

How to organize a metrological laboratory

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Bureau
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Outline - How to organize a metrological laboratory

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Anticipations

Recommendations of the EU on Trade, Industry, Customs, Taxation and Cooperation

- The EU expects BiH to establish a fully functioning single economic space and remove all unnecessary legal, technical and administrative barriers to the free movement of goods within the country.
- The EU expressed the need for a countrywide harmonized approach in metrology and for increased cooperation and coordination between the various levels of government.
- It also emphasized the need to strengthen efforts in the complex area of free movement of goods in order to prepare for the possible future participation in the EU's single market and confidence in quality

Anticipations

Purposes for acceptable and recognized quality

- All countries need to be able to enjoy the benefits of free trade and globalization,
- Innovations and competition,
- Access to international market and protection of domestic market,
- Consumer protection (health, security, environment),
- Help to regulators in defining and monitoring the implementation of technical regulations,
- Help in economic development through the development of metrology as one of the infrastructures,
- Guarantees reliable measurements, establishing a system that shall enable internationally accepted accreditation,
- The process from measurement to certification of products and services that guarantee the manufacturer declared satisfied product specifications and customer requirements and market demands need to be followed,
- Product price and market certification guarantee competitiveness, national markets are maintained and expanded.

International and regional context

- Metrology – the science of measurement - experimental and theoretical determinations at any field of science and technology
- Metrology - infrastructure and process of international and regional organizations
- Metrology - key scientific discipline for the implementation and harmonization of technical regulations
- As socio-economic category (fairness of trade, free movement of goods, health protection, environmental issues)
- Measurements must be traceable, harmonized, comparable, reliable
- All forms of physical and chemical measurement affect the quality of the life.
- Because of the need for international agreement on matters concerning metrology, an international treaty known as the Metre Convention was established as early as 1875. This treaty founded the BIPM and remains today the basis of international agreement on units of measurement.

International and regional context

- The CIPM Mutual Recognition Arrangement (CIPM MRA) is the framework through which National Metrology Institutes demonstrate the international equivalence of their measurement standards and the calibration and measurement certificates they issue.
- The outcomes of the Arrangement are the internationally recognized (peer-reviewed and approved) Calibration and Measurement Capabilities (CMCs) of the participating institutes.
- Approved CMCs and supporting technical data are publicly available from the CIPM MRA database (the KCDB).
- The CIPM MRA responds to the need for an open, transparent and comprehensive scheme to give users reliable quantitative information on the comparability of national metrology services and to provide the technical basis for wider agreements negotiated for international trade, commerce and regulatory affairs.
- The Regional Metrology Organizations (RMOs) are responsible for carrying out comparisons and other actions within their regions to support mutual confidence in the validity of the calibration and measurement certificates of their member NMIs.

International and regional context

- The RMOs play an important role within the CIPM MRA. In particular, they:
 - make proposals to the Consultative Committees on the choice of key comparisons;
 - carry out the RMO key comparisons, described in the Technical Supplement to the Arrangement, corresponding to the CIPM key comparisons;
 - participate in the JCRB;
 - carry out supplementary comparisons and other actions designed to support mutual confidence in the validity of calibration and measurement certificates issued by participating institutes (see paragraph 7.3 of the CIPM MRA).
- Currently six RMOs are recognized within the framework of the CIPM MRA:
 - Intra-Africa Metrology System (AFRIMETS);
 - Asia Pacific Metrology Programme (APMP);
 - Euro-Asian Cooperation of National Metrological Institutions (COOMET);
 - European Association of Metrology Institutes (EURAMET);
 - Inter-American Metrology System (SIM);
 - Gulf Association for Metrology (GULFMET).

National context

- The metrological activities are typically performed by the National Metrology Institute (NMI).
- The role of a NMI is to obtain, conserve, develop and disseminate the basic measurement units and the highest level of calibration standards.
- NMI provides traceability to the national system and it ensures that international technical guidelines are followed for the metrological performance and testing procedures of measuring instruments subject to legal controls, and from the point of view of manufacturers it ensures that their products meet international specifications for metrological performance and testing.
- A key criterion for evaluation of metrology capabilities is the highest reliability of measurement capabilities declared.
- The CMCs are issued in a database (KCDB) managed by the BIPM and published online.
- Calibration activities are also an essential part of the national metrology system and thus of the national quality system.

National context

- Once a well-functioning NMI is established, the quality of the goods produced will be more consistent. The integration of the NMI in regional metrology institutes strengthens trust in the national production system, facilitates the access of local companies to new markets for their exports and fosters the integration of firms in global value chains.
- Relationship of regional/international and national elements of quality
 - Technical regulations should be based on ISO standards,
 - National standardization institution converts ISO standards into national ones,
 - The competent body issue technical regulations and notify the WTO TBT Committee, and in case they are related to sanitary and phyto-sanitary protection the WTO SPS Committee,
 - Physical and chemical measurements must be traceable to NMI standard - competence is internationally proven by CIPM MRA contract and by the recognition of CMC,
 - Testing and analysis shall be carried out by accredited laboratories,
 - Certification bodies for products and management systems must to be accredited,
 - National accreditation body should be internationally recognized by ILAC.

Consideration (General information on metrology system)

- Do we have an operative National Metrology Institute (NMI)?
- Does NMI cover both scientific and legal metrology?
- Is there a roof metrology law in country? (... other documents...).
- Is our NMI divided in sectors covering independent fields?
- Is metrology system in country centralized?
- Do we have procedure for preparing and adopting bylaws?
- Are the needs of government policy and technical regulations met?
- Do we collaborate with other NMI in region?
- In which areas we have requests for providing metrology services?
- Are we satisfied with the quality of technical staff within our NMI?
- Do we direct our customers to other NMIs for services we are not able to provide at the moment? If yes, what are the reasons for not having developed metrology infrastructure in those areas where our country needs are evident?

Consideration (National standards, CA, traceability, and ILC)

- Are we responsible for nominating the national standards? Do we have laboratories with published (registered) CMCs?
- Do we have local clients for calibration services performed by laboratories holding national standards or providing traceability in other way? How many calibrations per year – about the profile of customers?
- What are the priorities to provide traceable measurements for industry in our country?
- Who is responsible for verification of measuring instruments?
- Do we have harmonized measuring instruments with neighboring countries, i.e. NMIs?
- Do we have separate national regulations covering non-harmonized measuring instruments? If yes, how many of non-harmonized measuring instruments we have?
- Do our laboratories provide metrology services to other clients in other countries?
- Do we take part in ILC? If yes, which ones?
- Do we have need for some particular inter-laboratory comparison?

Consideration (Quality management system)

- Do we have implemented QMS?
- What metrology fields are covered by QMS?
- Quality Management System of our NMI is in compliance with the requirements of which international standards: ISO 9001; ISO/IEC 17020; ISO/IEC 17025; ISO/IEC 17024; ISO/IEC 17043; ISO GUIDE 34; ..
- Do we perform customer survey?
- Is NMI quality system confirmed by RMO? Who performed Peer Review?
- Did we experience customer complaints? If yes, how many so far?
- Do we follow regulative documents covering the maintenance and expanding of the measurements ranges and/or updating measurement uncertainties?
- Do we regularly prepare quality objectives regarding the extension of metrological capabilities by means of CMC publishing?
- Do we maintain the plan for regular education of your technical staff?

Country case – Bosnia and Herzegovina

- Bosnia and Herzegovina is a country in Southeast Europe, on the Balkan Peninsula, bordered by Adriatic Sea, Croatia, Serbia and Montenegro. Bosnia and Herzegovina covers area of 51129 square kilometers with population of 4 613 414 (estimated in 2007).
- Institute of Standards, Metrology and Intellectual Property of Bosnia and Herzegovina from 1992 - 2000, as a governmental institution.
- The **Institute of Metrology of B&H (IMBIH)** has been established by restructuring the above mentioned Institute, as projected by the Law on Establishing the Institute for Metrology of B&H, issued in September 2004. Final separation between Institute of Metrology of B&H, Institute of Standardization of B&H and Institute of Intellectual Property of B&H has been done on **January 1, 2007**.



Country case – Bosnia and Herzegovina

- **The National Metrology System of B&H consists of:**
- Institute of Metrology of Bosnia and Herzegovina (IMBiH) - The National Metrology Institute,
- Two DIs (holder of national measurement standards),
- Accredited calibration laboratories,
- Nominated metrological laboratories and bodies (e.g. verification laboratories),
- Conformity assessment bodies for measuring instruments.
- **Legal framework of the Institute of Metrology of Bosnia and Herzegovina**
- IMBiH is established directly under the merit of the Council of Ministers of B&H.
- The legal framework for jurisdiction of the Institute of Metrology of B&H is stated in the laws:
 - Law on Metrology of B&H (Official Gazette of B&H, No. 19 from 2001)
 - Law on Measuring Units of B&H (Official Gazette of B&H, No. 19 from 2001)
 - Law on the Establishment of the Institute of Metrology of B&H (Official Gazette of B&H, No. 43 from 2004).
- Certain number of bylaws (36) are derived from the above mentioned laws.

Institute of Metrology of Bosnia and Herzegovina (IMBIH)

- Realizes the base of standards in Bosnia and Herzegovina, develops, creates, declares and maintains **national standards** of legal (SI) units of measurement,
- Provides **traceability** of the national standards through unbroken chain of intercomparison to international ones,
- Prescribes **metrological requirements** for standards, reference materials and measuring instruments, makes decisions on **recognition** of standards as national standards,
- Performs the **conformity assessment** including the pattern evaluation and pattern approvals of measuring instruments,
- Deals with **research and development** in the field of metrology, proposes the development **projects** and defines **priorities** in their realization in the field of metrology,
- Participates in the activities of **international organizations for metrology** representing Bosnia and Herzegovina therein, implements international agreements on **co-operation**, ...

Institute of Metrology of Bosnia and Herzegovina (IMBIH)

- The Director of the IMBIH, **notifies** metrological laboratories and, verification centers, prescribes the ways of **conformity assessment** for particular types of measuring instruments, types and ways of marking of measuring instruments and the contents and the form of the certificate of conformity with metrological regulations.
- The Director of IMBIH **nominates** the legal person for conformity assessment,
- IMBIH participates in the **activities** of the international organizations and associations in the field of metrology,
- IMBIH **appoints representatives** that will participate in their activities or observe them, and represent Bosnia and Herzegovina therein.
- IMBIH organizes and directs **scientific-research activities** in the field of metrology.
- Realization of the **projects** or their parts in the field of metrology is performed within the IMBIH in association with competent scientific-research organizations, institutions and individuals from the country and abroad.

Development of IMBIH laboratories

Fulfilting the country needs for metrology infrastructure:

- The importance of measurement results is increasing - rapid technological development,
- Consumers and industry have to make decisions every day based on the results of measurements that affect their economic and personal well-being,
- Consumers, who usually are not adequately informed about these processes are potentially damaged in terms of measurement results and their interpretation,
- Provides an important tool for measuring, and detailed analysis of results,
- Correct and precise measurements help to ensure fair market competition,
- Precise measurements play a vital role in industrial production,
- This is reflected in the quality management system, which requires traceability of measurements to SI units,
- Metrology must be transformed **from subjective** understanding **into world accepted criteria** which in international organizations for metrology convert to generally accepted documents,
- Small and medium-sized enterprises, which, unlike large, can not organize calibration and testing.

Development of IMBIIH laboratories

Approving calibration and measurement capabilities (CMC) of IMBIIH

- **CMC review criteria.** The JCRB requires that the range and uncertainty of the CMCs submitted is consistent with information from some or all of the following sources⁹:
 - 1. Results of key and supplementary comparisons
 - 2. Documented results of past CC, RMO or other comparisons (including bilateral)
 - 3. Knowledge of technical activities by other NMIs, including publications
 - 4. On-site peer assessment reports
 - 5. Active participation in RMO projects
 - 6. Other available knowledge and experience
- Technical support for CMCs is achieved mainly through the results of comparisons.
- **CMC review process.** In order for CMCs to be approved for publication in Appendix C, they must first be reviewed and approved by the appropriate Technical Committee within EURAMET (Intra regional review). Once this approval is obtained, CMCs undergo an inter regional review, where the TC/WGs from other RMOs verify that the review criteria have been followed, thus providing the technical confidence required for publication.

Development of IMBIH laboratories

Procedure for IMBIH QMS evaluation - List of EURMET reference documents:

- EURAMET: G/TCQ/PRC/001 ver. 2.0 from 13.04.2012.
- EURAMET guide no 3 “EURAMET procedures and review criteria for CMCs”.
- EUROMET Technical Committee Quality (TC-Q) – Terms of Reference.
- EURAMET Guide for on-site visits by peers in the frame work of CIPM MRA.
- CIPM 2007-25: Recommendations for on-site visits by peers.....
- EURAMET, “Guideline for initial QMS presentation”, TC-Quality.
- EURAMET, “Guideline for QMS annual report”, TC-Quality.
- EURAMET, “Guideline for QMS re-evaluation presentation”, TC-Quality.

The basis of QMS of IMBIH is in compliance with the requirements of ISO 9001 and the basis of QMS of testing and calibration laboratories fulfilling the requirements and criteria proscribed by the ISO/IEC 17025. Laboratory for verification implemented its QMS in compliance with the ISO/IEC 17020. Laboratory for Chemistry has implemented integrated QMS additionally covering the requirements of ISO/IEC 17043. QMS of IMBiH and its laboratories is based on self-declaration (via peer reviews) and external accreditation (testing laboratory for chemistry) and external certification related to the international standard ISO 9001.

Development of IMBIH laboratories (EURAMET route)

1. NMI arranges on/site peer review by themselves in compliance with the provisions of EURAMET guide for on/site visit by peers usually using external reviewers (ref.doc. 1, point 4).
2. Upon peer review (after all nonconformities have been resolved) and not later than 4 weeks before next SCTCQ and TCQ meeting NMI submits electronic version of the initial presentation of QMS (ref.doc. 1, point 5.2).
3. TCQ Secretary receives the documents and delivers the documents to appointed reviewers who send their comments to the Chairman and the Secretary (ref.doc. 1, point 5.2).
4. At the TCQ steering committee and plenary meeting submitted documents and comments are analyzed and the summary is presented to the NMI representative and the overall impression of the presentation is provided by TCQ members who are free to pose questions upon presentation (ref.doc. 1, point 5.2).
5. Within 2 weeks after the TCQ meeting all questions are sent directly by the reviewers to the NMI contact person (ref.doc. 1, point 5.2).
6. Within 6 weeks after the TCQ meeting NMI should send back the answers to the posted questions (ref.doc. 1, point 5.2).
7. Within 8 weeks after the TCQ meeting reviewer accepts or refuses the supplied complementary information and informs TCQ chairman and Secretary (ref.doc. 1, point 5.2).
8. Results of the review are reported to EURAMET Secretary and so made official (ref.doc. 1, point 5.2).
9. NMI submits annual report on the QMS status without oral presentation (ref.doc. 1, point 5.3).
Re/evaluation of the QMS is done within a maximum of 6 years, regular time being 5 years, after the initial presentation.
Re/evaluation includes oral presentation (ref.doc. 1, point 5.4).

Development of IMBiH laboratories

Structure of QMS

- ◆ QMS requirements apply to all staff members of IMBiH, and are valid for all activities essential for the services provided to clients in our own laboratories or, when needed, on external location.
- ◆ IMBiH's integrated QMS includes laboratories' QMSs containing documentation created in accordance with the requirements of the following standards: BAS EN ISO/IEC 17025, BAS EN ISO/IEC 17020 and BAS EN ISO/IEC 17043.
- ◆ Role of top management refers to the development and implementation of QMS and continual improvement of its efficiency through:
 - Establishment of Quality Policy;
 - Definition of clear (understandable) and measurable objectives' indicators;
 - Review of the Quality System;
 - Insurance of availability of all required resources and
 - Informing of all employees about the importance of meeting the requirements posted by customers / service users, as well as legal and regulatory requirements.

Development of IMBIH laboratories

Reconnaissance mutuelle
des étalons nationaux de mesure
et des certificats d'étalonnage et de mesurage
émis par les laboratoires nationaux de métrologie
Paris, le 14 octobre 1999



Mutual recognition
of national measurement standards
and of calibration and measurement certificates
issued by national metrology institutes

Paris, 14 October 1999

Comité international des poids et mesures

Bureau
international
des poids
et mesures

Organisation
intergouvernementale
de la Convention
du Mètre

Déclaration à signer
par les directeurs des laboratoires nationaux de métrologie
des États et entités économiques associés
à la Conférence générale des poids et mesures
et souhaitant participer à l'arrangement

Declaration to be signed
by directors of national metrology institutes of Associate States or
Economies of the CGPM wishing to participate in the arrangement

Je déclare, en tant que directeur du laboratoire national de métrologie désigné par
l'État ou l'entité économique associé(e) à la Conférence générale des poids et
mesures, que je souhaite participer à l'arrangement de reconnaissance mutuelle et
que je m'engage à respecter les règles et procédures de cet arrangement.

*I declare as director of the designated national metrology institute of an Associate
State or Economy of the CGPM that I wish to participate in this Mutual Recognition
Arrangement and agree to abide by the rules and procedures of the arrangement.*

Nom/Name	État ou entité économique associée à la CGPM/Associate State or Economy of the CGPM	BIPM
Signature		Signature
<i>Stjepan Zjadr</i>		<i>Michael Rieker</i>
Director of the Institute of Metrology of Bosnia and Herzegovina		Director of the BIPM

15 June 2011

*Tous les laboratoires et instituts mentionnés dans cette colonne participent à cet arrangement.
This arrangement covers all the institutes listed here.

IMBIH signed CIPM MRA
on June 15, 2011

Michael Rieker
Director of the BIPM
15 June 2011

Further development of IMBIIH capabilities

IMBIIH entered its first CMCs in KCDB on June 8, 2012.

- **Today, on November 14, 2017 IMBIIH has listed 59 CMCs:**
 - **CMCs General Physics (58)**
 - DC voltage, current, and resistance (20)
 - Temperature (9)
 - Mass, mass standard (8)
 - Time scale difference (6)
 - Frequency (6)
 - AC voltage, current, and power (6)
 - Time interval (3)
 - **CMC Chemistry (1)**
 - Yellow gold jewellery alloys (1)

Further development of IMBIIH capabilities

IMBIIH listed comparissons in KCDB

- | | |
|--|--|
| <ul style="list-style-type: none">▪ Pressure (4)▪ Mass standard (4)▪ Fluid Flow (3)▪ Standard Paltinum Resistance Thermometers (2)▪ Industrial thermometry (1)▪ Fixed Point Cells (1)▪ Resistance (2)▪ DC Voltage and Current (1)▪ Inorganics (1)▪ Time (1) | <ul style="list-style-type: none">▪ EURAMET (14)▪ COOMET (3)▪ GULFMET (2)▪ CCTF (1) |
|--|--|
- Key comparisson (13)
 - Supplementary comparisson (7)

Further development of IMBIH capabilities

Bosnia & Herzegovina became a member country of the European Metrology Research Program (EMRP) in March 2013.

This allows active participation in the latest *state-of-the-art* metrology research projects.

IMBIH's scientists took part in JRP project as RMG in different NMIs in duration of about 60 months from 2013 till now.

So far, IMBIH has taken part in 12 projects within energy, industry, environment and potential research call.



EMRP Participating Countries

Further development of IMBiH capabilities

IMBiH participation on research projects from 2014-2017

- **EMRP – European Metrology Research Programme**
 - **ENV58** MeteoMet2 Metrology for essential climate variables
 - **ENG52** Smart Grid II Measurement tools for Smart Grid stability and quality
 - **ENG54** Metrology for biogas
 - **ENG59** NNL Sensor development and calibration method for non-Newtonian fluids
- **EMPIR – European Metrology Programme for Innovation and Research**
 - **14RPT02** AWICal Traceable calibration of automatic weighing instruments
 - **14RPT03** ENVCRM Matrix reference materials for environmental analysis
 - **14RPT04** ABSORB Absorbed dose in water and air
 - **14RPT05** EURA-THERMAL Developing traceable capabilities in thermal metrology
 - **15RPT03** HUMEA research capabilities in humidity measurement (IMBiH Coordinator)
 - **15RPT04** Trace PQM Traceability routes for electrical power quality measurements
 - **JRP-g03** Metrology for biomethane
 - **JRP-r02** Certified forensic alcohol reference materials

Further development of IMBIIH capabilities

IMBIIH has signed and realizing memorandum of understanding with a number of NMIs and DIs:

- PTB – German NMI
- CMI – Czech NMI
- VSL – Dutch NMI
- TUBITAK UME – Turkish NMI
- VNIIM St.Petersburg - Russia
- VNIIMS Moscow - Russia
- KAZINMETR – NMI of Kazakhstan
- DMDM – Serbian NMI
- BEV – Austrian NMI
- DZM – Croatian NMI
- INRIM – Italian NMI
- INM – Moldova NMI
- MIRS – Slovenian NMI
- MATHMET - European centre for mathematics and statistics in metrology
- IMT – Slovenian DI
- LMK – Slovenian DI
- Institute Jozef Stefan – Slovenian DI

Further development of IMBIIH capabilities

IMBIIH achieved full/associate membership in the following regional/international organizations:

- OIML (International Organization of Legal Metrology) - Corresponding Member since March 1997
- EURAMET (European Association of National Metrology Institutes) - Member since 2009
- WELMEC (European cooperation in legal metrology) - Associate member since 2009
- BIPM / CGPM (International Bureau of Weights and Measures / General Conference for Measures and Weights) - Associate Member since 2011
- COOMET (Euro-Asian Cooperation of National Metrological Institutions)- Associate member since 2013
- GULFMET (Regional Metrology Organization of Gulf countries) - Associate member since 2013
- SMIIC (Standard and Metrology Institute for the Islamic Countries) - Associate member since 2013
- IAAO (International Association Assay Office) - Observer since 2010



Thank you for your attention!



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