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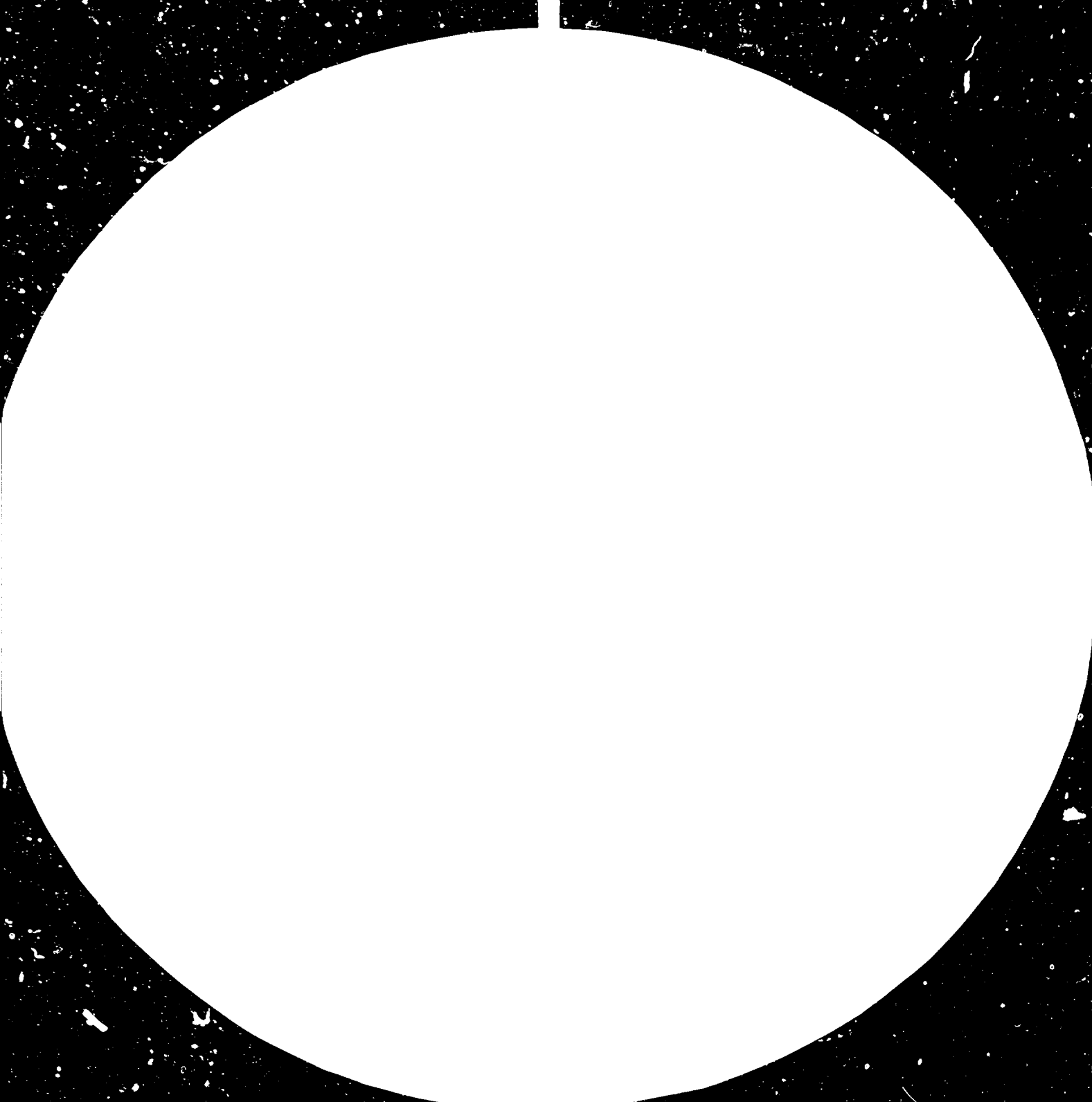

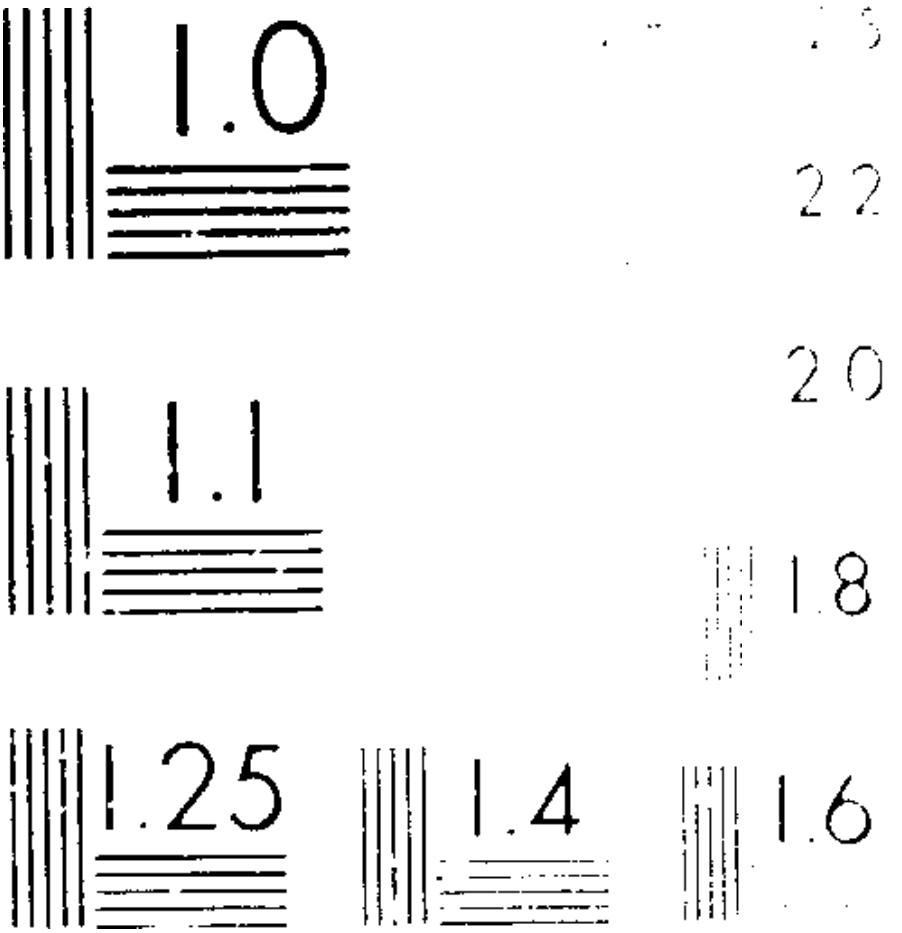
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THE IMPORTANCE OF METROLOGY IN INDUSTRIAL DEVELOPMENT FROM THE ASPECT OF DEVELOPING COUNTRIES*

prepared by

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* The views expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

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1. Introduction

Metrology, in its boarder sense is a field of work and knowledge which refers on measurement and has a primary aim in providing *reliability* and *accuracy* of measurement. Measurement gives the mankind the quantitative idea of the material world that surrounds it, and therefore of the legitimacy which rules the nature and hereby is the basis of all the exact sciences. Mendeleev's saying is well-known: „Science begins there where the measurements begin." or Thomson's: „We know the thing so much as we can measure it."

The success and speed of a country in scientific research, technique and production directly depend on the condition and level of its measuring techniques. We are recognizing that a country cannot prosper economically nor enlarge its industrial capacity, it cannot provide personal safety of its citizens, it cannot provide economic and with it political independence if it does not possess a sufficiantly advanced measuring technique and if it has not a sufficiently developed metrology.

2. Obligations of a country in the field of metrology

If we observe metrology from that aspect then it comes that a country is obligated to provide through its legislation the development of metrology and by that to fulfill one of the important conditions for:

– the development of science and industry
– the protection of citizens in the sense of accurate measuring in everyday life.

Apart from this there are boarder social interests for the development of metrology especially in the field of security and health. That is the reason why it is important in a country where there is not a system of metrology, to form an appropriate political and social atmosphere to raise the need for a system of metrology in the country and according to this to pass a law to organize this field.

A National law on metrology should:

– on one hand facilitate the development of scientific and technical knowledge and progress in the national economy by encouraging the standardization of units and standards of measurement as well as the modernisation of the measurement and measuring equipment and improvement in their accuracy.

Thus, the state metrological control could be applied to:

– measuring equipment used as standards for the verification of ordinary instruments;
– measuring equipment used in dealings (trade etc.);
– measuring equipment used in the field of public health, proteciton of people and property etc.

The Law on Metrology should especially contain apart from the general regulations:

a) units of measurement

Referring to the units of measurement it is advised that a country accept the „International system of

Units" (SI) which is accepted by the General Conference of Weights and Measures and recommended by the International Organisation of Legal Metrology. A country may authorize for some time or longer period certain units out of the SI system but these units have to be directly linked to those of the International System. The SI system is adopted in most of the countries in the world so the acceptance of the SI system makes the transactions among countries easier. The underdeveloped and mid-developed countries have some advantage over the developed countries in acceptance of the SI system for they usually need not invest large sums necessary for accepting the new SI system instead of the existing system of measurement. Our opinion is that the SI system is a long-term solution and that it took so an important role in the world that the postponement of its acceptance could mean a great material loss for a developing country.

b) control of measuring equipment

In measuring equipment control a national service can include the following categories of control:

- pattern approval
- initial verification
- verification after repair
- periodical verification
- supervision of the use of measuring equipment

c) penal regulations in the case of not fulfilling the law

d) financial provisions for supervison and pattern approval

The metrology service gives rise to the receipt of fees for services (except for inspections). It is favorable that the taken fees are used to improve the metrology service.

When preparing the national law on metrology the Recommendations of the General Conference of Weights and Measures and the Recommendations of the International Organisation of Legal Metrology should be taken into consideration. Their Recommendations should be applied progressively and parallel to the technical needs and possibilities of the country.

3. National Metrology Service

It is favorable to put the Law on Metrology into effect through the national metrology service which is together with other subjects responsible for the improvement of metrology in the country. The main aim of the national metrology service is to provide unity and reliability of measurement in the whole country. To fulfill these tasks the service should work on the following:

- verification, conservation and improvement of national (primary) standards, basic and derived units of measurement;
- pattern approval;
- drawing up metrological regulations (metrological decrees) and other regulations;
- initial and periodical supervision of measuring equipment;
- international collaboration in the field of metrology.

The developing countries which just start to develop industralization should discuss the limits of tasks of the metrology service laboratories, beginning from the classical basic fields of metrology to the tasks which claim needs and possibilities of a country relating import and export.

The organisation of a national metrology service requires besides the appropriate personnel significant financial resources for laboratory space and measuring equipment. Our opinion is that a metrology service which works on research and legal metrology at the same time is the most favorable. Separating research and legal metro-

logy in the sense of organizing separate institutes may have negative effects since the practice shows that these institutes very shortly cease to serve the needs of legal metrology and economy and begin to deal with their own work.

Because of the problem of personnel, equipment and space for organizing a national metrology service, especially the developing countries should use the existing personnel, universities, institutes etc. in the sense of using their knowledge and giving them authority of the country in these institutions in the form of authorized laboratories In this way the producer himself can provide initial verification and sealing of measuring equipment for mass production (catering dishes, measurement for length etc.) in which process of production and verification is automatic, it guarantees the satisfaction of the issued metrological requirements.

A separate decree can state which measuring equipment can be verified and sealed by research institutes, laboratories and producers etc. The national metrology service states the requirements that have to be satisfied by the authorized laboratories in connection with the personnel, equipment and space. They must take advantage of the knowledge on the universities, institutes etc. to establish standards, improve new measuring methods; experts from these institutes enter international working groups in the field of metrology etc.

In the development of a metrology system of that type where more subjects of the society are included in the national metrology service the national metrology service must have the role of coordinator. However, when organizing the development of metrology in this way it is necessary permanently to invest in space and equipment and especially in education of experts in metrology.

4. Influence of Metrology on the Development of Industry.

We can notice that recently metrology has moved from the sphere of consumer transactions to the sphere of production and its coordination. This qualitative change which is still going on gives a different character to the role of metrology. Metrology with its direct effect exerts influence on production and coordination by technological processes, helps to reduce the percentaga of bad products and semi-finished products as a whole. The active character of metrology is apparent when before the beginning of production metrological requirements influence the characteristics of the measuring equipment and instruments.

In every country every day a great number of measurement is made, from common to the most complicated ones. The working hours during which the measurements are made give an ever larger percentage in the relation to the whole work, so in some branches of industry it comes to 30 %.

It is generally known that only high level of measurement in the process of work provides substitution for spare parts and is the basis for specialisation and cooperation in production. The quality of production depends on accuracy of measurement in all the phases of production, especially with the measurement of characteristics of primary materials and components in the entering control, in production of integral parts, in installation and in the final control of the product. By the development of new measuring methods also automatic control is included which gives economic effects in the sense of shortening the time for control and reducing bad quality because of subjective mistakes.

High level of measurement is especially important where we have a lot of measurement informations which a man is not able to understand by the means of common control instrument and cannot give a operative correct solution.

Besides the great importance of metrology for scientific research which is the basis of the development of own technology and industry, the influence of a national metrology service on the faster development of the industry is seen in the following:

a) establishing national (primary) standards and forming of secondary and working standards and establishing the methods of their verification. Transmitting the values of units of phisical dimensions of primary standards to the secondary and working standards, a measurement unity is being formed and measurement accuracy of working standards is satisfied that are used to control all the measuring equipment in the technological process.

With a good control system of measuring equipment used in the technological process in an organisation for which accurate and verified working standards are the basis, a better quality and a great economic effect can be achieved. We could say that there is no technologic operation without measurement. The economic effects of a hardworking worker in the production are neglectible if inaccurate measurement is used or if the verified instruments are used over the permitted error.

It is true that the investments into the measuring equipment, space and personnel and the periodical verification are great, but these investments return rapidly through the reduced percentage of waste, better quality of products and by the higher price of the products on the market. The correct establishment of the direct economic effect of metrology is a very complex problem. There are numerous studies, experience, mathematical formulas etc. which can define the direct economic effect but because of the complex character of metrology all the datas are difficultly appliable in practice. Sometimes, for example, it is difficult to state if the waste rises because of the incorrect measurement or it is the result of some other mistakes of workers. However, if by sistematic supervison of measurement we eliminate measurement by inaccurate measuring and measuring equipment and if we stimulate the workers correctly, the percentage of waste will be reduced significantly and the stability of production and quality of products will increase.

Besides the direct expenses which arise in the production because of the bad quality, there exist the so called external expanses like loss of market, low price etc. which usually represent a still more important loss and they can be difficultly estimated.

Often the level of measurement in a production is a decision marker in selling the product, especially to the foreign market.

b) pattern approval

Before the assembly–line production the pattern approval of measuring equipment establishes the metrological characteristics and usability of the type. In this way the metrology service directly influences on the quality and reliability of the measuring equipment produced or imported from abroad. The importance of the metrology service is still greater as its experts examining the quality and reliability od the measuring equipment can help in construction and improve the construction of some measuring equipment.

c) verification of measuring equipment

The verification of measuring equipment includes the initial verification and the periodical verification. All the measuring equipment intended to operate, protect people and property and measuring equipment used in the field of public health are liable to verification.

All the new measuring equipment and repaired measuring equipment which can influence the accuracy of measurement are liable to initial verification. The initial verification is carried out before the measuring equipment is redy to be sold, e.i. before its usage and this is usually at the place of production or reparation. The personnel of the metrology service who carries out the initial verification directly influences the quality of the product. Their knowledge, experience and neutral position can significantly influence the permanent improving of quality and reliability of production. Experience shows that usually producers who carry out the initial verification and who have the pattern approval do not deal with difficulties when selling their products abroad.

initial verification is carried out for all the imported measuring equipment. In this way the import of measuring equipment that is not of high quality or adequate is prevented.

The metrology service by periodical verificaton and following the usage of measuring equipment in its exploitation defines the stability and reliability of the measuring equipment and informs the industry about the eventual defects which are to be eliminated in the new products or even prohibites the production of measuring equipment of low quality.

d) metrological regulations and instructions

Metrology finds its place especially in the process of production. However, metrological regulations and instructions can influence the phases before the production starts. The prescribed technical characteristics which are usually harmonized with international recommendations influence the work of experts and constructors who are in this way forced to develop a measuring equipment which has a quality for home and foreign market.

The international collaboration in the field of metrology plays a significant role in the work of international working groups of international organisations like: International Organisation of Weights and Measures, International Organisation of Legal Metrology etc. and enables the experts to exchange experience, to get information about the movements in the development of metrology in different fields, their contribution in forming the international recommendations and all that helps the faster development of own industry.

Conclusion

If we want to emphesize some important questions about the role of metrology in the industrial development of a country then it is necessary to say the following:

1) for the development of scientific research and industry of a country and by this for the development of its economic and political independence it is necessary to have an improved system of metrology;

2) to pass the law on metrology and international collaboration in the field of metrology it is the best to organize a national metrology service;

3) for the reasons of economy it is necessary for developing countries to make use of all the existing personnel, equipment and space in the country for the improvement of metrology and to give the role of coordinator to the national metrology service;

4) it would be necessary that the developing countries take a greater part in cooperations in the field of metrology in international limits aiming exchange of experience, international aid etc.