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ECE/ICP for materialer

Statusrapport 1998

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Innhold

Side

Sammendrag

ECE/ICP for materialer er et overvåkningsprogram hvis hovedmålsetting er å finne frem til dose-respons funksjoner mellom ulike materialer og de dominerende luftforurensningene i Europa. Dette gjennomføres ved felteksponering av utvalgte materialer på stasjoner hvor en parallelt registrerer et utvalg av miljøparametre. Programmet har vært 100% nasjonalt finansiert av deltakerlandene. I Norge har finansieringen vært dekket via SFTs overvåkningsprogram.

Fase 2 av programmet startet sin felteksponering i 1997 på 31 stasjoner i 18 land. I 1998 er første års nedtak av materialer gjennomført.

En workshop i Berlin ble gjennomført i uke 22, og årets Task Force møte ble avholdt i forbindelse med workshopen.

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1. Innledning

ECE/ICP for materialer er et overvåkningsprogram hvis hovedmålsetting er å finne frem til dose-respons funksjoner mellom ulike materialer og de dominerende luftforurensningene i Europa. Dette gjennomføres ved felteksponering av utvalgte materialer på stasjoner hvor en parallelt registrerer et utvalg av miljøparametre. Programmet har vært 100% nasjonalt finansiert av deltakerlandene. I Norge har finansieringen vært dekket via SFTs overvåkningsprogram.

Første fase av programmet startet i 1987 med siste inntak av materialer etter åtte år i 1995. I denne fasen var stasjonsutvalget og miljømålingene spesielt vinklet mot virkningene av SO_2. De svovelreduserende tiltak som er gjennomført i Europa i perioden har medført at en ønsket å videreføre programmet i et nytt forskningsprogram. En skulle spesielt fokusere på den mer komplekse forurensningssituasjonen for materialer som dagens forurensningsbilde gir med lave SO_2 konsentrasjoner, men hvor NO_2- og O_3-konsentrasjonene fremdeles er høye. En har derfor justert måleprogrammet og utvalget av stasjoner for å studere denne nye problemstillingen i en fase 2 av overvåkningsprogrammet

2. Målsetting

Målsettingen for programmet er å utvikle dose-respons funksjoner som kvantifiserer effektene av NO_2 og O_3 alene eller i kombinasjon med SO_2 .

3. Måleprogram

Fase 2 av felteksponeringsprogrammet startet i november 1997 med eksponering på 31 feltstasjoner i 18 land. Av de opprinnelige 39 feltstasjonene i fase 1 er 22 stasjoner med i fase 2. De gamle stasjonene har beholdt sitt stasjonsnummer, mens de nye har fått nummer fra 40 til 49. Tabell 1 gir en oversikt over deltakerlandene og stasjonene som er med i programmet.

Tabell 1: Oversikt over feltstasjonene

Site No	Country	Site name
01	Czech Republic	Prague- Bechovice
03	Czech Republic	Kopisty
05	Finland	Âhtäri
07	Germany	Waldhof Langenbrügge
09	Germany	Langenfeld Reusrath
10	Germany	Bottrop
13	Italy	Rome
14	Italy	Casaccia
15	Italy	Milan
16	Italy	Venice
21	Norway	Oslo
23	Norway	Birkenes
24	Sweden	Stockholm South
26	Sweden	Aspreten
27	United Kingdom	Lincoln Cathedral
31	Spain	Madrid
33	Spain	Toledo
34	Russia	Moscow
35	Estonia	Lahemaa
36	Portugal	Lisbon
37	Canada	Dorset
40	France	Paris
41	Germany	Berlin
42	Greece	Athens
43	Israel	Tel Aviv
44	Norway	Svanvik
45	Switzerland	Chaumont
46	United Kingdom	London
47	USA	Los Angeles
49	Belgium	Antwerpen

Tabell 2 gir en oversikt over hvilke materialer som er eksponert på feltstasjonene fritt 45° mot syd og eventuelt regnbeskyttet under tak. Likeledes vises hvilke parametre det er stilt krav om å måle, samt de en ønsker å få målt, men hvor det ikke er krav om å måle.

Tabell 2: Oversikt over måleprogrammet

Materialer	Eksponerings-forhold	Miljømålinger prioriterte alle stasjoner	Miljømålinger ønsket alle stasjoner
karbon stål	fritt eksponert	temperatur, relativ fuktighet, sol, SO_2, NO_2, O_3, mm nedbør, H^+, SO_4^{--} NO_3^-, Cl^-	HNO_3, NH_4^+, Na^+, Ca^{2+}, Mg^{2+}, K^+, partikler
karbon stål	under tak		
sink	fritt eksponert		
sink	under tak		
kopper	fritt eksponert		
kopper	under tak		
bronse støpt	fritt eksponert		
bronse støpt	under tak		
kalkstein	fritt eksponert		
kalkstein	under tak		
glass	fritt eksponert		
glass	under tak		
malt stål	fritt eksponert		

Kravet til miljømålingene er redusert slik at bare månedsverdier skal registreres og rapporteres til NILU som miljøsenter. For å redusere databehandlingens omfang på NILU har en satt krav til at alle data skal rapporteres i Excel-format på diskett eller på E-mail. Feltmålingene er planlagt å løpe i fire år med inntak etter ett, to og fire år. I tillegg er det planlagt trendanalyser ved ett-års eksponeringer av stål, sink og kalkholdig sandstein, første og tredje år.

4. Norges ansvar

NILUs og Norges hovedansvar er, som i fase 1, å være felles datasenter for hele programmet. NILU vil ha ansvar for kvalitetssikringen av dataene og for felles-rapporteringen av miljødataene i programmets rapportserie. Dette arbeidet har vært finansiert av SFT. I tillegg har NILU ansvar for tre feltstasjoner i Norge og for evalueringen av et malingssystem som eksponeres på alle stasjonene.

NILU har gått inn med egeninnsats for å drive tre feltstasjoner i Norge. En betydelig del av måleutgiftene på stasjonene blir imidlertid dekket av andre SFT-prosjekter på stasjonene. Jotun A/S har finansiert produksjonen av det felles malingssystemet for programmet.

5. Arbeid i 1998

En betydelig del av virksomheten har vært fokusert om sluttrapporteringen av fase 1, bidrag til Workshopen i Berlin i uke 32 og det etterfølgende Task Force møtet. NILU var medlem i arbeidsgruppen som planla Workshopen og bidro med følgende tre foredrag under arrangementet.

- "Trends in the environmental data during 8 years of the UN/ECE materials programme." Jan F. Henriksen and Alena Bartonova

- "Damage to painted systems - Statistical analysis of results after 8 years exposure": Jan F. Henriksen and Alena Bartonova

- "Modelling and mapping of degradation of built environment from available data and GIS based information tools". E. Haagenrud, J. F. Henriksen and T. Skancke.

Workshopen hadde samlet 46 deltakere fra 19 land. Ved siden av deltakerne i ECE/ICP for materialer, var det deltakere fra USA, Australia og en stor delegasjon fra Tyskland. Workshopen var meget vellykket, og en del viktige anbefalinger og konklusjoner om det videre arbeidet ble fattet. Se workshop report, Vedlegg A.

Umweltbundesamt i Berlin har ønsket å utgi foredragene fra Workshopen som en egen publikasjon, og dette arbeidet er nå snart ferdig.

Sluttrapporten for de fire malingssystemene i fase 1 av programmet, to malingssystemer for tre, en for malt stål og en for båndlakkert galvanisert stål ble avsluttet i august 1998.

Siden det bare har vært eksponering av stål og sink til trendanalyser i 1997, så er det ikke skrevet en egen miljørapport for perioden. Miljødataene er sendt til SVOUM Praha a.s. som vil rapportere dem sammen med sin trendanalyserapport.

I november er ettårs-prøvene i det nye testprogrammet tatt ned for alle norske feltstasjoner, og materialene er sendt til de respektive sub-sentrene.

6. Konklusjoner

Alle de planlagte rapportene i ECE/ICP for materialer fase 1 er nå ferdig rapportert. Det er ønskelig at deltakerne i programmet publiserer resultatene i tidsskrifter og ved konferanser så snart som mulig. Rapportene blir i prinsippet frigjort etter Executive Body møtet på slutten av året, og da kan andre bruke og publisere dataene.

Fase 2 startet i november 1997 på samtlige stasjoner, og første nedtak er november 1998.

Vedlegg A

Workshop report

Berlin 25-27 May 1998

Draft

UN/ECE CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

WORKSHOP ON QUANTIFICATION OF EFFECTS OF AIR POLLUTANTS ON MATERIALS

Workshop Report

prepared by the Chairman of the Task Force on the International Co-operative Programme on Effects of Air Pollution on Materials, Including Historic and Cultural Monuments

I. INTRODUCTION

1. The workshop on quantification of effects of air pollutants on materials took place in Berlin, Germany, from 25 to 27 May 1998. The workshop was organized by the Federal Environmental Agency (UBA), Berlin, and the Swedish Corrosion Institute, Stockholm, with the support of the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety.

2. The workshop was attended by 45 experts from 19 countries (Australia, Austria, Belgium, Canada, Czech Republic, Estonia, Finland, France, Germany, Israel, Italy, Norway, Portugal, Russian Federation, Spain, Sweden, Switzerland, United Kingdom and the United States of America). The UN/ECE secretariat was also represented. The workshop was co-chaired by Mr. S. Fitz (Germany) and Mr V. Kucera (Sweden).

3. The major objectives of the workshop, which had been included in the Executive Body's 1998 work-plan for the implementation of the Convention, were:

(a) To present and discuss the results of the first part of the International Co-operative Programme on Effects of Air Pollution on Materials, Including Historic and Cultural Monuments (ICP Materials), which has been completed after an eight-year exposure period in 1996; and

(b) To propose further activities within the framework of the Convention, based on reliable dose-response functions for the degradation of materials.

4. Consequently, the workshop addressed the following issues:

(a) Critical discussion of the ICP Materials results, with due consideration of the knowledge/experience gained by other relevant programmes;

(b) Establishing reliable dose-response functions that would take into account the combined effects of sulphur and nitrogen pollutants, ozone and acid precipitation;

(c) Identification of trends in the levels of acidifying air pollutants in Europe and their effects on deterioration rates of materials;

(d) Application of dose-response functions to the mapping of materials at risk (geographical distribution);

(e) Evaluation of economic damage to materials.

II. WORKSHOP DISCUSSIONS

5. The workshop was opened by Mr. W. Schenkel, Head of the Division 'Quality of the Environment' of the Federal Environmental Agency, who welcomed the participants on behalf of the host country and the host authorities/organizers.

6. Mr. V. Kucera (Sweden), Chairman of the International Co-operative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments (ICP Materials), reviewed the background of the workshop, described its aims and introduced its programme.

7. The workshop was organized in a series of plenary sessions, during which 28 papers and 1 poster were presented. Detailed discussions were carried out in two parallel discussion groups. The outcome of these discussions was then considered and summed up during the final plenary session.

8. The background papers, which provided the basis for the discussions, focused on:

(a) Quantification of effects of air pollutants on materials (results from ICP Materials), especially:

(i) Structural metals;
(ii) Glass;
(iii) Electric contact materials;
(iv) Polymer materials;
(v) Painted surfaces;
(vi) Stone materials;

(b) Presentation of quantitative results from other exposure programmes and for other/additional materials;

(c) Analysis of trends of corrosivity as related to environmental parameters;

(d) Mapping of acceptable levels of air pollutants and corrosion damage;

(e) Economic evaluation of air pollution damage to materials.

III. SPECIFIC CONCLUSIONS AND RECOMMENDATIONS

A. Results of the quantification of effects of air pollutants on materials from the ICP Materials Programme

9. Dose-response functions have been developed for all material groups studied. They describe the corrosion rates as a function of air pollutants and meteorological parameters and are useful for the mapping of, for instance, areas with high corrosion rates and as a basis for calculating the cost of damage.

10. Dose-response functions have been developed for all structural metals included in the programme, i.e. weathering steel, zinc, aluminium, copper and bronze. They are based on data from 1 to 8' years exposure and they describe deterioration as a function of SO_2, acid load in precipitation, temperature, relative humidity, time of exposure and, for bronze, copper and aluminium, also chloride in precipitation.

11. For glass materials representative of medieval glass windows, dose-response relations have been obtained which describe the deterioration as a function of SO_2, NO_2, acid load in precipitation, relative humidity, temperature and time of exposure.

12. For electric contact materials exposed in ventilated sheltered boxes, dose-response relations have been obtained for nickel and tin. The equation for nickel describes the deterioration as a function of SO_2, temperature and time of exposure. The equation for tin describes the deterioration as a function of ozone, temperature and time of exposure. The effect of pollutants was also demonstrated in so called Eurocard connectors of three performance classes and for silver and copper without obtaining any dose-response functions.

13. For the polymer materials polyethylene and polyamide, the evaluation is not completed and the conclusions are based on up to 2 years' exposure. The observed effects could be described as a function of temperature, sun radiation and time of exposure.

14. For painted surfaces, dose-response relations have been developed for alkyd paint on steel and for coil-coated alkyd melamine on galvanized steel describing the lifetime of the coatings as a function of SO_2, amount of precipitation, relative humidity and temperature. For cracking and fungus growth on painted wood, dose-response functions have

been developed which describe the deterioration as a function of relative humidity, temperature, chloride and sun radiation.

15. For the calcareous stone materials, Portland Limestone and White Mansfield Dolomitic Sandstone, dose-response relations have been obtained which describe the deterioration as a function of SO_2, acid load in precipitation, temperature and time of exposure.

B. Results from other exposure programmes

16. The workshop noted important results of some other international exposure programmes (ISOCORRAG, MICAT) and stressed the importance of keeping close contact with all relevant programmes.

C. Corrosivity trends as related to environmental parameters

17. Analyses of available data sets from ICP Materials show that the decreasing trend in the concentrations of acidifying air pollutants has resulted in decreasing corrosion attack. SO_2 is the largest single contributing factor to the decreasing corrosion trends. The decreasing acid load in precipitation is a contributing factor, its effect is however smaller than that of dry deposition.

18. The decrease in corrosivity is generally larger than expected from the drop in SO_2 and in H^+ concentrations. This cannot be directly related to a specific pollutant and reflects the multipollutant character of the deterioration process. This also motivates additional studies, including repeated 1-year exposures to be able to predict corrosion trends.

19. The response of materials which already have an exposure history to changes in pollutant combinations is more complex and also requires further work to elucidate the "memory effect", which may be especially important for instance for porous calcareous stone materials frequently used in objects of cultural heritage.

D. Mapping of acceptable levels of air pollutants and corrosion damage

20. The available dose-response functions are applicable to mapping procedures. Mapping areas with a high risk of corrosion damage on different pollution scenarios is an essential part of the programme and provides basic information for the valuation of damage.

21. The effect of chloride on dose-response functions for some materials is expressed as chloride ion concentration in precipitation. For mapping purposes, this parameter may have a limited availability in some regions. In general, care should be taken when extrapolating the equations outside the intervals of environmental parameters used for their calculations. This applies especially to temperature, SO_2 and chloride concentration.

22. All participants were encouraged to produce corrosion maps, with due account taken of the specific situation/conditions in mapped areas (including dominant receptors, e.g. buildings, metal constructions, etc.).

23. It is possible and appropriate to produce maps on different geographical scales, provided that the necessary data and models on the relevant scale are available.

E. Economic evaluation of air pollution damage to materials

24. The state of the art in this field has been established in the UN/ECE Workshop on economic evaluation of air pollution abatement and damage to buildings including cultural heritage held in Stockholm in January 1996.

25. The dose-response functions obtained by ICP Materials are useful for calculating the cost of damage to materials, including historic and cultural monuments, caused by air pollutants. They have been applied for instance in studies in Germany and Norway and they have also been provided to the Task Force of Economic Aspects of Abatement Strategies.

26. The estimates made so far for the materials included are believed to give a fair order of magnitude. They are, however, conservative, as several economic important materials are not included because of a lack of data. A very important category not included so far is the damage to cultural heritage, where more research is urgently needed.

27. The workshop also noted the importance of the work aiming at assessing service life in relation to the life-cycle analysis of building materials.

IV. OVERALL CONCLUSIONS AND RECOMMENDATIONS OF THE WORKSHOP

28. It is preferable to separate the effect of dry and wet deposition in dose-response functions to better understand the

deterioration processes and properly identify the role of different pollutants.

29. The functions should include the exposure time; this would greatly increase their applicability for prediction purposes. It would also be useful to address the reliability of the dose-response functions by specifying errors of estimated parameters in addition to the parameter values.

30. The workshop acknowledged that despite the substantial progress which had been made during the past years, there were still important gaps of knowledge. In the further development of the programme activities, the following parameters should especially be taken into account:

- Particulates of different kinds are important due to their different effects (accelerating, inhibiting, catalytic, soiling, etc.). The importance of the particulates should be further assessed, in relation to the existing data and to a possible covariance with important factors already being measured (such as SO_2).
- The direct effect of ozone especially on organic materials as well as the synergistic effect with other pollutants should be further elucidated.
- Data on UV A and B are needed to assess their effects on economically important organic materials like polymers, paints, etc.
- Salinity (chlorides) is important for some materials and its effects in combination with antropogenic pollutants should be assessed.
- Nitric acid is important especially for warm locations.
- Organic acids, aldehydes and VOCs may increase in importance if emissions rise due to the increased use of alternative fuels for motor vehicles.
- The effect of temperature in general and surface temperature in particular on the degradation processes needs further clarification.

Some of these parameters should be the subject of specific studies. The applicability of existing data should be assessed. UV A and B, salinity, particulates and nitric acid were considered to be of the highest priority.

31. Some of the obvious multipollutant effects are addressed in the new ICP exposure programme. However, there is a need to further investigate these issues in specific field and laboratory exposure studies.

32. While the "time of wetness" (TOW) concept is still considered very useful, its present definition ($T > 0$ °C, $RH > 80\%$) has proven not to

be generally applicable to various materials and regions. Moreover, TOW data are not easily obtainable. Therefore, the TOW term has been replaced by more appropriate temperature and relative humidity terms, for which data are easily obtainable.

33. The "acceptable level" approach has proved to be useful and a very communicative concept. It is easy to understand, and will continue to be used in the future. The "acceptable level" represents a rate of deterioration which is within a tolerance limit above the natural or background deterioration rate. In some cases this can vary for the same material since the tolerated deterioration is generally smaller for objects of cultural heritage than for technical constructions.

34. Transforming dose-response functions into lifetime expectancy functions is in principle possible. Specific uses of the material should be considered in detail and its acceptable or critical damage defined. The transformation is generally easier for materials like coatings than for structures, especially of porous materials like stone and concrete.

35. For cost assessments and national or international mapping purposes, yearly corrosion and environmental data are sufficient. To better understand corrosion processes, a higher time resolution and specific studies would be needed.

36. In view of the documented serious economic, social and cultural consequences of the damage to materials caused by air pollution, it is recommended that the following should be undertaken:

(i) Development of reliable dose-response functions that take into account the combined effects of sulphur and nitrogen pollutants, ozone and acid precipitation;

(ii) Evaluation of trends in the levels of acidifying air pollutants in Europe and their effects on deterioration rates of materials, including cultural heritage;

(iii) Assessment of materials at risk and their geographical distribution;

(iv) Assessment of economic damage to materials, including cultural and historical monuments.

These activities need adequate support (including funding) both on the national and the international level.

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ABSTRACT

** Kategorier:*	*A*	*Åpen - kan bestilles fra NILU*
	B	*Begrenset distribusjon*
	C	*Kan ikke utleveres*