UNITED NATIONS

E

Economic and Social Council

Distr.
GENERAL

EB.AIR/WG.1/1999/7
9 June 1999

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

EXECUTIVE BODY FOR THE CONVENTION ON
LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Working Group on Effects
(Eighteenth session, Geneva, 25-27 August 1999)
Item 5 (c) of the provisional agenda

FUTURE DEVELOPMENT OF THE PROGRAMME AND CREATION OF AN ENVIRONMENTAL DATABASE FOR THE NEW EXPOSURE PROGRAMME

Progress report by the Chairman of the Task Force on the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments

I. INTRODUCTION

1. The present report describes the future development of the International Cooperative Programme on Effects of Air Pollution on Materials including Historic and Cultural Monuments (ICP Materials). It consists of two main parts. The first concerns the use of previous results obtained during the course of the programme and includes the development of activities concerning mapping areas with increased corrosion risk and calculating costs due to corrosion damage. The second part is the further implementation of the multi-pollutant exposure programme including the creation of an environmental database for the first year of exposure.

GE.99-31780

II. MAPPING ACTIVITIES AND CALCULATION OF CORROSION COSTS

2. The aim of the original exposure programme was to perform a quantitative evaluation of the effects of sulphur pollutants in combination with NO_x and other pollutants as well as climate parameters on the atmospheric corrosion of important materials. The results of the materials exposure and the environmental measurements (1987-1995) were used to create a database suitable for quantifying the effects of acidifying air pollutants on corrosion of materials. The statistical evaluation of the results for the materials involved was performed by the responsible research sub-centres and published in separate reports. A unified approach for the statistical evaluation was then adopted in order to develop dose-response relations suitable for mapping purposes and calculating the cost of corrosion damage. Using the unified approach, dose-response relations have been obtained for copper, bronze, weathering steel, zinc, aluminium, nickel, tin, limestone, sandstone and glass. The effect of dry and wet deposition has been expressed as additive terms in the unified dose-response relations, which makes it possible to separate their individual contributions to the total corrosion attack.

3. Mapping activities have already started in individual countries and a special session was devoted to this subject at the Workshop on quantification of effects of air pollutants on materials, held in Berlin in May 1998 [1]. Contributions were presented from Sweden, Spain, Norway, Germany, Australia and the Russian Federation. It was concluded that the available dose-response functions were applicable to mapping procedures. Mapping areas with a high risk of corrosion damage in different pollution scenarios is an essential part of the programme and provides basic information for the valuation of damage. However, a need was identified to establish clear procedures for mapping in order to facilitate comparisons of maps produced by different institutes or organizations and for different countries. Therefore, it was decided that a workshop on mapping air pollution effects on materials, including stock at risk, would be held in Sweden in the spring of 2000. The workshop would be organized jointly by ICP Materials and the Task Force on Mapping.

4. An important task in the future work of ICP Materials is to initiate and participate in calculations of the costs of damage caused by air pollutants to materials including cultural heritage.

III. THE MULTI-POLLUTANT EXPOSURE PROGRAMME

5. The original field exposure programme was designed primarily for the evaluation of the effect of sulphur pollutants in combination with NO_x on important materials. The evaluation of the programme showed that this aim could be fulfilled as was described in the previous chapter.

6. The original aim of the programme is no longer sufficient to describe the task at hand. In many European countries the concentration of sulphur dioxide has decreased significantly, while the concentrations of nitrogen pollutants

and ozone remain high. Sulphur dioxide will still be one of the main pollutants, but the relative effects of NO_x, ozone and particulate matters are becoming more important. Therefore, a four-year multi-pollutant exposure programme started in the autumn of 1997. Compared with the original programme, changes have been made to the network of test sites, the exposed materials and the characterization of the environment. In short, these are the main changes of the programme:

(a) Improvement of the efficiency of the network of test sites by excluding 18 redundant sites from the original network of 39 sites;

(b) Taking into account the multi-pollutant situation by incorporating new combinations of climate and pollution with the addition of 9 new test sites;

(c) Increase in the share of urban sites from 14 out of 39 to 17 out of 30 by, for example, including new sites in Berlin, Paris and London;

(d) Extension of the programme to include 19 countries, compared to the 14 countries involved in the original programme;

(e) Improvement of the efficiency of environmental data reporting by using electronic communication, by reporting only monthly data and by replacing the not easily available parameter 'time of wetness' with temperature and relative humidity;

(f) Taking into account the multi-pollutant situation by changing the status of ozone from optional to mandatory and by including HNO_3 and particulates as new optional pollutant parameters;

(g) Improvement of the efficiency of the programme by excluding materials within groups of similar materials;

(h) Recognizing the increased importance of cultural heritage by including limestone as a new trend material.

7. The decreasing trend in the concentration of acidifying air pollutants found in the network of urban and rural sites of ICP Materials has resulted in a decreasing trend of corrosion rate of exposed materials. The trend exposures are considered to be an important tool for confirming the environmental effects of reductions in acidifying air pollutants achieved under the Convention, as well as a method for identifying other extraordinary environmental changes that result in damage to materials. The inclusion of limestone as a new material for trend exposures, besides the metals zinc and carbon steel, constitutes an important contribution to the understanding of the effects of pollution trends on the deterioration of objects of cultural heritage.

A. The test site network

8. A careful examination of the data after 8 years of exposure using principal component analysis (PCA) formed the basis for excluding redundant and incorporating new sites in the network. Figure 1 shows the network of test sites for the multi-pollutant programme. The original network consisted of 39

test sites from 14 countries. The multi-pollutant exposure programme includes 30 test sites from 18 countries, of which 21 test sites are from the original network.

B. The exposure of materials

9. The original programme included a wide range of materials, classified into the groups structural metals, paint coatings, stone materials and electric contact materials. Later, polymeric materials and glass materials were added. All of these groups are planned to be represented in the continued programme but the total number of materials in each group is less than in the original programme. The trend exposures, which were a successful part of the original programme, are continued and now include exposure of unalloyed carbon steel and zinc as before and also exposure of Portland limestone. The following is a list of materials included in the multi-pollutant exposure programme and the respective responsible sub-centres:

Structural metals

Unalloyed carbon steel and zinc for trend analysis	SVÚOM Praha a. s., Prague, Czech Republic
Zinc	EMPA, Corrosion/Surface Protection, Dübendorf, Switzerland
Copper and Cast Bronze	Bavarian State Conservation Office, Munich, Germany

Paint Coatings

Steel panel with alkyd primer and alkyd-acrylate topcoat (80 µm)	Norwegian Institute for Air Research (NILU), Lilleström, Norway

Stone materials

Portland limestone (also for trend exposure)	Building Research Establishment (BRE), Garston Watford, United Kingdom

Electric contact materials

To be confirmed (exposure not started in October 1997)	Swedish Corrosion Institute, Stockholm, Sweden

Glass materials

Glass M3 and Glass M1 (sensitive)	Institute of Chemistry, Academy of Fine Arts, Vienna, Austria

Polymer materials

To be confirmed (exposure not started in October 1997)	Vacant

C. Current status of the exposure of materials for the multi-pollutant programme

10. The first withdrawal in the multi-pollutant programme was performed in the autumn of 1998. The samples are currently under evaluation and the results will be presented at the Task Force meeting in Toronto, Canada, 9-11 June 1999. The results from the evaluation of carbon steel are shown in figure 2. The results are still preliminary and all samples are not yet evaluated. Carbon steel is one of the trend materials and so far results have been obtained for the periods 1987-88, 1992-93, 1994-95, 1996-97 and 1997-98.

D. The characterization of the environment

11. A new manual for environmental data has been prepared. It establishes new principles to make the procedure more efficient. In the multi-pollutant programme only the reporting of monthly values are mandatory. An electronic reporting form has been prepared and all participating countries should use this form. The parameters that are reported are shown in the table below.

12. For the climatic data all parameters are mandatory. There are two main differences with the original programme. First, the reporting of time of wetness is no longer considered important and its effect can be adequately described by the combined effect of temperature and relative humidity. Second, sunshine is reported in effect-units rather than time-units.

13. The gaseous pollutants are SO_2, NO_2, O_3 and HNO_3. SO_2 and NO_2 were mandatory in the original programme, while O_3 was optional, and HNO_3 not reported at all. The statistical evaluation of data obtained during the original programme showed that O_3 was an important parameter for some materials and especially for copper, which is a commonly used metal, for technical purposes as construction material as well as electric contact material and in objects of cultural heritage. HNO_3 is a secondary pollutant formed by the oxidation of NO_2. It is a strong acid with a high deposition velocity that is relatively independent of the relative humidity, which increases its importance for dry and warm climates. The effect of this pollutant has so far been the subject of few studies but it is potentially harmful for many

materials. The new sites have been partially selected with the aim of extending the temperature range of the network. Due to difficulties in performing reliable and cost-efficient measurements, the collection is only optional and will take place only during part of the programme.

14. The characteristics of precipitation are reported as in the original programme.

15. Particles are now part of the optional programme. They were not included at all in the original programme. The effect of particles has so far received less attention than the effect of gaseous pollutants. Particles have a different effect on the degradation process. They are usually hygroscopic, i.e. they attract water, and therefore prolong the time that the material is wet. They can also provide corrosion stimulators and can either be acidic or basic, the latter case decreasing the effect of acid deposition. Finally, they can lead to soiling, an optical effect with no direct impact on the performance of materials but which is important for the visual appearance of an object and requires costly cleaning measures. Due to the many possible effects of particulate matter outlined here it is necessary not only to measure the total amount of particles but also to obtain limited chemical information. The environmental sub-centre has designed an aerosol trap for this purpose. However, its collecting characteristics have to be calibrated in order to relate the measurements to other particulate measurements.

E. Current status of the creation of an environmental database for the multi-pollutant programme

16. Figure 3 shows examples of environmental data as ranking plots of SO_2, NO_2 and O_3. Many sites have an SO_2 concentration below 5 µg/m^3, which reflects the new multi-pollutant situation. The reporting of environmental data from national contact persons to the environmental sub-centre is still ongoing and a more complete database will be available after the Task Force's meeting in Toronto, in June 1999.

IV. REFERENCE

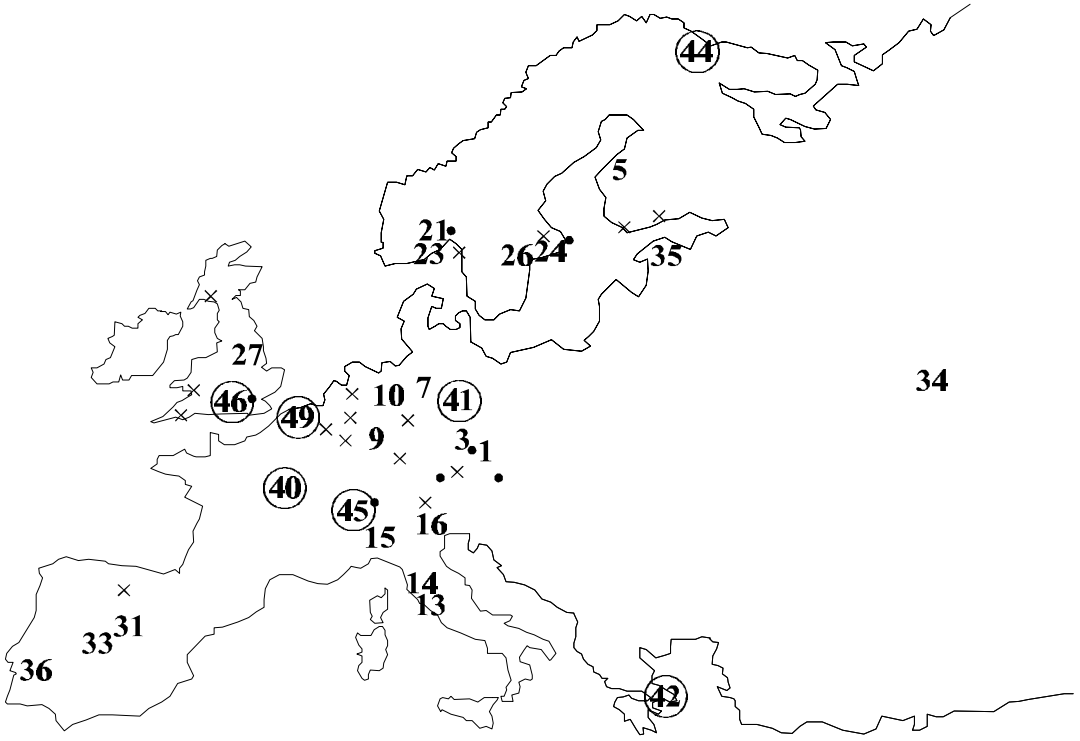
[1.] Quantification of Effects of Air Pollutants on Materials. Proceedings of the UN ECE Workshop on Quantification of Effects of Air Pollutants on Materials. Berlin, May 25-28, 1998. Edited by S. Fitz. Texte 24/99. Umweltbundesamt Berlin, 1999.

Note: References, tables and figures have been reproduced as received by the secretariat.

Table. Reporting of environmental data for the multi-pollutant exposure programme. All reporting is done on a monthly basis

Mandatory	**Optional**
<u>Climate data</u> Temperature, °C Relative humidity, % Sun radiation, MJ/m^2	
<u>Gases</u> SO_2, $\mu g/m^3$ NO_2, $\mu g/m^3$ O_3, $\mu g/m^3$	<u>Gases</u> [a]HNO_3, $\mu g/m^3$
<u>Precipitation</u> Amount, mm Conductivity, µS/cm H^+, pH units SO_4^{2-}, mgS/l NO_3^-, mgN/l Cl^-, mgCl/l	<u>Precipitation</u> NH_4^+, mgN/l Na^+, mgNa/l Ca^{2+}, mgCa/l Mg^{2+}, mgMg/l K^+, mgK/l <u>Particulates</u> [a]Deposition and chemical analysis

[a]External funding foreseen.



1 Prague (U)	21 Oslo (U)	37 Dorset (R)
3 Kopisty (I)	23 Birkenes (R)	40 Paris (U)
5 Ähtäri (R)	24 Stockholm South (U)	41 Berlin (U)
7 Waldhof Langenbrügge (R)	26 Aspvreten (R)	42 Athens (U)
9 Langenfeld Reusrath (R)	27 Lincoln Cathedral (U)	43 Tel Aviv (U)
10 Bottrop (I)	31 Madrid (U)	44 Svanvik (R)
13 Rome (U)	33 Toledo (R)	45 Chaumont (R)
14 Casaccia (R)	34 Moscow (U)	46 London (U)
15 Milan (U)	35 Lahemaa (R)	47 Los Angeles (U)
16 Venice (U)	36 Lisbon (U)	49 Antwerpen (U)

Figure 1. List of test sites (Number; name; type asurban/rural/industrial) and map showing approximate locations of European sites in the multi-pollutant exposure program. The research centres, responsible for the evaluation are indicated as (**!**), sites excluded from the original exposure programme (×) and new sites (O). The sites are located in Belgium (49), the Czech Republic (1,3), Finland (5), France (40), Germany (7,9,10,41), Greece (42), Israel (43), Italy (13-16), Norway (21,23,44), Sweden (24,26), United Kingdom (27,46), Spain (31,33), Switzerland (45) the Russian Federation (34), Estonia (35), Portugal (36), Canada (37) and the United States (47)

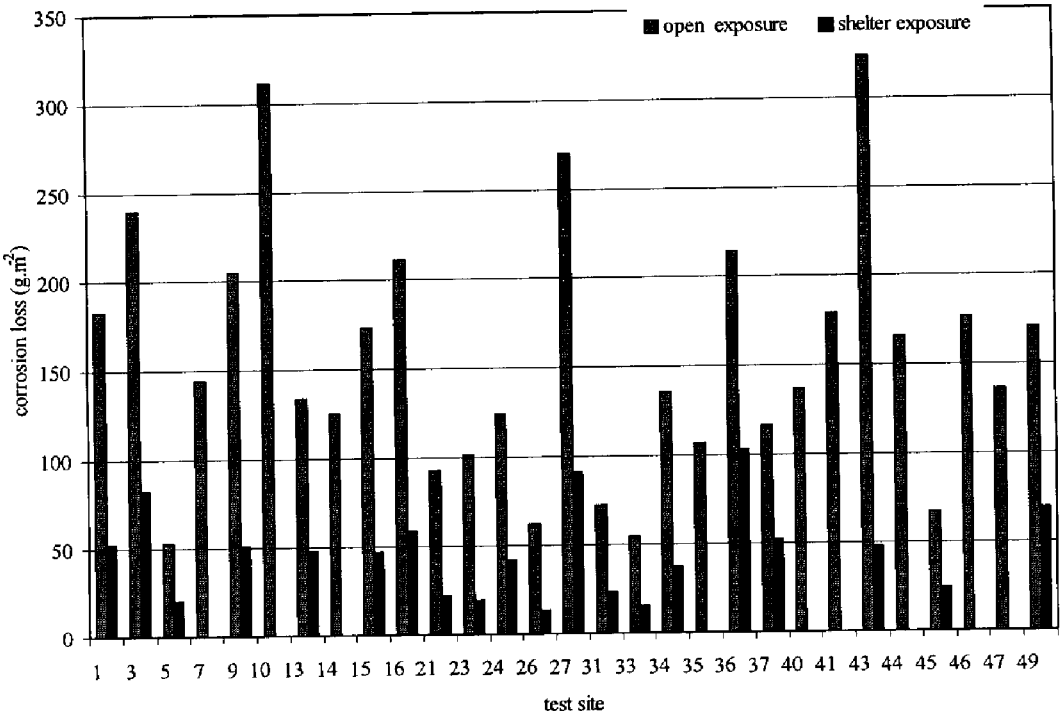


Figure 2. Corrosion loss of carbon steel after one year of exposure in the multi-pollutant programme (1997-98). For location of test sites see figure 1

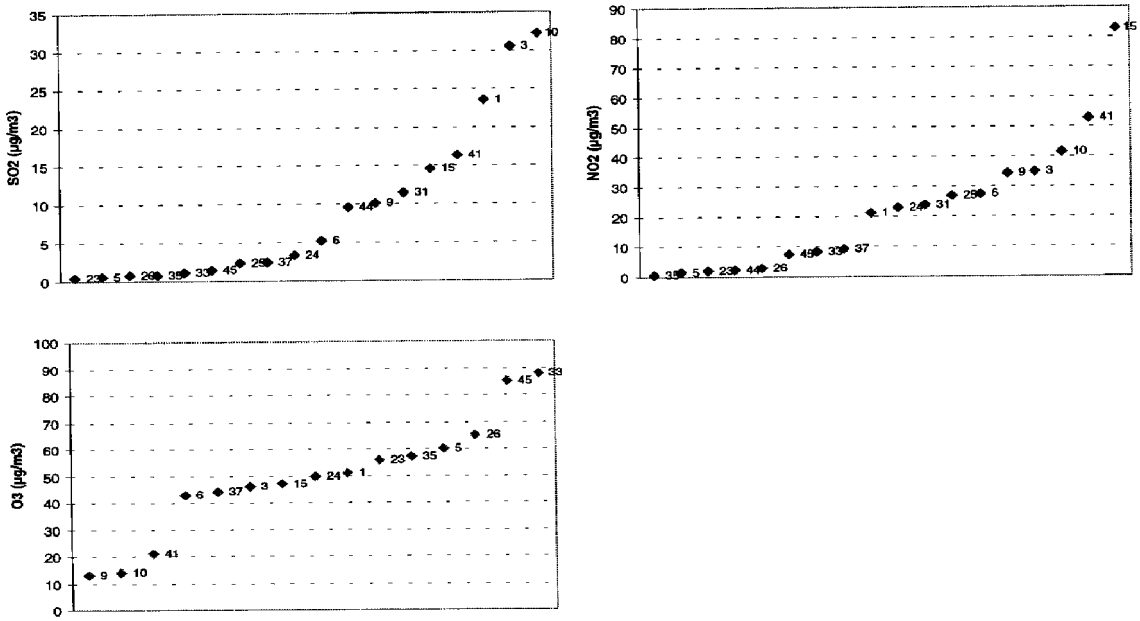


Figure 3. Ranked plots of SO_2, NO_2 and O_3 for the period 1996-97 versus test sites number. For location of test sites see figure 1