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QA/QC PROGRAMME ON AIR QUALITY MONITORING IN THE WHO EUROPEAN REGION (1994 – 2004)

Hans-Guido Mücke

WHO Collaborating Centre for Air Quality Management and Air Pollution Control
Federal Environmental Agency, Corrensplatz 1, 14195 Berlin, Germany
www.umweltbundesamt.de/whocc/titel/titel21.htm; hans-guido.muecke@uba.de

ABSTRACT

Since early 90ies the WHO Collaborating Centre operates a QA/QC programme on air quality monitoring in the WHO European Region. As main activity between 1994 and 2004 Intercomparison workshops have been carried out for air monitoring network laboratories on a regular basis to harmonise air quality measurements, analysis and calibration techniques. 36 air hygiene laboratories of public health and environmental institutions of 24 countries participated in twelve workshops. The majority of Intercomparisons were carried out for NO, NO_2, SO_2 and O_3. They produced predominantly satisfactory results for automatic methods. Manual methods were mainly in a good, and for several concentration levels partly very good accordance with the data obtained by monitors.

Key Words: Air Monitoring, Quality Assurance and Control, Intercomparison Measurements, Calibrations

1. INTRODUCTION

Already in the 70ies UNEP and WHO established a global programme on air quality monitoring (GEMS-Air) to assist countries in monitoring air pollution to improve the utilization of data for health risk assessment and to promote the exchange of information. In 1990, the WHO European Centre for Environment and Health (WHO/ECEH: until 2000 located in Bilthoven/NL, since 2001 in Bonn/D) was established besides to take over the responsibility for the programme 'Air Quality and Health (AIQ)' for the WHO European Region. Part of AIQ is the evaluation of air quality which is important for assessing the nature of population exposure to air pollution. Reliable data are indispensable for any further assessments of air pollution impacts on human health or measures. But problems in the comparability of air quality data have been identified within Europe. Therefore, WHO/Euro recommended quality assurance and control (QA/QC) activities to harmonise air quality measurements and data. Along this the WHO Collaborating Centre for Air Quality Management and Air Pollution Control (WHO/CC, Berlin) at the German Federal Environmental Agency (UBA) supports the efforts of harmonising air pollution measurements to improve comparability and applicability of data, e.g. for an international health impact assessment and in an environment and health information system. In 1994, WHO/CC started the international QA/QC programme 'European Intercomparison Workshop on Air Quality Monitoring' for air monitoring networks of the 52 WHO European Member States to harmonise air quality measurements, analysis and calibration techniques.

The main objective of this programme is to serve as a platform supporting especially laboratories responsible for QA/QC in air monitoring networks, either at the national, regional, or local level, which are not routinely involved in international QA/QC programmes. The workshop offers a sound opportunity to compare the operation and quality of ambient air measurements of continuous and discontinuous methods to be carried out with automated, semi-automated, and/or manual devices (monitors vs. sampling and analysis), to check calibration procedures and standards, and to share acquired experiences and know-how amongst the experts. Test gases (dry and without interfering substances) of inorganic and organic pollutants are generated continuously for different concentration levels during a one week workshop training campaign. The Intercomparison measurements are carried out at a central laboratory facility (sample air manifold at the German reference laboratory for air quality) to determine and evaluate the quality of the measured concentration values. Each participating laboratory has to apply their own complete equiment to measure and to achieve in situ calibration of its analysing method(s) using the national calibration method (reference or transfer standard). Laboratories participate on a voluntary basis. The technical description of the sample air manifold, generation of test gases, calibration procedures, and individual results of all Intercomparison measurements have been published in detail in the WHO/CC series ‘Air Hygiene Report’ (Mücke et al., 1995, 1996, 1999, 2000, 2003).

2. OVERVIEW

Between July 1994 and April 2004 the WHO/CC conducted twelve Intercomparison workshops for inorganic and organic pollutants (oxides of nitrogen, sulphur dioxide, carbon monoxide, ozone, and benzene, toluene, xylene). In total 36 air hygiene laboratories of public health (n=15; 11 national, 3 regional and 1 local) and environmental (n=21; 17 national, 2 regional and 2 local) institutions of 24 countries of the WHO European Region participated (Table 1).

Table 1. Participating laboratories (1994-2004)

Laboratories (n = 36)	Participations (n = 97) n
AEA Technology, National Environmental Technology Centre, Culham/UK	3
Brussels Institute for Management of the Environment, Brussels/B	2
City Centre of Sanitary and Epidemiological Surveillance, Moscow/RF	1
Czech Hydrometeorological Institute, Prague/CZ	3
Environmental Monitoring Centre, Yerevan/AR	1
Environmental Protection Ministry, Joint Reserach Centre, Vilnius/LT	4
Estonian Environmental Research Centre, Tallinn/EST	3
Federal Environmental Agency, Vienna/A	1
Federal Environmental Agency - UBA Pilotstation, Langen/D	10
Federal Environmental Agency - UBA Branch Schauinsland, Kirchzarten/D	4
Hydromet. Institute / Environ. Agency of Slovenia, Ljubljana/SI	6
Institute of Hygiene and Medical Ecology, Kiev/UA	1

Institute of Hydrometeorology, Tirana/AL	3
Institute of Medical Research and Occupational Medicine, Zagreb/HR	5
Institute of Public Health, Rijeka/HR	1
Institute of Public Health, Belgrade/SCG	4
Institute of Public Health, Bucharest/RO	2
Interregional Cell for the Environment, Brussels/B	1
Latvian Hydrometeorological Agency, Riga/LT	1
Main Administration of Hydrometeorology of Uzbekistan, Tashkent/UZ	4
Main Geophysical Observatory, St. Petersburg/RF	4
Ministry of Environment and Nature Resources Protection, Tblissi/GE	1
National Centre of Hygiene, Medical Ecology and Nutrition, Sofia/BG	7
National Environmental Health Centre, Riga/LV	1
National Institute of Hygiene, Budapest/H	5
National Institute of Public Health, Prague/CZ	7
Norwegian Institute for Air Research, Kjeller/N	2
Occupational Medicine Centre - Institute of Hygiene, Vilnius/LT	1
Research Institute of Hygiene and Epidemiology, Tirana/AL	1
Stadtwerke, Düsseldorf/D	1
State Committee of Sanitary and Epidemiological Surveillance, Moscow/RF	1
State Environmental Agency of North Rhine-Westphalia, Essen/D	2
Swiss Federal Laboratory for Material Testing and Research, Dübendorf/CH	1
Wojewodzka Stacja Sanitarno Epidemiologiczna, Katowice/PL	1
Wojewòdzka Stacja Sanitarno Epidemiologiczna, Warsaw/PL	1
YTV Helsinki Metropolitan Area Council, Helsinki/FIN	1

Besides in the 90ies the European Commission's Joint Research Centre, Institute for Environment and Sustainability, European Reference Laboratory of Air Pollution (JRC/IES/ERLAP) in Ispra/I, was nominated as responsible institution in the European Union in order to fulfill the QA/QC requirements within the implementation of the EC air quality directives. The basis for the organisation of Intercomparisons is laid down in Council Directive 96/62/EC, the so-called 'Framework Directive'. National Air Quality Reference Laboratories, representing the EU Member States, are required to participate in these harmonisation activities (Borowiak et al, 2000; http://ies.jrc.cec.eu.int/Units/eh/Projects/Aquila/). This results in an inhomogeneous distribution of laboratories from Western Europe (WE) participating between 1994 and 2004 in the WHO/CC Intercomparisons, while for laboratories from Central and Eastern Europe (CCEE) and Newly Independent States (NIS) the workshops are continuousely on high demand, as Figure 1 shows.

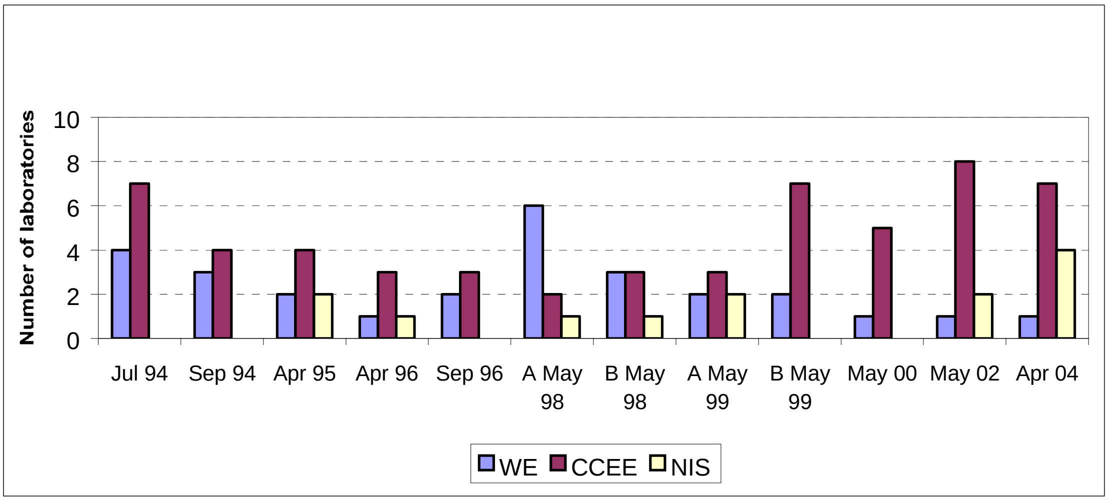

Figure 1. Number and geographical origin of participating laboratories (1994-2004)

3. RESULTS

Between 1994 and 2004 the combination of test gas components to be measured and compared varied slightly. With regard to European air quality regulations Intercomparisons of the inorganic gases NO, NO_2, SO_2 and O_3 were most relevant. Test gases for NO, NO_2 had been offered during eleven, for SO_2 and O_3 in seven workshops. Up to five concentration levels between 20 to 750 ppb for NO, 10 to 250 ppb for NO_2, 5 to 200 ppb for SO_2, and 20 to 220 ppb for O_3 had to be measured. Each concentration was generated for 1.5 hours. The laboratories were requested to report 0.5 hour mean values. Figure 2 depicts the number and proportion of all 0.5 hour mean values determined by manual (sampling and analysis) and automatic (monitors) methods during daytime measurements.

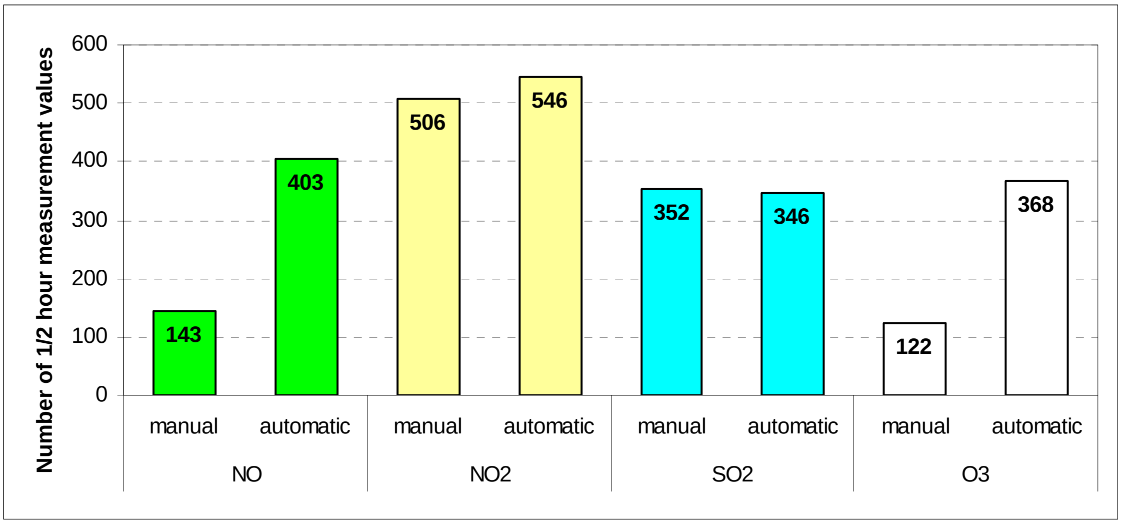

Figure 2.Number and proportion of manual and automatic measurements (1994–2004)

To ensure better and more comparable air quality data across the EU data quality objectives and compilation of results of air quality assessment for NO, NO_2 and SO_2 are set in the European Commission's Council Directive 1999/30/EC, and for O_3 in the Directive 2002/3/EC, the so-called 1st and 3rd 'Daughter Directives' on air quality. As defined, the required accuracy of 15% for continuous (automatic) NO, NO_2, SO_2 and O_3 measurements should be interpreted as being applicable in the region of the appropriate limit value.

During the Intercomparisons volume to volume ratios of test gases were generated by the UBA Pilotstation laboratory. In order to give a point of reference the results of UBA monitors were defined, accepted and used as target values, which is considered to be the most accurate mean for comparison purposes. UBA monitor values are not included in this interpretation. The evaluation of accuracy and uncertainty of the Intercomparisons are not in line with the ISO Guidelines of the 'Daughter Directives', due discontinuous (manual) methods have been applied. Intercomparisons record a momentary measuring situation under laboratory conditions only. Sources of uncertainty during sampling on site could not be considered. Therefore, two tolerance margins (+/-10% from the target value, and a more strict one of +/-5%) were set as a dimension for the interpretation and evaluation of the Intercomparison results. Figure 3 shows the percentage of the beforementioned NO, NO_2, SO_2 and O_3 0.5 hour mean measurement (automatic and manual) values within these margins of tolerance.

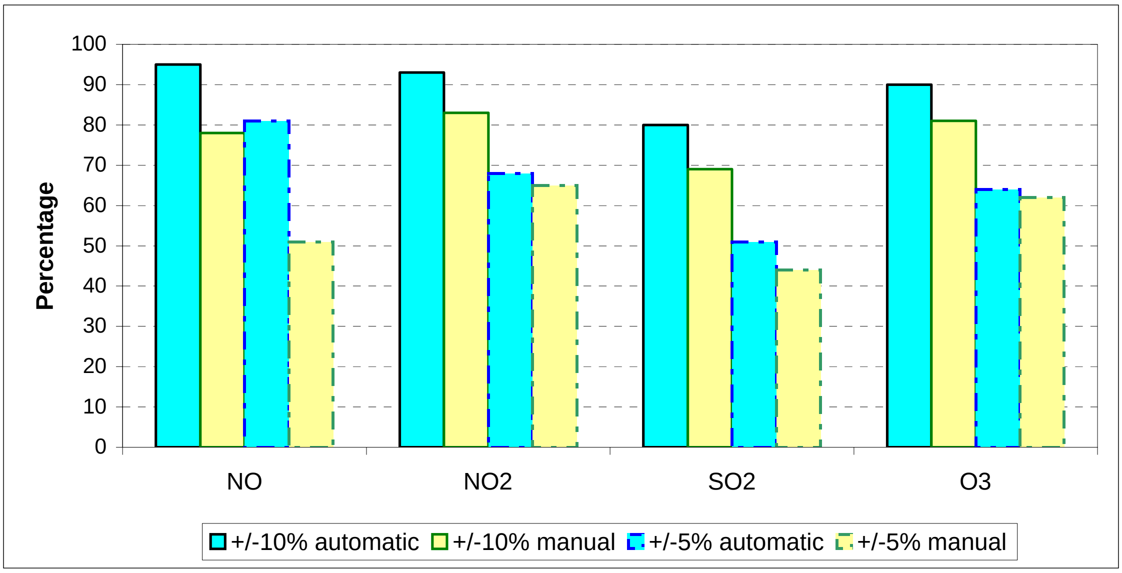

Figure 3. Percentage of manual and automatic daytime measurements within the tolerance margins of +/-10% and +/-5% (1994-2004)

Within the tolerance of +/-10% the values measured by automatic monitors provided satisfactory results agreeing on a high percentage rate with the target value. On average they are about 10% higher than those of manual methods, which is a sound result for discontinuous measurements, too. Regarding the tolerance of +/-5% the results of both methods vary considerably on a lower level, slightly better for automatic ones and with a minor distinction between the methods (except for NO). Both measurement methods show for both levels of accuracy nearly the same proportion for all components, which means about ¾ of values within a tolerance of +/-10% reaching also the margin of +/-5%.

Compared to NO, NO_2 and O_3 surprinsingly the results for SO_2 are not as good for both methods, although SO_2 has been measured for many years and the laboratories are well experienced. Particularely, the Intercomparisons showing problems with the detection of very low SO_2 concentrations (< 10 ppb).

4. CONCLUSIONS

The Intercomparison measurements produced predominantly satisfactory results for automatic methods within a tolerance margin of +/-10% from the target value. Manual methods (still operated in Eastern Europe countries, Caucasus and Central Asia / EECCA) were mainly in a good, and, for several concentration levels partly very good accordance with the data obtained by monitors. Intercomparisons record a momentary measuring situation under laboratory conditions only. More uncertainty sources occur probably under routine monitoring conditions, such as ambient air impact, sampling, drift and maintenance. In some countries calibration standards for automatic devices do not exist. Hence, such monitors had to be calibrated with the standard of the UBA Pilotstation.

The QA/QC programme 'Intercomparison workshops' of WHO/CC are to be seen as an important step to provide reliable data measured by automated and manual methods. Such training courses provide an excellent opportunity for laboratory experts to meet and to exchange technical information and experiences. Improvements in the quality of measurements have been identified for laboratories participating more frequently, in particular those from EECCA who switched from manual to automatic methods. Nevertheless, there is an urgent necessity to continue this QA/QC programme in the future in order to check and stabilise the level reached and stress the importance of intensifying the integration process of those countries not yet belonging to EU. The experiences gained during the Intercomparisons should also be disseminated through the participating laboratories to other centres or networks in the Member States.

Recently the WHO Regional Office for Europe and the European Commission strengthened their intention to intensify the cooperation in the broad field of environment and health. Because of the increasing number of EU Member States, which are Member States of the WHO European Region too, ERLAP and WHO/CC are preparing to harmonise their QA/QC activities on air quality for the near future, e.g. planning of joint Intercomparisons.

5. ACKNOWLEDGEMENT

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