

# DEVELOPMENT OF METROLOGICAL INFRASTRUCTURE IN R. MACEDONIA

*Lj. Arsov<sup>1</sup>, M. Cundeva-Blajer<sup>1</sup>*

<sup>1</sup> Ss. Cyril and Methodius University, Faculty of Electrical Engineering and Information Technologies,  
Karpos II b.b., Skopje, R. Macedonia  
*E-mail: mcundeva@feit.ukim.edu.mk*

**Abstract** – The paper deals with the development of the metrological infrastructure in R. Macedonia. A critical review of the present situation and specific factors of a small transition state are presented. Starting by the analysis of the needs, resources and the strategic goals of the country as well as the influence of the region and Europe, directions for further development of the metrological system in R. Macedonia are proposed. This strategic directions should be followed in the process of planning of the system in the next mid-term plan period.

**Keywords** metrological infrastructure, metrological resources, small metrology system.

## 1. INTRODUCTION

By the separation of the former Yugoslavia and creation of new countries on the Balkans, R. Macedonia has started with the development of a national metrological system, from the very first beginning of the 1990-ties. At that time there was no metrological regulation at state level, there was no national metrological institute, there were no national standards of the physical quantities and there was no organized metrological system, which would ensure the unity of the measurements and the traceability to international standards. During the last 20 years period the metrological system in R. Macedonia has gone under several phases, which were mostly influenced by the introduction of the new political system, the collapse of the economy, the process of privatisation and restructuring of the economy, the help of the EU. In the next section the current level of development of the metrological system in R. Macedonia is described.

## 2. REVIEW OF THE PRESENT STATE OF METROLOGICAL INFRASTRUCTURE

### 2.1. Metrological regulation

The Law on Metrology [1] is fully in compliance to the European demands and practice. The last changes of [1] were adopted in 2009 година and have enabled the transposition of the EU Directives (MID) 2004/22/EC and 75/107/EEC. The EU Directive (80/181/EEC) is transposed in the Rulebook of the measurement units [2], and the EU Directives 76/211/EEC and 2007/45/EC in the Rulebook on Metrological Control [3]. The EU Directive for measuring instruments (MID) 2004/22/EC is transposed in Rulebook on measuring instruments [4]. The EU Directive

90/384/EEC is transposed in Regulation for Weighing Balances, which has been adopted in compliance to the Law for Safety of Products.

Currently, there is a process of a transposition of the EU documents in the field of metrology, which are connected to certain types of measuring instruments (sector directives), [5], and [6].

### 2.2. State Bureau of Metrology

The Bureau of Metrology (BoM) is an organizational unit in the frame of the Ministry of Economy, as a legal entity which fulfills the tasks prescribed by the several and regulation [1-4]. According to Law on Metrology, [1], BoM is the national metrological institution, competent and responsible for: insurance of national and international traceability (of the physical quantities of the SI measurement units), realization and maintenance of the national standards, certified reference materials and calibration of standards and measuring instruments, type conformity assessment of measuring instruments, verification of measuring instruments, metrological control of the packed products and metrological surveillance. BoM represents the country in the international and regional metrological organizations. BoM has the primary role in the national metrological system and it fulfills the tasks and obligations in the scientific, industrial and legal metrology. BoM also controls the objects of precious metals.

The Metrological Council, composed of technical experts, is the advisory body of BoM during the activities of preparation of technical regulation.

### 2.3. Metrology laboratories in R. Macedonia

App. 90 laboratories in which calibration of length and angle (17 labs), velocity (17 labs), force and hardness (4 labs), reference materials (2 labs) and verifications of electricity meters (3 labs), water flow meters (14 labs), heat meters (1 lab), liquid fuel meters (2 labs) and Doppler radars (1 lab), alcohol level meters (1 lab), instrument transformers (1 lab), blood pressure meters (4 labs), balances (14 labs) exist in R. Macedonia. A part of these laboratories are in non-operational condition and it is considered that only the accredited laboratories perform measurement with quality and traceability. In Fig. 1. the accredited laboratories and verification (control) bodies in R. Macedonia are shown, [7].

#### 2.4. Insurance of the unity of the measurements

By the recognition of national standards of certain physical quantities, by establishment of control and type approval of the measuring instruments by the BoM, as well as through metrological control by BoM, metrological unity and comparability of the measurements in R. Macedonia are established. However, in practice only two national standards are recognised (national standard of mass and national standard of flow). Because of the small number of personnel and low level of equipment of BoM for metrological control, the control is partial and not frequent, sometimes transferred to other entities, which do not ensure impartial and objective control. This is especially obvious in certain fields, like telecommunications, electrical energy, heating, water supply, oil and derivatives supply.

#### 2.5. Traceability of the measurements

In R. Macedonia there is no established traceability to international and national standards for the main quantities, yet. The BoM, which possesses second order standards, participates in international inter-laboratory comparisons. In the Turkish NMI UME, the following BoM standards have been calibrated: mass, flow, pressure, temperature, liquids volume, length, DC voltage, resistance, density and volume of gases.

There are four calibration laboratories accredited against the standards ISO 17025, which have established traceability of their measurements to BoM or other countries' NMIs given in Fig. 1. Also, the Laboratory for electromagnetic quantities at the Faculty of Electrical Engineering and Information Technologies at the Ss. Cyril and Methodius University-Skopje has established traceability for DC voltage and electrical resistance. For the other physical quantities in R. Macedonia there is no traceability chain to national standards, so there is no completely established unity of the measurements.

### 3. INFLUENCING FACTORS TO THE DEVELOPMENT OF THE METROLOGICAL INFRASTRUCTURE

In this section, the factors influencing the development of the metrological infrastructure in R. Macedonia will be discussed: the posed strategic goals, the present state of the metrological infrastructure, the needs for metrological services, the metrological resources and the model of the metrological system.

#### 3.1. Strategic goals

Starting from the national strategy of R. Macedonia to become a member of the EU in shortest possible term, the

general strategic goal of the development of the Macedonian metrological system is to enable unity of the measurements in R. Macedonia, traceability to international standards, traffic of goods and services with no technical barriers as well as cooperation of the Macedonian economy with Europe and the world. This general strategic goal is related to several specific objectives: establishment of high-quality, efficient and low-cost metrological system tailored to the needs of the Macedonian economy.

#### 3.2. The present state of the metrological infrastructure

The present state of the metrological system was described above in Sec. 2. The organisation is a centralised with national metrology institute at the top (BoM) and accredited calibration laboratories and inspection bodies (verification bodies) as well as test laboratories as shown in Fig. 1.

The Law on Metrology and the Regulation for national standards enable the national standards to be distributed, possessed and maintained by industrial or scientific laboratories. In this moment there are no such distributed standards in R. Macedonia.

#### 3.3. The needs for metrological services

In the recent twenty years, the Macedonian industry went under the process of restructuring. Almost all big state enterprises in the metallurgy, mechanical, textile, food and chemical sector collapsed and new small to medium size private companies were established. In the frame of the former big industrial capacities existed metrological and test laboratories for support and development of the production process. These laboratories shared the destiny of the mother companies. Such were the laboratories of metal industry "MZT"-Skopje, electrical industry "EMO"-Ohrid, chemical industry "OHIS"-Skopje, metallurgic industry "Rudnici i zelezarnica"-Skopje, textile industry "Makedonka"-Stip etc. Together with the laboratories the equipment, the staff and the previously gained metrological experience was diminished. On the other side the new established SMEs did not have enough finances, knowledge and experience to establish proper metrological support of the production. So at this moment, there are notable demands for metrological support through testing, control and calibration in the following sectors: food, textile, construction, electrical and mechanical industries. In these sectors there is a need of development of test laboratories for the support of the production and also a need of calibration laboratories and establishment of national standards and traceability to international standards. In the sectors covered by the legal metrology in R. Macedonia the most important are the health, food, environment, energy, transport and trade sectors.

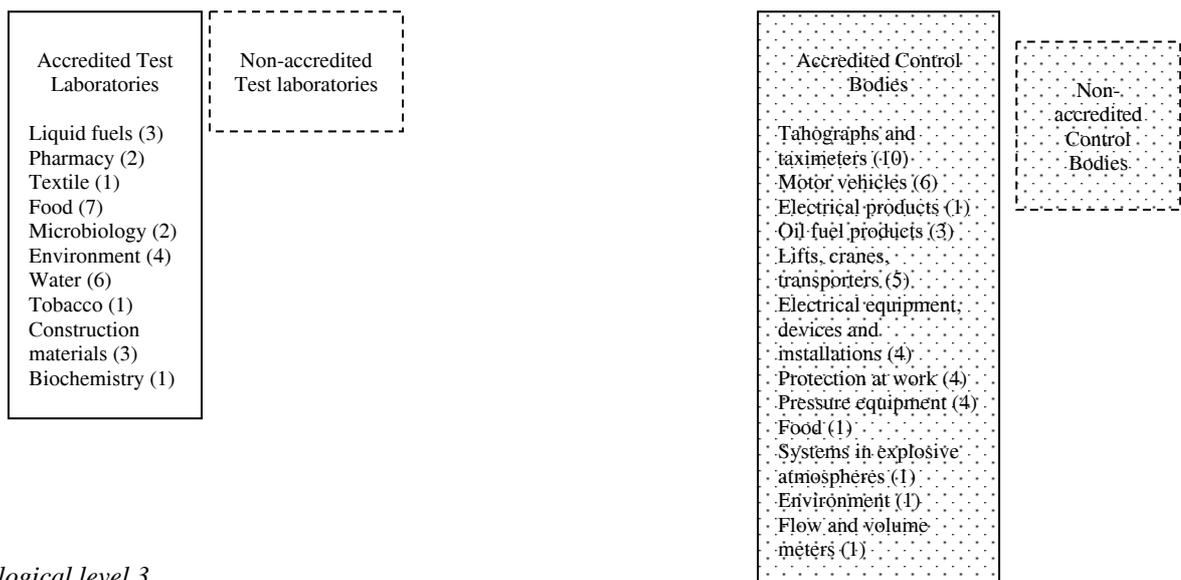
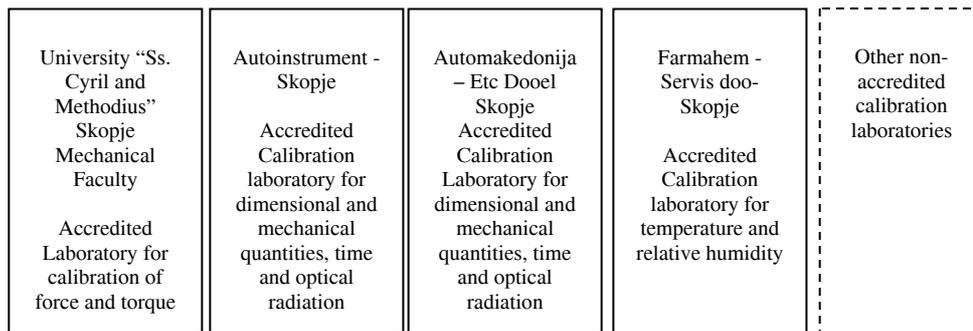
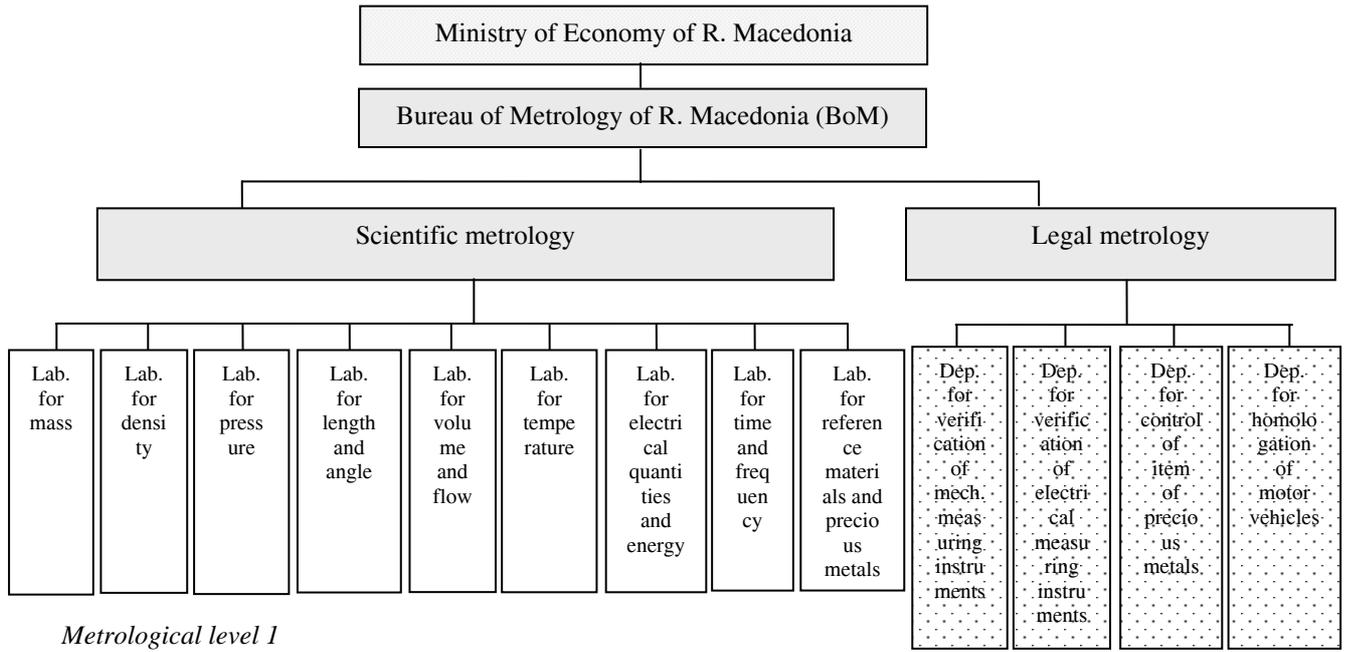


Fig. 1. The scheme of the metrological system in R. Macedonia

It is necessary to introduce quality and competencies in the medical laboratories, which are mostly in the public health system as well as in the system of private health care. For these laboratories it is necessary to calibrate the equipment, to ensure reference materials, reference laboratory and establishment of traceability.

The situation is similar in the assurance of the food safety.

The measurements of the environmental parameters currently are covered very weakly by the Ministry of Environment and Urban Planning as well as the Republic Office for Hydro-meteorological Affairs. For that measurements at this moment there are no standards, reference materials and reference laboratories as preconditions for insurance of traceability.

In the energy sector, according to [5], only in 2010 app. 231000 verifications of electricity meters had been accomplished. There are more than 10000 instrument transformers installed in R. Macedonia, whose verification is prescribed at every 5 years. There is only one laboratory, which is not impartial (owned by the distribution company EVN-Macedonia).

The above mentioned sectors express the need of immediate establishment of national standards, calibration laboratories and test laboratories for the following quantities: mass, length, time, temperature, chemical quantities, microbiological safety, pressure, humidity, velocity, radiation, flow of fluids, voltage, current, power, energy, resistance, capacitance, inductivity, frequency, acceleration, force, torque, angle, rotational velocity, rotational acceleration.

There is an annual need for a large number of verifications of measurement instruments, too. Our estimation of the needs for calibration/verification is presented in Table I.

TABLE I. Annual calibration/verification needs

	Activity	Units per year
1.	Calibration of instruments	10000
2.	Verification of electricity meters	80000
3.	Verification of water flow meters	80000
4.	Verification of heat meters	10000
5.	Verification of liquid fuel meters	600
6.	Verification of instrument transformers	2000

### 3.4. Resources for development of the metrological system

*Human resources:* in the past twenty years the experienced and trained staff of the metrological laboratories, mainly has left the laboratories because of the economical situation and the decrease of activities or has been retired. So the existing staff at the BoM and the metrological laboratories in R. Macedonia is insufficient in

number, and not enough educated. The coverage of the job places at the BoM currently 46 % (81 employed) and the situation in the other metrological laboratories is similar. Recently, the lack of staff has been the main constraint of the development of the metrological system. However, at the universities, in the laboratories, inspection bodies and industry there is a lot staff, which is involved in metrological activities and can be a base for further development of the metrological infrastructure.

*Knowledge and experience:* the main part of the metrological knowledge and experience inherited by the former Yugoslav metrological system was lost due to leaving of the staff and change of the metrological standards and regulation. In the regular education of the engineering study programmes the metrology is weakly present and the interest of the students is very low. The trainings and transfer of knowledge from the international community was not effective because of the lack of staff, which would absorb it.

The current situation is changing by introduction of MSc studies in Metrology and quality management and PhD Studies in Metrology organised by the Faculty of Electrical Engineering and Information Technologies at the Ss. Cyril and Methodius University in Skopje. The adoption and implementation of the international standards gives a positive contribution to the level of awareness of the importance of metrology and to the interest for new metrological techniques.

*Equipment:* the overall review of the present equipment of metrology infrastructure has shown that the metrological equipment is old, irregularly serviced and calibrated. The new equipment of the laboratories of the BoM, acquired through international assistance is incomplete. Particular metrological equipment is duplicated and insufficiently used. However, it can be concluded that BoM is equipped with new equipment and standards as well as the certain university laboratories and big enterprises laboratories.

*Premises:* the main part of the laboratories has activities in inadequate facilities. The new facilities of the BoM are not fully furnished yet with proper systems for control of the working conditions. The university laboratories have enough space and can be properly equipped for metrological activities. However, further investments in the laboratory facilities are needed.

### 3.5. Model of the metrological system

The existing metrological system of R. Macedonia is a centralised system with national laboratories and verification concentrated in the BoM. Through the recent development all the state investments in the metrological infrastructure as well as the international financial and technical assistance were concentrated to the BoM. So the BoM is partially capable to give services of calibration and verification of certain quantities as given in Section 2. This centralized model of development of the metrological system has driven to insufficient usage of the human resources, standards, equipment and metrological facilities, which exist in the country.

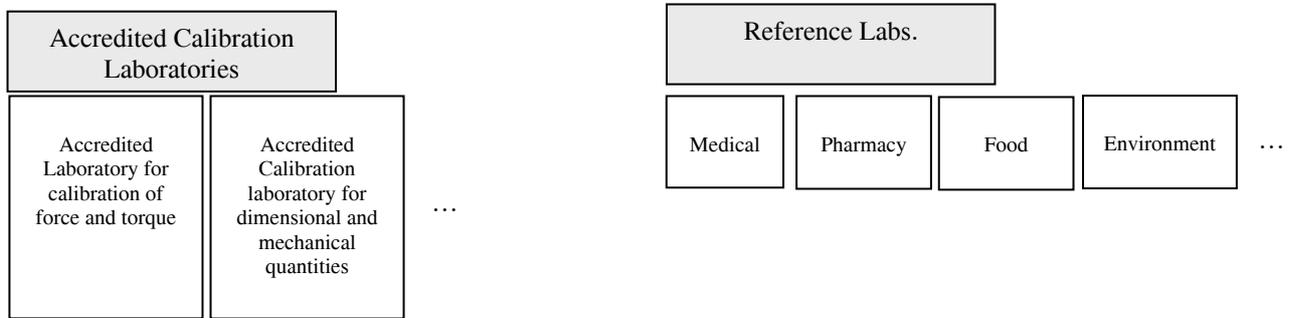
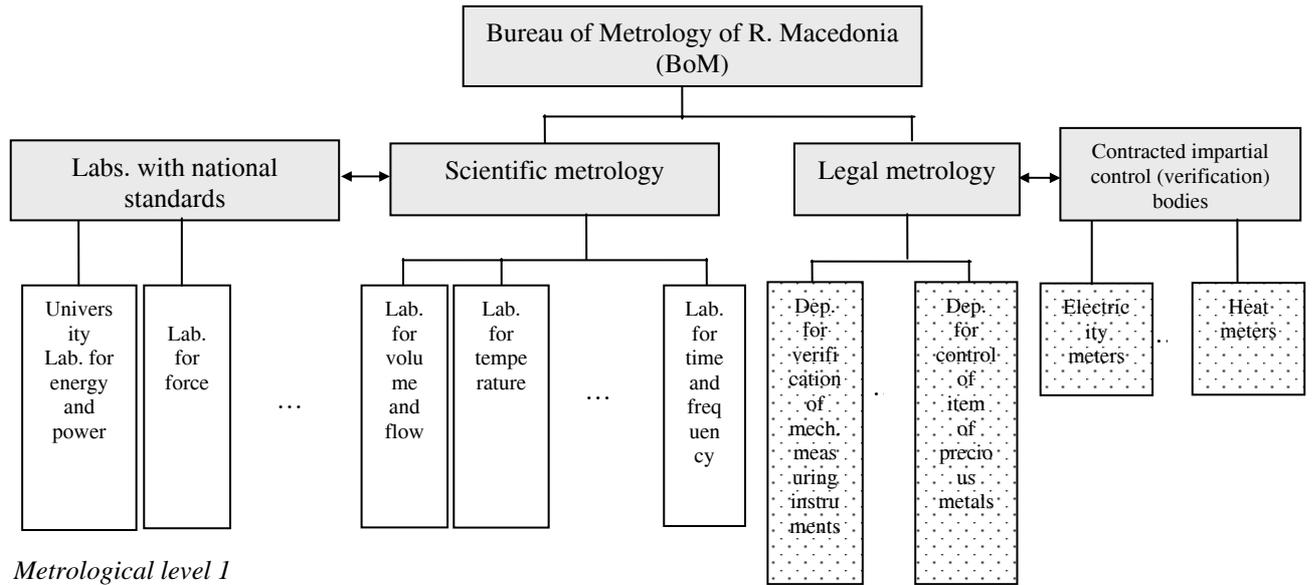


Fig. 2. The proposed model for development of the metrological system in R. Macedonia

Further, such system leads to expensive maintenance and insufficient usage of the new capacities of BoM despite the usage of the already sustainable metrological units at the universities, research institutes, industry, health institutions etc. This system by the beginning of the development of centralised BoM means a beginning from zero in construction, equipment, creating staff necessary for a completely new state institution.

Completely opposite would be the choice of a decentralised model with national laboratories, located at the existing already established and equipped with staff and equipment metrological laboratories. In R. Macedonia this potential is very important and the following units can be noted: the Laboratory for electromagnetic quantities at the Faculty of Electrical Engineering and Information Technologies at the Ss. Cyril and Methodius University in Skopje, the Laboratory for Length and the Laboratory for Force and Torque at the Faculty of Mechanical Engineering at the Ss. Cyril and Methodius University in Skopje, Laboratory for Reference Materials at Makstil-Skopje etc.

### 3.6. Technical help from the international community

The technical and financial help from the international community for a small country as R. Macedonia is a very important development factor. In the recent period the projects of technical and financial help to the BoM such as CARDS (1997-2000), CARDS Regional (2000-2003), SMAQVa 1-2 (2003-2006) has significantly helped in forming, equipment, staff training and transfer of metrological knowledge. The next projects BERIS, IPA 2008, IPA Regional, PTB for SEE NMI and GTZ project, as well as the bilateral program for cooperation with the Turkish NMI UME are expected to be useful in the realisation of a contemporary model of development of the metrological infrastructure.

## 4. FUTURE DEVELOPMENT OF METROLOGY INFRASTRUCTURE IN RM

On the basis of the previous considerations new configuration of the metrological infrastructure can be proposed. This configuration is displayed in Figure 2. The main characteristics of the proposed configuration would be: separation of BoM from the Ministry of Economy as national metrological institute, distributed national standards and laboratories, strengthened state metrological control, development of second order metrology laboratories for the main and mostly needed quantities, reference medical, pharmaceutical, food and environmental laboratories and development of independent and impartial control (verification) bodies for electricity, water flow, heat, liquid fuel meters and instrument transformers.

## 5. CONCLUSION

The paper described the development of the metrological infrastructure in R. Macedonia. A critical review of the present situation and specific factors of a small transition

state have been presented. Starting by the analysis of the goals, the present state, the needs for metrological services and the resources a model for development of metrology system in R. Macedonia has been proposed.

It may be concluded that the applied approach to the development of the metrological system in the past twenty years has resulted in a time-lag after the actual metrology needs and presently it is a constraint for a faster development of the economy and the international cooperation.

The realization of the development model proposed in Section 4. will lead to better usage of the development potentials, human resources, existing metrological equipment, facilities and know-how. This will facilitate the establishment of the national standards and international traceability and will contribute to faster, cheaper and sustainable development of the metrology infrastructure.

The international and governmental technical and financial assistance to the development of the metrology infrastructure, the key factor for the past and the future development of the metrology infrastructure has to be oriented not exclusively to the BoM, but wider to all the participants, state, public and private metrological laboratories.

## REFERENCES

- [1] "Law on Metrology", Official Gazette of R. Macedonia No.55/02, 84/07 and 120/09
- [2] "Rulebook of the Definitions, Nomenclature and Symbols, the Scope, Application and Obligation for Usage and Writing of the Legal Measurement Units", Official Gazette of R. Macedonia, No. 104/2007
- [3] „Rulebook on the manner and procedure for metrological supervision and requirements that pre- packed products should meet in terms of quantities and allowable deviations from the highlighted quantities and list of nominal quantities of pre-packed products”, Official Gazette of R. Macedonia, No. 83/2009
- [4] „Rulebook on Measuring Instruments”, Official Gazette of R. Macedonia No. 17/10
- [5] "Strategic Plan for the Development of the Bureau of Metrology and the Metrological Infrastructure of R. Macedonia 2010-2012", Bureau of Metrology of R. Macedonia, 2010.
- [6] [www.bom.gov.mk](http://www.bom.gov.mk)
- [7] [www.iarm.gov.mk](http://www.iarm.gov.mk)

### Author (s):

**Prof. Dr. Ljupco Arsov**, Ss. Cyril and Methodius University, Faculty of Electrical Engineering and Information Technologies-Skopje, Karpos II, b.b. POB 574, 1000 Skopje, R. Macedonia, phone: +389 2 3099111, fax: +389 2 3064262, e-mail: [ljarsov@feit.ukim.edu.mk](mailto:ljarsov@feit.ukim.edu.mk)

**Ass. Prof. Dr. Marija Cundeve-Blajer**, Ss. Cyril and Methodius University, Faculty of Electrical Engineering and Information Technologies-Skopje, Karpos II, b.b. POB 574, 1000 Skopje, R. Macedonia, phone: +389 2 3099162, fax: +389 2 3064262, e-mail: [mcundeve@feit.ukim.edu.mk](mailto:mcundeve@feit.ukim.edu.mk)