)	Daily mean	10 $\mu g\ m^{-3}$	Second largest daily mean monthly (expressed as sulphur)

4 North America

4.1 USA

The air quality management system (AQM) in the United States is federally mandated. Laws related to the environment are included in federal legislation (the United States Code). As the health, ecological, and economic impacts of air pollution in the United States have become more and more evident through sophisticated scientific approaches, the nation has endeavored to protect air quality through increasingly complex and ambitious legislation. The main steps towards current legislation are presented in Table 4.1.

The federal government's first major efforts towards cleaner air began in 1955 with the Air Pollution Control Act. These efforts were enhanced over the next 15 years through a series of enactments, including the Clean Air Act (CAA) of 1963. In 1970, two landmark events took place that helped to establish the basic framework by which air quality is managed in the United States. These events were the creation of the U.S. Environmental Protection Agency (EPA) and the passage of the CAA Amendments of 1970. This framework was further developed and refined with the passage of the CAA Amendments of 1977 and 1990.

The passage of the 1990 amendments marked an overall change in the federal approach to air pollution. The new legislation placed renewed emphasis on controlling emissions of hazardous air pollutants (HAPs) and introduced efforts aimed at controlling acid rain and ozone depletion in the

Table 4.1: Federal Air Quality Management Legislation in the United States (according to Air quality management in the United States, NRC 2004).

Date	**Legislation**	**Authorization**
1955	Air Pollution Control Act	Provided funds to local and state agencies for research and training
1959	Air Pollution Control Act Extension	Extended the 1955 act
1960	Motor Vehicle Exhaust Study	Authorized the Public Health Service (PHS) to study automotive emissions and health
1962	Air Pollution Control Act Extension	Extended 1955 act and required PHS to include auto emissions in their program
1963	Clean Air Act	Research at the federal level, aid to states for training, federal authority to abate interstate pollution, matching grants to local/state agencies for air pollution control
1965	Motor Vehicle Air Pollution Control Act	National standards for auto emissions, coordinated pollution control between United States, Canada, and Mexico, research into SO_2 and auto emissions
1967	Air Quality Act	Air quality control regions (AQCRs), air quality criteria, control technology documents, state implementation plans (SIPs), separate automotive emission standards for California
President Nixon (1970) created the Environmental Protection Agency (EPA) by Executive Order		
1970	Clean Air Act Amendments	National ambient air quality standards (NAAQS), SIPs to achieve NAAQS by 1975, new source performance standards (NSPS), national emission standards for hazardous air pollutants (NESHAP), aircraft emission standards to be developed by EPA, automotive emission standards for hydrocarbons and CO for 1975 models and for NO_x for 1976 models, states allowed to adopt air quality standards more stringent than federal standards, motor vehicle emissions inspection and maintenance (I/M) program, citizens allowed to sue for air pollution violations
1977	Clean Air Act Amendments	Geographic regions (Classes I, II, III) to preserve air quality, EPA-sanctioned emission offsets and emission banking within nonattainment regions, state permits that require prevention of significant deterioration (PSD) studies, lowest-achievable emission rate (LAER) in nonattainment regions, delayed auto emission standards set in 1970 Clean Air Act Amendments, section 169A declared a national goal of preventing and remedying visibility impairment due to anthropogenic pollution in mandatory Class I areas
1990	Clean Air Act Amendments	*Title I: Nonattainment regions* Nonattainment regions for ozone are ranked in terms of pollution severity; each has a deadline to achieve NAAQS. New and amended NAAQS must be attained in 5 years with a possible extension for another 5 years. **Classification (applicable only to ozone nonattainment areas)** — **Years to achieve NAAQS** Marginal — 3 Moderate — 6 Serious — 9 Severe — 15 (17 with a 1988 design value between 0.190 and 0.280 ppm) Extreme (Los Angeles) — 20 *Title II: Mobile sources* Gasoline reformulation toward lower toxic and VOC generation by 1997, reduction in 1990 NO_x emissions standards for light-duty vehicles (LDVs) by 60% beginning in 1994, reduction in 1990 hydrocarbons emissions standards for LDVs by 40% beginning in 1994, introduction of cold temperature (20°F) CO emissions standards set at 10 g/mile beginning in 1994, “Clean car” (ZEV, electric car) pilot program in California 150,000 vehicles by model year 1996 300,000 vehicles by model year 1999.

		Title III: Toxics Emissions of 189 hazardous air pollutants (HAPs) controlled[a] mass ≥ 10 tons/yr for a specific HAP mass ≥ 25 tons/yr for a combination of HAPs EPA-approved maximum achievable control technology (MACT) mandated. After 8 years, EPA must promulgate more stringent standards to address residual risks where necessary. *Title IV: Acid rain (Electricity Generation Facilities)* NOx: cut emissions by 2.0 × 106 tons/yr. SO2: by 2000, reduce to 9.2 × 106 tons/yr (U.S. total); by 2010, reduce to 8.9 × 106 tons/yr (U.S. total) Phase I (beginning 1995): 110 large power plants, Phase II (beginning 2000): remaining units. Policy: market-based "cap and trade" rather than "command and control". If a utility reduces SO2 emissions below its emissions "allowance," the utility can sell its extra "allowance" to another utility. *Title V: Permits* New and existing major sources must secure permits, duration ≤ 5 yr. Fees to sustain state air pollution control agencies. *Title VI: Stratospheric ozone* Phase out chlorofluorocarbons, halons, and carbon tetrachloride by 2000. Phase out methylchloroform (CH3CCl3) by 2002. Phase out hydrochlorofluorocarbons by 2030. *Title VII: Enforcement* Larger penalties. [a]Since the passage of the 1990 CAA Amendments, the list of hazardous pollutants has been modified, see http://www.epa.gov/ttn/atw/orig189.html.

atmosphere. Five major goals for protecting and promoting human health and public welfare are identified in the CAA as amended:

- Mitigating potentially harmful human and ecosystem exposure to six criteria pollutants;
- Limiting the sources of and risks from exposure to air toxics;
- Protecting and improving visibility impairment in wilderness areas and national parks;
- Reducing the emissions of species that cause acid rain, specifically SO2 and NOx;
- Curbing the use of chemicals that have the potential to deplete the stratospheric O3 layer.

The CAA prescribes a complicated set of responsibilities and relationships among federal, states, tribal, and local agencies. The federal government coordinates efforts through EPA and sets national air quality standards and approaches to pollution mitigation so that it can provide a basic level of environmental protection to all individuals in the U.S. State and local governments then develop, implement, and enforce specific strategies and control measures to achieve the national standards and goals. Although many aspects of the AQM system assume a collaborative relationship between the federal, state, and local agencies, the CAA empowers EPA to oversee the activities carried out by these agencies. In addition, the federal courts also have a role in AQM – final agency rules promulgated under the CAA are subject to judicial review and any citizen may file a civil action against EPA.

The CAA addresses two major categories of pollutants for which standards are set differently: criteria pollutants and hazardous air pollutants. Criteria pollutants are those in the ambient air that originated from diverse mobile or stationary sources, whereas HAPs are not specifically defined except that they cannot be criteria pollutants. In general, criteria pollutants occur over a large geographic area and have greater impacts on the general population and ecosystems than HAPs. Therefore, criteria pollutants are regulated primarily through the setting of ambient air concentration and time standards, i.e. NAAQS, and attaining these standards. Primary standards were set to protect public health, especially with an adequate margin of safety for most sensitive populations including asthmatics, children, and the elderly. Secondary standards were set to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

In addition to specifying a maximum ambient concentration, NAAQS included descriptions of monitoring and statistical methods used to determine whether an area is in compliance with the standard. Primary standards were to be achieved by individually designated deadlines, and EPA was authorized to enforce pertinent states to meet those deadlines. Secondary standards, however, were not specified with either deadlines or enforcement authority.

The CAA requires EPA to conduct a review of the air quality criteria and NAAQS for each pollutant at least every 5 years. It is a fairly complex process that involves input and comment from independent scientific bodies and the general public. Since the first set of NAAQS that were established in 1971, the list and definitions of criteria pollutants have evolved. The current six criteria pollutants are: carbon monoxide (CO), nitrogen dioxide (NO2), sulfur oxides (SOx), ozone (O3), particulate matter (PM2.5 and PM10), and lead (Pb). Details of the current standards are provided in Table 4.2. Some criteria pollutants are also further classified based on the severity of the pollution.

Sources:

EPA, http://www.epa.gov/ (accessed January 2011)

Assessment of the Effectiveness of European Air Quality Policies and Measures, Case study 2, Comparison of the EU and US Air Quality Standards & Planning Requirements, 4 October 2004.

Table 4.2. The National Ambient Air Quality Standards (NAAQS) of USA (http://www.epa.gov/air/criteria.html).

Pollutant	Primary Standards		Secondary Standards	
	Level	**Averaging time**	**Level**	**Averaging time**
Carbon monoxide	9 ppm (10 mg m^{-3})	8-hour (1)	None	
	35 ppm (40 mg m^{-3})	1-hour (1)		
Lead	0.15 $\mu g\ m^{-3}$ (2)	Rolling 3-month average	Same as Primary	
	1.5 $\mu g\ m^{-3}$	Quarterly average	Same as Primary	
Nitrogen dioxide	53 ppb (3)	Annual (Arithmetic Average)	Same as Primary	
	100 ppb	1-hour (4)	None	
Particulate matter (PM_{10})	150 $\mu g\ m^{-3}$	24-hour (5)	Same as Primary	
Particulate matter ($PM_{2.5}$)	15.0 $\mu g\ m^{-3}$	Annual (6) (Arithmetic Average)	Same as Primary	
	35 $\mu g\ m^{-3}$	24-hour (7)	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour (8)	Same as Primary	
	0.08 ppm (1997 std)	8-hour (9)	Same as Primary	
	0.12 ppm	1-hour (10)	Same as Primary	
Sulfur dioxide	0.03 ppm	Annual (Arithmetic Average)	0.5 ppm	3-hour (1)
	0.14 ppm	24-hour (1)		
	75 ppb (11)	1-hour	None	

(1) Not to be exceeded more than once per year.
(2) Final rule signed October 15, 2008.
(3) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard
(4) To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).
(5) Not to be exceeded more than once per year on average over 3 years.
(6) To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m3.
(7) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).
(8) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)
(9) (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(c) EPA is in the process of reconsidering these standards (set in March 2008).
(10) (a) EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard ("anti-backsliding").
(b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ 1.
(11) (a) Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

(http://ec.europa.eu/environment/archives/cafe/activities/pdf/case_study2.pdf, accessed January 2011)

http://epa.gov/oar/caa/caa_history.html (accessed January 2011)

Air Quality Management in the United States, National Research Council, 2004. The National Academies Press, Washington, D.C., 426 pp.

EPA, Air Pollution Orientation Course, http://www.epa.gov/apti/course422/index.html.(accessed January 2011)

5 Eastern Europe

Over recent years the European Union has been the principal driving force in raising environmental standards across the wider European region. Within the borders of the Union and beyond, EU environmental norms and standards have proved the benchmark which neighbouring countries are trying to reach.

Russia and the other eastern neighbour countries have worked with the European Commission to raise levels of environmental protection. These countries share a legacy of environmental problems from the past, as well as new pressures as they return to economic growth. These include low energy efficiency, the poor state of environmental infrastructure, unsustainable exploitation of natural resources, and air pollution. Environmental legislation is being modernised and public participation and awareness of environmental challenges is being increased.

Environmental co-operation between EU and the eastern neighbour countries has developed mainly through the Partnership and Co-operation Agreements (PCA) and sub-committees as well as via the Technical Aid to the Commonwealth of Independent States (Tacis) programme, replaced in 2007 by the European Neighbourhood and Partnership Instrument (ENPI). EU has also carried out environmental dialogue with individual countries, such as the Harmonisation of Environmental Standards II (HES II) project.

Since its foundation in 1991, the “Environment for Europe” (EfE) Process has brought together member States within the UNECE region, organizations of the United Nations system represented in the region, other intergovernmental organizations, regional environment centres, non-governmental organizations, the private sector and other major groups to discuss, decide and join efforts in addressing environmental priorities across the 56 countries of the UNECE region. In the Kiev (Ukraine) Ministerial Conference on 21-23 May, 2003, the countries of Eastern Europe, Caucasus and Central Asia (EECCA - Armenia, Belarus, Georgia, Kyrgyzstan, Republic of Moldova, Russian Federation, Ukraine and Uzbekistan) and South-Eastern Europe became the focus of a special effort to raise their environmental standards towards a common regional standard.

UNECE carries out Environmental Performance Reviews (EPR) in its South-East European, Caucasus and Central Asian member States. The review practice is a useful tool for helping these countries upgrade their environment in line with the pan-European objectives of the EfE process. The UNECE Committee on Environmental Policy (CEP) has been involved with the evaluation of air quality monitoring networks and national air protection strategies in the EECCA countries, preparing assessment reports, recommendations and guideline documents for the further development of their environmental management systems. For example, a Workshop on Enterprise Monitoring and Reporting was organised in Poland in September 2006. Based on the workshop results, the UNECE Working Group on Environmental Monitoring and Assessment prepared guidelines to EECCA authorities on strengthening environmental monitoring and reporting by enterprises which were adopted by the Sixth Ministerial Conference of EfE held in Belgrade, Serbia on 10-12 October, 2007 (ECE/CEP, 2007).

Sources:

http://ec.europa.eu/environment/enlarg/russianis_en.htm (accessed February 2011).

http://eeas.europa.eu/delegations/russia/eu_russia/tech_financial_cooperation/index_en.htm (accessed February 2011).

PCA, http://europa.eu/legislation_summaries/external_relations/relations_with_third_countries/eastern_europe_and_central_asia/r17002_en.htm (accessed February 2011).

Tacis, http://europa.eu/legislation_summaries/external_relations/relations_with_third_countries/eastern_europe_and_central_asia/r17003_en.htm (accessed February 2011).

ENPI, http://europa.eu/legislation_summaries/external_relations/relations_with_third_countries/eastern_europe_and_central_asia/r17101_en.htm (accessed February 2011).

HES II: http://www.ippc-russia.org/content/id/en/1.html (accessed February 2011).

EfE: http://www.unece.org/env/efe/welcome.html (accessed February 2011).

ECE/CEP, 2007: http://www.unece.org/env/documents/2007/ece/ece.belgrade.conf.2007.11.add.2.e.pdf (accessed February 2011).

5.1 Russia

According to Bridges and Bridges (1995) the former Soviet Union (USSR) presented itself as the first country in the world to establish hygiene (i.e. health) –based norms for air quality. Some of these were introduced already in the 1930s. In 1960, USSR adopted an Environmental Protection Law, as a result of an initiative of five states of which Russia was one (Bridges and Bridges, 1995).

Specific proposals for regulatory air quality were first introduced in 1973, eventually leading to the Air Quality Control Act in 1980.

Building from this inheritance, air quality regulations in the Russian Federation have been further elaborated to correspond with the guidelines and standards of WHO and EU. Article 9 of the 1993 Constitution of the Russian Federation stated that ‘the environment should be protected as a basis for the healthy life and work of the community’. Article 42 provides the right of the citizen to ‘reliable information on the state of the environment and for compensation of any harm to health or property through “ecocrime”’ (i.e. damage to the environment) (Bridges and Bridges, 1995). The current air quality legislation of the Russian Federation is based on the Federal Law on the Sanitary-Epidemiological Welfare of Population of March 30, 1999, N 52-FZ. The most recent air quality law is the Federal Law on Atmospheric Air Protection of May 4, 1999, N 96-FZ (amended several times). It establishes the legal framework for air protection and seeks to implement the constitutional rights of citizens to a healthy environment and reliable information about its condition. It is aimed at the protection of both human health and the environment from the adverse effects of air pollution. The basic principles and instruments include:

- Protection of human life and the health of present and future generations
- Prevention of irreversible effects of air pollution on the environment
- Technical emission standards and limit values for stationary and mobile emission sources
- Permitting procedures, fuel requirements, and pollution fees
- Sanctions for violation of the requirements of air protection legislation
- Rights of the citizens, legal persons and public associations to information on air quality and participation in air protection

The air quality standards of the Russian Federation are enforced via hygienic regulations (GN) as maximum permissible concentrations (MPC), sometimes also called maximum allowable concentrations (MAC). Two types of air quality standards are in effect for the ambient air of populated areas, comparable to the standards of EU and WHO (Mosecomonitoring, 2010; www.mosecom.ru):

- Short-term (20 minutes) maximum permissible concentration (MPC_{mp}), which should guarantee that there will be no acute reactions and no impact on human health in case of short-term exposure,

  and

- daily maximum permissible concentration (MPC_{ad}), which should guarantee that there will be no harmful effect on human health in case of long-term (lifelong) exposure.

Table 5.1: Ambient air quality standards for selected compounds in the Russian Federation.

Compound	Maximum short-term concentration MPC_{mp} (μg m^{-3})	Maximum daily average concentration MPC_{ad} (μg m^{-3})	Annual average concentration (μg m^{-3})
Carbon monoxide CO	5 000	3 000	
Nitrogen dioxide NO2	200	40	
Sulfur dioxide SO2	500	50	
Ozone O3	160	30	
Benzene	300	100	
Particulate matter PM10	300	60*	40
Particulate matter PM2.5	160	35*	25

* 99. percentile.

In addition, there are separate standards for air in working areas (MPC_{wa}) (HES II, 2008). The current standards are given in hygienic regulations GN 2.1.6.1338-03 (Maximum permissible concentration (MPC) of pollutants in the air of populated areas) and GN 2.2.5.1314-03 (Tentative safe exposure levels (TSEL) for pollutants in the air of working zone, later superceded by GN 2.2.5.2308-07). GN 2.1.6.1338-03 established ambient air quality standards for over 600 substances and prohibited the emission of over 40 substances. These standards are regularly evaluated against new scientific evidence, and revised accordingly. The revision is enacted by adopting new hygienic regulations as amendments of the original documents (HES II, 2008). To date, the standards for ambient air in populated areas have been amended 8 times, with the most recent amendment (GN 2.1.6.2604-10) in 2010 setting MPC-values and annual average concentrations for PM_{10} and $PM_{2.5}$. The current air quality standards in the Russian Federation for some common air pollutants in ambient air in populated areas are presented in Table 5.1.

References:

*Bridges and Bridges, 1995. Comparison of air quality in the UK and Russia, The Environmentalist, **15**, 139-146.*

Federal Law on the Sanitary-Epidemiological Welfare of Population of March 30, 1999, N 52-FZ, http://rospotrebnadzor.ru/documen/zakon (accessed February, 2011).

Federal Law on Atmospheric Air Protection of May 4, 1999, N 96-FZ, http://base.garant.ru/12115550/ (accessed February, 2011).

GN 2.1.6.1338-03, http://www.dioxin.ru/doc/gn2.1.6.1338-03.htm (accessed February, 2011).

GN 2.1.6.1338-03 (amended), http://www.mhts.ru/BIBLIO/SNIPS/gigien-normy/2.1.6.1338-03/2.1.6.1338-03.htm (accessed February, 2011).

GN 2.1.6.2604-10, http://89.rospotrebnadzor.ru/documents/ros/28308/ (accessed February 2011).

HES II, 2008. Harmonization of Environmental Standards II, Interim Technical report, Cluster 10, Environmental Quality Standards: 10.3 Setting Standards fort Ambient Air Quality and Emissions. EU-Russia Program of Cooperation, European Communities. http://www.ippc-russia.org/public/cluster10/10-3_Air_EQS_ELV_EN.pdf (accessed February 2011).

Mosecomonitoring, 2010. State Environmental Institution "Mosecomonitoring" under the Department for Nature Use and Environmental Protection of Moscow City Government: Air quality monitoring in Moscow, WHO Newsletter 46. http://www.umweltbundesamt.de/whocc/archiv/NL-46.pdf (accessed February, 2011).

www.mosecom.ru (accessed February, 2011).

5.2 Other EECCA countries

According to a review report prepared for the sixth session of the UNECE Working Group on Environmental Monitoring and Assessment (ECE/CEP, 2006) the air quality management in the the countries of Eastern Europe, Caucasus and Central Asia (EECCA countries) is based on the enforcement of the maximum permissible concentration (MPC or MAC) and tentative safe exposure level (TSEL) system developed during the former Soviet Union. Unfortunately, in many cases the existing standards also still date back to the norms established in the 1970s or 1980s. However, some EECCA countries – among them Russia, as discussed above – have already updated and supplemented these standards, or are in the process of doing so.

According to sanitary and hygienic requirements in the EECCA countries, single-interval (20 minutes) and computed daily average values are the basic toxicity measurements of substance concentrations in the air. To define a pollution level in urban areas, these values are compared with the corresponding maximum allowable concentrations for the substance. Most EECCA countries use MACs and TSELs established by the Ministry of Health of the former USSR 30–40 years ago. These standards are only health-based and do not take into consideration the protection of ecosystems and amenities.

EECCA standards are generally more stringent than the international ones, but they are also more basic. For example, many Western countries set different standards for different sizes of particulate matter (e.g. PM10 and PM2.5), while most EECCA countries use the concept of total suspended particulates (TSP). Similarly, many standards for air pollutants in non-EECCA countries differ according to length of exposure (e.g. 1 hour, 3 and 8 hours, and annually), whereas EECCA standards are based on 20 minutes length of measurements and 24-hour averages.

In its tenth session the Working Group prepared 'Guidelines for developing national strategies to use air quality monitoring as an environmental policy tool' (ECE/CEP, 2009). The aim of the Guidelines was to help countries of Eastern Europe, Caucasus, Central Asia and South-Eastern Europe make air quality monitoring a practical tool for environmental policy, especially for target-setting, for the development of pollution abatements strategies and for assessing progress in achieving policy targets and the effectiveness of abatement measures. The guidelines were presented to the UNECE Committee on Environmental Policy at its sixteenth session in Geneva in October 2009.

According to the Guidelines, the current air quality standards should be updated or discontinued and new ones set by the central-level competent authority responsible for the coordination of national air quality assessment and management systems. The WHO Air Quality Guidelines values may be taken into consideration when revising and setting new air quality standards. Nevertheless, as certain WHO values (especially annual mean values for PM_{10} and $PM_{2.5}$) are hardly achievable for many countries, it is recommended that the target countries consider the approach that has been developed and implemented either in the EU or in the United States of America.

In the first phase, the assessment of an existing set of national air quality standards should be carried out to decide which ones should remain in place (taking into account their role in permitting procedures like environmental expertise and setting emission limits) and which ones should be updated and or replaced. It is recommended to divide air pollutants among three categories: priority pollutants, important pollutants and other pollutants.

In the second phase, selected air quality standards should be introduced or updated for priority pollutants: mainly PM (PM_{10} in any case), ground-level ozone, SO_2 and NO_2. New or revised standards for other pollutants – CO, lead and benzene – could be added if found appropriate. It is also recommended that alert thresholds for sulphur dioxide, nitrogen dioxide and ground-level ozone and information threshold for ozone be introduced.

In the third phase, new or revised standards for important pollutants – $PM_{2.5}$ (if not introduced earlier), heavy metals (As, Cd and Ni) and PAHs (benzo(a)pyrene) – could be added depending on their impact on air quality in particular target country and limit values for the protection of vegetation (secondary standards) could be introduced as well, if not in place. Existing standards (MACs) for other pollutants could be either cancelled or retained, if considered necessary by a particular country, with respect to permitting procedures.

References:

ECE/CEP, 2006:
http://www.unece.org/env/documents/2006/ece/cep/ac.10/ece.cep.ac.10.2006.3.e.pdf (accessed February 2011).

ECE/CEP, 2009:
http://www.unece.org/env/documents/2009/ECE/CEP/ece.cep.2009.10.e.pdf (accessed February 2011).

UNECE Working Group on Environmental Monitoring and Assessment:
http://www.unece.org/env/europe/monitoring/past_mtgs.html (accessed February 2011).

6 Asia

The Clean Air Initiative for Asian Cities, the CAI-Asia Center is a registered Non-governmental organization (NGO) with a goal to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors. CAI-Asia's projects and activities aim to integrate air quality management, climate change mitigation, clean energy and sustainable transport into policies and programs of developing countries. CAI-Asia was established in 2001 by ADB (Asian Development Bank), the World Bank and USAID (United States Agency for International Development). Since 2007, CAI-Asia is a registered UN Type II Partnership with almost 200 organizational members, eight Country Networks, and the CAI-Asia Center as its secretariat. CAI-Asia is guided by a Partnership Council of five members representing CAI-Asia's organizational members: cities, government, NGOs/academia, private sector, and development agencies.

In 2010 CAI-Asia has reviewed and reported air quality data for 234 Asian cities, and information about air quality standards in Asian countries in cooperation with UNEP and WHO (CAI-Asia 2009; CAI-Asia 2010). Table 1 published in the report (CAI-Asia 2010) collects the air quality standards from 19 Asian countries (Table 6.1). Most of the CAI-Asia countries have already adopted national air quality standards for PM_{10}, SO_2, NO_2, O_3, CO and Pb in particles. For $PM_{2.5}$, only four of the countries have a standard. Nonetheless, there are a number of Asian countries still without national Ambient Air Quality Standards (NAAQS) — Afghanistan, Bhutan, Lao People's Democratic Republic (PDR) and Pakistan (Table 6.1). There is currently no information whether these countries are planning to adopt NAAQS in the near future (CAI-Asia 2010).

Several countries have plans to develop or review their air quality standards. According to China Daily, China is considering more stringent appraisal standards for air quality, and pilot projects are likely to start from coastal cities in the Yangtze River delta and Pearl River delta (CAI-Asia 2009). Environmental authorities are planning to include particles less than 2.5 microns ($PM_{2.5}$) and ozone, into the Air pollution Index (API), which currently measures concentration of sulfur dioxide, nitrogen dioxide and PM_{10}, or particles smaller than 10 microns (CAI-Asia 2009).

According to an enquiry by the CAI-Asia of plans to revise the standards within the next two years, several countries had plans for review. In the report published in November 2009, the following were listed in Table 2 (CAI-Asia 2009). Cambodia had ambition to develop air quality standards, but they have indicated that they need technical assistance and financial support for this. In Nepal, the ambient air quality standards are currently undergoing review and the Ministry of Environment Science and Technology has indicated that the standards will be revised and updated soon. Republic of Korea indicated that there are no concrete plans to revise the standards, but the areas for air quality standards development include: establishment of $PM_{2.5}$ standards, standardization of air quality measurement tools and cost benefit analysis of establishing ambient air quality standards.

Table 6.1: Summary of Ambient Air Quality Standards in Select Asian Countries (μg/m3, except mg/m3 for CO). Source CAI-Asia 2010; for further information see Appendix E.

Countries	PM 2.5		PM 10		SO2		NO2		O3		CO		Pb
	24-Hr	Year	24-Hr	Year	24-Hr	Year	24-Hr	Year	1-Hr	8-Hr	1-Hr	8-Hr	Year
Afganistan	-	-	-	-	-	-	-	-	-	-	-	-	-
Bangladesh	65	15	150	50	365	80	-	100	235	157	40	10	0.5
Bhutan	-	-	-	-	-	-	-	-	-	-	-	-	-
Cambodia	-	-	-	-	300	100	100	-	200	-	40	20	-
China: Grade I	-	-	50	40	50	20	80	40	160	-	10	-	1
China: Grade II	-	-	150	100	150	60	120	80	200	-	10	-	1
China, Grade III	-	-	250	150	250	100	120	80	200	-	20	-	1
Hong Kong SAR	-	-	180	55	350	80	150	80	240	-	30	10	-
India*	60	40	100	60	80	50	80	40	180	100	4	2	0.5
India**	60	40	100	60	80	20	80	30	180	100	4	2	0.5
Indonesia	-	-	150	-	365	60	150	100	235	-	30	-	1
Lao PDR	-	-	-	-	-	-	-	-	-	-	-	-	-
Malaysta	-	-	150	50	105	-	10	-	200	120	35	10	-
Mongolia	-	-	-	-	30	-	40	-	120	0	-	-	-
Nepal	-	-	120	-	70	50	80	40	-	-	-	10	0.5
Pakistan	-	-	-	-	-	-	-	-	-	-	-	-	-
Philippines	-	-	150	60	180	80	150	-	140	60	35	10	1
Republic of Korea	-	-	100	50	131	52	113	56	196	118	28.6	10.3	0.5
Singapore	35	15	150	-	365	80	-	100	-	147	40	10	-
Sri Lanka	50	25	100	50	80	-	100	-	200	-	30	10	-
Thailand	-	-	120	50	300	100	-	-	200	140	34.2	10.3	-
Viet Nam	-	-	150	50	125	50	-	40	-	120	30	10	0.5

China: Grade 1 = applies to specially protected areas, such as natural conservation areas, scenic spots, and historical sites;
China: Grade II = applies to residential areas, mixed commercial/residential areas, cultural, industrial, and rural areas;
China: Grade III = special industrial areas;
India* = NAAQS for Industrial, Residential, Rural and Other Areas;
India** = NAAQS for Ecologically Sensitive Areas (notified by Central Government);
SAR = Special Administrative Region;
PDR = People's Democratic Republic;

Sri Lanka indicated that there are no current plans for revise within 2 years, but there are plans to develop ambient air standards for lead (Pb). However, prior to ambient Pb standard formulation, a survey in ten major cities in Sri Lanka will first be conducted by Central Environmental Authority. They may need financial support to conduct this study. In Thailand, plans were to establish annual average standard for NO_2 in 2009 and ambient $PM_{2.5}$ standards were being developed. Finally in Vietnam, the NAAQS were revised in 2010 into the National Technical Regulation on Ambient Air Quality making compliance mandatory.

In the CAI-Asia report published in 2010, further revisions were reported. The Hong Kong Special Administrative Region (SAR) is also currently undergoing review of their Air Quality Objectives (AQO) (CAI-Asia 2010). Thailand has also concrete plans to develop a standard for $PM_{2.5}$ in the next couple of years (CAI-Asia 2010).

CAI-Asia compares the national standards for the WHO AQG levels, partly also for the US EPA levels. Most of the national standards lie behind these levels. In the recommendations, the countries are encouraged to move their air quality standards towards achieving the WHO guidelines, either directly or step wise via the WHO interim targets (CAI-Asia 2010).

Sources:

CAI-Asia 2009. Ambient air quality standards in Asia, Survey report (http://cleanairinitiative.org/portal/system/files/AQ_Standards_Report_Draft_2_Dec_FINAL.pdf, accessed February 2011).

CAI-Asia 2010. Air Quality in Asia: Status and Trends, 2010 Edition (http://cleanairinitiative.org/portal/system/files/Air_Quality_in_Asia_-_Status_and_Trends_2010_Ed._0.pdf, accessed February 2011).

6.1 China

The Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution was adopted in August 29, 1995. The last amendment was effective in September 1, 2000 (APPCL 2000).

According to the law, the local people's governments at various levels shall be responsible for the quality of the atmospheric environment under their own jurisdictions, making plans and taking measures to make the quality of the atmospheric environment under their own jurisdictions meet the prescribed standard. State air pollution health standards (Table 6.2) were established in regulations GB3095_1996 (1996 and 2001).

China has established three kinds of air quality standards:

- Level I standards apply to “nature reserves, resorts, and other areas in need of special protection”,
- Level II standards apply to “residential areas, mixed commercial and residential areas, culture areas, normal industrial areas designated by the urban zoning plan, as well as rural areas”, and
- Level III standards apply to “industrial areas”.

Law of the People’s Republic of China on Environmental Impact Assessment is the guiding regulation on prevention and control of pollutions of the construction projects from the designing stage to the daily operation stage (EIA LAW 2003). Besides these laws, China has disseminated laws of prevention and control on air pollution.

Table 6.2: Air Pollution Health Standards in China*.

Pollutant		Averaging time	Level I**	Level II***	Level III****
PM10	μg/m3	Day	50	150	250
		Year	40	100	150
PM2.5	μg/m3	Day	—	—	—
		Year	—	—	—
Sulfur Dioxide	μg/m3	Hour	150	500	700
		Day	50	150	250
		Year	20	60	100
Nitrogen Dioxide	μg/m3	Hour	120	240	240
		Day	80	120	120
		Year	40	80	80
Carbon Monoxide	mg/m3	1-hour	10	10	20
		8-hour	—	—	—
		Day	4	4	6
Ozone	μg/m3	1-hour	160	200	200
		8-hour	—	—	—
Lead	μg/m3	Rolling 3-mo average	—	—	—
		Quarterly average	1.5	1.5	1.5
		Year	1.0	1.0	1.0

*According to GB3095-1996 (1996) [text in Chinese] and GB3095-1996 [text in Chinese] (2001).
**Level I standards apply to "nature reserves, resorts, and other areas in need of special protection."
***Level II standards apply to "residential areas, mixed commercial and residential areas, culture areas, normal industrial areas designated by the urban zoning plan, as well as rural areas."
****Level III standards apply to "industrial areas."

The people's governments of provinces, autonomous regions and municipalities directly under the Central Government may establish their local standards for items not specified in the national standards for atmospheric environment quality. According to a recent comprehensive report on the environmental legislation in China (Finpro 2008a), the Chinese government has enacted more than 30 administrative decrees regarding environmental protection. In addition, departments concerned have also issued a number of administrative rules and decrees on environmental protection. To implement the state's environmental protection laws and regulations, people's congresses and people's governments at local levels, proceeding from specific conditions in their own areas, have enacted and promulgated more than 600 local laws on environmental protection.

Regulations and standards are also available for the monitoring of the air. In 2008, came into effect technical requirements and test procedures for ambient air sampler HJ/T 375-2007 and HJ/T 376-2007 for automatic continuous testing of SO2, NOX and other harmful substances. The standard applies to samplers suited to ambient air sampling. (Finpro 2008a)

Environmental standards are an important component of China's environmental statutory framework. They include environmental quality standards, pollutant discharge or emission standards, basic environmental criteria, criteria for samples, and criteria for methodology. As stipulated in Chinese law, the environmental quality standards and pollutant discharge standards are compulsory standards, and those who violate these compulsory environmental standards must bear the corresponding legal responsibility. (Finpro 2008a)

Finpro (Finpro, 2008a) assessed the Chinese air pollution legislation more like ‘policy statements and propositions of ideals’ rather than laws. Recognizing this, Chinese leadership strove to create more specific legislation, resulting in stricter environmental statutes such as the amendments to the Air Pollution Prevention and Control Law in 2000 (APPCL 2000) and the Environmental Impact Assessment Law enacted in 2002 (EIA Law 2003). However, weak language continues to plague legislation due to a practice of enacting so-called ‘policy laws’: laws that do not set out specific requirements but rather outline general policies.

According to the law, the need for an environmental impact statement is required for new industrial activity. “An environmental impact statement on construction projects shall include an assessment of the atmospheric pollution the project is likely to produce and its impact on the ecosystem, stipulate the preventive and curative measures. The statement shall be submitted, according to the specified procedure, to the administrative department of environmental protection concerned for examination and approval. When a construction project is to be put into operation or to use, its facilities for the prevention of atmospheric pollution must be checked and accepted by the administrative department of environmental protection. Construction projects that do not fulfill the requirements specified in the State regulations concerning environmental protection for such construction projects shall not be permitted to begin operation or to use.” (APPCL 2000.)

The monitoring of air quality is the task of the authority. “The administrative department of environmental protection under the State Council shall set up a monitoring system for atmospheric pollution, organize a monitoring network and work out unified monitoring measures.” (APPCL 2000.)

However, in the Law of the People’s Republic of China on Environmental Impact Assessment, it is stated that the report of the environmental impacts of a construction project shall include e.g suggestions for carrying out environmental monitoring over the construction project. (EIA Law 2003)

The air quality of the locality is connected with the production plans if the standards are not met. “With regard to the regions not meeting the prescribed standards for the quality of atmospheric environment and the acid rain control areas and the sulfur dioxide pollution control areas designated as such with the approval of the State Council, the State Council or the people's government of provinces, autonomous regions and municipalities directly under the Central Government may delimit them as the major areas for the total emission control air pollutants. The concrete measures for the State Council shall prescribe the total emission control of major air pollutants.” (APPCL 2000.)

An open policy against the public is evident in the law: “The administrative department of environmental protection under the people's governments of large and medium-sized cities shall regularly publish reports on the quality of the atmospheric environment and gradually introduce the system of forecasting the quality of atmospheric environment. A report on the quality of the atmospheric environment shall include such contents as the characteristics of urban atmospheric pollution, the types of major pollutants and the extent of harm caused by the pollution.” Also FinPro reports about openness in the air quality data: “China pays great attention to supervision exercised by the people and media over law-breaking activities regarding the environment - it has opened channels for the masses of people to report on environmental problems and adopted measures for the media to expose environmental lawbreaking activities.” (Finpro 2008a)

Finpro (Finpro 2008a) foresees that China will speed up the amendment and improvement of existing laws, regulations and standards and fill the law gap. China will also improve technical specification and environmental standard system, identify environmental limits in a scientific way and encourage more stringent local emission standards. With active cooperation with legal department, the authority and effectiveness of environmental law enforcement will be ensured through legal means. Further, the “11th Five-Year Plan” environmental targets and tasks will be fragmented to local government at all levels that will carry out their own target. China will set up an examination mechanism on environmental management performance and mainstream environmental protection into the economic and social development evaluation system. It will identify scientific assessment indicators and integrate them into the comprehensive evaluation system for the performance of party and government officials.

In November 2008, China’s Ministry of Environmental Protection (MEP) invited a number of U.S. air pollution experts to a workshop in Beijing to discuss the proposed amendment of China’s Atmospheric Pollution Prevention and Control Law and lessons that might be learned from the U.S. air pollution regulatory system, the 1970 U.S. Clean Air Act and the Clean Air Act’s subsequent amendments. A report about the current legislation and administration in China as well as detailed proposals from US experts for amendment of law and administration was published (Natural Resources Defense Council, 2009). Below is a summary of the major conclusions from the report concerning the monitoring of air quality.

Expert recommendations: National Ambient Air Quality Standards

China has established a system of national atmospheric environmental quality standards, but has faced challenges in achieving implementation. Moreover, China's recent efforts to focus on the environmental health impacts of pollution are not reflected in the current Air Pollution Law, with certain pollutants left out of the scope of regulation and monitoring and only limited mention of health considerations in the law's text.

- Health-based Ambient Standards. Make China's national ambient environmental quality standards explicitly health-based; i.e., based strictly on scientific information on the effects of pollutants on public health and environmental quality. Ensure that the major air pollutants that impact human health are within the scope of regulation. Require monitoring and reporting of concentrations of all of these major pollutants in the outdoor air.
- Prioritize Achievement of Ambient Standards. Elevate and clarify the importance of ambient standards in the law to ensure that they receive as much focus as Total Emissions Control targets.
- Establish Clear Consequences for Non-compliance. Establish clear consequences, such as the use of regional project approval limitations, with stronger central authority in order to improve enforcement.
- Public Participation. Provide for an appropriate scope of public participation in the standard setting process to strengthen the scientific basis and public acceptance of ambient air quality standards.

Expert recommendations: Combining Air Quality Standards with Total Emissions Control (TEC)

- China should maintain a strong focus on meeting ambient air quality standards, even as it pushes forward to implement emissions-driven programs.

Expert recommendations: State Implementation Plan Process

- Air Quality Planning. China should develop regional, provincial and/or municipal planning systems akin to SIPs for the purpose of attaining ambient standards. Greater planning specifically focused on how jurisdictions can meet air quality targets is essential to improved air quality.
- Strengthening Monitoring and Reporting. Accurate and timely monitoring and reporting are critical to the effective implementation of air pollution plans. Funding and human resources devoted to monitoring and reporting, as well as penalties for cheating on monitoring and reporting, must be increased substantially.

References:

APPCL 2000. Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution 2000. (http://www.npc.gov.cn/englishnpc/Law/2007-12/12/content_1383930.htm, accessed March 2011).

Finpro 2008a. Echo Liu (Ed.), Environmental Legislation in China (Mainland), Finpro Shanghai, 2008, 84 pp. (http://www.teknologiateollisuus.fi/fi/materiaalipankki/?categoryHeader=4, accessed March 2011).

EIA Law 2003. Law of the People's Republic of China on the Environmental Impact Assessment 2003. (http://www.chinaenvironmentallaw.com/, accessed March 2011)

Natural Resources Defense Council, 2009. Amending China's Air Pollution Prevention and Control Law: Recommendations from the International Experience. (http://china.nrdc.org/AirLawAmendment, accessed March 2011)

Clean Air Initiative for Asian Cities Center, 2010. Air Quality in Asia: Status and Trends, 2010 edition. (http://cleanairinitiative.org/portal/system/files/Air_Quality_in_Asia_-_Status_and_Trends_2010_Ed._0.pdf, accessed March 2011).

6.1.1 Hong Kong and Macao

Hong Kong and Macao are high degree autonomy areas of China with their own environmental legislation. This summary of their air quality standards in is mainly based on a comprehensive overview report "Environmental Legislation in Hong Kong and Macao", compiled by Finpro (Finpro 2008b).

The main legislative instruments on air and noise pollution in Hong Kong are as follows:

Air Pollution Control Ordinance (APCO) (Cap.311): This is the principal law for managing air quality in Hong Kong. Regulations cover specific areas related to air pollution, such as power plant emissions, motor vehicle fuel types and vehicle emissions, asbestos control and industrial emissions. This ordinance gives Environmental Protection Department of the Government of the Hong Kong the power to control air pollution originating from industry sources, commercial operations and construction work.

Ozone Layer Protection Ordinance (Cap.403): This ordinance controls the production, recycling, import and export of products containing ozone-depleting substances. These regulations are a response to Hong Kong's international obligations in the area.

The status of VOCs (Volatile Organic Compounds) has also been addressed in recent government regulation as they play a big role in causing smog and reducing visibility. The new Air Pollution Control Regulation, effective from April 2007, controls and imposes maximum limits on the VOC emissions from architectural paints/coatings, printing inks and six selected consumer products.

Table 6.3. Air quality standards in Hong Kong.

Component	Concentration in µg/m^3 (i)				
	Averaging time				
	1 hour (ii)	8 hours (iii)	24 hours (iii)	3 months (iv)	1 year (iv)
SO_2	800		350		80
Total suspended particulates			260		80
Respirable Suspended Particulates (v)			180		55
NO_2	300		150		80
CO	30 000	10 000			
Photochemical Oxidants (as ozone) (vi)	240				
Pb				1.5	

(i) Measured at 298 K(25°C) and 101.325 kPa (one atmosphere)
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres or smaller.
(vi) Photochemical oxidants are determined by measurement of ozone only.

The Environmental Protection Department coordinates the Environmental Standards and Guidelines set by the Hong Kong government. The Standards and Guidelines are divided into statutory and non-statutory. The difference between the two types of Standards and Guidelines should not, however, be taken as a difference between mandatory and voluntary measures. Some of the non-statutory standards for example give an explanatory note saying that the compliance or non-compliance of the non-statutory standards might affect the granting of licences. Thus in practice, while the non-statutory standards are not “hard regulation” per se, the owner of a restaurant, housing estate or waste treatment plant for example might nonetheless have to follow them in order to be granted a licence to operate their business.

Air Quality Objectives for seven widespread air pollutants were established in 1987 under the Air Pollution Control Ordinance, based on international standards as model solutions for air quality management. The present standards were published in the Hong Kong Government Gazette in 1994 (Table 6.3).

In 2006, a proposal for the amendment of the Hong Kong air quality objectives was published (ACE/2006). The need to monitor small particles (PM2.5) was justified against regulations in the EU, USA and WHO.

In Macao, the Meteorological and Geophysical Bureau of Macao monitors and analyses local air quality through the 24-hour operation of road side, high density residential area and ambient automatic monitoring stations.

The main legislative instruments in Macao relating to air pollution control are:

- Decree no. 62/95/M. Aims to control and reduce ozone layer pollution
- Administrative regulation 28/2004. Protects public areas from littering and general polluting activities

Sources:

FinPro 2008b. Environmental Legislation in Hong Kong and Macao. Finpro, 2008, 36 pp. (http://www.teknologiateollisuus.fi/fi/materiaalipankki/?categoryHeader=4. (accessed March 2011)

Guide to the Environmental Impact Assessment Ordinance, http://www.epd.gov.hk/eia. (accessed December 2010).

Hong Kong, existing air quality objectives, http://www.epd-asg.gov.hk/english/backgd/hkaqo.html. (accessed December 2010).

Special supplement nr 5 to the Hong Kong Government Gazette, published by authority, 24.6.1994. http://www.epd.gov.hk/epd/english/envir_standards/files/apgn8e.pdf. (accessed December 2010).

6.2 India

This summary of air quality standards in India is mainly based on a comprehensive overview report "Environmental legislation in India", compiled by Finpro (Finpro 2008c).

India has adopted almost all environmental protection acts and rules enforced in developed countries. There are around 30 acts and rules related to environment. The laws are in place, but the enforcement mechanisms are very weak. The awareness on conservation of the environment is also very low: Even educated people do not see the connection between their actions and the environmental degradation. The Indian Constitution provides necessary directives and powers for framing and enforcing environmental legislation. The Ministry of Environment and Forests, the Central Pollution Control Board and State Pollution Control Boards (SPCBs) form the regulatory and administrative core. (Finpro, 2008c)

The Bureau of Indian Standards is responsible for formulating and enforcing standards for 14 sectors. On average, it takes between 12 and 28 months to issue a new standard or harmonize an existing national standard with an international one. Some standards are fast tracked and developed within 12 months to meet industry demands. Standards are also reviewed and updated on a regular basis; reviews generally take place at least once in five years. (Finpro, 2008c)

Table 6.4: Air quality standards in India (The Gazette of India Extraordinary, November 18, 2009; see Appendix F).

Pollutant	Time Weighted Average	Concentration in Ambient Air		
		Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
Sulphur Dioxide (SO_2), µg/m3	Annual * 24 hours **	50 80	20 80	Improved West and Gaeke; Ultraviolet fluorescence
Nitrogen Dioxide (NO_2), µg/m3	Annual * 24 hours **	40 80	30 80	Modified Jacob & Hoch-heiser (Na-Arsenite); Chemiluminescence
Particulate Matter (size less than 10 µm) or PM10 µg/m3	Annual * 24 hours **	60 100	60 100	Gravimetric; TOEM; Beta attenuation
Particulate Matter (size less than 2.5 µm) or PM2.5 µg/m3	Annual * 24 hours **	40 60	40 60	Gravimetric; TOEM; Beta attenuation
Ozone (O_3) µg/m3	8 hours ** 1 hour **	100 180	100 180	UV photometric; Chemiluminescence; Chemical Method
Lead (Pb) µg/m3	Annual * 24 hours **	0.50 1.0	0.50 1.0	AAS/IPC method after sampling on EPM 2000 or equivalent filter paper; ED-XRF using Teflon filter
Carbon Monoxide (CO) mg/m3	8 hours ** 1 hour **	2 4	2 4	Non Dispersive Infra Red (NDIR) spectroscopy
Ammonia (NH_3) µg/m3	Annual * 24 hours **	100 400	100 400	Chemiluminescence; Indophenol blue method
Benzene (C_6H_6) µg/m3	Annual *	5	5	Gas chromatography based continuous analyzer; Adsorption and Desorption followed by GC analysis
Benzo(a)Pyrene (BaP) - particulate phase only, ng/m3	Annual *	1	1	Solvent extraction followed by HPLC/GC analysis
Arsenic (As), ng/m3	Annual *	6	6	AAS/IPC method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m3	Annual *	20	20	AAS/IPC method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98 % of the time in a year. 2 % of the time, they may exceed the limits but not on two consecutive days of monitoring.

Standard formulation in India is a continuous process. The entire list of current and proposed standards is comprehensive and sector / industry specific. The standards can be found on the web site of the Central Pollution Control Board at http://www.cpcb.nic.in/ under 'Environmental Standard' (Finpro 2008c).

The national ambient air quality standards in India were reviewed very recently, in 2009. Now the standards cover limit values for SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3, Pb, CO, NH_3, benzene, benzo(a)pyrene, As and Ni. The notification of the Central Pollution Control Board (CPCB 2009) also lists methods allowed for measuring the concentrations. The standards are presented in Table 6.4. For some of the components, the recipient area has been divided into an ecologically sensitive area and other area that covers industrial, residential, rural and other area. The ecologically sensitive area is notified by Central Government and has lower limit values. If any of the standard values is exceeded on two consecutive days of monitoring, further investigation is needed.

Environmental Impact Assessment has been and will continue to be the principal methodology for appraising and reviewing new projects. It is an environmental clearance that must be delivered to either national level or state level authorities in case of practically every new project; expansion and modernization of an existing project; or change in product mix in an existing manufacturing unit. It is also mandatory for large industries to submit annual Environmental statement which later on could be extended into environmental audit (Finpro, 2008c).

The Ministry of Environment and Forests with its regional offices and representatives – usually SPCBs – carry out random field visits to collect samples and data on the environmental performance of the cleared projects. In cases of inadequate compliance, the issue is taken up with the concerned State governments and nodal ministries. Due to lacking environmental performance, some production plants have been shut down by the government officials (Finpro, 2008c).

Sources:

Central Pollution Control Board (CPCB) http://www.cpcb.nic.in/ (accessed March 2011).

CPCB 2009. National ambient air quality standards, Central pollution control board. Gazette of India, Extraordinary, Part III, Section 4.
(http://www.cpcb.nic.in/National_Ambient_Air_Quality_Standards.php, accessed March 2011)

Finpro, 2008c. Environmental legislation in India, Finpro, 2008, 35 pp.
(http://www.teknologiateollisuus.fi/fi/materiaalipankki/?categoryHeader=4, accessed March 2011)

7 Discussion and conclusions

A survey of the existing air quality standards in selected countries has been carried out. The most commonly controlled air pollutants are the sulphur and nitrogen oxides, carbon monoxide, ozone, lead, and particulates. Other controlled pollutants include benzene, ammonia, heavy metals and persistent organic pollutants (benzo(a)pyrene, BaP). The standards vary, due to differing averaging periods and different number of allowed exceedances. In some countries, different standards are applied to different environments, typically with the strictest standards in ecologically sensitive areas and more lenient ones in residential or industrial areas.

It needs to be emphasized that the field of air quality management and standardization is constantly changing, with the emergence of new scientific knowledge of air pollutants and their effects, and the ensuing development of new standards and approaches to air quality management. The information compiled here is based on the situation in each country at the time of the writing of the report. Especially the regulations in different countries are presented as they have been during the preparation of the cited reference documents, web sites, and other available material.

As a general trend, the standards are becoming more stringent with time as new information about the effects of air pollutants becomes available. Another trend is the extension of the regulation to cover new compounds and the application of new evaluation techniques, such as air quality modeling in addition to the traditional monitoring methods.

A good example of the redefinition of standards with time is the particulates. In the early days of air quality regulation, the measurement of total suspended particles was considered sufficient information of their concentration. However, it soon became evident that the respirable fraction of the particles, i.e. PM_{10}, caused the most harmful effects to humans and thus PM_{10} was standardized. In recent years the classification has been further refined, and new standards have been issued for the fine particle fraction $PM_{2.5}$. These new standards are already included in the air quality regulation in many countries and others are in the process of adopting them.

Aerosol research, however, has long been focused on even smaller particle sizes, such as PM1, as well as the chemical composition of the particles which is of primary importance with respect to assessing their health effects. Recently, a new instrument has been developed which is capable of routinely characterizing and monitoring the mass and chemical composition of non-refractory submicron particles in real time (Ng et al. 2011). The advantage of this Aerosol Chemical Speciation Monitor (ACSM) is its capability to analyse not only the inorganic compounds but also the organics in the particle composition, allowing for more precise source analysis in episodic air quality situations. In future, the particle regulation may well be developed to include this type of multifunctional monitoring approaches.

As already discussed in Chapter 2, the upcoming revision of the Gothenburg Protocol will focus attention on black carbon as a component of particulate matter, as well as on the precursors of tropospheric ozone. This will undoubtedly also be reflected in future definitions of air quality management policies.

Another general feature of air quality standards is their ongoing homogenization all over the world. This is due to the strong role of the international organizations like UNECE and WHO in setting the focus and establishing the guidelines for air quality management. The leading authorities, such as EU and the US EPA, also work with third countries in their neighbouring and target areas, developing their air quality management systems to eventually strive towards the high air quality standards of the developed countries. In addition, international financial institutions and organizations such as the World Bank Group have set environmental guidelines which must be followed in projects financed by them. In the most recent version of the Environmental, Health and safety Guidelines of the International Finance Corporation (IFC EHS Guidelines 2007) it is stated that projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that:

- Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines or other internationally recognized sources;

- Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed.

Some parts of world, most notably the Latin America and Caribbean and the Australian and African continents, were not included in this survey. Air quality standards exist in several Latin American countries, but the available literature and other information about them was for the most part not in English. Australia has a developed air quality management system, but it was left out of the report because the available resources did not allow for a detailed analysis. For the African countries, very little if any air quality related information was found in the literature and web search, and it appears that other environmental problems are more pressing and presently receive most of the attention in Africa. However, this situation is likely to change in the near future.

Due to time and resource constraints this survey focused on the existing air quality standards in different countries. The air quality management practises of the countries, including the application of the standards in e.g. the environmental impact assessment and permitting of industries and possible monitoring requirements set for them, were not considered in detail. The logical extension of this work would be a more thorough review of these practises and their consequences to the industries or enterprises.

References:

Ng, N. L., Herndon, S. C., Trimborn, A., Canagaratna, M. R., Croteau,P. L., Onasch, T. B., Sueper, D., Worsnop, D. R., Zhang, Q., Sun, Y. L., and Jayne, J. T., 2011. An Aerosol Chemical Speciation Monitor (ACSM) for Routine Monitoring of the Composition and Mass Concentrations of Ambient Aerosol. Aerosol Science and Technology 45: 770-784. DOI: 10.1080/02786826.2011.560211.

IFC EHS Guidelines 2007. World Bank Group Environmental, Health, and Safety Guidelines, updated April 30, 2007. (http://www.ifc.org/ifcext/sustainability.nsf/Content/EHSGuidelines, accessed March 2011)

Sources and References

Air Quality Management in the United States, National Research Council, 2004. The National Academies Press, Washington, D.C., 426 pp.

APPCL 2000. Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution 2000. (http://www.npc.gov.cn/englishnpc/Law/2007-12/12/content_1383930.htm, accessed March 2011).

Assessment of the Effectiveness of European Air Quality Policies and Measures, Case study 2, Comparison of the EU and US Air Quality Standards & Planning Requirements, 4 October 2004. (http://ec.europa.eu/environment/archives/cafe/activities/pdf/case_study2.pdf, accessed January 2011)

Bridges and Bridges, 1995. Comparison of air quality in the UK and Russia, The Environmentalist, ***15****, 139-146.*

CAFÉ Directive 2008/50/EC.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDFEEA (accessed January 2011).

CAI-Asia 2009. Ambient air quality standards in Asia, Survey report (http://cleanairinitiative.org/portal/system/files/AQ_Standards_Report_Draft_2_Dec_FINAL.pdf, accessed February 2011).

CAI-Asia 2010. Air Quality in Asia: Status and Trends, 2010 Edition (http://cleanairinitiative.org/portal/system/files/Air_Quality_in_Asia_-_Status_and_Trends_2010_Ed._0.pdf, accessed February 2011).

Central Pollution Control Board (CPCB) http://www.cpcb.nic.in/ (accessed March 2011).

Clean Air Initiative for Asian Cities Center, 2010. Air Quality in Asia: Status and Trends, 2010 edition. (http://cleanairinitiative.org/portal/system/files/Air_Quality_in_Asia_-_Status_and_Trends_2010_Ed._0.pdf, accessed March 2011).

CPCB 2009. National ambient air quality standards, Central pollution control board. Gazette of India, Extraordinary, Part III, Section 4.

(http://www.cpcb.nic.in/National_Ambient_Air_Quality_Standards.php, accessed March 2011)

ECE/CEP, 2006: http://www.unece.org/env/documents/2006/ece/cep/ac.10/ece.cep.ac.10.2006.3.e.pdf (accessed February 2011).

ECE/CEP, 2007: http://www.unece.org/env/documents/2007/ece/ece.belgrade.conf.2007.11.add.2.e.pdf (accessed February 2011).

ECE/CEP, 2009: http://www.unece.org/env/documents/2009/ECE/CEP/ece.cep.2009.10.e.pdf (accessed February 2011).

ECE/CEP/2009/10, http://www.unece.org/env/documents/2009/ECE/CEP/ece.cep.2009.10.e.pdf (accessed January 2011).

ECE/CEP/AC.10/2006/3, http://www.unece.org/env/documents/2006/ece/cep/ac.10/ece.cep.ac.10.2006.3.e.pdf (accessed January 2011).

EEA Report No 8/2010, Impact of selected policy measures on Europe's air quality, ISSN 1725-2237, European Environment Agency.

EfE: http://www.unece.org/env/efe/welcome.html (accessed February 2011).

EIA Law 2003. Law of the People's Republic of China on the Environmental Impact Assessment 2003. (http://www.chinaenvironmentallaw.com/, accessed March 2011)

EMEP, http://www.emep.int/ (accessed January 2011).

ENPI, http://europa.eu/legislation_summaries/external_relations/relations_with_third_countries/eastern_europe_and_central_asia/r17101_en.htm (accessed February 2011).

EPA, Air Pollution Orientation Course, http://www.epa.gov/apti/course422/index.html.(accessed January 2011)

EPA, http://www.epa.gov/ (accessed January 2011)

Federal Law on Atmospheric Air Protection of May 4, 1999, N 96-FZ, http://base.garant.ru/12115550/ (accessed February, 2011).

Federal Law on the Sanitary-Epidemiological Welfare of Population of March 30, 1999, N 52-FZ, http://rospotrebnadzor.ru/documen/zakon (accessed February, 2011).

Finpro 2008a. Echo Liu (Ed.), Environmental Legislation in China (Mainland), Finpro Shanghai, 2008, 84 pp. (http://www.teknologiateollisuus.fi/fi/materiaalipankki/?categoryHeader=4, accessed March 2011).

FinPro 2008b. Environmental Legislation in Hong Kong and Macao. Finpro, 2008, 36 pp. (http://www.teknologiateollisuus.fi/fi/materiaalipankki/?categoryHeader=4. (accessed March 2011)

Finpro, 2008c. Environmental legislation in India, Finpro, 2008, 35 pp. (http://www.teknologiateollisuus.fi/fi/materiaalipankki/?categoryHeader=4, accessed March 2011)

GN 2.1.6.1338-03 (amended), http://www.mhts.ru/BIBLIO/SNIPS/gigien-normy/2.1.6.1338-03/2.1.6.1338-03.htm (accessed February, 2011).

GN 2.1.6.1338-03, http://www.dioxin.ru/doc/gn2.1.6.1338-03.htm (accessed February, 2011).

GN 2.1.6.2604-10, http://89.rospotrebnadzor.ru/documents/ros/28308/ (accessed February 2011).

Government Decision on air quality guidelines and target value for sulphur deposition, 480/1996 (in Finnish).

Government Decree on Air Quality, 31/2011 (in Finnish).

Government Decree on arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons, 164/2007 (in Finnish).

Guide to the demonstration of equivalence of ambient air monitoring methods, Report, EC Working Group on Guidance for the Demonstration of Equivalence, January 2010.

Guide to the Environmental Impact Assessment Ordinance, http://www.epd.gov.hk/eia. (accessed December 2010).

HES II, 2008. Harmonization of Environmental Standards II, Interim Technical report, Cluster 10, Environmental Quality Standards: 10.3 Setting Standards fort Ambient Air Quality and Emissions. EU-Russia Program of Cooperation, European Communities. http://www.ippc-russia.org/public/cluster10/10-3_Air_EQS_ELV_EN.pdf (accessed February 2011).

HES II: http://www.ippc-russia.org/content/id/en/1.html (accessed February 2011).

Hong Kong, existing air quality objectives, http://www.epd-asg.gov.hk/english/backgd/hkaqo.html. (accessed December 2010).

http://ec.europa.eu/environment/air/index_en.htm (accessed January 2011)

http://ec.europa.eu/environment/air/legis.htm (accessed January 2011)

http://ec.europa.eu/environment/air/quality/standards.htm (accessed January 2011)

http://ec.europa.eu/environment/enlarg/russianis_en.htm (accessed February 2011).

http://ec.europa.eu/environment/policyreview.htm (accessed January 2011)

http://eeas.europa.eu/delegations/russia/eu_russia/tech_financial_cooperation/index_en.htm (accessed February 2011).

http://epa.gov/oar/caa/caa_history.html (accessed January 2011)

http://europa.eu/legislation_summaries/environment/air_pollution/l28159_en.htm (accessed January 2011)

http://europa.eu/legislation_summaries/environment/air_pollution/index_en.htm (accessed January 2011)

http://www.who.int/ (accessed January 2011)

IFC EHS Guidelines 2007. World Bank Group Environmental, Health, and Safety Guidelines, updated April 30, 2007. (http://www.ifc.org/ifcext/sustainability.nsf/Content/EHSGuidelines, accessed March 2011)

Krzyzanowski M. and Cohen, A., Update of WHO air quality guidelines. Air Quality and Atmospheric Health 1:7-13, 2008. DOI 10.1007/s11869-008-0008-9.

Mosecomonitoring, 2010. State Environmental Institution "Mosecomonitoring" under the Department for Nature Use and Environmental Protection of Moscow City Government: Air quality monitoring in Moscow, WHO Newsletter 46. http://www.umweltbundesamt.de/whocc/archiv/NL-46.pdf (accessed February, 2011).

Natural Resources Defense Council, 2009. Amending China's Air Pollution Prevention and Control Law: Recommendations from the International Experience. (http://china.nrdc.org/AirLawAmendment, accessed March 2011)

Ng, N. L., Herndon, S. C., Trimborn, A., Canagaratna, M. R., Croteau,P. L., Onasch, T. B., Sueper, D., Worsnop, D. R., Zhang, Q., Sun, Y. L., and Jayne, J. T., 2011. An Aerosol Chemical Speciation Monitor (ACSM) for Routine Monitoring of the Composition and Mass Concentrations of Ambient Aerosol. Aerosol Science and Technology 45: 770-784. DOI: 10.1080/02786826.2011.560211.

PCA, http://europa.eu/legislation_summaries/external_relations/relations_with_third_countries/eastern_europe_and_central_asia/r17002_en.htm (accessed February 2011).

Special supplement nr 5 to the Hong Kong Government Gazette, published by authority, 24.6.1994. http://www.epd.gov.hk/epd/english/envir_standards/files/apgn8e.pdf. (accessed December 2010).

Tacis, http://europa.eu/legislation_summaries/external_relations/relations_with_third_countries/eastern_europe_and_central_asia/r17003_en.htm (accessed February 2011).

The Sixth Environment Action Programme of the European Community 2002–2012. (http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:242:0001:0015:EN:PDF, accessed January 2011).

UNECE Working Group on Environmental Monitoring and Assessment: http://www.unece.org/env/europe/monitoring/past_mtgs.html (accessed February 2011).

UNECE, http://www.unece.org (accessed January 2011).

WHO 2005. WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global update 2005, World Health Organization 2006.

WHO 2000. Air quality guidelines for Europe, 2nd ed. Copenhagen, World Health Organization Regional Office for Europe, 2000 (WHO Regional Publications, European Series, No. 91)

WHO 1987. Air quality guidelines for Europe. Copenhagen, World Health Organization Regional Office for Europe, 1987 (WHO Regional Publications, European Series, No. 23)

www.mosecom.ru (accessed February, 2011).

Appendices

Appendix A: Monitoring requirements according to the EMEP monitoring strategy 2010-2019 (ECE/EB.AIR/GE.1/2009/15).

MONITORING REQUIREMENTS FOR THE VARIOUS LEVELS SPECIFIED BY THE MONITORING STRATEGY

Levels 1 and 2 are mandatory. The Notes column refers to requirements for variables to be measured as part of the EU and WMO monitoring obligations. Information on reference methods is provided in the EMEP Manual for Sampling and Chemical Analysis and in the QA/QC section available on the EMEP-CCC website.

Level 1 sites : Observations contribute to the assessment of atmospheric transport and deposition of key parameters relevant for acidification, eutrophication, photochemical oxidants, heavy metals and particulate matter (see also para. 20 (a))			
Programme	**Parameters**	**Minimum time resolution**	**Notes**
Inorganic compounds in precipitation	SO_4^{2-}, NO_3^-, NH_4^+, H^+ (pH), Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^- , (cond)	Daily	Recommended by WMO/GAW and its precipitation network (GAW Report No 158 and GAW report No 172 (Strategic plan 2008-2015)
Heavy metals in precipitation	Cd, Pb (1st priority), Cu, Zn, As, Cr, Ni (2nd priority)	Daily/weekly	Deposition of As, Cd, Ni is required in the Directive 2004/107/EC. CEN method established
Inorganic compounds in air	SO_2, SO_4^{2-}, NO_3^-, HNO_3, NH_4^+, NH_3, (sNO_3, sNH_4), HCl, Na^+, K^+, Ca^{2+}, Mg^{2+}	Daily	Recommended to be complemented with low cost denuders or passive samplers
NO_2 in air	NO_2	Hourly/Daily	EU Directive 2008/50/EC (note differences in reference methodology)
Ozone in air	O_3	Hourly	EU Directive 2008/50/EC
PM mass in air	$PM_{2.5}$, PM_{10}	Hourly/Daily	EU Directive 2008/50/EC. Included in WMO/GAW recommendation for the aerosol network, GAW report No. 153
Gas particle ratios of N-species	NH_3, NH_4^+,HCl, HNO_3, NO_3^- (in combination with filtre pack sampling)	Monthly	Low-cost methods
Meteorology	Precipitation amount (RR), temperature (T), wind direction (dd), wind speed (ff), relative humidity (rh), atmospheric pressure (pr)	Daily (RR), Hourly	Can be taken from a representative meteorological site

Level 2 sites: Level 2 sites should also measure a majority of parameters required at level 1. (See also para. 20 (b))

Programme	Parameters	Minimum time resolution	Notes
Acidification and eutrophication Observations contributes to the assessment of nitrogen chemistry, influence by local emissions and dry deposition fluxes (see also para. 18b)			
Gas particle ratio	NH_3/NH_4^+, HNO_3/NO_3^- (artifact-free methods)	Hourly/Daily	
Ammonia in emission areas (optional)	NH_3	Monthly	Optional low cost alternative to provide high spatial resolution information in emission areas, where desired.
Photochemical oxidants observations contributes to the assessment of oxidant precursors (see also paragraph 18b)			
NOx	NO, NO_2	Hourly	In the EU Directive 2008/50/EC, WMO GAW
Light hydrocarbons	C_2-C_7	Hourly	In the EU Directive 2002/3/EC and benzene in 2008/50/EC, WMO GAW
Carbonyls	Aldehydes and ketones	8hourly twice a week	In the EU Directive 2002/3/EC,
CH_4	Methane	hourly	WMO GAW
Heavy metals observations contributes to the assessment of mercury and heavy metals fluxes (see also paragraph 18b)			
Mercury in precipitation	Hg	Weekly	In the EU Directive 2004/107/EC
Mercury in air	Hg (TGM),	Hourly/Daily	In the EU Directive 2004/107/EC
Heavy metals in air	Cd, Pb (1st priority.), Cu, Zn, As, Cr, Ni (2nd priority)	Daily/Weekly	In the EU Directive 2004/107/EC for As, Cd, Ni and 2008/50/EC for Pb
Persistent organic pollutants observations contributes to the assessment of persistent organic pollutants (see also paragraph 18b)			
POPs in precipitation	PAHs, PCBs, HCB, chlordane, HCHs, DDT/DDE	Weekly	PAH in EU Directive 2004/107/EC. POP is included in UNEP Stockholm Convention
POPs in air	PAHs, PCBs, HCB, chlordane, HCHs, DDT/DDE	Daily/Weekly	PAH in EU Directive 2004/107/EC. POP is included in UNEP Stockholm Convention

Particulate matter observations contributes to the assessment of particulate matter and its source apportionment (see also paragraph 20 (c)).			
PM mass in air	PM_1	Hourly/Daily	
Mineral dust in PM10	Si, Al, Fe, Ca	Daily/Weekly	Chemical speciation included in WMO/GAW recommendation for the aerosol network, GAW report No 153 and No 172
EC and OC in PM10	Elemental and Organic Carbon	Daily/Weekly	Chemical speciation included in WMO/GAW recommendation for the aerosol network, , GAW report No 153 and No 172
Aerosol absorption	Light absorption coefficient	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172. Core parameter
Aerosol size/number distribution	dN/dlogDp	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172
Aerosol scattering	Light scattering coefficient	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172. Core parameter
Aerosol Optical Depth	AOD at 550 nm	Hourly	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172. Core parameter
Tracers observations contributes to the assessment of individual long-range transport events and their source apportionment (see also paragraph 18b)			
Carbon Monoxide	CO	Hourly	In the EU Directive 2004/107/EC, WMO GAW report No 172
Halocarbons	CFCs, HCFCs, HFCs, PFCs, SF_6	Hourly	WMO GAW report No 172

Level 3 sites **Research based and voluntary -monitoring at these sites do not require all level 1 and level 2 parameters. Level 3 sites also include campaign type data.** Observations contribute to the understanding of processes relevant for long-range transport of air pollutants and support model development and validation (see also para. 18c).			
Programme	**Parameters**	**Minimum time resolution**	**Notes**
Dry deposition flux	SO_2, NH_3, HNO_3 (SO_4^{2-}, NH_4^+, NO_3^-)	Hourly	
Dry deposition flux of O3	O_3	Hourly	
Dry deposition flux of VOCs	OVOCs and terpenes	Hourly	
Hydrocarbons	C_6-C_{12}	Hourly/Daily	WMO GAW report No 172
NOy chemistry	PAN, organic nitrates	Hourly/Daily	WMO GAW report No 172
Vertical profiles	O_3 soundings, aerosol Lidar,	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network (GAW report No 153).
OC fractionation	Water soluble and water insoluble OC (WSOC/WINSOC)	Hourly/Daily	
Organic tracers	Levoglucosan, others	Daily, weekly	
Isotopic information	OC, VOCs	Hourly/Daily/ Weekly	
Greenhouse gases	CO_2, N_2O	Hourly	WMO GAW report No 172
Hydrogen	Hydrogen (H_2)	Hourly	WMO GAW report No 172
Major inorganics in both $PM_{2.5}$ and PM_{10}	SO_4^{2-}, NO_3^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^+ (Cl^-)	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172.
Mercury speciation	TGM, RGM and TPM	Daily/Weekly	
Congener-specific	POPs PCBs, PAHs, PCDDs and PCDFs	Daily/Weekly	

GAW Report No. 172: WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008–2015.

Appendix B: The WHO 1987 guideline values for the evaluated 28 pollutants (Air quality guidelines for Europe. Copenhagen, World Health Organization Regional Office for Europe, 1987. WHO Regional Publications, European Series, No. 23).

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/m^3 10–20 ng/m^3	1 year (rural areas) 1 year (urban areas)	19
Carbon disulfide	100 $\mu g/m^3$	24 hours	7
Carbon monoxide	100 mg/m^3[b] 60 mg/m^3[b] 30 mg/m^3[b] 10 mg/m^3	15 minutes 30 minutes 1 hour 8 hours	20
1,2-Dichloroethane	0.7 mg/m^3	24 hours	8
Dichloromethane (Methylene chloride)	3 mg/m^3	24 hours	9
Formaldehyde	100 $\mu g/m^3$	30 minutes	10
Hydrogen sulfide	150 $\mu g/m^3$	24 hours	22
Lead	0.5–1.0 $\mu g/m^3$	1 year	23
Manganese	1 $\mu g/m^3$	1 year[c]	24
Mercury	1 $\mu g/m^3$[d] (indoor air)	1 year	25
Nitrogen dioxide	400 $\mu g/m^3$ 150 $\mu g/m^3$	1 hour 24 hours	27
Ozone	150–200 $\mu g/m^3$ 100–120 $\mu g/m^3$	1 hour 8 hours	28
Styrene	800 $\mu g/m^3$	24 hours	12
Sulfur dioxide	500 $\mu g/m^3$ 350 $\mu g/m^3$	10 minutes 1 hour	30
Sulfuric acid	—[e]	—	30
Tetrachloroethylene	5 mg/m^3	24 hours	13
Toluene	8 mg/m^3	24 hours	14
Trichloroethylene	1 mg/m^3	24 hours	15
Vanadium	1 $\mu g/m^3$	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 (µg/m³)	Reflectance assessment: black smoke[b] (µg/m³)	Gravimetic assessment: Total suspended particulates (TSP)[c] (µg/m³)	Gravimetic assessment: Thoracic particles (TP)[d] (µg/m³)
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 µg/m³ 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 10µm); 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).

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 µg/m³
Hydrogen sulfide	0.2–2.0 µg/m³	0.6–6.0 µg/m³	7 µg/m³
Styrene	70 µg/m³	210–280 µg/m³	70 µg/m³
Tetrachloroethylene	8 mg/m³	24–32 mg/m³	8 mg/m³
Toluene	1 mg/m³	10 mg/m³	1 mg/m³

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).

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.

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

Substance	Guideline value	Averaging time	Remarks
Nitrogen dioxide	95 μg/m³ 30 μg/m³	4 hours 1 year	In the presence of SO_2 and O_3 levels which are not higher than 30 μg/m³ (arithmetic annual average) and 60 μg/m³ (average during growing season), respectively
Total nitrogen deposition	3 g/m²	1 year	Sensitive ecosystems are endangered above this level
Sulfur dioxide	30 μg/m³ 100 μg/m³	1 year 24 hours	Insufficient protection in the case of extreme climatic and topographic conditions
Ozone	200 μg/m³ 65 μg/m³ 60 μg/m³	1 hour 24 hours averaged over growing season	
Peroxyacetylnitrate	300 μg/m³ 80 μg/m³	1 hour 8 hours	

Appendix C: The WHO 2000 guideline values (Air quality guidelines for Europe, 2nd ed. Copenhagen, World Health Organization Regional Office for Europe, 2000. WHO Regional Publications, European Series, No. 91).

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

Substance	Time-weighted average	Averaging time
Cadmium	5 ng/m³[a]	annual
Carbon disulfide[b]	100 μg/m³	24 hours
Carbon monoxide	100 mg/m³[c]	15 minutes
	60 mg/m³[c]	30 minutes
	30 mg/m³[c]	1 hour
	10 mg/m³	8 hours
1,2-Dichloroethane[b]	0.7 mg/m³	24 hours
Dichloromethane	3 mg/m³	24 hours
	0.45 mg/m³	1 week
Fluoride[d]	–	–
Formaldehyde	0.1 mg/m³	30 minutes
Hydrogen sulfide[b]	150 μg/m³	24 hours
Lead	0.5 μg/m³	annual
Manganese	0.15 μg/m³	annual
Mercury	1 μg/m³	annual
Nitrogen dioxide	200 μg/m³	1 hour
	40 μg/m³	annual
Ozone	120 μg/m³	8 hours
Particulate matter[e]	Dose–response	–
Platinum[f]	–	–
PCBs[g]	–	–
PCDDs/PCDFs[h]	–	–
Styrene	0.26 mg/m³	1 week
Sulfur dioxide	500 μg/m³	10 minutes
	125 μg/m³	24 hours
	50 μg/m³	annual
Tetrachloroethylene	0.25 mg/m³	annual
Toluene	0.26 mg/m³	1 week
Vanadium[b]	1 μg/m³	24 hours

[a] The guideline value is based on the prevention of a further increase of cadmium in agricultural soils, which is likely to increase the dietary intake.

[b] Not re-evaluated for the second edition of the guidelines.

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

[d] Because there is no evidence that atmospheric deposition of fluorides results in significant exposure through other routes than air, it was recognized that levels below 1 µg/m³, which is needed to protect plants and livestock, will also sufficiently protect human health.

[e] The available information for short- and long-term exposure to PM_{10} and $PM_{2.5}$ does not allow a judgement to be made regarding concentrations below which no effects would be expected. For this reason no guideline values have been recommended, but instead risk estimates have been provided (see Chapter 7, Part 3).

[f] It is unlikely that the general population, exposed to platinum concentrations in ambient air at least three orders of magnitude below occupational levels where effects were seen, may develop similar effects. No specific guideline value has therefore been recommended.

[g] No guideline value has been recommended for PCBs because inhalation constitutes only a small proportion (about 1–2%) of the daily intake from food.

[h] No guideline value has been recommended for PCDDs/PCDFs because inhalation constitutes only a small proportion (generally less than 5%) of the daily intake from food.

Table 3. 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[a] (index substance for viscose emissions)	200 µg/m³	—	20 µg/m³
Hydrogen sulfide[a]	0.2–2.0 µg/m³	0.6–6.0 µg/m³	7 µg/m³
Formaldehyde	0.03–0.6 mg/m³	—	0.1 mg/m³
Styrene	70 µg/m³	210–280 µg/m³	70 µg/m³
Tetrachloroethylene	8 mg/m³	24–32 mg/m³	8 mg/m³
Toluene	1 mg/m³	10 mg/m³	1 mg/m³

[a] Not re-evaluated for the second edition of the guidelines.

Table 4. Carcinogenic risk estimates based on human studies[a]			
Substance	IARC Group	Unit risk[b]	Site of tumour
Acrylonitrile[c]	2A	2×10^{-5}	lung
Arsenic	1	1.5×10^{-3}	lung
Benzene	1	6×10^{-6}	blood (leukaemia)
Butadiene	2A	–	multisite
Chromium (VI)	1	4×10^{-2}	lung
Nickel compounds	1	4×10^{-4}	lung
Polycyclic aromatic hydrocarbons (BaP)[d]	–	9×10^{-2}	lung
Refractory ceramic fibres	2B	1×10^{-6} (fibre/l)$^{-1}$	lung
Trichloroethylene	2A	4.3×10^{-7}	lung, testis
Vinyl chloride[c]	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] Not re-evaluated for the second edition of the guidelines.

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

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

[a] F* = fibres measured by optical methods.

Table 6. Risk estimates and recommended action level for radon progeny		
Exposure	Lung cancer excess lifetime risk estimate	Recommended level for remedial action in buildings
1 Bq/m³	$3–6 \times 10^{-5}$	≥ 100 Bq/m³ (annual average)

Table 7. Guideline values for individual substances based on effects on terrestrial vegetation

Substance	Guideline value	Averaging time
SO_2: critical level	10–30 µg/m³ [a]	annual
critical load	250–1500 eq/ha/year [b]	annual
NO_x: critical level	30 µg/m³	annual
critical load	5–35 kg N/ha/year [b]	annual
Ozone: critical level	0.2–10 ppm·h [a, c]	5 days–6 months

[a] Depending on the type of vegetation (see Part III).

[b] Depending on the type of soil and ecosystem (see Part III).

[c] AOT: Accumulated exposure Over a Threshold of 40 ppb.

Appendix D: EU air quality standards (Official Journal of the European Union (OJ) L 152, 11.6.2008, OJ L 23, 26.1.2005, and OJ L 87, 21.3.2009).

LIMIT VALUES FOR THE PROTECTION OF HUMAN HEALTH

A. Criteria

Without prejudice to Annex I, the following criteria shall be used for checking validity when aggregating data and calculating statistical parameters:

Parameter	Required proportion of valid data
One hour values	75 % (i.e. 45 minutes)
Eight hours values	75 % of values (i.e. 6 hours)
Maximum daily 8-hour mean	75 % of the hourly running eight hour averages (i.e. 18 eight hour averages per day)
24-hour values	75 % of the hourly averages (i.e. at least 18 hour values)
Annual mean	90 % (1) of the one hour values or (if not available) 24-hour values over the year

(1) The requirements for the calculation of annual mean do not include losses of data due to the regular calibration or the normal maintenance of the instrumentation.

B. Limit values

Averaging Period	Limit value	Margin of tolerance	Date by which limit value is to be met
Sulphur dioxide			
One hour	350 µg/m^3, not to be exceeded more than 24 times a calendar year	150 µg/m^3 (43 %)	— (1)
One day	125 µg/m^3, not to be exceeded more than 3 times a calendar year	None	— (1)
Nitrogen dioxide			
One hour	200 µg/m^3, not to be exceeded more than 18 times a calendar year	50 % on 19 July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2010	1 January 2010
Calendar year	40 µg/m^3	50 % on 19 July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2010	1 January 2010

Benzene			
Calendar year	5 µg/m^3	5 µg/m^3 (100 %) on 13 December 2000, decreasing on 1 January 2006 and every 12 months thereafter by 1 µg/m^3 to reach 0 % by 1 January 2010	1 January 2010
Carbon monoxide			
maximum daily eight hour mean (2)	10 mg/m^3	60 %	— (1)

Averaging Period	Limit value	Margin of tolerance	Date by which limit value is to be met
Lead			
Calendar year	0,5 µg/m^3 (3)	100 %	— (3)
PM_{10}			
One day	50 µg/m^3, not to be exceeded more than 35 times a calendar year	50 %	— (1)
Calendar year	40 µg/m^3	20 %	— (1)

(1) Already in force since 1 January 2005

(2) The maximum daily eight hour mean concentration will be selected by examining eight hour running averages, calculated from hourly data and updated each hour. Each eight hour average so calculated will be assigned to the day on which it ends i.e. the first calculation period for any one day will be the period from 17:00 on the previous day to 01:00 on that day; the last calculation period for any one day will be the period from 16:00 to 24:00 on that day.

(3) Already in force since 1 January 2005. Limit value to be met only by 1 January 2010 in the immediate vicinity of the specific industrial sources situated on sites contaminated by decades of industrial activities. In such cases, the limit value until 1 January 2010 will be 1,0 µg/m^3. The area in which higher limit values apply must not extend further than 1 000 m from such specific sources.

▼B

ANNEX I

Target values for arsenic, cadmium, nickel and benzo(a)pyrene

Pollutant	Target value [1]
Arsenic	6 ng/m^3
Cadmium	5 ng/m^3
Nickel	20 ng/m^3
Benzo(a)pyrene	1 ng/m^3

[1] For the total content in the PM_{10} fraction averaged over a calendar year.

ANNEX IV

Data quality objectives and requirements for air quality models

I. **Data quality objectives**

The following data quality objectives are provided as a guide to quality assurance.

	Benzo(a)pyrene	Arsenic, cadmium and nickel	Polycyclic aromatic hydrocarbons other than benzo(a) pyrene, total gaseous mercury	Total deposition
— Uncertainty				
Fixed and indicative measurements	50 %	40 %	50 %	70 %
Modelling	60 %	60 %	60 %	60 %
— Minimum data capture	90 %	90 %	90 %	90 %
— Minimum time coverage:				
Fixed measurements	33 %	50 %		
Indicative measurements (*)	14 %	14 %	14 %	33 %

(*) Indicative measurement being measurements which are performed at reduced regularity but fulfil the other data quality objectives.

Appendix E: Air quality standards in Asia (CAI-Asia 2009. Ambient air quality standards in Asia, Survey report; CAI-Asia 2010. Air Quality in Asia: Status and Trends, 2010 Edition)

Status of Air Quality Standards

Table 1 Summary of Ambient Air Quality Standards in Select Asian Countries (μg/m³)

Countries	$PM_{2.5}$		PM_{10}		SO_2		NO_2		O_3		CO ('000)		Pb
	24-Hr	Annual	24-Hr	Annual	24-Hr	Annual	24-Hr	Annual	1-Hr	8-Hr	1-Hr	8-Hr	Annual
Afghanistan	-	-	-	-	-	-	-	-	-	-	-	-	-
Bangladesh	65	15	150	50	365	80	-	100	235	157	40	10	0.5
Bhutan	-	-	-	-	-	-	-	-	-	-	-	-	-
Cambodia	-	-	-	-	300	100	100	-	200	-	40	20	-
China: Grade I	-	-	50	40	50	20	80	40	160	-	10	-	1
China: Grade II	-	-	150	100	150	60	120	80	200	-	10	-	1
China: Grade III	-	-	250	150	250	100	120	80	200	-	20	-	1
Hong Kong SAR	-	-	180	55	350	80	150	80	240	-	30	10	-
India*	60	40	100	60	80	50	80	40	180	100	4	2	0.5
India**	60	40	100	60	80	20	80	30	180	100	4	2	0.5
Indonesia	-	-	150	-	365	60	150	100	235	-	30	-	1
Lao PDR	-	-	-	-	-	-	-	-	-	-	-	-	-
Malaysia	-	-	150	50	105	-	10	-	200	120	35	10	-
Mongolia	-	-	-	-	30	-	40	-	120	0	-	-	-
Nepal	-	-	120	-	70	50	80	40	-	-	-	10	0.5
Pakistan	-	-	-	-	-	-	-	-	-	-	-	-	-
Philippines	-	-	150	60	180	80	150	-	140	60	35	10	1
Republic of Korea	-	-	100	50	131	52	113	56	196	118	28.6	10.3	0.5
Singapore	35	15	150	-	365	80	-	100	-	147	40	10	-
Sri Lanka	50	25	100	50	80	-	100	-	200	-	30	10	-
Thailand	-	-	120	50	300	100	-	-	200	140	34.2	10.3	-
Viet Nam	-	-	150	50	125	50	-	40	-	120	30	10	0.5

China: Grade I = applies to specially protected areas, such as natural conservation areas, scenic spots, and historical sites; **China: Grade II** = applies to residential areas, mixed commercial/residential areas, cultural, industrial, and rural areas; **China: Grade III** = special industrial areas; **India*** = NAAQS for Industrial, Residential, Rural and Other Areas; **India**** = NAAQS for Ecologically Sensitive Areas (notified by Central Government); **SAR** = Special Administrative Region; **PDR** = People's Democratic Republic; **Pb** = lead; **PM_{10}** = Particles with aerodynamic particle diameters of 10 micrometers or less; **$PM_{2.5}$** = Particles with aerodynamic particle diameters of 2.5 micrometers or less

Ozone (**O_3**) Conversion factor for ppb to μg/m³: 1.962
Sulfur dioxide (**SO_2**) Conversion factor for ppb to μg/m³: 2.616
Carbon monoxide (**CO**) Conversion factor for ppb to μg/m³: 1.145
Nitrogen dioxide (**NO_2**) Conversion factor for ppb to μg/m³: 1.880

Source: CAI-Asia Center, 2010. [Collected from various sources]

Table 2. Summary of Status of Establishment and Revision of Ambient Air Quality Standards in Asia

Countries	Has Existing Standards	Year standards were first established	Years standards revised/ modified	Plans to revise in the next 2 years
Bangladesh	yes	1997	2005	None
Cambodia	yes	2000	No	Yes, but they have indicated that they need technical assistance and financial support for this.
China	yes	1982	1996, 2000	2009-06-05 11:09 : http://www.chinadaily.com.cn/bizchina/2009-06/05/content_8252783.htm 1) China Daily: Tougher rules for air quality likely soon China is mulling more stringent appraisal standards for air quality, and pilot projects are likely to start from coastal cities in the Yangtze River delta and Pearl River delta next year. Environmental authorities are planning to include particles less than 2.5 microns (PM2.5) and ozone, into the API, which currently measures concentration of sulfur dioxide, nitrogen dioxide and PM10, or particles smaller than 10 microns.
Hong Kong SAR	yes	1987	currently undergoing review	
India	yes	1982	1994, 2009	India only recently revised its standards
Indonesia	yes	1999	No	No Answer
Nepal	yes	2003	currently undergoing review	The ambient air quality standards are currently undergoing review and the MoEST have indicated that the standards will be revised and updated soon.
Philippines	yes	1978	1992	None
Republic of Korea	yes	1978	1983, 1991, 1993, 2001, 2007, 2009	No. However, the areas for air quality standards development include–establishment PM2.5 standards, standardization of air quality measurement tools and cost benefit analysis of establishing ambient air quality standards.
Sri Lanka	yes	1994	2008	No. But there are plans to develop ambient air standards for lead (Pb). However, prior to ambient Pb standard formulation, a survey in ten major cities in Sri Lanka will first be conducted by CEA. They may need financial support to conduct this study.
Thailand	yes	1981	1995, 2001, 2004, 2007	1. Establish annual average standard for NO_2 in 2009. 2. Ambient $PM_{2.5}$ standards are currently being developed.
Viet Nam	yes	1995	2001, 2005, 2009	The NAAQS are currently being revised into the National Technical Regulation on Ambient Air Quality. This will be promulgated in 2009.

Appendix F: Air quality standards in India – The Gazette of India Extraordinary. November 18, 2009.

रजिस्ट्री सं॰ डी॰ एल॰-33004/99 REGD. NO. D. L.-33004/99

सत्यमेव जयते

भारत का राजपत्र
The Gazette of India

असाधारण

EXTRAORDINARY

भाग III—खण्ड 4

PART III—Section 4

प्राधिकार से प्रकाशित

PUBLISHED BY AUTHORITY

सं. 217] नई दिल्ली, बुधवार, नवम्बर 18, 2009/कार्तिक 27, 1931

No. 217] NEW DELHI, WEDNESDAY, NOVEMBER 18, 2009/KARTIKA 27, 1931

NATIONAL AMBIENT AIR QUALITY STANDARDS
CENTRAL POLLUTION CONTROL BOARD
NOTIFICATION

New Delhi, the 18th November, 2009

No. B-29016/20/90/PCI-I.—In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No.14 of 1981), and in supersession of the Notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect, namely:-

NATIONAL AMBIENT AIR QUALITY STANDARDS

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), µg/m^3	Annual* 24 hours**	50 80	20 80	- Improved West and Gaeke -Ultraviolet fluorescence
2	Nitrogen Dioxide (NO_2), µg/m^3	Annual* 24 hours**	40 80	30 80	- Modified Jacob & Hochheiser (Na-Arsenite) - Chemiluminescence
3	Particulate Matter (size less than 10µm) or PM_{10} µg/m^3	Annual* 24 hours**	60 100	60 100	- Gravimetric - TOEM - Beta attenuation
4	Particulate Matter (size less than 2.5µm) or $PM_{2.5}$ µg/m^3	Annual* 24 hours**	40 60	40 60	- Gravimetric - TOEM - Beta attenuation
5	Ozone (O_3) µg/m^3	8 hours** 1 hour**	100 180	100 180	- UV photometric - Chemilminescence - Chemical Method
6	Lead (Pb) µg/m^3	Annual* 24 hours**	0.50 1.0	0.50 1.0	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
7	Carbon Monoxide (CO) mg/m^3	8 hours** 1 hour**	02 04	02 04	- Non Dispersive Infra Red (NDIR) spectroscopy
8	Ammonia (NH_3) µg/m^3	Annual* 24 hours**	100 400	100 400	-Chemiluminescence -Indophenol blue method

(1)	(2)	(3)	(4)	(5)	(6)
9	Benzene (C_6H_6) µg/m^3	Annual*	05	05	- Gas chromatography based continuous analyzer - Adsorption and Desorption followed by GC analysis
10	Benzo(a)Pyrene (BaP) - particulate phase only, ng/m^3	Annual*	01	01	- Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), ng/m^3	Annual*	06	06	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni), ng/m^3	Annual*	20	20	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note. — Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

SANT PRASAD GAUTAM, Chairman

[ADVT-III/4/184/09/Exty.]

Note: The notifications on National Ambient Air Quality Standards were published by the Central Pollution Control Board in the Gazette of India, Extraordinary vide notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998.

Printed by the Manager, Government of India Press, Ring Road, Mayapuri, New Delhi-110064 and Published by the Controller of Publications, Delhi-110054.