

Organizations for Standardization of Quantities and Units

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Abstract. Many international organizations have contributed to the development of the International System of Units (SI). The highest international authority on units is the General Conference on Weights and Measures (CGPM), which is an intergovernmental body. Legal aspects of units and metrology are dealt with by the International Organization of Legal Metrology (OIML), whereas scientific questions in this field are dealt with by scientific unions such as the International Union of Pure and Applied Physics (IUPAP), and the International Union of Pure and Applied Chemistry (IUPAC). Among their many tasks the international standards organizations, i.e. the International Organization for Standardization (ISO), and the International Electrotechnical Commission (IEC), implement the SI as adopted by the CGPM. They also standardize quantities, i.e. their definitions, names, and letter symbols. The main purpose of this article is to present these two organizations for standardization and to describe their role in the standardization of quantities and units.

1. Introduction

The world's highest authority on units of measurement is the *General Conference on Weights and Measures* (Conférence Générale des Poids et Mesures, CGPM). The CGPM controls, via the *International Committee for Weights and Measures* (Comité International des Poids et Mesures, CIPM), the *International Bureau of Weights and Measures* (Bureau International des Poids et Mesures, BIPM), which is an intergovernmental organization established through the *Metre Convention* (Convention du Mètre). The Convention du Mètre was signed by seventeen countries in Paris in 1875.

It was the CGPM which in 1960 adopted the *International System of Units* (Système International d'Unités, SI). The SI is founded on a system of quantities. Quantities and systems of quantities are, however, outside the scope of the CGPM.

Legal aspects of units and measurements are dealt with by the *International Organization of Legal Metrology* (Organisation Internationale de Métrologie Légale, OIML). This was established in 1955 and is also an intergovernmental organization based on an international convention. The OIML consists of the *International Conference on Legal Metrology* (Conférence Internationale de Métrologie Légale), which controls, via the *International Committee of Legal Metrology* (Comité International de Métrologie Légale, CIML), the *International Bureau of Legal Metrology* (Bureau International de Métrologie Légale, BIML).

There exist many international scientific unions representing different professional groups. Among these, working for the propagation of the SI, should be noted the *International Union of Pure and Applied Physics* (IUPAP) and the *International Union of Pure and Applied Chemistry* (IUPAC).

The standardization of quantities and the system of quantities, on which the SI is founded, is dealt with by the *International Organization for Standardization* (ISO) and its Technical Committee number twelve, ISO/TC 12, *Quantities, units, symbols, conversion factors*. The ISO was established in 1946 and was given a consultative status to the *United Nations* (UN) through the *United Nations Conference on Trade and Development* (UNCTAD) in 1948. ISO/TC 12 was created in 1947.

The standardization of quantities and units for electricity and magnetism began long before the ISO was founded. The *International Electrotechnical Commission* (IEC) was formed in 1906, and the first item on its agenda was the standardization of units. It was the IEC which in 1938 adopted the MKSA (metre, kilogram, second, ampere) system on which the SI was later founded.

In this article, the intergovernmental organizations BIPM and OIML, and the international scientific unions IUPAP and IUPAC, are presented very briefly to show their role in the global framework. The main purpose of the article is to present the two international organizations for standardization, ISO and IEC, their history, their structure and their role in the standardization of quantities and units.

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2. Intergovernmental Organizations

2.1 Introductory remarks

In most countries the system of units of measurement for trade and industry is governed by law. The practical realization of the most commonly used units is controlled by public authorities in each country. In order to coordinate and harmonize these activities on a global level the intergovernmental organizations, the BIPM and the OIML, were established. These two organizations are briefly presented in this section.

2.2 BIPM – CGPM – CIPM

The *International Bureau of Weights and Measures* (Bureau International des Poids et Mesures, BIPM) was set up by the *Metre Convention* (Convention du Mètre), signed in Paris (FR) on 20 May 1875, and is situated in the Pavillon de Breteuil in Sèvres, just outside Paris. Its upkeep is financed jointly by the member states of the Metre Convention. As of 1 January 1994, there were forty-seven member states. The main task of the BIPM is to ensure world-wide harmonization of physical measurements including units of measurement. In accordance with the Metre Convention, all these units promoted by the BIPM are based on the Metric System, which was established during the French Revolution in the 1790s.

The BIPM operates under the exclusive supervision of the *International Committee for Weights and Measures* (Comité International des Poids et Mesures, CIPM), consisting of eighteen scientists from separate member states.

The CIPM meets every year. It closely follows the scientific activity and financial situation of the BIPM and has set up since 1927 nine *Consultative Committees* (Comités Consultatifs) to follow and advise on the various fields of experimental or theoretical activity at the BIPM. This activity has grown rapidly owing to the increasing complexity of the definitions and the realizations of the SI units.

One of these committees is the *Consultative Committee for Units* (Comité Consultatif des Unités, CCU), whose membership includes representatives from national laboratories, and international standardization bodies and scientific unions.

The CIPM operates under the authority of the *General Conference on Weights and Measures* (Conférence Générale des Poids et Mesures, CGPM) consisting of delegates appointed by the governments of all the member states of the Metre Convention and which meets at present every four years. The responsibilities of the CGPM are:

- (a) to make the necessary arrangements to assure the propagation and improvement of the *International System of Units* (Système International d'Unités, SI), the successor to the Metric System;

- (b) to confirm the results of new fundamental metrological determinations;
- (c) to adopt important decisions concerning the organization and development of the BIPM;
- (d) to elect members of the CIPM;
- (e) to vote on the budget for the coming four years.

2.3 OIML – BIML – CIML

The *International Organization of Legal Metrology* (Organisation Internationale de Métrologie Légale, OIML) is based on an international convention signed by thirty-seven countries in 1955. (As opposed to the Metre Convention, this convention is not known by a special name.) As of 1 January 1994, the number of member countries was fifty-one and the number of correspondent-member countries forty. The main purposes of this intergovernmental organization are:

- (a) to determine the general principles of legal metrology;
- (b) to study the problems of legal metrology of a legislative and regulatory character;
- (c) to establish model draft laws and regulations for measuring instruments.

The bodies of this organization are:

- (a) the *International Bureau of Legal Metrology* (Bureau International de Métrologie Légale, BIML), situated in Paris (FR);
- (b) the *International Committee of Legal Metrology* (Comité International de Métrologie Légale, CIML);
- (c) the *International Conference on Legal Metrology* (Conférence Internationale de Métrologie Légale) together with various technical committees (Pilot Secretariats and Reporting Secretariats).

2.4 Concluding remarks

The BIPM and the OIML are situated just outside and in Paris, respectively. French is the official language of the two organizations. In order to make the content of decisions and recommendations more readily accessible for a greater number of readers, English-language translations are published of all important documents. However, these English translations are not to be considered as official text. In case of dispute, it is always the French text which is authoritative.

3. Scientific Unions

3.1 ICSU and CODATA

Scientists of different disciplines have come together in many countries and formed national scientific

unions for their respective fields, such as physics, chemistry, mechanics, astronomy and the life sciences. The national unions have in their turn founded an international union for each field, such as the *International Union of Pure and Applied Physics* (IUPAP), the *International Union of Pure and Applied Chemistry* (IUPAC) and the *International Union of Theoretical and Applied Mechanics* (IUTAM). All these international scientific unions work under the umbrella of the *International Council of Scientific Unions* (ICSU).

There are also some committees working inside ICSU, e.g. the *Committee on Data for Science and Technology* (CODATA) and the *Committee on Space Research* (COSPAR). For the subject of this article CODATA is the most interesting committee. It is an interdisciplinary committee, which deals with data of importance to science and technology, their compilation, critical evaluation, storage and retrieval. Its scope includes quantitative data on the properties and behaviour of matter, characteristics of biological and geological systems, and other experimental and observational data. CODATA covers all disciplines represented by the member unions of ICSU, but its activities concentrate on problems which are common to the various disciplines.

The most important work of CODATA in the field of quantities and units is the determination of the fundamental physical constants. The most recent values are given in the *1986 Adjustment of the Fundamental Physical Constants*, CODATA Bulletin 63 (1986).

3.2 IUPAP

The IUPAP was created in 1922 in Brussels (BE). Its aims include:

- (a) the stimulation of international cooperation in physics;
- (b) the promotion of international agreements on the use of symbols, units, nomenclature and standards.

In each country the IUPAP is represented by a national committee. The number of member countries of the IUPAP was forty-three on 1 January 1994. The General Assembly directs the work of the Union, appoints the Executive Committee and sets up commissions pertinent to the work of the Union.

In 1931 the *Commission for Symbols, Units and Nomenclature* (SUN Commission) was created to promote international agreement and make international recommendations in the field of symbols, units and nomenclature. In 1978 the IUPAP decided to amalgamate the SUN Commission with its *Commission on Atomic Masses and Fundamental Constants*. The most recent publication is IUPAP 25 (1987) entitled *Symbols, Units, Nomenclature and Fundamental Constants in Physics*, published in 1987.

3.3 IUPAC

The IUPAC, established in 1919, is the international body which represents chemistry among the other disciplines of science. Its objectives are:

- (a) to promote continuing cooperation among the chemists of its member countries;
- (b) to study topics of international importance to pure and applied chemistry which need regulation, standardization or codification;
- (c) to cooperate with other international organizations which deal with topics of a chemical nature;
- (d) to contribute to the advancement of pure and applied chemistry in all its aspects.

As of 1 January 1994, there were forty member countries and, in addition, fourteen observer countries. The IUPAC also has an affiliate-membership scheme in which more than 5 000 chemists are enrolled. The work of IUPAC is directed by its General Assembly which meets biennially, appoints an Executive Committee, and sets up relevant Commissions. The IUPAC has its Secretariat in Oxford (GB).

The IUPAC is recognized throughout the world as the international authority on chemical nomenclature, terminology, symbols, the molar masses of the elements and related matters. Its Commission I.1 of the *Division of Physical Chemistry, on Symbols, Terminology and Units*, is chiefly responsible for recommendations relevant to the work of ISO/TC 12, but other Commissions (especially Commission VII.2 *Quantities and Units of the Division of Clinical Chemistry*) also contribute to the field. Their work is correlated by the *Interdivisional Committee on Nomenclature and Symbols* (IDCNS). The most recent publication on quantities and units is *Quantities, Units and Symbols in Physical Chemistry* (International Union of Pure and Applied Chemistry, Blackwell Scientific Publications, Oxford, 1993).

3.4 Concluding remarks

The IUPAP and the IUPAC participated very actively in the development of different metric unit systems, IUPAP mainly in the field of mechanics, heat and electromagnetism, and IUPAC in the field of chemistry. The IUPAC especially played an active part in the discussions that took place before the inclusion of the mole in the SI as the base unit for amount of substance. They are both represented in the CCU.

Today IUPAP and IUPAC play an important role by disseminating the SI to the scientific community through their above-mentioned publications.

4. International Organizations for Standardization

4.1 ISO and IEC

There exist two organizations for global standardization, the *International Organization for Standardization* (ISO) which works in all fields except electrotechnology, and the *International Electrotechnical Commission* (IEC) for standardization in the electrotechnical field. Members of the ISO and the IEC are the national standards bodies of some ninety countries and fifty countries, respectively. The ISO and the IEC serve to facilitate the development of global consensus agreements on International Standards. They are non-governmental organizations, and their standards are voluntary in nature, which means that they have to be good enough for industry and service organizations to find them advantageous and to apply them. The ISO and IEC international standardization process operates approximately 900 technical committees (TC) and subcommittees (SC) of national delegations from the member countries; each committee is responsible for one technical field. The TCs and SCs have established some 3 000 working groups (WG) of experts. The work of these committees and working groups results in the publication of some 900 new or revised International Standards every year. The Central Secretariat of the ISO and the Central Office of the IEC are situated next to each other in Geneva (CH).

The primary function of the ISO and the IEC is to provide a mechanism through which people can work together when they need international agreements. The structures and rules of operation are contained in a basic organizational document, the *ISO/IEC Directives*, which consists of three parts. The structure of the technical work is built around the TCs and SCs, each of which is managed by a chairman and a secretariat assigned to one of the member countries.

Draft International Standards (DIS) adopted by the TCs are circulated to all member bodies of the ISO and the IEC, for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

4.2 ISO – ISO/TC 12

In 1926 the *International Standards Association* (ISA) was founded in New York (US). Sixteen European countries were members of the ISA together with the USA and Japan. The ISA worked mainly in the field of mechanical engineering; it ceased to operate when the Second World War broke out in 1939.

The ISO was created in February 1947 as the result of a conference attended by representatives of twenty-five national standards bodies and held in London (GB) in October 1946. At the same conference, the ISA was dissolved after seven years of inactivity. One of the first subjects for standardization within the ISO was quantities, units, symbols and nomenclature in physics,

chemistry, technology and mathematics. This became the scope of the Technical Committee number twelve, ISO/TC 12, *Quantities, units, symbols, conversion factors and conversion tables*, which was established in 1947. Later, in the 1980s, when pocket calculators had become very common, “and conversion tables” was deleted from the title. In 1948 the *Danish Standards Association* (Dansk Standardiseringsråd, today named Dansk Standard, DS) agreed to act as the Secretariat for this committee.

Prof. Torkild Bjerger from the Technical University in Copenhagen (DK), together with the Secretary of ISO/TC 12, Mrs Vibeke Simonsgaard, made up a “Proposal of the Secretariat for the first meeting of the committee”. This was structured very much like the present International Standard with an Introduction and eight Tables with quantities: Space and time; Periodic and aperiodic phenomena; Mechanics; Heat; Electricity and magnetism; Light; Sound; Chemistry and atomic physics. For each quantity the name, symbol and definition were specified; likewise the name, symbol and definition were specified for each unit.

As regards the unit systems it was stated: “The MKSA or Giorgi system is recommended for universal use”. However, the so-called centimetre, gram, second, Franklin system and the centimetre, gram, second, Biot system, which had recently been accepted by the IUPAP, were also mentioned. The three-dimensional CGS system was mentioned, but not recommended.

The first Plenary Meeting of ISO/TC 12 took place in Copenhagen (DK) during six days in 1952. The result was very meagre, and it was decided to meet again in Copenhagen in 1953, also for six days. This time the result was even more disappointing. Following a proposal from the Secretariat it was therefore decided to appoint a small working group – the Advisory Panel – with six members from outside the Secretariat. When the Advisory Panel had agreed on a proposal regarding a group of quantities, this was submitted to the national ISO members for comments and voting, often more than once; when in doubt it was necessary to hold a Plenary Meeting.

The first Advisory Panel consisted, apart from the Chairman, Prof. Bjerger and the Secretary, Mrs Simonsgaard, of Prof. Jan de Boer (NL) (IUPAP and SUN Commission), Mr E. J. Le Fevre (GB), Prof. Ulrich Stille (DE), Mr A. Pallez (FR) and Prof. Emile Thomas (BE). Later others took over: Mr F. A. Gould (GB), Dr Hugh Wolfe (US), Mr Jean-Claude Courtier (FR), Prof. Max L. McGlashan (GB) (IUPAC) and Prof. Sigmar German (DE).

In 1957 Prof. Henning Højgaard Jensen (DK) replaced Prof. Bjerger as the Chairman of the Advisory Panel. It was during a Plenary Meeting of ISO/TC 12, which was opened by Prof. Bjerger and chaired by him for the first day, that Prof. Højgaard Jensen was elected to succeed Prof. Bjerger. Then Prof. Højgaard Jensen

chaired the last three days of the Plenary Meeting and Prof. Bjerger continued as head of the Danish delegation.

The Advisory Panel had close connections with other organizations; several of the members were connected to the Metre-Convention bodies. Sometimes the Advisory Panel invited specialists in different fields. In particular a representative of IEC/TC 25 often took part in the discussions on electromagnetism.

ISO/TC 12 works on the standardization of both quantities and units in the whole of physics, chemistry and technology, except electrotechnology, and part of mathematics; it emphasizes quantity calculus, a formalism introduced more than a hundred years ago by J. C. Maxwell. It was given an axiomatic formulation by Wallot in 1922 and a thorough treatment by Ulrich Stille in his book *Messen und Rechnen in der Physik* (1955). Nevertheless quantity calculus has not yet been generally accepted. It is widely used in schools and by university students, but many advanced scientists are still inclined to use more home-made formulations.

In 1975 the number of parts of the International Standard ISO 31, *Quantities and units* had grown to the following fourteen:

- Part 0: *General principles*
- Part 1: *Space and time*
- Part 2: *Periodic and related phenomena*
- Part 3: *Mechanics*
- Part 4: *Heat*
- Part 5: *Electricity and magnetism*
- Part 6: *Light and related electromagnetic radiations*
- Part 7: *Acoustics*
- Part 8: *Physical chemistry and molecular physics*
- Part 9: *Atomic and nuclear physics*
- Part 10: *Nuclear reactions and ionizing radiations*
- Part 11: *Mathematical signs and symbols for use in the physical sciences and technology*
- Part 12: *Dimensionless parameters*
- Part 13: *Solid state physics*

However, in 1969 a different kind of document was published. This was ISO/R 1000, *Rules for the use of units of the international system of units and a selection of decimal multiples and sub-multiples of the SI units*. At that time the publications were called *Recommendations*, which is why the letter R appears before the number 1000. It was not until the 1970s that the name Recommendation was replaced by *International Standard*.

In ISO/R 1000 selected decimal multiples and sub-multiples of the SI units, and certain other units suitable for use with the SI, were recommended for general use. This recommendation, the idea of which was Vibeke Simonsgaard's own, was not very popular in the Advisory Panel at first, because it drew attention from the more complete series of ISO/R 31, *Quantities and units*. But Vibeke Simonsgaard had long planned for ISO/R 1000 and had made an agreement with the Secretary General of the ISO, at that time Mr Olle

Sturén from Sweden, to save the running number 1000 for this particular document. It subsequently became one of ISO's bestsellers.

In 1979 all International Standards published by ISO/TC 12, i.e. the fourteen parts of ISO 31 and ISO 1000, were collected in the ISO Handbook, *Units of Measurement*. A second edition of this Handbook was published in 1982 and contained the complete set of the latest International Standards from ISO/TC 12 handled by its first and famous Secretary, "Madame ISO", Mrs Vibeke Simonsgaard. Among these International Standards was the 1981 edition of ISO 1000, with the new title, *SI units and recommendations for the use of their multiples and of certain other units*.

The completion of ISO 31 and ISO 1000 coincided with the retirement of Mrs Vibeke Simonsgaard after thirty-five meetings of the Advisory Panel and eight Plenary Meetings of ISO/TC 12. In 1980 the Danish Standards Institution informed ISO that it wanted the Secretariat to go to another country and the Secretariat of ISO/TC 12 was transferred from Denmark in 1981. The choice for the new Secretariat fell on Sweden and the *Swedish Standards Institution* (Standardiseringskommissionen i Sverige, today named Standardiseringsen i Sverige, SIS), with Mr Anders J. Thor as Secretary. In 1986 Prof. Henning Højgaard Jensen was appointed the first Chairman of ISO/TC 12 after having served as Chairman of the Advisory Panel and as Chairman of all ISO/TC 12 Plenary Meetings since 1957.

In 1982 the new Secretariat started its work. It relied then on the same Advisory Panel as the earlier Secretariat. However, Technical Committee number 25 of the International Electrotechnical Commission, IEC/TC 25, *Quantities and units, and their letter symbols*, was now permanently represented on the Advisory Panel by its Chairman, Prof. Erna Hamburger. In 1988 the Secretary of ISO/TC 12, Mr Anders J. Thor, was appointed Chairman of IEC/TC 25 and the Secretary of IEC/TC 25, Dr Arthur McCoubrey, replaced Prof. Hamburger on the Advisory Panel of ISO/TC 12. Thus the harmonization of International Standards on Quantities and Units from ISO and IEC was guaranteed.

During 1991 Dr Chris Kuyatt replaced Dr McCoubrey as Secretary of IEC/TC 25 and on the Advisory Panel. Furthermore Dr Barry Taylor (US) and the Director of the BIPM, Dr Terry Quinn (GB) became members of the Advisory Panel in 1989 and 1993, respectively.

In 1983 the oldest parts of ISO 31 were five years old and therefore subject to periodic review according to rules laid down in the Directives. Three years later, in 1986, all parts of ISO 31 were subject to the five-year review and it was decided to carry out a complete revision. This was completed in 1992 when the latest editions of ISO 31 were published in English and French. All parts carried the same titles as earlier, except

Part 12, for which the title *Dimensionless parameters* was replaced by *Characteristic numbers*. The following year, 1993, all these International Standards, including a new edition of ISO 1000, were published in the third edition of the ISO Standards Handbook *Quantities and Units*.

The changes in the new editions were not extensive. One of the principal new items was the presentation of the quantities of dimension one, formerly inappropriately called "dimensionless quantities". It was explicitly stated that the coherent SI unit for all these quantities is the number one (1). In particular, the supplementary units in the SI, radian (rad) and steradian (sr), for plane angle and solid angle respectively, were treated as units of dimension one with special names. They were therefore included in the table of SI derived units with special names. Furthermore, about fifty new quantities and fifteen new mathematical signs and symbols were added without changing the structure of the different parts of ISO 31.

4.3 IEC – IEC/TC 25

The IEC is the organization responsible for all international standardization in the field of electrical technology. When founded, one of its principle tasks was to standardize the units for electromagnetic quantities.

During the latter part of the nineteenth century several international conferences were held on systems of electromagnetic units. This is described elsewhere in this issue of *Metrologia*. The different systems discussed were all founded on the base units centimetre, gram and second (CGS). In fact there has never existed any electrical unit system of practical importance based on the Imperial units, i.e. foot, pound, second, etc. Even the father of modern electromagnetism, James Clerk Maxwell from Great Britain, used CGS units. However, it turned out that it was not possible to have one coherent system with full symmetry between the electric and the magnetic units when using only three base units. This was shown by the Italian engineer Giovanni Giorgi in 1901, who proposed to add a fourth base unit to the system, one of an electrical nature. Giorgi first proposed the ohm as the fourth base unit, but the choice later fell on the ampere. At the same time he replaced the centimetre by the metre and the gram by the kilogram in order to preserve pre-existing derived units such as watt (W), volt (V), and the unit of force that later was given the name newton (N). At the same time he also rationalized the electromagnetic quantities. By introducing the factor 4π together with ϵ_0 and μ_0 in the expressions for the electric and magnetic fields, respectively, Giorgi made this factor disappear in all equations where it was not natural.

Giorgi's proposal – the Giorgi system or MKSA system – was discussed at several international conferences. At the sixth *International Electrical*

Congress in St Louis (US) in 1904 it was decided to create an international body, the International Electrotechnical Commission, to consider questions concerning standardization of nomenclature and units.

The IEC was founded at a constitutive meeting on 26 and 27 June 1906 in London, at which thirty-three representatives from sixteen countries were present. As early as 1908 it was appreciated by the Council of the IEC that it was desirable to standardize the letter symbols used in electrical technology.

In January 1914 the first edition of IEC Publication 27, entitled *International Symbols*, was published. It contained symbols for thirty-six quantities, sixteen units and seven mathematical signs. The second edition followed in February 1915 and was the subject of many revisions in the following years.

At a meeting in Scheveningen (NL) in 1935 the work on quantities and units within the IEC was reorganized and split between what later became three Technical Committees, known formerly as Advisory Committees, these being IEC/TC 1, *Nomenclature*; IEC/TC 24, *Electric and Magnetic Magnitudes and Units*; and IEC/TC 25, *Letter Symbols and Signs*. Later IEC/TC 24 and IEC/TC 25 were merged to form IEC/TC 25, *Quantities and units, and their letter symbols*.

Dr John Wennerberg from Sweden was appointed Chairman of a Sub-Committee for the purpose of revising IEC Publication 27. As a unique exception from the usual practice, Dr Wennerberg was left free to select his collaborators.

The Report from Dr Wennerberg was considered by IEC/TC 25 during the General Meeting of the IEC in Torquay (GB) in 1938. At that time Dr J. F. Meyer from the USA was the Chairman of IEC/TC 25, but he could not attend the meeting. The meeting was therefore chaired by Prof. Giovanni Giorgi, who had worked in close contact with Dr Wennerberg for several years. At this meeting Giorgi's rationalized MKSA system – the Giorgi system – was finally adopted by the IEC. In this system the new mechanical unit of force, the newton (N), replaced the old non-coherent unit kilogram-force (kgf), also called kilopond (kp) in some countries.

Because of the Second World War the work of IEC/TC 25 was delayed. The next meeting was not held until 1950 in Paris under a new chairman, Prof. Max Landolt from Switzerland. This led to the third edition of IEC Publication 27, now entitled *International Letter Symbols used in connection with Electricity*, published in 1953; the fourth edition was approved and published in 1964.

In 1969 Prof. Landolt died and Mr Olof Bager from Sweden was appointed Chairman of IEC/TC 25. In 1971 the fifth edition of IEC Publication 27-1 (now split into different parts) was published under the title *Letter symbols to be used in electrical technology* – Part 1: *General*. The other parts were issued later: Part 2: *Telecommunications and electronics*; Part 3:

Logarithmic quantities; Part 4: *Symbols for quantities to be used for rotating electrical machines*. Part 2: *Telecommunications and electronics* was first published in 1972 and was followed by several supplements. In 1974 the first edition of Part 3: *Logarithmic quantities*, was published.

Mr Bager's term of office as Chairman of IEC/TC 25 expired in 1980 and Prof. Erna Hamburger from Switzerland was appointed to succeed him. During Prof. Hamburger's chairmanship, Part 4: *Symbols for quantities to be used for rotating electrical machines*, was completed and was published in 1985. Prof. Hamburger also started a revision of Part 3: *Logarithmic quantities*. This revision was performed in close cooperation with the Secretary of ISO/TC 12, Mr Anders J. Thor.

Although IEC/TC 25 and ISO/TC 12 had already cooperated over many years, their presentations of logarithmic quantities were quite different from the point of view of principle. In practice, however, the difference between the two committees was not so large. In the revised, second edition of Part 3 two important sentences were added:

"For a complete definition of a logarithmic quantity, the base of the logarithm shall be specified."

and

"When coherence with the SI is required, natural logarithms shall be used."

At the same time ISO/TC 12 decided to treat the unit bel (B) as the main logarithmic unit and not the sub-multiple decibel (dB), which is much more commonly used. With these changes there were no remaining principal contradictions in the presentation of logarithmic quantities and units between IEC/TC 25 and ISO/TC 12. The basis for this agreement was reached at a Plenary Meeting of ISO/TC 12 in Washington D.C. in 1973, at which the Chairman of IEC/TC 25 participated.

Unfortunately Prof. Hamburger died in 1988 before the second edition of Part 3: *Logarithmic quantities*, was published, and later that year Mr Anders J. Thor was appointed to succeed her as Chairman

of IEC/TC 25. Since Prof. Hamburger had almost finished the revision of Part 3: *Logarithmic quantities*, the second edition could be published in 1989. The latest revision is that of Part 1: *General*, of which the sixth edition was published in 1992. This edition has been completed with general rules for using and printing quantities and units. These rules are in complete agreement with those given by ISO/TC 12 in ISO 31, *Quantities and units*.

Most of the time since the creation of IEC/TC 25 in 1935, the USA has been responsible for its Secretariat. The present Secretary of IEC/TC 25 is Dr Chris Kuyatt. Among the earlier Secretaries Mr Olof Bager, Dr Chester Page, Dr David Goldman and Dr Arthur McCoubrey should be mentioned.

4.4. Dissemination of international standards

The ISO and IEC do not serve only as tools to reach international agreements on difficult and important technical matters. Their most important function may be the fast and effective network they provide to spread the information contained in international standards. Here the different national standards organizations play an important role. They have access to all international standards, traditionally printed or in electronic form.

Basic standards, such as those on quantities and units, are generally translated into the different national languages, whereas standards in more specialized fields are often used without translation from the official ISO and IEC languages, i.e. English, French and Russian. From the national standards organizations national and international standards are distributed to industry, service organizations, schools and universities. Therefore, in most countries, international standards have a fast and effective impact on society.

Acknowledgement. In this article Henning Højgaard Jensen is mainly responsible for the text on ISO/TC 12 before its Secretariat was transferred from Denmark, and Anders J. Thor is responsible for the rest of the text.