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English Version

**Ambient air quality - Guide for the measurement of elemental carbon (EC) and organic carbon (OC) deposited on filters**

Qualité de l'air ambiant - Guide pour le mesurage du carbone élémentaire (EC) et du carbone organique (OC) déposés sur filtre

Außenluftqualität - Leitfaden zur Messung von auf Filtern abgeschiedenem elementarem Kohlenstoff (EC) und organisch gebundenem Kohlenstoff (OC)

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## Foreword

This document (CEN/TR 16243:2011) has been prepared by Technical Committee CEN/TC 264 "Air quality", the secretariat of which is held by DIN.

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## Introduction

For air quality across the European Union to be assessed on a consistent basis, Member States need to employ standard measurement techniques and procedures. The aim of this Technical Report is to present guidance on the measurement procedures to be followed when monitoring elemental carbon (EC) and organic carbon (OC) deposited on filters, following Council Directive 2008/50/EC on ambient air quality and cleaner air for Europe [1]. This requires the chemical speciation of the sub-2,5 µm size fraction of suspended particulate matter (PM<sub>2,5</sub>) in ambient air, as described in Annex IV:

### MEASUREMENTS AT RURAL BACKGROUND LOCATIONS IRRESPECTIVE OF CONCENTRATION

#### A. Objectives

*The main objectives of such measurements are to ensure that adequate information is made available on levels in the background. This information is essential to judge the enhanced levels in more polluted areas (such as urban background, industry related locations, traffic related locations), assess the possible contribution from long-range transport of air pollutants, support source apportionment analysis and for the understanding of specific pollutants such as particulate matter. It is also essential for the increased use of modelling in urban areas.*

#### B. Substances

*Measurement of PM<sub>2,5</sub> shall include at least the total mass concentration and concentrations of appropriate compounds to characterise its chemical composition. At least the list of chemical species given below shall be included. SO<sub>4</sub><sup>2-</sup>, Na<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, Ca<sup>2+</sup>, elemental carbon (EC), NO<sub>3</sub><sup>-</sup>, K<sup>+</sup>, Cl<sup>-</sup>, Mg<sup>2+</sup>, organic carbon (OC)*

#### C. Siting

*Measurements should be taken in particular in rural background areas in accordance with parts A, B and C of Annex III*

The method described in this Technical Report is focused primarily on harmonization and improvement of the data quality of thermal-optical measurement method for EC and OC used in monitoring networks, with guidance regarding the different protocols (analytical parameters) used currently within that method. The method is seen to be suitable for practical use in routine monitoring networks.

There are no traceable primary reference materials available for EC and OC analysis and there is no absolute scientific distinction between EC and OC. Therefore, the method set out in this Technical Report provides operational definitions of the measured quantities.

In February 2009, a workshop took place to provide an overview of the measurements made in Europe and worldwide. The workshop was organised by the Joint Research Centre in Ispra, Italy. The report of this workshop is available [2]. Consensus was reached for the following ranking of measurement techniques:

- a) thermal method with optical correction for EC and OC for samples collected on filters,
- b) other off-line analysis techniques for EC and OC for samples collected on filters,
- c) other on-line analysis techniques for EC and OC for samples collected on filters,
- d) other analysis techniques for either EC and/or OC,
- e) other analysis techniques measuring surrogates for either EC and/or OC (i.e. light absorption).

Due to the fact that the networks of the EU member countries have to measure EC and OC starting in June 2010 and CEN/TC 264/WG 35 "EC/OC in PM" has neither a mandate nor other funding available to perform necessary validation trials, WG 35 agreed on the following resolutions:

## 1) Resolution 35

Given

- the urgent need for Member States to have a standardised method for EC and OC, as they are due to start sampling from June 2010, and
- in the absence of a mandate from the Commission,

the WG agrees that they will work on a CEN Technical Report for EC and OC as a priority. The text of the Technical Report will be made available to interested people (e.g. network operators) when it is ready. This TR will describe several protocols for thermal-optical methods that will give different results for EC and OC, because validation data is needed both to specify one standard method and to properly characterise that method. If a mandate is given, the priorities will be reconsidered at the time.

## 2) Resolution 36

WG 35 agrees that the Commission shall be formally informed that the Technical Report will be an unsatisfactory substitute for a full standard, as it will delay the start of comparable data across the EU – variations of more than 100 % for EC can be expected. It may also have financial consequences for some Member States who have to change their method when the standard is produced.

## 3) Resolution 37

WG 35 agrees that the Technical Report shall include optical charring correction using both transmittance and reflection data, and recording of results using both sets of data shall be encouraged.

There are some open issues on the measurement procedure that can only be decided after further validation, e.g.:

- the applicable concentration ranges of the proposed method are limited by the optical correction and thermal protocols applied in the analysis of EC and OC; since the latter is dependent on the instrument as well as the chosen protocols no definitive values can be given;
- temperature measurement in the instrument ovens: location and reproducibility;
- influence of sampling artefacts on the data quality;
- provision and use of reference materials.

Attention is given to harmonizing the sampling with that for anions and cations in PM<sub>2,5</sub> as far as possible. The measurements for anions and cations are described in prCEN/TR 264125:2010 [3] and those for PM<sub>2,5</sub> in EN 14907:2005 [4].

NOTE: EN 14907:2005 is under revision and will be incorporated in the revision of EN 12341:1998 *Ambient air quality – Standard gravimetric measurement method for the determination of the PM<sub>10</sub> mass fraction of suspended particulate matter*.

## 1 Scope

This Technical Report gives guidance on the measurement of elemental carbon (EC) and organic carbon (OC) following the requirement for the networks of all EU member countries to measure EC and OC in particulate matter from June 2010 at background sites according to the Council Directive 2008/50/EC on ambient air quality and cleaner air for Europe.

The Technical Report describes the analytical procedures for determining EC and OC on quartz fibre filters as  $\mu\text{g}/\text{cm}^2$ , and the subsequent calculation of concentrations as  $\mu\text{g}/\text{m}^3$ . Sampling onto filters is to be done in accordance with EN 14907 for  $\text{PM}_{2.5}$ . The sampling process determines the size fraction of the particulate matter, the retention of semi-volatile material, and ab/desorption of volatile organic compounds on the filter at the time of sampling.

The same analysis method may also be used for other size fractions. Any possible additional artefacts e.g. due to charring or higher concentrations of carbonates would need to be assessed in those cases.

The measurement procedures are applicable for:

- rural background,
- urban background,
- road side and
- industrial sites.

The scope includes non rural site measurements, to allow the assessment of additional exposure of people in urban areas as stated in the objectives of the council directive and to achieve coherence in the European approach. Measurements are made over a nominal sampling period of 24 h, and concentrations are expressed as  $\mu\text{g}/\text{m}^3$ , where the volume of air is the volume at ambient conditions near the inlet of the sampler at the time of sampling.

The applicable concentration range of the proposed method is limited by the optical correction, instrument, and thermal protocols applied in the analysis of EC and OC. Therefore no definitive values can be given. The experience from EMEP shows the applicability of the method at regional background sites.

## 2 Terms, definitions and abbreviations

For the purposes of this document, the following terms and definitions apply.

### 2.1 Terms and definitions

#### 2.1.1

##### **total carbon**

##### **TC**

total quantity of carbon atoms in a PM sample, whatever the constituent it belongs to. This includes EC, OC and IC

**NOTE** It is understood that the measure of TC released from a PM sample in a specified thermal desorption and oxidation process may be different for different protocols, and that it will not necessarily be all of the carbon atoms in the sample.

#### 2.1.2

##### **elemental carbon**

##### **EC**

fraction of the non-IC total carbon in a PM sample, characterised by its non-volatility according to a specified thermal / optical protocol. EC evolves from the sample by oxidation only