

Internationally Harmonized and Reliable Measurements:

Inevitabilities for the Sustainable Development and International Competitiveness of a Modern State

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THE ROLE OF A NATIONAL METROLOGY INSTITUTE IN MODERN SOCIETY:

The Metrology Institute of the Republic of Slovenia challenged by present and future measurement needs in the country

Dr Ivan Skubic, Director of the Metrology Institute of the Republic of Slovenia

In developed economies, and in particular countries struggling for existence or for penetration into demanding international markets (Slovenia included), measurement-related activities represent a 3–6 percent share of GDP. In order to ensure adequate traceability of these measurements (including measurements in chemistry) to the prescribed and internationally agreed SI (or if not possible, to other agreed) units, Slovenia needs a well-functioning metrology system.

In any country, especially a developed country, the national metrology institution and the metrology system constitute its key technical quality infrastructure. Although metrological activities are often in the background of other activities, there can be no quality of life (e.g. environment, food, health, technical safety), no quality of Slovenian products and services, no progress and no co-operation with other countries without them. The Slovenian metrology system has therefore from the very beginning established close links with the most advanced metrology systems in Europe

METROLOGY: a scientific discipline and infrastructure at the same time

Prof Dr Janko Drnovšek, Chairman of the Metrology Board

Metrology in the European area represents technical infrastructure directly linked to the implementation of directives and hence to the operation of the common European market. On the other hand, metrology is inevitably linked to science and research, from where it actually emerged.

The synergy which has built up over the last years under the umbrella of EUROMET is certainly a key motivator in promoting metrology even further at a time when the field cannot survive in isolation. Obvious proof is the iMERA project, in which all major metrology institutes came together, forming a consortium consisting of European metrology institutes, large and small, cooperating on equal basis. This is of utmost importance for Slovenia and other small countries.

A common European research area, called ERA, is being implemented in various fields. Metrology has already been pivotal in common European projects and welcomes this mutual cooperation of the majority of European national metrology institutes and, generally speaking, European governments.

Implementation of the Metrology European Research Area (iMERA) as an ERA-NET 6th Framework Programme is a project with high expectations. Fusion and sharing of scientific metrology resources for basic and applied research is certainly one of the project's key goals; however, this goal can only be reached if the needs of all stakeholders can be satisfactorily met. The biggest national institutes, which had already led the basic research in metrology, will appreciate the niche expertise of other NMIs since only the complete picture of knowledge, both basic and applied, is a guarantee for metrology to efficiently and successfully implement its fundamental mission of serving the market in the broadest sense with accurate and traceable measurements in all areas.

EUROMET, a European collaboration for measurement standards, is one of the most active European associations in the area of measurement and testing, in which Slovenia actively participates in eight out of ten subject areas. In a number of research projects, Slovenia is taking an active role due to the close relations between the national metrology system and the research sector. The Metrology

and the world in order to acquire knowledge and ensure traceability, to contribute to international comparisons, as well as to participate in joint projects.

The Metrology Institute of the Republic of Slovenia (MIRS) plays the central role in the Slovenian metrology system, covering both scientific and legal metrology. In implementing its mission, MIRS closely collaborates with Slovenian universities as well as with research and other institutes. It is

also a participating member in various international organizations in the field of metrology and related activities, both in Europe (EUROMET, WELMEC, AEAO) and worldwide (Meter Convention, OIML, ISO/REMCO).

Being aware of the importance of metrology for the successful and sustained development of the country, MIRS, as a national institution, systematically collects and analyzes national needs in its fields of activity, and through a clear definition of

Institute of the Republic of Slovenia (MIRS), part of the Ministry of Higher Education, Science and Technology, co-ordinates metrology activities nationally and represents the metrology system of Slovenia internationally.

As an advisory body to the minister responsible for Metrology, a Metrology Board was established in order to provide an adequate scientific basis and to define national priorities in metrology in Slovenia. The Board works closely with MIRS and co-operates with corresponding bodies elsewhere.



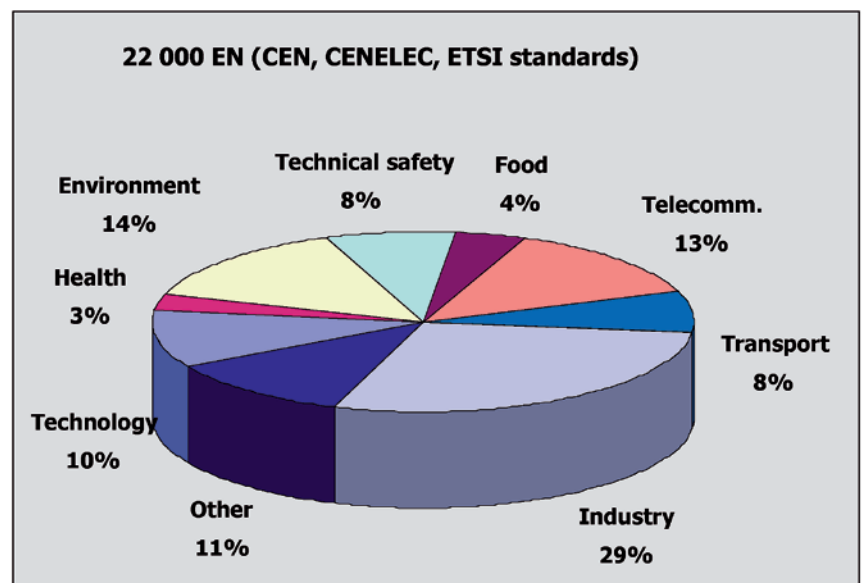
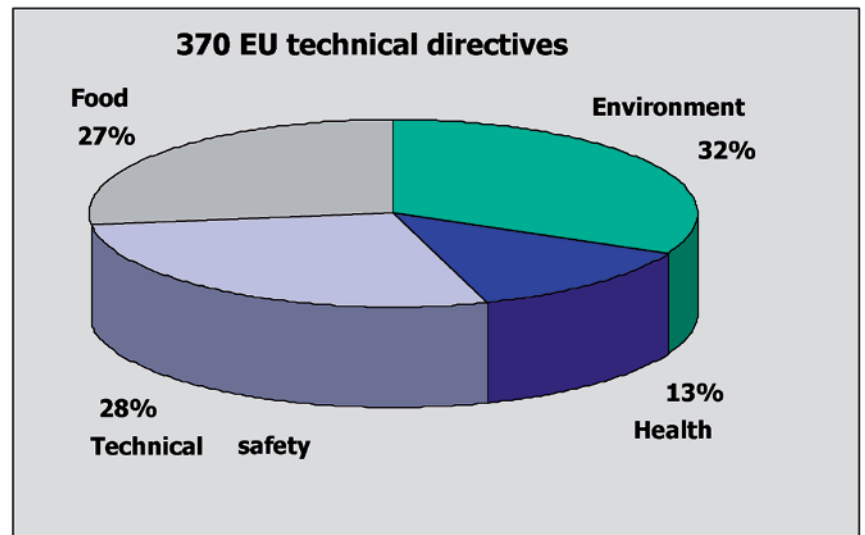
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priorities and by taking into account the characteristics of the systems it manages, efficiently provides appropriate Environmenttechnical services.

National implementation of almost 400 EU technical directives and several thousand EU technical standards in all relevant sectors (see Fig. 1) requires confident and precise measurements. Besides, the quality of Slovenian products and services demanded by customers requires even more

institute is of fundamental importance for successful implementation in this respect. In order to achieve international recognition and to demonstrate full international compatibility and professional competence, MIRS, together with co-operating institutions responsible for national and reference measurement standards, is active in implementing the CIPM MRA through co-operation in many EUROMET (currently 30) inter-comparisons and other projects. In addition, for optimal results in harmonizing the national metrology system with advanced European solutions, MIRS is participating in various projects, especially those of the European Framework Programme and other EU and international projects. In order to fulfil its basic mission, MIRS,

Fig. 1 EU technical directives (without amendments) and EU technical standards, implementation of which requires accurate and confident measurements.



The Metrology Institute of the Republic of Slovenia – Mission Statement

MIRS, the National Metrology Institute of the Republic of Slovenia, is responsible for establishing and managing the national metrology system, which:

- ensures the international compatibility of Slovenia;
- ensures protection of health, environmental protection, general technical safety and consumer protection to the residents of the Republic of Slovenia;
- enables the Slovenian economy to attain global competitiveness.

Responsibilities of the Metrology Institute of the Republic of Slovenia:

- preparing and implementing metrology strategy;
- establishing the national measurement standards system;
- functioning as the national metrological laboratory for specific physical quantities;
- proposing and defining priorities in selecting and financing R&D projects related to metrology;
- managing the legal metrology system;
- managing the precious metals system;
- collaborating with international and other organizations as the representative of Slovenia's national metrology service.

together with co-operating institutions responsible for national and reference measurement standards, provides adequate measurement traceability for the needs of all relevant sectors and ensures adequate knowledge transfer where additional education and training in metrology is needed

or where complex or important measurement problems have to be solved.

MIRS is also responsible for managing the national legal metrology system, which covers measuring instruments used in the protection of human and animal health, protection of the environment and general technical safety, transactions in goods and services, and in proceedings before administrative and judicial authorities. The highest level of metrology, which must be assured by the Government and which is the responsibility of the national metrology institution, is not a market commodity, however. Its adequate functioning is in the public interest, and thus appropriate funding by the Government, at least in the key areas of national need, is of crucial importance to the normal functioning of the entire State.

For the future, we must ensure a capable and flexible national metrology institute, capable of effective international co-operation and responsiveness

to the needs of society in both existing and newly emerging fields such as metrology in chemistry, nanotechnology, biotechnology, forensics and anti-fraud protection.

The achievements attained in setting up our national metrology system are the result of 15 years of endeavours, commitments and in-depth work of many individuals. Bearing in mind our vision to establish a fully functional metrology system in independent Slovenia, in accordance with our needs and capabilities, and to become the core of this system, we can claim today, on the fifteenth anniversary of the Slovenian metrology system, to have come a long, successful way towards our final goal.

MIRS, as the Slovenian national metrology institute, is well aware of its responsible role, and today's results represent a commitment to the future as well. On this occasion, I would like to express my sincerest thanks to all who through their fine work and efforts have contributed to the results we have achieved.

NATIONAL METROLOGY INFRASTRUCTURE IN

SLOVENIA: Strong co-operation among the Metrology Institute of the Republic of Slovenia, the universities of Ljubljana, Maribor and Primorska and various research institutes

The metrology system of Slovenia is organized under the Metrology Institute of the Republic of Slovenia (MIRS), the National Metrology Institute. Due to the specific requirements of a small country with very diverse needs for metrology across all sectors of society, a distributed metrology system has proven to be the most suitable solution. This dispersed system was established in order to use all available resources and potentials at various scientific and research institutions within Slovenia dealing with metrology. MIRS, as the responsible institution under the Metrology Act, facilitates and co-ordinates the operation of the entire system within which work in the area of scientific and legal metrology as well as analysis of precious metal alloys is organized. MIRS is also solely responsible for several metrological activities at the highest level. Metrological traceability at the highest metrological level in Slovenia is maintained by the laboratories responsible for national measurement standards, which constitute a uniform system, either

within MIRS or in close collaboration with MIRS.

Financially and in terms of expertise, scientific metrology is the most important and by far the most demanding metrological activity in Slovenia. For optimal use of resources, scientific metrological infrastructure, expertise and human resources are shared with legal and industrial metrology whenever possible.

It must be emphasized that legal metrology in EU candidate countries, such as Slovenia, has undergone serious changes, namely transition from overall obligatory type approvals and primary verifications to the new EU practice of one-stop testing. So legal metrology in the case of Slovenia is narrower in its scope of operation but at a significantly higher technical level, and hence it is closer to, and whenever possible shares resources with, the scientific metrology infrastructure, as already mentioned.

The Metrology Institute of the Republic of Slovenia, in respect of the "Rules on National Measurement Standards", has recognized six metrological laboratories for national measurement standards. The quality systems of the laboratories responsible for national measurement standards are in conformity with the SIST EN ISO/IEC 17025 standard. These laboratories, which represent a distributed system of Slovenian national measurement standards, operate within MIRS as well as in different co-operating institutions. Their quality systems are connected to the MIRS overall quality system, which is in conformity with SIST ISO 9001:2000. In this way, their uniform operation, based on the Rules on National Measurement Standards, is assured.

The National Standards of Electric Current and of Time and Frequency

**Slovenian Institute of Quality and Metrology – SIQ,
Tržaška 2, Ljubljana**

The Slovenian Institute of Quality and Metrology (SIQ) operates as an independent, impartial and non-profit organization in the field of metrology (responsible body for the national standards of electric current and of time and frequency, and a calibration laboratory), as well as in the fields of testing and certification of electrical and electronic devices, and assessment and certification of management systems.

The beginnings of SIQ activities go back to 1960, when a specialized industrial institute called the Institute of Automation was founded, which included the development units of the Iskra factories and became a common R&D organization for the entire Iskra group. In a special Measurement and Quality Department, as the central testing and metrology laboratory of Iskra, the Institute started systematically developing quality testing, measuring techniques

and maintenance of measuring instruments. This department later became an independent organization called the Institute of Quality Tests and Metrology (IKM), which was renamed the Slovenian Institute of Quality and Metrology (SIQ) in 1992. The SIQ is organized on the model of this type of institution in Europe and the rest of the world, and in accordance with the requirements of relevant standards.



The National Standard of Mass

The Metrology Institute of the Republic of Slovenia – MIRS

Mass Laboratory, Grudnovo nabrežje 17, Ljubljana

The priority activities of the Mass Laboratory, which operates within the Metrology Institute, are ensuring measuring traceability at the international level for the physical quantity of mass and value transfer to the mass standards of a lower hierarchical level in Slovenia. In order to obtain international recognition as the responsible body for the national standard of mass, the laboratory places key emphasis on inter-laboratory comparisons within the framework of the EUROMET organization, as well as with other national institutions. R&D work in the area of the physical quantity of mass



allows the laboratory to meet national needs and to maintain adequate proficiency.

Within specified terms of reference, the laboratory also provides other accredited services (calibration of weighing instruments) and performs the most complex tasks in legal metrology.

The National Standard of Thermodynamic Temperature

University of Ljubljana, Faculty of Electrical Engineering, Laboratory of Metrology and Quality, Tržaška 25, Ljubljana

The Laboratory of Metrology and Quality operates within the Faculty of Electrical Engineering of the University of Ljubljana. It was established in 1954 as the Laboratory of Electrothermics and has been operating as the Laboratory of Metrology and Quality since 1992. While the laboratory was developing, and because of the growing importance of quality assurance, it also started dealing with quality control. More than 700 investigations for domestic and foreign companies have been conducted by the laboratory, comprising more than 12,000 pages of documents. The laboratory staff also teach



and engage in scientific research within the Faculty.

The laboratory is the responsible body for the national standard of temperature and in addition is the calibration laboratory for temperature and humidity at the highest level in Slovenia. The laboratory was the first in Slovenia, and among the first in Europe, to pass an audit successfully under the new standard for calibration and testing laboratories, SIST EN ISO/IEC 17025.



The National Standard of Length

University of Maribor, Faculty of Mechanical Engineering, Laboratory for Production Measurement, Smetanova 17, Maribor

The Laboratory for Production Measurement has been operating within the Institute of Production Mechanical Engineering of the Faculty of Mechanical Engineering at the University of Maribor since 1968. From the very beginning, the laboratory has been involved in research and development as well as educational work and services in the field of production measurement (measurement of the geometry of work pieces in production) and quality assurance.

The laboratory traditionally cultivates close contacts with Slovenian companies (especially in the metalworking and other industries), helping them to solve practical problems of dimensional measurement. The laboratory conducts research and development projects and provides consulting and training of staff in industry. In addition to maintenance of the national standard, the Laboratory's infrastructure also allows the calibration of standards of length and measuring equipment for the verification of legal measuring instruments.

The laboratory has so far carried out 70 complex R&D tasks within the framework of national and international R&D programs. The bibliography of the laboratory's associates comprises over 300 different publications.

Metrology in Chemistry

Measurement in chemistry is considered to be one of the most extensive and complex fields of metrology. Appropriate support to the national reference laboratories in ensuring adequate traceability, taking into account the needs and priorities of all relevant sectors (environmental protection, protection of health, food, industry ...) is one of the important strategic assignments of the Metrology Institute (MIRS) as required by law. In addition, proper implementation of European technical directives from the stated sectors is of essential importance, not only because of our envisaged future within the EU and general globalization, but also for the quality of each Slovenian's everyday life in the broadest possible sense.

The responsibilities of MIRS in relation to metrology in chemistry are thus related to the following tasks:

- preparation and implementation of the national metrology strategy in chemistry;
- preparation and implementation of policy concerning the use of certified reference materials and reference materials;

- preparation and implementation of policy concerning participation of Slovenian chemical laboratories in inter-laboratory comparisons;
- managing and coordinating the participation of Slovenian chemical laboratories in inter-laboratory comparisons;
- functioning as the national standard laboratory for analysis of precious metal alloys and certain other measurements in chemistry;
- proposing and defining priorities in selecting and financing R&D projects related to metrology in chemistry;
- managing the legal metrology system related to measurement in chemistry;
- preparation of national legislation concerning metrological topics in chemistry;
- proper implementation of European technical directives;
- dissemination of metrological knowledge to analysts and end users of the results;
- collaboration with European and international organizations and representing the national metrology service in these groups;
- active participation in joint EU projects within the 6th Framework Programme of the EU.

Certain specific characteristics of measurements performed in chemistry (like various sample matrixes from environmental, food, clinical and forensic sectors) obviously require similar but distinct metrological infrastructures for chemistry and physical quantities, with clearly defined responsibilities for all parties involved. The main bodies in the national metrological infrastructure in chemistry are the Metrology Institute of the Republic of Slovenia (MIRS), field and reference laboratories, Slovenian Accreditation (SA), Slovenian Institute for Standardization (SIST), universities, research institutes, various regulatory bodies and other end users of the results.

Specific national needs and establishing compatibility with international requirements have imposed certain priorities, among which tasks related to setting up a sound dispersed national metrological infrastructure in chemistry and defining policy in relation to certified reference materials (CRM) and other reference materials (RM) as well as inter-laboratory comparisons are considered the highest.

Research and development activities concerning metrology in chemistry are devoted mainly to detailed studies of various traceability aspects which are still not fully clear and remain debatable in chemistry. Establishing and developing a proper understanding of uncertainty is another important topic, in which international recognizable concepts, as well as specific national needs concerning measurement capabilities, must be taken into account.

At the international level, activities related to traceability in support of research and industry are realized within the EUROMET subject area METCHEM (Metrology in Chemistry), while active participation in ISO/REMCO (ISO Committee on Reference Materials) enables our experts to take part in policy-making related to certified reference materials.

A great deal of effort is constantly being devoted to dissemination of knowledge about the metrological aspects of analytical chemistry. Cooperation with the Institute for Reference Materials and Measurements of the Joint Research Centre of the European Commission (EC-JRC-IRMM)

is extremely valuable, resulting in the organization of various events (e.g. roundtable discussions, think shops, workshops) among which courses in the framework of



TrainMiC (International Centre for Training in Metrology in Chemistry) are of particular importance. Active participation in and/or the organization of numerous international and national meetings, as well as publishing scientific and expert papers in *Messages*, *Acta Chimica Slovenica* and other relevant scientific journals, are also among our essential strategic orientations.

The National Standard of Amount of Substance

**The Metrology Institute of the Republic of Slovenia – MIRS
Laboratory for Analytical Chemistry, Grudnovo nabrežje 17, Ljubljana**

In conformity with the Precious Metal Articles Act (Official Gazette of RS no. 04/06), MIRS functions as the national institution responsible for systematic regulation in the area of precious metals. The MIRS Department for Precious Metals is the leading national laboratory responsible for the chemical analysis of precious metals and maintaining the national standard. Via the application of recently updated measurement equipment (ICP-AES, XRF) for the determination of the volume of precious metals, including recommendations of quality assurance and good laboratory practice, the traceability of measurements of the volume of precious metals at the highest international level has been achieved. The laboratory, organized at the top scientific level, performs R&D work in the field of chemical analysis of precious metals and supports other analytical chemistry laboratories concerned with assaying and determination of precious metals. In addition, quick and accurate performance of chemical analysis and hallmarking service is offered to customers along with control of production.

The laboratory is a full member of the AEAO, Association of European Assay Offices, which enables effective collaboration in various inter-laboratory comparison tests.



Reference alloys for XRF determination of the amount of precious metals

The National Institute of Chemistry – KI

Laboratory for Water Chemistry, Biology and Technology, Hajdrihova 19, Ljubljana

The National Institute of Chemistry is an internationally recognized research organization in the field of chemistry and its related disciplines. It was established in 1946 as the Chemistry Laboratory of the Slovenian Academy of Arts and Sciences. Today, it is a public institution for scientific research and development activities.

Development of analytical, physical-chemical and biological methods for pollution evaluation of surface water is an important activity of the Laboratory for Waste Chemistry, Biology and Technology, which also maintains the national standard for amounts of substances in surface and waste water.