IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

Round-robin tests for measuring of hazardous substances 2012

Round-robin tests for in-house and external measuring stations

Information for participants

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1 Introduction

During performance of a risk assessment, it is frequently necessary for the concentration of a hazardous substance in a workplace atmosphere to be measured. Under the German TRGS 400 (2), overall responsibility for identifying and assessing hazards presented by hazardous substances at the workplace lies with the employer [1]. The measurements of hazardous substance required for this purpose may be performed by either internal (company) or external test bodies.

A test body may be regarded as suitable if it possesses the necessary expertise and facilities. The suitability of external test bodies is assured by accreditation. No provision is made for formal accreditation of internal test bodies. They must however satisfy the requirements of Annex 1 of the TRGS 402 [2]. To ensure that the quality parameters of analysis methods are observed, both internal and external test bodies must employ quality assurance methods in line with up-to-date good practice.

Round-robin tests may be used to support quality assurance for test bodies. The Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA) provides internal company test departments with the opportunity to participate in round-robin tests. The IFA organizes the round-robin tests with the co-operation of the Bundesverband der Messstellen für Umwelt- und Arbeitsschutz e.V. (BUA), the German association of environmental and OSH measurement bodies. The BUA recommends regular participation in the IFA's round-robin tests.

Where possible, round-robin tests are offered in which the entire analysis method can be tested. All round-robin tests are conducted in accordance with the requirements of ISO Guide 43 and DIN EN ISO/IEC 17043 [3, 4]. Participants will receive a detailed evaluation and a certificate of participation (see Annex, p. 22).

2 Organization of the round-robin tests

Organization and performance of the round-robin tests, including evaluation and documentation of the results, are conducted by the IFA. For 2012, six different round-robin tests are offered and are intended to cover the widest possible range of hazardous substances. Generally, participants are sent ready-loaded samples. Since 2002, however, round-robin tests have also been possible involving sampling on a dynamic test gas stream, and a round-robin test in which the participants are required to prepare conditioned thermal desorption tubes.

The costs arising for the round-robin tests are paid directly to the IFA.

The sequence of the round-robin tests will be adjusted for 2012. The metals round-robin test will be moved to the summer months, and the participants will receive a longer period of eight weeks for its completion.

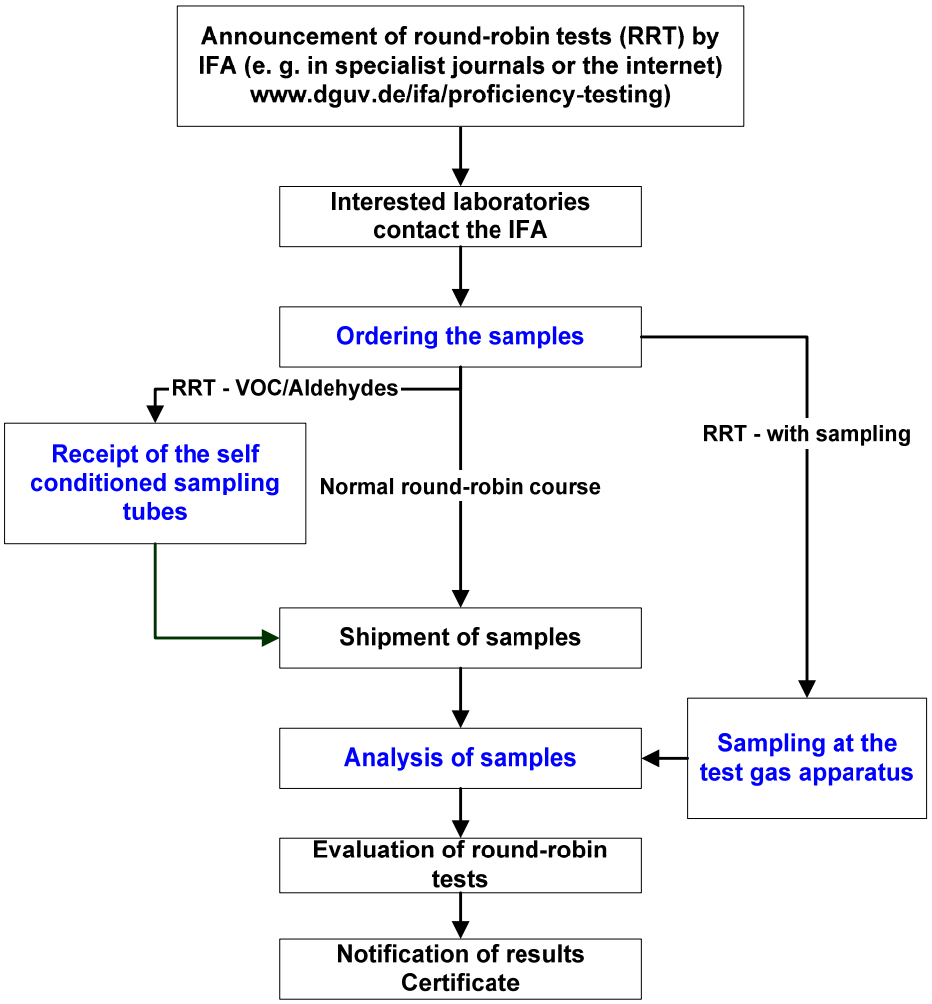
The following round-robin tests are planned for 2012:

1. Solvents on activated charcoal (February/March 2012)
2. Inorganic acids (March/April 2012), with/without sampling as preferred (06/07 March 2012 at the IFA in Sankt Augustin)
3. Organic substances (May/June 2012) at the IFA in Sankt Augustin with thermal desorption with/without sampling as preferred (08/09 May 2012 at the IFA in Sankt Augustin)
4. Metal dusts (July/August 2012)
5. Aldehydes (September 2012), with/without sampling as preferred at the IFA in Sankt Augustin)
   1st test date: 11/12 September 2012
   2nd test date: 13/14 September 2012
6. Solvents including sampling at the IFA in Sankt Augustin
   1st test date: 23/24 October 2012
   2nd test date: 24/25 October 2012

Round-robin tests always follow a similar procedure (see Fig. 1). Exceptions arise only when, for example, the stability of the samples is limited or when sampling is to be conducted by the participants themselves.

Full information on the IFA's round-robin tests is available on the Internet for interested parties and participants. The information can be found at www.dguv.de/ifa/proficiency-testing, and provides order forms for download. Complete and up-to-date information for participants is available here on short call.

Fig. 1: Flow chart for IFA round-robin tests (RRT)



3 Provision of the samples

3.1 Metals

Bodies taking part are provided with approximately 1 g of a dust which is to be analyzed for five metals (e.g. Ni, Pb, Co, Cu and As). The participants will be informed in good time of the metals selected. The analysis method (AAS methods, ICP) may be selected freely.

The recommended digestion method is that published by the DFG (the German Research Foundation) [5] and the IFA [6] for the digestion of metal dusts.

3.2 Solvents

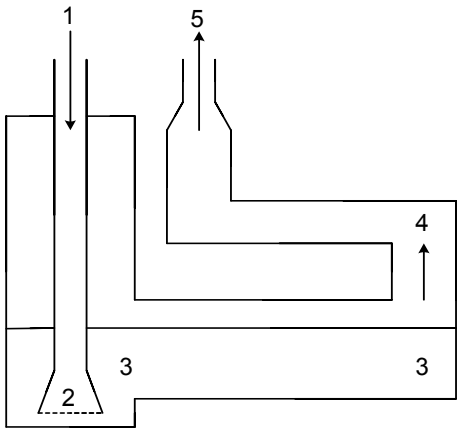
3.2.1 Production of the sorbent tubes

The task of producing samples for organic solvents is assumed by an external laboratory. The sorbent tubes are prepared by means of a dynamic test gas apparatus. The apparatus is shown in Figs. 2 and 3. Only one sorbent tube is loaded in each case. The pump to be used for application of the sample substance to the sorbent tubes must be calibrated. Where constant-flow pumps are employed, the volume drawn through the tube is measured during sampling by means of a gas meter.

If an intermittent pump is employed, the volume of a single stroke is determined prior to the start of the test. During sampling, a suitable facility is used to count the total number of strokes, thereby enabling the total volume to be determined by multiplication of the total number of strokes with the volume of a single stroke.

Once the sorbent tube has been loaded, it is sealed by means of the associated polyethylene caps and is ready for analysis.

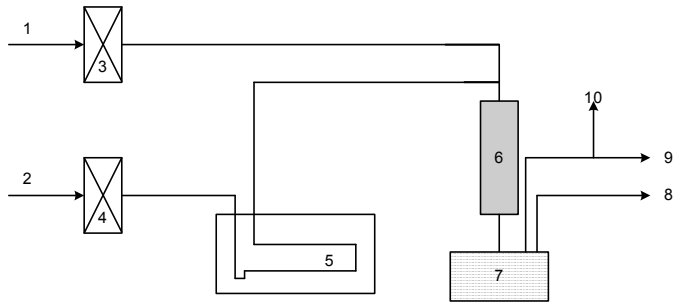
Fig. 2: Absorption bottle for saturation of the gas flow with vapourizable substances



1 = Gas inlet – nitrogen
2 = Glass frit
3 = Solvent
4 = Deflector tube for the prevention of aerosol formation
5 = Gas outlet – nitrogen saturated with solvent

The absorption bottle is fully submerged in a tempered water bath.

Fig. 3: Apparatus for loading of the sample tubes



1 = Air inlet
2 = Nitrogen inlet
3, 4 = Volumetric flow regulator
5 = Tempered water bath and absorption bottle
6 = Mixing tube
7 = Gas bottle
8 = Gas outlet – aspirator
9 = Gas outlet – sampling
10 = Gas outlet – process gas chromatograph

3.2.2 Loading of the sorbent tubes

TYPE B and NIOSH activated charcoal tubes manufactured by Dräger are employed as the sample carriers. Either tube type may be used, according to preference. The maximum allowable workplace concentration (AGW = German occupational exposure limit) of the substance concerned (see Table 1) serves as a basis for the absolute concentration.

The following boundary conditions are assumed for the purpose of calculation:

1. Concentration range: 0.01 to 2 times the AGW[1]
2. Volumetric flow: a) For TYPE B tubes: 20 l/h
   b) For NIOSH tubes: 8 l/h
3. Sampling duration: Two hours

One sample kit is supplied comprising:

- One pack of unopened tubes from the same production batch
- Three sample tubes, each generally containing three to five hazardous substances of differing concentration (see Table 1) for analysis

For the 13 selected substances, the loading concentration will lie within the following ranges (see Table 1):

[1] For carcinogenic substances and substances without a limit value the data base “GESTIS-International Limit Values for chemical agents” (www.dguv.de/ifa/gestis-limit-values) was applied for the purpose of calculation.

Table 1: Selection of the solvents

Hazardous substance	Concentration TYPE B tubes In mg/tube		Concentration NIOSH tubes In mg/tube	
	Min	Max	Min	Max
i-butyl acetate	0,192	38,4	0,077	15,36
n-butyl acetate	0,192	38,4	0,077	15,36
cyclohexane	0,280	56,0	0,112	22,40
ethyl acetate	0,600	120,0	0,240	48,00
ethylbenzene	0,176	35,2	0,070	14,08
n-heptane	0,840	168,0	0,336	67,20
n-hexane	0,072	14,4	0,029	5,76
n-octane	0,960	192,0	0,384	76,80
i-propyl acetate	0,168	33,6	0,067	13,44
n-propyl acetate	0,168	33,6	0,067	13,44
toluene	0,076	15,2	0,030	6,08
m-/p-xylene	0,176	35,2	0,070	14,08
o-xylene	0,176	35,2	0,070	14,08

The actual limit values of several countries are listed in the database “GESTIS International limit values” (www.dguv.de/ifa/gestis-limit-values).

3.3 Inorganic acids (HCl, HNO_3, H_3PO_4, H_2SO_4)

The round-robin test for volatile inorganic acids may be conducted either with or without sampling. The participants may therefore choose whether they wish to perform sampling for volatile inorganic acids themselves, or to have the sample carriers supplied to them.

3.3.1 Round-robin test with sampling

- Volatile inorganic acids: HCl, HNO_3

A large-scale dynamic test gas stream can be found at the IFA. It is suitable for parallel sampling by up to 12 participants (see Fig. 4).

Fig. 4: Test gas stream at the IFA

The concentrations to be measured will lie within the range between 1/10 and two times the AGW[2] (HCl, H_2SO_4 and H_3PO_4) and 0.5 and one time the AGW (HNO_3) value. The test will last approximately two hours for each test array. Three test arrays will be conducted.

The participants will receive a description of the apparatus, and in particular of the ports for sampling apparatus, in good time.

- Low-volatile inorganic acids (see 3.3.2.)

The participants will in addition receive the sample kit for H_2SO_4 and H_3PO_4, round-robin test without sampling.

3.3.2 Round-robin test without sampling

- Volatile inorganic acids

The production of samples for volatile inorganic acids is conducted parallel to the round-robin test with sampling. Orbo 53 silica gel tubes manufactured by Supelco or impregnated quartz fibre filters are employed as the sample carriers.

Each participant receives a sampling kit comprising:

– Three loaded sample carriers (quartz fibre filters or Orbo 53), and

– Two unloaded sample carriers for blank value adjustment.

- Low-volatile inorganic acids

Quartz-fibre filters are treated for production of the sulphuric acid and phosphoric acid samples. The samples are produced by means of microliter syringes for loading onto the filter. The participants may take advantage of this facility at no extra charge. It comprises:

[2] The German acronym AGW stands for Arbeitsplatzgrenzwert (Occupational Exposure Limit value – OEL)

– Three loaded filters stabilized immediately following loading
– Two unloaded filters for blank value adjustment.

For HCl and HNO_3, the IFA recommends that the analysis method for hazardous substances described in IFA Folder No. 6172/DFG [7, 8] be employed as the procedure. For H_2SO_4 and H_3PO_4, a procedure according to IFA Folder 6173 Pages 1 and 2/the DFG method is recommended [9, 10]. Ion chromatography should be employed for analysis.

3.4 Aldehydes

The round robin test is offered alternatively with and without sampling. Participants may choose whether they wish to perform sampling for aldehydes themselves, or to have the self conditioned sample carriers supplied to them.

The concentration for Formaldehyde will lie in the range between 0.01 and 1 mg/m³, for Acetaldehyde, Propionaldehyde, Acrolein and Butyraldehyde in the range between 0.1 and 3 mg/m³.

The actual selection including the concentration range will be announced timely on the IFA's homepage.

3.4.1 Round-robin test with sampling

At the dynamic test gas stream at the IFA up to twelve participants can carry out parallel sampling (see Fig. 4). Analysis should be conducted by HPLC according to IFA Folder No. 6045 [11].

3.4.2 Round-robin test without sampling

The production of samples for volatile inorganic acids is conducted in parallel to the round-robin test with sampling. The sample carriers must be sent by the participants to the IFA prior to the round-robin test. Only personal air samplers are used at the IFA. The sample carrier should not generate a back pressure exceeding 5.0 kPa under the specified conditions.

Where internally fabricated sample carriers are used, please supply an adapter to our terminals (GL14/GL25 threaded connection) on the test gas stream.The samples are loaded by the IFA before being returned to the participants.

Each participant receives a sample kit comprising:

– Three loaded sample carriers, and
– Two unloaded sample carriers for blank value adjustment.

3.5 Organic substances for analysis by thermal desorption

The round robin test is offered alternatively with and without sampling. Participants may choose whether they wish to perform sampling for organic substances themselves, or to have the self conditioned sample carriers supplied to them.

3.5.1 Round-robin test with sampling

- Volatile organic substances (VOC)

Up to 12 participants can carry out parallel sampling at the dynamic test gas stream at the IFA (see Fig. 4). The concentrations to be measured will lie within the range between 5 to 50 µg/m³. Analysis has to be conducted by gas chromatography by means of thermal desorption to DIN EN ISO 16017-1 [12].

3.5.2 Round-robin test without sampling

- Volatile organic substances (VOC)

The production of samples for volatile inorganic acids is conducted in parallel to the round-robin test with sampling. The particular feature of this round-robin test is that thermal desorption tubes are employed for loading which must be conditioned by the participants prior to the round-robin test. Each participant (analysis laboratory) submits seven thermal desorption tubes to the IFA. Only personal air samplers are used at the IFA. The sample carrier should not generate a back pressure exceeding 5.0 kPa under the specified conditions. Where internally fabricated sample carriers are used, please supply an adapter (GL14/GL25 threaded connection) for the test gas stream. The samples are loaded by IFA before being returned to the participants.

Each participant receives a sample kit comprising:

– Four (two as duplicates) loaded Tenax-TA tubes (three to six individual substances)

– Two tubes for blank value adjustment, removed from the pure gas of the dynamic test stream, before spiking the tubes

– One unloaded tube.

The loading concentration lies within a range of 5 to 50 µg/m³. The tubes and the blank value adjustments will be loaded with a sampling volume of 2 l. Analysis has to be conducted by gas chromatography by means of thermal desorption to DIN EN ISO 16017-1 [12].

Correction for the blank reading:

In the IFA's experience, the blank reading of the apparatus can generally be ignored. Experience has shown however that where Tenax tubes are used, substances which may simulate a blank reading are detected sporadically and non-reproducibly. At least eight blank reading samples are taken by the IFA for each test. Should these readings show a significant blank value caused by the apparatus, the participants are informed immediately by e-mail.

Correction should be made for the blank value against participants' blank samples only if the detected substance concentrations can be attributed clearly to the participants' tubes.

Substances are selected which are relevant to indoor air contamination (see Table 2). Since standards of some of these substances are very difficult to obtain, the quantitative analysis can be performed both in terms of the substance itself and in toluene equivalents. Refer to Table 3 for the chemicals employed for manufacture of the test gas.

Table 2: Examples of substance selection in the thermodesorption round-robin test

Substance group	Substances
Alkanes	n-heptane, n-octane, n-decane, n-dodecane, n-pentadecane
Alcohols	propylene glycol, butan-1-ol , 2-butoxyethanol, 2-(2-butoxyethoxy)-ethanol, 2-ethyl-1-hexanol, 2-phenoxyethanol
Aromates	toluene, o-, m-, p-xylene, ethylbenzene, trimethylbenzene
Esters	n-butyl acetate, 2-butoxyethyl acetate, 2-(2-butoxy ethoxy)-ethyl acetate
Ketones and aldehydes	butan-2-one, hexanal, octanal, acetophenone
Terpenes	3-carene, limonene, α-pinene

Table 3: Examples of the chemicals used for production of the samples

Substance	Purity in %	CAS No.	Product no.	Source
alpha-Pinene	98	80-56-8	14,752-4	Aldrich
Limonene R(+)	99	5989-27-5	62118	Fluka
3-Caren	90	13466-78-9	11,557-6	Aldrich
Toluene	99.9	108-88-3	1.08331	Merck
o-Xylene	99	95-47-6	30576	BDH
m-Xylene	99	108-38-3	98672	Fluka
p-Xylene	99	106-42-3	95682	Fluka
Ethylbenzene	99	100-41-4	03080	Fluka
1,3,5-Trimethylbenzene	99	108-67-8	63910	Fluka
2-Butoxyethyl acetate	99	112-07-2	30,728-9	Aldrich
2-(2-Butoxyethoxy)ethyl acetate	97	124-17-4	821014	Merck
n-Butyl acetate	99.5	123-86-4	109652	Merck
Hexanal	99	66-25-1	21520	Fluka
Octanal	98	124-13-0	806901	Merck
Butan-2-one	99.5	78-93-3	04380	Fluka
Acetophenone	98	98-86-2	800028	Merck
2-Ethyl-1-hexanol	98	104-76-7	800990	Merck
Propylene glycol	99	57-55-6	8222324	Merck
2-Butoxyethanol	99.8	111-76-2	20398	Fluka
2-(2-Butoxyethoxy)ethanol	99	112-34-5	53,764-0	Aldrich
2-Phenoxyethanol	98	122-99-6	P1,560-9	Aldrich

Substance	Purity in %	CAS No.	Product no.	Source
Butan-1-ol	99.7	71-36-3	1988	Merck
n-Decane	98	124-18-5	30550	Fluka
Dodecane	99	112-40-3	D22,110-4	Aldrich
Pentadecane	99	629-62-9	P7385	Sigma
n-Heptane	99	142-82-5	104365	Merck
n-Octane	95	111-65-9	74823	Fluka

3.6 Solvents with sampling

Round-robin tests including sampling are performed on IFA's dynamic test gas stream at Sankt Augustin, which is capable of presenting a homogeneous test gas simultaneously to up to 12 participants (see Fig. 4).

The concentration of the solvent test gases is selected in consideration of the atmospheric limit values of the solvents, generally being in the order of 0.01 to 2 times the relevant atmospheric limit value. The substances listed in Table 4 can be analyzed by means of the analysis methods described [13 to 16].

In addition, passive collectors can be employed (see Fig. 5). Participants using passive collectors are requested to indicate this on the order form.

Table 4: Examples of substance selection – Round-robin tests on solvents, including sampling

Substance group	Substances
Alkanes	n-hexane, cyclohexane, n-heptane, methylcyclohexane, n-octane, n-nonane, n-decane
Alcohols	ethanol, 1-propanol, 2-propanol, n-butanol, i-butanol, 2-butanol, 2-methyl-2-propanol, cyclohexanol
Aromates	toluene, ethylbenzene, o-/m-/p-xylene, propylbenzene, cumene, 1,2,3-trimethylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene
Esters	methyl acetate, ethyl acetate, n-propyl acetate, i-propyl acetate, n-butyl acetate, i-butyl acetate
Ethers	1-methoxy-2-propanol, 2-methoxyethyl acetate, tetrahydrofuran, ethoxyethyl acetate, 2-methoxy-1-methylethyl acetate, butoxyethanol, butoxyethyl acetate
Ketones	acetone, butanone, cyclopentanone, 2-hexanone, 4-methyl-2-pentanone, cyclohexanone, diisobutyl ketone

The substance groups to be analyzed will be indicated in good time on the Internet.

Based upon experience gained in recent years, one test-gas mixture will contain ketones only. The two remaining test gases will not contain ketone.

Fig. 5: Diffusion chamber of the test gas stream

4 Processing and documentation of the analysis results

Upon receipt of the samples, the duration of processing will be stated, which will generally be in the order of four weeks.

A USB stick (2.0) is supplied with the samples for data recording.

Data are recorded by input of the results in a dedicated input program (RingDat, Prodata, Dresden). The program, which has an interface in two languages (German or English), runs on all versions of MS WINDOWS from Windows 2000 onwards. Participants are required to print out and sign their results and return the signed copy to the IFA **together with the data media**. The data are immediately entered into a database and anonymised for further analysis. They are then analysed and displayed graphically with the aid of ProLab Plus. The IFA conducts statistical analysis.

Following completion of analysis, each participating test body receives confirmation of its participation, containing the following information

- Laboratory number
- Own laboratory result and |z|-score
- Reference value of the sample tubes
- "True" value of the samples following elimination of outliers (GRUBBS test)
- Standard deviation

and a round-robin test report containing the following information

- Tabular and graphical presentation of the entire analysis results and the outliers
- Tabular and graphical presentation of the |z|-score analysis
- Alphabetical list of all participants
- List of the analysis methods employed by the participants.

5 Evaluation

5.1 Preliminary remarks regarding the analysis software

Since 2011, Quo data's Prolab Plus software has been used for interpretation of the results of the round-robin tests (quo data, Gesellschaft für Qualitätsmanagement und Statistik mbH, D-01187 Dresden, http://www.quodata.de/index.php?id=10). The interpretation methods employed in the software fully satisfy the requirements of ISO 5725-2, -3, -5; DIN 38402 A 45 and ISO 13528 [17 to 21]. The software also offers numerous other features. The interpretation methods that we have used in the past are of course supported by this software.

5.2 General statistical values

The round-robin tests are evaluated in accordance with ISO Guide 43 Annex A. The basis for scoring of the participants according to this ISO guide is evaluation by the "z-score" [3]. Should more than one result (generally three) be indicated by the participants, the discrete results are averaged for each hazardous substance.

Discrete mean value:

$$C_{jk} = \frac{1}{n_{jk}} \sum_{i=1}^{n_{jk}} C_j$$

i	=	Index for discrete values	n	=	Number of measurements
j	=	Index for the laboratory	c_{jk}	=	Discrete mean value
k	=	Index for feature level	c_j	=	Discrete value

The total mean value $\mathbf{C}_k$ is then calculated, which generally serves as the reference value during the evaluation. At round-robin tests that include sampling the mean concentration found analysing quality control samples can be defined as target concentration. This value is used for further statistical analyses such as the total standard deviation $\mathbf{S}_k$, GRUBBS test and z score. Where certified materials are employed, the concentration stated on the certificate is defined as the reference value. The total mean value and total standard deviation are calculated from the data.

Total mean value:

$$C_k = \left(\frac{1}{N_k} \right) \sum_{i=1}^{N_k} C_{jk}$$

Total standard deviation: $$S_k = \sqrt{\left(\frac{1}{N_k - 1}\right) \sum_{i=1}^{N_k} (C_{jk} - C_k)^2}$$

N_k = Number of discrete mean values for the feature level k

S_k = Total standard deviation

C_{jk} = Discrete mean value

C_k = Total mean value

5.3 GRUBBS test for outliers

It is generally assumed that the body of data is subject to normal distribution. The outlier test is then performed at the 95% level (both sides α = 2.5%). The elimination of outliers ultimately produces a mean value which closely approximates to the "*true value*" of the sample.

The z-score of all participating laboratories, including those eliminated as outliers, is calculated with the aid of the outlier-free mean value and the outlier-free standard deviation. The z-score can be regarded as the *quality characteristic* of the mean value of the individual laboratories (see below).

In the GRUBBS outlier test, the procedure is for all laboratory mean values to be calculated in the first instance and the total mean value and total standard deviation then to be determined from them. The difference is then formed between the discrete mean values and the reference value/total mean value, the discrete mean value with the greatest difference to the reference value/total mean value being substituted marked * in the formula of the GRUBBS outlier test. The test value t is compared to the tabular value for a significance level of α = 2.5% when considered from both sides (see above).

If it is confirmed as an outlier, it is removed from the body of data, and the total mean value and total standard deviation recalculated. The difference between the new total mean value/ reference value and the discrete mean values is calculated and the greatest difference substituted in the GRUBBS formula. If this value is also confirmed as an outlier, it is likewise removed.

The procedure is repeated until no more outliers can be eliminated.

Grubbs outlier test: $$t = \left| \frac{C_{jk}^{*} - C_k}{S_k} \right|$$

C_{jk}^{*} = Discrete mean value

C_k = Total mean value/reference value

S_k = Total standard deviation

t = Test value

Should the data exhibit such strong variation that no outliers can be identified by means of the GRUBBS test, they are defined by the deviation from the reference value. An outlier is

recognized as such in this case when the deviation > ± 36%. Where the data material is heterogeneous, the limit can be increased to 50%, or identification of the outliers not be performed.

5.4 z-score analysis

All discrete mean values are considered in the z-score analysis, including the values identified as outliers in the GRUBBS test. Outliers are however omitted from the total standard deviation required for calculation and the total mean value/reference value.

The z-score analysis is based upon the following formula:

$$z = \frac{\left(c_{jk}{}^{*} - c_k\right)}{s}$$

$\mathbf{C_{jk}}^{*}$ **=** Discrete mean value

$\mathbf{C_k}$ **=** Total mean value/reference value

s **=** Maximum permissible deviation from the reference value (as a rule 10%)

A permissible deviation of 10% is assumed for **s** during analysis of the round-robin tests. Where data material exhibits strong scatter the permissible deviation may be increased to up to 20%.

The discrete results are then evaluated as shown below:

		|z|	≤	1	Good result
1	≤	|z|	≤	2	Satisfactory result
2	≤	|z|	≤	3	Questionable result
3	≤	|z|			Extremely questionable result

A result for which |z| ≤ 2 is deemed satisfactory, i.e. the round-robin test is deemed passed. Should the |z| score exceed 2, review of the analysis method employed is advisable.

The z-score can be used to determine further statistically important parameters, which shall not however be considered in any greater detail at this point.

5.5 Certificate

The certificate of participation is produced individually from each participant's results for all round-robin tests. The certificate is produced in accordance with the following rules:

- All substances are stated on the certificate for which, averaged over all samples, a z-score ≤ 2 was attained.

Calculation for the discrete substance:

Of three samples, at least two must yield discrete z-scores < 2; a z-score distribution such as “2.9”, “2.8”, “0”, which purely mathematically would yield a mean value of 1.9, results in participation for the substance being deemed unsuccessful.

No single sample may yield a z-score > 3.

- Participation in the round-robin test is deemed successful when a z-score ≤ 2 (see above) is obtained for over 50% of the analyzed substances.
- Should z-scores ≤ 2 be obtained for fewer than 50% of the analyzed substances, the certificate merely confirms participation in the round-robin test.

6 Literature

[1] Gesetz über die Durchführung von Maßnahmen des Arbeitsschutzes zur Verbesserung der Sicherheit und des Gesundheitsschutzes der Beschäftigten bei der Arbeit (Arbeitsschutzgesetz – ArbSchG) vom 7. August 1996 (BGBl. I, S. 1246), latest amendment of 5 February 2009 (BGBl. I, S. 160)

[2] TRGS 402, Ermitteln und Beurteilen der Gefährdungen bei Tätigkeiten mit Gefahrstoffen: Inhalative Exposition (02.2010). http://www.baua.de/cln_135/de/Themen-von-A-Z/Gefahrstoffe/TRGS/TRGS-402.html

[3] ISO Guide 43 Annex A: Proficiency testing by interlaboratory comparisons – Part 1: Development and operation of proficiency testing schemes. Genf 1996

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7 Annex

IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

Company, place

has successfully participated in the

Round-robin test
„Organic solvents
with sampling“

on 27 and 28 October 2010
at
Institut fürArbeitschutz der Deutschen Gesetzlichen Unfallversicherung (IFA)
(Institute for Occupational Safety and Health of the
German Social Accident Insurance (IFA))
at Sankt Augustin/Germany

for the following solvents

acetone
2-butanone
4-methylpentan-2-one
cyclopentanone
cyclohexanone
n-octane
n-nonane
toluene
ethylbenzene

Head of Sub-Division Chemical Agents II

Dr D. Breuer