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## REPORT ON: PROFICIENCY TESTING WIV-ISP AI2014

*Proficiency testing for quantitative analysis of aluminium (Al) released in simulant after contact with Al foil according to the Regulation of Council of Europe relative to metals and alloys used as food contact materials and articles (CM/Res(2013)9)*

**Brussels, June 2014**

## SUMMARY

Proficiency Testing (PT) WIV-ISP Al2014 — Proficiency testing for quantitative analysis of aluminium (Al) released in simulant after contact with Al-foil according to the Regulation of Council of Europe relative to metals and alloys used as food contact materials and articles (CM/Res(2013)9) was organized by Scientific Institute of Public Health, Brussels, Belgium (WIV-ISP).

Each participant laboratory received five (5) samples:

- ▶ Four (4) samples of the same batch of Al-foil
- ▶ One (1) container with simulant solution spiked with Al

Homogeneity and stability testing were carried out according to the International Harmonized Protocol for proficiency testing (Thompson et al. 2006) on the testing items. The samples were dispatched to the participant laboratories on 8 April 2014. The testing material was dispatched as an independent set of samples without giving further information but the laboratory -and sample codes.

Two (2) laboratories registered to the PT WIV-ISP Al2014. Both laboratories submitted their results in time. Both laboratories used adequate conditions stipulated by the CM/Res(2013)9. Due to the small number of participants, the organizer also submitted results in order to be able to perform statistical evaluation.

The assigned value ( $X_a$ ) was calculated:

- ▶ Al-release in simulant in contact with Al-foil samples (Al-release): by **robust statistics**
- ▶ Spiked simulant (spiked simulant): by **formulation**

The target-value of standard deviation for the proficiency assessment was estimated ( $\sigma_p$ ):

- ▶ Al-release in simulant in contact with Al-foil samples: **Horwitz function** (Thompson 2000)
- ▶ Spiked simulant: **Horwitz function** (Thompson 2000)

The target-value of standard deviation was used in conjunction to the assigned value to derive the z-scores for participants' results.

z-scores are considered only as informative since the number of participants is very small.

Table 1 Summary of the results of the PT WIV-ISP AI2014.

Parameter	Assigned value – X <sub>a</sub>	Target value standard deviation – σ <sub>p</sub>	Number of participants*	Number of results with satisfactory z- score	Satisfactory z- score rate
	mg/kg	mg/kg	-	-	%
AI in simulant	5.15	0.64	2	2	100
AI-release	76.55	7.96	2	2	100

*\*Due to the small number of participants, the organizers submitted 15 results for both AI-release and spiked simulant in order to be able to perform statistical evaluation.*

The use of data included in the present report for reasons other than the evaluation of laboratory performance is not allowed without the previous written consent of the WIV-ISP.

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## 1 SCOPE

**Proficiency testing (PT) is an essential part of laboratory quality procedure.** It consists of periodical independent assessments of laboratory performance and consequently an important tool to assure the validity and reliability of results. Its basic aim is to assist laboratories to have a continuous supervision on the quality of their results and undertake corrective actions if necessary (Thompson et al. 2006).

Additionally, successful participation in PT schemes is a requirement of the standard ISO/IEC 17025, for accreditation of chemical analysis laboratories (ISO/IEC 17025:2005 2005). Therefore, together with method validation, PT participation is an essential tool for laboratory quality assurance.

The present PT, WIV-ISP AI2014, is organized in order to strengthen the technical competency of laboratories carrying out release experiments from metallic food contact materials and articles and to ensure the quality of goods as well as consumer's health protection with respect to the Resolution of Council of Europe concerning metals and alloys used as food contact materials and articles (CM/Res(2013)9) (Council of Europe 2013).

## 2 SAMPLES

### 2.1 SAMPLE SELECTION

An Al-foil intended for baking without any restriction was selected as testing item.

A set of four samples was dispatched to the participants together with a simulant solution spiked with Al. The Al foil samples were presented in the form of square of 10 cm × 10 cm as stipulated by CM/Res(2013)9.

### 2.2 SAMPLE PREPARATION

The testing item was purchased on the local market and cut into 80 pieces of 10 cm × 10 cm. The 10 cm × 10 cm pieces were immediately put in clean bags without any pre-treatment.

The simulant solution was prepared by WIV-ISP in previously thoroughly cleaned PTFE bottle.

### 2.3 SAMPLES HOMOGENEITY AND STABILITY TESTING

Homogeneity testing for the Al-foil samples was carried out on 12, randomly selected pieces according to the IUPAC Harmonized Protocol (Thompson et al. 2006). All measurements and subsequent calculations were performed by WIV-ISP.

Homogeneity of the simulant solution was not examined as it is stated that homogeneity testing is not necessary in case of truly homogeneous, e.g. stable solutions (Thompson and Lowthian 1996).

Stability of the simulant solution was evaluated according to the IUPAC Harmonized Protocol



(Thompson et al. 2006). For this purpose, the sample solution was divided in two equal portions, one undergoing adequate treatment (kept in the dark at ambient temperature) and the other undergoing extreme conditions (kept at 30°C, daylight). Samples were analysed after 16 days in duplicate.

## 2.4 SAMPLE DISTRIBUTION

The samples were dispatched on 8 April 2014. Each participant received four (4) labelled samples and one (1) simulant solution spiked with Al in a Falcon tube of 50 mL. All samples were identified with the title of the PT, the laboratory code and the sample code. The samples were accompanied by:

- ▶ Cover letter with instructions for the results submission
- ▶ Sample receipt confirmation form
- ▶ Results reporting form

All forms and informative documents were provided on paper and electronically.

The closing date for result submission was 9 May 2014.

## 3 RESULTS REPORTING FORM

Participants were asked to report on the Results reporting form:

- ▶ Analytical method used for analyte quantification
- ▶ Al concentration in mg/L of the simulant solution
- ▶ Al concentration in mg/kg of each Al-foil sample

## 4 STATISTICAL EVALUATION OF RESULTS

### 4.1 SPIKED SIMULANT

**Assigned value:**

- ▶ The assigned value was obtained from the **formulation**. Formulation consists of samples that are prepared by adding known amounts or concentrations of the target analyte to a well-characterized base material containing none (Thompson et al. 2006).

**Target-value of standard deviation** for proficiency assessment  $\sigma_p$

- ▶ In the present PT,  $\sigma_p$  was derived from a mathematical model predicting the variability of results at different analyte concentrations. The most frequently used model in this context is the **Horwitz function**:  $\sigma_H = 0.02c^{0.8495}$  where  $\sigma_H$ : Horwitz standard deviation and  $c$ : concentration of the analyte. Both  $\sigma_H$  and  $c$  are expressed as mass ratios. In the present PT,  $\sigma_H$  corresponds to the target-value standard deviation ( $\sigma_p$ ).

### Statistical evaluation of the results:

- ▶ Detection of **outliers** was performed by:
  - Grubbs-test
  - Dixon Q test
  - Hampel test
- ▶ **Youden-plot** was constructed and qualitatively evaluated

---

## 4.2 RELEASE EXPERIMENT

### Assigned value:

- ▶ The assigned value was calculated as the **robust mean** value of the mean values of the four (4) samples

### Target-value of standard deviation for proficiency assessment $\sigma_p$

- ▶ In the present PT,  $\sigma_p$  was derived from a mathematical model predicting the variability of results at different analyte concentrations. The most frequently used model in this context is the **Horwitz function**:  $\sigma_H = 0.02c^{0.8495}$  where  $\sigma_H$ : Horwitz standard deviation and  $c$ : concentration of the analyte. Both  $\sigma_H$  and  $c$  are expressed as mass ratios. In the present PT,  $\sigma_H$  corresponds to the target-value standard deviation ( $\sigma_p$ ).  $\sigma_p$  calculated with Horwitz-function was compared to the one determined on the basis of the uncertainty measurement evaluation by estimating the inter-laboratory reproducibility through a model of random sampling (according to the Eurachem guide-measurement of the uncertainty from sampling) using robust Analysis of Variance (Ramsey and Ellison 2007)

### Statistical evaluation of the results:

- ▶ Detection of **outliers** was performed by:
  - Visual representation of the results:
    - Schematic representation of the results
    - Box plot
  - Grubbs-test
  - Dixon Q test
  - Hampel
- ▶ **Normality**:
  - Rankit method
- ▶ Robust mean value of the reported four (4) results after outlier-elimination was used for the evaluation of laboratory performance concerning Al-release. The median of the means was compared to the mean of means and the robust mean
- ▶ **Youden-plot** was constructed and qualitatively evaluated

### 4.3 Z-SCORE CALCULATION

Participants' z-scores were calculated as:

$$z = \frac{x - X_a}{\sigma_p}$$

Where:      x:      Reported result by participant  
               $X_a$ :      Assigned value  
               $\sigma_p$ :      Target-value standard deviation for proficiency assessment

- a) Results with  $|z| \leq 2$  are designated as acceptable or satisfactory
- b) A result with  $2 < |z| < 3$  shall be considered to give a 'warning signal' according to ISO 13528:2005 and is designated as questionable according to the IUPAC International Harmonized Protocol
- c) A result with  $|z| > 3$  shall be considered to give an 'action signal' according to ISO 13528:2005 and is designated as unacceptable or unsatisfactory according to the IUPAC International Harmonized Protocol

In the present PT though, due to the small number participants, z-scores are to be interpreted with precaution.

## 5 RESULTS

**Due to the small number of participants, the organizers submitted 15 independent results of theirs in order to be able to perform statistical evaluation. All release testing were carried out in different ovens and electric plates in order to simulate the different possible methods of heating that the participant laboratories may use during release experiment. It is, therefore, important to note that z-scores are issued but to be interpreted with precautions.**

In total, four (4) laboratories were invited. Two (2) laboratories that subscribed to the present PT. Their participation was compulsive. The two (2) other laboratories' participation was optional. These laboratories did not respond to the invitation for the present PT.

All participating laboratory submitted its results in time. Both laboratories used ICP-AES for the determination of Al. Specifications concerning the sample treatment and testing conditions stipulated by the CM/Res(2013)9 are listed in Table 2. According to the questionnaires returned to the organizers, **all participant laboratory used the adequate testing conditions.**

In subsequent tables and figures, the laboratories are identified with an identification number. Laboratories' identifications and the corresponding codes are listed in Table 3.

Table 2 Specifications on sample treatment and testing conditions according to CM/Res(2013)9.

Testing conditions	CM/Res(2013)9
Extract solution during release experiments	citric acid 5 g/L
Number of release test	1
Temperature during release experiment (°C)	100°C
Duration of release experiment	2h
Sample pre-treatment	No special treatment before experiment

Table 3 List of laboratory codes and corresponding laboratory identification numbers.

Lab Code	Lab ID on Figures and Tables
Lab1	16
Lab2	15
Lab3	17
Lab4	14
Lab5	13
Lab6	12
Lab7	11
Lab8	10
Lab9	9
Lab10	8
Lab11	7
Lab12	6
Lab13	5
Lab14	4
Lab15	3
Lab16	2
Lab17	1

Table 4  $X_a$  and  $\sigma_p$  of Al in simulant.

Parameter	Symbol	Unity	Spiked simulant
Assigned value	$X_a$	mg/kg	5.15
Target value standard deviation	$\sigma_p$	mg/kg	0.64

Table 5 Descriptive summary statistics of Al release.

Parameter	Symbol	Unity	Al release
Median of means	Xmed	mg/kg	75.57
Mean of means	Xmm	mg/kg	76.36
Robust mean	Xrm	mg/kg	76.55
Number of results	n	-	17
Standard deviation	$\sigma$	mg/kg	5.49
Robust standard deviation	MAD_E	mg/kg	4.84
Standard deviation based on EURACHEM guide		mg/kg	8.65
Target-value of standard deviation (Horwitz-function)	$\sigma_p$	mg/kg	<b>7.95</b>
$u^2/sp^2$		-	0.36
Assigned value	Xa	mg/kg	<b>76.55</b>

## 5.1 SPIKED SIMULANT

The **stability** of the simulant solution was proven. The test was carried out according to The International Harmonized protocol on proficiency testing (Thompson et al. 2006) using a set of 5 control samples (kept in the dark at ambient temperature) and a set of 5 experimental samples (kept at daylight at 30°C). The samples were analysed 16 days after preparation.

The **assigned value** (Xa) of Al-concentration in simulant is determined by formulation. The **target-value standard deviation** ( $\sigma_p$ ) is determined by Horwitz function. Values are listed in see Table 4.

**No outliers** were detected either by Grubbs, Dixon's Q or Hampel test for the submitted results.

## 5.2 RELEASE EXPERIMENT

**Homogeneity** of the Al-foil samples was tested and was proved to be sufficient.

The **assigned value** of Al-release into food simulant and the **target-value standard deviation** are listed in Table 5.

Presence of **outliers** were checked with different tests:

- (a) Visual check: 1 outlier detected (see Figure 1)
- (b) Box plot: 1 outlier detected (see Figure 2)
- (c) Dixon Q: 1 outlier detected (see Figure 3)
- (d) Hampel: 1 outlier detected (see Figure 4)
- (e) Grubbs: 1 outlier detected (see Figure 5)

Both visual and statistical tests are indicating the presence of one (1) outlier in the dataset that has been removed for subsequent statistical evaluation.

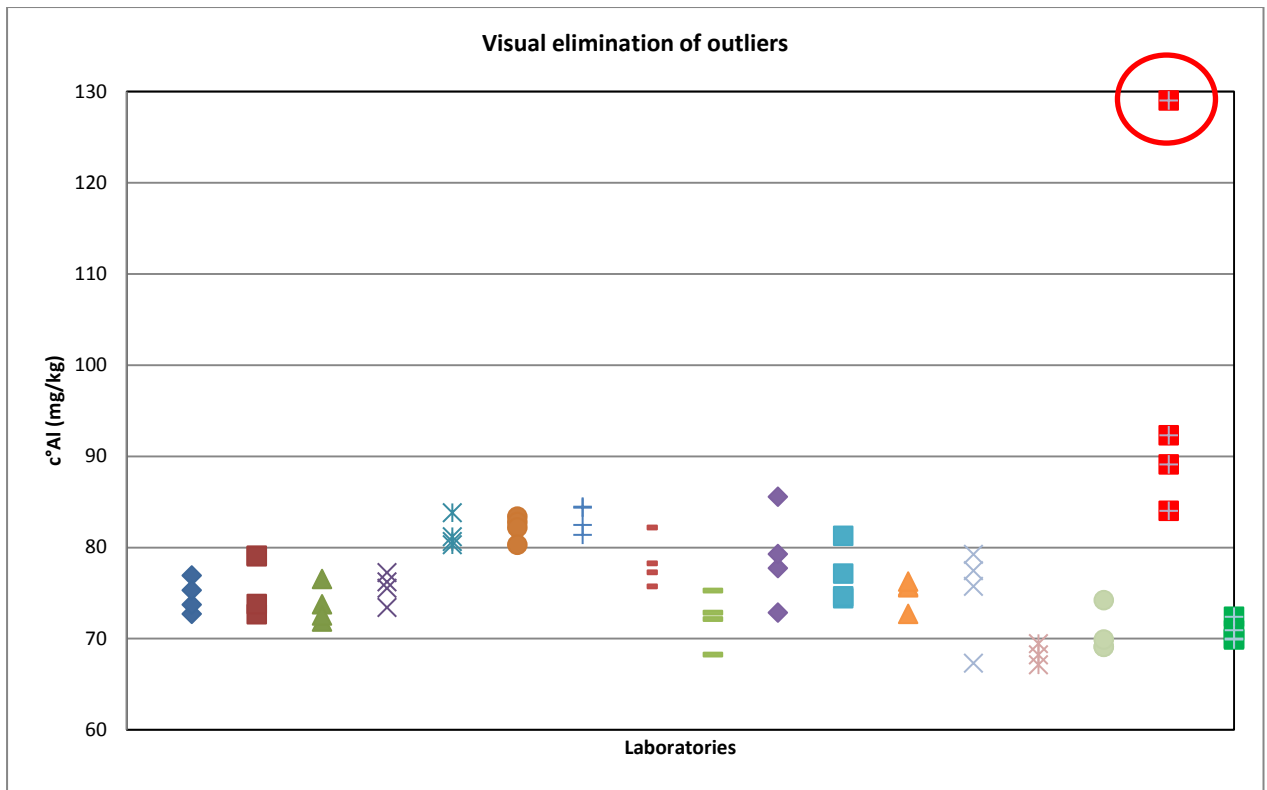


Figure 1 Visual examination of Al release data to check possible outliers.

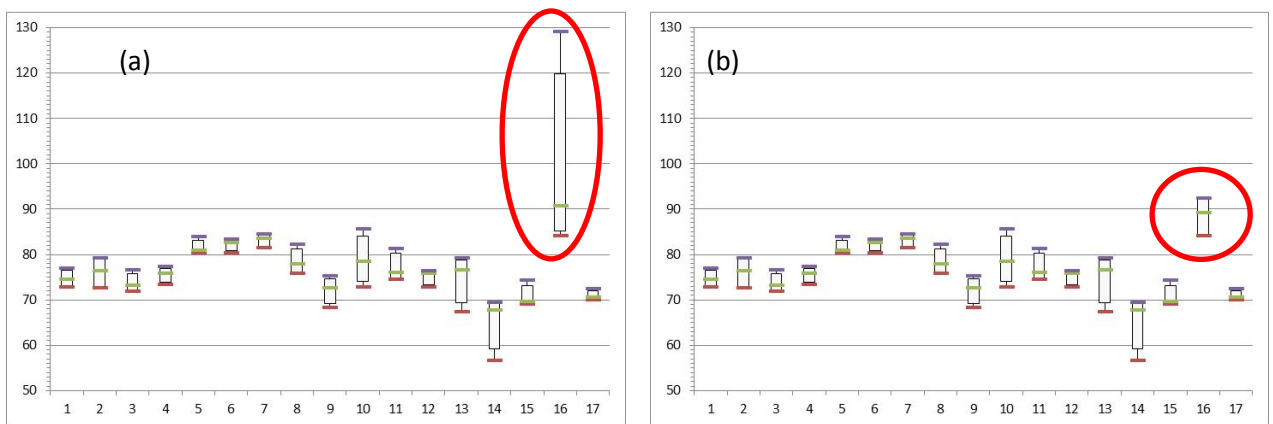


Figure 2 Box plot (a) with all data and (b) data without suspected outlier.

Mean all	Q22	Mean without 16	Q22
65.33	0.3251	65.33	0.3251
70.56		70.56	
70.80		70.80	
72.13		72.13	
73.67		73.67	
74.66		74.66	
74.91		74.91	
75.07		75.07	
75.57		75.57	
76.14		76.14	
76.86		76.86	
78.35		78.35	
78.84		78.84	
81.47		81.47	
82.16		82.16	
83.16		83.16	
98.60	0.5913	88.47	0.3569
alpha0.05	0.49	alpha0.05	0.49
alpha0.01	0.577	alpha0.01	0.577
Conclusion L0.05	ok	Conclusion L0.05	ok
Conclusion L0.01	ok	Conclusion L0.01	ok
Conclusion H0.05	outlier	Conclusion H0.05	ok
Conclusion H0.01	outlier	Conclusion H0.01	ok

Figure 3 Dixon Q test.

Mean with 16_rep1	x-median	Conclusion	Mean without 16_rep1	x-xmedian	Conclusion
74.66	0.92	ok	74.66	0.92	ok
76.14	0.56	ok	76.14	0.56	ok
73.67	1.91	ok	73.67	1.91	ok
75.57	0.00	ok	75.57	0.00	ok
81.47	5.90	ok	81.47	5.90	ok
82.16	6.59	ok	82.16	6.59	ok
83.16	7.59	ok	83.16	7.59	ok
78.35	2.78	ok	78.35	2.78	ok
72.13	3.44	ok	72.13	3.44	ok
78.84	3.27	ok	78.84	3.27	ok
76.86	1.28	ok	76.86	1.28	ok
75.07	0.50	ok	75.07	0.50	ok
74.91	0.66	ok	74.91	0.66	ok
65.33	10.25	ok	65.33	10.25	ok
70.56	5.01	ok	70.56	5.01	ok
98.60	23.03	outlier	88.47	12.89	ok
70.80	4.77	ok	70.80	4.77	ok
MAD	3.267		MAD	3.267	

Figure 4 Hampel test.

Mean all	G	H/L 0.05	Conclusion 0.05	H/L 0.01	Conclusion 0.01	sum(xi-x) <sup>2</sup>	
74.66	0.32	2.62	ok	2.89	ok	5.30	
76.14	0.11	2.62	ok	2.89	ok	0.68	
73.67	0.46	2.62	ok	2.89	ok	10.82	
75.57	0.19	2.62	ok	2.89	ok	1.92	
81.47	0.63	2.62	ok	2.89	ok	20.38	
82.16	0.73	2.62	ok	2.89	ok	27.07	
83.16	0.86	2.62	ok	2.89	ok	38.47	
78.35	0.19	2.62	ok	2.89	ok	1.95	
72.13	0.67	2.62	ok	2.89	ok	23.30	
78.84	0.26	2.62	ok	2.89	ok	3.54	
76.86	0.01	2.62	ok	2.89	ok	0.01	
75.07	0.26	2.62	ok	2.89	ok	3.55	
74.91	0.29	2.62	ok	2.89	ok	4.19	
65.33	1.62	2.62	ok	2.89	ok	135.28	
70.56	0.89	2.62	ok	2.89	ok	40.87	
98.60	3.02	2.62	Outlier	2.89	Outlier	468.39	
70.80	0.86	2.62	ok	2.89	ok	37.92	
						sum(xi-x) <sup>2</sup>	823.65
						HH	219.98
						LL	822.96
						Ghh	0.2671
						Gll	0.9992
						alpha0.05	0.3822
						alpha0.01	0.2990
						HH	Conclusion 0.05 double outlier
						LL	Conclusion 0.01 double outlier
							Conclusion 0.05 ok
							Conclusion 0.01 ok

Mean without 16	G	H/L 0.05	Conclusion 0.05	H/L 0.01	Conclusion 0.01	sum(xi-x) <sup>2</sup>	
74.66	0.31	2.62	ok	2.89	ok	2.91	
76.14	0.04	2.62	ok	2.89	ok	0.05	
73.67	0.49	2.62	ok	2.89	ok	7.26	
75.57	0.14	2.62	ok	2.89	ok	0.62	
81.47	0.93	2.62	ok	2.89	ok	26.12	
82.16	1.06	2.62	ok	2.89	ok	33.63	
83.16	1.24	2.62	ok	2.89	ok	46.22	
78.35	0.36	2.62	ok	2.89	ok	3.97	
72.13	0.77	2.62	ok	2.89	ok	17.90	
78.84	0.45	2.62	ok	2.89	ok	6.14	
76.86	0.09	2.62	ok	2.89	ok	0.24	
75.07	0.23	2.62	ok	2.89	ok	1.66	
74.91	0.26	2.62	ok	2.89	ok	2.10	
65.33	2.01	2.62	ok	2.89	ok	121.77	
70.56	1.06	2.62	ok	2.89	ok	33.61	
88.47	2.21	2.62	ok	2.89	ok	146.53	
70.80	1.01	2.62	ok	2.89	ok	30.93	
						sum(xi-x) <sup>2</sup>	481.68
						HH	213.37
						LL	481.38
						Ghh	0.4430
						Gll	0.9994
						alpha0.05	0.3822
						alpha0.01	0.2990
						HH	Conclusion 0.05 ok
						LL	Conclusion 0.01 ok
							Conclusion 0.05 ok
							Conclusion 0.01 ok

Figure 5 Grubbs test.



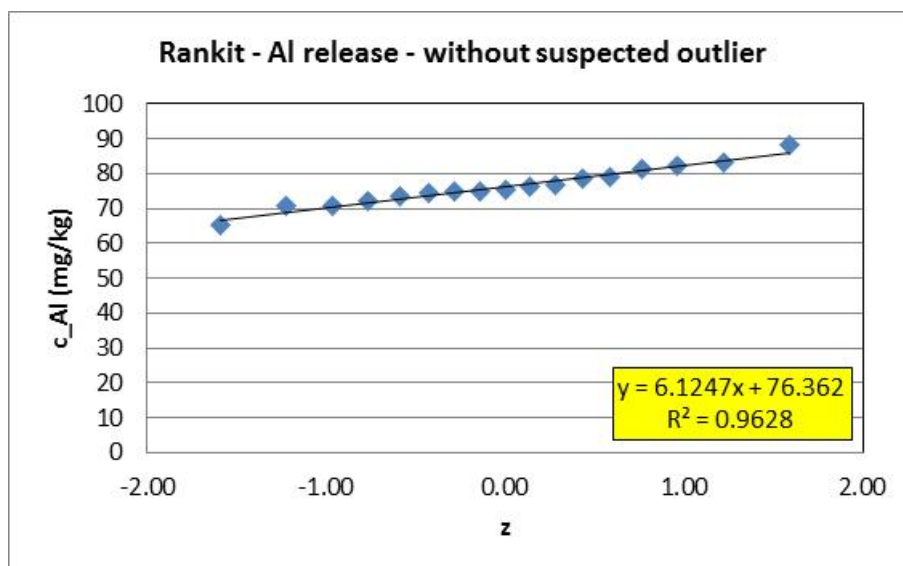


Figure 6 Rankit method applied to dataset after elimination of outlier.

**Distribution** of the data was evaluated with the Rankit method (see Figure 6). A straight line ( $y = a \cdot z + b$ ) fitted to the rankits (see equation characteristics on Figure 6). For normally distributed data, the intercept ( $b$ ) and the slope ( $a$ ) are estimates of the mean and standard deviation, respectively. The  $b$  estimates the median (rankits are symmetrical around 0 and the 50<sup>th</sup> percentile corresponds to  $z = 0$ ). For the normal distribution, the median equals the mean, so the 50<sup>th</sup> percentile also estimates the mean. The slope estimates the standard deviation because the rankits are scaled so that one rankit is one standard deviation on the original scale.

Indeed, the values of mean of means, median, and robust mean correspond well with the one found through rankit method. The same conclusion can be drawn for the standard deviation values (see Table 5).

It can be concluded, therefore, that the results follow a normal distribution. The assigned value can thus be determined as the robust mean.

### 5.3 Z-SCORE CALCULATION

The submitted results and participants performance evaluation through z-score are recorded in Table 6 . Schematic representations of z-score plots of Al-determination in spiked simulant and in Al-release testing from Al-foil are shown in Figure 7 and Figure 8.

Table 6 Participants' submitted results, means, and z-scores.

Lab ID	Al in simulant		Al-release from Al-foil samples						
	c_Al	z-score	Sample1	Sample2	Sample3	Sample4	Mean value	Mean value - outlier	z-score
	mg/L		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
1	5.12	<b>-0.05</b>	72.70	76.90	73.71	75.31	74.66	74.66	<b>-0.24</b>
2	5.14	<b>-0.01</b>	79.09	72.66	73.79	79.00	76.14	76.14	<b>-0.05</b>
3	5.14	<b>-0.02</b>	76.52	71.86	73.75	72.53	73.67	73.67	<b>-0.36</b>
4	5.21	<b>0.10</b>	77.22	73.39	76.19	75.49	75.57	75.57	<b>-0.12</b>
5	5.12	<b>-0.05</b>	80.62	81.16	83.81	80.30	81.47	81.47	<b>0.62</b>
6	5.09	<b>-0.09</b>	83.38	82.78	82.19	80.30	82.16	82.16	<b>0.71</b>
7	5.12	<b>-0.05</b>	84.46	82.46	84.35	81.38	83.16	83.16	<b>0.83</b>
8	5.20	<b>0.08</b>	82.19	77.27	75.71	78.25	78.35	78.35	<b>0.23</b>
9	5.13	<b>-0.03</b>	72.14	72.85	75.28	68.26	72.13	72.13	<b>-0.56</b>
10	5.17	<b>0.02</b>	85.54	77.71	79.27	72.85	78.84	78.84	<b>0.29</b>
11	5.20	<b>0.07</b>	77.11	81.27	74.41	74.63	76.86	76.86	<b>0.04</b>
12	5.13	<b>-0.03</b>	75.76	72.68	75.60	76.25	75.07	75.07	<b>-0.19</b>
13	5.12	<b>-0.05</b>	75.71	77.44	79.22	67.28	74.91	74.91	<b>-0.21</b>
14	5.20	<b>0.08</b>	67.12	56.54	69.44	68.20	65.33	65.33	<b>-1.41</b>
15	5.13	<b>-0.03</b>	69.12	69.07	74.20	69.88	70.56	70.56	<b>-0.75</b>
16	4.86	<b>-0.45</b>	129.00	92.30	84.00	89.10	98.60	88.47	<b>1.50</b>
17	5.44	<b>0.45</b>	70.00	70.90	72.40	69.90	70.80	70.80	<b>-0.72</b>

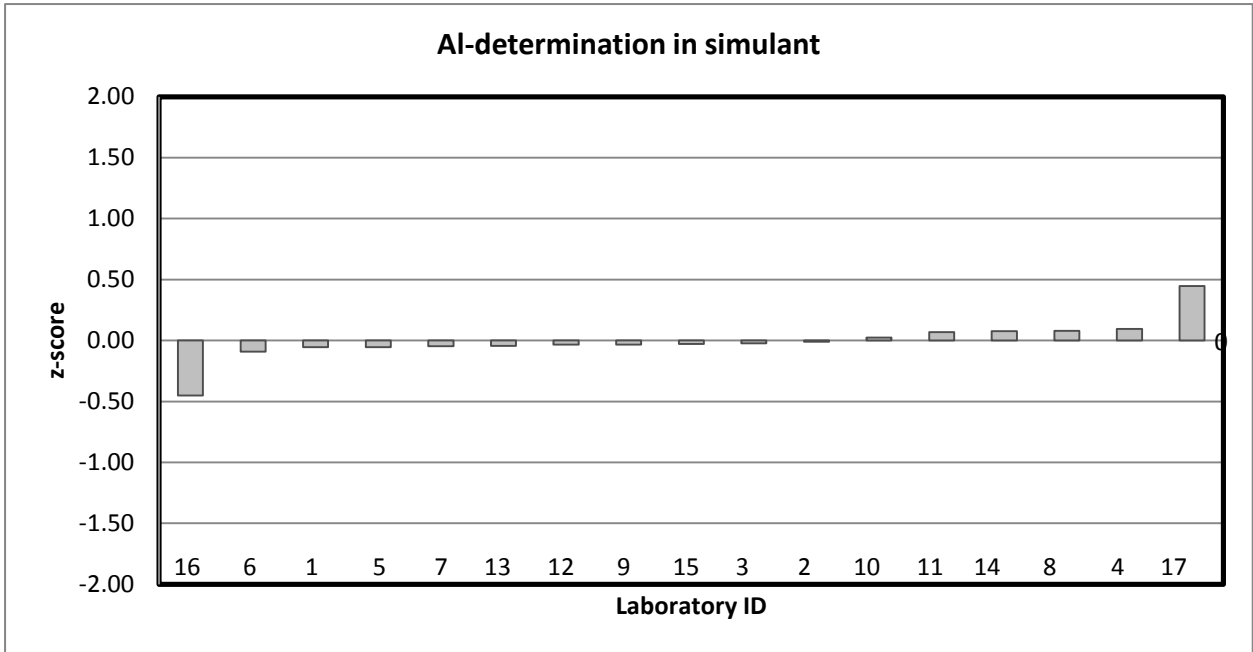


Figure 7 z-score plot of Al determination for spiked simulant.

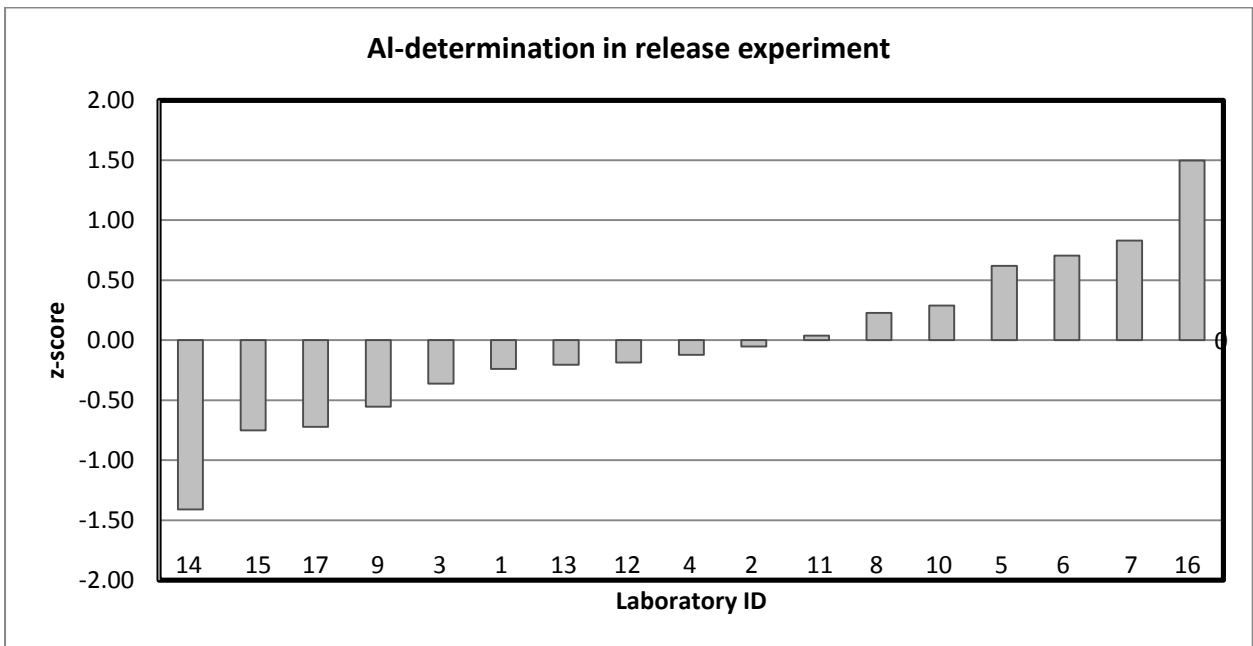


Figure 8 z-score plot of Al determination for Al-release experiment.

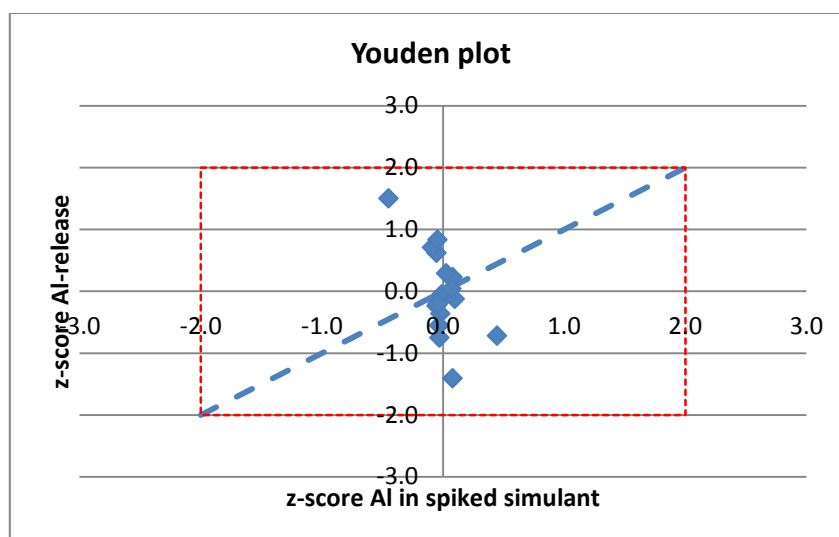


Figure 9 Youden plot.

Evaluation of the **Youden plot** (Figure 9):

- ▶ Laboratory performance according to the Youden plot (Figure 9) is good (data points scattered around 0)
- ▶ No systematic error is observed (no consistently too high or too low results that would lay in the lower left quadrant or higher right quadrant)
- ▶ Presence of random error is observed. **Hypothesis:** random error originating from the intensity of heating during release experiment

## 6 CONCLUSION

The present PT, WIV-ISP Al 2014, was organized relative to the Resolution of Council of Europe concerning metals and alloys used as food contact materials and articles (CM/Res(2013)9). In this context, Al-release from Al foil purchased on the local market and in spiked simulant solution were proposed to be reported by the technique of their choice. In the present case, all results were reported using the technique of ICP-AES. All participant laboratory used adequate testing conditions.

Stability and homogeneity preliminary tests were satisfactory.

For Al-determination in spiked simulant:

- ▶ No outlier was found
- ▶ All z-scores were satisfactory

For Al-determination in release testing:

- ▶ 1 outlier was detected and subsequently eliminated for statistical evaluation
- ▶ All z-scores were satisfactory

Summary of the present study is shown in Table 7.

Table 7 Summary of PT WIV-ISP AI2014.

	AI in simulant			AI-release		
	Method/Parameter	Illustration	Result	Method/Parameter	Illustration	Result
<b>Preliminary testing Assigned value (X<sub>a</sub>)</b>	Stability	-	OK	Homogeneity		OK
	Formulation	Table 4	5.15	Robust mean value of the mean values	Table 5	76.55
<b>Target-value standard deviation (σ<sub>p</sub>) Detection of outliers</b>	Horwitz function:	Table 4	0.64	Horwitz function	Table 5	7.95
	Schematic representation	-	-	Schematic representation	Figure 1	1 outlier
<b>Distribution Youden-plot</b>	Dixon Q	-	No outlier	Box plot	Figure 2	1 outlier
	Grubbs	-	No outlier	Dixon Q	Figure 3	1 outlier
	Hampel	-	No outlier	Grubbs	Figure 5	1 outlier
	Rankit method	-	-	Hampel	Figure 4	1 outlier
	Youden plot	Figure 9	No systematic error Presence of random error	Rankit method	Figure 6	Normal distribution
				Youden plot	Figure 9	No systematic error Presence of random error
<b>Laboratory performance</b>	z-score	Table 6 Figure 7	Satisfactory z-score		Table 6 Figure 8	Satisfactory z-score

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