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Estimation of uncertainty in the single burning item test

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National foreword

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Estimation of uncertainty in the single burning item test

Messunsicherheit - Thermische Beanspruchung durch einen einzelnen brennenden Gegenstand (SBI)

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Contents

Page

European foreword **4**

1 Scope **5**
1.1 General **5**
1.2 Calculation procedure **5**
1.2.1 Introduction **5**
1.2.2 Synchronization of data **5**
1.2.3 Heat output **5**

2 Uncertainty **9**
2.1 Introduction **9**
2.2 Elaboration of terms and concepts **11**
2.2.1 Mean and variance **11**
2.2.2 Estimation of the confidence interval for the population mean **12**
2.2.3 Sources of uncertainty **12**
2.2.4 Standard uncertainties for different distributions **12**
2.2.5 Combined uncertainty **15**
2.2.6 Expanded uncertainty **16**
2.2.7 Uncorrected bias **16**
2.3 Combined standard uncertainties **17**
2.3.1 Combined standard uncertainty on sums **17**
2.3.2 Combined standard uncertainty on averages **18**
2.3.3 Combined standard uncertainty of a product and a division **19**
2.3.4 Combined standard uncertainty on the heat release rate (Q) **20**
2.3.5 Combined standard uncertainty on the depletion factor (ϕ) **22**
2.3.6 Combined standard uncertainty on the initial O_2-concentration ($X^{D°}_{O2}$) **22**
2.3.7 Combined standard uncertainty on the volume flow rate (V_{D298}) **23**
2.3.8 Combined standard uncertainty on the air density (ρ_{air}) **24**
2.3.9 Combined standard uncertainty on specimen heat release rate ($Q_{specimen}$) **24**
2.3.10 Combined standard uncertainty on the average heat release rate (Q_{av}) **24**
2.3.11 Combined standard uncertainty on FIGRA **25**
2.3.12 Combined standard uncertainty on THR600s **25**
2.3.13 Combined standard uncertainty on the volume flow (V(t)) **25**
2.3.14 Combined standard uncertainty on the smoke production rate (SPR) **25**
2.3.15 Combined standard uncertainty on specimen smoke production rate (SPR) **26**
2.3.16 Combined standard uncertainty on the average smoke production rate (SPR_{av}) **26**
2.3.17 Combined standard uncertainty on SMOGRA **26**
2.3.18 Combined standard uncertainty on TSP600s **27**
2.4 Confidence interval classification parameters **27**
2.5 Standard uncertainty on the different components **28**
2.5.1 Uncertainty on the data acquisition (DAQ) **28**
2.5.2 Transient error **28**
2.5.3 Aliasing error **28**
2.5.4 Uncertainty on data synchronicity **29**
2.5.5 Uncertainty on the component E and E' **30**
2.5.6 Uncertainty on the component φ **36**
2.5.7 Uncertainty on the component p_{atm} **36**
2.5.8 Uncertainty on the component T_{room} **36**
2.5.9 Uncertainty on the component α **38**

2.5.10 Uncertainty on the component c **38**
2.5.11 Uncertainty on the component A and L **39**
2.5.12 Uncertainty on the component q_{gas} **40**
2.5.13 Uncertainty on the component k_t **40**
2.5.14 Uncertainty on the component k_p **43**
2.5.15 Uncertainty on the component Δp **44**
2.5.16 Uncertainty on the component T_{ms} **44**
2.5.17 Uncertainty on the component I **46**

Annex A (informative) List of symbols and abbreviations **48**

European foreword

This document (CEN/TR 16988:2016) has been prepared by Technical Committee CEN/TC 127 "Fire Safety in Buildings", the secretariat of which is held by BSI.

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1 Scope

1.1 General

The measuring technique of the SBI (single burning item) test instrument is based on the observation that, in general, the heats of combustion per unit mass of oxygen consumed are approximately the same for most fuels commonly encountered in fires (Huggett [12]). The mass flow, together with the oxygen concentration in the extraction system, suffices to continuously calculate the amount of heat released. Some corrections can be introduced if CO_2, CO and/or H_2O are additionally measured.

1.2 Calculation procedure

1.2.1 Introduction

The main calculation procedures for obtaining the HRR and its derived parameters are summarized here for convenience. The formulas will be used in the following clauses and especially in the clause on uncertainty.

The calculations and procedures can be found in full detail in the SBI standard [1].

1.2.2 Synchronization of data

The measured data are synchronized making use of the dips and peaks that occur in the data due to the switch from ‘primary’ to ‘main’ burner around $t = 300$ s, i.e. at the start of the thermal attack to the test specimen. Synchronization is necessary due to the delayed response of the oxygen and carbon dioxide analysers. The filters, long transport lines, the cooler, etc. in between the gas sample probe and the analyser unit, cause this shift in time.

After synchronization, all data are shifted so that the ‘main’ burner ignites – by definition – at time $t = 300$ s.

1.2.3 Heat output

1.2.3.1 Average heat release rate of the specimen (HRR_{30s})

A first step in the calculation of the HRR contribution of the specimen is the calculation of the global HRR. The global HRR is constituted of the HRR contribution of both the specimen and the burner and is defined as

$$\mathrm{HRR}_{\mathrm{total}}(t) = E'\dot{V}_{D298}(t)x_{\mathrm{a\_O2}}\left(\frac{\phi(t)}{1+0{,}105\phi(t)}\right) \qquad (1)$$

where

$\mathrm{HRR}_{\mathrm{total}}(t)$	is the total heat release rate of the specimen and burner (kW);
E'	is the heat release per unit volume of oxygen consumed at 298 K, = 17 200 (kJ/m3);
$\dot{V}_{D298}(t)$	is the volume flow rate of the exhaust system, normalized at 298 K (m3/s);
$x_{\mathrm{a\_O2}}$	is the mole fraction of oxygen in the ambient air including water vapour;
$\varphi(t)$	is the oxygen depletion factor.

The last two terms $x_{\mathrm{a\_O2}}$ and $\left(\frac{\phi(t)}{1+0{,}105\phi(t)}\right)$ express the amount of moles of oxygen, per unit volume, that have chemically reacted into some combustion gases. Multiplication with the volume flow gives the