Transference of physical unit dimension

Speaker: Olga V. Shemagonova
Belarusian State Institute of Metrology
93 Starovilensky tract, Minsk
220053, Belarus
Belgim@belgim.belpak.minsk.by
Phone: (+375)-017-233-62-63; Fax: (+375)-017-213-09-38

Authors: L. Astafjeva, O. Shemagonova
Belarusian State Institute of Metrology

Abstract

Assurance system of measurement uniformity of Belarus does work out ideology and documents for hierarchy schemes regarding international and regional requests.

Summary

A structure of measurement standard (MS) base of every country reflects the structure of the International System of Units based on the base unit MSs. Taking into account that a metrological foundation is a reproduction and conservation of the physical units therefore every country creates and develops their national MSs to provide its economic activities and to receive reliable and accurate results of measurements.

Measurement assurance system of Belarus

Nowadays in Belarus there is a measurement assurance system (MAS) of Belarus represented a coordinated and officially recognized organizational and science-technical system as well as a combination of instructions and regulations, standards and measuring instruments, body and services which activities aim at achieving a traceability and required accuracy of measurements.

One of the main MAS objective is a measurement assurance as one of the most important element of a single market of Belarus and a protection of inhabitants' interests from inaccurate and incorrect measurements.

One of the main MAS task is establishment, confirmation, maintenance and conservation of national standards as well as establishment of unified order of transference of physical unit dimension from national measurement standards (MSs) to other measuring instruments.

Measurement assurance activity in Belarus is regulated by legislative acts and normative documents and realized by the agencies of a state metrological service and notified bodies.

Measurement results carried out within MAS are expressed in legal units and have a traceability to national and international standards, declared level of accuracy and reliability. They are a basis to take a decision in economics, industry, science, trade, public health, environment control, product and natural resources assessment and supervision, safety, transport and other fields.

MAS includes legislative, theoretical, technical and organizational bases which consists of interconnected and cooperated with each other elements making completeness and uniformity of

the system. Technical bases are determined by reproducing of transference of physical unit dimension under carrying out tests, metrological certification and calibration of measurements instruments. [5]

Measurement standard base of Belarus

Measurement standard base of Belarus is concentrated in Belorussian state institute of metrology ensuring the highest accuracy of the base and derived SI units reproduction and its foundation consists of:

1. eleven standards:
   - national standard of time and frequency;
   - national standard of temperature value;
   - national standard of AC electric tension value;
   - national standard of DC electric tension value;
   - national standard of magnetic induction value;
   - national standard of spectral and directional transmittance and diffuse reflection position;
   - national standard of luminous intensity and illumination;
   - national standard of plane angle value - degree;
   - national standard of molar part of hydrogen in nitrogen;
   - national standard of kerma in air;
   - national standard of electric power value.
2. eight reference standards:
   - reference standard of mass;
   - reference standard of length within the range of 0.1-100 mm;
   - reference standard of AC electric resistance;
   - reference standard of pressure value;
   - reference standard of plane angle value in the field of small angles (second) in range of 0 – 1200";
   - reference standard of length value in the field of roughnesa parameter measurements;
   - reference standard in the field of deviation from linearity and planarity;
   - reference standard of force value.
3. over 40 000 working measuring instruments.

Analysis of normative documents on hierarchy schemes

In practice a measurement assurance principle is realized by transference of physical unit dimension from national MSs to other measuring instruments on the base of which there are hierarchy schemes established an standards hierarchy and accuracy of transference of physical unit dimension from standards to working measuring instruments. In hierarchy schemes it is also pointed a calibration procedure and corresponding devices.

Standards of the highest level are usually in the meteorological organisations which carry out a transference of physical unit dimension on the highest levels of schemes.

The lowest level of such schemes has a general character as it encloses a considerable group of measuring instruments which are combined by general metrological and sometimes structural attributes. These schemes are a base for establishment of hierarchy schemes of enterprises which use a large amount of different measuring instruments with two, three or more accuracy grade.

In Belarus contents and construction of hierarchy schemes are regulated by an intergovernmental normative document "GOST 8.061-80 " Verification schedules. Scope and layout." According to this document hierarchy schemes are subdivided into state, departmental and local ones depending on the fields of use.

The state hierarchy scheme applies to all measuring instruments of a given physical quantity which are used in the country. It establishes an order of transference of physical unit dimension from state standard to secondary standards and reference devices and then to working measuring instruments as well as the requirements to calibration devices and procedures. The state hierarchy scheme is as though "a metrological assurance frame of measurement type, structure of a plane of its further development and improvement". [4]

Departmental hierarchy schemes enclosed measuring instruments which are to be verified within specific field or department and local hierarchy scheme of separate enterprises are worked out on the base of the state hierarchy scheme. These hierarchy schemes specify the requirements of the state hierarchy scheme in conformity with a specific character of department or enterprises.[1,4]

On the international level the process of transference of physical unit dimension is regulated by international document №5 "Principles for the establishment of hierarchy schemes for measuring instruments" which is a base for all formers who works out hierarchy schemes [2].

There is 43 normative documents regulated a transference of physical unit dimension according to hierarchy schemes in Belarus. They are worked out and reviewed as it is required to establish and modernise the standards and develop the new methods of transference of physical unit dimension. These documents mainly have a level of intergovernmental normative documents (GOST) and represented intergovernmental hierarchy schemes.

Quantity of the normative documents established the requirements to the standards of base and derived SI units and state hierarchy schemes in the context of years is given in table 1 and in figure 1 of Appendix 1.

Table 1

Unit type	Quantity of the normative documents in the context of years						Total
	from 1971 to1975	from 1976 to 1980	from 1981 to 1985	from 1986 to 1990	from 1991 to 1995	from 1996 to 2000	
Base units	1	-	2	2	3	1	9
Derived units	3	7	10	9	3	2	34
Total	4	7	12	11	6	3	43

Quantity of the normative documents established the requirements to the standards of base and derived SI units and state hierarchy schemes in the context of unit types is given in table 2 and in figure 2 of Appendix 1.

Table 2

№	Unit		Quantity of the normative documents
	Name of quantity	Name and symbol of unit	
	BASE UNITS		
1	Mass	kilogram (kg)	1
2	Time	second (s)	1
3	Length	metre (M)	2
4	Electric current	ampere (A)	3
5	Thermodynamic temperature	kelvin (K)	2
6	Amount of substance	mole (mol)	0
7	Luminous intensity	candela (cd)	0
	DERIVED UNITS		
1	Plane angle	radian (rad)	1
2	Solid angle	steradian (sr)	0
3	Frequency	hertz (Hz)	1
4	Force	newton (N)	1
5	Pressure, stress	pascal (Pa)	9
6	Energy, work, quantity of heat	joule (j)	2
7	Energy flow rate, heat flow rate, power	watt (W)	6
8	Electric charge (quantity of electricity)	coulomb (C)	0
9	Electric potential, electric tension, electromotive forse	volt (V)	3
10	Electric capacitiance	farad (F)	2
11	Electric resistance	ohm (Ω)	1
12	Conductance	siemens (S)	0
13	Magnetic flux	weber (Wb)	1
14	Magnetic flux density, magnytic induction	tesla (T)	3
15	Inductance	henry (H)	1
16	Celsium temperature	ºC	2
17	Luminous flux	lumen (lm)	0
18	Illuminance	Lux (lx)	3
19	Activity (of a radioactive source)	becquerel (Bq)	0
20	Absorbed dose, kerma	gray (Gy)	0
21	Dose equivelent	sievert (Sv)	0

From the above mentioned facts it is obvious that most of the normative documents were worked out in the first part of eighties years and after that there is a considerable reduction and nowadays they have to be updated to recent requirements of science and technology as well as conditions of removal of technical barriers.

Linkage between national and international standards in hierarchy schemes

For increasing effective co-operation between countries recently there is an increase of accreditation role and quantity of agreements of the mutual recognition of the testing and calibration results. Therefore there is more and more a need of recognition of the testing results which are independent of a country where it is carried out. In the results there was a Agreement of mutual recognition entitled "Mutual recognition of national standards and calibration and measurements results issued national metrological institutes".

Nowadays there is an Agreement between Belarus and other countries about carrying out a coordinated policy in the fields of standardization, metrology and certification concerned the highest standard element and related to calibration. Due to this Agreement it is required to establish the general requirements to products for ensuring healthcare, environmental protection; to recognize testing and metrological accreditation results, recognition of accredited, tested, verified, calibrated and measuring laboratories and so on [3].

In the field of legal metrology where a lot of countries work on the base of hierarchy schemes worked out for measuring instruments' calibration there is also a mutual coordination or traceability to international standards and for calibration.

In connection with the mentioned above one more step is a coordination between national and international standards with a purpose to reflect this connection in the hierarchy schemes for transference of physical unit dimension to working measuring instruments. It means that it is necessary to put in additional level pointing a name of international standards, its general characteristic and, perhaps, comparison results with national standard. There is a example of the structure of this connection in the hierarchy schemes given in Appendix 2.

The establishment of the additional level will let:

1. trace a unit from working measuring instruments thought national standards to international ones;
2. analyze a place of national standards in comparison with international standards;
3. hierarchy scheme be not only the frame but a real active scheme correspondingly adapted to present requirements;
4. actualizate hierarchy schemes as carrying out standard comparisons in time;
5. the consumers and customers receive information about the results of comparisons.

References

1. Intergovernmental document *GOST 8.061-80 " Verification schedules. Scope and layout."*
2. OIML. International document №5 *"Principles for the establishment of hierarchy schemes for measuring instrument*s".
3. *Agreement about carrying out a coordinated policy in the fields of standardization, metrology and certification,* Izmeritelnaya tehnika, 1992, №4, pp.4-5.

4. M.N.Selivanov, A.E.Fridman, G.F.Kudrjashova, *Kachestvo izmerenij: Metrologicheckaya spravochnaya kniga,* Leniztad, Leningrad, 1987, pp. 247-290.
5. State standard of Belarus STB 8000-2000 "System of ensuring the uniformity of measurements of Belarus. Basis statements".

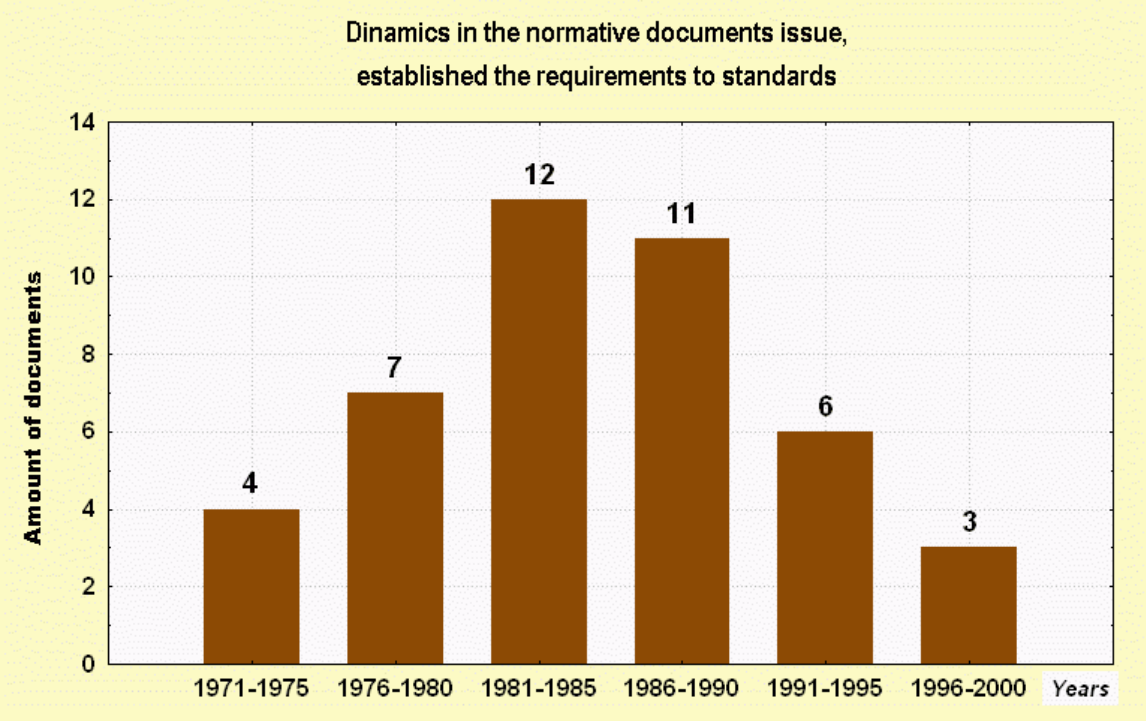


Fig. 1 Quantity of the normative documents established the requirements to the standards of base and derived SI units and state hierarchy schemes in the context of years

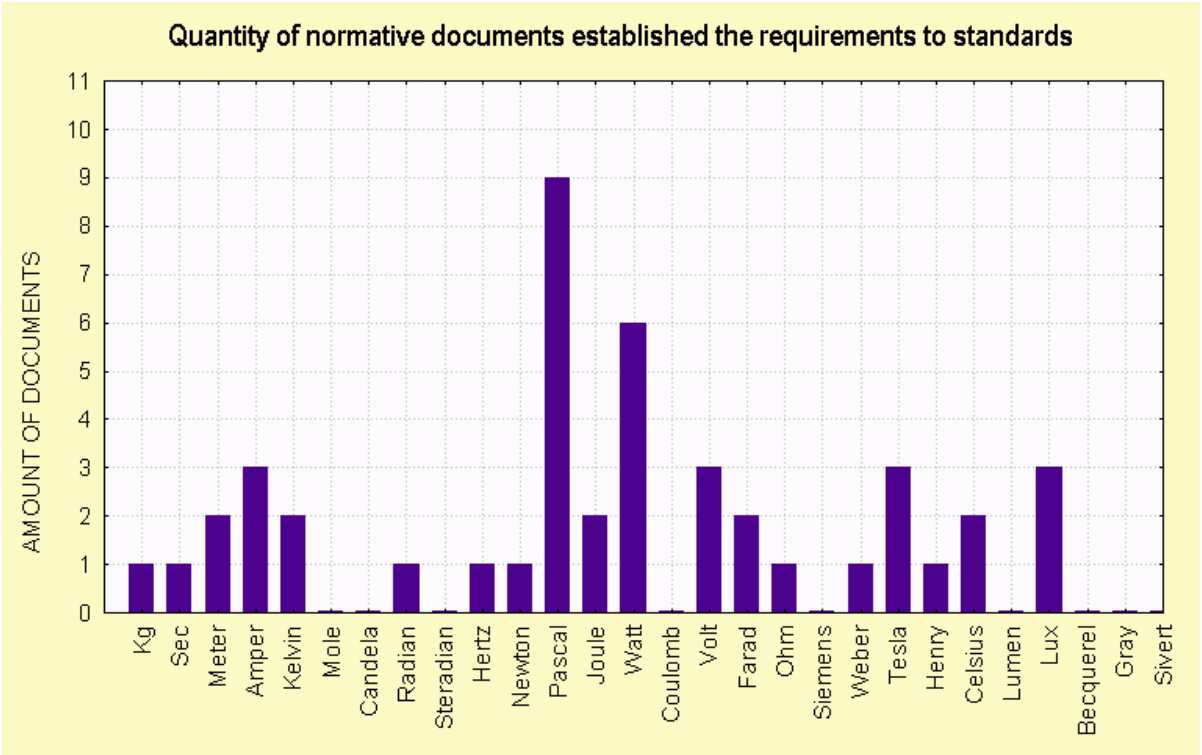
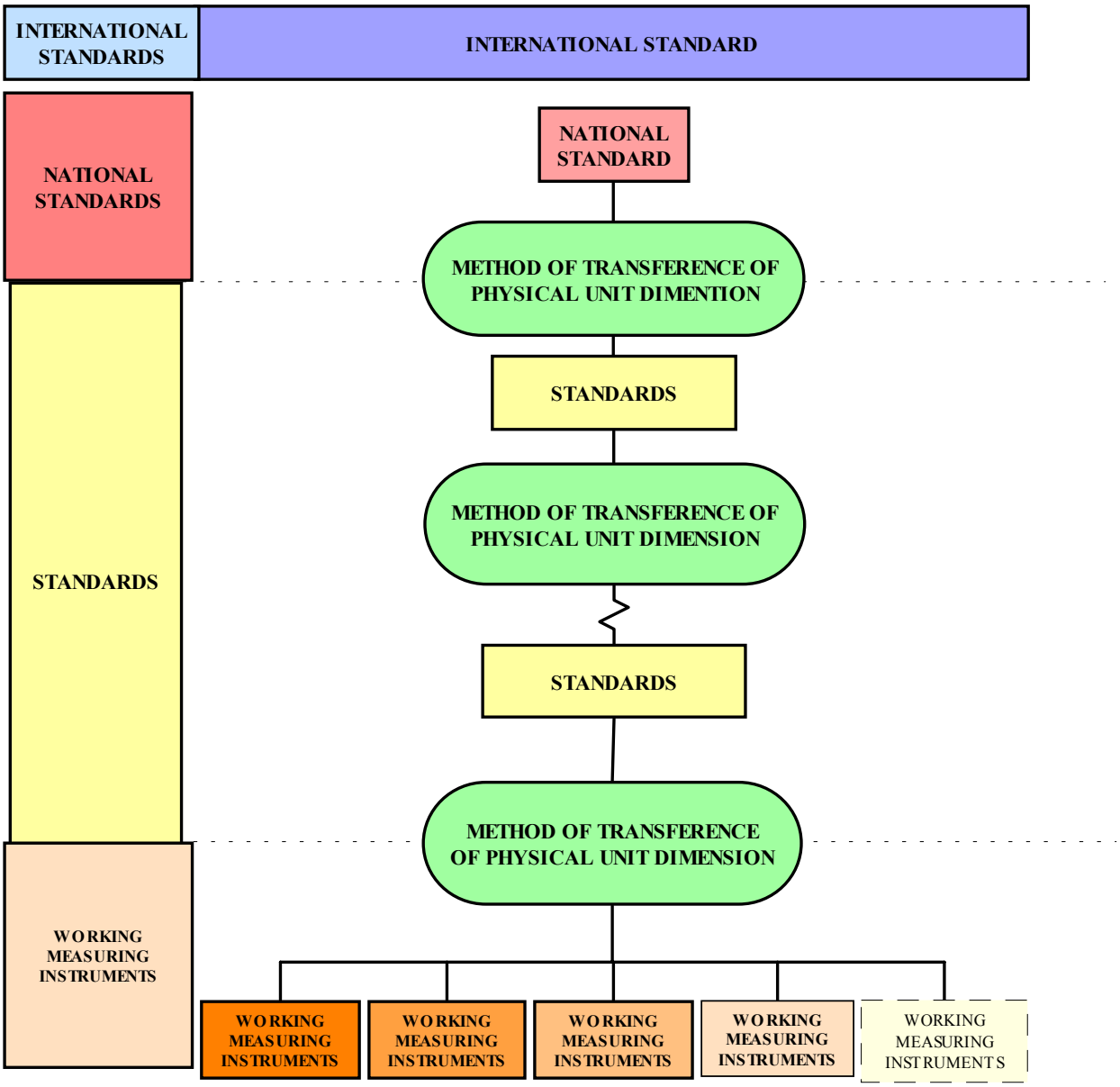


Fig. 2 Quantity of the normative documents established the requirements to the standards of base and derived SI units and state hierarchy schemes in the context of unit types



An example of using the connection between national and international standards in hierarchy scheme