Technical report No 16

EUROAIRNET
site selection 1998

Prepared by:
Steinar Larssen and Mihalis Lazaridis

November 1998

Project manager:
Gabriel Kielland
European Environment Agency

European Environment Agency

Cover design: Rolf Kuchling, EEA

Legal notice

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server (http://europa.eu.int)

Printed in Copenhagen

Printed on recycled and chlorine-free bleached paper

European Environment Agency
Kongens Nytorv 6
DK-1050 Copenhagen K
Denmark
Tel: +45 33 36 71 00
Fax: +45 33 36 71 99
E-mail: eea@eea.eu.int

Table of content

1. Introduction

1.1. The process leading to establishment of EUROAIRNET

The main goal behind the establishment of the Europe wide air quality monitoring and information network of the EEA (EUROAIRNET) is to improve significantly the reporting of air quality data in Europe, with a coverage that makes possible comprehensive assessments of European air quality within a year or a little more after the end of a monitoring year.

The attempts by the European Topic Centre on Air Quality (ETC-AQ) and other groups to make such assessments include the Dobris assessments of 1990 and 1995 (EEA 1994, 1998), the Topic Report "Air Pollution in Europe 1993 - A Pilot Report" (Larssen and Hagen, 1996), the EEA Monographs "Air Pollution in Europe 1997" (EEA, 1997) and "Assessment and Management of Urban Air Quality in Europe" (Richter and Williams, 1998), and the Technical Report "EoI Pilot Data Report" prepared by ETC-AQ (Sluyter, 1999). All these efforts showed that timely, extensive and consistent assessments of local air pollution on the European scale are still not fully possible. There are considerable gaps in spatial coverage, the data quality is not well documented so consistency is not well known, and the data are two-three years old at the time of publication.

The first attempt to set criteria for the design of EUROAIRNET was made in the Position Paper on EUROAIRNET presented and discussed at the 1st European Workshop on Air Quality Monitoring and Assessment in Copenhagen April 1996 (Larssen, 1996). Considering this starting point, the criteria for design of EUROAIRNET have been further developed. A draft report on criteria was presented and discussed at the 2nd Workshop in Brussels in September 1997. After that, comments were received from some countries and other bodies. The comments received resulted in a complete reconsideration of the sections on Station Classification Criteria and QA/QC Criteria. A final draft report on "Criteria for EUROAIRNET" was prepared in mid-1998 (Larssen et al., 1999). This final draft was sent to the countries for final comments, before the Third EIONET Workshop on Air Quality Monitoring and Assessment held in September 1998.

1.2. Site selection process

The site selection process started in mid 1997. The initial draft "Criteria for EUROAIRNET" report which was prepared for the 2nd workshop provided the basis for starting to select areas and stations. The ETC-AQ designed a Station Description Table (see Annex 1) which was sent to all EEA and PHARE countries in mid July, with a request to select areas and stations according to the selection criteria, and fill in the appropriate data and information about them in the tables.

There were separate tables for:

- cities and agglomerations
- industrial areas
- rural areas.

Since then many countries have made their first selection of EUROAIRNET stations, and returned filled-in questionnaires. By July, questionnaires (or similar information in other forms) had been received from 18 countries (see Table 3.1). For Germany, separate tables were received from 15 Länder, in addition to the UBA regional background stations.

This report provides a summary of the information returned from these countries. The ongoing review process aims at:

– urging other countries to also select areas and stations;
– working with the countries to, if necessary, modify or extend their selection of stations to satisfy more closely the selection criteria.

1.3. Objectives of EUROAIRNET

EUROAIRNET shall provide information to support and to facilitate the assessments of air quality to be produced by EEA. The information shall be available in such a form that it is suitable to:

- facilitate a general description of air quality across Europe, and its development over time (trend);
- enable comparison of air quality across Europe;
- produce estimates of exposure of the European population, and of materials and ecosystems;
- estimate health effects;
- quantify damage to materials and vegetation;
- produce emissions/exposure relations and exposure/effect relations;
- support development of cost-effective abatement strategies;
- support the framing and implementation of legislation (in relation to air quality directives);
- influence/inform/assess effectiveness of future/previous policy.

The assessments should be based upon concentration fields (space-time fields) produced by the monitoring and information network or by a combination of monitoring and modelling, and should cover local as well as regional scales. The modelling efforts are essential in forming the links between emissions on the one hand and exposure and effects on the other hand.

The specific objectives of EUROAIRNET can be separated in three stages:

Stage 1 objective:

Air pollution exposure assessments on the European scale to be produced from monitoring alone.

This objective requires a network that is representative for the different exposure situations in the various cities and regions in Europe.

Stage 2 objective:

Air pollution exposure assessments to be produced by a combination of monitoring and modelling.

This objective requires in addition that stations are selected that are suitable for comparison with calculations using dispersion models. Also, meteorological measurements in the various areas (i.e. cities) are necessary, and also local inventories of emissions, spatially distributed in a regular grid.

Stage 3 objective:

The network will support quantitative assessments of exposure and effects, a basis for proposing cost-effective abatement strategies.

This objective requires in addition quantitative information about the distribution of the exposed objects (population, materials, ecosystems), and dose-response relationships. For assessment of, for example, detailed population exposure to quantify health effects, models are needed for coupling between air quality and population in space and time, as well as dose-response relationships for the various health effects.

We are in the first phase of EUROAIRNET establishment, and in this phase the Stage 1 objective should be the guiding one, but the Stage 2 objective should also be fulfilled in some selected cities. Assessments of exposure shall be produced by monitoring alone. At the same time, in some cities exposure assessments should be produced by a combination of monitoring and modelling.

Exposure assessments should be made for the following “stock-at-risk”: human population, materials, ecosystems.

2. Criteria for EUROAIRNET

The establishment of EUROAIRNET shall be guided by criteria which will ensure as far as possible that the objectives of the network are fulfilled. The criteria developed for Stage 1 of EUROAIRNET are the following:

- Selection of areas to be monitored
- Classification of monitoring stations
- Selection of compounds and methods
- Data Quality Objectives
- QA/QC procedure classification

These are summarised briefly below. Further details are provided in "Criteria for EUROAIRNET" (Larssen et al., 1999).

2.1. Selection of areas to be monitored

For population exposure assessment, the criteria are given in Table 2.1. For materials exposure assessment, see Table 2.2.

Table 2.1: Assessment of population exposure: Criteria for selection of areas/ stations to be fulfilled by country state as far as possible

Type of area	Criteria	
	Area selection	Station selection
Cities and Agglomerations		
>0.5 mill	All cities	All stations, for up to 20 stations in the agglomeration. When subset is selected (when >20 stations), the selection must contain all station categories represented in the city, and must be spatially distributed in the agglomeration to cover the whole population.
0.25-0.5 mill	At least 25% of the cities	The selected areas (cities) must represent high, medium and low levels of industrialisation, as occurring in the country.
0.05-0.25 mill	At least 10% of the cities	The selected areas (cities) must represent high, medium and low levels of industrialisation, as occurring in the country.
Rural areas	1)	
Industrial areas outside cities	All areas with air pollution above the WHO AQ Guidelines	All existing monitoring stations in these areas.

1) Monitoring needs and network/station selection to be made by each country in consultation with ETC-AQ. At least 50% of the rural population should be covered in terms of being reasonably well represented by monitoring stations for the relevant compounds, e.g. O_3, PM_{10}, $PM_{2.5}$.

Table 2.2: Assessment of materials. Criteria for selection of areas/stations, to be fulfilled by each country as far as possible.

Type of area	Criteria	
	Area selection	Station selection
Urban areas >0.5 mill.	At least 10% of the cities	At least three stations in the selected area representing high urban pollution, traffic and average urban background.
Industrial areas	At least 5% of the areas	At least two stations in the selected area representing high and medium level of pollution.
Rural areas	Areas with different climatic conditions	One station in each of the different climatic areas of the state.

Assessment of ecosystems exposure

As stated in the "*Criteria for EUROAIRNET*" Report (Larssen et al., 1999), each country will be asked initially to develop its own plan for a monitoring network to give representative air pollution exposure of ecosystems. This information is to be evaluated by ETC-AQ in consultation with each country, on basis of which a European strategy may be developed.

In the stage 1 of EUROAIRNET, it can nevertheless be stated that:

- the EMEP stations should be included in EUROAIRNET;
- the rural ozone stations representing exposure of forests and crops should be included in EUROAIRNET;
- other existing rural stations monitoring S- and N-compounds in air and precipitation, and ozone precursors (NO_X and VOC) should be included in EUROAIRNET.

2.2. Classification of monitoring stations

When attempting to assess exposure from monitoring alone, it is important to know the spatial representativeness of the monitoring sites, whether they represent the average air pollution level in the broader area where they are located, or whether they represent hot-spot pollution related to traffic, industrial or other sources. The classification of sites into classes will aid the exposure assessment.

The same station classification scheme will be used under EUROAIRNET as used under the Exchange of Information (EoI) Decision, see Table 2.3.

Table 2.3: Exchange of Information (EoI) site classes

Type of station		Type of zone		Characterisation of zone	
Traffic	(T)	Urban	(U)	Residential	(R)
Industrial	(I)	Suburban	(S)	Commercial	(C)
Background	(B)	Rural	(R)	Industrial	(I)
				Agricultural	(A)
				Natural	(N)
				Res/Com	(RC)
				Com/Ind	(CI)
				Ind/Res	(IR)
				Res/Com/Ind	(RCI)
				Agri/Natural	(AN)

The background station class has the subclasses ***urban***, ***suburban*** or ***rural***. Rural stations can be located fairly near or very far from sources. For rural sites located relatively close to emission sources, the pollution level will be dependent on actual distance, especially for primary pollutants. For ozone, distance to sources of NO_X is important.

Additional classification of rural stations is therefore beneficial, in order to be able to compare stations. See Larssen et al. (1999) for details:

- Urban and sub-urban background stations:
  Located within urban areas/agglomerations.
- Rural stations:
  - Near-city background stations:
    Located in rural/agricultural areas, with a distance of 3-10 km from built-up areas and other major sources.
  - Regional stations:
    Located in rural/agricultural areas, with a distance of 10-50 km from built-up areas and other major sources.
  - Remote stations:
    Located in rural/natural areas, with a minimum distance of 50 km to built-up areas and other major sources.

The EoI station classes are relevant to differing degrees for exposure of populations, materials and ecosystems:

Table 2.4: Relevance of station class for types of exposure

Station classes	Relevant for exposure of		
	Population	Materials	Ecosystems
Traffic stations	x	(x)	
Industrial stations	x	x	x
Background stations			
- Urban/suburban background stations	x	x	(x)
- Background stations			
- Near city background stations	x	x	x
- Regional background stations	x	(x)	x
- Remote stations			x

To be able to use data from EUROAIRNET to compare air pollution levels between cities or countries or different environments, some specific additional information about station location for some of the stations may be needed, information that is not part of the EoI classification. Such additional information includes for instance:

For Traffic stations:

- Traffic volume (accuracy: ± 2,000 vehicles/day)
- Traffic speed (accuracy: ± 5 km/h, average daytime traffic)
- Distance from kerb (accuracy: ± 1 meter

For Background/Rural stations:

- Distance to nearest built-up areas and other major sources.

For such stations, countries will be asked for the additional data and information.

2.3. Selection of compounds and methods

Compounds

Table 2.5 gives the compounds selected to be monitored in EUROAIRNET, in three priorities. The selection is based upon the requirements in the Framework Directive (the Directive on air quality assessment and management, EU Directive 96/62/EC), the proposed Daughter Directives (CEC, 1997) and WHO guidelines (WHO 1987, 1996).

Methods

Either reference or equivalent methods must be used.

Table 2.5: Selected compounds and indicators to be included in EUROAIRNET, Stage 1.

	Population exposure		Materials exposure		Ecosystems exposure	
	Aver. time	Medium/ compound	Aver. time	Medium/ compound	Aver. time	Medium/ compound
Priority 1	1h (24h)[1)] 1h or 24h 24h or[2)] longer	**Air**. SO_2, NO_2, NO_x, O_3 PM_{10}, $PM_{2.5}$ Pb	24h or longer " aa	**Air**: SO_2, O_3, NO_2, temp., relative humidity **Precipitation**: mm, pH **Materials**[3)]: Weight loss, steel panels	1h 24h aa 24h	**Air**: O_3 SO_2, SO_4^{2-}, NO_2 NO_X **Precipitation**: SO_4^{2-}, NO_3^-, NH_4^+, Ca^{2+}, pH, (H+)
Priority 2	1h 1h or 24h 24h or[2)] longer	CO SPM (or TSP), BS Benzene, PAH, Cd, As, Ni, Hg	24h or longer " " aa	**Air**: HNO_3 (gas) **Precipitation:** Cl, SO_4^{2-}, NO_3^- **Soiling**: PM_{10}, SO_4^{2-} **Materials**[3)]: Weight loss, zinc panels	1h	**Air**: VOC, NO_x
Priority 3	Other compounds		aa	**Materials**[3)]: Weight loss, copper panels. Damage to calcareous stone		

aa: Annual average/exposure.

1) To be able to fully evaluate the measured levels relative to guidelines, these compounds should be reported as 1-hour averages.
24-hour average data from integrating samplers will also be accepted.

2) For these compounds, mainly long-term average concentrations are of interest for the assessment of effects. However, measurement methods often take much shorter samples (e.g. 24-hour or weekly samples), and shorter samples are also needed in order to explain variations in terms of source contributions, etc.

3) Measurements of weight loss of standardised panels of material, measured according to standard procedures (Swedish Corrosions Institute, 1989).

Priority 1 Steel
Steel is the most frequently used reference material for characterisation of the corrosivity of the environment through out the world. Several ISO standards use this material since the corrosivity of steel is highly reproducible if the same production badge is used for the exposure.

Priority 2 Zinc
Zinc is used as reference material in standards in the same way as steel. Zinc tends to give slightly different results compared to steel mainly because zinc gives larger spread in the exposure results.

Priority 3 Copper and calcareous stone
These two materials are to a less extent used as reference materials. However, they are important materials for our cultural heritage. Copper has a slow corrosion rate and may need longer exposure time than one year. Calcareous stone will differ in quality from stone quarry to stone quarry, and different countries are recommended to select their own reference material for stone among the most frequently used calcareous stone types in their country.

2.4. Data quality objectives

The accuracy of air quality data and their spatial and temporal representativeness is obviously very important for the quality of the assessments produced from the data.

Data Quality Objectives (DQOs) are set, so that when they are fulfilled, one can use the data confidently for the purposes for which DQOs have been set.

The objectives of EUROAIRNET that guide the quantification of DQOs, are:

- the data shall enable comparison of air quality across Europe;
- the data shall enable detection of the trends in air quality in Europe, as well as in each area where stations are located, over a reasonable time period (3-5 years), dependent upon the magnitude of the trends;
- the data shall enable the assessments of exposure.

Regarding the first two monitoring objectives (related to mapping/comparability and trend detection) the following DQOs for EUROAIRNET data are proposed. Regarding the monitoring objective related to exposure (of population, materials, ecosystems), the quantification of DQOs requires further analysis, to be carried out as a next step.

DQOs have been set for the following Data Quality Indicators:

- Accuracy
- Precision
- Area of representativeness
- Data temporal coverage

Table 2.6 gives a summary of the EUROAIRNET DQOs set to date.

Table 2.6: A summary of DQOs for EUROAIRNET

	Data Quality Objectives				
Monitoring objective	Accuracy	Precision	Data completeness		Representative-ness (spatial)
			Temporal	Spatial	
Mapping/comparability	≤ 10%	≤2 ppb	≥90%	1)	1), 2)
Trend detection	3)		≥90%	1)	1), 2)

1) The DQOs are set for station-by-station comparison (for same station class) and for trend detection at any one station.
In the case of comparisons, e.g. of cities or larger entities, or trend assessment for larger areas the requirements to spatial coverage and representativeness would be strict. To quantify those requires more analysis.
2) To be eligible for comparison with a station of the same class in another location (city, country), representativeness criteria should be complied with, as described on page 27.
3) To detect a trend with a certain accuracy, the combined accuracy and precision of the measurement must be considerably better than the expected trend (expressed as relative change).

2.5. QA/QC procedure classification

Procedures for Quality Assessment (QA) and Quality Control (QC) are developed to ensure that the data produced from monitoring will at least satisfy the DQOs. Complete QA/QC procedures are rather complex, and they should be documented. A very important element in the quality control procedures is the calibration procedures and the traceability of the calibration standards used in the network/station back to absolute standards of known quality. Institutions responsible for the QA/QC procedures and their follow-up may be international, national, regional or local.

Under the establishment and operations of EUROAIRNET, the quality of the data will be the responsibility of the network/station operators. Checking the procedures or the data quality will remain a national responsibility. ETC-AQ has asked the network operators to classify their QA/QC procedures according to a given scheme. Networks/stations with level 5 QA/QC procedure will not be accepted, and those in level 4 only on a temporary basis. They should be upgraded to 3 or better.

The ETC-AQ will also, by means of a questionnaire and country visits, collect some essential information about the QA/QC system in each network.

3. Summary of selected sites, September 1998

As per July 1998, 18 countries (11 EEA and 7 PHARE) have responded to the EUROAIRNET questionnaire. The 18 countries which have responded are listed in Table 3.1 below. A detailed list of the cities included in each country is given in Annex 1.

Table 3.1: Countries which have made a first selection of areas and stations for EUROAIRNET

EEA	PHARE
Austria	Bulgaria
Belgium	Czech Republic
Finland	Estonia
Germany	Hungary
Luxembourg	Poland
Italy	Romania
Netherlands	Slovak Republic
Norway	
Portugal	
Sweden	
U. K.	

Table 3.2 shows, per country, the number of cities and stations selected, per city and station class. Also QA/QC classes and data availability are summarised.

Table 3.2: Overview of selected cities and stations per country, and QA/QC and data availability classes

Country	Number of cities in each population class[1]					% of urban popu-lation	Number of stations								QA/QC class[5]	Data avail. [6]
							Total	Local pollution stations				Ind. areas and small towns		Rural/ remote pollution stations		
								In urban areas			Near city stations	Ind. areas	Small towns[2]			
	Total	1	2	3	4			T	I	U						
Austria	4	1		3			30	9		17	4				?	
Belgium	13	1	1	5	6		79	15		19		8	5	32	3	6
Bulgaria	21	1	2	15	3		75			61			14		3, 4	6
Czech Republic	18	1	2	15			46	2	1	29	2	6		6	2, 3, 4	6-12
Estonia	1	1					6	1	1	1				3	3, 4	6
Finland	4	1		3			18	11	3	1	2			1	2	3-8
Germany	96	14	15	57	10		261	50	18	75	46[3]	21	5	46	2,3,4	1-6
Hungary	6	1		5			15	5	1	9					2	6
Luxembourg	1			1			5	2				1		2	2	2
Italy	8	6	2				82	65		13	4				2	6
Netherlands	9	2	2	5			21	13[4]		7	1				4	2-4
Norway	3	1		2			18	2	1	3				12	2, 3, 4	6
Poland	5	5					20	1		17	2				2, 3, 4	6
Portugal	2	1	1				12	8		4					2, 3	6
Romania	9	1	4	4			54		2	52					3	6
Sweden	9	1	1	7			9			9					4	6
Slovak Republic	5		1	4			10	7	2	1					1, 2	
U. K.	29	9	11	9			103	17	3	55	5	4		19	3	3
EEA Total	178	37	33	92	16		639	192	26	203	62	34	10	112		
PHARE Total	65	10	9	43	3		226	16	7	170	4	6	14	9		
Overall Total	243	47	42	135	19		865	208	33	373	66	40	24	121		

1) Class 1: >0.5 million; Class 2: 0.25-0.5 million; class 3: 50,000-250,000; Class 4: 25,000-50,000.
2) Population 20,000-25,000.
3) 4 of these stations are near small towns with a population of <25,000.
4) Including one rural traffic station.
5) See section 4.3
6) Number of months into the new year when quality-controlled data files are available for transfer to AIRBASE.

In total there are 241 cities/agglomerations selected (45, 42 and 135 in the three larger city size classes respectively). Of these, 178 are in EEA member countries (11 countries reported so far) and 63 in PHARE countries (7 countries reported so far). In addition, 19 towns of population 25-50,000 have been selected.

A total of 861 stations have been selected, 735 local pollution stations and 126 rural stations. There are 24 stations in industrial areas, and 208, 33 and 363 traffic, industrial and urban background stations respectively, in urban areas. 24 stations are classified as near-city background stations.

Germany, with 15 Länder and the UBA rural network in addition, has selected the largest number of areas and stations, 96 and 261 respectively.

The distribution within each country between urban background and hot-spot stations in urban areas (traffic, industrial) gives an indication of the opinion of the authorities in each country regarding how to conduct surveillance of air quality. The general picture is that there is a dominance of **urban background** stations among the selected stations in most countries. However, in Finland, Italy and the Netherlands, most selected stations are **traffic** stations, indicating that they consider hot-spot monitoring most important. Also Belgium has selected a relatively large number of traffic stations.

Stations in **industrial areas** (outside large cities) have been selected only in Belgium, Czech Republic, Germany and Luxembourg.

Stations in smaller towns (pop. <20,000) have been selected by Belgium, Bulgaria and Germany. This selection may be due to some special sources in those cities.

Stations in **rural areas** have been selected by 8 of the 18 countries, with many stations in particular in Belgium, Bulgaria, Germany and the UK.

4. Acceptance of EUROAIRNET selection

Answering the request from ETC-AQ, countries have selected stations for EUROAIRNET and submitted station information according to the tables provided. Based upon cooperative work and discussions between ETC-AQ and each country, there will be a validation and acceptance of the selection, for stage 1 of EUROAIRNET.

The validation/acceptance procedure must be based upon fulfilment of the design criteria. The details of this procedure will be formulated and discussed with countries.

Validation and acceptance will follow during and after consultations with the countries.

4.1. Area selection criteria

The area selection criteria (see section 2.1) are specified separately for the three types of exposure:

- human population,
- materials, and
- ecosystems,

and for three types of areas:

- cities,
- industrial areas, and
- rural areas.

For each of the types of exposure, exposure in all or some of the three types of areas (cities, industrial areas, rural areas) may be relevant for the effects of the pollution. This would depend for instance on the compound in question. For instance, for the population in rural areas, exposure to ozone may be relevant, but the exposure to NO_2 may not be.

The tables below are intended to show to what extent the areas already selected satisfy the selection criteria for these different types of exposure. In this section, this is evaluated for Europe as a whole and for the EEA and PHARE areas separately.

4.1.1. Selection of areas for population exposure assessment in cities and agglomerations

In total, 224 cities have been selected out of 1,113 cities with population above 50,000 (Table 4.1). All 677 urban and near-city stations have been indicated to represent exposure of the nearby population.

The cities/agglomerations are separated into classes. All cities above 0.5 million inhabitants should be selected. 19 EEA cities and 3 PHARE cities are missing, mainly because several countries have not selected yet.

For smaller cities, the selection criteria are already well satisfied. This may indicate that our selection criteria for such cities were set too low.

Monitoring stations in smaller towns (less than 50,000 inhabitants) were also selected:

- 25,000-50,000: 18 towns (10 in Germany, 5 in Belgium, 3 in Bulgaria)
- 20,000-25,000: 35 towns (16 in Germany, 5 in Belgium, 14 in Bulgaria).

The degree of Spatial Coverage (column in Table 4.1) will not be evaluated before more countries have selected stations for EUROAIRNET.

Table 4.2 shows the criteria fulfilment per country. For most countries that have selected areas, the criteria are fulfilled, but there are some shortcomings, e.g.:

- Some class 1 cities have not been selected:
  - UK: Leeds and Nottingham
  - Poland: Wroclaw, Poznan
- Italy, Portugal and UK could select some (more) class 3 cities.

Table 4.1: Selection of areas for Population Exposure Assessment in Cities/Agglomerations. Degree of fulfilment of criteria. Population statistics: 1990 (WHO)

EEA	Total no.	Selection criteria	No. of areas to be covered in EUROAIRNET	So far selected	Fulfilment of criteria	Spatial coverage
Cities > 0.5 millions	56	All	56	37	Unsatisfactory	
0.25 – 0.5 millions	67	$\geq$ 25%	>16	33	OK	
0.05 – 0.25 millions	745	$\geq$ 10%	>74	92	OK	
25,000-50,000				16		
PHARE						
Cities > 0.5 millions	12	All	12	10	Unsatisfactory	
0.25 – 0.5 millions	26	$\geq$ 25%	>6	9	OK	
0.05 – 0.25 millions	208	$\geq$ 10%	>20	43	OK	
25,000-50,000				3		
EEA+PHARE						
	Total no.	Selection criteria	No. of areas to be covered in EUROAIRNET	So far selected	Fulfilment of criteria	Spatial coverage
Cities > 0.5 millions	67	All	67	47	Unsatisfactory	
0.25 – 0.5 millions	93	$\geq$ 25%	>22	42	OK	
0.05 – 0.25 millions	953	$\geq$ 10%	>94	135	OK	
< 50,000				19		

Table 4.2: Selection of areas per country for population exposure in cities and agglomerations

	> 0.5 mill.				0.25-0.5 mill.				0.05-0.25 mill.				0.025-0.05 mill.		0.020-0.025 mill.
	Total #	Sel. #	Sel. %	Crit.	Total #	Sel. #	Sel. %	Crit.	Total #	Sel. #	Sel. %	Crit.	Total #	Sel. #	Total #
Albania					0				6				3		2
Austria	1	1	100	+	0	0			7	3	43	+	8		8
Belgium	1	1	100	+	1	1	100	+	16	5	30	+	9	5	12
Bosnia	0				1				4				?		?
Bulgaria	1	1	100	+	2	2	100	+	22	15	68	+	?	3	?
Czech Rep.	1	1	100	+	2	2	100	+	21	15	71	+	27	0	15
Denmark	1				0				5				15	0	4
Estonia	1	1	100	+	0				2				?		?
Finland	1	1	100	+	0	0			11	3	27	+	16	0	11
France	6				15				90				68	0	44
FYROM	0				1				3				7		130
Germany	14	14	100	+	16	15	94	+	237	59	24	+	291	10	8
Greece	2				0				5				20		18
Hungary	1	1	100	+	0	0			20	5	25	+	28		?
Iceland	0				0				1				?		
Ireland	1				0				2				3		2
Italy	6	6	100	+	7	2	29	+	125	0	0	÷	210	0	97
Latvia	1				0				5				?		?
Liechtenstein															
Lithuania	1				1				4				?		?
Luxembourg		0				0			1	1	100	+	1		
Netherlands	2	2	100	+	2	2	100	+	36	5	14	+	36	0	8
Norway	1	1	100	+	0	0			6	2	33	+	14	0	8
Poland	5	3	60	÷	10	0	0	÷	69	0	0	÷	72		47
Portugal	1	1	100	+	1	1	100	+	4	0	0	÷	9	0	12
Romania	1	1	100	+	8	4	50	+	38	4	11	+	39	0	25

Table 4.2 contd.

	> 0.5 mill.				0.25-0.5 mill.				0.05-0.25 mill.				0.025-0.05 mill.		0.020-0.025 mill
	Total #	Sel. #	Sel. %	Crit.	Total #	Sel. #	Sel. %	Crit.	Total #	Sel. #	Sel. %	Crit.	Total #	Sel. #	Total #
Slovak Rep.	0				1	1	100	+	10	4	40	+	13	0	12
Slovenia	0				0				4				?		?
Spain	7				9				74				81	0	53
Sweden	1	1	100	+	1	1	100	+	17	7	41	+	19	0	10
UK	11	9	82	÷	15	11	73	+	108	9	5	÷	115	0	51
Switzerland	0				1				8				6		
Malta															
Cyprus	0				0				2				?		
Croatia	1				0				7				8		1
Serbia	1				0				18				18		2

Industrial areas

Only a few industrial areas have been selected so far, namely 22 areas (42 stations) in 5 countries (see Table 4.3 and Annex 2). All stations represent population exposure, but some of the stations are also indicated by countries to represent materials and ecosystems exposure as well (Table 4.3).

Countries will be asked to list the industrial areas (outside cities and towns) with potential air pollution problems. Then the fulfilment of criteria can be evaluated.

Table 4.3: Selected industrial areas

Country	No. of ind. areas	No. of stations	No. of stations per type[1] of exposure		
			P	M	E
Belgium	6	11	11	11	5
Czech Republic	3	6	6	5	0
Germany	9	21	21	1	1
Luxembourg	1	1	1	0	0
UK	4	4	4	0	0
Total EEA	20	37	37	12	6
Total PHARE	3	6	6	5	0
Total	23	43	43	17	6

1) P = Population exposure, M = Materials exposure, E = Ecosystems exposure.

Rural areas

A total of 70 areas (82 stations) in seven countries have been selected (see Table 4.4 and Annex 3). Of the 82 stations, 43 are classified by the countries as representative for population exposure. Many rural stations represent ecosystems exposure only, and some are also indicated by countries to represent materials exposure (Table 4.4).

The selection of rural stations needs to be increased for most countries to fulfil the criterion: to cover >50 % of the rural population reasonably well.

Table 4.4: Selected areas and stations in rural areas

Country	No of rural areas	No. of stations	No. of stations per type[1] of exposure			Of these, some are EMEP stations
			P	M	E	
Belgium	22	23	23	12	12	1
Czech Republic	6	18	7	0	18	
Estonia	3	3	0	0	3	2
Finland	1	1	0	0	1	
Germany	30	30	6	0	42	10
Luxembourg	2	2	2	0	2	
Norway	12	12	11	1	12	7
UK	19	19	19	0	16	14
Total EEA	86	87	68	13	73	32
Total PHARE	9	21	7	0	21	2
Total	95	108	75	13	94	34

1) P = Population exposure, M = Materials exposure, E = Ecosystems exposure

4.1.2. Selection of areas for materials' exposure

10 countries have indicated that a number of their monitoring stations are suitable to assess materials exposure. This concerns a total of 126 stations in 71 areas covering partly cities, industrial areas, or rural areas (Table 4.5).

It must be clarified whether these stations indeed measure weight loss of materials.

The stations in the UN-ECE ICP programme are listed in Table 4.6, which also indicates which of the ICP stations have also been selected for EUROAIRNET.

Fulfilment of criteria:

In cities/agglomerations:

The selection criteria specify that at least 10 % of the cities with more than 0.5 mill. inhabitants should have at least three stations for materials exposure assessment, i.e. at least 7 cities.

This criterion appears to be fulfilled.

Industrial areas

At least 5 % of the areas should be covered with stations for materials exposure.

A total of 16 stations in 12 industrial areas in three countries (Belgium, Czech Republic, Germany) have so far been selected.

Table 4.5: Selected areas and stations with monitoring programme indicated by the countries to be suitable to assess materials exposure

	No. of areas			No. of stations		
	Cities/ agglom.	Industrial	Rural	Cities/ agglom.	Industrial	Rural
Belgium	17	6	12	43	11	12
Czech Republic	8	5		9	5	
Estonia			1			
Finland	1			6		
Germany	4	1		7		
Hungary	5			7		
Luxembourg	1			1		
Norway	2			1		1
Poland	1			1		
Portugal	1			4		
Romania	6			18		
Total	46	12	13	97	16	13

Rural areas

According to the criterion, materials exposure stations should be selected in each of the different climate zones in a country. 13 rural stations in Belgium are also selected for materials exposure assessment.

Table 4.6: Classification of the monitoring sites included in the ICP on effects on materials

Countries	Number of sites					Of these,
	Traffic	Industry	Urban background	Near city	Regional	selected for EUROAIRNET
EEA countries						
Belgium			1			
Finland			1		1	1
France			1			
Germany		1	1	1	1	
Greece			1			
Italy	2		1		1	
The Netherlands		1			1	
Norway			1		2	2
Portugal			1			
Spain		1	1		1	
Sweden			2		1	
United Kingdom			2			
PHARE countries						
Estonia					1	1
The Czech Republic		1	1			2
TACIS countries						
Russia			1			
Other countries						
Switzerland					1	
TOTAL	2	4	14	1	10	

4.1.3. Selection of areas for ecosystems' exposure

Each country was asked to develop its own plan for a monitoring network for ecosystem exposure assessment.

Rural areas

The following should be included in EUROAIRNET:

- the EMEP stations
- rural ozone stations
- other existing rural stations monitoring S- and N-compounds in air and precipitation.

Table 4.4 shows that 94 stations in about 70 areas in seven countries have been selected to represent ecosystems exposure. 34 of these stations are

also EMEP stations (in Belgium, Estonia, Germany, Norway, UK) (Table 4.4).

Industrial areas

Table 4.3 shows that six stations in industrial areas in Belgium and Germany have been selected to also represent ecosystem exposure.

Cities/agglomerations

Stations in the following 11 cities have been indicated by the countries to be suitable to also assess ecosystems exposure:

Czech Republic:	Brno, Plzen, Usti Nad Labem
Germany:	Berlin, Hamburg, Rostock
Italy:	Firenze, Genova, Milano, Roma
Poland:	Krakow

4.2. Compound coverage

The compound selection criteria (see section 2.3) specify pollutants to be included by EUROAIRNET, in three priority classes, for assessment of exposure of the population, materials and exposure respectively.

Table 4.7 and Table 4.8 give a summary of the extent of monitoring of the various compounds at the selected stations, all countries viewed together. In this overview automatic monitoring (hourly data) and integrating sampling (24 hour data or longer averages) are presented separ4ately. At this stage, stations in cities, industrial areas or rural areas have not been separated.

4.2.1. Compound coverage for population exposure

Priority 1 Compounds:

SO_2, NO_2, NO_x, O_3:	1-hour averages (24-hour averages accepted for SO_2 and NO_2)
PM_{10}, $PM_{2.5}$:	24-hour averages
Pb:	24-hour or longer averages.

SO_2 and NO_2 are measured at more than 625 (more than 80%) of the stations, mostly as 1-hour averages (Table 4.7). NO_x is covered to a large extent. O_3 is measured at about 40 % of the sites, PM_{10} at only 25 %, and lead at only 15 % of the sites. The first selection process for monitoring stations suitable for the EUROAIRNET shows that none of the stations selected measure $PM_{2.5}$.

Thus, some priority 1 compounds are monitored extensively, but the PM_{10} coverage should be improved.

An analysis of compound coverage per country and station class when available will show more precisely how compounds are covered, dependent upon the source, micro-environment and country.

Table 4.7: Compound coverage for Population Exposure Assessment. Degree of fulfilment of criteria (Priority 1).

Average time of measurements	Number of Sites						
	SO_2	NO_2	NO_x	O_3	PM_{10}	Pb	Benzene
1 hour	563	589	468	321	189		37
24 hours	96	45			11	113	32
> 24 hours	7			4		7	6
Total	645	626	468	325	200	120	75
% of all stations	82	80	59	41	25	15	9.5

Priority 2:
Criteria: CO, TSP, BS: 1-hour averages (24-hour averages accepted)
Benzene, PAH, Cd, As, Ni, Hg: 24-hour or longer averages.

CO and TSP/SPM are monitored at about 40% of the stations. Benzene is measured at about 10%, and the other compounds (BS, PAH, metals) at only 1-5% of the stations.

An analysis of coverage per country and station class when available will show a clearer picture.

In addition, country-wide overview tables are presented in Annex 4, where a detailed study of the monitoring situation in various European countries and cities is also shown.

Table 4.8: Compound coverage for population exposure assessment. Degree of fulfilment of criteria (Priority 2).

Average time of measurements	Number of sites						
	CO	TSP	BS	PAH	Cd	Ni	As
1 hour	337	165					
24 hours		130	24	26	38	38	7
> 24 hours					12		
Total	337	295	24	26	50	38	7
% of all stations	43	37	3	3	6	5	1

Priority 3:
Other compounds

4.3. Data quality (QA/QC)

4.3.1. Data quality objectives (DQO)

Countries and networks have not yet been asked to report the DQOs they have set for their monitoring activities. This will be included in a later questionnaire.

4.3.2. QA/QC procedure classification

The current criteria for QA/QC procedure classification are shown in Section 2.4. At the time countries filled in the Site Selection Tables, however, the following criteria for classification were used:

1. 1st level: No documented QC
2. 2nd level: Local QC procedures
3. 3rd level: National QA procedures
4. 4th level: QC by accredited institution.

The level of QA/QC procedures in the countries who have reported range between 1 and 4, with most on levels 2 and 3 (Table 4.9).

Table 4.9: QA/QC procedure classification, as reported by the countries using above criteria

EEA	QA/QC class	PHARE	QA/QC class
Austria	1, 2	Bulgaria	3, 5
Belgium	2, 3	Czech Republic	2, 3, 4
Finland	2	Estonia	3, 4
Germany	2, 3, 4	Hungary	2
Luxembourg	2	Poland	2, 3, 4
Italy	2	Romania	3
the Netherlands	4	Slovak Republic	1, 2
Norway	2, 4		
Portugal	2, 3		
Sweden	4		
UK	3		

Thus, there is mainly a distribution between local and national QC procedures, but for some networks there is no documented QC. Some networks are at level 4, with QC by accredited institution. Within each country, the level of QA/QC may vary between networks and compounds.

More specific information on QA/QC procedures will be collected.

4.3.3. Area of representativeness

The Station Information Tables also contained a column for "Representativeness radius" (RR). Most countries filled out this column for most stations. Table 4.10 gives a summary of the estimated RR, given as ranges for each station class in each country. In many countries the estimated RR varied from station to station of the same class. Some countries gave the same estimate for all their stations in a class (Finland, Netherlands, Norway, UK).

There is an acceptable variability in RR per station class, and most stations fall within the following ranges of RR:

Traffic:	10-50 meters
Industrial:	0.1-5 km
Urban background:	0.1-2 km
Near city background:	1-5 km
Regional background:	5-25 km
Remote background:	30-500 km (total variation)

Table 4.10: Area of representativeness (radius) of selected stations

	Traffic meters	Industrial km	Urban background km	Near-city background km	Regional km	Remote km
Austria						
Belgium	10-50	0.1-0.2	0.01-3	2	5	
Bulgaria			0.3-2			
Czech Rep.	10	0.1-5	0.1-3	10	10-40	200
Estonia	10	0.1	0.1		25	
Finland	10		0.5			
Germany	5-50	0.5-10	0.1-2	3-5	1-50	30
Hungary	10-100	0.3	0.1-2			
Luxembourg		1	0.02-0.1		20	
Italy	10-50		0.1-1	0.5-2		
the Netherlands	30	5	1			
Norway	10		0.5			
Poland	30		0.5-2	2		
Portugal	10		0.4-0.5			
Romania			0.1-0.5	0.1-0.5		
Sweden			0.5			
Slovak Rep.	10-20	0.03	0.05			
UK[1)]	1-10	0.01-0.1	0.1-2	2-10	25-150	200-500
Total variation	1-100	0.01-5	0.01-2	0. 5-10	1-150	30-500

1) The range of radius given in the table was by UK indicated identically for all stations of a given class.

Compliance with criteria:

Traffic stations: The criteria now specify that representativeness in terms of the **length** of street/road the station is representative for, is more meaningful than **radius**. The representativeness of traffic stations should be re-evaluated.

Industrial stations: No criteria are given for such stations, but a meaningful comparison between stations requires some specific information about source, distance from main source, etc.

Urban background stations: The criterion says that stations with RR>1-1.5 km are suitable for comparison between different cities. It appears that many countries for the moment evaluate the RR of their UB stations to be less than this range.

Near-city background: Criteria for suitable comparison between stations: RR>5 km.
Countries now evaluate the RR of their NCB stations to be less than 5 km.

Regional background stations: Criteria for suitable comparison between stations: RR>20 km. Many of the selected stations have an estimated RR less than 20 km.

Remote background stations: Criteria for suitable comparison between stations: RR>60 km. Only few remote stations have been selected. Their estimated RR range is 30-500 km.

Remarks

More work is needed on this topic, both to prepare guidelines for estimation of RR, and to do the actual estimation. The fact that RR may vary between compounds even within the same station class has not yet been considered directly.

4.3.4. Monitoring methods

A summary is given in Table 4.11 of the monitoring methods reported by countries in the Station Information Tables. The table clearly shows the following dominating methods:

SO_2 : UV Fluorescence (UVF)
NO_x/NO_2: Chemiluminescence (w/O_3) (CHL)
O_3 : UV Absorption (UVA)
CO : IR Absorption (IR)
Pb : Atomic Absorption spectrometry (AAS) (of filter samples)
VOC : GC/FID
BTEX: GC/FID

For particles, there are several methods in use:

PM_{10} : Beta absorption, TEOM, GRAVimetric (filter sampling)
TSP : Beta absorption, GRAVimetric (filter sampling)
BS : REFLectometry (of filter samples).

The actual samplers and instruments are most often not specified, but for particle sampling, the High-volume samplers (Poland), Sierra Dichotomous sampler (Norway), "Klein-filter-gerät" (KFG) (Germany) and LIB-sampler (Germany) are used. Belgium also reports using the Nephelometer method.

There are some other methods used for manual gaseous sampling/analysis:

SO_2: TCM/Pararosaniline (Bulgaria/Romania)
Manual: H_2O_2 -IC (Sweden)

Diffusive sampling (Sweden)
Coulometry (Poland

NO_2 : Griess-Saltzmann (G-S) (Bulgaria/Poland/Romania)
Manual: Impregnated filter (IMF-NaI) (Sweden)
Diffusive sampler (Sweden)

O_3: Volumetric (titration) (Romania)
Manual: Diffusive sampler (Sweden)

VOC: Diffusive sampler (Sweden)

Table 4.11: Summary of reported monitoring methods

	SO_2	NO_x/ NO_2	O_3	$PM_{2.5}$	PM_{10}	TSP/ SPM	BS	Pb	CO	VOC	B(TEX)
Austria											
Belgium	UVF FPD	CHL	UVA		BETA TEOM NEPH		REFL		IR	FID PID	GC
Bulgaria	UVF	CHL	UVA		BETA	BETA			IR		
Auto											
Man	TCM	G-S				GRAV		AAS			
Czech Rep.	UVF	CHL	UVA		BETA	GRAV			IR		
Estonia	UVF	CHL	UVA			GRAV			IR		
Finland	UVF	CHL	UVA		TEOM BETA GRAV	GRAV			IR		
Germany	UVF	CHL	UVA		BETA	BETA	REFL		IR	GC/ FID	GC/FID
Auto					TEOM						
Man				KFG	KFG	LIB		AAS			
Hungary	UVF	CHL	UVA			BETA			IR		
Luxembourg	UVF	CHL	UVA		TEOM				IR	GC/ FID	GC/ FID
Italy	UVF	CHL	UVA		GRAV	BETA			IR	GC/ FID	GC/ FID
the Netherlands	UVF	CHL	UVA		BETA		REFL		IR		GC
Norway	UVF	CHL	UVA	TEOM DICHO	TEOM						
Poland	UVF	CHL	UVA		TEOM				IR		
Auto											
					BETA	HIVOL					
Man	COUL	G-S				GRAV					
Portugal											
Romania	TCM	G-S	VOL U			GRAV		AAS			
Sweden	H_2O_2-IC	IMF (NaI)	DIFF				REFL			DIFF	
Man	DIFF	DIFF									
Slovakia	UVF	CHL	UVA		TEOM			AAS	IR		
UK	UVF	CHL	UVA		TEOM				IR		Auto GC
Reference methods:											
EC	TCM	CHL	UVA	-	-	-	-	AAS	-	-	-
ISO/CEN	UVF	CHL	UVA		WRAC		OECD		IR		
	TCM	G-S			KFG						
					HIVOL						

Compliance with reference methods

This is summarised and commented in Table 4.12. For SO_2, NO_x and NO_2, O_3, CO and Pb, reference methods are used at most stations.

For PM_{10}, CEN has recently proposed three reference methods. These are used to a very little extent. The automatic methods beta ray absorption and TEOM are mostly used.

Table 4.12: Use of reference methods in the selected EUROAIRNET stations

	Reference methods		Comments
	EC	ISO/CEN	
SO_2	TCM	UVF	Most countries use one of these reference methods. Sweden uses other methods for manual stations.
NO_x/NO_2	G-S (NO_2)	CHL (NO_x, NO_2)	Most countries use one of these reference methods. Sweden uses other methods for manual stations.
O_3	UVF	UVF	Most countries use one of these reference methods Sweden and Romania use other methods for manual stations.
Pb	AAS		All countries reporting Pb sampling here use this method.
PM_{10}		WRAC/KFG/ HIVOL-SSI	Germany uses KFG at some stations. Otherwise, all countries use other methods, mainly automatic methods (beta-absorption or TEOM).
CO		IR	All countries use this method.

4.4. Data availability

EEA and ETC-AQ are preparing procedures and tools that will shorten the time delay between the monitoring and the time when quality controlled data will be available. The target is to have data available for transfer from national or local data bases to ETC-AQ within 6 months of the end of each reporting year (calendar year).

Most countries collect the data from the selected stations in **central** data bases. For German Länder, it is assumed that this means the central data base in each of the Länder, not a national data base.

In Italy, the data are collected in local (or regional) data bases. In Germany, Portugal, Hungary and Norway (and Finland) some of the data resides in local data bases.

Table 3.2 shows that most of countries themselves report that their data are available within 6 months.

5. References

CEC (1997) Proposal for a Council Directive relating to Limit Values for SO_2, NO_2, particulate matter and lead in ambient air. Brussels (COM(97)500 final, 97/0266 (SYN)).

EEA (1994) Europe's Environment. The Dobriš Assessment. Ed. by D. Stanners and P. Bourdeau. Copenhagen. European Environment Agency.

EEA (1997) Air pollution in Europe 1997. Ed. by A. Jol and G. Kielland. Copenhagen, European Environment Agency (EEA Environmental Monograph no. 4).

EEA (1998) Europe's Environment. The Second Assessment. Elsevier.

Larssen, S. (1996) European air quality monitoring and information network. Position paper for the European workshop on Air Quality Monitoring and Assessment, Copenhagen 23-25 April 1996. Kjeller (NILU F12/96).

Larssen, S. and Hagen, L.O. (1996) Air pollution monitoring in Europe - Problems and trends. Copenhagen. EEA Topic Report 26/1996.

Larssen, S. and Hagen, L.O. (1996b) Air pollution in Europe 1993 - A pilot report. Copenhagen. EEA Topic Report 25/1996.

Larssen, S., Sluyter, R. and Helmis, C. (1999) Criteria for EUROAIRNET. Copenhagen. EEA Technical Report no. 12.

Richter, D. and Williams, P.W. (1998) Assessment and Management of Urban Air Quality in Europe. Copenhagen. EEA Environmental Monograph No. 5.

The Swedish Corrosion Institute (1989) Description of test sites. Stockholm (UN/ECE International Co-operative Programme on Effects on Materials, including Historic and Cultural Monuments. Report No. 2).

World Health Organization (1987) Air Quality Guidelines for Europe. Copenhagen, WHO (WHO Regional Publications, European Series No. 23).

WHO (1996) Revised WHO Air Quality Guidelines. Guideline section of selected chapters. WHO-ECEH, Bilthoven (Unedited version, 5. November, 1996).

WMO (1992) Report of the WMO Meeting of Experts on the Quality Assurance Plan for the Global Atmospheric Watch. Garmish-Partenkirchen (WMO Report No. 80).