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MEASUREMENT SUPPORT SERVICES

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Abstract - The participation of the developing countries in the international trade put even stronger emphasis to the safe operation of their quality systems throughout the whole economy (industry, agriculture, scientific research, public health services, higher education, etc.) The operation of these systems need ever more sophisticated and expensive instruments. These instruments also are a sizeable part of national wealth.

The safe operation of the precision measuring instruments has essential importance in the creditable performance of the quality systems, and it needs support (background) services and in the developing countries there is a considerable shortage in these services.

This paper summarizes the elements of the technical background of the instrumentation support services which are essential in the safe operation of the quality systems and presents the latest experience gained in the application of the concept which was developed in co-operation with Physikalisch- Technische Bundesanstalt (PTB in Braunschweig, Berlin, Germany) in different countries, and provides information on the sustainability of such services.

Keywords: instrumentation, local capability, sustainability

1. BACKGROUND INFORMATION

The limited quantity and the large variety of the measuring instruments in the developing countries cannot provide enough technical work to justify the establishment of necessary efficient service stations by the individual manufacturers. On the other hand the wide variety of the equipment/instruments being used by the various institutions in the country limits their capabilities and capacities in maintaining and repairing the high sophisticated precision measuring instruments.^[1]

The ISO family of standards and other quality programs such as Total Quality Commitment (TQC) determine, what elements of production process are required to maintain quality regardless of the product manufactured both in cases of export and import. A key issue within these programs the product inspection and test.

Important requirements for measuring equipment in ISO relevant standard

Nonconforming measuring equipment

Any item of measuring equipment

that has suffered damages
that has been overloaded or mishandled
that shows any malfunction,
whose proper functioning is subject to doubt
that has exceeded its designated confirmation interval, or
the integrity of whose seal has been violated

shall be removed from service by segregation, prominent labelling or marking. Such equipment shall not be returned to service until the reasons for its non conformity have been eliminated and it is again confirmed

Intervals of confirmation

Measuring equipment (including measurement standards) shall be confirmed at appropriate intervals (usually periodic), established on the basis of their stability, purpose and usage. The intervals shall be such that confirmation is again carried out prior to any probable change in accuracy that is of significance in the use of the equipment. Depending on the results of calibrations at preceding confirmations, intervals of confirmation shall be shortened, if necessary. to ensure continued accuracy.

Environmental conditions

Measurement standards and measuring equipment shall be calibrated, adjusted and used in an environment controlled to the extent necessary to ensure valid measurement results. Due consideration shall be given to temperature, rate of change of temperature, humidity, lighting, vibration, dust control, cleanliness, electromagnetic interference and other factors affecting the results of measurements. Where pertinent, these factors shall be continuously monitored and recorded and, when necessary, correcting compensations shall be applied to measurement results.

It is evident that quality cannot be assured without strict control and accurate measurements. Well-planned quality management systems are needed which depend upon the background services of the country's instrumentation infrastructure. Without instrumentation infrastructure and suitable support (background) instrumentation services it is impossible to build up and operate effective and economical quality systems, which are needed by the manufacturing companies.

In the framework of the Southern African Developing Countries (SADC) Programme on Standardization, Quality Assurance, Accreditation and Metrology (SADC SQAM), the Secretariat of SADC Co-operation in Measurement Traceability (SADCMET) is supporting the implementation of such projects which ensure the long-term viability of the joint vision of the SADC SQAM structures, namely the establishment of an internationally recognized conformity assessment infrastructure in the SADC region. A reliable infrastructure for maintaining and repairing the installed instrumentation base for testing and measurement is an indispensable element of this vision.

2. MEASUREMENT SUPPORT SERVICES

In order to achieve the general objectives of the quality systems, a module system should be set up with the purpose of optimal utilization of the national stock of instruments. Developing countries and countries with economies in transition vary considerably in level of their development, economical systems and market environments. Despite of this diversity, they share a number of common features. One of the common features is the insufficient instrumentation infrastructure. According to the experience of MTA-MMSZ Ltd. Co., Budapest in Hungary, (MTA MMSZ) the following background instrumentation services may be needed:^[4,7]

2.1 Instrument and measuring technique investment consulting services

In solving a measuring problem it is important to choose the proper measuring method and the appropriate instruments. Institutes and companies are forced to change their profile very often so they have to face new challenges time to time. In the new fields they lack of the suitable instrumentation and the expertise to use the instruments. They can choose their new instrument from a wide selection. The instrument suppliers are very aggressive to promote their products but it is very difficult to get an unbiased, objective advice for instrument purchase. The above problems raise a steady demand for an effective consulting service. Such a service can be provided by a staff of experts specialized in different specific areas of measurement and instrumentation. Their personal expertise is extended by a comprehensive

knowledge base, which consists of several independent databases, catalogue and leaflet library, etc.

2.2 Training and education on how to run and maintain the instruments

Education and training in any regions is identified as of prime importance. Development of human resources is the cheapest way of investment with a relatively short time of return of investment. The lack of professional expert knowledge greatly hinders the efficient utilization of the instrument pool.

The training needs for the operation and maintenance of test equipment should be carefully assessed before purchase. In the absence of such training, expensive equipment may not give the desired accuracy or may remain out of action for long periods. In both cases, considerable material and moral damages can be caused.

The training program has to cover all needs for further education of the customers' experts, education and training of the engineers/technicians of the ISSC, and organized courses for outside experts (managers, service engineers).

2.3 Instrument maintenance and repair activity.

Precision measuring equipment are suitable only when they are functioning with the specified accuracy. Even the properly operated instruments of best quality will sometimes break down. For the repair and servicing of instruments experts with suitable qualifications and skill, as well as spare parts are needed. Developing countries may not have adequate facilities for repairing testing instruments, imported sophisticated instruments, in particular. Arranging for visits of repair team from abroad or sending equipment to foreign centres for repair are expensive and time consuming. The servicing activity includes: putting instruments into operation, their servicing during and after the warranty, their repair, maintenance and overhaul. For that reason local capability to provide repair and maintenance services has to be established.

2.4 Renting and leasing of instruments

Often instruments are needed only for short periods and would be redundant after accomplishing the task (e.g. while the instrument from the original set-up is under repair or calibration). In such cases purchase would be an unnecessary investment and this solution would be even slow because delivery takes time. Renting companies provide the instruments needed temporarily from their pool without delay. These instruments are checked and calibrated according to the specification. The customer pays a fee only for the short renting period. The customers even can buy the rented instruments either with leasing or direct payment. The leasing has several other advantages e.g. the company can treat these kinds of payments as operating expenses etc.

2.5 Calibration

Calibration plays an important role in the operation of the Quality Systems. The measuring and testing activity is useful only if the results of measurement are reliable, i.e. they are sufficiently accurate with a known degree of uncertainty. Calibration provides traceability, ensuring that the uncertainty level of every measurement made in the organization can be traced to known reference standards. A well organized calibration scheme gives the manufacturer the certainty that the features of the delivered products are within the specification and it gives the customer the assurance that he is buying exactly what he expects in terms of technical parameters and performance levels.

Calibration of measuring and test equipment is essential to the reliability of test data. For this it is necessary to maintain a list of all equipment with associated details. The equipment register should also contain associated calibration details and the measurement standards against which the equipment has been calibrated. The calibration methods, procedures and references should be traceable to national or international measurement standards, and appropriate certificates certifying to this should be available on record.

2.6 Procurement of instruments, marketing and trading

The first step in establishing suitable inspection and testing facilities is the purchase of the equipment. Not every company has purchase department with practice in the instrument procurement and business transactions. Even the general trading firms are unaware about the instrument market and the reliability of different instrument suppliers. Companies, which have special practice in the instrument trade, can solve most effectively the complex task of instrument procurement.

2.7 Measuring technique services

Instruments and testers in themselves are usually not enough to solve special measuring tasks. Specialized theoretical and practical expertise is also indispensable. At times companies cope with special measuring tasks which their own staff can not solve. In these cases prompt technical help is needed from companies which can send experts who have the necessary knowledge and practical experience to solve the given task. Sometimes beside the experts special instrumentation is needed so the service provider offer a turnkey solution for the problem.

2.8 Development and design of special purpose instruments

Very often special measuring demands cannot be met by means of general-purpose instruments currently available on the market. In this cases special purpose instrument or sensor with technical and construction specifications suiting the given task are required.

This order of these support services does not mean general priority list. At any site the priority order and the list of the services has to be identified according to the local requirements. The elements may be set up in the most practical sequence as defined according to the said requirements. The listed support services enable more efficient use of resources. Each activity serves and helps to solve the instrumentation management problems of a country. However, it must be emphasized that their complex use within an organisation like the Instrumentation Support Services Centre (ISSC) may even result in qualitative advantages. extended by a comprehensive knowledge base, which consists of several independent databases, catalogue and leaflet library, repair and maintenance service, etc. This service can be built up step by step in a modular structure and the more modules are implemented the more effective support of each module can be reached.

3. LOCAL CAPABILITY

Efficient use of national instrumentation resources is necessary not only for the viable operation of the existing systems, but also is a prerequisite for technical, industrial and economic development. In the developing countries limited attention is paid to instrumentation both at the level of policy and strategy. A commonly recurring problem in those countries is the absence of sufficient repair and maintenance services with the result that many instruments are out of order. Further all necessary support services (consultancy, measuring engineering, etc.) needed for the safe operation of the quality systems are missing. The status of instrumentation in developing countries in general is resulting in wastage of national resources, low efficiency and productivity of the instrumentation services. For that reason the establishment local capability providing all necessary services for the quality control laboratories is an urgent and broad need. The optimal utilization of available precision measuring instruments can be achieved through the establishment of a local ISSC.

The Hungarian approach to this lack of services enables all services needed for the operation of the precision and control instruments, to be managed together. The ISSC provides some or all of the services, which are needed, for the safe operation of precision measuring instruments. The main advantage of the ISSC concept that modules which provide seemingly independent services are implemented within the same organization and under the same management can strengthen the usefulness of each other.

This system - according to the United Nations Industrial Development Organisation (UNIDO, Vienna, Austria) - appears to be unique in its organisation and services, responding any complex problem and inquiry for instrumentation services in a developing country.

In Vietnam it was recognized at an early date (1989) that there was an urgent need for the development of instrumentation infrastructure. It was also recognised very

early that within the technical infrastructure of the country, composed of the Bureau of Standards, Metrology Office and Quality Control Laboratories, the local ISSC has also to be embedded. These institutions could act as efficient basis for the elaboration and realization of an effective national instrumentation supply, management and policies whereby they could also be of great help in the optimal utilization of the available financial, technical and personal resources available. As a first step the Repair and Maintenance, After Sale Service and Consultancy modules were implemented in 1991.

The Government of Islamic Republic of Pakistan has recognized the necessity of the development of the instrumentation infrastructure which is essential in managing the background instrumentation services necessary for the smooth operation of the instruments used in all fields of the economy in the country. The Ministry of Science and Technology requested UNIDO's assistance in establishing a National Electronic Equipment and Scientific Instruments Register and also in the preparation of a National Instrumentation Policy Framework. The MTA-MMSZ was selected by UNIDO for the execution of the services of the approved project and the implementation was carried out in 1997-1998. As the output of the project the National Instrumentation Policy Draft and the National Instrumentation Acquisition Policy Draft were elaborated by MTA-MMSZ in the framework of a complex program for the essential improvement of the level in measuring culture and its personal, technical and institutional background in Pakistan. Moreover the finalized version of National Electronic Equipment and Scientific Instruments Register (NEESIR) was installed on the PC system procured to this task in National Institute of Electronics, Islamabad (NIE). The staff of NIE was trained on the use of NEESIR. The necessary activities for the sustainable operation in the future were also outlined jointly with the responsible experts of NIE.

Physikalisch-Technische Bundesanstalt, Braunschweig (PTB) and MTA-MMSZ convened the series of Interregional Workshops on this topic in 1995 and 1996.^[6] During these courses all experience collected through the past 40 years and the economical system change in Hungary, especially, were introduced to the participants. As a result of the courses the preparatory work was commenced in several countries to develop the instrumentation services using the Hungarian approach. In Cambodia, Morocco, Nepal, Uganda official requests with project proposals regarding their local ISSC were submitted to the German Embassies in order to ask for assistance in the development of these services.

The appropriate local strategy for the maintenance of the universities equipment in Morocco has been built up also using the experience learnt through the participation in the TCs and meetings organised mainly by PTB and MTA/MMSZ in 1987 and 1995 in BUDAPEST.

MTA/MMSZ in co-operation with PTB prepared a proposal to include the instrumentation services into the development of Measurement Standardization Test and Quality Control (MSTQ) infrastructure in the developing countries. In the framework of the project: "Support of MSTQ in African and Arabic countries," which project is implemented by the PTB on behalf of the Ministry of Technical Co-operation and Development of Germany in 1999 PTB entrusted MTA-MMSZ to prepare a conception of 3 phases for implementing a feasible local ISSCs and asked for UNIDO's contribution in the implementation of such conception. In order to develop the safe operation of the Quality Schemes in developing countries UNIDO positively considered PTB's request for co-operation in the field of improving the instrumentation support services in the SADC countries. In this way no new preparatory assistance was needed in the case of the establishment of the local ISSC in Malawi, in the South Region, which is just under implementation.

In West Africa the Standards Organisation of Nigeria (SON, Lagos) is implementing its local ISSC with UNIDO support. The detailed survey was accomplished in June 2001 and the first training was carried out by MTA MMSZ in December 2001, also with UNIDO support. Now SON is acquiring the minimum tools, measuring instruments and consumable from its own resources.

The main advantages of the Hungarian Approach are, as follows:

- The instrumentation background services necessary for the smooth operation of the projects implemented under Donor's Aid Programme could be facilitated through local services on long term basis;
- The assistance of Donor in the instrumentation services field, would also support, among others, the operation of the quality control systems in the recipient developing countries;
- The human resource base of the recipient developing country is enhanced;
- Better utilization of instrumentation resources is attained;
- Forming of the engineers'/technicians' mind in instrumentation and measuring culture can be reached;
- Because of its modular structure step-wise implementation is possible.

The UNIDO's co-ordination with PTB will ensure synergetic effects in the region during the implementation of the Malawi project, as the German co-operation is currently upgrading the ISSC attached to the Kenya Bureau of Standards in the East Region of Africa. The evaluation of the Phase 1 of the program for the development of instrumentation support services further the results in approaching the self sustainability of the local Malawi

Bureau of Standards' ISSC unit will be analysed jointly by UNIDO and PTB.

4. SUSTAINABILITY OF SUCH SERVICES

Sustainability, after the execution of the project, is an essential criterion for fund mobilisation. The Systems Approach of MMSZ has proved sustainable in the present economic transition in Hungary from the centrally planned to the market economy. This may provide the same possibility for the developing countries.

As an independent non-profit institute of the Hungarian Academy of Sciences MTA-MMSZ, as an ISSC was founded in 1957 to provide background services for academic institutes in measurements and instrumentation. The company succeeded in becoming a profit oriented, self-financing institution in 1974. By that time it already provided country-wide services. At the establishment of the institute Hungary had a centrally planned economy and the economical conditions were very much like those of some developing countries. There was no free market, the convertible resources were limited, however, the technical connections with the developed countries have never stopped.

After the change of economic system the markets of the former socialist countries have practically collapsed. In this way many hundreds of big and middle enterprises became bankrupt. Nevertheless the economic force of MTA-MMSZ' institutional system is shown by the fact that the company survived. MTA-MMSZ was able to flexibly adapt itself to the fundamental change of the economy. The customers of MTA-MMSZ's services changed from the big companies to the small and medium-sized enterprises. The professional staff was cut to half (keeping alive all of its departments at a minimal working configuration with all essential services carried out by the most qualified engineers and technicians) and the volume of the instrument pool was reduced from HUF 600 millions to HUF 200 millions. Activities which did not produce profits were reduced or abolished. On the other hand, new activities were started (e.g.: instrument purchase, leasing and trading) to meet the new requirements. The cost of the company was decreased in all possible ways. From 1992 as a result of the economical changes, MTA-MMSZ has been working as a profit-oriented, private company. The institutes in the developing countries may also establish their local, profit oriented unit.

According to the Hungarian example the sustainability was reached in two years after the relevant decision. Under one management, these services can be developed in a way enabling them to support one or another and at the same time all incentives necessary for holding the trained personnel for longer periods and motivating them for maximum output can be used efficiently.

In Vietnam the ISSC was privatised in two years following the implementation of the relevant UNIDO/UNDP project in 1991 and it is still working under market conditions.

During the start of the implementation of the UNIDO project in Malawi the operation of the ISSC has been commenced. The "old" value of the precision measuring instruments which were repaired by the ISSC Unit during the first training is about US \$ 65,000.- The present value of the measuring instruments, which can solve the mentioned measuring tasks would cost approximately US \$ 200.000.- This sum does neither contain the value of the measurements, which are carried out with the repaired measuring instruments, nor the effects of the measurements in the work of the customers. Of course the new instruments would operate more reliable and would make possible to perform more job with higher accuracy and sensitivity but to be able to use them it needs expensive, new investment. The value of the basic tools could be covered from a part of the income of Malawi Bureau of Standards (MBS) from the repair activity provided for outside customers during the first training, which fact shows that the MBS ISSC Unit started its way to become a self sustainable organization.^[8]

5. STEP-WISE IMPLEMENTATION

Considering the modular structure^[2] of the Hungarian approach implementation can be carried out in steps in developing countries and countries in transition so that effective use of resources can be reached. After a survey of the most important needs of different services (consultancy, repair and maintenance, etc.) the seeds of the first units of an ISSC should be established. The work can be started with four to eight persons.

For instance in Hungary MTA-MMSZ began its activity with renting. In this way it was possible to save convertible currency, as it was emphasized, which could help the procurement. The renting activity needs its own service basis for the necessary repair and calibration work. This was the ground of the After Sale Service module. There was always steady demand for the advisory service, too, since all responsible decision makers needed special expert information before making a decision. And it was a well-known fact that the success of a decision depends on the information analysed before making it. To satisfy this requirement the Consultancy module was implemented. The demand for solving special measuring, and controlling tasks was present throughout the whole national economy. For performing them many times the instruments of the clients were not enough, and further special expertise was also needed. So the measuring engineering module was established.

When these modules were together in the institute the basic expertise necessary for the development was available, and to explore this possibility the development of single purpose instruments/systems could be started. Without training and

education it is impossible to perform any work in our world, so this module was needed to operate the system. And if an institute provides training and education for its own engineers there is the possibility for arranging courses for outside engineers, too. The co-operation of units furnishes a great surplus for training.

The construction of the system from the modules presented now is based on the experience of MTA MMSZ in Hungary. The modules can be implemented individually or in the same or any other combination in new centres or existing institutes in order to meet the specific needs of a country. According to the conditions of the country the implementation of ISSC can be started by any of these modules.

In Malawi and in Nigeria the Repair and Maintenance and the Instrument registry with the Consultancy activities were selected as the most important services. In case of the repair and maintenance of old measuring instruments it is essential to have information on the conditions of all measuring instruments of the customers, which needs to establish the Instruments registry.

In order to achieve an efficient implementation of the local ISSC unit the analysis of the needs for instrumentation services and preparation of the priority order of the requirements is needed through using the Instrument registry, to be able to focus the efforts. The importance of the management aspects (definite leadership, organisation, motivation, functions, responsibilities, layout, stores, necessary place for work, furniture, etc.) of the establishment of the local ISSC unit has to be emphasized. the reorganisation of existing units (personal, layout of the workplace, administration) is suggested The ISSC Unit has to be a profit centre, which prepares its own profit and loss statement; Its costs and income have to be separated from the institutes' other units. The different functions in the ISSC Unit (repair, procurement/import, administration) have to be separated. The responsible person of each function has to be appointed to be able to carry out the efficient step-wise implementation. The technical background (sources of technical documentation of old measuring instruments, continuous support in special technical expertise, special spare parts) has to be established, too, for the ISSC.

CONCLUSIONS

In order to establish local capability for providing efficient instrumentation support services for the safe operation of the quality systems in developing countries

- 1./ Systematic approach is needed and the consideration of management aspects is essential.
- 2./ The establishment of the ISSC Unit is needed, as a "profit centre", to be able to prove its sustainability.
- 3./ The technical background (sources of technical documentation of old measuring instruments, special technical expertise, special spare parts) necessary for the ISSC's work has to be established, too. Any co-operation in this regard can only work on commercial basis.

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