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## Economic Commission for Europe

Executive Body for the Convention on Long-range  
Transboundary Air Pollution

**Steering Body to the Cooperative Programme for  
Monitoring and Evaluation of the Long-range  
Transmission of Air Pollutants in Europe**

**Working Group on Effects**

**Second joint session\***

Geneva, 13–16 September 2016

Item 14 of the provisional agenda

**Progress in activities in 2016 and further development  
of effects-oriented activities**

### **Effects of air pollution on materials\*\***

**Progress report by the Programme Coordinating Centre of the  
International Cooperative Programme on Effects of Air Pollution  
on Materials, including Historic and Cultural Monuments**

#### *Summary*

The present report presents the results of the activities undertaken over the past year since the previous report by the Programme Coordinating Centre for the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments (ICP Materials) to the Working Group on Effects. The activities and the report on them are in accordance with the request of the Executive Body to the

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\* The Executive Body to the Convention agreed that, as of 2015, the Working Group on Effects and the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe should meet jointly, to achieve enhanced integration and cooperation between the Convention's two scientific subsidiary bodies (ECE/EB.AIR/122, para. 47 (b)).

\*\* The present document is being issued without formal editing.



Convention on Long-range Transboundary Air Pollution in its 2016–2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1, item 1.1.1.5) and the informal document approved by the Executive Body for the Convention at its thirty-fourth session, “Basic and multi-year activities in the 2016–2017 period” (items 1.1.1–1.1.3, 1.1.6, 1.1.7 and 1.8.1–1.8.3).

The report of the ICP Materials presents the results of its thirty-second Task Force meeting (Rome, Italy, 11 to 13 May 2016). In particular, the report describes materials exposed in the 2014–2015 exposures for trend analysis and new scientific results for aluminium in particular and summarises the concluded pilot study and the recently launched call for data on inventory and condition of stock of materials at risk at the United Nations Educational, Scientific and Cultural Organization (UNESCO) cultural heritage sites.

## **I. Introduction and overview of deliverables**

1. The present report by the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments (ICP Materials) describes results and activities carried out by that programme since its last report to the Working Group on Effects, submitted to the first joint session of the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) and the Working Group on Effects (Geneva, 14–18 September 2015). The results are presented here in accordance with item 1.1.1.5 (ICP Materials) of the 2016–2017 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/133/Add.1) and with the informal document approved by the Executive Body for the Convention at its thirty-fourth session, “Basic and multi-year activities in the 2016–2017 period” (items 1.1.1–1.1.3, 1.1.6, 1.1.7 and 1.8.1–1.8.3).

2. ICP Materials is co-chaired by Mr. Johan Tidblad (Sweden) and Mr. Pasquale Spezzano (Italy) with Mr. Johan Tidblad acting also as head of the ICP Materials Programme Centre. Austria, Croatia, the Czech Republic, Estonia, Finland, France, Germany, Greece, Italy, Norway, Poland, the Russian Federation, Slovakia, Spain, Sweden, Switzerland, the United Kingdom of Great Britain and Northern Ireland and the United States of America (17 countries and approximately 30 experts) participate in the work of ICP Materials.

3. The thirty-second meeting of the ICP Materials Task Force was held in Rome, Italy from 11 to 13 May 2016 with 15 participants from 12 countries including the Italian representative to the Executive Body of the Convention.

4. During 2015 the following report was delivered: Report No. 77: Pilot study on the inventory and condition of stock of materials at risk at UNESCO cultural heritage sites. Part IV: The relationship between the environment and the artefact. The report is available on the ICP Materials home page.<sup>1</sup>

5. In 2016, the following ICP Materials reports are expected: Report No 78 Results of corrosion and soiling from the 2014–2015 exposure programme for trend analysis, and Report No 79 Technical Manual of exposure programmes for trend analysis.

6. In addition, a call for data on inventory and condition of stock materials at UNESCO cultural heritage sites was launched in 2015 with an expected status report in 2017.

## **II. Workplan items common to all International Cooperative Programmes**

### **A. Guidelines for reporting on the monitoring and modelling of air pollution effects**

7. The Guidelines for reporting on the monitoring and modelling of air pollution effects (ECE/EB.AIR/2008/11/ECE/EB.AIR/WG.1/2008/16/Rev.1)<sup>2</sup> specify that for effects of particulate matter on materials the degree of soiling should be reported, and for multiple

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<sup>1</sup> [www.corr-institute.se/icp-materials/web/page.aspx?sid=3293](http://www.corr-institute.se/icp-materials/web/page.aspx?sid=3293).

<sup>2</sup> Adopted by the Executive Body for the Convention by its decision 2008/1.

pollutant effects on materials the corrosion of indicator materials carbon steel, zinc and limestone should be reported. This is part of the ongoing activities of ICP Materials (for exposure of materials for trend analysis, see below).

## **B. Efforts to enhance the involvement of countries in Eastern Europe, the Caucasus and Central Asia**

8. The Russian Federation is a member of the ICP Materials Task Force and contributes with an exposure site in the recently concluded exposure for trend analysis. The thirty-second meeting of the ICP Materials Task Force was originally planned to be held in St Petersburg in 2016 with an increased number of invitations for participants from countries in Eastern Europe, the Caucasus and Central Asia. However, at the last moment the responsible institute cancelled the commitment and the meeting instead was held in Rome as described above. In addition, the national focal point for EMEP and the Working Group for Effects in Montenegro has declared interest in the work of ICP Materials and participation in meetings but has not participated due to lack of funding.

## **C. Cooperation with programmes and activities outside the region**

9. ICP Materials and its experts collaborate with international standardisation work in the field of atmospheric corrosion, in particular ISO Technical Committee 156 Corrosion of metals and alloys and the European Committee for Standardization (CEN) TC 346 Conservation of cultural heritage.

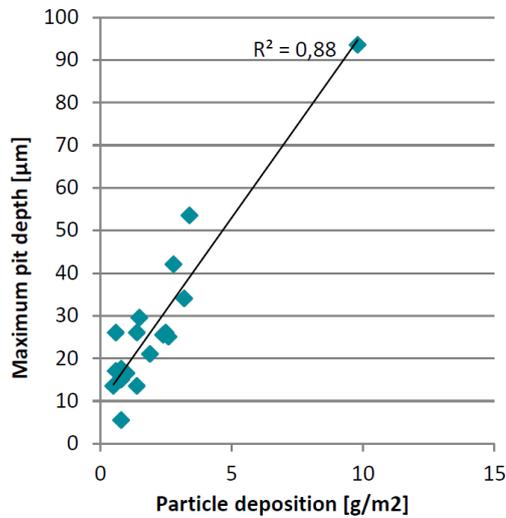
# **III. Workplan items specific to the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments**

## **A. Corrosion and soiling of selected materials under different environmental conditions**

10. Exposures for trend analysis are performed each third year in the network of ICP Materials test sites. The recently completed exposure (2014–2015) includes samples of carbon steel, zinc, copper, limestone and soiling of modern glass. In addition, samples exposed for four years (2011–2015) of carbon steel, weathering steel, zinc, aluminium and limestone will be evaluated and reported in 2016 (corrosion data) and with a subsequent report on trends in corrosion, soiling and environmental data for the period 1987–2015 in 2017. In addition, stainless steel was also exposed for the first time at selected sites in the network of test sites. A special study on aluminium exposed for four years and its corrosion products will be presented in 2016 where one result is the correlation between particulate deposition and the maximum pit depth. This is new scientific information where previously only the average corrosion expressed as mass loss was related to the average sulphur dioxide (SO<sub>2</sub>) concentration.

Figure

**Maximum pit depth on aluminium after four years of exposure vs particle deposition**



**B. United Nations Educational, Scientific and Cultural Organization cultural heritage sites**

11. In 2015, the last concluding part IV of the “Pilot study on inventory and conditions of stock of materials at risk at five UNESCO cultural heritage sites” was finalized. The UNESCO study is presented in four individual ICP Materials reports during the period 2011–2015: I Methodology (Report 68); II Determination of stock of materials at risk for individual monuments (Report 70); III Economic evaluation (Report 73); and IV The relationship between the environment and the artefact (Report 77). The last report was discussed and approved during the thirty-second meeting of the Programme Task Force.

12. Based on the results from the four reports, the main conclusions from the study are as follows: being located in the heart of European capitals, the studied UNESCO sites are impacted by air pollution, mainly due to nitric acid (HNO<sub>3</sub>; product of nitrogen oxide (NO<sub>2</sub>) oxidation) and fine particulate matter (PM<sub>10</sub>), two pollutants that currently seem to play a prominent role in determining damage of limestone. The improvement of air quality between 2000 and 2010, mainly attributable to a significant reduction of air concentration of SO<sub>2</sub>, produced a small decrease in the recession rate for limestone, first year exposure, which for the studied UNESCO sites was quantified in about 5–8 per cent. Calculated recession rates after one year of exposure are above the background corrosion rate (3.2 µm per year (year<sup>-1</sup>) and generally close to the target for the year 2050 (6.4 µm year<sup>-1</sup>) or even at one case close to the target for 2020 (8.0 µm year<sup>-1</sup>). Corrosion due to air pollution would result in material deterioration costs ranging from €9.2 per square metre per year (m<sup>-2</sup> year<sup>-1</sup>) to €43.8 m<sup>-2</sup> year<sup>-1</sup>, depending on the status of the material, the pollution level and the climatic conditions. These costs add to the cost in background areas, estimated from €14 m<sup>-2</sup> year<sup>-1</sup> to €28 m<sup>-2</sup> year<sup>-1</sup>. In developing future air pollution abatement strategies it would be important to consider the reduction of atmospheric NO<sub>2</sub> and PM<sub>10</sub> concentrations to protect historical and cultural monuments.

13. In continuation of the pilot study on inventory and conditions of stock of materials at risk at five UNESCO cultural heritage sites, ICP Materials has launched a call for data on “Inventory and condition of stock of materials at UNESCO cultural World heritage sites”. The Programme Task Force agreed to launch the call for data at its thirty-first meeting (Kjeller, Norway, 22–24 April 2015). A pre-announcement letter was sent to Heads of

Delegations to the Working Group on Effects for early information purposes on 18 June 2015. A proposal for the call was approved at the first joint session of the Steering Body to EMEP and the Working Group on Effects (Geneva, 14–18 September 2015). The call for data was launched on 22 October 2015.

14. The main purpose of this call for data is to offer interested Parties the opportunity to collect available documented information to be used for the identification of UNESCO cultural World heritage sites that are at a potential risk of corrosion or soiling and to provide relevant data on the adverse effects of air pollution on our built heritage. The ultimate objective is to provide policy makers the evidence of the effects of air pollution not on a generic material or a generic artefact but on easily recognizable symbols of our culture and history.

15. The official letter of the call for data, a template for submission of data, an explanatory note with instructions on the use of the reporting template, and a brochure exemplifying the step by step approach for the previously assessed UNESCO sites were provided by the call. These documents have been also made available for downloading on the ICP Materials website.

16. This call for data requires qualitative and quantitative data on both the historic/cultural monument and on the environment. In view of the complexity of the call, the deadline for submission of the data is set to March 2017. Six Parties to the Convention have announced their intention to participate in the call: Croatia, Germany, Italy, Norway, Sweden, and Switzerland. In some cases, some clarification on the organization of the call and on the reporting of the data was required.

17. The status of the call was presented and discussed at the thirty-second meeting of the Programme Task Force. The Task Force discussed ways to encourage participation in the call and stressed that the call should promote national activities on the effects of air pollution on cultural heritage, within the limits of available resources. Preliminary indications on the modalities of participation were presented by some of the members of the Task Force.

#### **IV. Messages for the attention of other bodies**

18. The 2014–2015 exposure for trend analysis has been successfully completed and a detailed analysis of trend results for the period 1987–2015 are expected in 2017. New scientific findings have already been obtained, especially regarding the corrosion of aluminium (see para. 10 and figure).

19. The information regarding the involvement of the Russian Federation and Montenegro (see para. 8) is relevant for the further involvement of countries in Eastern Europe, the Caucasus and Central Asia.

20. ICP Materials has launched a call for data on “Inventory and condition of stock of materials at UNESCO cultural World heritage sites” and Six Parties to the Convention have already announced their intention to participate in the call: Croatia, Germany, Italy, Norway, Sweden, and Switzerland. Of these, Croatia has previously not participated in the activities of ICP Materials and its contribution is therefore especially welcomed.