The European Group of Organisations for Fire Testing, Inspection and Certification

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Fire testing: Calibration of smoke opacity measuring systems

(revision of EGOLF SM 3:1996)

Contents

Foreword

This document has been prepared by EGOLF and the method adopted for use by all EGOLF member laboratories when calibrating smoke opacity measurement systems to be used for measuring smoke opacity in reaction to fire testing.

1 Scope

This document establishes a procedure for calibration of smoke opacity measuring instruments and systems intended for measurement of smoke opacity during reaction to fire tests. It is applicable to each of the two different light sources which are generally used to measure the opacity of smoke, i.e. those based on either a laser light source or a white light source. The calibration procedure involves the use of calibrated neutral density filters. The calibration procedures for neutral density filters are also given within this document.

2 Normative References

ISO 13943 Fire safety - vocabulary

EN 13823 Reaction to fire tests for building products. Building products excluding floorings exposed to the thermal attack by a single burning item

DIN 50 055 Light measuring system for testing smoke development

ISO 9705 Fire tests - Full scale room test for surface products.

NT FIRE 004 Nordtest method: Building Products : heat release and smoke generation.

NT FIRE 032 Nordtest method: Upholstered furniture Burning behaviour - full scale test.

3 Terminology and definitions

3.1 Terminology

The results of measured smoke density from different international and national tests may be expressed as smoke opacity, smoke obscuration or extinction coefficient.

3.2 Definitions

For the purposes of this calibration method the definitions given in ISO 13943 apply, together with the following:

3.2.1 smoke opacity: the ratio of the incident luminous flux to the transmitted luminous flux through smoke under specified conditions

3.2.2 smoke obscuration: the reduction of light transmitted by smoke as measured by light attenuation.

3.2.3 extinction coefficient (k): the exponential reduction of light intensity by smoke obscuration, expressed according to :

$$k = \frac{1}{L} \ln \frac{I_o}{I}$$

where :

L = path length of light subject to attenuation by smoke.

I_o = intensity of light incident on sensor in the absence of smoke.

I = intensity of light incident on sensor in the presence of smoke .

4 Principle of the calibration method

Fire tests in which smoke opacity is measured normally utilise a fire or decomposition apparatus, a measuring chamber or pipe through which smoke passes and a light measuring instrument or system which measures the attenuation of light (or increase in optical density) due to the smoke.

This light measuring instrument or system comprises a light source, usually with a voltage stabilising power pack, a light receiver and a recording device.

The light source to be used is white light based (normally a gas filled tungsten filament lamp with a colour temperature of about 2900°K).

The calibration procedure comprises comparison of the performance of the smoke opacity measurement instrument or system against calibrated neutral density filters.

Note: if a laser light source is used, a similar procedure can be used. Laser light optical smoke opacity measurements are sometimes considered to be sensitive to the colour of the smoke.

Procedures are provided for both initial calibration of smoke opacity measurement systems and subsequent in use calibration.

The calibration procedures for neutral density filters are also given.

5 Equipment

The calibration procedures given within this method shall be performed on an optical bench or on the smoke opacity measuring instrument or system itself.

When performing the calibrations on an optical bench the mechanical alignment shall be checked on the smoke opacity measuring instrument or system itself before calibration is started.

6 Initial calibration procedure for smoke opacity measurement systems

Use of the white light source is described in several international and national test methods including DIN 50 055, ISO 9705, NT FIRE 004, NT FIRE 032. The test equipment for measuring smoke opacity is generally well described in these test methods.

The calibration procedure using the white light source shall be as follows:

a) The alignment of the system shall be checked, the light intensity be set to that required and the transmission value be adjusted to 100%.

Note DIN 50 055 specifies that the light intensity shall be set to 1500 cd/m^2

c) b) The extinction coefficient or optical transmission value of the smoke opacity measurement system shall be calibrated against five neutral density filters in the optical density range of 0,05 to 2,0. The optical density calculated with the measured light receiver signal shall be within either +(plus or minus) 5% or + (plus or minus) 0,01 of the actual value of the filters, whichever represents a wider tolerance.

It is recommended that the possibility of reflections is checked, and also the value on the calibration certificate and / or the manufacturer's declaration. Reflections may be the cause of results deviating from what is expected.

Note : filters are commercially available which have an additional anti-reflection coating which give a surface reflection of less than 0.5% per surface, see 8.1.2.

d) Any permitted damping devices shall be adjusted during the initial calibration of the system by recording the step response of a neutral density filter with an appropriate recorder or oscilloscope.

e) Where spectral eye response filters are to be used in the measurement of smoke opacity using the white light system, then calibration shall be carried out using these.

7 "In use" calibration procedure for smoke opacity measurement systems

Once the smoke opacity measurement system has been initially calibrated, the EGOLF "in -use" calibration procedure shall be as follows:

a) The alignment and the zero value of the extinction coefficient (at 100% transmission) of the smoke opacity measurement system shall be checked before each test.
Note: pollution after testing materials may occur and this will produce sticky smoke.

b) Any special requirements of the test under consideration shall be followed.

c) At least once a year the smoke opacity measurement system shall be re-calibrated, using the procedures given in clause 6.

d) If the smoke opacity measurement system is not used for a period of more than 6 months it shall be re-calibrated by the procedures given in clause 6 using either one or two filters before use.

e) After every occasion when the smoke opacity measurement system is serviced or repaired it shall be re-calibrated by the procedures given in clause 6 before it is returned to use.

8 Neutral density filters

8.1 General

8.1.1 Commercially available neutral density filters are normally of three types :

a) Those where a light absorbent material is contained within the body of the filter and is homogeneously distributed throughout that filter.

b) Those where a light absorbent material is contained within the body of the filter but is non-homogeneously distributed throughout the filter, e.g. contained within layers.

c) Those where a light absorbent material is applied to the surface of the filter.

8.1.2

a) Neutral density filters where a coating is applied to the surface are likely to be damaged and the coating lost when frequently used or handled. Neutral density filters where the light absorbent material is homogeneously distributed throughout the filter have best long term performance stability of all types.

EGOLF recommends that neutral density filters of the type in which the light absorbent material is homogeneously distributed within the body of the filter should only be used.

b) Neutral density filters with an additional anti-reflection coating shall be used when an unacceptable surface reflection of greater than 0.5% per surface is seen. Such filters shall be capable of giving a surface reflection of less than 0.5% per surface.

c) The spectral response curve of the neutral density filter shall be determined using a spectrophotometer, in both visible and infrared regions of the spectrum. The correct optical density of the neutral density filter shall be determined from the spectral response curve.

Note: it is known that some types of neutral density filters show a variation of more than 10% in optical density in the visible light spectra and more than 50% in the infrared spectrum.

8.2 Calibration of neutral density filters

The EGOLF procedure for calibration of neutral density filters shall be as follows:

a) The frequency of calibration of neutral density filters used by the laboratory shall depend upon the type used :

(i) Those where a light absorbent material is contained within the body of the filter and is homogeneously distributed throughout that filter shall be calibrated every five years.

(ii) Those where a light absorbent material is contained within the body of the filter and is non-homogeneously distributed throughout the filter, eg contained within layers shall be calibrated every two years.

(iii) Those where a light absorbent material is applied to the surface of the filter shall be calibrated every year.

b) Neutral density filters used by the laboratory shall be calibrated in an adequate manner, preferably by an accredited calibration laboratory.

c) Neutral density filters for calibration of laser light sourced smoke opacity measuring systems shall be calibrated at the laser wavelength of 0.6328 mm.

d) Where neutral density filters are to be calibrated using the calibrated light intensity meter then this shall be carried out by an accredited [or failing that an authorised] calibration laboratory against standards traceable to national standards and be provided with a certificate of conformity.