JAPAN INTERNATIONAL COOPERATION AGENCY
MALAYSIA ECONOMIC PLANNING UNIT,
PRIME MINISTER'S DEPARTMENT

THE STUDY FOR UPGRADING THE MEASUREMENTS CENTRE, STANDARDS AND INDUSTRIAL RESEARCH INSTITUTE OF MALAYSIA

FINAL REPORT

(SUMMARY)

JANUARY, 1994

JAPAN QUALITY ASSURANCE ORGANIZATION

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PREFACE

In response to a request from the Government of Malaysia, the Government of Japan decided to conduct a study for Upgrading the Measurements Centre, SIRIM of Malaysia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Malaysia a study team headed by Mr. Kiyoto Mitsui, Japan Quality Assurance Organization, from June to July 1993.

The team held discussions with the officials concerned of the Government of Malaysia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

January, 1994

Kensuke Yanagiya
President
Japan International Cooperation Agency

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CHAPTER 1

BACKGROUND AND OBJECTIVE OF THE STUDY

1. BACKGROUND AND OBJECTIVE OF THE STUDY

1.1 Background of the Study

Project-type technical cooperation (National Metrology Laboratory Project) was provided for 4 years from December, 1981 to January, 1986 for the SIRIM Measurement Centre of the Standards and Industrial Research Institute of Malaysia (SIRIM), greatly contributing to the establishment of measurement standards, improvement of measuring technologies/techniques and provision of calibration services in Malaysia. Seven years after the completion of the said cooperation, the capacity and capability of the SIRIM Measurement Centre have begun to fall short of the more advanced and diverse requirements of Malaysian industries, leading to a strong call for the expansion and strengthening of its functions. Functional consolidation of the SIRIM Measurement Centre is also called for by the "Study to Plan the Promotion of Industrial Standardisation and Quality Control" implemented during the period between January, 1992 and January, 1993 to improve the international competitiveness of Malaysian industrial products.

Against this background, the Japan International Cooperation Agency (JICA) sent the Project Feasibility Study Team to Malaysia in February, 1993 in response to a request made by the Malaysian side to assist the development study on the proposed upgrading of the SIRIM Measurement Centre and to discuss the contents of the request and other issues with related organizations in Malaysia.

As a result of the discussions, the SIRIM requested JICA to prepare a master plan for the fundamental upgrading of the existing functions of the SIRIM Measurement Centre to strengthen the base for industrial development and to further support the increasingly advanced nature of industrial activities in Malaysia.

In response to this request, JICA sent the Preliminary Study Team to Malaysia in March, 1993 which subsequently confirmed the background and contents of the request. Following a series of consultations to facilitate the implementation of a full-scale study, the Scope of Work (S/W) for the implementation of the Study for Upgrading of the SIRIM Measurement Centre, Standards and Industrial Research Institute of Malaysia (the Study) was signed by the JICA Team and the Economic Planning Unit (EPU) of the Prime Minister's Department.

1.2 Objective of the Study

The objective of the Study is the preparation of a master plan for the upgrading of the SIRIM SIRIM Measurement Centre to ensure the efficient management of the national metrology system in Malaysia. The intended master plan will place special emphasis on the following items, taking the present conditions of the national standards and industrial metrology system and also the current industrial requirements in Malaysia into consideration.

(1) Establishment, renewal and maintenance of national standards

(2) Establishment and enforcement of national traceability system

(3) Research and development of measurement technologies/techniques

(4) Promotion of wider use of traceability technologies to industries

(5) Provision of calibration service

1.3 Scope of the Study

The scope of the Study is described below as determined in the S/W.

(1) Study on Background

(a) Current industrial situation

(b) National industrial development policies

(c) Legal metrology system

(d) General conditions relating to national standards, legal metrology system, industrial measurement system, traceability system and calibration service

(2) Current State of Metrology and Future Plan

(a) Policies, laws, regulations and management system relating to metrology system

(b) Metrology management system

(c) Calibration organizations and their activities

(d) Suitability of traceability system

(e) Measurement facilities and technical staffs

(f) Education and training of technical staffs

(3) Preparation of Development Plan for Measurement System

(a) Upgrading and expansion of national standards

(b) Enforcement of industrial measurement system

(c) Restructuring of traceability system

(d) Expansion of calibration service

(4) Preparation of SIRIM SIRIM Measurement Centre Upgrading Project

(a) Functions and activities

(b) Management

(c) Staff recruitment

(d) Equipment

(e) Facilities, floor area and layout

(f) Cost estimate

(g) Necessary measures for training of technical staffs

(h) Implementation plan

CHAPTER 2

PRESENT STATUS AND FUTURE OUTLOOK OF INDUSTRIAL DEVELOPMENT IN MALAYSIA

2. PRESENT STATUS AND FUTURE OUTLOOK OF INDUSTRIAL DEVELOPMENT IN MALAYSIA

2.1 Overview of Economy

2.1.1 Economic growth and changes in economic structure

The economy of Malaysia has sustained stable growth for the last two decades. Though Malaysia has a relatively small population, industrialization of the nation is well advanced and the Gross National Product (GNP) level is also in a moderate range.

Malaysia's average growth rate of the Gross Domestic Product (GDP) in real terms in the 1970s was 6.6% per annum in 1970-75 and 8.6% in 1975-80. In the 1980s, the growth rate in real terms declined to 5.1% per annum in 1980-85, under the influence of the recession of 1985-86. However, owing to rapid recovery of the economy, the annual growth rate was sustained at the level of 6.8% in 1985-90.

Recent growth of the GDP shows a higher rate than in the past, namely, 8.7% in 1989, 9.8% in 1990 and 8.6% in 1991, respectively, in comparison with the previous years.

The greatest factor behind the drastic expansion of the Malaysian economy is the growth of exports. The Government has promoted economic growth by encouraging industrialization of export-oriented business as a basic strategy, in view of limits of domestic-market-oriented industrialization due to the limited scale of the domestic market based on the small population. As Table 2-4 shows, exports reached the comparatively high ratio of 33% in the gross national expenditure as early as 1980. Then, exports sustained substantial growth, far higher than that of the GDP, resulting in the annual average of 7.1% in 1980-85 and 14.9% in 19XS90. In particular, growth in the past three years has been remarkable: 18.1°~ in 1989,18.3% in 1990 and 16.2% in 1991 which are almost two times higher than the growth rate of the GDP. Consequently, the ratio of exports in the gross national expenditure rose year by year and reached 45.8% in 1991.

Analysis of the composition of the GDP shows that both the agriculture sector (including forestry and fisheries) and the mining sector (excluding oil and natural gas) continued modest growth while the manufacturing sector grew rapidly, particularly in recent years. Since the mid-1970s, the development of oil and natural gas has advanced so that it has become the core industry in the mining sector in place of tin production, a traditional mining industry. The average annual rate of growth in 1985-90 shows a very high figure of 13.f)% in manufacturing industry compared to only 4.6% in the agriculture sector and 4.3% in the mining sector even including oil and natural gas. Growth of the manufacturing industry, particularly in the past two years, has been further advanced, with 17.9% in 1990 and 15.5% in 1991. This pulled up the ratio of the sector in the GDP from 19.6% in 1980 to 28.7% in 1991 while that ratio of agriculture as well as the mining sector (including oil and natural gas) declined respectively from 22.9% and 10.1% in 1980 to 17.3% and 9.3% in 1991.

As such, industrialization in Malaysia has developed rapidly in the 1980s and manufacturing industry is thus the leading force for economic growth of the country. For further development of the economy, expansion of manufacturing industry, in particular export-oriented industry, is indispensable.

2.1.2 Structure of external trade

The structure of the export industry has greatly changed in the past decade. Primary products such as rubber, oil palm, tin and timber are the traditional export items. Since the 1980s, however, exports of these primary products stagnated or declined. After the 1970s, the export of oil, and in the mid-1980s, the export of natural gas as LNG, have started. Although these two items now form the principal export industry, current growth is not conspicuous. The Government has made efforts to promote the export-oriented industrialization since the mid-1970s. Exports of manufactured products grew at an annual average rate of 14.6% in 1980-85, and their share in total exports expanded from 22.4% in 1980 to 32.8% in 1985. After 1985, it rose further to 30.5% per annum on average and registered a 59.2% share in total exports in 1990. Thus, the manufactured products are the main export items in Malaysia recently, followed by oil and LNG with the share of 1~.2%, timber 8.9%, oil palm 5.5%, rubber 3.8% and tin, which registered 8.9% of total exports in 1980, counts merely 1.1% now.

Among manufactured exports, the largest items are electrical and electronics products, and textiles and garments. Out of these two groups, the former dominated 56.5% of all exports of the manufactured products while the latter was 8.7% on average in the three years of 1988-90. Shares of the other products were: food processing and chemicals 4.7% respectively, metal 3.9%, transport equipment 3.5%, wood-based 3.3% and rubber-based 3.1%.

2.2 Present State of Industrial Development and Structural Characteristics of Industry in Malaysia

2.2.1 Historical changes in industrialization strategy and industrial development policy

In Malaysia, since gaining independence in 1957, various industrial policies have been introduced in order to promote rapid growth of the manufacturing industries. These policies were mainly aimed at attracting investment from the developed countries.

In 1971, the New Economic Policy (NEP) was introduced and a new dimension and direction to industrialization was set force. Industrialization became an important vehicle to achieve the objectives of the NEP, particularly in terms of providing opportunities for employment and equity restructuring.

In the 1980s, the second phase of import-substituting industrialization took place; it put emphasis on the heavy industry sector. A number of large projects such as iron and steel, cement, the national car and small engine production ware initiated under the leadership of the Heavy Industries Corporation of Malaysia (HICOM). However, during this period, the world economy entered a recessionary phase as a result of the second oil crisis. In 1982, the Government was confronted with the twin-deficit problem in the fiscal and external balances as the recession was more prolonged and deeper than expected. As a countermeasure, the structural adjustment program was introduced to cut government expenditure, particularly on low-priority and import-intensive projects. At the same time, a comprehensive policy package was announced to encourage the private sector to act as a driving force for the growth of economy. Thus from 1984 onwards, economic policy was oriented towards deregulating the economy and reducing the role of the public sector while the industrialization strategy was based on export-led growth.

In the process of structural adjustment of economy, industrial policies were reviewed comprehensively and the Industrial Master Plan (IMP) was introduced to plot the industrialization strategy for the period 1986-95. The IMP framed policies to promote outward-oriented industries with particular emphasis on resource-based industries and diversification of the non-resource based industries, as well as several heavy industries.

In 1991, the effect of past policies and strategies were thoroughly reviewed during the formulation of the Second Outline Perspective Plan (OPP2) and the Sixth Malaysia Plan (SMP). Under these plans, Malaysia stepped forward to a renewed economic development which will be a core of industrialization as the basis of the economic growth. At present, these development plans are being implemented within the overall framework of the National Development Policy (NDP) which will enable Malaysia to become a developed nation by the year 2020.

2.2.2 Present state of manufacturing industry

Under the positive industrialization policy of the Government, industrial growth in Malaysia has been very rapid in the past two decades. As reviewed in 2.1 growth of the manufacturing industry in the latter half of the 1980s was most remarkable and value added in the sector reached nearly 29% of the GDP in real terms in 1991 as the largest growth element of Malaysia. The manufacturing industry is also the largest export industry in Malaysia. It accounted for about 59% of total exports with such manufactured exports as electrical and electronics products, textiles and garments, etc. In terms of employment, the manufacturing industry absorbs about 20% of total employment, next to the agriculture sector including forestry and fisheries.

Also in terms of exports, the electrical and electronics industry is the largest having a 56.5% share on average in total manufactured exports in 1988-90. The textile and garments industry follows as the second largest export industry, having a 8.7% share during the same period. These two sectors account for almost 65% of exports of manufactures and about 35% of total exports. Other exports of manufactures are as follows: food products 4.7%, chemical and chemical products 4.7%, metal products 3.9%, transport equipment 3.5%, wood-based products 3.3%, rubber-based products 3.1% and non-metallic mineral products 1.7%.

2.2.3 Areal distribution of manufacturing industry

Historically, industries in Malaysia have developed in Peninsular Malaysia mostly in the west coast area.

It is likely that these three states of Selangor (including Kuala Lumpur), Johor and Penang will still be investment centers for general manufacturing industries, while progress of industrialization is also expected in the states of Perak, Kedah, Melaka and Sarawak. Industries related to oil and natural gas will expand in Terengganu State on the east coast of Peninsula Malaysia and Sarawak State in Borneo Island as they are located close to oil and natural gas fields.

2.3 Industrial Development Plan of the Government

2.3.1 Long-term economic development policy and economic growth target

Following the First Outline Perspective Plan (OPP1), 1971-1990, the Second Outline Perspective Plan (OPP2), 1991-2000, embodying the National Development Plan (NDP) was adopted in June 1991.

As the first phase in the implementation of the OPP2, the Sixth Malaysia Plan (SMP), covering the period 1991-1995, is being implemented. The SMP elaborates the strategies as well as the programs and projects designed to achieve the objectives of NDP.

The objective of the NDP is to attain a balanced development of the economy in order to establish a more united and just society towards the realization of the ultimate objective that Malaysia becomes a fully developed nation by the year 2020 not only economically but also in all other aspects. The NDP places emphasis on increasing efforts to make the economy more resilient in meeting external changes and uncertainties, and also a need to maintain a conducive climate to attract investment into the country in order to cope with increasing competition around the world and from neighboring countries for foreign capital and investment.

Economic policies under the NDP are therefore directed towards:

1) strengthening the domestic sources of growth by maintaining macro-economic stability, promoting private sector efficiency and productivity, encouraging high levels of private investment, diversifying the industrial base and expanding exports; and

2) accelerating human resource development which can contribute to improvements in productivity and efficiency to cope with the problem of diminishing natural resources and labor supply.

After the recession of the mid-Eighties, the Malaysian economy has recovered strongly. The economic policy anticipates that this growth momentum will continue in the 1990s, that are targeting to grow by an average rate of 7% per annum in real terms in the decade of OPP2 as compared with the average growth of 6.7% achieved during the OPP1 period.

The manufacturing sector is expected to play the leading role for achieving the GDP growth target. The target average growth rate for the manufacturing sector set at 10.5% per annum in real terms by far exceeds the growth rate envisaged for all the other sectors of the economy in the OPP2 period. Thus the manufacturing sector's share to GDP is projected to increase from 27% in 1990 to about 37% by the year 2000, making Malaysia an industrial-oriented economy, increasingly dependent on manufacturing exports for the growth of incomes and employment in the country. Manufacturing exports are projected to account for about 81% of total exports by the year 2000 as compared with 60.4% in 1990.

2.3.2 Long-term development strategy of manufacturing industry

The manufacturing industry, particularly export-oriented industry, has sustained rapid growth in recent years. Nevertheless, with recognition of risks associated with increasing competition in the export of manufactured products which Malaysia will face especially from neighboring countries which have the advantage of low labor costs, the policy plan emphasizes that Malaysia cannot rely as strongly as it does now on exports of electronics and electrical products, and textiles and garments for the growth of the export sector. Further, emphasis is placed on structure of the industrial base which remains potentially weak as it is heavily concentrated in two sub-sectors, the electrical and electronics and the textile and apparel sub-sectors. Although these two sub-sectors continue to be the major contributors to output growth and export earnings, the plan has identified several issues still to be solved. These issues are:

1) limited linkages both within the sub-sector and with the rest of the economy, notably with SMIs;

2) heavy dependently on imported technology coupled with inadequate R&D activities leading to limited product development and design capabilities;

3) inadequate international marketing capabilities, with exports hinging on parent companies' demand and specifications, subcontracting arrangements and GSP privileges; and

4) competitive advantage lying in the availability of relatively low cost, productive and skilled labor with comparatively lower wage rates vis-a-vis the NIEs and the developed countries.

Thus, in order to remain competitive in the export of manufactured goods and to sustain rapid economic growth, the NDP has adopted the development strategy of increasing productivity and further diversifying into higher value-added production, while pursuing policy reforms aimed at widening and deepening the industrial base, leading to higher value-added products and increased linkages with SMIs.

Towards this end, the NDP's development strategy for the manufacturing is as follows:

1) <u>Identification of new sources of growth</u> to further accelerate the expansion of the manufacturing sector,

2) <u>Pursuance of industrial deepening</u> in order to achieve greater value-added and linkages both vertical and horizontal,

3) <u>Further promotion and upgrading of SMIs</u> to make them an important and viable vehicle for industrial expansion and the creation of inter-industry linkages and support, with the target of raising the contribution of SMIs in terms of value-added and labor absorption in the manufacturing sector to the level of 40% and 50%, respectively, within the next decade from the current positions of 20% and 30%.

4) <u>Acceleration of regional dispersal of industries</u> not only to achieve a more balanced distribution of investment but also to locate industries closer to sources of labor and raw materials.

5) <u>Expediting the restructuring and rationalization of industries</u> which have lagged behind in growth as a result of outmoded structures of production and technology, and high cost of production. This includes the development of selected basic industries, particularly machinery and engineering, automobiles and chemicals, which can create new demand for intermediate and capital goods and services, provide new opportunities for growth, industrial technology and

inter-linkages, and in particular nurture SMIs in the manufacture of component parts and intermediate products.

6) Export promotion of manufactured products

2.3.3 SMP's Industrial development plan

The SMP's thrust for industrial development is to promote new sources of growth so as to strength and diversify the industrial base while maintaining the importance of the traditional sources of growth, namely, the electric and electronics, and textile and apparel industries. It emphasizes the development of export-oriented, high value added, high technology industries with strong support from R&D and the growth of domestic high technology industries.

CHAPTER 3

MEASUREMENT SYSTEM AND TECHNICAL REGULATIONS

3. MEASUREMENT SYSTEM AND TECHNICAL REGULATIONS

A measurement system is a technical basic necessity for the orderly running of a country and is utilised in combination with legal technical regulations. The main objectives of measurement regulations are the maintenance of fair trading practices, ensuring of the health and safety of the public and protection of the environment. The development of industries and the economy generally expands the scope of the role played by the measurement system with more occasions on which measurement results play a decisive role.

The Weights and Measures Act in Malaysia has been introduced to ensure fair trade but its regulatory functions are mainly centred on that equipment used for metric measurement, such as "balances", "rules" and "measures". The subject area for administrative measurement regulations is comparatively limited. At the same time, the absence of a consistent measurement system and/or national standards relating to measurement requirements in such administrative areas as transport, telecommunications and pollution control, etc. has prompted examination of the possible introduction of a measurement system by the relevant government ministries and agencies.

Urgent examination of the issues described below appears necessary to establish the correct legal framework to improve and consolidate the national measurement system.

3.1 Legal Metrology System

A weights and measures act mainly aims at maintaining economic order. As the types of measurements required to ensure fair trade are diverse, however, it is very common for the subjects of technical regulations, such as the official inspection and approval of measuring instruments, to be restricted to those areas which have significant bearing on the protection of general consumers. While the question of how far measurement regulations should extend is an issue of national sovereignty, the global trend is for the scope of regulations to be extended in accordance with both industrial and economic development. Meanwhile, regulating methods tend to be simplified with the active use of a pattern approval system and/or certification system of the private sector together with official inspection and approval.

In Malaysia where economic development is rapidly progressing, the current Weights and Measures Act and administrative arrangements to enforce the Act are deemed inadequate to fully meet the present social requirements. Aware of the inadequacy, the Enforcement Division of the Weights and Measures Department, Ministry of Domestic

Trade and Consumer Affairs, which is the competent agency for Malaysia's national metrology affairs, has been examining suitable future measures to improve the situation. The basic improvement alternatives under examination are (i) revision and upgrading of the present Weights and Measures Act which mainly deals with the inspection of measuring equipment to a more comprehensive measurement law and (ii) introduction of a type of basic metrology law in addition to the existing Weights and Measures Act. Regardless of which of these alternatives is opted for, the establishment of uniform national measurement standards (legal metrology units and standards embodying such units) is necessary. The integration and sharing of technical measurement standards in all fields and the harmonisation of such national standards with international norms and standards are also required.

The field survey which was conducted as part of the Study obtained vital information to be used to meet the above-mentioned requirements for legal regulations. Based on the findings of the field survey team, the present main technical issues and corresponding remedial measures are outlined item-by-item below.

3.1.1 Legal Metrology Units

It appears essential for legal metrology units in Malaysia to be based on the SI in view of the ever expanding scope of Malaysia's international trade and also in view of the current common international practice. In fact, Malaysia launched a 10 year plan in 1972 to harmonize its national legal metrology units with the SI and all present legal metrology units used for trade and certification under the existing Weights and Measures Act are determined based on SI units. In some industrial areas, however, the use of such non-metric units as inches, pounds and indigenous units is permitted together with non-SI units, including the gravitational unit system. As these non-metric and non-SI units are defined in terms of conversion factors with the corresponding SI units, the SIRIM Measurement Centre is only required to maintain certain scope and accuracy of SI-based measurement standards for practical purposes. However, it is necessary for the SIRIM Measurement Centre to keep in its possession those standards and others for frequently used non-SI units to meet the demand of specific industries.

In theory, all non-SI units can be created by combining the relevant SI units provided the basic SI units (length, mass, time, electrical current, temperature quantity of substance and illumination units) are firmly maintained and supplied. Technical assurance of the social uniformity of measurement standards demands a government organization to determine the combined legal metrology units (for example, force, pressure, volume/flow, voltage and electric power, etc.) and measurement standards and to inform/supply them to the relevant sectors. As legal standards and industrial standards are the same from a technical point of view, they can share the facilities designed to maintain and control national standards. Given the likelihood of an increased demand for administrative work in regard to measurement standards in the future, the establishment of a wide range of legal metrology units, including standards for industrial use, as soon as possible is desirable.

The present Weights and Measures Act in Malaysia sets forth the legal metrology unit for some 80 different physical quantities and is adequate for the immediate legal control purposes. The types of units of which clear definition will be required in the near future include those for protection from radiation, those relating to environmental measurements and those relating to industrial safety such as material strength and hardness, etc. Part V, Section 34 of the Weights and Measures Act stipulates that all metrology units to be used by laws and regulations must adopt the appropriate SI units and/or conversion factors listed in the Third Schedule of the Act.

3.1.2 Types and Accuracy as Required by Legal Metrology Units

In determining the scope of legal metrology, the minimum requirement appears to be the inclusion of those metrology units used for trade with the public (consumers) or which are directly related to industrial safety, transport safety and safe living. In this context, the legal determination of technical standards and compliance evaluation methods relating to the rights and duties of the public also appears essential. Although the enforcement of a law does not usually require a very high degree of accuracy, there are many types of quantities to be addressed by law. Accordingly, the methods or manner of effecting technical control are numerous. In general, the necessary tests and inspections are conducted by either a competent agency or private laboratory certified by the competent agency based on compliance with the set technical standards. In either case, a mechanism must be provided whereby consistent measurement standards are maintained and controlled with government responsibility and duly informed to related organizations. This necessity has prompted the listing of areas to be examined in connection with the Study and pending issues relating to the identified areas and points to note for the future improvement of measurement standards are summarised below.

(1) Official Inspection or Certification of Commercial Measuring Instruments (particularly those relating to public utilities such as watt meters, gas meters, water meters, taxi meters and telephone unit counters, etc.)

At present, meters to calculate the charges for public utility services, such as electricity and gas, are controlled by the competent agencies, including the Electricity and Gas Supply Department of the Ministry of Energy, Telecommunications and Posts, Waterworks Department of the same ministry and Road Transport Department of the Ministry of Transport, while measurement standards are supplied by the SIRIM. The technical linkage between these agencies and the SIRIM, however, is generally inadequate. One example is that the verification of meters is not conducted by the competent agencies and the inspection results of private companies are simply approved.

Appropriate control of these meters in accordance with official standards is important not only for the enforcement of fair trading practices as well as for the protection of consumers but also for the progress of the rationalisation of energy use throughout the country. Moreover, such control is required for supply and demand adjustment and for taxation purposes.

As far as its purposes are concerned, the method of technical control is the same as the control method for "scales and other measuring instruments" under the Weights and Measures Act. The actual control regime should consist of pattern approval, testing and verification by the competent agencies, certification of private verification institutions and/or commissioning of such work to private companies depending on the actual circumstances. For the technical part of the regime, it is necessary to achieve unification of measurement technologies/techniques so that the development of various measurement standards can be conducted in a coherent manner. To be more specific, it is necessary to establish a system whereby the SIRIM conducts the regular calibration of standard instruments. It is also desirable for the SIRIM to conduct the pattern approval testing of meters together with the provision of a verification service or to at least conduct technical evaluation to confirm the testing results of other institutions. With regard to the certification of testing and verification institutions, confirmation of their technical competence and the traceability of measurement standards are essential. The supply of such standards should be an important function of the SIRIM.

The subject scope of the present Weights and Measures Act in Malaysia and the issues to be examined in the Upgrading Project are briefly described next for reference purposes. The Act intends the control of all measurements used for trade based on quantity and stipulates that government organizations must conduct the limited verification and inspection of measuring instruments used for domestic "retailing" services. The measuring instruments referred to by the Act are those tools, machines or devices used to measure length, area, volume, time or mass. This means that of those meters mentioned earlier for utility services, watt-hour meters are not subject to the Act while others are, in principle, subject to the Act. The fact that these meters are not currently subject to control may be explained by the historical divisions of the relevant jurisdiction and the technical difficulty of providing the necessary inspection/verification facilities. Another important role of the Act is ensuring the introduction of adequate administrative and technical measures to prevent incorrect measurement. In this context, the introduction of a pattern approval system appears essential in view of the complex structures and mechanisms of measuring instruments. Given the fact that an electronics revolution is taking place, even in the field of mass-meters, i.e. scales, for commercial use, the Weights and Measures Department or the SIRIM should establish an appropriate pattern testing system in the near future. Furthermore, from the viewpoint of ensuring fair trade practices, it is necessary for measurements of such quality elements of merchandise as ingredients and density, etc. to be brought under the control regime.

Note: The Weights and Measures Department has a plan to set up its own metrology laboratory which was not certain when the Field Survey was conducted. This laboratory aims to calibrate the standards and measuring equipment owned by the verification offices under the Weights and Measures Department. Effective implementation of legal metrology will be expected when it is established.

(2) Measurement Standards for National Land Surveying

Standards in this field are currently maintained and controlled by the Survey Department of the Ministry of Land and Regional Development. The calibration of laser distance measuring equipment, which demands high accuracy, is entrusted to the NPL (National Physical Laboratory) in U. K. Accurate surveying is essential not only for conservation purposes and for the rational development/utilisation of national land as well as for the prevention of natural disasters but also for fair land transactions and the smooth implementation of civil engineering and building projects. Measurement standards which are consistent with those in other fields must, therefore, be upheld.

For the domestic provision of measurement standards for surveying equipment, it is necessary to have at least a 50m long thermostatic laboratory together with a long bench, mobile measuring table and various related equipment, including an angle standard, to allow measurement over a long length. The SIRIM cannot currently meet these requirements and the provision of such facilities and equipment must be discussed as part of the Upgrading Project.

(3) Measurement Standards for Telecommunication Business (frequency, time, hour)

Technical control in this field is conducted by the Telecommunications Department of the Ministry of Energy, Telecommuications and Posts with the calibration of frequency standards and high frequency equipment, which demand a high degree of accuracy, being entrusted to the SISIR in Singapore. The current over-crowding in radio use makes the accurate allocation of frequencies while strictly controlling the illegal use of radio waves critically important. The provision of highly reliable standards and advanced technologies is a precondition for such tight allocation of frequencies and equipment control. At present, the SIRIM has no standards to meet this precondition and, in view of the urgency of this issue, such standards must be provided in the first phase of the Upgrading Project.

(4) Measurement Standards Relating to Road Transport Vehicles and Pattern Approval

Body inspection and other vehicle inspection work are currently conducted by the Road Transport Department of the Ministry of Transport. The number of inspection items is fairly limited and measurement standards are only available for body weight, emission gas (carbon emission volume of diesel vehicles) and transmissivity of window glass, etc. The calibration of measuring instruments is entrusted to the Weights and Measures Department and the SIRIM. Pattern approval is confirmation of the inspection results certified by car manufacturers or foreign inspection institutions. The Department does not have its own facilities to conduct testing and inspection.

There is currently only one domestic vehicle manufacturer in Malaysia. As the number of cases of vehicles undergoing extensive repair or remodelling is small, there is little need for pattern approval testing or detailed body inspection. In the future, however, it will be essential to establish facilities which are capable of testing the compatibility of all vehicle components and functions with the relevant standards, necessitating the introduction of relevant measurement standards. The scope of the SIRIM's calibration services should, therefore, accordingly be expanded.

(5) Measurement Standards for Pollution Control

Control relating to air pollution, water contamination, soil contamination, noise and vibration, etc. is currently the responsibility of the Department of Environment of the Ministry of Science, Technology and Environment pursuant to the Environmental Quality Act and Clean Air Act, etc. In fact, most control takes the form of administrative guidance based on set guidelines. In the case of an actual environment measurement being required, the Department of Environment, which is empowered to enter premises to conduct inspection, collects samples and request the Chemistry Department of the Ministry of Science, Technology and Environment to analyse them. With regard to noise and vibration, only guidelines are currently in force. The Department of Environment hopes that the SIRIM will acquire calibration capability to maintain the reliability of noise and vibration-related measuring equipment.

In Malaysia, all types of work relating to chemical analysis and the measurement of ingredients are entrusted to and conducted by the Chemistry Department which is currently preparing its own plan to consolidate the relevant technical regime. While all chemical measurement standards are ultimately traceable to SI units, the routes of traceability are generally very complex. Although unique technical methods are used in each field, most working standards are spread via certified reference materials. Whether or not the National SIRIM Measurement Centre should be given jurisdiction over chemical standard-related work is a decision of a political nature. As far as the technical aspect is concerned, the compatibility of measurement standards can be maintained provided that there is a single organization responsible for such standards. This organization need not necessarily be the SIRIM Measurement Centre.

Based on the above considerations, it appears appropriate not to include chemical standard-related facilities in the Upgrading Project except for calibration facilities for such pollution-related equipment as noise meters and vibration meters.

(6) Measurement Standards Relating to Customs Law

The Customs Law clearly stipulates the need for calibrating related equipment (for example, tanks for oil trade and flow meters, etc.) with the required accuracy. The actual calibration work is conducted by such independent surveyors as the SGS (details of these surveyors are given later), the technical competence of which has been confirmed by the SIRIM. As the scope of the SIRIM's technical competence confirmation is rather limited at present, the expansion and upgrading of the relevant measurement standards and calibration capability of the SIRIM are deemed highly necessary to secure the required level of traceability.

3.2 Other Metrology-Related Legal Regulations

All the items discussed in 3.1 represent those fields in which the introduction of measurement standards with the enforcement of laws and regulations is directly required. There are other fields in which the requirement for measurement standards has yet to materialise or in which consolidation of the technical basis for measurement is required prior to the actual enforcement of regulations. Some important fields of this nature, the inclusion of which in the Upgrading Project should be considered, are described below.

(1) Regulations on Environmental Conservation and Waste Disposal

A resolution passed by the UN Conference on Environment and Development (Earth Summit in Rio de Janeiro in 1992) calls for international cooperation to implement comprehensive measures to maintain a healthy natural environment in addition to conventional regulations on specific pollutants. In order to meet this challenge, various measurement technologies and measurement standards must be developed in regard to environmental assessment, pollution-free products and production processes and safe waste disposal, etc. While most of the new requirements can be met by the skillful application of the basic measurement standard regime, the effective calibration of special measuring instruments will require the SIRIM Measurement Centre's possession of the relevant facilities and technical capability.

(2) Regulations on Electromagnetic Interference

The ever increasing use of electronic equipment in all types of fields has necessitated the introduction of regulative measures from the viewpoint of public interest in order to prevent accidents or problems caused by electromagnetic interference. The testing of electromagnetic waves generated by such equipment and the testing of equipment resistance to electromagnetic noise require a large number of instruments and facilities, including such extensive facilities as an electromagnetic dark room. Although these instruments and facilities are not included in the Upgrading Project, their inclusion in a future upgrading programme is deemed appropriate in view of the likely development of testing requirements in this area.

(3) Regulations on Buildings and Industrial Safety

There is a marked tendency for building safety standards to become more detailed and stricter in accordance with the more advanced nature and higher density of building service facilities. As a large number of measuring instruments are used to test the conformity of building facilities and equipment with various standards relating to materials, construction work and use safety, a social organization is required to provide calibration services based on fair standards. Most of the anticipated work in this field can be conducted by the ordinary calibration service. Because of the involvement of many types of special equipment, however, proper attention should be paid to the development of calibration requirements in this field and arrangements should be made to immediately respond to the requirement to expand the scope of the calibration service once such requirement actually arises.

(4) Regulations on Safety of Consumer Goods

The number of instances of official standards being introduced in regard to the safety of various products used in daily life to protect consumers is increasing. The conformity of standards relating to the safety of electrical appliances, fire-resistance and inflammability of clothing, curtains and carpets, safety of pressure containers and safety of gas appliances, etc. is judged by means of various tests and inspections stipulated by the relevant standards. While most of these tests and inspections are probably conducted by the manufacturers and/or third party organizations, the responsibility to establish standards and to confirm the technical competence of these manufacturers and organizations must lie with the government. Therefore, it is desirable that the Upgrading Project incorporate preparatory measures to perform such responsibility in response to the possible introduction of new regulations in this field.

3.3 Response to Bilateral or Multilateral Approval of Standards and Certification Systems

All the requirements described so far relate to domestic legal regulations in Malaysia. Given the Malaysian industrial policy of further promoting export industries, consolidation of the metrology system is extremely important to respond to the move toward international standards and certification systems, i.e. the mutual approval of testing and inspection results. According to the principles of the GATT Standard Code, it is desirable for an exporting country to test and inspect export products based on the standards of the importing country and to attach a conformity certificate to the products to be exported to indicate where the product inspection responsibility lies. In order to provide such a certificate, the exporting country must have a system capable of testing and inspecting export products in accordance with international standards or the standards of the importing country. This system must be operable for at least the types of tests and inspections stipulated by international standards and codes, etc. The scope of the system will most likely rapidly expand with an increase of the subject products and improvement of product performance. In many cases, new products or the performance level will need to face testing or inspection under the legal regulations already in force in the importing country. To make mutual approval feasible under such circumstances, it is essential that the government of the exporting country guarantee the reliability of the testing and inspection conducted in its country. This entails government responsibility to consolidate measurement standards which form the basis of all testing and inspection. From this viewpoint, it is also essential for the SIRIM Measurement Centre Upgrading Project to sufficiently allow for further expansion in the future to deal with new duties arising from the bilateral and multilateral approval of standards and certification systems.

CHAPTER 4

CURRENT CONDITIONS AND PROBLEMS OF MEASUREMENT SYSTEM

4. CURRENT CONDITIONS AND PROBLEMS OF MEASUREMENT SYSTEM

4.1 Outline of Measurement System in Malaysia

4.1.1 Measurement Standards

Measurements standards mean the basic unit values for specific types of quantities to be used as the standards for measurement and also mean the methods, tools and instruments to realise specific quantities using such basic units. Measurement standards are often simply referred to as "standards" in the field of measurement. In the narrow sense, they are basic standards (primary standards) for relevant types of quantities while, in the broad sense, they are used as the general name for all standards, inclusive of secondary and lower standards which are introduced to relate primary standards to practical measurement levels. In reality, it is inconvenient if only one standard of a specific value exists for one type of quantity. Consequently, such secondary standards as a standard weight of 100 grammes and a standard weight of 1 gramme, etc. are introduced to improve the practicability of standards to cover all necessary areas of measurement. Standards in a broad sense, therefore, include a variety of measurement methods, tools and instruments.

While measurement standards represent standard quantity values (sizes), they are actually expressed in various forms, ranging from the physical representation of quantity by such tools as the kilogramme standard and such standard weights for such standards as thermodynamic temperature scales where the actual quantity is only determined when the set procedure to determine such scales is strictly followed. The former types of measurement standards which concretely indicate a specific quantity value and which are used as measurement standards are called "standards" in JIS terminology. Accordingly, the temperature fixing apparatus and platinum resistance thermometer, etc. used to determine thermodynamic temperature scales only constitute part of a standard and are not "standards" in JIS measurement terminology. In practice, however, a standard pressure gauge and standard thermometer, etc. used in association with secondary or lower measurement standards are often called "standards". All tools and instruments used in association with primary, secondary and lower measurement standards are referred to as "standards" in this report.

As described above, the primary standards for measurement are transformed to more convenient values or forms to facilitate practical measurement. This transformation can be conducted by transfer standards (secondary and tertiary standards, etc.) which act as the medium to translate the basic values of quantities determined by primary standards to those used for practical measurement.

In the case of the measurement of mass for example, while the kilogramme standard represents the primary standard, there are many intermediate (transfer) standards before reaching the level of weights used for practical purposes. Each standard receives the reference value from a higher standard and then transfers it to a lower standard. At every transaction of the reference value to a lower standard (this process is called calibration), the accuracy of the standard deteriorates, creating a hierarchical system of varying accuracies, from the most accurate primary standard to the least accurate working standard. This standard transfer system, where a higher standard branches out to numerous lower standards, is a rational system to relate the single primary standard to a number of practical measurement methods. From the viewpoint of primary standards, this system is called the "standard supply system" in that a basic quantity value is supplied from a higher standard to a lower standard in sequence. Conversely, from the viewpoint of a practical measurement method, the system is called the "traceability system" in that the origin of the basic quantity value can be traced back up to the primary standard.

All measurements in the same category must be made based on the same standard to avoid confusion, making the traceability of measurement results to the primary standard important. In this context, the role played by transfer standards of accurately transferring the value set by the primary standard must be fully recognised. Moreover, it is necessary for the primary standard to be common to not only a single country but worldwide.

Accurate measurement requires the proper management of measuring instruments and the control of measurement standards is the very basis of such management. The usual practice regarding the management of primary standards, the highest standards in the traceability system shown in Fig. 4-1, is for a national research institute for standards to be responsible for primary standard management. The SIRIM Measurement Centre in Malaysia is such an institute. Secondary and lower standards are managed and controlled by intermediate transfer organizations or the standards offices of manufacturers in accordance with the actual traceability system for each type of quantity. Secondary and lower standards are not controlled by a special laboratory or research institute as in the case of primary standards but by a number of different organizations concurrently. Therefore, specific methods or procedures to control such lower standards are essential so that standards on the same level guarantee the same results.

There are 2 types of measurement standards as mentioned earlier. One type depends on hardware called standards while the other depends on software which is in fact a set of specifications for a method (process) to realise a standard value. Even with the former, however, various know-how (software) is required to transfer one value of a standard to another value of another standard of a lower level. Similarly, the latter is not self-sufficient as tools or instruments of a certain performance level are required to achieve the objective. In short, measurement standards rely on hardware standards and their proper use and both aspects must be properly managed to ensure measurement accuracy. Needless to say, a higher standard, i.e. more accurate standard, demands a technically more advanced control regime, necessitating the proper education and training of technical staffs responsible for the management and control of measurement standards.

4.1.2 Outline of Measurement System in Malaysia

The highest research institute responsible for the management and control of measurement standards in Malaysia is the SIRIM Measurement Centre of the Standards and Industrial Research Institute of Malaysia (SIRIM), the function of which is equivalent to the combined functions of the National Research Laboratory of Metrology, Electrotechnical Laboratory and Communications Research Laboratory in Japan. In addition to the management and control of primary standards (national standards) in Malaysia, the SIRIM provides a calibration service for industries and other government organizations.

Secondary and lower standards are managed and controlled by the following 8 organizations, as of July 1993, which are accredited under the Skim Akreditasi Makmal Malaysia (SAMM) system along with the SIRIM Measurement Centre. Most of these accredited organization provide a calibration service for general customers.

The SIRIM Measurement Centre manages and controls the national standards in the following fields.

- Length
- Mass
- Temperature
- Electrical (DC, low frequency)
- Volume/flow
- Time/frequency
- Force/pressure

The SIRIM was appointed as the custodian of weights and measures in 1981 by the Ministry of Trade and Industry pursuant to the Weights and Measures Act of 1971. Following its appointment, the SIRIM conducts the calibration of the standards owned by the regional verification offices established as part of the legal metrology system and used for the verification of measuring instruments and other purposes. In addition, the SIRIM also provides a calibration service for measuring instruments and testing equipment upon the request of private research laboratories, testing organizations and factories, etc.

4.2 SIRIM

4.2.1 Role and Functions

The SIRIM is a non-profit organization under the jurisdiction of the Ministry of Science, Technology and Environment (MOSTE) which was established pursuant to the Standards and Industrial Research Institute of Malaysia Incorporation Act (Act 157 of 1975) with the merger of the Standards Institution of Malaysia (SIM) with the National Institute for Scientific and Industrial Research (NISIR). As described earlier, the SIRIM was appointed as the organization responsible for the control of weights and measures by the Weights and Measures Act of 1981.

The main activities of the SIRIM related to measurement and quality are outlined next.

(a) Development and Establishment of Malaysian Standards (MSs)

(b) Implementation and Management of Certification Mark System Based on MSs and other foreign standards

(c) Implementation and Management of Quality Assessment and Registration System Based on ISO 9000 Standard

(d) Secretarial Function of SAMM System Based on ISO/IEC Guide 25

(e) Implementation of Joint Research and Development Projects with Private Sector

(f) Provision of Information Service

(g) Provision of Technical Service

(h) Development and Establishment of Measurement Standards

(i) Provision of Measurement Calibration Service

4.2.2 SIRIM Measurement Centre

The SIRIM Measurement Centre was first established as the National Metrology Laboratory in 1979 as an internal organization of the SIRIM. Project-type technical cooperation was provided by Japan for 4 years, commencing in 1981, with the provision of equipment totalling some 300 million yen, the dispatch of 25 Japanese experts to Malaysia and the acceptance of 12 Malaysian trainees in Japan.

The SIRIM Measurement Centre has a total of 49 staff members and consists of the Measurement Standards Research Unit which is responsible for the research and development of measurement standards and the Measurement Services Unit which is responsible for the provision of the measurement and calibration service.

As its internal organization suggests, the SIRIM Measurement Centre mainly has 2 functions, i.e. the research and development of measurement standards and the provision of the measurement and calibration service. The measurement standards research and development activities consist of research on Malaysian measurement standards in view of their acquiring traceability to global measurement standards, research on methods and technologies to maintain and improve measurement accuracy and the development of standards best suited to the Malaysian measurement standards system. When the need arises, the SIRIM Measurement Centre, together with its counterparts throughout the world, participates in the international comparison of standards to improve its own measurement standards management and control technologies and to confirm measurement accuracy. It is common practice throughout the world for this type of research and development to be conducted by a national metrology research institute and to be directly funded by the government in view of the necessity for a large budget.

The measurement and calibration service is the supply of measurement standards, which are researched, developed, managed and controlled by the SIRIM

Measurement Centre, to other organizations, particularly to the industrial circle. As already pointed out, metrology is one component of the technical infrastructure for industrial development. Production control based on accurate measurements leads to a qualitative improvement of products, making the provision of a measurement and calibration service for the industrial circle extremely important. It is frequently the case all over the world for various public organizations to receive standards from a central metrology research institute, which also provides a measurement and calibration service, and to supply these standards to the industrial circle. These public organizations are generally operated with the charge made for the measurement and calibration service.

The Measurement Standards Research Unit has 13 technical staff members and 4 laboratories, i.e. Mechanical Measurement Laboratory, Electrical Laboratory, Thermodynamic Laboratory and Flow Laboratory. The Measurement Services Unit has 29 technical staff members and 7 laboratories, i.e. Electrical Laboratory, Volume and Flow Laboratory, Temperature Laboratory, Force and Pressure Laboratory, Mass Laboratory, Acoustics, Time and Frequency Laboratory and Length and Dimension Laboratory. Although the functions and objectives of these 2 units differ, their measurement technologies have common ground and purposes, facilitating mutual exchange.

All technical staff members of the SIRIM Measurement Centre have at least the minimum academic qualifications and many are quite experienced. Most of the technical staffs trained in Japan under the technical cooperation project are still employed at the SIRIM Measurement Centre. The one shortcoming appears to be the fact that the recent reassignment has resulted in many technical staffs being assigned to new fields in which they lack sufficient expertise or experience.

The SIRIM Measurement Centre building has a total floor area of some 2,500m^2. The building has the following shortcomings which were pointed out as long ago as the time of the above technical cooperation.

(a) Inadequate Air-Conditioning Facilities

(b) Lack of Emergency Power Supply System

(c) Absence of Appropriate Storage Area for Measuring Instruments Left by Customers for Calibration

(d) Absence of Cargo Transportation Facilities

The number of calibrations has increased by approximately 2.5 times in the past 3 years. There appears to be 3 reasons for the increased demand for the calibration service.

(a) Increased Recognition of Importance of Measurement Calibration for Industrial Development

(b) Increased Number of Companies Registered With SIRIM's Quality Schemes

(c) Increased Number of Accredited Laboratories

While the number of calibrations conducted by the SIRIM Measurement Centre has been increasing every year, there has also been a series of requests by client companies and organizations for expansion of the calibration fields, upgrading of the calibration accuracy and shortening of the calibration time. These requests directly relate to the calibration capability of the SIRIM Measurement Centre (in terms of facilities and equipment and technical level of staff) and will be analysed in detail later. It is sufficient to point out here that the number of the SIRIM Measurement Centre's staff is inadequate and that, as previously mentioned, the staff lack sufficient experience in their assigned work.

4.2.3 Accredited Calibration Organizations

Malaysia has historically had its own laboratory accreditation scheme for each industrial sector. The SIRIM introduced the SIRIM Laboratory Accreditation Scheme (SILAS) in 1987. In the case of the rubber industry, the accreditation scheme was launched as early as 1965 by the Rubber Research Institute of Malaysia (RRIM) and 48 laboratories and companies have so far been accredited. In the case of the chemical industry, the Institut Kimia Malaysia (IKM) has so far accredited 46 laboratories and companies. The establishment of the SAMM in 1991 marked the national unification of the independent accreditation schemes enforced by the authoritative organizations in various fields.

The fields subject to accreditation are 6 in the case of testing and 5 in the case of calibration and it is planned to increase these in the future.

Testing : ① chemistry, ② biochemistry, ③ mechanical, ④ electrical, ⑤ fire-fighting and ⑥ non-destructive examination

Calibration : ① temperature, ② electrical quantities, ③ mechanical quantities/mass/force, ④ flow/pressure/viscosity/density and ⑤ length

There are 17 testing laboratories and 8 calibration organizations which have been accredited under the SAMM as of July, 1993. The 8 accredited calibration organizations and their subject fields of accreditation are listed below.

- Nusantara Technologies Sdn. Bhd. (pressure and mechanical)
- Pyrometro Services (temperature)
- Mecomb Malaysia Sdn. Bhd. (electrical)
- Naval Dockyard Sdn. Bhd. (pressure)
- Matsushita Industrial Corporation Sdn. Bhd. (electrical, mechanical and pressure)
- Singapore Electronic Engineering, Ltd. (electrical)
- ITS Calibration Laboratory Sdn. Bhd. (optical)
- Institut Voltan dan Arus Tinggi, Universiti Teknologi Malaysia (electrical)

In addition to the above already accredited organizations, AIROD, the Defence Science and Technology Centre (DSTC) and Mitsutoyo, etc. are now preparing to apply for accreditation. The geographical distribution of these accredited calibration organizations, including those at the application preparatory stage but excluding Matsushita (MAICO) which does not provide a calibration service outside the company, is as follows.

Shar Alam	:	2
Kuala Lumpur	:	3
Petaling Jaya	:	3
Perak	:	1

The above geographical distribution means that most accredited calibration organizations are located in and around Kuala Lumpur with none existing in other industrial areas. While the subject area of their calibration services is naturally the entire country, their geographical concentration makes it difficult to properly supplement the calibration service provided by the SIRIM Measurement Centre because of the time required to transport measuring instruments, etc. to be calibrated except those from companies in or near Kuala Lumpur.

As electrical, mechanical and pressure measurements, which are the most basic quantities for industrial purposes, are covered, it is believed that the present line-up of accredited calibration organizations can reasonably supplement the calibration capability of the SIRIM Measurement Centre although the calibration accuracy is slightly lower than that of the SIRIM Measurement Centre in many fields.

CHAPTER 5

CURRENT STATUS OF SIRIM MEASUREMENT CENTRE BY MEASUREMENT FIELD

5. CURRENT STATUS OF SIRIM MEASUREMENT CENTRE BY MEASUREMENT FIELD

5.1 Current Situation of SIRIM Measurement Centre

As already described several times, the SIRIM Measurement Centre is at the top of the measurement system in Malaysia, is responsible for the management and control of Malaysian national standards and provides a calibration service for industrial circles and others. The functions of the SIRIM Measurement Centre are divided into "the management and control of measurement standards", i.e. research and development of metrology, and "the supply (dissemination) of measurement standards", i.e. the provision of a measurement calibration service.

Roughly speaking, the SIRIM Measurement Centre has laboratories corresponding to the following fields and these laboratories are engaged in research and development activities as well as providing a calibration service in their respective fields.

- Length (Dimensions)
- Mass
- Volume and Flow
- Force and Pressure
- Temperature
- Electrical (including time/frequency and acoustics)

The technical staffs assigned to these laboratories conduct both "the research and development of metrology" and "the calibration service" and are not particularly specialised in either of these 2 functions of the laboratories.

The SIRIM Measurement Centre is outlined below. A detailed description of each laboratory of the SIRIM Measurement Centre is given in 5.2 onwards.

(1) Measurement Facilities and Equipment

Many of the measurement facilities and equipment owned by the SIRIM Measurement Centre were originally provided by Japan under a technical cooperation project which commenced in 1982. Together with those purchased by the SIRIM in subsequent years, these facilities and equipment form the traceability system for each measurement field. Although many are getting old, posing a problem of parts availability when repair work is necessary, they are actively used to fulfil the principal functions of the SIRIM Measurement Centre. While they cover all the fields which form the basis for industrial development, there is a lack of high frequency-related equipment in the electrical field and it is currently planned to acquire such equipment.

Some of the facilities and equipment are not regularly calibrated and others lack sufficient calibration records which are essential for research and development purposes.

(2) Technical Staffs

A small number of technical staffs is assigned to each laboratory. Although these technical staffs appear to have a certain level of knowledge and technical competence, their lack of adequate experience cannot be ignored. In general, a measurement technical staff is required to have at least 5 years' experience in a particular field. Unfortunately, the SIRIM Measurement Centre has few technical staffs which meet this criterion, creating a problem of the under-use of the available facilities and equipment.

(3) Calibration Service

Each laboratory provides a calibration service upon the request of the industrial circle and various organizations and the volume of calibration work has conspicuously increased in recent years. The inadequate number of technical staffs and the shortage of experience pointed out in (2) above mean, however, that the period required to conduct calibration (from acceptance of the original request to the issue and posting of the calibration certificate following the completion of calibration) has become quite long.

The best accuracy of the calibration service provided by a calibration organization is determined by the level of the facilities and equipment in use and also by the technical competence of the technical staffs. In the case of the SIRIM Measurement Centre, the lack of a sufficient number of technical staffs and the lack of experience on the part of these technical staffs cause some concern in regard to the ability of the SIRIM Measurement Centre to provide a highly accurate calibration service.

(4) Laboratory Conditions

1) Space

All the laboratories lack sufficient space for the proper installation of measurement facilities and equipment. The absence of a storage room at the SIRIM Measurement Centre to store equipment and instruments for which calibration has been requested makes it necessary for the laboratories to store them, further squeezing the limited work space.

2) Temperature and Relative Humidity Control

The SIRIM Measurement Centre is equipped with a central air-conditioning system and small laboratories have been created to deal with those types of calibration work which demand highly accurate temperature and relative humidity control. The lack of 24 hour air-conditioning due to the limited electrical capacity of the building is one of the shortcomings in this aspect of the operation of the SIRIM Measurement Centre together with inadequate emergency measures to deal with power failures and moisture-proofing measures.

3) Storage Room and Degree of Cleanliness

The cleanliness of a measurement laboratory must be maintained in view of the laboratory's handling of precision equipment to conduct highly accurate measurements. A certain level of cleanliness is, therefore, essential. If the structure of a laboratory makes it difficult to improve its cleanliness above a certain level, it is necessary to prohibit the direct access of clients to the laboratory. Moreover, the subject items of calibration should not be directly taken into the laboratory from outside without prior cleaning. In the case of the SIRIM Measurement Centre, the lack of a storage room makes it impossible to enforce these requirements and clients and the calibration subjects have free access to the laboratories. This practice should be changed as soon as possible as such a change will not create any great problem.

5.2 Current Situations of Laboratories in SIRIM Measurement Centre

5.2.1 Dimensional Laboratory

(1) Standards and Other Equipment

Most of the primary standards and calibration equipment currently owned by the Dimensional Laboratory were originally donated under the Japanese technical cooperation which commenced in 1982. All the equipment is still actively used for calibration and other work, but some of them have not been regularly calibrated.

(2) Calibration Work

The Dimensional Laboratory conducts the calibration of the following standards and measuring instruments.

1) Gauge blocks
2) Scales (linear scales)
3) Others
   - pin gauges
   - clearance gauges
   - ring gauges
   - tape measures
   - micrometers
   - calipers
   - dial gauges

The number of calibration applications made to the Dimensional Laboratory in 1992 was treble that in 1991 and the number in 1993 is expected to pass the 8,000 mark. In particular, applications for gauge block calibration have been rising. Most applications are associated with a variety of gauges which form the basis for in-house standards. In general, gauges calibrated by the SIRIM Measurement Centre are used as standards to calibrate the measuring instruments owned by individual companies for practical work.

A calibration charge is set for each group of instruments, such as gauge blocks, linear scales, measuring tapes and pin gauges, etc. Separate charges are made for auxiliary work, such as demagnetizing, which accompanies the calibration work. As these charges, which are subject to government approval, are generally low, no complaint has been voiced by the clients in this regard.

(3) Technical Staffs

The Dimensional Laboratory currently has 3 technical staffs. Calibration of highly precise equipment is conducted by the research officer. The assistant is responsible for the calibration of gauge blocks while the technician deals with micrometers and calipers, etc. The research officer was formerly in charge of the Temperature Laboratory and is kept very busy as he is also an assessor for ISO 9000-based quality assurance system registration. While these technical staffs conduct a sizable volume of calibration work, the staff shortage has resulted in a lengthy waiting list. Insufficient experience due to the inadequate transfer of technology is also believed to be a factor in the piling up of work.

Even though a high degree of specialisation is required to run the Dimensional Laboratory, the importance of establishing a system to accumulate or store knowledge and technical expertise appears to have been relatively ignored.

(4) Laboratory Block

The Dimensional Laboratory block is located on the ground floor consists of an ante-room and a precision measurement room. The latter has a controlled temperature of 20°C ± 1°C and relative humidity of 55% ± 5% and 2 sets of independent air-conditioners and de-humidifiers are operated throughout the day and night in turn. The air is internally circulated and no external air is mixed. One apparent problem is that the de-humidifier stops operation during the night due to the excessive collection of water, making the relative humidity high in the morning. On arrival at the laboratory, the staff immediately remove the water and start operation of the de-humidifier but the calibration work is halted for at least one hour every morning.

Power failures are said to occur much less often than before. In the case of a power failure, however, almost a full day is required for the laboratory to regain the suitable temperature and relative humidity conditions.

Everyone must change their footwear on entering the laboratory. This appears to be the only practice to maintain the cleanliness of the laboratory.

The ante-room has the same specifications as the other rooms and is centrally air-conditioned to maintain the set temperature and relatively humidity conditions of 24°C ± 2°C and 65% ± 5% respectively. The precision measurement room houses all the calibration equipment except for the long comparator used to calibrate tape measures and the universal measuring machine. The coordinate measuring machine, 1m long linear scale comparator and 2 stone surface tables take up a large amount of space. Many pieces of equipment and instruments, including the comparators for gauge block calibration, are placed on top of the stone surface tables and many gauge blocks and instruments waiting for calibration are scattered around to acclimatise them to the room temperature. The remaining space is just sufficient for people to squeeze through, making the use of other rooms for administrative work and the cleaning of gauge blocks necessary.

5.2.2 Mass Laboratory

(1) Standards and Other Equipment

The standards and other calibration equipment currently owned by the Mass Laboratory are believed to be adequate to meet the immediate calibration requirements.

The standard weights controlled and used by the Mass Laboratory are calibrated every 5 years. In addition to space on the ground floor, the Mass Laboratory also has a R & D room on the first floor. The Mass Laboratory is responsible for the management and control of weights and calibration equipment to properly maintain the national standards. The weight used as the national standard in Malaysia is the 1 kg weight which is officially claimed to be of the E1 class of the OIML classification. This weight requires calibration every 7 years. Since the time of its purchase in 1978, it was calibrated in 1984 in Australia and in April, 1991 in New Zealand by the New Zealand Department of Scientific and Industrial Research. The present calibrated value is just slightly outside the limits of permissible error for an E1 class weight.

(2) Calibration Work

The Mass Laboratory provides a calibration service for the following standards and measuring instruments.

1) Standard weights
   - Standard steel weights
   - Standard brass weights
2) Standard cast iron weights

3) Balances

4) Gravimetric measurement of volume of standard tanks and others

5) Push-pull gauges

6) Dead weight standard testers (weights only)

The Mass Laboratory received some 8,000 calibration requests in fiscal 1992, of which some 6,000 requests were for standard weights, followed by some 1,000 requests for the calibration of standard cast iron weights. The number of mass calibration requests increased at an annual rate of some 50% in fiscal 1993, indicating the likelihood of a further increase in the coming years.

The calibration charge is set for each standard weight of different class and mass. Similarly, the calibration charge for a balance depends on the capacity and sensitivity (minimum reading value) of the balance. The calibration charge for weights used for a dead-weight standard pressure gauge is set separately and depends on the number of weights to be calibrated and the scope of weighing. Different sets of calibration charges for standard tanks are imposed depending on the tank capacity which is measured by either the gravimetric method or volmetric method. Special reduced charges are applied in the case of the calibration of those weights and tanks of the Metrological Verification Offices.

(3) Technical Staffs

As there is no SAMM accredited calibration organization in the field of mass, the Mass Laboratory must meet all Malaysia's mass calibration demand itself. The burden of conducting such a large volume of calibration work falls on the 5 staff members of the Mass Laboratory.

(4) Laboratory Space

The weight calibration room is located on the ground floor. Large weights are calibrated near the entrance while standard weights and small tanks are calibrated in the balance room at the back. The calibration of large tanks is conducted in a large room on the first floor. The absence of a storage at the SIRIM Measurement Centre again means that the equipment and instruments to be calibrated are places all over the available space of the Mass Laboratory, resulting in a deterioration of the workability and work efficiency because of the lack of room to manoeuvre.

5.2.3 Volume and Flow Laboratory

(1) Standards and Other Equipment

Most of the equipment and instruments currently owned by the Volume and Flow Laboratory were originally donated under the technical cooperation project and the standard tank for large liquid meters and the 50 litre piston prover, which is the volmetric standard for liquefied petroleum gas, are managed by the PETRONAS at Port Klang.

The calibration of standard liquid tanks and flasks, etc. is conducted by gravimetric method using distilled water. The gas flow measuring equipment donated under the technical cooperation project has never been used for calibration work because of the lack of a basic verification system based on the mass standard (kilogramme standard).

(2) Calibration Work

The Volume and Flow Laboratory provides a calibration service for a wide range of items, including tanks, pressure containers, gas meters and flow meters, etc., the number of calibrations was 313 for volume calibration and 560 for flow calibration. Approval of the calibration results of accredited calibration organizations constitutes the largest part of the work load. This type of work, which comprises on-site calibration at the request of clients, accounts for approximately 70% of the entire work. The subject equipment and instruments include bulk storage tanks, flow meters and master meters used by the petroleum industry, palm oil industry and other chemical industries and are related to the collection of taxes. The actual calibration work is conducted by an accredited surveyor and an official of the SIRIM witnesses the work with a view to approving the reliability of the calibration results. At present, there are 9 accredited surveyors.

This calibration work must be supervised by a staff member of the SIRIM who is appointed as an assistant chief officer as stipulated by the Weights and Measures Act. In the early days, such an assistant chief officer was actually sent to the calibration site to supervise the work. With the recent quality and technical improvement of the calibration work conducted by surveyors, however, other staff members of the SIRIM are also assigned to supervision work without any negative result. As the staff of the Volume and Flow Laboratory cannot fully meet the demand, the staff members of other laboratories are also recruited to conduct the requested calibration and supervisory work. From a geographical point of view, the calibration demand is split almost half and half between the Malaysian Peninsula and East Malaysia.

In terms of the work volume, the calibration of meters and tanks on the premises of the SIRIM is the next largest job although the subject equipment is restricted to relatively small pieces. Meters with a large capacity used for commercial trade involve very fairly pressure and cannot be calibrated by the existing facilities of the Volume and Flow Laboratory. The calibration of such meters is commissioned to an inspection organization in Amsterdam.

With regard to those flow meters installed in factories which cannot be sent to the Volume and Flow Laboratory because of their integration to an operating system or other reasons, an official of the SIRIM should, in principle, be sent to the premises to conduct the required calibration work. Because of the current lack of vehicle and vehicle-mountable calibration equipment, however, the Volume and Flow Laboratory is obliged to commission a surveyor to conduct the calibration work. On their part, surveyors find it difficult to conduct such work due to the low level of commission set by the SIRIM.

(3) Technical Staffs

Most of the Volume and Flow Laboratory's technical staffs have been continuously working since the time of their training under the technical cooperation project.

5.2.4 Force and Pressure Laboratory

(1) Standards and Other Equipment

Within the calibration equipment and instruments owned by the Force and Pressure Laboratory, such mass-related equipment as a proving ring, standardising box and dead weight-type standard pressure gauge were donated under the technical cooperation project. Most of the remaining equipment was subsequently purchased by the SIRIM using its own budget. Only the calibration certificates issued at the time of procurement are available for this equipment and no calibration records nor histories are maintained.

(2) Calibration Work

The main equipment and instruments which can be calibrated by the Force and Pressure Laboratory are listed below and some 1,200 calibration requests were met in fiscal 1992.

1) Force : load cells, load columns, proving rings and hydraulic jacks

2) Pressure : pressure gauges, pressure converters, vacuum gauges, digital pressure gauges and pressure gauge calibrators, etc.

The calibration of pressure gauges and vacuum gauges accounts for some 65% of all the work. The dominant pressure unit in use is still psi (pounds per square inch) of the yard-pound system, accounting for 80% of the work. Adoption of the metric system by industries in Malaysia has been slow in this field. The remaining calibration work is conducted in the field of force and the calibration of proving rings accounts for 5% of all calibration work conducted at the Force and Pressure Laboratory. The rest is taken up with the calibration of load cells and load columns, etc. As the universal testers and tensile testing machines installed in factories are also subject to the calibration service provided by the Force and Pressure Laboratory, an on-site calibration service is also provided.

In the case of the calibration of dead weight-type standard pressure gauges, calibration of the dead weight (a set of weights) is commissioned to the Mass Laboratory.

Most of the equipment currently owned by the Force and Pressure Laboratory is capable of satisfying the requirements of clients in terms of accuracy. However, it appears that clients have an incorrect impression in this regard due to the oldness of the equipment.

(3) Technical Staffs

Three technical staffs, i.e. 2 research officers and one technician, are assigned to the Force and Pressure Laboratory and all calibration work is conducted by these 3 technical staffs.

The technician also helps at the Volume and Flow Laboratory to witness the calibration work conducted by surveyors. Since the research officers are often involved in on-site calibration, none of these technical staff members has enough time to conduct calibration work in the laboratory. Therefore, the calibration of a pressure gauge at the laboratory generally requires 2 - 3 weeks.

5.2.5 Temperature Laboratory

(1) Standards and Other Equipment

Most of the standards and other equipment currently owned by the Temperature Laboratory were donated in 1985 under the technical cooperation project. Between 1988 and 1991, standard thermometers, thermal comparison baths and several other pieces of equipment were added using the SIRIM's own budget. A total of some 90 pieces of equipment and instruments are maintained in a fairly good condition and are assumed to retain their original performance. The shortage of manpower, i.e. only 3 technical staffs are assigned to the Temperature Laboratory, means that only some equipment and instruments are regularly used for calibration work. The Temperature Laboratory has liquid-in-glass thermometers, thermal baths for the calibration of such contact thermometers as thermocouples, electric furnaces, standard resistance thermometers and electric meter-recorders, etc.

(2) Calibration Work

The calibration service currently provided by the Temperature Laboratory consists of comparison calibration where readings on a standard thermometer and the thermometer subject to calibration are compared with each other in a thermal bath or electric furnace. The subject temperature range is between -80°C and 1,400°C.

The Temperature Laboratory has calibrated more than 1,000 thermometers and electric temperature measuring instruments, etc. per year since fiscal 1991. In fiscal 1992, it calibrated as many as some 1,700 pieces of thermal equipment and instruments. As the laboratory has only 3 technical staffs, however, these technical staffs lack the time to conduct the maintenance of standards. Given the prospect of a further increase of calibration requests in this field from the industrial circle together with a greater demand for more advanced calibration services, expansion of the calibration facilities and manpower of the Temperature Laboratory appears urgent.

The Temperature Laboratory does not calibrate the standard thermometers (calibration of temperature scales) based on its own reproduction of the international temperature scale (ITS-90). While it is desirable to reproduce the fixed points of temperature stipulated by the ITS-90 to maintain the national temperature standards, the present equipment and technology levels of the laboratory make this difficult. An alternative option is to ensure the traceability of national standards to international standards by means of requesting a foreign standard organization, capable of meeting the ITS-90, to calibrate the standard thermometers. Unfortunately, however, it is difficult for the Temperature Laboratory to rely on this option on a regular basis due to cost and other constraints.

Another problem of the present calibration service is the inability of the Temperature Laboratory to fully respond to calibration requests for radiation thermometers and optical pyrometers. A series of new equipment, including a standard radiation thermometer, fixed point blackbody furnace and comparison blackbody furnace, should be purchased to solve this problem.

The accuracy of the comparative calibration of thermometers can only be secured if certain criteria are properly met regarding the thermal uniformity and stability of the thermal bath or electric furnace used for such comparison. Unfortunately, these characteristics are not thoroughly checked in the case of the existing thermal baths and electric furnaces. Given the almost certain likelihood of an increase of the required accuracy level in the future, these characteristics of thermal baths and electric furnaces must be quantitatively measured with a view to their upgrading or replacement depending on the findings.

(3) Technical Staffs

Three technical staffs are currently assigned to the Temperature Laboratory. As mentioned earlier, the present manpower strength is inadequate to deal with the total calibration demand. New staff should be allocated to the Temperature Laboratory to fully utilise the range of available facilities and equipment to provide the upgraded calibration service requested by the industrial circle.

(4) Laboratory Space

The main laboratory space relating to temperature is located on the ground floor and consists of 2 laboratories. The larger laboratory (approximately $100m^2$)

contains such large equipment as the water thermal bath, oil thermal bath, salt bath and electric furnace and their control devices. The neighbouring smaller laboratory (approximately 30m^2), which is separated from the larger laboratory by a solid wall, contains the platinum resistance thermometer and other precision instruments for the measurement of resistance. While it is sensible to separate large pieces of equipment which produce heat and vibration from sensitive precision instruments from the viewpoint of air-conditioning, the absence of wiring and conduits, including those for measuring purposes, directly connecting the 2 laboratories must constitute a large obstacle to the smooth running of laboratory operation. The presence of many large pieces of equipment and the need for space to allow the safe passage of dangerous substances and temporary wiring or piping suggest that the present laboratory space is far from satisfactory. The minimum enlargement of the present space by some 50% and re-arrangement of the equipment layout are deemed urgent to upgrade the current required work and services to a satisfactory level.

5.2.6 Electrical Laboratory

The Electrical Laboratory consists of 3 laboratories, i.e. DC and Low Frequency Laboratory, Time and Frequency Laboratory and Acoustics Laboratory. The current conditions of these laboratories are described here in terms of the standards they own and other basic related issues.

(1) DC Voltage Standards

Three sets of standard cells with an air bath are used as the national standards to maintain the DC voltage standards. The Zener voltage standards are used as the transfer standard for disseminating national standards. The standard voltage is maintained as the average value of this group of standard cells and the standard transfer is made by direct comparison with the national standard. The automatic measurement system, including automatic data processing, is used for this work and Fig. 5-7 gives an example of such work. The secular changes of the calibrated values of the standards are unclear due to the lack of regular calibration, absence of records on the history of standards and absence of such important data as the date of calibration and temperature, etc. in the available records.

The standard cells donated under the technical cooperation project are currently used as the voltage standards for calibration work and are controlled together with the national standards. One problem in this regard is that there are no fundamental arrangements to combat power failures which occur relatively often except for the provision of an uninterruptive power supply unit which can cope with a power failure lasting for a few minutes. In the case of a long power failure, this could have a serious adverse effect on the maintenance of the standard cells as it would make the air bath temperature move outside the regulated range.

In the research and development field, a plan to establish the Josephson voltage standard system is in progress and a liquid helium dewar vessel for very low temperature use and a cryogenic control device, etc. have already been purchased using the SIRIM's own budget. The possession of a quantum standard is important to not only improve the measurement accuracy but also to upgrade the status and credibility of the Electrical Laboratory.

(2) Resistance Standards

The resistance standards are maintained by means of the group control of 5 Thomas-type 1Ω standard resistors placed in a thermostatic oil bath (500 litres). These resistors also act as transfer standards. A Hamon device for build-up and such measuring instruments of the highest class as DCCP and DCCB are installed to establish both high and low resistance standards using the above standard resistors. At present, an automatic measuring device is being manufactured and will be in service in the near future.

While the level of equipment at the Electrical Laboratory is sufficient enough to maintain the national standards, the actual management practices pose several questions. Firstly, the thermostatic oil bath is not constantly run and the standard resistors, which are the primary standards, are placed outside the oil bath. The reason for this is that 24 hour operation of the oil bath would make it impossible to maintain a room temperature of 23°C due to the heat generated by the oil agitating motor as the capacity of the present air-conditioning system cannot cope with the extra heat. As a result, the oil bath is only operated when calibration work is actually conducted. Secondly, the paraffin oil is not replaced often enough because of the high cost. Thirdly, some measuring instruments are out of order, indicating inadequate maintenance. Finally, regular calibration of the resistance standards is not conducted and their calibration histories are not kept.

(3) LC Standards

The capacitance standards are controlled by standard condensers (10 pF, 100 pF and 1,000 pF standards), the calibration of which is conducted using a capacitance bridge. A standard inductor and standard AC resistor are used as the inductance standard and AC resistor standard respectively while a LCR meter is used for their calibration.

The management and control of capacitance standards rely on hand-made equipment throughout the world and the 1404 type standard condenser is the only suitable item for use as a standard. As a result, emphasis is placed on the level of management technologies/techniques rather than on equipment. The Electrical Laboratory's technical staff responsible for LC standards was only recently assigned and his calibration experience is not yet adequate enough for him to be fully conversant with the conditions and histories of the present standards and equipment.

(4) AC Voltage Standards

The AC voltage standard and AC/DC disparity standard are supplied by the AC calibrator and AC/DC thermal transfer standard, etc. which use the AC/DC disparity values established by the AC voltage standard and transfer standard. All the standards and equipment involved in the above processes are of the highest class. Their regular calibration and appropriate analysis and evaluation of calibration data should establish and maintain sufficiently accurate AC standards.

(5) Time and Frequency Standards

The national standards for time and frequency are managed by 3 Cesium atomic frequency standards and accuracy in the order of 10^{-12} is believed to have been established. The rubidium atomic frequency standard is used as the secondary standard for the maintenance and transfer of these standards. With the use of a standard quartz clock for calibration work, the level of the available equipment is fairly high.

Some 200 calibration requests were dealt with in fiscal 1992. The subject items were mainly stop watches and digital timers. The number of calibration requests in this field has been increasing with a higher level of accuracy demanded. While it may be necessary to procure several new pieces of equipment to meet the increasing calibration demand, immediate emphasis should be placed on improving the technical competence of the technical staffs and on establishing a reliable accuracy control system.

(6) High Frequency-Microwave Standards

The SIRIM Measurement Centre does not currently deal with these standards but has recently begun a study on how to incorporate this field into its scope of business because of the increasing calibration demand. No concrete decision has yet been made to procure the necessary standards and equipment.

(7) Acoustic Standards

A pistonphone is currently used as the reference sound source and a standard microphone determines the standard field for the comparison calibration of noise meters. While the necessary facilities for comparative measurement are in place, the standard microphone has not been calibrated for some time. The Acoustics Laboratory is the only laboratory in Malaysia capable of conducting the calibration of acoustics. While the calibration demand has so far been weak, it is expected to increase in the future as the need for noise measurement from the viewpoint of environmental conservation and anti-pollution measures becomes stronger.

(8) Technical Staffs

The Electrical Laboratory has a total of 15 technical staffs, of which 6 technical staffs are assigned to R & D, 5 to the calibration service and 4 to the time and frequency section. In reality, however, all the technical staffs are engaged in both R & D and the calibration service.

Only one-third of the technical staffs have previous experience in electrical calibration. As the remaining two-thirds only have several months' working experience in the Electrical Laboratory, they cannot be relied upon as fully-fledged electrical technical staffs.

In general, technical staffs with a least 5 years' experience are required for the electrical measurement of standards and leaders are expected to have 10 - 15 years' experience. It is understandably difficult for the SIRIM Measurement Centre, a relatively new institution, to meet these criteria. It is one of the SIRIM Measurement Centre's biggest challenges to continue to train technical staffs and to transfer technologies to them to achieve the required level of manpower with the appropriate technical competence.

(9) Standards and Other Equipment

Many of the present standards and other equipment owned by the Electrical Laboratory were originally donated under the technical cooperation project which lasted for 4 years, commencing in 1981, and belong to the Measurement Standard Research Unit. The equipment owned by the Measurement Service Unit is divided into that donated during the after-care period following the completion of the technical cooperation project and that which was purchased by the SIRIM's own budget over the years, much of which comprises the latest highly accurate standards and measuring instruments. Although the general understanding of the SIRIM's management is that the SIRIM Measurement Centre's facilities and equipment are 10 years behind the technical standards in the industrial circle, this belief is not valid in the case of electrical equipment. While all the equipment owned by the Electrical Laboratory belongs to either the Measurement Standard Research Unit or the Measurement Service Unit for practical purposes, much of the equipment is actually shared by both sections due to shortage. While this common use has blurred to some extent where the maintenance responsibility lies, it is an effective means of avoiding overlapping investment. It appears that any immediate need for electrical calibration can be sufficiently dealt with by the present equipment.

Given the increasing industrial demand for the provision of higher standards as part of the calibration service provided by the Electrical Laboratory, continued upgrading of the present facilities and the procurement of new equipment are necessary while maximising the efficient utilisation of the existing facilities and equipment.

(10) Laboratory Space

At present, the Measurement Standard Research Unit of the Electrical Laboratory houses the DC voltage standard, resistance standard and AC voltage standard facilities in a single laboratory. Similarly, the LC standards are housed in a partitioned section of the laboratory which also houses the time and frequency standards. In each of these areas, there is no space for temporary work as almost all the available space is taken up by standards and measuring instruments, making expansion of the laboratory space essential.

The SIRIM Measurement Centre building is not totally suitable to house laboratories in terms of its structure and building services. Several improvements should be made to the building to make it capable of maintaining national standards. For example, urgently required facilities include a special air-conditioning system which is capable of accurately controlling the temperature and relative humidity in each laboratory, special fire-extinguishing facilities (using inert gas) because of the use of a large volume of oil for the thermostatic tanks and other facilities, a shielded room to shut out electromagnetic noise and an emergency power supply unit to maintain the vital power supply at the time of power failures.

The need for improvement applies equally to both the Measurement Standard Research Unit and Measurement Service Unit. Neither the DC and Low Frequency Laboratory (responsible for DC voltage and current, resistance, LC, AC voltage and current and power standards) nor the RF Laboratory (responsible for time and frequency, acoustic and microwave standards) located on the first floor have sufficient space to conduct their work in an efficient manner. The DC and Low Frequency Laboratory is divided into 3 sections, one of which is used as a reception-cum-office. Because of the lack of storage space for equipment to be calibrated, this equipment is piled on the floor and desks, further squeezing the limited space. Another problem is the lack of a lift or similar for the safe transportation of equipment.

The temperature and relative humidity of the laboratories are controlled by an ordinary on-off air-conditioning system and a high precision air-conditioning system specially designed for laboratory use is not provided. The set temperature and relative humidity are around 23°C and 60% respectively but the air-conditioning system is operated without such fundamental problems as the system's inadequate capability and the laboratories' inadequate thermal insulation performance being solved. Moreover, 24 hour operation is not possible.

The proper management of electrical standards demands the continuous supply of good quality power. Voltage fluctuations, waveform distortions and momentary power failures, etc. must be avoided, not only in view of providing the necessary support for precision measuring instruments but also in view of achieving accurate temperature control. A long power failure in particular can seriously damage standards. For example, a standard cell is said to require several months to regain its normal state once it has been subject to thermal stress.

Long power failures lasting for anywhere between half a day and 2 days are said to occur at an average of once a month. Power failures occurred twice during the field study, one of which lasted for a full day. The distribution network in the area has only one line and there is no alternative line for automatic switch-over at the time of a power failure. The lack of an uninterrupted power supply system of the distribution network for important government facilities and general hospitals, etc. makes it essential for the SIRIM Measurement Centre to have its own reliable emergency power supply system.

(11) Calibration Work

The Electrical Laboratory has been conducting more than 1,000 calibrations a year since fiscal 1991 and the actual number of calibrations in fiscal 1992 totalled 1,538, confirming the increasing trend in recent years.

A general shortage of experienced technical staffs to deal with the rapidly increasing number of calibration requests and a general shortage of calibration facilities are also evident at the Electrical Laboratory and 2 - 3 months are required from the acceptance of a calibration request to the issue of the calibration certificate. All private companies visited by the Study Team expressed dissatisfaction at this lengthy process and desire for improvement. The situation is well recognised by the staff of the Electrical Laboratory. The calibration room is divided into 3 sections, one of which is used as a reception-cum-office. There is a visible pile-up of equipment and instruments to be calibrated on the worktables and floors, suggesting that the number of calibration requests far exceeds the capacity of the Electrical Laboratory. In short, the calibration service section of the Electrical Laboratory has the familiar problem of a manpower shortage vis-a-vis the volume of requested work.

CHAPTER 6

SURVEY ON INDUSTRIAL REQUIREMENTS

6. SURVEY ON INDUSTRIAL REQUIREMENTS

6.1 Objectives

The SIRIM Measurement Centre recognises by itself the fact that its calibration capability is some 10 years behind the level required by the current stage of industrial technologies. As stated earlier, the purpose of the Study is the preparation of a plan to efficiently upgrade the overall capability of the SIRIM Measurement Centre taking the future requirements into proper consideration. It is, therefore, important to understand the what type of metrological calibration service, its extent and required level of accuracy are required in order to clarify the expected role of the SIRIM Measurement Centre. As the highest calibration requirement level sets the calibration capability level to be maintained by the SIRIM Measurement Centre, it is unnecessary to survey a huge number of samples and it is both efficient and effective for this type of survey to be restricted to factories with a proven high technological level.

Twenty-two manufacturing companies in different fields were selected from the above point of view and were visited as possible clients of the SIRIM Measurement Centre to identify their calibration requirements. Current problems relating to measurement standards were also identified.

The necessary communication and coordination for the survey were conducted by staff of the SIRIM Measurement Centre and the survey team was accompanied on each visit by a SIRIM official. The direct involvement of the SIRIM in the survey not only facilitated the survey procedure but also gave the SIRIM officials the opportunity to hear the opinions and requests of the visited companies. As a result, a common understanding of the present problems of the Malaysian measurement system in general and of the calibration service provided by the SIRIM Measurement Centre in particular was achieved by the survey team members and the SIRIM officials.

6.2 Survey Items and Outline of Survey Results

(1) Survey Items

The survey was conducted by means of interviews on the following items.

1) Company Outline

Capital; number of employees; main products; registration under ISO 9000 or preparations for registration

2) Management System for Measurement Standards

In-house management system for measurement standards and other aspects

3) Standards

Types and names of standards; calibration of standards (place of calibration and frequency)

4) Shop Floor Instruments

Types and names of instruments; calibration of instruments (in-house calibration method, external place of calibration and frequency); availability of calibration manuals; technical level of employees responsible for calibration (training history and qualifications, etc.)

5) Requests for SIRIM (SIRIM Measurement Centre)

Fields or types of quantities to be calibrated; calibration frequency; calibration period; calibration charge level; others

6) Visit to in-house calibration room (laboratory) and other facilities

(2) Outline of Survey Results

The results of the survey are compiled in Table 6-1. The questionnaire (check-list) used in the survey is given in Table 6-2. The survey is outlined below prior to detailed analysis of the survey results.

1) Companies Visited

The following fields and number of companies to be visited were selected to cover the core industries in Malaysia's manufacturing sector.

- Electrical : 8 companies
- Semi-conductor : 4 companies
- Chemical : 3 companies
- Machine : 2 companies
- Automobile : 1 company
- Glass : 1 company
- Others : 3 companies

Geographically speaking, 16 of the companies are located in or around Kuala Lumpur while the remaining 6 are located in or around Penang. Many of these companies are Japanese subsidiaries although some have been established with other foreign capital or domestic capital. In general, they are of medium size or larger and most have a clear policy on calibration.

2) Management System for Measurement Standards

One type of management system or another is in operation at all the visited companies. Some have a well developed in-house traceability system while others conduct the calibration of each instrument without overall traceability.

Some 60% of all the visited companies (13 out of 22) have an in-house traceability chart and some 70% (15 out of 22) have either already registered under the ISO 9000 or are preparing to register. As can be imagined, these companies have extensive and well organized data on management based on the strict enforcement of such control. The ISO 9000 series quality system standards demand that companies are equipped with a good measurement control system. The fact that enforcement of the control system is an essential condition for successful registration is well reflected on the current state of registration in Malaysia. Those companies in the electrical and semi-conductor fields tend to have a good control system in terms of both the organizational set-up and enforcement although this excellence may be partly explained by the stricter metrology requirements in these fields. Appendix 2 is an excerpt from the ISO 9000 series standards showing the requirements in relation to measurement control.

3) Standards

While the phrase "standards equipment" used in the check list appears to have confused some companies, 15 companies (some 70%) provided the survey team with a list of the standards in their possession. These companies apparently maintain and control their in-house standards under appropriate conditions.

All the companies except one use the SIRIM Measurement Centre as the main organization meeting their standard calibration requirements. To be more precise, the SIRIM Measurement Centre is not the only organization used by them. Others include SAMM accredited calibration laboratories (Nusantara, Pyrometro and Seel, etc.), instrument manufacturers (Yokokawa, Hewlett

Packard and Mitutoyo, etc.), parent companies and the SISIR in Singapore. Excepting SIRIM and accredited calibration laboratories, there is a question of the proper traceability to national standards in regard to the above-mentioned organizations and companies. Whenever international traceability is clearly established, however, the calibration work conducted by these companies and organizations should be recognised as being properly done.

The main reason why the companies request places other than the SIRIM Measurement Centre to conduct calibration is that calibration by the SIRIM Measurement Centre requires a longer time to complete compared to the other service providers. In addition, the on-site calibration services provided by others is another attraction. The inability of the SIRIM Measurement Centre to conduct calibration in certain fields was also pointed out by several companies.

Most of the companies have their standards calibrated every year, indicating that the habit of regular calibration is taking root.

It is apparent that the SIRIM Measurement Centre occupies the central position in measurement control in Malaysia. Nevertheless, its lack of calibration capability in certain measurement fields and the long time required to complete the work forces companies to use the calibration services provided by other organizations and instrument manufacturers.

4) Shop Floor Instruments

Some 60% of the companies conduct the in-house calibration of the measuring instruments and equipment they possess and use on the shop floor in accordance with the calibration manuals using the standards in their possession. Other companies use the SIRIM Measurement Centre, instrument manufacturers and SAMM accredited laboratories for their calibration requirements. At most companies, this type of calibration is conducted once or twice a year, indicating that the habit of regular calibration has spread to measuring instruments used on the shop floor.

When calibration is entrusted to SAMM accredited calibration laboratories, the question of traceability should not arise. In the case of instrument manufacturers and others, however, there may be a problem of traceability to the national standards. From the companies' point of view, they have no choice but to entrust calibration to other private companies simply because the SIRIM Measurement Centre cannot always satisfy their calibration requirements due to the reasons given in 3) above. This suggests that there is a large potential need for the calibration of shop floor instruments by the SIRIM Measurement Centre.

5) Requests from Industries to the SIRIM Measurement Centre

The fact that most of the visited companies use the SIRIM Measurement Centre for the calibration of their standards and measuring instruments indicates their high expectations of the SIRIM Measurement Centre in regard to calibration work. Because of these high expectations, the companies expressed a wide range of requests. Some of these requests relate to problems for which concrete solutions have not yet been found world-wide due to the highly advanced nature of the technological requirements. Many companies also expressed a wish to establish a cooperative relationship with the SIRIM Measurement Centre, making it necessary for the SIRIM Measurement Centre to examine the desirable form of its future links with the industrial circle.

Concrete requests in regard to the work of the SIRIM Measurement Centre mainly concern the introduction of a calibration service covering the electrical (high frequency) field which the SIRIM Measurement Centre is not currently capable of providing. In short, strong requests were made for the introduction of new calibration fields as well as for the upgrading and expansion of the existing calibration service. Many companies also desire an on-site calibration service.

Another strong request is for a shortening of the calibration process, from the acceptance of the calibration application to the issue of the calibration certificate, to approximately 2 weeks. Some companies requested that the calibration certificate issued by the SIRIM Measurement Centre be accompanied by its English translation.

With regard to calibration charges, all the companies said that the level of charges was lower than others or reasonable and no complaint was made regarding the current level of the SIRIM Measurement Centre's charges.

In the Penang area, expansion of the calibration capability of the Penang Branch of SIRIM was strongly requested to make it unnecessary for certain types of calibration work to be conducted by the main office.

The Penang Branch of SIRIM renders an express calibration service with additional 75% charge and under this service calibration report will be issued within 3 days. The express calibration service is requested from industries in other area.

Some of the companies requested the provision of calibration technology training (not a seminar but training in actual calibration work). Given the SIRIM Measurement Centre's current number of staff and the volume of work faced by them, the provision of training in the immediate future appears difficult. Nevertheless, the possibility of providing such training in cooperation with other organizations, such as the CIAST, should be seriously considered.

(3) Survey Conclusions

The survey made it very clear that all the visited companies have high expectations in regard to the calibration work conducted by the SIRIM Measurement Centre. Their expectations are both specific and urgent and include the introduction of new calibration fields, expansion of the calibration range and improved accuracy, shortening of the calibration time (and the introduction of an on-site calibration service), improved format of the calibration certificate and the provision of training courses. It is unfortunate that the SIRIM Measurement Centre's public relations activities have often been found to be ineffective and not thorough enough. This means that while companies are aware of the calibration service provided by the SIRIM Measurement Centre, they do not know the exact contents of the service.

The abundant potential or real demand for calibration on the part of companies makes the SIRIM Measurement Centre's expansion of the scope its calibration service urgent. The recruitment of new manpower, the current shortage of which is duly recognised by the SIRIM Measurement Centre (and SIRIM management), should be given priority in any future upgrading project in the form of a suitable manpower development programme.

Table 6-1 List of Company Survey Results

Company						Calibration of Standards			Calibration of Measuring Instruments			Requests for SIRIM Measurement Centre			
Industry	No.	ISO 9000 Status	Management System	Availability of Traceability Chart	Availability of List of Standards	Calibrated by	Frequency (times/year)	Remarks	Calibrated by	Frequency (times/year)	Remarks	No. of Requests and Accuracy Level	Calibration Time Length	Calibration Charge Level	Remarks
Electrical	1	-	O	O	O	SIRIM: 90% In-House: 10%	1	High frequency calibration conducted by parent company	-	-	Provides calibration service for clients	2	To be shortened to 2 weeks or less	Low	Wants an express calibration service
	2	-	O	O	O	SIRIM: 10 types of standards	1	16 types of standards cannot be calibrated by SIRIM	In-house	1	Twice yearly calibration of instruments related to safety	7	To be shortened to 2 weeks or less	-	Calibration charge system is unclear
	3	9002 Planned	O	O	O	Mainly SIRIM but also SISIR	1-2	Wishes to know environmental conditions required of a calibration room	SIRIM In-house	1-2	List of instruments available	None	Slow	Low	Wants an on-site calibration service; metrological terminology is not uniform
	4	-	O	O	O	SIRIM: 5 types SAMM Accredited Lab: 6 types Manufacturers: 4 types	1	Calibration cost: RM 11,882	In-house	1	List of instruments available	None	-	Half of others	Wants an express calibration service
	5	-	O	×	O	SIRIM: 10 types SISIR Manufacturers	2	Owns 36 types of standards	In-house	2	List of instruments available	None	Long	Reasonable	Wants an on-site calibration service and an express calibration service
	6	9002 Planned	O	O	O	SIRIM: 3 types Manufacturers: 13 types	1	Repair and calibration conducted by manufacturers	In-house	2	List of instruments available	5	To be shortened to around 2 weeks	-	
	7	-	O	×	O	SIRIM: SISIR Parent Company	1-2		SAMM Accredited Lab Manufacturers In-house	1	Half of the 500 instruments calibrated on-site	3	To be shortened to 2 weeks or less	Half or one-third of others	Wants a training course on calibration technologies/techniques, and a certificate in English
	8	In Preparation	O	O	O	SIRIM: 19 types SISIR Parent Company	1	Has a manual to deal with instruments out of calibration	In-house	2	Calibration engineers trained by parent company	2	-	-	Wants measures to prevent electromagnetic interference
Semi-conductor	1	9002 Planned	O	O	O	SIRIM: 5 types Manufacturers: 8 types	1	Owns 13 types of standards	In-house	2	Calibration manuals available	2	To be shortened to 2 weeks or less	Reasonable	Wants a training course on calibration technologies/techniques
	2	9002 Acquired	O	O	-	Parent Company Manufacturers SISIR	1	No calibration request made to SIRIM	In-house	1 or more	-	1	To be shortened to 10 days or less	-	Wants simultaneous return of calibrated instrument and calibration certificate
	3	In Preparation	O	×	-	SIRIM: 2 types Parent Company: 2 types	1		In-house Manufacturers	2	9 calibration engineers	5	To be shortened to 3 weeks or less	-	Wants simultaneous return of calibrated instrument and calibration certificate
	4	9002 Planned	O	O	O	SIRIM: Parent Company Manufacturers	1	Owns 8 types of standards	In-house Manufacturers	1	Calibration engineers trained by parent company	3	To be shortened to 10 days or less	-	Wants a training course on calibration technologies/techniques, certificates in English and simultaneous return of instrument and certificate
Chemical	1	-	O	×	O	SIRIM:	1	Little interest in measurement control	In-house Manufacturers	1	-	None	None	-	
	2	9002 Planned	O	×	O	SIRIM: 11 types Calibration Lab In-House	1	Owns 13 types of standards	In-house	2	-	1	To be shortened to around 2 weeks	Reasonable	
	3	In Preparation	O	×	-	-	-	No standards	Manufacturers	1-2	Few instruments in use	2	-	-	Hopes to be awarded SIRIM Mark
Machine	1	In Preparation	O	O	O	SIRIM: 13 types	1		-	-	Provides calibration service for clients	5	Long	Low	Preparing to acquire SAMM accreditation
	2	9002 Under Assessment	O	O	-	SIRIM Manufacturers	1		In-house	1	List of instruments available	2	-	-	
Automobile	1	-	O	O	O	SIRIM: 9 types SAMM Accredited Lab: 4 types Manufacturers: 4 types	1	Quarterly calibration of some standards	In-house SIRIM SAMM Accredited Lab	1	Quarterly calibration of some instruments List of instruments available	None	-	-	
Glass	1	9002 Acquired	O	×	O	SIRIM: 12 types Overseas: 1 type	1	Calibration cost: RM 3,605	In-house	2	List of instruments available; 4 calibration engineers	3	To be shortened to around 2 weeks	-	Wants certificates in English, training course on calibration technologies/ techniques and simultaneous return of instrument and certificate
Others	1	-	O	×	-	SIRIM	1		In-house	1-2	Annual audit of leading client	3	-	Reasonable	
	2	9002 Acquired	O	O	-	SIRIM SAMM Accredited Lab Manufacturers	2		In-house	2-12		1	Long	Low	
	3	9002 Under Assessment	O	×	-	SIRIM: 6 types SAMM Accredited Lab: 17 types	1-2		In-house SAMM Accredited Lab	1-2	Calibration cost: RM 30,000 - 40,000 List of instruments available	2	To be shortened to 2 weeks or less	Low	

Refer to the main text for the actual contents of the requests.

Table 6-2 Questionnaire (Check List)

FACTORY VISIT FOR CALIBRATION SERVICES

1. About the Calibration Services:
   - i) Measurement Control System : Traceability Chart
     Standards equipment →
     Measuring/Testing Equipment
   - ii) Standards Equipment : Quantities (Length, Mass, Force & Pressure, Temperature Electrical, etc)
     List of Equipment : (Name, Model, Range, Accuracy)
   - iii) Calibration for Standards Equipment :
     - a) Where : SIRIM, Foreign Country (SISIR, etc), Mother Company, Others (SAMM Lab. etc)
     - b) How many : ( ) Times/Year and Reason
       Present Situation and Future Plan
     - c) Accuracy
   - iv) Calibration for Measuring/Testing Equipment :
     - a) Where : SIRIM, Foreign Country (SISIR, etc), Mother Company, Others (SAMM Lab. etc)
     - b) How many : ( ) Times/Year and Reason
       Present Situation and Future Plan
     - c) How to : Testing Items, Number of Testing Points
       List of Equipment : (Name, Model, Range, Accuracy)

2. About the Requests/Needs for SIRIM:
   - i) Expansion of Quantities
   - ii) Upgrading of Accuracy
   - iii) Delivery-term for Calibration Services (Expected period)
   - iv) Fee of Calibration (Expected Fee)

3. About the Problems and Countermeasures

4. Observation of your Calibration Laboratory (if possible)

CHAPTER 7

PROPOSAL FOR UPGRADING SIRIM MEASUREMENT CENTRE

7. PROPOSAL FOR UPGRADING SIRIM MEASUREMENT CENTRE

7.1 Establishment of National Metrology Committee

7.1.1 Aim of this proposal

Many countries adopt engineering and technical regulations based on the laws in order to secure people' safe lives and to maintain the economical order properly. Many of such regulations require unified engineering and technical specifications concerning metrology and measurement for their enforcement. As described in Chapter 3 "Measurement System and Technical Regulation," our study proved that several sections and departments take charge of establishing and enforcing most of the engineering and technical regulations independently in Malaysia but do not make efforts to examine the standards and technologies of metrology from a versatile standpoint or to establish unified metrological and technical standards or rules. They adopt the regulations of the law of weights and measures to measuring and weighing for transactions and certifications, which have a direct relation with peoples' lives. However, that law is applicable to a limited range only, and accordingly it does not provide a unified basis of the measuring technology necessary for a wide variety of administrative actions.

In addition, the specifications, accuracy and other requirements of the measuring instruments necessary for enforcing various legal regulations are not specified, and such instruments do not have required performances in many cases. The characteristics and reading accuracies of the measuring instruments should be certified through the calibration done by the national organization of metrology, SIRIM or other organizations accredited by SIRIM. However, SIRIM is not ready for or capable of fulfilling all requirements. As a result, the legal regulations are not so effective in many cases.

To solve these problems, it is necessary to grasp the specifications and quantity of necessary measuring instruments in the stage of planning and enforcing new regulations and to make the engineering details of the regulations into practical forms. For this purpose, it is necessary to establish liaison committees about measurement in the sections and departments concerned and to make versatile examinations about smooth enforcement of further regulations. Thus, we propose that a national liaison conference should be established for this purpose. (We call it temporarily the National Metrology Committee.)

The National Metrology Committee makes it possible to specify the targets of new regulations. The sections and departments participating in the Committee will be able to grasp the current conditions of SIRIM and other measurement organizations. If there is a great inconsistency between the actual condition and the target, temporary measures can be taken for more practical and efficient actions.

7.1.2 Purpose, structure, and activity of the National Metrology Committee

The purpose, structure, and activity of the National Metrology Committee are summed up as shown below.

1) Purpose

1. Harmonizing the engineering and technical matters of the legal regulations planned by the sections and departments concerned

2. Enhancing engineering cooperation between the sections and departments concerned in order to establish a unified metrology system

3. Clarifying the metrology characteristics necessary for enforcing legal regulations (such as specifications, accuracies, ranges, and so forth of measuring equipment) and adjusting these requirements to the calibration and measurement capability

4. Making every effort to unify the certificates of the measuring and weighing instruments and standards as far as possible in order to eliminate duplicate inspections or certifications

5. Preparing a plan of a unified measurement law covering a wide range of metrology and measurement

2) Structure of National Metrology Committee

The National Metrology Committee consists of representatives of the sections and departments in charge of legal regulations and representatives of SIRIM, the custodian of metrology. It is managed by SIRIM. The applicable sections and departments in charge of legal regulations include the Measures and

Weights Dept, Environment Dept, Transport Dept, Electricity and Gas Supply Dept, and Chemistry Dept, etc. Many other sections and departments concerned should take part in the conference.

Great importance is attached to the international harmonization about engineering regulations. Thus, it is recommended that the committee members should include specialists of international standardization.

Fig. 7-1 shows the organization of the committee.

3) Activity of National Metrology Committee

The major activity of the National Metrology Committee is to investigate the details and enforcement procedures of the legal regulations concerning measurement from a technological standpoint and to propose effective procedures based on agreement of the committee members. In examination, the committee will grasp the levels of applicable technologies, take account of enforcing procedures to achieve the target step by step, and avoid estrangement between the political target and target of enforcement. It may ask corrective opinions about regulations which are difficult from a technical standpoint from the sections and departments concerned. The sections and departments take charge of such regulations and should be responsible for enforcement. Thus, this committee, a horizontal organization of the sections and departments, will not have any authority of judging validity or invalidity of the regulations themselves.

7.1.3 Measurement law

One of the major purposes of the National Metrology Conference is to draft the measurement law. This section describes the details.

The measurement law to be considered for Malaysia should cover the details of the weights and measures law currently in use and should provide the concept of measurement and metrology as the basis of various legal regulations. It belongs to the general laws. In other words, it is regarded as one of the most important legal regulations concerning measurement and metrology. Various regulations will be enforced in close contact with the measurement law. Thus, the activities of the National Metrology Committee proposed in this paper will be covered by the measurement law in the future.

OIML's international document No. 1 "Law of Metrology" and Measurement Law of Japan are appended for reference.

7.2 Expansion Plan for SIRIM Measurement Centre Activities

At present, the SIRIM Measurement Centre has two major functions. One is to maintain and control the Malaysian national standards of metrology (i.e., to research and develop the standards). The other is to provide calibration services (i.e., to supply the standards). These two functions cover quite different business operations, though they should be complementary to each other and be fulfilled in close cooperation. The former is mainly related to scientific researches and technological developments, while the latter provides engineering services such as calibration of measuring instruments and standards all the time. Accordingly, there are differences in the forms and operations of the organizations, education and training of the staff, communication with external organizations, and methods of optimum. Thus, this paper refers to the part of SIRIM concerning the former as the National Metrology Laboratory (NML) and the part concerning the latter as the National Calibration Laboratory (NCL), and proposes the expansion plans for them. These proposals do not mean that these laboratories should have separate organizations. It is intended to make their operations independent.

With the rapid advance of industrial technology in Malaysia, it is urgent to establish the metrological standards and measurement technologies which are the basis of industrial technology. For this purpose, it is necessary to improve the range and quality of NML's operations remarkably. Judging from the characteristics of operations, the NML may be located in any area of Malaysia. However, its location and building facilities should be suitable to an organization which represents the nation and takes charge of international operations. On the other hand, the NCL should desirably be located in a place near the industrial areas to which it mainly provides the calibration services. It should have several facilities, including branch offices. As described in Chapter 2 "Present Status and Future Outlook of Industrial Development in Malaysia," the NCL should have offices in Kuala Lumpur, Penang, and Johol Baharu at least, judging from the current distribution of industrial areas.

It is important to locate the NML in a place which will be permanently the national center of science and technology and have potential for development. Thus, it should be examined comprehensively with regard for the basic principles of the science and technology policy. This report examines only the necessary conditions of the location without regard to actual places and describes the engineering issues, which should be taken into account when determining the location.

7.2.1 National Metrology Laboratory (NML)

7.2.1.1 Outline of expansion plan

Prior to explaining the details of the NML expansion plan, this section describes the outline of the plan.

1) Aim of the NML

The aim of the NML is to maintain and control the national standards recognized internationally as the Malaysian national metrology organization and to provide them to the calibration organizations.

1. The NML should maintain, control, research, develop and desseminate the national standards and measurement technology.

2. The NML as a representative metrology organization of Malaysia should join international comparison of metrological standard to examine the technological level and to acquire international reputation and recognition.

3. The NML should desseminate measurement standard and measurement technology the NCL and other organizations with necessary standards.

4. The NML should provide training.

As for the measures which the NML nearly undertakes, the NML provides calibration services for a while in order to avoid duplicate investment to the NML and NCL and for efficient utilization of the facilities as described below.

2) Quantities to be dealt with

Judging from expected industrial progress, etc. in the decade from now and the demands of the industry we surveyed this time, we recommend that the quantities which the NML handles and their best accuracies be as shown below.

1.	Length	: 0.5 ppm	(2 ppm)
2.	Mass	: 0.5 ppm	(0.002mg)
3.	Volume and flow	: 0.1%	(0.5%)
4.	Force and pressure	: 0.01%	(0.025%)
5.	Temperature	: 0.001°C	(0.01°C)

6. Electrical

a) Direct current and low-frequency : 1 ppm (10 ppm)

b) High-frequency : 1%

c) Time and frequency : 10^{-13} (10^{-11})

d) Magnetic : 0.01%

e) Photometry : 1.0%

f) Acoustic : 0.1% (0.1 dB)

g) Vibration : 0.5%

Note: Values in parentheses show the best accuracy at present.

The NML should carry out researches and development concerning these quantities in order to maintain the national standards at the required accuracies. The target of the engineering level which the NML should aim at should be such that it will be highly appraised by other nations' organizations when it is compared with the international standards. Thus, the NML does not always need to establish the national standards based on the International System of Units (SI) by itself. It may take over internationally certified standards from other nations' organizations as necessity requires.

The Chemistry Dept should take charge of the chemical standard reference materials, since it is examining independently the method of unified management and domestic distribution of the standard reference material now. The NML, therefore, will not take charge of such operations for a while. The electromagnetic wave strength is not included in this expansion plan, since calibration technology in the electromagnetic wave strength is not established now.

3) Building

When drafting the plan, we determined the necessary area of the laboratory for each quantity, and added the areas of the common-use facilities such as the conference room, office room, warehouse and lavatories; traffic facilities such as entrances, corridors, and elevators; and ancillary facilities such as the machine room, monitor room and duct spaces to find the necessary total floor area. We examined metrological laboratories in overseas countries and decided that the ratios of the sum of the common-use and traffic facilities and other facilities should be 0.5 and 0.5, respectively, provided the total required area is 1.0.

We recommend that 6 meter × 8 meter modules be used to construct a building with consideration of the Measurement Centre currently in use and for easy operation. Each laboratory consists of two modules, in principle. A wider laboratory should have an area which is an integral multiple of the module area. Laboratories related each other should be placed closely. The recommended building height should be 4 to 4.5 meters as we take account of piping and wiring works and layout of the experimental instruments and equipment. The floor should have the average load resistance of 500 kg/m^2 or so. A two-storied building is adopted for the reason of economical use of the land, though a one-storied building is ideal since instruments and equipment should be subject to as few vertical vibrations as possible.

The floor area of each laboratory in this facility is described below. The floor area of the laboratories is approx. 2400 m^2 and the total floor area of the NML is approx. 5000 m^2.

In general, a metrology laboratory requires a land area of around 10 times to its floor area of its building considering necessary area for utilities like parking lot, internal power station, etc. and for a future expansion. Accordingly, in case that NML is established independently around 5 ha land area will be necessary, on the other hand when NML is established within or near SIRIM complex around 2 ha land area will be necessary because present facilities of SIRIM are utilized effectively.

The following shows the general requirements to be taken into account when designing the laboratory building:

1. Air conditioning facility

   a) The ratings of the temperature and humidity should comply with the international and domestic standards, in principle.

   b) The temperature and humidity in the whole building should be controlled to 27°C ±5°C and 65% ±20% in compliance with the Malaysian Standards.

c) The temperature and humidity in each laboratory should be determined according to the quantity which the laboratory handles in compliance with the international standard concerning the laboratory conditions (ISO554-1976). If some special conditions are required, they should be determined in compliance with the international standards.

d) The circulation rate and ventilation rate of the room air should be determined according to experiences in equivalent laboratories.

2. Vibration and noise insulation

a) Vibration insulation

The NML should be located in a location free from vibrations transmitted from the ground, since it carries out precision experiments in a quiet environment. To keep out harmful vibrations from outside, a building is recomended to be 500 m or more apart from the nearest trunk road. At least, it must be 200 m or more linearly apart from the nearest trunk road. A laboratory for precision experiments and measurements must be 50 m or more apart from a service road on the site. Vibrations produced in other facilities (i.e., produced from the machine room and equipment used in other laboratories) must be reduced in the vibration source facilities to prevent them from being transmitted. In particular, laboratories which must not be exposed to vibration must be located on the ground floor. Precision instruments should be placed on independent bases as necessity requires.

b) Noise insulation

In order to remove noises and aerial vibrations transmitted from outside, it is necessary to examine proper countermeasures against noises when selecting the building site. In general, the best possible means is to locate the building apart from the noise source. The target noise level must be 50 dB or less. If necessary, the building itself should be noise-insulated.

3. Water feeding and draining

The water feeding and draining facilities must have much more capacities than the normal standard. It is recommended to supply cooling water to equipment and instruments from an exclusive water feeding system (neutral