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TRAINING ACADEMY

Beginner 2

Course 4.1

STANDARDISATION TRAINING ACADEMY

Topic:

THE ROLE OF METROLOGY IN QUALITY INFRASTRUCTURE

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Module Objectives

After completing this module, you should be able to:

1. understand that metrology has become one of the most sophisticated sciences and one in which cooperation is essential to maintain modern technology;
2. understand that Quality Infrastructure (QI) relies on a measurement system that ensures that measurements are made with appropriate accuracy and reliability and may be related to other measurements made domestically or internationally; and
3. understand that National Measurement Institutes (NMIs) are responsible for providing measurement capabilities within their economies and maintaining measurement capabilities at levels which provide comparability with institutes from other economies.

Key Terms

General Conference on Weights and Measures (CGPM), International Bureau of Weights and Measures (BIPM), International Committee for Weights and Measures (CIPM), Designated Institutes (DIs), European Association of National Metrology Institutes (EURAMET), European Collaboration in Measurement Standards (EUROMET), National Measurement Institutes (NMIs), International Organisation of Legal Metrology (OIML), Regional Metrology Organisations (RMOs), and the Western Europe Legal Metrology Cooperation (WELMEC)

About The Author

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Biljana Tošić is a Teaching Assistant and a Research Assistant at the Faculty of Organisational Sciences, University of Belgrade. She earned a B.Sc. and M.Sc. in Quality Management and Standardisation and another M.Sc. in Human Resources Management at the same Faculty. She is currently a Ph.D. Candidate, working on a doctoral dissertation titled ''The significance of the expertise in standardisation for the internationalisation of SMEs''. To date, she has been engaged in teaching several courses at the Faculty: Fundamentals of Quality, Standardisation 1, Metrology with the Fundamentals of Engineering, Normative Regulation of Quality, and Accreditation and Certification. She has been a member of the organisational board of the World Standards Cooperation Academic Day 2019 and the International Cooperation for Education about Standardisation (ICES) WorkShop 2019. She has been a member of the technical board of the International Symposium SymOrg 2020 titled ''Business and Artificial Intelligence'' and the SymOrg 2022 titled ''Sustainable Business Management and Digital Transformation: Challenges and Opportunities in the post-COVID Era''. She has been engaged in project III 47003 ''Infrastructure for technology-enhanced learning in Serbia'', supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia (2017-2020). She has been Editor in Chief of the Quality Media Station, the first media centre for quality established within the TEMPUS project titled ''Enhancement of Quality Infrastructure in Western Balkan Countries (EQIWBC)'' (2015-2017). She is currently a member of the National Mirror Committee Conformity Assessment & Quality Management KS CASCO at the Institute for Standardisation of Serbia (National Technical Committee related to ISO/CASCO, ISO/TC 176, ISO/TC 176/SC 1, ISO/TC 176/SC 2, ISO/TC 176/SC 3, ISO/TC 283, CEN/SS F20, CEN/TC 279, CEN/TC 379, CEN/TC 381, CEN/TC 389, CEN/CLC/JTC 1, and CEN/CLC/JTC 4).

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1 METROLOGY

Metrology, the science of measurement, seems to be the oldest of three core components of QI. [1] Nowadays, metrology has become one of the most sophisticated sciences and one in which cooperation across the world is absolutely essential to maintain modern technology. [2] Over the last few decades, metrology has changed significantly, especially considering the majority of technological developments, such as electronics, computers, micro-technology, lasers and many more that have pushed measurement capability to unbelievable accuracy. [3] QI relies on a national measurement system that ensures that measurements are made with appropriate accuracy and reliability and may be related to other measurements made domestically or internationally. [4] This is essential to ensure the compatibility of trade and commerce. [5] Measurement also underpins testing, as many items require calibration by specialist laboratories to ensure that such tests are traceable to international measurement standards. [6] Manufacturing also requires consistent and reliable measurements for the interoperability of components, as do measurements associated with traded commodities. [7]

In 1875, a diplomatic conference on the metre took place in Paris where 17 governments signed the diplomatic treaty **the Metre Convention**. [8] The signatories decided to establish a permanent scientific institute – **the International Bureau of Weights and Measures** (**Bureau international des poids et mesures – BIPM**). [9] The Metre Convention was slightly modified in 1921. [10] In early 2023, it counts 63 member states and 40 states and economies that are associates of the CGPM, with the right to attend the CGPM as observers. [11]

Representatives of the governments of the member states meet every fourth year at the **General Conference on Weights and Measures (Conférence générale des poids et measures – CGPM)**. [12] The CGPM meets to discuss and examine the work done by the **National Metrology Institutes (NMIs)** and the BIPM and gives

[1] Kellerman, M. (2019). Ensuring Quality to Gain Access to Global Markets (A Reform Toolkit). Accessed on October 27, 2022. Retrieved from: https://thedocs.worldbank.org/en/doc/249621553265195570-0090022019/original/FullQIToolkitReport.pdf, pp. 69.
[2] Ibid., pp. 69.
[3] Bucher, J., et al. (2004). The Metrology Handbook. The Measurement Quality Division, ASQ Quality Press., pp. xi.
[4] ISO/UNIDO. (2010). Building trust. The Conformity Assessment Toolbox. Accessed on October 27, 2022. Retrieved from: https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/casco_building-trust.pdf, pp. 18.
[5] Ibid., pp. 18.
[6] Ibid., pp. 18.
[7] Ibid., pp. 18.
[8] Howarth, P., Redgrave, F. (2008). Metrology – In Short (EURAMET, 3rd ed.), Accessed on October 27, 2022. Retrieved from: https://www.euramet.org/publications-media-centre/documents/metrology-in-short/?L=0, pp. 29.
[9] Ibid., pp. 29.
[10] Ibid., pp. 29.
[11] BIPM. (2023). Member States. Accessed on January 23, 2023. Retrieved from: https://www.bipm.org/en/member-states
[12] Howarth, P., Redgrave, F. (2008). Metrology – In Short (EURAMET, 3rd ed.), Accessed on October 27, 2022. Retrieved from: https://www.euramet.org/publications-media-centre/documents/metrology-in-short/?L=0, pp. 29.

recommendations on the new fundamental metrological determinations and all major issues of concern to the BIPM. [13]

The CGPM elects 18 representatives to the **International Committee for Weights and Measures (Comité international des poids et mesures – CIPM),** which meets annually. [14] The CIPM supervises the BIPM on behalf of the CGPM and co-operates with other international metrology organisations. [15] The CIPM prepares work for decisions to be made by the CGPM. [16] The CIPM is supported by 10 consultative committees (CC) and the president of CCs is a member of the CIPM (other members are usually representatives of the NMIs). [17]

The organisation of the Metre Convention is given in **Fig. 1**.

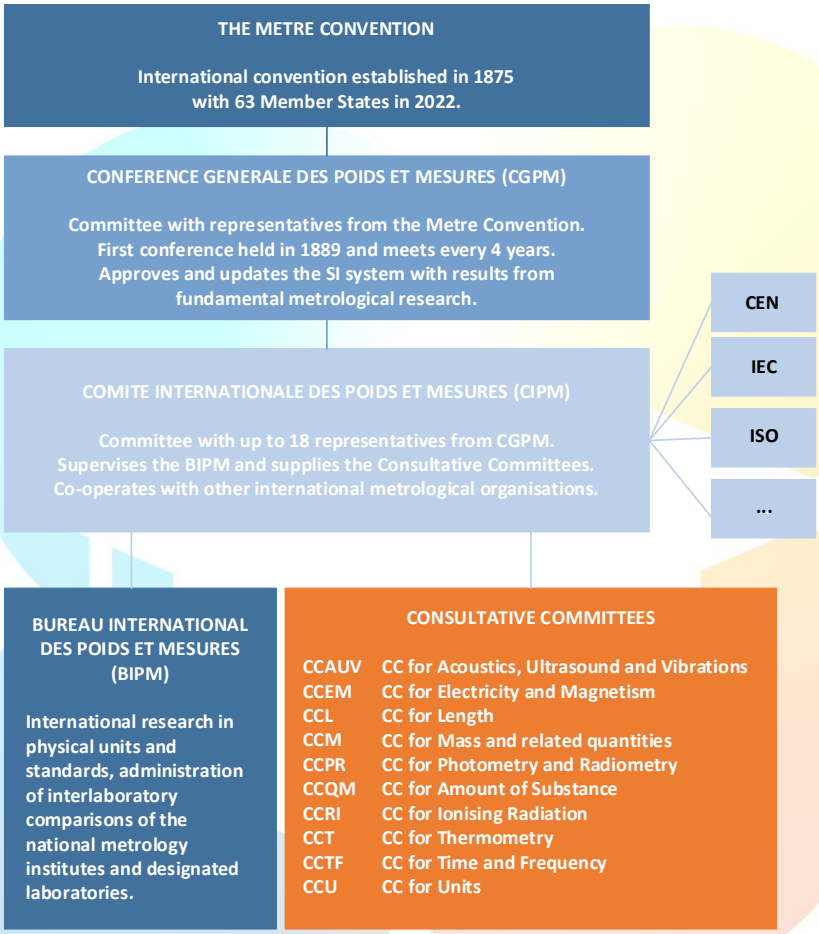

Fig. 1. The organisation of the Metre Convention [18]

[13] Ibid., pp. 29.
[14] Ibid., pp. 29.
[15] Ibid., pp. 29.
[16] Ibid., pp. 29.
[17] Ibid., pp. 29.
[18] Ibid., pp. 30.

The International Organisation of Legal Metrology (*Organisation Internationale de Métrologie Légale – OIML*) is an intergovernmental treaty organisation, established in 1955, at the Convention, and aims to ''enable economies to put in place effective legal metrology infrastructures that are mutually compatible and internationally recognised, for all areas for which governments take responsibility, such as those which aim to facilitate trade, establish mutual confidence and harmonise the level of consumer protection worldwide''. [19] At the end of 2022, the OIML had a total of 63 member countries and 64 corresponding member countries. [20]

To learn more about the OIML, please visit the following link:

- https://www.oiml.org/en

At the regional level, the collaboration among NMIs is coordinated by **Regional Metrology Organisations (RMOs)** whose main activities generally consist of: [21]

- comparisons of national measurement standards and activities of the CIPM MRA;
- cooperation in metrology research and development;
- facilitating traceability to primary realisations of the SI;
- cooperation in developing the metrological infrastructure of the member countries;
- joint training and consultation; and
- sharing of technical capabilities and facilities.

At the European level, **the European Collaboration in Measurement Standards (EUROMET)** was established in 1987 in Madrid, as a legal entity, to coordinate European metrology. [22] In 2007 **the European Association of National Metrology Institutes (EURAMET)** was established as a registered association of public utility under German law. [23] The EURAMET aims to coordinate the cooperation of European NMIs in the areas such as ''research in metrology, traceability of measurements to the *SI* units, international recognition of national

[19] OIML. (2023). What is the OIML?. Accessed on January 30, 2023. Retrieved from: https://www.oiml.org/en/about/about-oiml
[20] OIML. (2023). Our members. Accessed on January 30, 2023. Retrieved from: https://www.oiml.org/en/structure/members
[21] Howarth, P., Redgrave, F. (2008). Metrology – In Short (EURAMET, 3rd ed.), Accessed on October 27, 2022. Retrieved from: https://www.euramet.org/publications-media-centre/documents/metrology-in-short/?L=0, pp. 34.
[22] Erard, L. et al. (2006). Organisation of Metrology: Industrial, Scientific, Legal. In D., Placko (Ed.). Metrology in industry - The Key for Quality (1st ed.). London: ISTE Ltd., pp. 51.
[23] Howarth, P., Redgrave, F. (2008). Metrology – In Short (EURAMET, 3rd ed.). Accessed on October 27, 2022. Retrieved from: https://www.euramet.org/publications-media-centre/documents/metrology-in-short/?L=0, pp. 39.

measurement standards and related Calibration and Measurement Capabilities (CMC)''. [24] Through sharing knowledge, the EURAMET also aims to encourage the development of national metrology infrastructures. [25]

To learn more about the EURAMET, please visit the following link:

- https://www.euramet.org

The Western Europe Legal Metrology Cooperation (WELMEC) was established in June 1990 by a Memorandum of Understanding (MoU) for cooperation, following the development and the adoption of the first New Approach Metrology Directive – **the Non-automatic Weighing Instruments Directive (NAWID)**. [26] Initially signed by authorities from 18 countries, over the following years, WELMEC grew to an organisation with a total of 38 member organisations, 11 observer organisations, and nine corresponding organisations. [27]

To learn more about the WELMEC, please visit the following link:

- https://www.welmec.org/

At the national level, **National Measurement Institutes (NMIs)** are responsible for providing the compatibility of measurements. [28] It is their responsibility to provide the measurement capabilities needed within their economies and to maintain measurement capabilities at levels which provide comparability with institutes from other economies. [29] Still, in many economies (both developed and developing countries), access to appropriate high-level measurements for some quantities must be through NMIs from other economies. [30]

QI Diagnostics and Reforms Toolkit (Module 4), jointly developed by the World Bank Group and the National Metrology Institute of Germany, explores in detail scientific metrology, legal metrology, and industrial metrology and may be accessed freely via the following link:

- https://thedocs.worldbank.org/en/doc/481401553265353035-0090022019/original/Part2.Module4Metrology.pdf

[24] EURAMET. (2022).2022.). About EURAMET. Accessed on October 27, 2022. Retrieved from: https://www.euramet.org/about-euramet/.
[25] Ibid.
[26] WELMEC. (2022). About WELMEC. Accessed on January 30, 2023. Retrieved from: https://www.welmec.org/about-welmec/welmec-members/
[27] Ibid.
[28] ISO/UNIDO. (2010). Building trust. The Conformity Assessment Toolbox. Accessed on October 27, 2022. Retrieved from: https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/casco_building-trust.pdf, pp. 19.
[29] Ibid., pp. 19.
[30] Ibid., pp. 19.

SUMMARY

Metrology, the science of measurement, seems to be the oldest of three core components of QI. [31] Nowadays, metrology has become one of the most sophisticated sciences and one in which cooperation across the world is absolutely essential to maintain modern technology. [32] QI relies on a national measurement system that ensures that measurements are made with appropriate accuracy and reliability and may be related to other measurements made domestically or internationally. [33] This is essential to ensure the compatibility of trade and commerce. [34] Measurement also underpins testing as many items require calibration by specialist laboratories to ensure that such tests are traceable to international measurement standards. [35] Manufacturing also requires consistent and reliable measurements for the interoperability of components, as do measurements associated with traded commodities. [36] At the international level, the measurement science and measurement capabilities are coordinated by **the International Bureau of Weights and Measures (BIPM)**. [37] The BIPM is an intergovernmental organisation established by the Metre Convention through which Member States act together on matters related to measurement science and measurement standards. [38] At the regional level, the collaboration among NMIs is coordinated and administered by **Regional Metrology Organisations (RMOs)** whose main activities generally consist of: [39]

- comparisons of national measurement standards and activities of the CIPM MRA;
- cooperation in metrology research and development;
- facilitating traceability to primary realisations of the SI;
- cooperation in developing the metrological infrastructure of the member countries;
- joint training and consultation; and
- sharing of technical capabilities and facilities.

[31] Kellerman, M. (2019). Ensuring Quality to Gain Access to Global Markets (A Reform Toolkit). Accessed on October 27, 2022. Retrieved from: https://thedocs.worldbank.org/en/doc/249621553265195570-0090022019/original/FullQIToolkitReport.pdf, pp. 69.
[32] Ibid.
[33] ISO/UNIDO. (2010). Building trust. The Conformity Assessment Toolbox. Accessed on October 27, 2022. Retrieved from: https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/casco_building-trust.pdf, pp. 18.
[34] Ibid., pp. 18.
[35] Ibid., pp. 18.
[36] Ibid., pp. 18.
[37] Ibid., pp. 18.
[38] BIPM. (2023). Work Programme of the BIPM Headquarters for the four years 2024-2027. Accessed on January 30, 2023. Retrieved from: https://www.bipm.org/documents/20126/76321966/WP-2024-2027-EN.pdf/e67a1f42-8fa0-0b5c-4083-b639509a4a16?t=1673967995789
[39] Howarth, P., Redgrave, F. (2008). Metrology – In Short (EURAMET, 3rd ed.), Accessed on October 27, 2022. Retrieved from: https://www.euramet.org/publications-media-centre/documents/metrology-in-short/?L=0, pp. 34.

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[40] ISO/UNIDO. (2010). Building trust. The Conformity Assessment Toolbox. Accessed on October 27, 2022. Retrieved from: https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/casco_building-trust.pdf, pp. 19.
[41] Ibid., pp. 19.
[42] Ibid., pp. 19.

GLOSSARY

General Conference on Weights and Measures (CGPM)

meets to discuss the work done by the NMIs and the BIPM and gives recommendations on the new fundamental metrological determinations and all major issues of concern to the BIPM [43]

International Bureau of Weights and Measures (BIPM)

was established in 1875, at the Convention, as a permanent scientific institute [44]

International Committee for Weights and Measures (CIPM)

supervises the BIPM on behalf of the CGPM and co-operates with metrology organisations [45]

Designated Institutes (DIs)

other institutes (excluding NMIs) that also hold recognised national standards in that country may also be designated and participate in the CIPM MRA through the signatory NMI [46]

European Association of National Metrology Institutes (EURAMET)

was established in 2007 as a registered association of public utility under German law [47]

European Collaboration in Measurement Standards (EUROMET)

was established in 1987 in Madrid, as a legal entity, to coordinate European metrology [48]

[43] Howarth, P., Redgrave, F. (2008). Metrology – In Short (EURAMET, 3rd ed.), Accessed on October 27, 2022. Retrieved from: https://www.euramet.org/publications-media-centre/documents/metrology-in-short/?L=0, pp. 29.
[44] Ibid., pp. 29.
[45] Ibid., pp. 29.
[46] Ibid., pp. 31.
[47] Ibid., pp. 31.
[48] Erard, L. et al. (2006). Organisation of Metrology: Industrial, Scientific, Legal. In D., Placko (Ed.). Metrology in industry - The Key for Quality (1st ed.). London: ISTE Ltd., pp. 51.

National Measurement Institutes (NMIs)

are responsible for providing the compatibility of measurements at the national level [49]

International Organisation of Legal Metrology (OIML)

an intergovernmental treaty organisation, established in 1955, at the Convention, and ''aims to enable economies to put in place effective legal metrology infrastructures that are mutually compatible and internationally recognised, for all areas for which governments take responsibility, such as those which facilitate trade, establish mutual confidence and harmonise the level of consumer protection worldwide'' [50]

Regional Metrology Organisations (RMOs)

are responsible for coordination and administration of the collaboration among NMIs [51]

Western Europe Legal Metrology Cooperation (WELMEC)

was originally established in June 1990 by a Memorandum of Understanding (MoU) [52]

[49] ISO/UNIDO. (2010). Building trust. The Conformity Assessment Toolbox. Accessed on October 27, 2022. Retrieved from: https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/casco_building-trust.pdf, pp. 19.
[50] OIML. (2023). What is the OIML?. Accessed on January 30, 2023. Retrieved from: https://www.oiml.org/en/about/about-oiml
[51] Howarth, P., Redgrave, F. (2008). Metrology – In Short (EURAMET, 3rd ed.), Accessed on October 27, 2022. Retrieved from: https://www.euramet.org/publications-media-centre/documents/metrology-in-short/?L=0, pp. 34.
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Kellerman, M. (2019). Ensuring Quality to Gain Access to Global Markets (A Reform Toolkit). Accessed on October 27 2022. Retrieved from: https://thedocs.worldbank.org/en/doc/249621553265195570-0090022019/original/FullQIToolkitReport.pdf

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