AL 14-lea CONGRES INTERNAȚIONAL DE METROLOGIE

„Valoare adăugată prin intermediul unei măsurări mai bune”

22-25 Iunie 2009, Paris, Franța

14TH INTERNATIONAL CONGRESS OF METROLOGY

“Added value through better measurement”

22-25 June 2009, Paris, France

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INSTITUTUL NAȚIONAL DE METROLOGIE
NATIONAL INSTITUTE OF METROLOGY

French College of Metrology (CFM) în colaborare cu Laboratoire National de Métrologie et d’Essais (LNE) organizează la fiecare doi ani Congresul Internațional de Metrologie în orașe diferite din Franța.

Gazdele celui de al 14-lea Congres Internațional de Metrologie sunt institute binecunoscute şi care se bucură de o mare apreciere în domeniul lor de activitate. French College of Metrology (CFM) a fost creat în mai 2003 ca o asociație în baza legii 1901, care preia responsabilitățile predecesorului său, Collège de Métrologie. Principala sa misiune este de a promova metrologia industrială prin acțiuni colective adecvate scopului, după cum urmează:

- Difuzarea culturii metrologice şi a cunoştiințelor în domeniul ştiințific, industrial şi al mediului comercial;
- Identificarea necesităților pe care instituțiile şi organizațiile trebuie să le îndeplinească în domeniul metrologiei;
- Organizarea schimburilor de experiență pentru persoanele implicate în domeniul metrologiei;
- Contribuția acțiunilor colective coerente, atât la nivel național cât şi regional;
- Întreprinderea de acțiuni adecvate care au scopul de promovare şi dezvoltare în domeniul metrologiei.

Laboratoire National de Métrologie et d’Essais (LNE) este un membru “ex officio” al Consiliului de Administrație al Colegiului Francez de Metrologie. Printre sarcinile sale clasice, LNE acționează ca o interfață între diversele Institute Naționale de Metrologie. Ca membru al Comitetului de Organizare şi a Comitetului Ştiințific şi Tehnic al celor mai multe congrese de metrologie care au fost organizate de către French College of Metrology, LNE oferă sprijin susținut, atât în organizare, cât şi pentru numeroasele comunicări ştiințifice.

Congresele anterioare s-au desfăşurat la Lyon în 2005 şi Lille în 2007. Anul acesta, al

The French College of Metrology in cooperation with the Laboratoire National de Métrologie et d’Essais (LNE) organises every two years The International Metrology Congress in different cities from France.

The hosts of this 14th International Congress of Metrology are well known and respected institutes in their field of activity. The French College of Metrology (CFM) was created in May 2003 as an association based on the law of 1901, taking over the responsabilities from its predecessor the Collège de Métrologie. Its main task is to promote industrial metrology by carrying out appropriate collective actions, as follows below:

- Disseminate the metrological culture and knowledge in the scientific, industrial and commercial environment;
- Identify the needs that enterprises and organizations must fulfil in the field of metrology;
- Be the exchange forum for people concerned with metrology;
- Contribute to coherent collective actions on national and regional levels;
- Undertake any suitable action in order to promote and develop metrology.

The Laboratoire National de Métrologie et d’Essais (LNE) is an ex officio member of the Board of Directors of the Collège Français de Métrologie. Among its standard tasks LNE acts as interface with the foreign National Metrology Laboratories. As a member of the Organisation Committee and of the Scientific and Technical Committee of most metrology congresses organised by the French Collège, the LNE provides active support with the organisation as well as the various communications.

Previous congresses took place in Lyon in 2005 and Lille in 2007. This year, the 14th

14–lea Congres Internațional de Metrologie a avut loc, începând cu 22, până la 25 June 2009, în Paris, capitala Franței, în inima regiunii Île - de-France (Palatul Congresului, Porte Maillot). Acest Congres a fost organizat în parteneriat cu: Eurocopter - Group, Renault, Acac, BEA Métrologie, Cetiat, Cetim, IMQ; LNE (FR), NPL (UK); EA, Euramet, BIPM, OIML etc.

Evenimentul a fost un mare succes. Cei peste 750 de delegați și 200 de vizitatori la al 14-lea Congres, comparativ cu evenimentele anterioare, a demonstrat interestul crescut în domeniul metrologiei. O statistică a Congreselor din perioada 1995 - 2007 este dată în tabelul 1

International Congress of Metrology was held from 22 to 25 June 2009 in Paris, the capital of France, at the heart of the Île-de-France region (Palais des Congrès, Porte Maillot). This Congress was organized in partnership with: Eurocopter - Group, Renault, Acac, BEA Métrologie, Cetiat, Cetim, IMQ; LNE (FR), NPL (UK); EA, Euramet, BIPM, OIML etc.

The event was a great success. More than 750 delegates and 200 visitors participated in the 14th Congress, compared with the previous events, the participants showed an increased interest in metrology issues. A statistics for 1995 to 2007 Congresses is given in table 1.

Tabelul 1. Statistica privind Congresele desfășurate între 1995 - 2007
Table 1: Statistics for 1995 to 2007 Congresses

	M95	M97	M99	M01	M03	M05	M07
Participare globală Global participation	450	500	630	530	540	830	650
Vizitatori Visitors	-	100	300	100	100	150	120
Țări participante Represented countries	10%	20%	25%	29%	25%	40%	35%
Țări participante Represented countries	21	27	32	35	35	65	40
Conferințe Conferences	102	131	178	160	160	205	170
Număr de standuri Number of stands	25	48	56	50	44	64	73
ărere generală bună sau foarte bună Good or very good general opinion	81%	82%	82%	76%	85%	81%	82%
Audiență **Audience**							
Industrie Industry	52%	51%	55%	52%	43%	40%	56%
Universități University	14%	15%	11%	13%	18%	16%	17%
Organizații publice Public organisms	23%	17%	14%	20%	14%	35%	24%
Altele Others	7%	17%	20%	15%	25%	9%	3%
Vor veni la următorul Congres Will come for next Congress	40%	42%	37%	38%	38%	38%	49

În 2009, misiunile Congresului au abordat aspecte importante şi strategice referitoare la:

- îmbunătățirea tehnicilor de măsurare, în scopul de a garanta calitatea produselor şi proceselor;
- contribuția la îmbunătățirea proceselor de măsurare;
- promovarea măsurării ca un instrument de calitate în cadrul companiilor;
- evaluarea performanțelor în domeniul metrologiei şi implicațiile acestora pentru industrie, R&D şi societate;
- analiza progresului în domeniul tehnologiei inovatoare;
- demonstrarea valorii de măsurare ca o dovada a calității;
- participarea la dezvoltarea de tehnologii inovatoare.

Congresul Internațional a început luni, 22 iunie, când participanții au ajuns şi au luat parte la deschiderea oficială. Sesiunile de comunicări şi postere, precum şi 'Round Tables' au avut loc începând cu ziua de marți 23 iunie până joi, 25 iunie. Peste 1 000 de participanți, din 50 de țări, au avut ocazia de a discuta subiecte diverse cu specialişti şi profesionişti în diverse domenii din cadrul unor companii multinaționale, laboratoare, organizații de sănătate şi producători de mijloace de măsurare.

Acest forum internațional de mare importanță în domeniul metrologiei a avut sesiuni de prezentări orale, sesiuni de postere şi 6 mese rotunde. Subiectele care au fost discutate şi prezentate, au acoperit următoarele teme:

- **controlul măsurării**, analize şi procese de încercare;
- **mărimi fizice şi chimice**;
- **reglementări** şi scopurile acestora;
- **metrologie legală** şi **recunoaştere internațională**;
- **noutăți în metrologie** şi noi sectoare.

În plus, Congresul a fost un loc de întâlnire pentru specialiştii în metrologie din mediul industrial şi al laboratoarelor ştiințifice prin:

- 6 mese rotunde, şi aproximativ 180 de prezentări;
- **90 standuri cu expoziție** de echipamente de măsurare şi service;
- vizite tehnice la diverse companii.

Temele planificate pentru cele 6 mese rotunde, dedicate aspectelor zilnice din industrie, au fost prezentate după cum urmează:

- *Care este miza pentru metrologie în domeniul sănătății;*
- *Metrologie şi reducerea emisiilor de gaze cu efect de seră;*
- *Metrologie şi performanță industrială;*
- *Temperaturi industriale şi materiale noi;*

In 2009, the Congress tasks were focused on some important and strategic issues related to:

- improvement of measurement techniques in order to guarantee the quality of products and processes;
- contribution to improving measurement processes;
- promotion measurement as a tool for quality within companies;
- assessing developments in metrology and their implications for industry, R&D and society;
- review progress in innovative technologies;
- demonstration of the value of measurement as a tool for quality;
- participation in the development of innovative technologies.

The International Congress started on Monday, June 22nd when the participants had arrived and took part to the official opening of the Congress and the exhibition. The technical sessions and Round Tables took place from Tuesday, 23rd untill Thursday, 25th. About 1 000 participants from fifty countries had the opportunity to discuss specific topics with specialists and professionals in companies, laboratories, health organizations and measuring instruments manufacturers.

This major international forum of metrology of great importance featured presentations of papers, sessions and six round tables. During the days of the congress were discussed or presented subjects covering the following themes:

- **control of measurement**, analysis and test processes;
- **physical and chemical quantities**;
- **regulations** and their aims ;
- **legal metrology** and **international recognition**;
- **new metrology** and new sectors.

Additionally, the Congress was a meeting place for specialists in metrology from industry and scientific laboratories through:

- 6 industrial round table sessions, and about 180 presentation;
- **90 booths exhibition** of equipment and service;
- technical visits to companies.

The themes planned for the 6 round tables sessions, dedicated to daily industrial issues, were presented as follows:

- *What's at stake for metrology in the health field;*
- *Metrology and reduction of greenhouse effects gas emissions;*
- *Metrology and industrial performance;*
- *Industrial temperatures and new materials*

- *Acreditare, probleme economice şi de strategie;*

- *Măsurări wireless în mediul industrial.*

Producătorii de echipamente de măsurare, furnizorii de servicii şi organizaţiile oficiale au prezentat ultimile lor îmbunătăţiri tehnice în 90 de standuri destinate expoziţiei.

În timpul Congresului s-au efectuat vizite tehnice la sediul unor binecunoscute companii/ laboratoare. Participanţii la congres, care au fost interesaţi în vizitarea laboratoarelor au avut posibilitatea să viziteze următoarele locuri interesante cum ar fi:

- LNE Trappes;
- Musée du CNAM;
- Renault Technocentre.

În timpul Congresului, a avut loc o sesiune specială dedicată întâlnirii CIPM-MRA. Biroul Internaţional de Măsuri şi Greutăţi (BIPM) este asociat Congresului cu ocazia celei de-a 10[a] Aniversare a CIPM de implementare a Acordului de Recunoaştere Reciprocă.

Al 14-lea Congres International de Metrologie a avut sesiuni de comunicări orale, postere şi mese rotunde, cu subiecte foarte interesante, grupate în 27 de domenii:

1. Metrologie şi Sănătate;
2. Sănătate/Radiaţii Ionizante;
3.Dimensionale: Măsurări Topografice şi Măsurări 3D;
4. Dimensionale: Măsurări şi Tehnologii noi;
5. Măsurări 3D
6. Control Nedistructiv – Duritate de Suprafaţă Roughness;
7. Tehnologii noi;
8. Măsurări Optice;
9. Debit Industrial;
10.Termometrie: Scara Internaţională de Temperatură;
11. Temperatură Industrială şi Umiditate;
12. Scara de Temperatură;
13. Temperaturi Industriale;
14.Mediu şi Energie;
15.Mediu;
16. Energie;
17. SI: Către noi definiţii;
18. Sistemul International de Unităţi;
19.Chimie Pentru Mediu şi Sănătate;
20. Chimie;
21. Electricitate: Către noi aplicaţii;
22. Electricitate;
23. Incertitudini de Măsurare;
24. Măsurarea ca Instrument de Conducere,
25. Masă şi mărimi conexe
26. Metrologie Legală;
27. Recunoaşterea Internaţională a

- *Accreditation, economic and strategic issues;*

- *Wireless measurements in the industrial environment.*

Manufacturers of measurement equipments, providers of services and the official organisations had presented their latest technical improvements in 90 booths exhibition.

Technical visits to major firms / laboratories were possible during the Congress. Participants to the congress which were interested in visiting laboratories had the opportunities to visit the following interesting places such as:

- LNE Trappes;
- Musée du CNAM;
- Renault Technocentre.

During the Congress, a special session on the CIPM MRA took place. The International Bureau of Weights and Measures (BIPM) is associated to the Congress on the occasion of the 10th Anniversary of the implementation of the Mutual Recognition Arrangement of the CIPM.

At the **14th International Congress of Metrology** were presented both oral and poster sessions as well as the round tables which had very interesting topics in the following 27 areas:

1. Metrology and Health;
2. Health/Ionizing Radiation;
3. Dimensional: Topographic and 3D Measurements;
4. Dimensional: Measurements and New Technologies;
5. 3D Measurements;
6. Non Destructive Control – Surface Roughness;
7. New Technologies;
8. Optical Measurements;
9. Industrial Flow;
10. Thermometry: International Temperature Scale;
11. Industrial Temperature and Humidity;
12. Temperature Scale;
13. Industrial Temperatures;
14. Environment and Energy;
15. Environment;
16. Energy;
17. The SI: Towards New Definitions;
18. International System of Units;
19. Chemistry for Environment and Health;
20. Chemistry;
21. Electricity: Towards New Applications;
22. Electricity;
23. Uncertainties of Measurement;
24. Measurement as a Managing Tool;
25. Mass And Related Quantities;
26. Legal Metrology;
27. International Recognition of Calibration

Certificatelor de Etalonare.

28. CIPM MRA.

- MASĂ ROTUNDĂ 1 - Temperatură Industrială şi materiale noi;
- MASĂ ROTUNDĂ 2- Importanța metrologiei în sănătate;
- MASĂ ROTUNDĂ 3 - Măsurări Wireless în mediul industrial;
- MASĂ ROTUNDĂ 4 - Acreditare, probleme economice şi strategice;
- MASĂ ROTUNDĂ 5 - Metrologie şi reducerea efectului de seră datorat emisiei de gaz;
- MASĂ ROTUNDĂ 6 - Acreditare, probleme economice şi strategice.

La cel de-al 14-lea Congres Internațional de Metrologie, au fost acceptate trei lucrări ştiințifice românești, după cum urmează:

1 Mirela ANGHEL – INM/Romania - *Uncertainty evaluation of mass concentration of exhaled breath alcohol;*

2 Adriana VÂLCU, George POPA, Sterică BAICU – INM/Romania - *Mass measurement and uncertainty evaluation of standard weights;*

3 Elvira BUZAC – INM/Romania - *Traceability and uncertainty: metrological notions defining the quality of measurements.*

Din partea INM doi specialişti şi-au prezentat lucrările în sesiunea de postere 'METROLOGY AND HEALTH' şi 'MASS AND RELATED QUANTITIES'.

În figurile 1 si 2 sunt prezentate posterele participante la cel de-al 14-lea Congres Internațional.

În timpul acestor prezentări, autorii au avut discuții interesante şi constructive cu specialişti interesați de subiectele abordate în articole.

Schimbul de idei care a avut loc în timpul discuțiilor au fost marcate de un puternic simț de colegialitate şi de împărtăşire a experiențelor proprii. Majoritatea acestor discuții au fost binevenite şi fără, nici o urmă de îndoială, ele trebuie luate în calcul pentru îmbunătățirea activității ştiințifice în domeniul metrologiei.

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Certificates;

28. CIPM MRA.

- ROUND TABLE 1 - Industrial temperatures and new materials;
- ROUND TABLE 2- Stake for metrology in the health field;
- ROUND TABLE 3 - Wireless measurements in the industrial environment;
- ROUND TABLE 4 - Accreditation, economic and strategic issues;
- ROUND TABLE 5 - Metrology and reduction of greenhouse gas emissions;
- ROUND TABLE 6 - Accreditation, economic and strategic issues.

At this 14th International Congress of Metrology, three Romanian scientific works had been accepted as follows:

1 Mirela ANGHEL – INM/Romania - *Uncertainty evaluation of mass concentration of exhaled breath alcohol;*

2 Adriana VÂLCU, George POPA, Sterică BAICU – INM/Romania - *Mass measurement and uncertainty evaluation of standard weights;*

3 Elvira BUZAC – INM/Romania - *Traceability and uncertainty: metrological notions defining the quality of measurements.*

Two specialists from INM presented their papers on poster session METROLOGY AND HEALTH section and MASS AND RELATED QUANTITIES section, respectively.

The posters presented in the 14th International Congress of Metrology are given in figures 1 and 2.

During their presentations, the authors had interesting and constructive discussions with specialists interested in the topic of the articles.

The exchange of ideas in the discussions were marked by a sense of collegiality and mutual sharing of experiences. Most of their remarks were welcomed and without a shadow of doubt they must be taken into account for improving the scientific activity in the metrology field

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UNCERTAINTY EVALUATION OF MASS CONCENTRATION OF EXHALED BREATH ALCOHOL

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Abstract. Accurate, reliable and traceable alcohol measurement results in exhaled breath are widely required in forensic investigations. Based on the experience of the National Institute of Metrology, Romania (INM) the paper describes the method applied to prepare the standard solutions used to calibrate the evidential breath analyzers, to test their performance, to assign the mass concentration values using such instruments. Examples of measurement uncertainty evaluation are given both for the mass concentration associated with the standard solution and with the reported measurement result. The measurements were performed using different breath alcohol analyzers, simulators and sets of standard solutions.

A reference measurement standard has been developed by the Gas Concentration Group in INM in cooperation with Dräger Safety Romania, consisting of a wet simulator (based on the principle reported by Dubovski). To ensure an adequate traceability, a combination of GC, electrochemical oxidation and IR methods has been used.

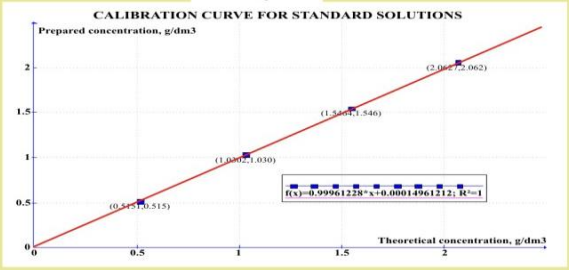
Legal aspects:

- only blood test results are admissible in court
- however, there is an increased tendency to use for legal purposes the alcohol tests performed in human breath
- by using **evidential breath analyzers** (EBAs or ethylometers), automatically measuring the mass concentration of alcohol in exhaled human breath, in milligrams of ethanol per cubic decimeter of exhaled breath, mg/dm^3.
- all specific tests are performed in accordance with the Romanian Legal Metrology Norm NML-012/05, based on the OIML Recommendations R126

Preparation of the standard solutions:

- Selection of the standards and their measurement range
- Weighing the alcohol
- Volume measurement of water
- Preparation of the alcohol / water mixtures
- Calculating the mass concentration γ_{eth} of each prepared mixture
- Verification of the γ_{eth} values against a calibrated ethylometer
- Assigning the final value of mass concentration

A set of mass values were weighted: 0,515; 1,030; 1,546; and 2,062 g. The mass concentration of ethanol in solution, γ_{eth}, was determined using the equation: $\gamma_{eth} = \frac{m_{eth}}{V_{H_2O}} \cdot P_{eth}$



Traceability aspects:

The concentration of ethanol present in vapor phase above a liquid-water mixture depends on two factors: the temperature of the mixture and the alcohol concentration in the liquid

$$\gamma_{air} = \gamma_{eth} \cdot A \cdot e^{B \cdot t}$$

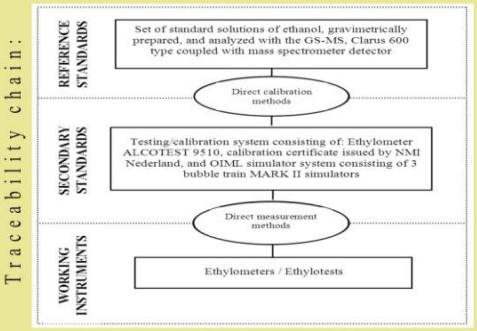
where:

γ_{air} is the mass concentration of ethanol in vapor phase above the liquid-water mixture, mg/dm^3;

γ_{eth} is the mass concentration of ethanol in solution, g/dm^3

For t equal to 34.0 °C and introducing the experimental values of A and B:

$$\gamma_{air} = 0.386\,66 \cdot \gamma_{eth}$$



In practice, mass concentrations of ethanol, starting from ethanol of 99,8 % purity, were weighted on a calibrated Mettler Toledo balance, max. 310 g, d=0,0001 g. Distilled water was added to prepare standard solutions, which were analysed by chromatography methods, and a calibration curve was drawn. After preparation each standard solution was put into 3 flask-bubble train, in accordance with OIML R 126. The mass concentration of ethanol in air was delivered by the system simulator and this gas was directly measured, against an ethylometer, (calibration certificate issued by NMI, The Nederlands).

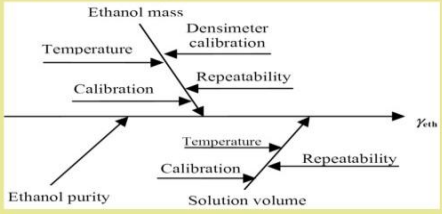
Calibration system used by the INM for EBAs calibration and verification

GC-MS used to additionally check the mass concentration of alcohol standard solution obtained by gravimetric method

Mark II A thermo-controlled flasks, and Alcotest 9510 ethylometer, both produced by Dräger Safety AG & Co, KGaA, Germany

Uncertainty evaluation of concentration of ethanol in exhaled breath

The cause-effect diagram:



The relative standard uncertainty for mass concentration of alcohol in exhaled breath calculated as the ratio between the standard uncertainty and mass concentration value has the final value of 0.003 91. For the example given, the value of the mass concentration of alcohol may be stated as

$\gamma_{air} = (0.400 \pm 0.001)$ mg/dm^3.

To evaluate the measurement uncertainty, the spreadsheet calculation method described in ISO 8258 was used. The EXCEL application was developed by the author of this paper and is being used in daily practice.

The uncertainty budget for a mass concentration of 1.03 g/dm^3 is summarized here:

Quantity	Value	Standard uncertainty	Probability distribution	Relative standard uncertainty
Mass of ethanol, g	1.030	0.001 00	Normal	0.000 97
Volume of flask, cm^3	1 000.00	0.30	Normal	0.000 30
Purity of reagent	0.998	$0.002 / \sqrt{3} =$ 0.001 155	Rectangular	0.001 16
Density of the ethanol reagent, g/dm^3	0.789	0.05	Normal	0.000 06
Mass concentration of standard solution, g/dm^3	1.028	0.001 6	Normal	0.001 542

The combined standard uncertainty was evaluated starting from the equation:

$$u_{c(\gamma_{air})} = \sqrt{\left(\frac{\partial \gamma_{air}}{\partial \gamma_{eth}}\right)^2 \cdot u^2_{\gamma_{eth}} + \left(\frac{\partial \gamma_{air}}{\partial t}\right)^2 \cdot u^2_t}$$

For a temperature of 34.0 °C, by replacing the coefficients, the equation becomes:

$$u_{c(\gamma_{air})} = \sqrt{0.388\,7^2 \cdot u^2_{\gamma_{eth}} + (0.025\,6 \cdot \gamma_{eth})^2 \cdot u^2_t}$$

The uncertainty budget for the mass concentration of alcohol in exhaled breath:

Quantity	Value	Standard uncertainty	Probability distribution	Relative standard uncertainty
Mass concentration of standard solution, g/dm^3	1.028	0.001	normal	0.001 542
Temperature, °C	34.0	$0.1 / \sqrt{3} =$ 0.057 7	rectangular	0.000 02
Mass concentration of alcohol in exhaled breath, mg/cm^3	0.400	0.000 617	normal	0.001 542

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THE MASS MEASUREMENT AND UNCERTAINTY EVALUATION OF STANDARD WEIGHTS

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Abstract

To find out the level of competence of calibration laboratories an interlaboratory comparison of seven standard weights between the National Institute of Metrology (acting as a pilot laboratory) and sixteen metrology laboratories throughout Romania was performed. The interlaboratory comparison reported, has tested the best measurement capability of each laboratory in calibration of seven standard weights. The comparisons were carried out between April 2007 and December 2008, the traveling standards used, belonging to INM, having nominal values: 10 kg, 1 kg, 500 g, 200 g, 100 g, 20 g and 100 mg.
The density and the volume of each weight were furnished by INM. The laboratory's results are presented for each weight, uncertainty declared and the errors normalized of each laboratory (E_n values), with respect to the INM.

Introduction

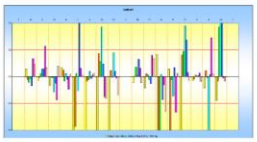
An interlaboratory comparison of seven mass standards was carried out between 17 metrology laboratories throughout Romania, during the period April 2007 – December 2008. LP and the comparison scheme was chosen to minimize the influence of any instability in their mass.
The seventeen participants in the comparison were: Piatra Neamt, Vaslui, Suceava, Ploiesti, Pitesti, Târgoviste, Craiova, Slatina, Drobeta Turnu Severin, Târgu Jiu, Resita, Baia Mare, Satu Mare, Zalau, Bistrita and Bucharest.
Each laboratory has been assigned a code (for the confidentiality's results), LP having the code "1".

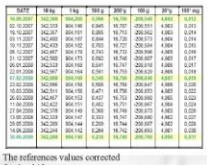
Results

The results of the intercomparison are summarized in Table 1. The results are presented exactly that were sent by the participants. Graphs 2 to 7 present the differences between participants' results and reference value, and uncertainty (k=2) for all the weights. Graphs 2' to 7' present details of the graphs mentioned above

Laboratory's code	10 kg E mg	10 kg U mg	1 kg E mg	1 kg U mg	500 g E mg	500 g U mg	200*g E mg	200*g U mg	100 g E mg	100 g U mg	20* g E mg	20* g U mg	100*mg E mg	100*mg U mg
1	342,5	2,4	904,20	0,14	1,00	0,07	16,79	0,34	-208,54	0,02	4,862	0,009	0,002	0,002
15	344	9,2	904,16	0,21	0,972	0,199	16,693	0,149	-206,607	0,145	4,814	0,038	0,0168	0,0019
2	341,150	7,105	904,100	4,437	0,947	0,348	16,789	0,224	-206,509	0,162	4,859	0,047	0,018	0,018
12	339,6	7,5	904,161	1,5	0,8	1,2	16,678	0,03	-205,590	0,025	4,788	0,01	0,003	0,004
6	348	16	904,28	0,28	0,74	0,14	16,74	0,10	-208,60	0,12	4,790	0,026	0,010	0,004
7	29,86	139,84	885,40	10,969	1,96	0,999	16,09	1,429	-179,62	1,130	5,14	1,040	0,057	0,016
5	296	16	903,9	1,6	0,6	0,8	16,8	0,3	-208,62	0,16	4,81	0,08	0,019	0,016
14	56	110	906,8	3	2,05	2,5	17,5	0,4	-208,47	0,3	4,73	0,1	-0,008	0,030
10	155	59	907	12	0,3	11	16,3	0,15	-208,0	0,12	4,8	0,11	-0,06	0,11
1	342,5	2,5	904,16	0,20	0,54	0,07	16,76	0,03	-208,54	0,02	4,867	0,013	0,003	0,003
16	334	40	904,2	3,7	1,4	2,5	16,8	0,79	-208,5	0,21	4,82	0,04	0,018	0,006
11	280	150	905	8	0,9	5,7	16,74	0,13	-208,69	0,11	4,836	0,035	0,011	0,011
4	480	166	896,3	1,3	-1,8	1,9	16,8	0,6	-208,92	0,29	4,78	0,08	0,005	0,011
8	391	174	893,020	2,244	0,258	1,345	16,490	0,352	-206,568	0,277	4,529	0,207	0,029	0,027
17	170	56	898,8	5,3	3	2,8	17,16	0,2	-208,4	0,16	4,83	0,17	0,00	0,16
9	335	50,0	903,7	5,0	0,50	2,5	16,76	1,9	-208,66	0,5	4,83	0,2	0,018	0,05
3	300	100	906	8	0	8	16,66	0,68	-208,621	0,8	4,92	0,08	0,04	0,10
13	268,1	61,4	903,8	2,1	1,91	0,84	21,71	0,17	-139,64	0,15	4,797	0,056	0,019	0,062
1	342,2	2,7	904,14	0,20	0,03	0,07	16,74	0,05	-208,70	0,04	4,860	0,01	0,001	0,002

Deviation from nominal mass (E) and expanded uncertainty (U) for the corresponding values





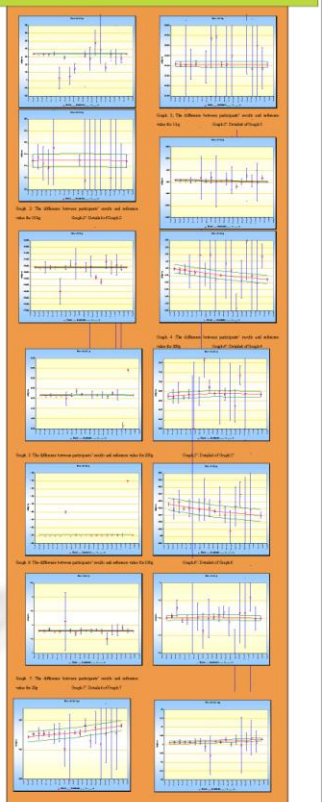
The references values corrected for the drift

$$E_n = \frac{x_{lab} - x_{ref}}{\sqrt{U_{lab}^2 + U_{ref}^2}}$$

Nominal Value	10 kg	1 kg	500 g	200*g	100 g	20* g	100* mg
U_{ref}	2,8	0,28	0,29	0,87	0,09	0,015	0,008
Laboratory's code	Normalized deviations E_n						
15	0,28	-0,10	-0,21	-0,09	-0,33	0,67	0,46
2	-0,16	-0,02	0,12	0,29	0,29	**1,13**	0,34
12	-0,35	-0,02	-0,94	-0,57	-0,25	-0,87	0,39
6	0,34	0,25	-0,17	0,11	-0,11	-0,47	0,09
7	**-2,24**	**1,16**	0,13	-0,52	**25,57**	0,32	0,06
5	**-2,92**	-0,17	-0,11	0,20	-0,07	0,06	0,13
14	**-2,60**	0,37	0,56	**1,80**	0,47	-0,75	-0,82
10	**-3,16**	0,24	-0,03	0,89	0,20	-0,06	-0,71
1	0,00	0,00	0,00	0,00	0,00	0,00	0,00
16	-0,21	0,01	0,36	0,06	0,55	0,32	-0,22
11	-0,42	0,11	0,08	-0,11	-0,26	0,80	0,67
4	0,83	**-5,01**	**2,15**	0,00	-0,86	-0,30	**-4,30**
8	0,28	**-4,02**	-0,10	-0,73	0,34	**-1,52**	0,13
17	**-3,13**	0,82	0,94	**1,90**	**1,37**	0,16	-0,16
9	-0,15	-0,09	0,07	0,01	0,24	0,14	-0,18
3	-0,42	0,23	-0,04	**-5,90**	0,08	**1,46**	0,12
13	-0,88	-0,16	**1,85**	**27,17**	**396,18**	0,06	0,17
1	0,00	0,00	0,00	0,00	0,00	0,00	0,00

$E_n > 1$
$E_n < -1$

Normalized deviations E_n from reference values



Discussions

-Six participating laboratories (6,9,11,12,15,16) obtained compatible results with that of LP for all the weights;
-For 10 kg weight, five participating laboratories (5,7,10,14,17) differ from the results of LP;
-For 1 kg weight, three participating laboratories (4,7,8) differs from the result of LP;
-For 500g weight, two participating laboratories (4,13) differ from the result of LP;
-For 200g weight, four participating laboratories (3,13,14,17) differ from the results of LP;
-For 100g weight, three participating laboratories (7,13,17) differ from the results of LP;
-For 20g weight, three participating laboratories (2,3,8) differ from the results of LP;
-For 100mg weight, one participating laboratory (4) differ from the results of LP
-LP asked participants to review their results for confirmation.
-Two participating laboratories (5, 11) have taken into account uncertainty due to the eccentricity even the balances have a suspended load receptor;
-Eight participating laboratories (2,4,8,10,14,15,16,17) have no taken into account in their uncertainty budgets the contribution due to the eccentricity;
-Eight participants (2,6,7,10,12,14,15,17) didn't use additional weights in the calibration and also have no taken into account in their uncertainty budgets the contribution due to the difference between standard and test.
-Five participants (4,5,8,9,13) wrongly calculated uncertainty associated to reference standard, being not in accordance with ch. C.6.2.2 from OIML R 111;
-Two participants have no taken into account in their calculation the air buoyancy effect.

Conclusions

Analyzing the results of interlaboratory comparison it can be seen that 17% from the total results are discrepant. Six from the 16 laboratories (6, 9, 11, 12, 15, 16) obtained compatible results with LP. Three laboratories (2, 5, 10) have only one result with "E_n" number larger than one and seven laboratories (3, 4, 7, 8, 13, 14, 17) have two or more results with "E_n" number larger than one. The results obtained can be used to demonstrate the participating laboratory's measurement capability. The participants who obtained results greater than [-1, +1] should analyze the reasons in order to remedy and correct them. By analyzing the results, are proposed the next corrective measures:
-It is advisable that some participants must review the uncertainty analysis;
-In the case of a big difference between standard and test it is advisable to use additional weights so that this difference is as small as possible. Otherwise it should be increased uncertainty with this component;
-Further qualification of the personnel in calibrating and estimating uncertainty.