BS EN 15915:2010

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Copper and copper alloys — Determination of silver content — Flame atomic absorption spectrometric method (FAAS)

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee NFE/34, Copper and copper alloys.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Copper and copper alloys - Determination of silver content - Flame atomic absorption spectrometric method (FAAS)

Cuivre et alliages de cuivre - Détermination de l'argent - Méthode par spectrométrie d'absorption atomique dans la flamme (SAAF)

Kupfer und Kupferlegierungen - Bestimmung des Silbergehaltes - Flammenatomabsorptionsspektrometrisches Verfahren (FAAS)

This European Standard was approved by CEN on 19 June 2010.

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Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 15915:2010) has been prepared by Technical Committee CEN/TC 133 “Copper and copper alloys”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2011, and conflicting national standards shall be withdrawn at the latest by January 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

Within its programme of work, Technical Committee CEN/TC 133 requested CEN/TC 133/WG 10 "Methods of analysis" to prepare the following document:

EN 15915, *Copper and copper alloys — Determination of silver content — Flame atomic absorption spectrometric method (FAAS)*.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies two flame atomic absorption spectrometric methods (FAAS) for the determination of the silver content of copper and copper alloys in the form of unwrought, wrought and cast products.

The methods are applicable to products having silver mass fractions between 0,01 % and 2,0 %.

a) Method A is applicable to copper and copper alloys having silver mass fractions between 0,01 % and 1,0 % and containing antimony or tin not greater than 0,005 0 % or silicon not greater than 0,010 %.

b) Method B is applicable to copper and copper alloys having silver mass fractions between 0,01 % and 2,0 % and antimony or tin greater than 0,005 % and silicon greater than 0,010 %.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1811-1, *Copper and copper alloys — Selection and preparation of samples for chemical analysis — Part 1: Sampling of cast unwrought products*

ISO 1811-2, *Copper and copper alloys — Selection and preparation of samples for chemical analysis — Part 2: Sampling of wrought products and castings*

3 Principle

Dissolution of a test portion in an appropriate acid solution followed, after suitable dilution, by aspiration into an air/acetylene flame of an atomic absorption spectrometer. Measurement of the absorption of the 328,1 nm line emitted by a silver hollow-cathode or electrodeless discharge lamp.

4 Reagents

During the analysis, use only reagents of recognized analytical grade and only distilled water or water of equivalent purity.

WARNING — Special care shall be taken to strictly exclude chlorine and chloride ions from all operations, reagents, equipment and the laboratory air. For that reason all reagents indicated hereafter shall be freshly prepared and not stored after analysis.

4.1 Nitric acid, HNO_3 (ρ = 1,40 g/ml).

4.2 Nitric acid solution, 1 + 1.

Add 500 ml of nitric acid (4.1) into 500 ml of water.

4.3 Boric acid, H_3BO_3 (40 g/l solution).

4.4 Hydrofluoric acid, HF, 48 % (ρ = 1,14 g/ml).

WARNING — Hydrofluoric acid is a hazardous substance. Care shall be taken and it shall be used under an efficient fume hood.

4.5 Fluoroboric-nitric acid mixture.

In a 500 ml one-mark volumetric flask introduce:

- 150 ml of boric acid (4.3);
- 20 ml of hydrofluoric acid (4.4);
- 300 ml of nitric acid solution (4.2).

Dilute to the mark with water and mix well.

4.6 Silver stock solution, 1,0 g/l Ag.

Weigh (0,5 ± 0,001) g of silver (Ag ≥ 99,99 %) and transfer it into a 250 ml beaker. Add 50 ml of the nitric acid solution (4.2) and cover with a watch glass. Heat gently until the silver is dissolved and then boil or alternatively heat the solution in a boiling water bath until nitrous fumes have been expelled. Cool to room temperature, transfer the solution into a 500 ml one-mark volumetric flask, dilute to the mark with water and mix well.

1 ml of this solution contains 1 mg of Ag.

4.7 Silver standard solution, 0,050 g/l Ag.

Transfer 10,0 ml of the silver stock solution (4.6) into a 200 ml one-mark volumetric flask. Dilute to the mark with water and mix well.

1 ml of this solution contains 0,050 mg of Ag.

4.8 Silver standard solution, 0,020 g/l Ag.

Transfer 5,0 ml of the silver stock solution (4.6) into a 250 ml one-mark volumetric flask. Dilute to the mark with water and mix well.

1 ml of this solution contains 0,020 mg of Ag.

4.9 Copper base solution A, 10 g/l Cu.

For method A.

Weigh 5,0 g of pure copper (Ag ≤ 0,000 5 %) and transfer it into a 600 ml beaker. Add 100 ml of the nitric acid solution (4.2) and cover with a watch glass. Heat gently until the copper is completely dissolved, then boil or alternatively heat the solution in a boiling water bath until nitrous fumes have been expelled. Cool to room temperature and transfer the solution quantitatively into a 500 ml one-mark volumetric flask, dilute to the mark with water and mix well.

4.10 Copper base solution B, 10 g/l Cu.

For method B.

Weigh 5,0 g of pure copper (Ag ≤ 0,000 5 %) and transfer it into a 600 ml plastic beaker. Add 75 ml of water, 10 ml of hydrofluoric acid (4.4) and by small fractions, 75 ml of nitric acid (4.1) and cover with a watch glass. Heat gently until the copper is completely dissolved, then heat the solution in a boiling water bath until nitrous fumes have been expelled. Cool to room temperature and transfer the solution quantitatively into a 500 ml plastic one-mark volumetric flask and add 75 ml of boric acid (4.3). Dilute to the mark with water and mix well.

5 Apparatus

5.1 Atomic absorption spectrometer, fitted with an air/acetylene burner.

5.2 Silver hollow-cathode or electrodeless discharge lamp.

6 Sampling

Sampling shall be carried out in accordance with ISO 1811-1 or ISO 1811-2, as appropriate.

Test samples shall be in the form of fine drillings, chips or millings, with a maximum thickness of 0,5 mm.

7 Procedure

7.1 Preparation of the test portion solution — Method A

7.1.1 General

Method A is applicable to products having silver mass fractions between 0,01 % and 1,0 % and containing antimony or tin not greater than 0,005 0 % or silicon not greater than 0,010 %.

7.1.2 Test portion

Weigh (0,5 ± 0,001) g of the test sample.

7.1.3 Test portion solution

7.1.3.1 General

Transfer the test portion (7.1.2) into a 200 ml conical flask and add 20 ml of the nitric acid solution (4.2). Warm gently until dissolution is complete, then boil or alternatively heat the solution in a boiling water bath until nitrous fumes have been expelled. Cool to room temperature.

7.1.3.2 Silver mass fractions below 0,2 %

Transfer the dissolved test portion (7.1.3.1) into a 100 ml one-mark volumetric flask. Dilute to the mark with water and mix well.

7.1.3.3 Silver mass fractions between 0,1 % and 1,0 %

Transfer the dissolved test portion (7.1.3.1) into a 500 ml one-mark volumetric flask. Dilute to the mark with water and mix well.

7.2 Blank test

Carry out a blank test simultaneously with the determination, following the same procedure and using the same quantities of all reagents as used for the determination, but substituting pure copper for the test portion (7.1.2).

7.3 Check test

Make a preliminary check of the apparatus by preparing a solution of a reference material or a synthetic sample containing a known amount of silver and of composition similar to the material to be analysed. Carry out the procedure specified in 7.5.

7.4 Establishment of the calibration curve

7.4.1 Preparation of the calibration solutions

The presence of copper in the calibration solutions compensates for chemical interaction effects of copper in the test solution. Normally no similar additions are required to compensate for the effect of alloying elements. If an alloying element is present in the material to be analysed in mass fraction $>$ 10 %, an appropriate mass of this element shall be added to the calibration solutions. The volumes of copper base solution A added (4.9) have been calculated to compensate for chemical interaction effects of copper in test solutions of copper or high-copper alloys. Overcompensation may occur if the same volumes are added when the test samples are copper-based alloys where the percentage of copper is lower. In these cases the volumes of copper base solution shall be decreased to match the copper content of the test sample in solution.

NOTE The range of calibration solutions is appropriate for most current models of equipment of average performance. The range and operating conditions should be selected for optimum measurements by the particular equipment available.

Into each of a series of 100 ml one-mark volumetric flasks, introduce the volumes of silver standard solution (4.7), nitric acid solution (4.2) and copper base solution A (4.9) shown in Tables 1 or 2 depending on the expected silver content. Dilute to the mark with water and mix well.

Table 1 — Calibration for silver mass fractions between 0,01 % and 0,2 %

Silver standard solution volume (4.7) ml	**Corresponding silver mass** mg	**Corresponding silver concentration** mg/ml[b]	**Nitric acid solution** (4.2) ml	**Copper base solution A** (4.9) ml	**Corresponding copper mass** g	**Corresponding silver mass fraction of sample** %
0[a]	0	0	10	50	0,5	0
1	0,05	0,000 5	10	50	0,5	0,01
2	0,10	0,001 0	10	50	0,5	0,02
5	0,25	0,002 5	10	50	0,5	0,05
7	0,35	0,003 5	10	50	0,5	0,07
10	0,50	0,005 0	10	50	0,5	0,10
15	0,75	0,007 5	10	50	0,5	0,15
20	1,00	0,010 0	10	50	0,5	0,20

[a] Blank test on reagents for calibration curve.

[b] After final dilution.

Table 2 — Calibration for silver mass fractions between 0,1 % and 1,0 %

Silver standard solution volume (4.7) ml	**Corresponding silver mass** mg	**Corresponding silver concentration** mg/ml[b]	**Nitric acid solution** (4.2) ml	**Copper base solution A** (4.9) ml	**Corresponding copper mass** g	**Corresponding silver mass fraction of sample** %
0[a]	0	0	2	10	0,1	0
2	0,10	0,001 0	2	10	0,1	0,10
5	0,25	0,002 5	2	10	0,1	0,25
7	0,35	0,003 5	2	10	0,1	0,35
10	0,50	0,005 0	2	10	0,1	0,50
15	0,75	0,007 5	2	10	0,1	0,75
20	1,00	0,010 0	2	10	0,1	1,00

[a] Blank test on reagents for calibration curve.

[b] After final dilution.

7.4.2 Adjustment of the atomic absorption spectrometer

Fit the silver hollow-cathode or electrodeless discharge lamp (5.2) into the atomic absorption spectrometer (5.1), switch on the current and allow it to stabilize. Adjust the wavelength in the region of 328,1 nm to minimum absorbance. Following manufacturer's instructions, fit the correct burner, light the flame and allow the burner temperature to stabilize. Taking careful note of the manufacturer's instructions regarding the minimum flow rate of acetylene, aspirate the calibration solution of highest concentration of analyte and adjust the burner configuration and gas flows to obtain maximum absorbance.

7.4.3 Spectrometric measurement of the calibration solutions

Aspirate the relevant series of calibration solutions (7.4.1) in succession into the flame and measure the absorbance for each. Take care to keep the aspiration rate constant throughout the preparation of the calibration curve. Spray water through the burner after each measurement.

NOTE For certain types of apparatus, instead of water it is preferable to use a solution containing the attack reagents, in the same concentrations as in the test portion solutions.

7.4.4 Calibration curve

Establish the calibration curve using measured absorbances and corresponding analyte amounts. Use appropriate spectrometer software or an off-line computer for regression calculations or prepare a graphical representation.

7.5 Determination

7.5.1 General

The analysis shall be carried out independently, in duplicate.

7.5.2 Preliminary spectrometric measurement

Carry out a preliminary measurement on the test portion solutions (7.1.3.2 or 7.1.3.3) following the procedure specified in 7.4.2 and 7.4.3 at the same time as the spectrometric measurements are carried out on the calibration solutions. Estimate the preliminary analyte amount by using the calibration curve (7.4.4).

7.5.3 Spectrometric measurements

7.5.3.1 Use of the calibration curve

Repeat the measurements and determine the concentration directly using the appropriate calibration curve.

7.5.3.2 Use of bracketing method

Carry out a second measurement on the test portion solution (7.1.3.2 or 7.1.3.3), following the procedure specified in 7.4.3, by bracketing between two new calibration solutions with a composition similar to that of the calibration solutions, but having silver concentrations slightly higher and slightly lower (± 10 %) than the estimated silver concentration of the test portion solution.

To prepare these calibration solutions, follow the procedure specified in 7.4.1 using, however, suitable quantities of silver standard solution (4.7).

7.6 Preparation of the test portion solution — Method B

7.6.1 General

Method B is applicable to products having silver mass fractions between 0,01 % and 2 % and containing antimony or tin greater than 0,005 % and silicon greater than 0,010 %.

7.6.2 Test portion

Weigh (1 ± 0,001) g of the test sample.

7.6.3 Test portion solution

7.6.3.1 General

Transfer the test portion (7.6.2) into a 250 ml plastic beaker. Add 50 ml of the fluoroboric-nitric acid mixture (4.5) and cover with a watch glass.

Allow the dissolution proceed at room temperature.

Transfer the dissolved test portion into a 100 ml plastic volumetric flask. Dilute to the mark with water and mix well.

7.6.3.2 Silver mass fractions between 0,01 % and 0,15 %

Transfer 20,0 ml of the test portion solution (7.6.3.1) into a 100 ml one-mark volumetric flask. Add 4 ml of nitric acid solution (4.2). Dilute to the mark with water and mix well.

7.6.3.3 Silver mass fractions between 0,10 % and 0,60 %

Transfer 5,0 ml of the test portion solution (7.6.3.1) into a 100 ml one-mark volumetric flask. Add 5 ml of nitric acid solution (4.2). Dilute to the mark with water and mix well.

7.6.3.4 Silver mass fractions between 0,50 % and 2,00 %

Transfer 2,0 ml of the test portion solution (7.6.3.1) into a 100 ml one-mark volumetric flask followed by 3,0 ml of the copper base solution B (4.10). Add 6 ml of nitric acid solution (4.2). Dilute to the mark with water and mix well.

7.7 Blank test

Carry out a blank test simultaneously with the determination, following the same procedure and using the same quantities of all reagents, as used for the determination, but substituting pure copper for the test portion (7.6.2).

7.8 Check test

Make a preliminary check of the apparatus by preparing a solution of reference material or a synthetic sample containing a known amount of silver and of a composition similar to the material to be analysed. Carry out the procedure specified in 7.9.

7.9 Establishment of the calibration curve

7.9.1 Preparation of the calibration solutions

The presence of copper in the calibration solutions compensates for chemical interaction effects of copper in the test solution. Normally no similar additions are required to compensate for the effect of alloying elements. If an alloying element is present in the material to be analysed in mass fraction $>$ 10 %, an appropriate mass of this element shall be added to the calibration solutions. The volumes of copper base solution B added (4.10) have been calculated to compensate for chemical interaction effects of copper in test solutions of copper or high-copper alloys. Overcompensation may occur if the same volumes are added when the test samples are copper-based alloys where the percentage of copper is lower. In these cases the volumes of copper base solution shall be decreased to match the copper content of the test sample in solution.

NOTE The range of calibration solutions is appropriate for most current models of equipment of average performance. The range and operating conditions should be selected for optimum measurements by the particular equipment available.

Into each of a series of 100 ml one-mark volumetric flasks, introduce the volumes of silver standard solution (4.7 or 4.8), nitric acid solution (4.2) and copper base solution B (4.10) shown in Tables 3, 4 or 5 depending on the expected silver content. Dilute to the mark with water and mix well.

Table 3 — Calibration for silver mass fractions between 0,01 % and 0,15 %

Silver standard solution volume (4.8) ml	**Corresponding silver mass** mg	**Corresponding silver concentration** mg/ml[b]	**Nitric acid solution** (4.2) ml	**Copper base solution B** (4.10) ml	**Corresponding copper mass** g	**Corresponding silver mass fraction of sample** %
0[a]	0	0	4	20	0,2	0
1	0,02	0,000 2	4	20	0,2	0,01
2	0,04	0,000 4	4	20	0,2	0,02
5	0,10	0,001 0	4	20	0,2	0,05
7	0,14	0,001 4	4	20	0,2	0,07
10	0,20	0,002 0	4	20	0,2	0,10
12	0,24	0,002 4	4	20	0,2	0,12
15	0,30	0,003 0	4	20	0,2	0,15

[a] Blank test on reagents for calibration curve.

[b] After final dilution.

Table 4 — Calibration for silver mass fractions between 0,10 % and 0,60 %

Silver standard solution volume (4.7) ml	**Corresponding silver mass** mg	**Corresponding silver concentration** mg/ml[b]	**Nitric acid solution** (4.2) ml	**Copper base solution B** (4.10) ml	**Corresponding copper mass** g	**Corresponding silver mass fraction of sample** %
0[a]	0	0	5	5	0,05	0
1	0,05	0,000 5	5	5	0,05	0,10
2	0,10	0,001 0	5	5	0,05	0,20
3	0,15	0,001 5	5	5	0,05	0,30
4	0,20	0,002 0	5	5	0,05	0,40
5	0,25	0,002 5	5	5	0,05	0,50
6	0,30	0,003 0	5	5	0,05	0,60

[a] Blank test on reagents for calibration curve.

[b] After final dilution.

Table 5 — Calibration for silver mass fractions between 0,50 % and 2,00 %

Silver standard solution volume (4.7) ml	**Corresponding silver mass** mg	**Corresponding silver concentration** mg/ml[b]	**Nitric acid solution** (4.2) ml	**Copper base solution B** (4.10) ml	**Corresponding copper mass** g	**Corresponding silver mass fraction of sample** %
0[a]	0	0	6	5	0,05	0
2	0,10	0,001 0	6	5	0,05	0,50
3	0,15	0,001 5	6	5	0,05	0,75
4	0,20	0,002 0	6	5	0,05	1,00
5	0,25	0,002 5	6	5	0,05	1,25
6	0,30	0,003 0	6	5	0,05	1,50
7	0,35	0,003 5	6	5	0,05	1,75
8	0,40	0,004 0	6	5	0,05	2,00

[a] Blank test on reagents for calibration curve.

[b] After final dilution.

7.9.2 Adjustment of the atomic absorption spectrometer

Fit the silver hollow-cathode or electrodeless discharge lamp (5.2) into the atomic absorption spectrometer (5.1), switch on the current and allow it to stabilize. Adjust the wavelength in the region of 328,1 nm to minimum absorbance. Following manufacturer's instructions, fit the correct burner, light the flame and allow the burner temperature to stabilize. Taking careful note of the manufacturer's instructions regarding the minimum flow rate of acetylene, aspirate the calibration solution of highest concentration of analyte and adjust the burner configuration and gas flows to obtain maximum absorbance.

7.9.3 Spectrometric measurement of the calibration solutions

Aspirate the relevant calibration solutions (7.9.1) in succession into the flame and measure the absorbance for each. Take care to keep the aspiration rate constant throughout the preparation of the calibration curve. Spray water through the burner after each measurement.

NOTE For certain types of apparatus, instead of water it is preferable to use a solution containing the attack reagents, in the same concentrations as in the test portion solutions.

7.9.4 Calibration curve

Establish the calibration curve using measured absorbances and corresponding analyte amounts. Use appropriate spectrometer software or an off-line computer for regression calculations or prepare a graphical representation.

7.10 Determination

7.10.1 General

The analyses shall be carried out independently, in duplicate.

7.10.2 Preliminary spectrometric measurement

Carry out a preliminary measurement on the test portion solution (7.6.3.2, 7.6.3.3 or 7.6.3.4) following the procedure specified in 7.9.2 and 7.9.3 at the same time as the spectrometric measurements are carried out on the calibration solutions (7.9.1). Estimate the preliminary analyte amount by using the calibration curve according to 7.9.4.

7.10.3 Spectrometric measurement

7.10.3.1 Use of the calibration curve

Repeat the measurements and determine the concentration directly using the appropriate calibration curve.

7.10.3.2 Use of bracketing method

Carry out a second measurement on the test portion solution (7.6.3.2, 7.6.3.3 or 7.6.3.4), following the procedure specified in 7.9.3, by bracketing between two new calibration solutions with compositions similar to those of the calibration solutions (7.9.1), but having silver concentrations slightly higher and slightly lower (± 10 %) than the estimated silver concentration of the test portion solution.

To prepare these calibration solutions, follow the procedure specified in 7.9.1 using, however, suitable quantities of silver standard solution (4.7 and 4.8).

8 Expression of results

8.1 Use of the calibration curve

Calculate the silver mass fraction, in percent (%), as follows:

$$w_{\mathrm{Ag}} = \frac{c_1}{m} \times V_{\mathrm{f}} \times D_r \times 100 \tag{1}$$

where

w_{Ag} is the silver mass fraction in percent (%);

c_1 is the silver concentration from the calibration curve, in milligrams per millilitre (mg/ml);

m is the sample mass of the test portion in milligrams (mg);

V_f is the volume of the test portion solution (7.1.3.2, 7.1.3.3 and 7.6.3.2, 7.6.3.3 or 7.6.3.4.) in millilitres (ml);

D_r is the dilution ratio.

NOTE For 7.6.3.2 D_r = 5;
for 7.6.3.3 D_r = 20;
for 7.6.3.4 D_r = 50.

8.2 Use of bracketing method

Calculate the silver mass fraction, in percent (%), as follows:

$$w_{Ag} = \frac{c_2}{m} \times V_f \times D_r \times 100 \qquad (2)$$

where

c_2 is the silver concentration, calculated using Equation (3), in milligrams per millilitre (mg/ml);

m is the sample mass of the test portion, in milligrams (mg);

V_f is the volume of the test portion solution (7.1.3.2, 7.1.3.3 and 7.6.3.2, 7.6.3.3 or 7.6.3.4.) in millilitres (ml);

D_r is the dilution ratio.

NOTE For 7.6.3.2 D_r = 5;
for 7.6.3.3 D_r = 20;
for 7.6.3.4 D_r = 50.

$$c_2 = C_1 + (C_2 - C_1) \times \frac{S_0 - S_1}{S_2 - S_1} \qquad (3)$$

where

C_1 is the lower silver concentration of the calibration solution used, in milligrams per millilitre (mg/ml);

C_2 is the higher silver concentration of the calibration solution used, in milligrams per millilitre (mg/ml);

S_0 is the absorbance value of the test portion solution;

S_1 is the absorbance value of the calibration solution corresponding to the concentration C_1;

S_2 is the absorbance value of the calibration solution corresponding to the concentration C_2.

9 Precision

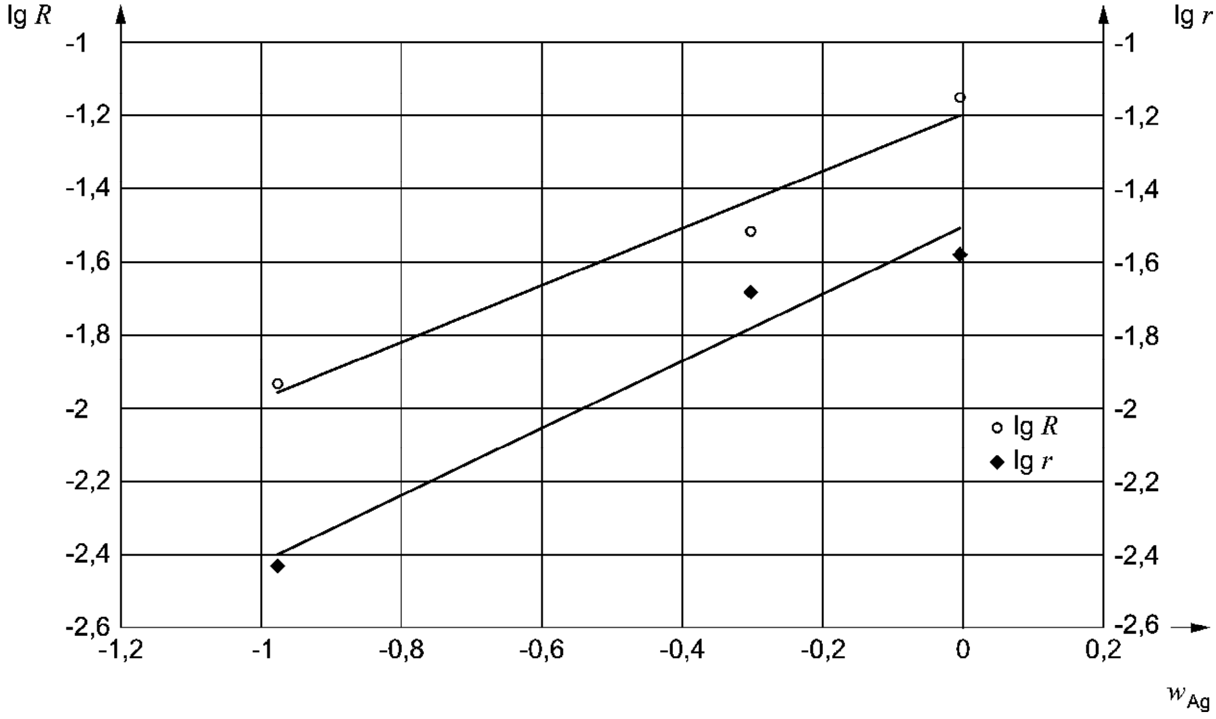
Nine laboratories operated in validating these methods and obtained the results summarized in Table 6 and Table 7 and Figure 1 and Figure 2 respectively.

Table 6 — Method A − Statistical information

Level	Reference value %	Found %	Repeatability r	Reproducibility R
1	0,1	0,105 6	0,003 7	0,011 7
2	0,495	0,497 1	0,020 8	0,030 6
3	0,978	0,987 2	0,026 4	0,071 2

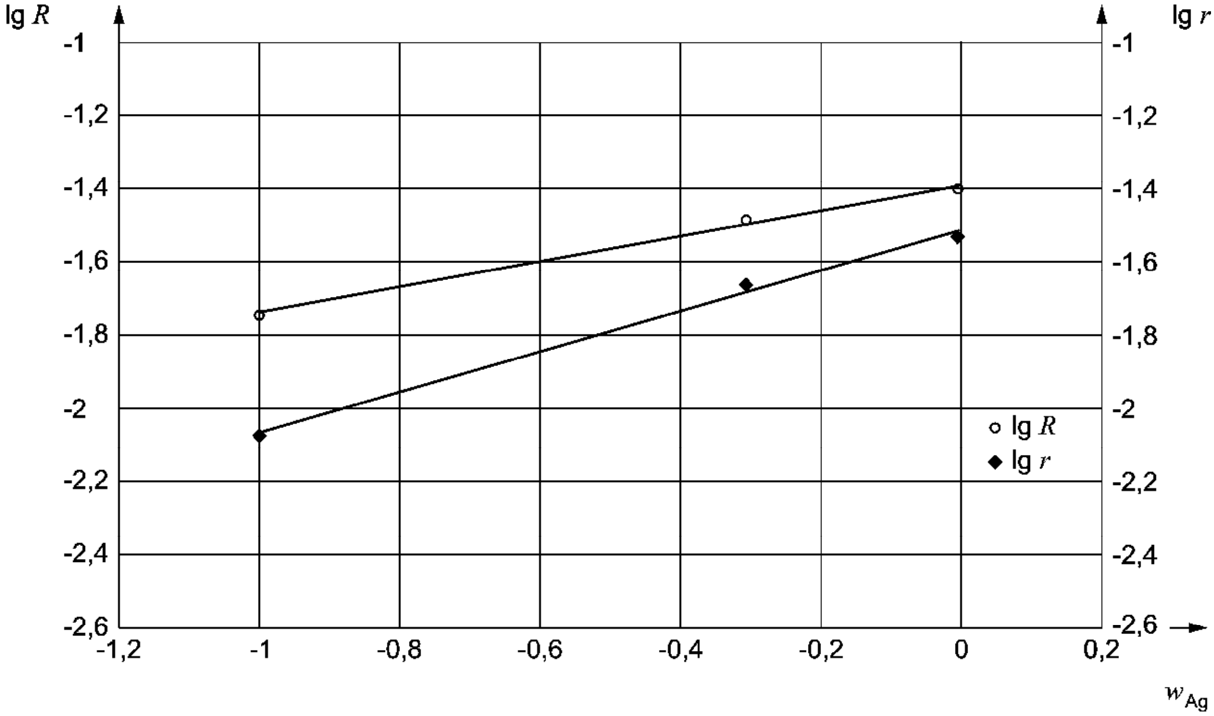
Table 7 — Method B − Statistical information

Level	Reference value %	Found %	Repeatability r	Reproducibility R
1	0,1	0,100 0	0,008 4	0,018 1
2	0,495	0,492 0	0,021 7	0,032 8
3	0,978	0,987 5	0,029 6	0,039 8



NOTE $\lg r = 0{,}916\,9 \lg w_{\mathrm{Ag}} - 1{,}503\,9$
$\lg R = 0{,}774\,7 \lg w_{\mathrm{Ag}} - 1{,}198\,7$

Figure 1 — Method A − lg relationship between silver concentration (w_{Ag}) and repeatability r and reproducibility R



NOTE lg $r = 0{,}554\,6 \lg w_{Ag} - 1{,}512\,7$
lg $R = 0{,}349\,4 \lg w_{Ag} - 1{,}389$

Figure 2 — Method B − lg relationship between silver concentration (w_{Ag}) and repeatability r and reproducibility R

10 Test report

The test report shall contain the following information:

a) identification of the test sample;

b) reference to this European Standard (EN 15915);

c) test method used;

d) results;

e) any unusual characteristics noted during the determination;

f) any operation not included in this European Standard or in the document to which reference is made or regarded as optional;

g) date of the test and/or date of preparation or signature of the test report;

h) signature of the responsible person.

Bibliography

[1] ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

[2] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

[3] ISO 5725-3, *Accuracy (trueness and precision) of measurement methods and results — Part 3: Intermediate measures of the precision of a standard measurement method*

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BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

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