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, as shown in Fig. 4-1. 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.

- Nusantara Technologies
- Pyrometro Services
- Mecomb Malaysia
- Naval Dockyard

- Matsushita Industrial Corporation
- Singapore Electronic Engineering, Ltd.
- ITS Calibration Laboratory
- Institut Voltan dan Arus Tinggi, Universiti Teknologi Malaysia

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

It has already been stated that the SIRIM Measurement Centre plays a central role in Malaysia's metrology system. In this section, the role and functions of the SIRIM, including those of the SIRIM Measurement Centre, are described.

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 SIRIM Incorporation Act stipulates the functions and powers of the SIRIM to be as follows.

(1) Functions

The functions of the SIRIM are:

(a) to promote, develop and promulgate standards for commerce and industry and for goods produced in or imported into Malaysia whether for consumption in Malaysia or for export or re-export;

(b) to promote industrial efficiency and development;

(c) to promote public and industrial welfare, health and safety;

(d) to promote and undertake industrial research with the object of -

(i) improving technical processes and methods;

(ii) discovering new processes and methods;

(iii) encouraging the utilization of Malaysian products; and

(iv) adopting or adapting technology developed in other countries for use in Malaysia, and to apply the results of such research;

(e) to provide industrial extension and consultative services to assist industry in meeting standards; and

(f) generally to improve production processes and techniques.

(2) Powers

The powers vested in the SIRIM are:

(a) prepare, frame, modify or amend specifications and promulgate standard specifications;

(b) promote research in relation to specifications and provide for the examination and testing of commodities, processes and practices and for those purposes establish such laboratories and other facilities as it thinks fit;

(c) make provision for the registration of standard marks and regulate their use;

(d) encourage and undertake educational work in connection with standardisation;

(e) collect and disseminate by any convenient means, including the publication of reports, pamphlets, booklets, journals and other matters, information concerning standardisation and related matters;

(f) develop and maintain a collection of library and museum materials concerning standardisation and related matters;

(g) assist the Federal Government, State Governments, local authorities and other public bodies in the preparation of any specification required by them;

(h) cooperate with the industrial sector, Federal Government, State Governments, local authorities and other public bodies or authorities with a view to securing the adoption of standards;

(i) cooperate with any person, association or organization outside Malaysia having similar functions as those of the Institute, with a view to furthering the effective performance of the functions of the Institute;

(j) solicit and accept for the purposes of the Institute any money, land or other property from any body of persons or organization by way of grant, subsidy, donation, gift, subscription or otherwise, and where it accepts any such money, land or other property, extend to the body of persons or organization such concessions or benefits as it thinks fit;

(k) become a member of or affiliated to any international body concerned with standardisation and related matters;

(l) adopt with or without modifications any international or foreign specification as suitable for use in Malaysia;

(m) appoint agents in Malaysia or abroad for such purposes as the Institute may determine;

(n) establish branch offices of the Institute in Malaysia;

(o) undertake tests, investigations and researches in such manner as the Institute thinks advisable with the object of improving the technical processes and methods used in industry and of discovering processes and methods that may promote the expansion of existing industries, the development of new industries or the better utilisation of waste products;

(p) advise on questions of a scientific, technological or techno-economic nature affecting the utilisation of natural resources and the development of productive enterprises and related services;

(q) promote the training of research workers in the industrial field;

(r) undertake or collaborate in the preparation, publication and dissemination of useful technical information;

(s) cooperate with Government Departments, research institutions, universities, technical colleges, technical or scientific societies and other bodies in order to promote industrial research and the training of investigators in pure and applied sciences, technical experts, craftsmen and artisans;

(t) otherwise assist in the advancement of industrial research and technical training.

The organization of the SIRIM is shown in Fig. 4-2. The SIRIM has some 1,000 employees to perform its above-described functions and powers. The main activities of the SIRIM related to measurement and quality are outlined next.

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

The SIRIM acts as the secretariate for work to develop and establish Malaysian Standards, discusses their drafts with industrial circles, government ministries and agencies, universities and knowledgeable persons and has established some 1,800 MSs as of 1993.

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

The SIRIM conducts product testing and factory inspection in the electrical, electronics, machine and chemical industries and has issued the MS Mark Licence to some 850 companies as of the end of 1992.

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

The SIRIM sends qualified assessors to conduct factory inspections and some 150 companies are registered as having factories with an approved quality assurance system as of 1993.

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

The SIRIM sends qualified inspectors to conduct testing laboratory inspections and 17 testing laboratories and 8 calibration organizations have been accredited as of July, 1993.

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

Many R & D projects have been implemented by the various R & D centres of the SIRIM jointly with the public and private sectors.

(f) Provision of Information Service

The SIRIM has an extensive library which collects standards and documents from all over the world and which is open to the public. In addition, the SIRIMLINK service was launched in 1993, providing computer access to the information and data held by the library.

(g) Provision of Technical Service

The SIRIM conducts the testing of products, components and materials, etc. upon the request of private companies.

(h) Development and Establishment of Measurement Standards

The SIRIM establishes, maintains and manages measurement standards in various quantities and researches and develops measurement standards as well.

(i) Provision of Measurement Calibration Service

The SIRIM manages and controls measurement standards as the highest institution responsible for the upkeep of the weights and measures of the Malaysian metrology system and provides a calibration service for measuring instruments and testing equipment, etc. upon the request of government agencies and private companies, etc.

The Head Office of the SIRIM is located at Shah Alam near Kuala Lumpur, the capital of Malaysia, and all the above-mentioned functions are performed at the Head Office. The SIRIM has 5 branches, i.e. North Branch at Penang, South Branch at Johor Bahru, East Coast Branch at Kuala Terengganu, Sabah Branch and Sarawak Branch.

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. Following the organizational shake-up in subsequent years, the SIRIM Measurement Centre is now controlled by the Standards and Quality Division of the SIRIM as shown in Fig. 4-2.

The organization of the SIRIM Measurement Centre is shown in Fig. 4-3. 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 subject fields, scope and accuracy of the primary standards (national standards) which are managed and controlled by the SIRIM Measurement Centre are listed in

Table 4-1. These fields are length, mass, force, pressure, temperature, electrical quantities, frequency/time and acoustics. The accuracy shown for each field in Table 4-1 is the highest level of accuracy within the scope of measurement and does not mean that this level of accuracy is maintained throughout the scope of measurement.

The SIRIM Measurement Centre building has a total floor area of some 2,500m^2 as shown in Fig. 4-4. The building was constructed by the Malaysian government using its own funds in order to receive the previously mentioned project-type technical cooperation from Japan. The cost of the building was some 3 million Malaysian dollars, accounting for almost half of the some 5.95 million Malaysian dollars spent by the Malaysian government in connection with the Japanese technical cooperation. 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

Some of the laboratories require an extremely high degree of control of temperature and relative humidity. Although the building has a central air-conditioning system with additional cooling units for several of the laboratories, the air-conditioning capacity still falls short of fully meeting the measurement environment criteria set by international standards. The inadequate dehumidification allows the possibility of a deterioration of the facilities and equipment due to condensation.

(b) Lack of Emergency Power Supply System

The building does not have an emergency power supply system. Therefore, power failures have not only an adverse physical effect on the facilities and equipment but also damage their accurate performance. In the case of those standards requiring particularly stable accuracy, many months may be required to verify the possible effects of a power failure and to regain their original accuracy through necessary adjustments. In addition to these tremendous hazards, there are also potential problems of a loss of computer memory and hindering of the smooth operation of the measurement and calibration service.

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

The SIRIM Measurement Centre provides a calibration service for unspecified customers which brings a large number of measuring instruments and standard, etc. to the SIRIM Measurement Centre throughout the year. The absence of an appropriate storage area in the building usually makes it necessary to directly take these instruments to the relevant laboratories for storage until calibration is conducted. Consequently, the hardly spacious laboratories have become even more congested, resulting in a loss of work space and the possibility of damage to or even the loss of such instruments. The free access of customers to the laboratories may also create a problem of the leaking of confidential information or data.

(d) Absence of Cargo Transportation Facilities

The 3-story building is not equipped with the necessary facilities, a hoist for example, to safely transport or lift heavy objects. The calibration equipment and facilities are generally very delicate, as well as heavy, and require disassembly before transportation in the case of their relocation despite the problems of work safety and preservation of equipment accuracy inherent in such disassembly and transportation work. The building's lack of appropriate transportation facilities obviously makes it difficult to safely move or lift instruments or standards for which calibration is requested.

The number of calibrations conducted at the SIRIM Measurement Centre and the income arising from the service charge in the last 3 years are shown in Table 4-2. The number of calibrations has increased by approximately 2.5 times in this period. 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

As already discussed in Chapter 2, Malaysian industries, particularly the manufacturing industry, has shown remarkable growth in the last 10 years. The manufacturing industry has consolidated itself as the key export industry in Malaysia and improved quality has increased the international competitiveness of Malaysian products. Proper measurement technologies/techniques are the very basis of the quality improvement of products. While it was formerly foreign subsidiaries and large domestic companies which requested the calibration service because of their awareness of the need to establish proper measurement technologies, this awareness has become widely shared throughout Malaysian industries in recent years, reflecting the higher level of industrialisation.

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

The movement to evaluate and register with the quality assurance system based on the ISO 9000 Standard is currently in rapid progress throughout the world. This involves objective evaluation of the existing quality assurance systems adopted by companies in the light of the ISO 9000 Standard, an international standard for quality assurance. The movement mainly commenced in European countries in the mid-1980's. Even before then, companies evaluated the conformity of their products with the relevant domestic and international standards. The ISO 9000 Standard is new in that it enables companies to evaluate their quality assurance systems, making it possible for them to improve product quality through the improvement of production processes. As registration became an essential requisite for commercial trade, those companies not registered under the ISO 9000 Standard could no longer have access to the European market, prompting companies all over the world to gain registered status. In Malaysia, the SIRIM was quick to introduce this registration system in 1987. As of 1993, some 150 companies are registered and many others are in the process of application or are preparing for application.

The ISO 9000 Standard sets very strict measurement control for companies. All measuring instruments and testing equipment used by companies for inspection purposes must be traceable to national standards, making it necessary for these instruments and equipment, etc. to be calibrated by the SIRIM or another calibration organization. See the Appendix for the requirements of the ISO 9000 Standard.

(c) Increased Number of Accredited Laboratories

Self-inspection by a company can create the problem of objectivity. In many cases, purchasers desire objective testing and inspection results issued by a third party as a precondition for trade. Whether or not such testing and inspection results issued by a third party are, in fact, accurate and objective depends on verification of the technical competence of the said third party (laboratory). Therefore, it is important to evaluate if the quality assurance system of a laboratory satisfies the prescribed standards as in the case of companies. Laboratory accreditation schemes have been introduced to conduct such evaluation. The ISO/IEC Guide No. 25 provides the basis for laboratory accreditation. While the basic concept of the Guide is the same as that of the ISO 9000 Standard, the Guide demands fairness and neutrality as essential qualities of laboratory work. Laboratories subject to accreditation schemes include calibration organizations providing a calibration service. Laboratory accreditation schemes have been established in many countries to control not only public organizations but also laboratories run by inspection companies and manufacturing companies, etc. Malaysia formerly had a number of laboratory accreditation schemes in different industrial fields. The need to establish a uniform national scheme resulted in the launch of the SAMM in 1991 under which 17 testing laboratories and 8 calibration organizations have been accredited as of July, 1993. As those laboratories and calibration organizations accredited under other schemes require accreditation under the SAMM, the number will definitely increase in the future.

As in the case of the ISO 9000 Standard, the ISO/IEC Guide No. 25 sets very strict measurement control for laboratories and calibration organizations. All measuring instruments and testing equipment used by laboratories for testing and inspection purposes and all standards and measuring instruments used by calibration organizations for calibration purposes must be traceable to national standards, making the calibration of these instruments and equipment, etc. by the SIRIM or another calibration organization essential. See the Appendix for the requirements of the ISO/IEC Guide 25.

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 SAMM, the rationalised national scheme, has the following objectives.

- To unify all existing laboratory accreditation schemes in Malaysia
- To grant formal recognition to laboratories with proven capability and competence in specific fields of calibration/testing
- To reduce and to eventually eliminate the practice of multiple assessments of laboratories
- To upgrade the status and standard of calibration and testing laboratories in the country
- To promote the acceptance, both in Malaysia and overseas, of calibrations/tests conducted by SAMM-accredited laboratories
- To enhance the quality, acceptability and reputation of made-in-Malaysia products in domestic and overseas markets

The ISO/IEC Guide 25 is used to provide accreditation criteria under the SAMM and the SIRIM acts as the implementation body to check the accreditation of laboratories. See the Appendix for the ISO/IEC Guide 25.

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 with a detailed description given later.

- 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.

The number of accredited calibration organizations by subject field is given below. MAICO is again excluded and those organizations at the preparatory stage are given the fields which they are believed to be capable of dealing with.

Electrical	:	5
Mechanical	:	4
Pressure	:	4
Optical	:	1
Temperature	:	1
Length	:	1

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.

4.3 SAMM Accredited Calibration Organizations

As of July, 1993, there are 8 calibration organizations accredited under the SAMM and their role is defined as supplementing the calibration capability of the SIRIM Measurement Centre. As already explained earlier, however, the calibration capability of these organizations is currently rather limited. Each of these calibration organizations, including those preparing to apply for accreditation, are briefly described in the following section.

4.3.1 Current State of Accredited Calibration Organizations

(1) NUSANTARA

Nusantara Technologies Sdn. Bhd. (NUSANTARA) is based in Shah Alam and is a joint venture established in 1989 by a Malaysian company and Singapore company. Its accredited fields are pressure and length as shown in Table 4-7. Several employees are engaged in the calibration service and work in a calibration room which is equipped with temperature and humidity control functions. It has the following measuring instruments among others.

- Shop gauge measuring machine
- Coordinate measuring machine
- Hydraulic pressure calibrator
- Mu-checker
- Planekator
- Calibrator tester
- Profile projector
- Digimatic head
- Test gauge

NUSANTARA conducts several hundred calibrations a year and the number is said to be gradually increasing. Because of the small calibration room and the limited number of calibration technical staffs, NUSANTARA falls short of the anticipated level of supplementing the calibration service provided by the SIRIM Measurement Centre.

(2) PYROMETRO

Pyrometro Services (PYROMETRO) is based in Kuala Lumpur and was established in 1991 by 2 brothers. As shown in Table 4-4, its accredited field is temperature. Two employees are engaged in the calibration service which is mainly conducted on the premises of clients rather than in-house. The overwhelming proportion of PYROMETRO's work is calibration of the temperature reading of clients' electric furnaces.

While the calibration service was not particularly busy at first, the number of requests has steadily increased following the company's accreditation under the SAMM which has bolstered client confidence in the company. In the 5 months after acquiring accredited status in 1992, 360 calibrations were conducted. In the first half of 1993, 280 calibrations were conducted with a planned annual volume of 700 calibrations. The main clients are laboratories and manufacturing companies. Calibration takes from one day to some 2 weeks depending on the type of work and the certificate is issued approximately one week after the completion of measurement. The calibration charges of PYROMETRO are as follows.

Oven or furnace	:	per piece (3 measurement points)	300 M$
Temperature indicator	:	upto 500°C	100 M$
		500°C or more	110 M$
		(minimum of 5 measurement points)	
Temperature recorder	:	upto 3 channels	120 M$
		each additional channel	10 M$

PYROMETRO is quick to complete a client's request and provides a flexible calibration service, including night work when the client's production line is not in operation so as not to disrupt the business of the client.

At present, PYROMETRO is the only company to be accredited for temperature calibration and its 2 technical staffs are working hard to cope with the required work level. While PYROMETRO is capable of meeting client requirements, the calibration technology level is not particularly high. It is undeniable that the overall calibration capability of PYROMETRO is limited by the lack of sufficient manpower.

(3) MECOMB

Mecomb Malaysia Sdn. Bhd. (MECOMB) is a subsidiary of Sime Darby Berhad and is a joint venture with a Singapore company. MECOMB is based in Petaling Jaya near Kuala Lumpur and its business consists of consulting, product development, equipment repair and the manufacture of industrial fans, etc. It also acts as the agent for such electronic instrument manufacturers as Fluke and Tektronics. MECOMB employs some 150 workers, 10 of which are engaged in calibration work (7 for electrical calibration and 3 for mechanical calibration). MECOMB is currently only accredited for electrical calibration as shown in Table 4-5 and it intends to apply for accreditation for mechanical calibration in the future.

MECOMB conducts some 1,000 calibrations a year. Its calibration room has a regulated temperature of 23°C ± 1°C and a relative humidity of 55% or less, meeting the relevant international standards.

The actual calibration procedure is based on the manuals for measuring instruments manufactured by Fluke and Tektronics. Any necessary adjustment of the instruments is conducted prior to calibration. It can be said that the calibration service provided by MECOMB is part of its agency work for Fluke and Tektronics. Consequently, the subject fields of the calibration service are rather limited.

MECOMB's calibration technical staffs must undergo a 2 to 4 weeks' training session at Fluke or Tektronics. In addition, in-house training sessions and seminars, etc. are provided, illustrating MECOMB's active commitment to the education and training of its calibration technical staffs.

The standards owned by MECOMB are annually calibrated by the SIRIM, SISIR (of Singapore), NIST (of the US) or Tektronics. Standards with a higher accuracy are calibrated twice a year. In-house calibration is annually conducted using these standards.

(4) NAVAL

Naval Dockyard Sdn. Bhd. (NAVAL) is based in Perak and is accredited for pressure calibration as shown in Table 4-6. Although detailed information has not been collected, the accreditation fields and degree of accuracy suggest that the calibration capability of NAVAL is inadequate to supplement that of the SIRIM Measurement Centre.

(5) MAICO

Matsushita Industrial Corporation Sdn. Bhd. (MAICO) manufacturers such electrical appliances as air-conditioners and electric fans, etc. and is based in Petaling Jaya. Its calibration laboratory for the in-house service has been accredited for electrical, mechanical, mass and force calibration. While only a few technical staffs are engaged in calibration work, they have Matsushita's own qualification after having undergone a training session of several months at Matsushita in Japan.

Although MAICO is accredited under the SAMM, it has no intention of providing a general calibration service in the near future and is currently content with providing guidance for MAICO-related companies and cooperating factories and conducting the calibration of the standards owned by these companies and factories.

MAICO's electrical calibration laboratory has a regulated temperature of 23°C ± 1°C and a relative humidity of 55% or less while the length calibration laboratory has a regulated temperature of 20°C ± 0.5°C and a relative humidity of 55% or less.

(6) SEEL

Singapore Electronic and Engineering, Ltd. (SEEL) was accredited under the name of its preceding company of Concode Sdn. Bhd. Concode merged with SEEL of Singapore in December, 1992 and the accreditation status was inherited by the new company. It is located on the KL Industrial Park in Kuala Lumpur and is accredited for electrical calibration as shown in Table 4-8. Of its 11 employees, 4 are engaged in calibration work after having undergone a training session at the parent company in Singapore.

SEEL conducted some 250 calibrations of such instruments as oscilloscopes, digital multi-meters, panel meters, voltmeters, ammeters and ohmmeters, etc. in fiscal 1992.

SEEL's calibration laboratory has a regulated temperature of 23°C ± 2°C and a relative humidity of 70% or less. Any adjustment of an instrument for calibration is conducted prior to calibration. However, no repair work is conducted. Approximately 2 weeks are required for calibration which is conducted in accordance with the manual for the instrument concerned. The standards owned by SEEL are calibrated by the SIRIM. While SEEL intends to continue to use the SIRIM's inexpensive calibration service, it also sends its standards to its parent company once a year for calibration due to the long time required for calibration by the SIRIM.

(7) ITS

ITS Calibration Laboratory Sdn. Bhd. (ITS) is part of the ITS Group and the parent company sells medical, physical and chemical appliances. Another of the Group's companies, Envilab Sdn. Bhd. provides a waste water analysis service and is accredited as a SAMM laboratory.

ITS is based in Petaling Jaya and has 3 calibration technical staffs. It is accredited for optical calibration as shown in Table 4-9 and conducts the calibration of colour measurement using a colourimeter and the calibration of the wave lengths of both ultra violet and visible rays. In principle, the calibration service provided by ITS is an after-service for analysis equipment sold by the Group but is also provided for the calibration of similar instruments. As the subjects of calibration are analysis equipment, many clients of ITS are laboratories. ITS also conducts the calibration of electronic balances and temperature gauges and intends to acquire additional SAMM accreditation to cover these instruments. Standard samples, which are reconfirmed every 2 years on the manufacturer's instruction, are used for the calibration of the UV spectrophotometer.

Following accreditation in October, 1992, some 200 calibration requests were received by the end of the year. Calibration takes approximately 4 hours and a report is compiled on the following day and sent to the client with the equipment. The absence of a highly experienced calibration technical staff and the difficulty of educating or training new recruits are cited as the reasons why ITS cannot meet the general calibration requirements at present.

Although ITS is the only accredited organization in the field of optical calibration, it currently is incapable of providing adequate support for the SIRIM Measurement Centre due to the insufficient number of calibration technical staffs and the character of its calibration service, i.e. part of the after-service for equipment and instruments sold by a related company.

(8) IVAT

The Institut Voltan dan Arus Tinggi, Universiti Teknologi Malaysia (IVAT) is a laboratory belonging to the Malaysian University of Technology in Kuala Lumpur. It is accredited for electrical calibration as shown in Table 4-10 and is capable of conducting the electrical impulse testing of bushing, cables, connectors and electrostatic voltmeters, etc. Unlike other calibration organizations, however, it receives very few requests for testing or calibration and its work in the calibration field appears to be virtually limited to technical consultation. IVAT has such standards as a standard capacitor, potentiometer, oscilloscope and calipers, etc.

IVAT is not an exception among university laboratories in terms of owning testers and measuring instruments and other university laboratories can be assumed to be capable of providing testing and calibration services. Nevertheless, it may be asking too much of them to provide such services on a regular basis as their main function is research.

4.3.2 Other Calibration Organizations

In addition to the calibration organizations which are accredited under the SAMM, there are several organizations which have not yet been accredited but which plan to apply for accreditation. Some of these organizations are outlined next.

(1) AIROD

AIROD was established in 1985 as a joint venture between Lockheed of the US and the Malaysian air industry and is located near Subang International Airport. It employs some 1,000 workers and its scope of business covers the repair, overhaul, assembly and testing of aircraft, the calibration of measuring instruments and standards and the development/manufacture of related products.

Calibration is conducted by 20 technical staffs in the electrical, mass, length and pressure calibration fields, etc. Electrical calibration accounts for half of the calibration work load.

AIROD has a total of 11 accreditations based on accreditation schemes in the US, Indonesia, Thailand, China, Philippines, UK and Lockheed and is now preparing to acquire accreditation under the SAMM.

The environmental conditions of the calibration rooms are fairly good. All the rooms have a double door system and are clean rooms with a regulated temperature and relative humidity of 21°C ± 3°C and 70% or less respectively. The mass and length calibration rooms have particularly strict conditions and are constantly regulated at 20°C ± 0.5°C and 55% or less. The effects of entering and leaving these rooms are carefully monitored and access is restricted in order to minimise the undesirable disruption of the room conditions.

The calibration rooms are spacious and a wide range of standards and measuring instruments, including high precision measuring instruments, are available. The calibration of standards is usually entrusted to overseas calibration organizations in the US, Japan, Australia and Singapore. The SIRIM Measurement Centre is seldom used for calibration purposes. In-house calibration is regularly conducted in accordance with the company regulations. The education and training of calibration technical staffs mainly takes place in the US and Australia.

As AIROD's calibration capability is higher than that of many accredited organizations, the company can assist the calibration work of the SIRIM Measurement Centre following its accreditation under the SAMM.

(2) DSTC

The Defence Science and Technology Centre (DSTC) was established in 1968 as the Defence Technical Centre of the Ministry of Defence to provide scientific and technical support for the defence efforts of the Malaysian military. It was renamed the Defence Research Centre in 1972 to emphasise its research on national defence and was again renamed in 1985 when it was given its present name with the additional functions of receiving and transferring defence technologies. The DSTC is based in Kuala Lumpur and provides a calibration service for the extremely wide range of measuring instruments owned by the military. It also analyses the causes of accidents.

The DSTC manages and controls the military standards for length, mass, force, pressure, electrical quantities (voltage, resistance, capacity, inductance and frequency) and temperature. It supplies standards to the 3 armed services which in turn supply such standards to military bases.

The equipment owned by the DSTC was originally donated by the Australian government in 1970 and the maintenance of this equipment in subsequent years has been rather inadequate. The DSTC cannot expect the provision of technical assistance by the Australian military because of the different types of standards used by the latter.

The DSTC has the following standards.

a) Length : gauge blocks

b) Mass : standard weights (upto 200 grammes)

c) Pressure : deadweight standard pressure gauge (upto 1,600 psi)

d) Force : standard proving ring
(accuracy: 0.02%, range: 250 - 10,000 kgf)

loop-type standard proving ring
(accuracy: 0.05%, range: 250 - 50,000 kgf)

e) Electrical : standard resistance, standard capacitance, standard inductance, microwave voltmeter, cesium frequency standard

The standards owned by the DSTC are calibrated by the SIRIM Measurement Centre or abroad.

The DSTC plans to apply for SAMM accreditation in the future. As it enjoys a high level of technical competence because of its function as the guardian of military standards, it will certainly be capable of assisting the SIRIM Measurement Centre once accredited. However, the expected heavy work load of calibrating the equipment and instruments owned by the military will probably make it necessary for the DSTC to cut back the volume of work for the military in order to provide a general calibration service.

(3) MITUTOYO

Mitutoyo (Malaysia) Sdn. Bhd. (MITUTOYO) is a subsidiary established in Malaysia by Mitutoyo, a manufacturer of measuring instruments and provides a calibration service in addition to the sale of such instruments. Further details of MITUTOYO are given in Chapter .

MITUTOYO is based in Petaling Jaya and has 23 employees. Several technical staffs are engaged in the calibration service which is basically an after-service for the instruments sold by the company. Requests for calibration by third parties are accepted when the technical staffs are available.

MITUTOYO current lacks an independent calibration room and calibration is conducted in one corner of the temperature-controlled show room. However, the company plans to construct an exclusive calibration room in the near future.

As of the July term of fiscal 1993, MITUTOYO has received 50 calibration requests. It is in close communication with the SIRIM Measurement Centre and recommends its clients use of the SIRIM Measurement Centre if requested calibration work appears unsuitable for it to accept.

MITUTOYO is expected to assist the SIRIM Measurement Centre in terms of length calibration once its accreditation application has been accepted and it will be necessary to increase the number of technical staffs depending on the calibration request level.

(4) YOKOGAWA

Yokogawa Electric (Malaysia) Sdn. Bhd. (YOKOGAWA) is a subsidiary of Yokogawa Electric Corporation a leading manufacturer of electrical instruments in Japan, and is engaged in sales and servicing. Further details of YOKOGAWA are given in Chapter 6.

YOKOGAWA is based in Kuala Lumpur and has some 100 employees, 25 of which are assigned to calibration work. Four of these employees are responsible for the maintenance of standards. The main equipment used for calibration work is as follows.

- Digital thermometer
- Electric voltage and current standards (DC and AC)
- Standard resistors
- Digital multimeters

Most of this equipment is calibrated by the SIRIM Measurement Centre while some is calibrated at the company's factory in Singapore.

4.4 SISIR

The Singapore Institute of Standards and Industrial Research (SISIR) frequently conducts calibration work on the request of Malaysian companies and research laboratories because of its geographical proximity to Malaysia and the fact that it maintains standards in those fields which the SIRIM Measurement Centre is incapable of handling. The SISIR is in the process of completing a project by the middle of 1993 under which it has received the Josephson junction array voltage standard from the United Nations Development Programme (UNDP) as the regional standard for its supply of voltage standards to ASEAN countries to uniformatise their voltage standards. As this development will significantly affect the future management of the voltage standard at the SIRIM Measurement Centre, the SISIR was visited by the Study Team despite of its location outside Malaysia. The current state of measurement control at the SISIR is outlined below.

4.4.1 Organization

The SISIR moved to its present premises on Science Park in 1991. Measurement control is conducted by the Standards and Quality Division which consists of the National Metrology Centre (NMC) and the Calibration Measurement Centre (CMC).

4.4.2 NMC

(1) Functions of NMC

The NMC has the following functions.

(a) To manage the national standards and to supply standards to the CMC and accredited calibration organizations

(b) To upgrade the national physical standards

(c) To manage standards to secure traceability to and from SI units and to promote the use of SI units

(d) To conduct R & D on measurement technologies/techniques

(e) To contribute to the development of industries

In addition, the NMC actively promotes the following activities in the international arena.

(a) Participation in the Asia/Pacific Metrology Programme (APMP)

(b) Promotion of mutual cooperation with metrology research institutes in neighbouring countries, including the SIRIM and NIM (China)

(c) Comparison of standards with those of other ASEAN countries

(2) Standards

The standards owned by the NMC traceable to the BIPM (International Bureau of Weights and Measures) and their conformity to such national standards as the NIST (US), NPL (UK), NML (Australia), PTB (Germany), BNM (France) and ETL (Japan) has been verified.

The Josephson voltage standard system, manufactured under the guidance of the NIST using 1V and 10V devices, is in good operational order and internal calibration is conducted every 4 months. The NMC compares DC voltage standards in the ASEAN region with a measurement accuracy of within ± 0.01 ppm using the transfer standard VS4. It plans to develop a quantum hall resistance standard by 1995.

The NMC has 4 standards laboratories where the pre-determined environmental conditions are strictly regulated.

- Electrical Standard Laboratory	:	temperature - 23°C ± 1°C relative humidity - 55% ± 5%
- Temperature Standard Laboratory	:	temperature - 23°C ± 1°C relative humidity - 55% ± 5%
- Mechanical Standard Laboratory	:	temperature - 20°C ± 1°C relative humidity - 55% ± 5%
- Length Standard Laboratory	:	temperature - 20°C ± 0.3°C relative humidity - 55% ± 5%

(3) Engineers

The NMC employs 27 workers, including 4 assistants. Their distribution by calibration field is given below.

- Electrical : 7 (3 for DC and resistance, 1 for AC and high voltage and 3 for time and frequency)
- Temperature : 4
- Optical : 3
- Length : 4
- Mechanical : 5

(4) Supply of DC Voltage Standards

Based on the general technical competence of the NMC, the SISIR's supply of DC voltage standards to the SIRIM appears highly feasible. With the introduction of the quantum hall resistance standard system in the future, the supply of resistance standards will certainly become viable. The SISIR has clearly expressed its willingness to assist the SIRIM in any way it can.

4.4.3 CMC

The CMC conducts calibration work relating to electrical, temperature, mechanical and length and conducted approximately 9,500 calibrations in fiscal 1992 for some 1,000 companies.

The SISIR has its own accreditation scheme which is called the Singapore Laboratory Accreditation Scheme (SINGLAS) and has so far accredited 26 laboratories and 7 calibration organizations.

Table 4-1 Present Situation of Metrological standards in SIRIM Measurement Centre

Parameters	Range	Best Accuracy
Length	0.1 μm ~ 10 m	± 2 ppm
Mass	1 mg ~ 1 ton	± 0.002 mg
Force	0 ~ 220 ton	± 0.025 %
Pressure	0 ~ 8000 psi	± 0.01 %
Temperature	−50 ~ 1400 ℃	± 0.01 ℃
Electrical Voltage	0 ~ 1.5 kV	± 1 ppm
Electrical Resistance	0 ~ 10^{16} Ω	± 1 ppm
Electrical Current	0 ~ 100 A	± 10 ppm
Electrical Inductance	0 ~ 1000 H	± 0.02 %
Electrical Capacitance	0 ~ 1000 F	± 0.002 %
Frequency/Time	0 ~ 10 GHz	± 10^{-11}
Acoustic	70 ~ 140 dB	± 0.1 dB

Source : SIRIM

Table 4-2 Number of Calibration Works done by the Measurement Centre and Total Calibration Fees collected

	1 9 9 0	1 9 9 1	1 9 9 2
Mass	4,416	7,258	7,950
Length	350	2,260	7,664
Volume	—	—	313
Flow	1,425	296	560
Force and Pressure	518	704	1,206
Temperature	583	1,378	1,697
Electricity	924	1,100	1,400
Time/Frequency	0	151	180
T O T A L (Number)	8,216	13,147	20,970
TOTAL FEES (RM)	495,165	640,000	1,098,000

Source : SIRIM

Table 4-3 Scope of Accreditation (NUSANTARA)

Name : Nusantara Technologies Sdn. Bhd.

Location : Shah Alam, Selangor Darul Ehsan

Fields of Calibration : Pressure and Mechanical Calibrations

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
1. PRESSURE MEASURING DEVICE		
A. Pressure Measuring Devices Test Fluid Oil	25 - 8,000 psi	0.2%
2. DIMENSIONAL METROLOGY		
A. Limit Gauges		
1. Plain Plug Gauges	1 mm to 10 mm	2 μm
	10 mm to 50 mm	3 μm
	50 mm to 150 mm	4 μm
2. Plain Ring Gauges	1.5 mm to 25 mm	2 μm
	25 mm to 150 mm	3 μm
3. Plain Gap Gauges	0.5 mm to 50 mm	2 μm
	50 mm to 150 mm	3 μm
	150 mm to 300 mm	5 μm
4. Profile Gauges		25 μm
5. Other limit gauges including length, height and depth involving Plane Co-ordinate position of Holes and Spigots	Up to 300 mm	(2+10xlength in m) μm
B. Jigs, Fixtures and Cutting Tools and Components		
1. Jigs, Fixtures and Cutting Tools	Maximum dimensions 700 mm x 500 mm x 400 mm	(5+10xlength in m) μm per coordinate
2. Components	Maximum dimensions 700 mm x 500 mm x 400 mm	(6+10xlength in m) μm per coordinate
C. Measuring Instruments and Tools		
1. Surface Plates	150 mm to 1219 mm or 6" to 48"	0.002 mm
2. Bevel Protractors	Blade - 6" to 12" Angle attachments 0 to 360 deg.	Angle:0.1 deg.
3. External Micrometers	0 to 50 mm	0.002 mm
4. Internal Micrometers	5 to 300 mm	0.002 mm
5. Depth Micrometers	0 to 300 mm	0.002 mm
6. Dial Gauges	Dial gauges reading in 0.01 mm and 0.001 mm	0.0015 mm
7. Electronic and Mechanical Calipers	0 to 300 mm	0.004 mm
8. Electronic and Mechanical Height Gauges	0 to 300 mm	0.004 mm
9. Feeler Gauges	0.01 mm to 1.0 mm	0.002 mm
10. Dial Test Indicator	Dial Test Indicators reading in 0.001 mm, 0.002 mm and 0.01 mm	0.0015 mm

Table 4-4　Scope of Accreditation (PYROMETRO)

Name　: Pyrometro Services

Location : Kuala Lumpur

Fields of Calibration : Heat and Temperature Measurement

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
1. PERMANENT LABORATORY		
Rare Metal Thermocouples	0 to 500 ℃	1 ℃
	500 to 1000 ℃	2 ℃
	1000 to 1300 ℃	0.3% of Reading
Base Metal Thermocouples	0 to 500 ℃	1 ℃
	500 to 1000 ℃	2 ℃
	1000 to 1300 ℃	0.3% of Reading
Heat Enclosures	0 to 500 ℃	3 ℃
	500 to 1000 ℃	4 ℃
	1000 to 1300 ℃	5 ℃
Temperature Recorders/Indicators	-200 to 1760 ℃	0.1% of Reading +0.5 ℃
2. SITE CALIBRATION		
Heat Enclosures	0 to 500 ℃	3 ℃
	500 to 1000 ℃	4 ℃
	1000 to 1300 ℃	5 ℃
Temperature Recorders/Indicators	-200 to 1760 ℃	0.1% of Reading +0.5 ℃

Table 4-5 Scope of Accreditation (MECOMB)

Name : Mecomb Malaysia Sdn. Bhd.

Location : Petaling Jaya, Selangor Darul Ehsan

Fields of Calibration : Electrical Measurement

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
DC Voltmeter	0 to 1100 V	±0.02 %
AC Voltmeter	0 to 1100 V	±0.2 %
	50 Hz to 1 kHz	
	0 to 110 V	±0.2 %
	1 kHz to 20 kHz	
	0 to 19.9999 V	±0.32 %
	20 kHz to 50 kHz	
DC Ammeter	0 to 2 A	±0.1 %
AC Ammeter	0 to 2 A	±0.28 %
	50 Hz to 1 kHz	
Ohmmeter	Four terminal	
	1 Ω	±0.08 %
	10 Ω	±0.04 %
	100 Ω to 10 kΩ	±0.02 %
	Two terminal	
	100 kΩ	±0.02 %
	1 MΩ	±0.04 %
	10 MΩ	±0.2 %
Oscilloscope/ Curve Tracer	Amplitude	
	0.2 mV to 100 VDC	±1 %
	Timing	
	1 ns to 5 s	±0.004 %
	Bandwidth	
	0 to 500 MHz	±0.04 %
Frequency/Period	Frequency	
	0.001 MHz to 1050 MHz	±20 ppm
	Period	
	1 ns to 5 s	±40 ppm

Table 4-6 Scope of Accreditation (NAVAL)

Name : Naval Dockyard Sdn. Bhd.

Location : Lumut, Perak Darul Ridzuan

Fields of Calibration : Pressure Measurement

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
Pressure Measuring Devices	1 bar - 600 bar	±0.12 %
	0 - 30 in Hg	±0.4 %

Table 4-7 Scope of Accreditation (MAICO)

Name : Matsushita Industrial Corporation Sdn. Bhd.

Location : Petaling Jaya, Selangor Darul Ehsan

Fields of Calibration : Electrical, Mechanical and Pressure

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
1. ELECTRICAL MEASUREMAENT		
AC Voltage	1 mV - 19.9999 mV	±(0.05 % of reading)
	20 mV - 199.999 mV	do
	0.2 V - 1.99999 V	do
	2 V - 19.9999 V	do
	20 V - 199.99 V	do
	200 V - 1,100 V	±(0.1 % of reading)
DC Voltage	0 - 19.9999 mV	±(0.05 % of reading)
	20 mV - 199.999 mV	do
	0.2 V - 1.99999 V	do
	2 V - 19.9999 V	do
	20 V - 199.99 V	do
	200 V - 1,100 V	do
AC Current	10 μA - 199.999 μA	±(0.1 % of reading)
	0.2 mA - 1.99999 mA	do
	2 mA - 19.9999 mA	do
	20 mA - 199.999 mA	do
	0.2 A - 1.99999 A	do
	2 A - 50.00 A	do
DC Current	10 μA - 199.999 μA	±(0.01 % of reading)
	0.2 mA - 1.99999 mA	do
	2 mA - 19.9999 mA	do
	20 mA - 199.999 mA	do
	0.2 A - 1.99999 A	do
	2 A - 30.000 A	±(0.2 % of reading)
Resistance	1 Ω	±(0.04 % of reading)
	10 Ω	do
	100 Ω	do
	1 kΩ	±(0.01% of reading)
	10 kΩ	do
	100 kΩ	do
	1 MΩ	±(0.1 % of reading)
	10 MΩ	do
	0.001Ωx(0-10)+	
	0.01Ωx(0-10)+	
	0.1Ωx(1-11)+	±(0.03% of reading)
	1Ωx(0-10)+	
	10Ωx(0-10)+	
	100Ωx(0-10)	
	[100Ωx 10 +	
	1kΩx 10 +	±(0.1% of reading)
	10KΩx 10 +	
	100KΩx 10 +	±(1.0 % of reading)
	1MΩx 10 +	for step 1 MΩ, 10 MΩ
	10MΩx 10]	

Table 4-7 Scope of Accreditation (MAICO) (Cont'd)

Name : Matsushita Industrial Corporation Sdn. Bhd.

Location : Petaling Jaya, Selangor Darul Ehsan

Fields of Calibration : Electrical, Mechanical and Pressure

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
2. MECHANICAL, MASS AND FORCE		
Dial Gauge		
Pick Test	0 - 25 mm	±2 μm
Dial Thickness Gauge	0 - 5 mm	±0.8 μm
	1.005 mm - 100 mm	Grade 0 (Refer JIS B 7506)
Outside Micrometer	0.991 mm - 1.009 mm	Grade 0 (Refer JIS B 7506)
	125 mm	do
Two Point Inside Micrometer	150 mm	Grade 0 (Refer JIS B 7506)
	175 mm	do
	200 mm	do
	250 mm	do
	300 mm	do
Optical Parallel	12.00 mm - 25.37 mm	±0.01 mm
Optical Flat	Diameter 60 mm	±0.1 μm
Vernier Depth Gauge	0 - 150 mm	± 2 μm
Caliper	0 - 300 mm	± 5 μm
Height Gauge	0 - 600 mm	± 5 μm
Steel Rule	0 - 1000 mm	± 10 μm
Electronic Balance	10 mg - 20 kg	Class 2 (Refer MIS K 2013)
Beam Balance	10 mg - 20 kg	Class 2 (Refer MIS K 2013)
Spring Balance	10 mg - 20 kg	Class 2 (Refer MIS K 2013)
Tension Gauge	10 mg - 20 kg	Class 2 (Refer MIS K 2013)
Torque Wrench	0 - 180 kgf·cm	±1 % + 1 digit
	0 - 900 kgf·cm	±1 % + 1 digit
Torque Driver	0.1 kgf·cm- 100 kgf·cm	±0.5 % of f.s.
3. PRESSURE		
Pressure Gauge	0.5 kgf/cm²-50 kgf/cm²	± 0.2 gf/cm²

Table 4-8 Scope of Accreditation (S E E L)

Name : Singapore Electronic and Engineering Ltd.

Location : Kuala Lumpur

Fields of Calibration : Electrical

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
DC Voltmeter	100.00 μV - 1000.0000 mV	±0.01 %
AC Voltmeter	1.00 mV - 100.0000 mV	
	10 Hz - 31 kHz	±0.25 %
	32 Hz - 33 kHz	±0.20 %
	30 kHz - 100 kHz	±0.40 %
	100 kHz - 330 kHz	±1.5 %
	320 kHz - 1 MHz	±4.5 %
	1.000000 V and 10.00000 V	
	10 Hz - 31 kHz	±0.20 %
	32 Hz - 33 kHz	±0.15 %
	30 kHz - 100 kHz	±0.20 %
	100 kHz - 330 kHz	±0.60 %
	320 kHz - 1 MHz	±3.2 %
	100.0000 V	
	10 Hz - 31 kHz	±0.20 %
	32 Hz - 33 kHz	±0.15 %
	30 kHz - 100 kHz	±0.20 %
	1000.000 V	
	45 Hz - 330 Hz	±0.20 %
	300 Hz - 10 kHz	±0.20 %
	10 kHz - 33 kHz	±0.20 %
DC Ammeter	100.0000 μA - 100.0000 mA	±0.050 %
	1.000000 A	±0.10 %
AC Ammeter	100.0000 μA	
	10 Hz - 1 kHz	±0.30 %
	1 kHz - 5 kHz	±0.30 %
	1.000000 mA	
	10 Hz - 1 kHz	±0.25 %
	1 kHz - 5 kHz	±0.30 %
	10.00000 mA	
	10 Hz - 1 kHz	±0.25 %
	1 kHz - 5 kHz	±0.30 %
	100.0000 mA	
	10 Hz - 1 kHz	±0.25 %
	1 kHz - 5 kHz	±0.30 %
	1.000000 A	
	10 Hz - 1 kHz	±0.30 %
	1 kHz - 5 kHz	±0.40 %
DC Ohmmeter	10 Ω	±0.03 %
	100 Ω	±0.012 %
	1 kΩ	±0.012 %
	10 kΩ	±0.012 %
	100 kΩ	±0.018 %
	1 MΩ	±0.036 %
	10 MΩ	±0.066 %
	100 MΩ	±0.24 %

Table 4-8　Scope of Accreditation （ＳＥＥＬ）　(cont'd)

Name　　: Singapore Electronic and Engineering Ltd.

Location : Kuala Lumpur

Fields of Calibration :　認定分野 : Electrical

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
Oscilloscope	Vertical Deflection:	
	10 mV_{pp} - 100 V_{pp}	±(1.0 %+ 4 μV)
	Time base:	
	1 ns - 5 s	±0.0002 %
	Bandwidth:	
	250 kHz - 250 MHz	±0.28 %
	250 MHz - 1050 MHz	±2 %

Table 4-9 Scope of Accreditation (I T S)

Name : ITS Calibration Laboratory Sdn. Bhd.

Location : Petaling Jaya, Selangor Darul Ehsan

Fields of Calibration : Optical Measurement

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
LOVIBOND COLOUR MEASUREMENT AND GRADING SYSTEM	RED:	
	0.1R - 0.9R	±0.2R
	1R - 9R	±0.2R
	10R - 70R	±0.5R
MODEL:AF900	YELLOW:	
AF905	0.1Y - 0.9Y	±0.2Y
	1Y - 9Y	±0.2Y
	10Y - 70Y	±0.5Y
	BLUE:	
	0.1B - 0.9B	±0.2B
	1B - 9B	±0.2B
	10B - 70B	±0.5B
	NATURAL:	
	0.1N - 0.9N	±0.2N
	1N - 3N	±0.2N
SPECTROPHOTOMETER	WAVELENGTH ACCURACY	
(UV and VISIBLE)	220 nm - 1000 nm	±2 nm
	PHOTOMETRIC ACCURACY	
	AT 590 nm (0 % - 100 %)	±1.0 %T

Table 4-10 Scope of Accreditation (I V A T)

Name : Institut Voltan Dan Arus Tinggi, Universiti Teknologi Malaysia

Location : Kuala Lumpur

Fields of Calibration : Electrical

Instrument Calibrated	Range	Best Measurement Expressed as an uncertainty(±)
Impulse High Voltage Meters	up to 200 kV peak	±3.3 %
AC Meters	up to 200 kV rms	±3.3 %
DC Meters	up to 200 kV	±3.3 %

Fig. 4-1 Standard Transfer and Traceability Chart

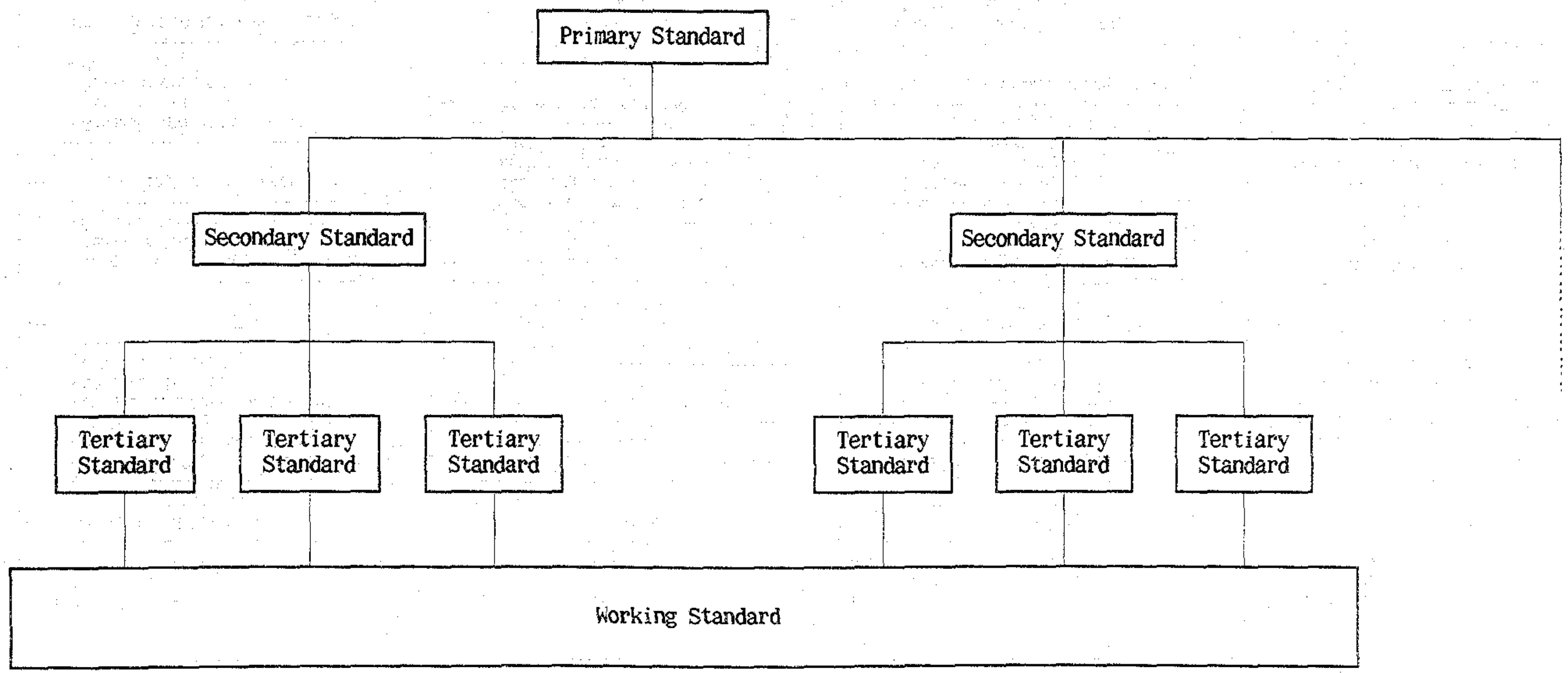


Fig. 4-2 Organization Chart of SIRIM (As of January, 1993)

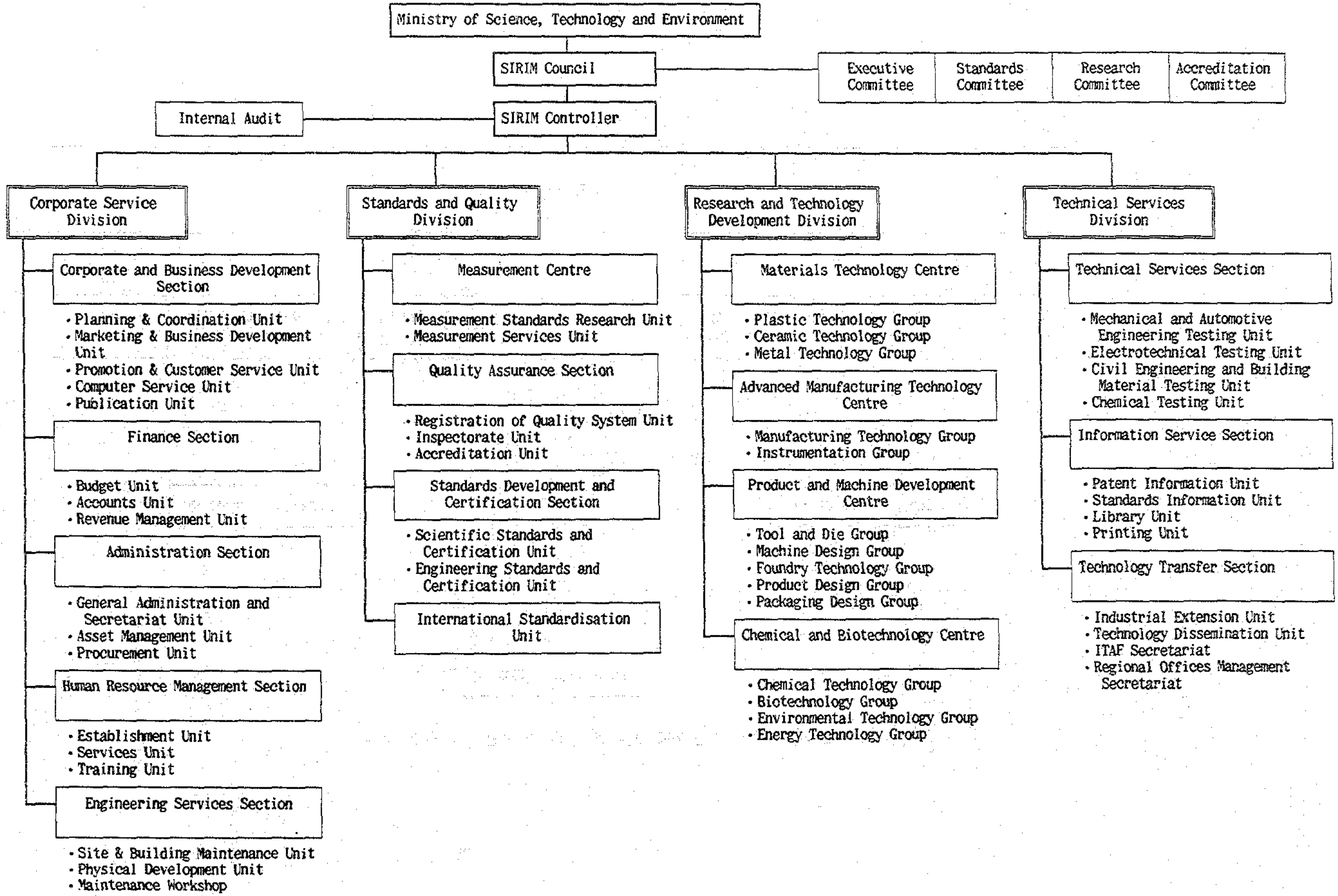


Fig. 4-3 Organization Chart of SIRIM Measurement Centre (As of January, 1993)

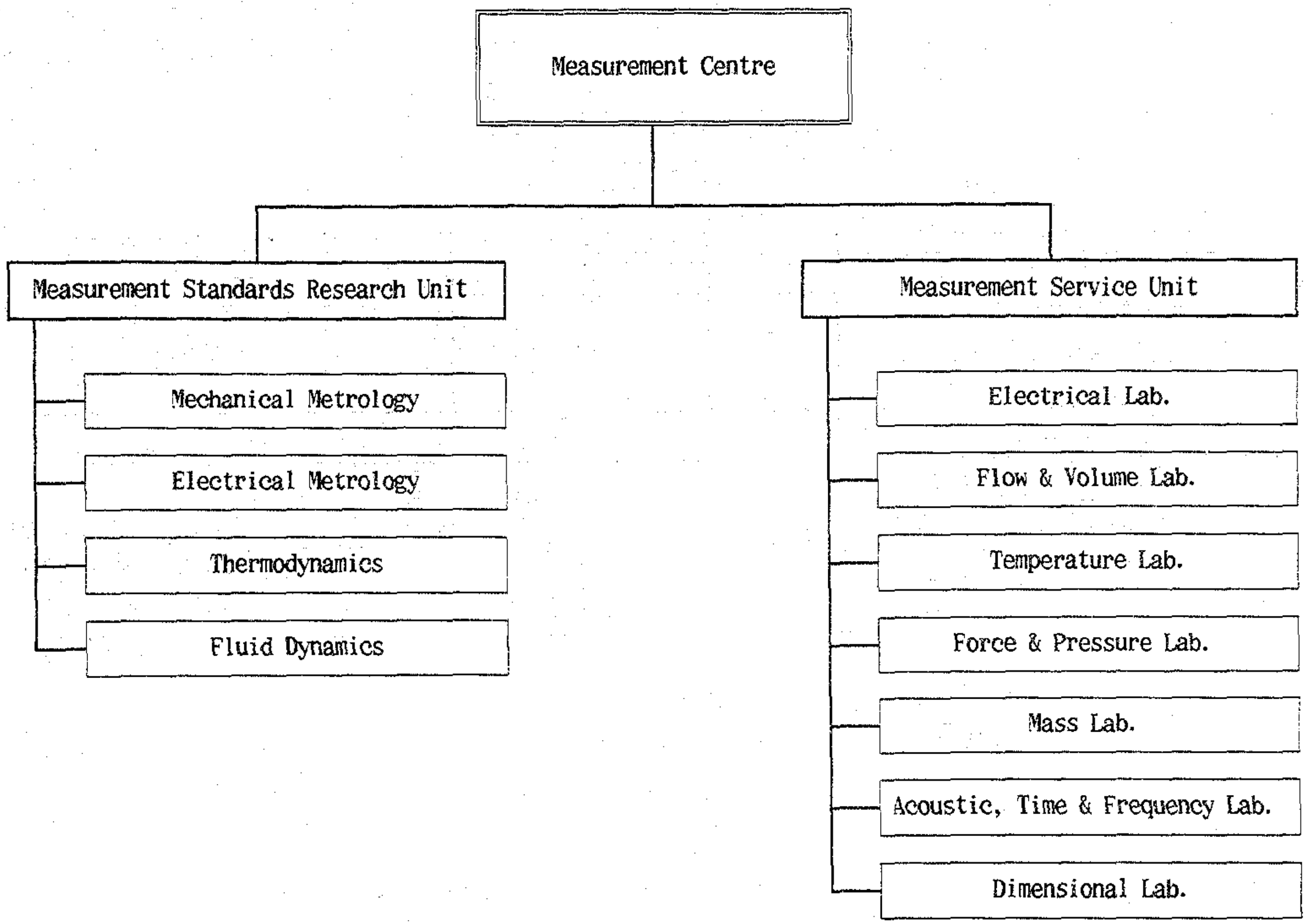
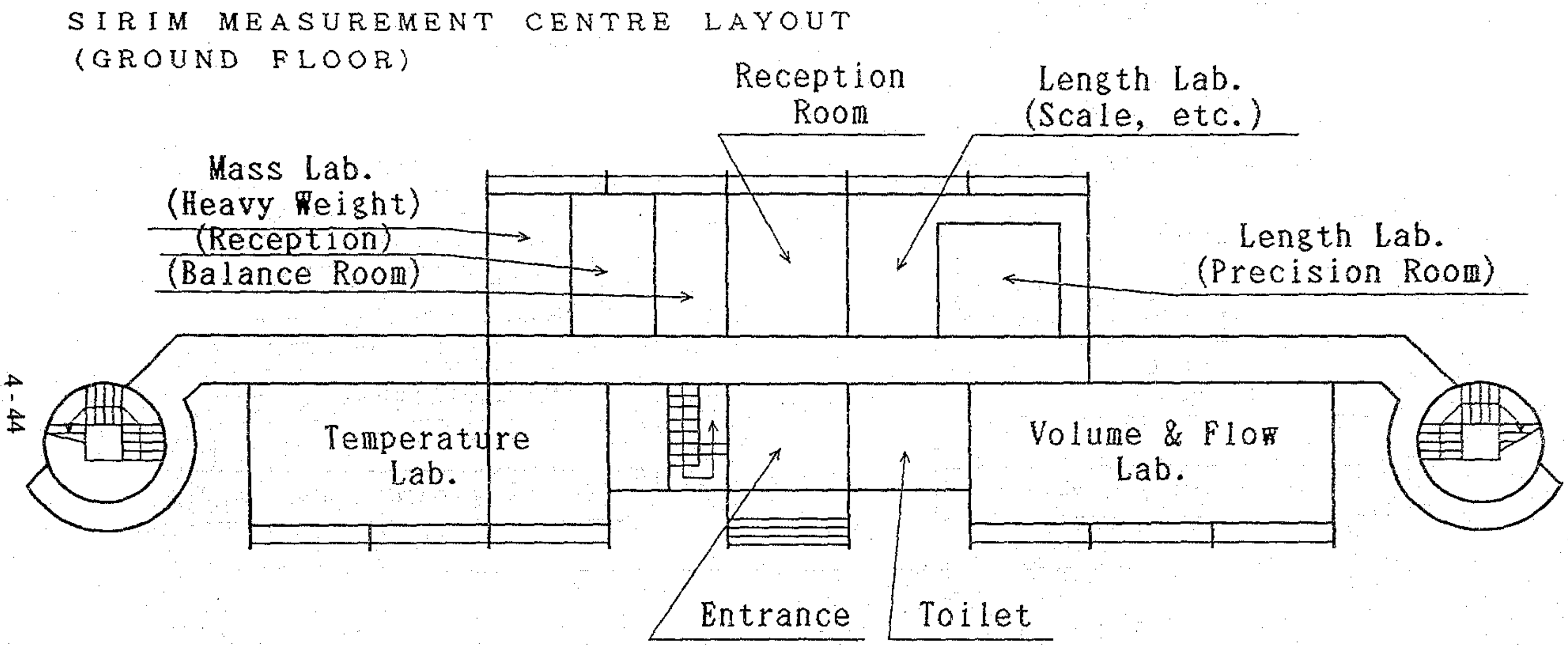
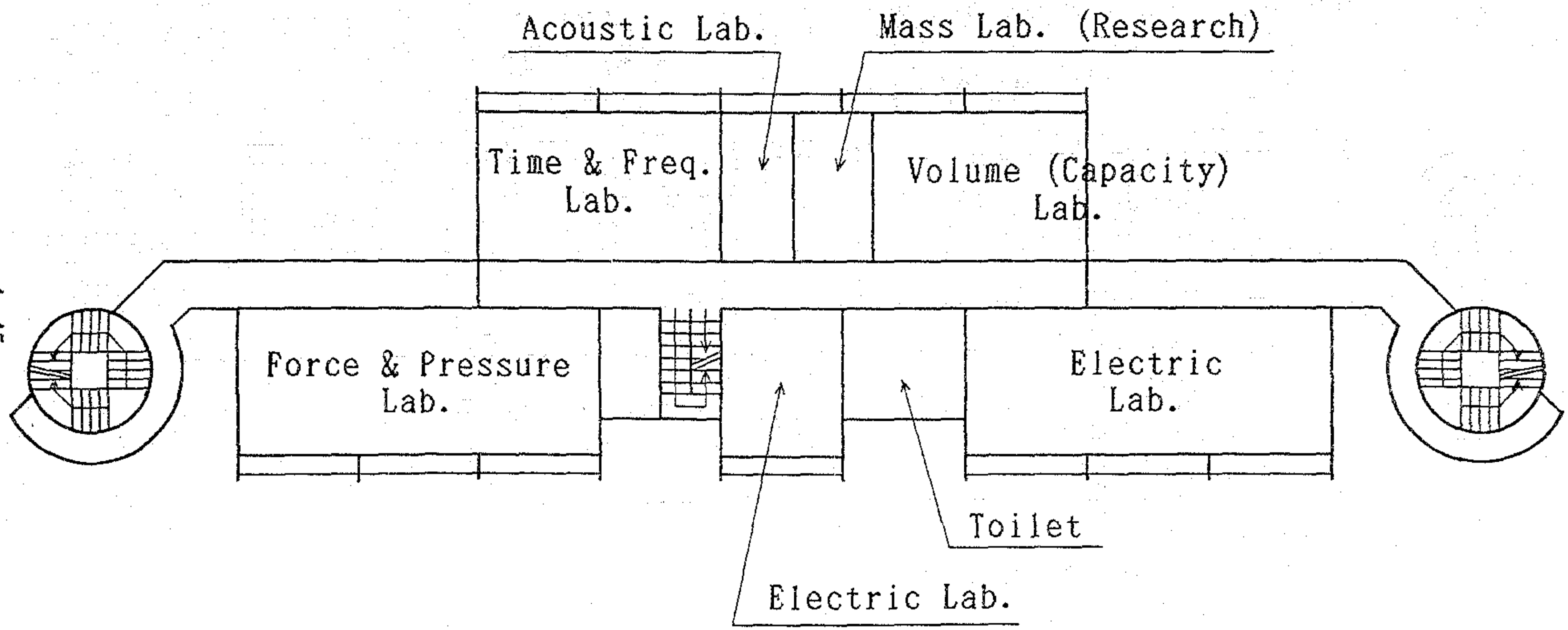


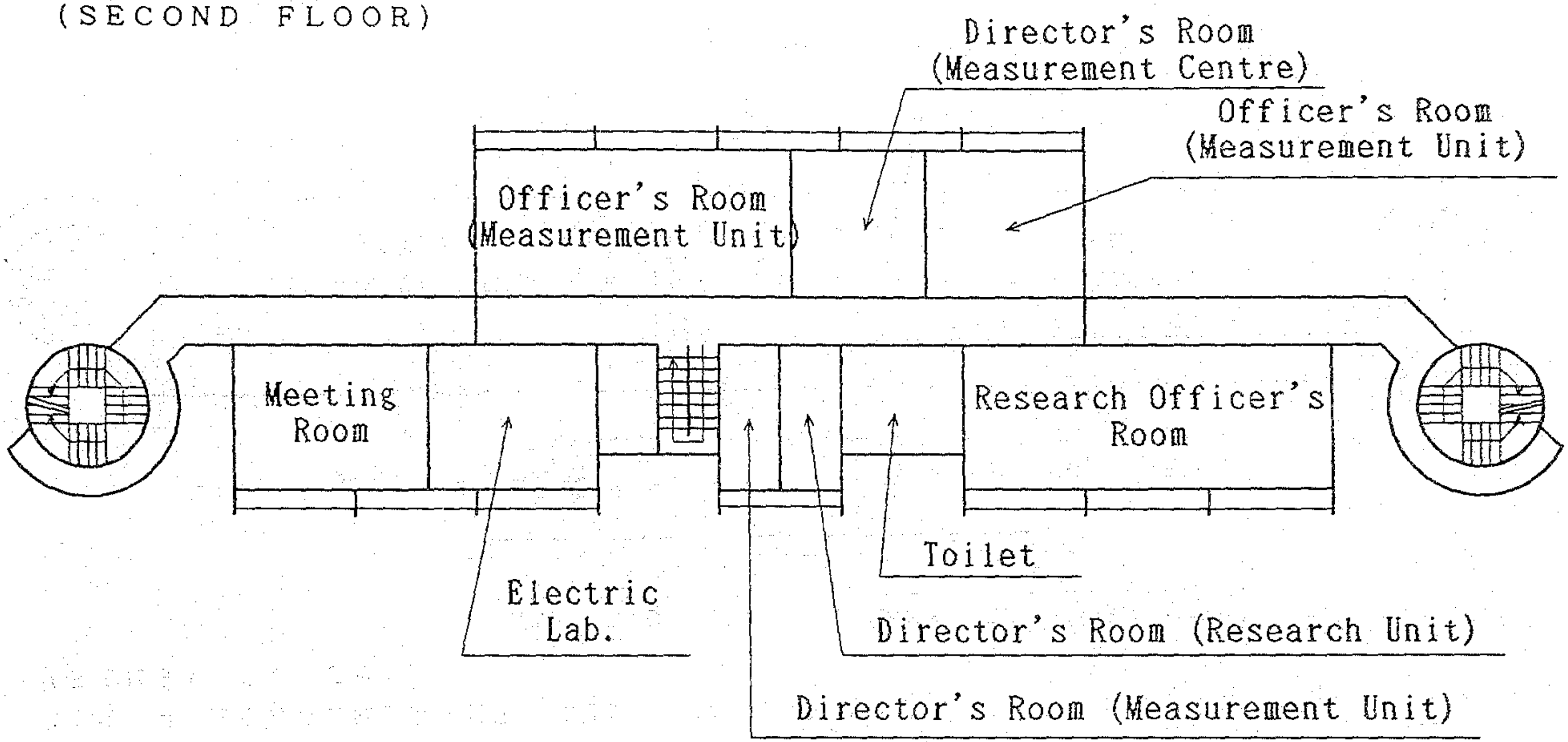
Fig. 4-4 Layout of SIRIM Measurement Centre



SIRIM MEASUREMENT CENTRE LAYOUT
(FIRST FLOOR)



SIRIM MEASUREMENT CENTRE LAYOUT
(SECOND FLOOR)



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.

(1) Research and Development of Metrology

The management and control of measurement standards means the management of Malaysian national standards. It also means research and development to maintain these standards at a level which is recognised by the international community. Research and development activities in metrology in Malaysia are only undertaken by the SIRIM Measurement Centre.

(2) Calibration Service

Measurement accuracy can only be maintained if national standards which are established as the result of research and development activities are supplied to industrial circles and related organizations. Therefore, the calibration service is essential for the growth and improvement of industrial activities.

In addition to the SIRIM Measurement Centre, SAMM accredited calibration organizations provide such a calibration service. As already analysed in the previous chapter, however, it is difficult to say that these accredited calibration organizations can provide adequate support for the calibration service of the SIRIM Measurement Centre due to their limited scope in terms of the subject fields, accuracy and service area.

In response to the rapidly increasing calibration demand in the industrial circle in recent years in terms of both quality and quantity, the organizational structure of the SIRIM Measurement Centre was revised in January, 1992 and was divided into (i) the Measurement Standards Research Unit responsible for the management and control of national standards and the research and development of advanced measurement technologies and (ii) the Measurement Service Unit responsible for the efficient supply of standards to the industrial circle. As this reorganization was conducted not long ago, re-allocation of the work and re-distribution of the equipment have not yet been completed except in the electrical field where systems based on the new structure have been put in place and set in motion.

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 organizational structure of the SIRIM Measurement Centre and its floor plans are shown in Fig. 4-3 and Fig. 4-4 respectively in Chapter 4.

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

5.2.1.1 Current Conditions

(1) Standards and Other Equipment

The primary standards and calibration equipment currently owned by the Dimensional Laboratory are listed in Table 5-1. Most were originally donated under the Japanese technical cooperation which commenced in 1982. The traceability of the standards associated with the Dimensional Laboratory is shown in Fig. 5-1. All the equipment is still actively used for calibration and other work. The main equipment is outlined below.

The 00 class gauge block which was donated in 1983 has never been officially calibrated since that time. However, its calibration values have been confirmed by comparison with those of the 00 class gauge block which was purchased in 1992 with a calibration certificate issued under the NAMAS, the laboratory accreditation scheme in the UK. Consequently, the original gauge block is still used as the actual calibration standard. It was decided to purchase a new gauge block because the cost little differed from the cost of having the calibration work conducted abroad.

In 1991, a ceramic gauge block (00 class) was purchased, again with a NAMAS calibration certificate, following a request for the calibration of ceramic gauge blocks.

A standard linear scale (1m) was donated in 1984 and was calibrated in April, 1993 by the National Research Laboratory of Metrology in Japan. Tape measures (10m and 20m) were donated in 1983 and have never been calibrated since that time. These are occasionally used for calibration work.

An angle gauge (set of 9 pieces) was purchased in 1990 and has not since been calibrated. A ring gauge was purchased in 1992 to respond to the increasing number of calibration requests made by the manufacturers of pipes, tubes and ball bearings, etc. The level blocks donated in 1985 have not been calibrated since.

The comparator (0 - 100mm) used for gauge block calibration has an integral data processing unit and is effectively used to achieve high calibration work efficiency. It has 3 measurement modes (ISO 3650, NF E10-010 and OIML Nr.30). The ISO 3650 mode (1979) is used for calibration purposes unless a special request is made by the client.

The coordinate measuring machine has suffered many breakdowns since the end of the technical cooperation period. Its data processing unit was replaced by the latest model at the time of one of these breakdowns.

At present, the Dimensional Laboratory is said to be incapable of calibrating screw gauges, the flatness of level blocks and angle gauges, etc. As the relevant equipment was donated during the technical cooperation period together with the transfer of technology, this inability is caused by the transfer of the original technical staffs to other sections without a proper internal transfer of technology.

As the list of equipment shows, shape measurement equipment was included in the original donation list of the technical cooperation project. However, this equipment is kept in the Force and Pressure Laboratory on the first floor and is little used. Some of these standards and measuring equipment are not regularly calibrated. In addition, there is also a problem of the lack of calibration records.

(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

Table 5-1 shows the transition of the number of calibration applications made to the Dimensional Laboratory in the last 3 years. The number 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.

One characteristic of the recent application trend is the increase of calibration requests for ceramic gauge blocks. There were 3 applications in 1991 but this figure increased to 8 in 1992, indicating the tendency for users to select to replace old gauge blocks with ceramic gauge blocks.

As shown in Table 5-2, 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. The SAMM accredited calibration organizations which conduct length calibration usually charge more than double the charge of the Dimensional Laboratory although their work is completed much faster.

According to staff of the Dimensional Laboratory, they sometimes do not understand how to operate those measuring instruments of which calibration is requested. Guidance on the operating and maintenance methods is sometimes provided for clients as many problems occur due to the improper operation and maintenance of such instruments. There are examples of the method to read calipers or micrometers being incorrect despite their proper calibration. Engineers of the Dimensional Laboratory believe that the technological level of their clients is generally low.

When an instrument subject to calibration is found to be faulty or inaccurate, the client is informed of this fact. The instrument is then repaired by the manufacturer or a repairer prior to its calibration at the Dimensional Laboratory for the issue of a calibration certificate. In the case of the breakdown of the calibration equipment or instruments owned by the Dimensional Laboratory, the first action is to internally discover the cause of the breakdown. If the problem is one of the replacement of parts, the necessary spare parts are procured for the internal repair of the equipment. If the repair is found to be beyond the capability of the Dimensional Laboratory staff, the manufacturer (or supplier) is approached. As manufacturers tend to be overseas companies, however, the length of time required for repair always poses a problem.

In regard to the calibration of gauge blocks, measurement is conducted after thorough cleaning. Examination of accepted gauge blocks prior to measurement by the Study Team members found that many had visible scratches, raising concern in regard to their accuracy. While lapping treatment to remove these scratches should be conducted, the lack of the relevant expertise on the part of the existing technical staffs makes this treatment impossible.

Calibration of the 00 class (highest accuracy) gauge blocks should be conducted as an absolute measurement using the light wave interferometer. However, the

Dimensional Laboratory uses the comparative calibration method using its 00 class gauge blocks instead of the absolute measurement method. The number of 00 class calibration requests is only one or two a month at present. Nevertheless, given the fact that the gauge block calibration demand is rapidly expanding in terms of both quality and quantity as shown by the increasing number of applications in the last few years, the urgent acquisition of the facilities and technologies for the absolute measurement by the Dimensional Laboratory is necessary.

The Dimensional Laboratory usually requires 3 - 4 weeks from the date of acceptance to calibrate a set of gauge blocks and to issue the certificate. The calibration work itself only takes some 2 days, depending on the actual number of blocks, indicating the long queue for the work. While the technical staffs work overtime to deal with the mounting work, many clients have expressed dissatisfaction in regard to the long waiting time. As described in Chapter 6, many of the companies visited by the Study Team members share this dissatisfaction and expressed a strong desire for a shorter calibration time for not only gauge blocks but also for other instruments. It was explained that the Dimensional Laboratory gives priority, if possible, to urgent calibration needs, including cases where calibration is urgently required prior to examination of the quality assurance system based on the ISO 9000 Standard.

(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. The technical staff who underwent specialist training under the technical cooperation project has been relocated to the Johor Bahru Branch. The present research officer was transferred from the Temperature Laboratory 3 years ago but has not yet undergone specialist training on length measurement except for his own efforts to learn through the relevant documents. His lack of experience in this particular field cannot be denied. All the present staff members should be given the opportunity to undergo training at other organizations which specialise in length measurement as their technical competence is inadequate.

(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. Given the continuous increasing trend of the demand for gauge block calibration described above, it will soon be necessary to establish a room for the exclusive calibration of gauge blocks. Some old pieces of equipment and instruments found in the precision measurement room are not used because of the unavailability of spare parts, in turn caused by the termination of their manufacture.

5.2.1.2 Current Problems

(1) Shortage of Technical Staffs and Lack of Sufficient Experience

The subject items of the present calibration service provided by the Dimensional Laboratory are such standards and measuring instruments as gauge blocks and micrometers, etc. owned by companies and used as their reference standards for manufacturing. For these subject items, only some of the equipment and technologies transferred during the technical cooperation project are actually used for calibration work. In particular, the use of shape measuring equipment is inadequate to the extent that requires for calibration involving this equipment have declined despite the presence of the equipment. The main reason for this is the staff shortage. The insufficient transfer of knowledge and technical expertise from the predecessor to the present staff and the insufficient in-house training of the staff to use all the available equipment due to their busy work schedules are also responsible for the insufficient use of equipment.

(2) Insufficient Space

The absence of a storage (warehouse) to temporarily store equipment and instruments to be calibrated is a problem for not only the Dimensional Laboratory but also for the SIRIM Measurement Centre as a whole, creating havoc. The use of laboratory space for storage inevitably causes congestion in all laboratories. The Dimensional Laboratory is no exception and is probably worse than other laboratories due to the necessity of acclimatising the equipment and instruments to the room temperature prior to calibration. Any future increase of the number of technical staffs must, therefore, be accompanied by a physical expansion of the laboratory space.

(3) Independence of R & D Work and Calibration Work

Top priority in upgrading project planning should be given to increasing the number of staff and upgrading the technical competence. It is highly advisable that the achievement of these objectives be accompanied by the functional division between the R & D of standards and the calibration work. At present, both functions are performed in the same room and those responsible for the control of standards are often preoccupied with calibration work. The R & D function is performed by one research officer and one technician and these are responsible for the control of standards in the length, mass and force/pressure fields.

5.2.2 Mass Laboratory

5.2.2.1 Current Conditions

(1) Standards and Other Equipment

The standards and other calibration equipment currently owned by the Mass Laboratory are listed in Table 5-3 and are believed to be adequate to meet the immediate calibration requirements. Some of these standards and calibration equipment were originally donated under the technical cooperation project. Fig. 5-3 shows the traceability at the Mass Laboratory.

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.

Many of the present calibration requests are for the standard weights and balances owned by the Metrological Verification Offices of the Ministry of Domestic Trade and Consumer Affairs and its branches in accordance with the statutory requirement under the Weights and Measures Act. As these items must be regularly calibrated, there is a constant flow of calibration requests from these offices. The annual increase of 4 - 5 branch offices means that the Mass Laboratory receives an ever increasing number of calibration requests for newly acquired standard weights and balances. Moreover, upgrading of the weight class is in progress for old weights, making their strict calibration necessary. As a result, it is no exaggeration to say that the Mass Laboratory is flooded with calibration work.

Most of the standard weights to be calibrated are of the F1 class or lower based on the OIML classification and there are few weights of upper classes, such as E2. In the case of standard weights, no adjustment of mass is conducted for calibration purposes while minute adjustment can be made in the case of M1 class cast iron weights. This minor adjustment is conducted on the condition that the lid of the hole for this minute adjustment can be opened. If the lid cannot be opened, this fact is included in the calibration report. The measurement of such weight is conducted without any change to the state of the weight.

While most calibration work is conducted in the Mass Laboratory, a technical staff may be sent on-site to calibrate cast iron weights because of the heavy weight. At present, one to one and a half months is required for the Mass Laboratory to complete the requested calibration work and to issue the calibration certificate.

In addition to the above work, the mass calibration section conducts the calibration of standard tanks of upto 20 litres in capacity by means of measuring water mass as stipulated by the Weights and Measures Act.

The calibration charge is set for each standard weight of different class and mass as listed in Table 5-4. 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.

5.2.2.2 Current Problems

(1) Shortage of Technical Staffs

There is an apparent shortage of technical staff vis-a-vis the work load. As the technical level of the Mass Laboratory staff appears to be satisfactory, further efficiency improvement can be achieved by creating a systematic calibration system to adequately meet the required work and accuracy. In short, it is deemed necessary for the Mass Laboratory to deal with only highly accurate standards of superior classes while delegating the calibration of less accurate standards to other calibration organizations.

(2) Insufficient Space

The Mass Laboratory requires more working space, mainly because of the absence of a storage for equipment and instruments awaiting calibration at the SIRIM Measurement Centre. Appropriate transportation measures should also be introduced in view of the heaviness of many of these pieces of equipment and instruments.

(3) Development of National Standard Management and Control System

It is urgently required for the Mass Laboratory to develop the capability to manage and control national standards without reliance on external organizations. The SIRIM Measurement Centre should have more than one standard class 1kg weight, should acquire the capability to compare these weights with each other or with international standards and should learn the calibration techniques to use the divisions or multiplications of standard weights for the supply of appropriate standards in a wide range. In addition to the construction of new facilities and the procurement of new equipment, technical training must be provided for the staff.

5.2.3 Volume and Flow Laboratory

5.2.3.1 Current Conditions

(1) Standards and Other Equipment

The equipment and instruments currently owned by the Volume and Flow Laboratory are listed in Table 5-5. Most 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 traceability at the Volume and Flow Laboratory is shown in Fig. 5-4.

The gas flow measuring equipment is of the low pressure type with a working pressure of around the standard atmospheric pressure designed to check household gas meters and is little used as calibration equipment.

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. as shown in Table 5-6. In fiscal 1992, 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 as listed below.

1) Petrochemical Inspection (M) Sdn. Bhd.
2) Ritchie & Bissect (M) Sdn. Bhd.
3) Caleb Brett (M) Sdn. Bhd.
4) Oga System Sdn. Bhd.
5) MOGAS (M) Sdn. Bhd.
6) Nippon Kaiji Kentei (NKK) Sdn. Bhd.
7) Damai Teknik (M) Sdn. Bhd.
8) RANACO Marine (M) Sdn. Bhd.
9) Shin Nihon Kentei Kyokai (M) Sdn. Bhd.

The calibration work conducted by these surveyors, in fact, takes place all over Malaysia, including East Malaysia, because of the production of oil and natural gas along the South China Sea coastline. In the case of the large prover tanks (3,000 - 10,000 litres) and master meters used to calibrate bulk storage tanks, those owned by petroleum or chemical companies can be used as standards. The prover tanks (50 - 2,000 litres), master meters and other calibration equipment owned by surveyors are calibrated annually at the SIRIM Measurement Centre.

Approval of the calibration results by a surveyor commences with the submission of a calibration outline by the surveyor which is then scrutinised by the SIRIM Measurement Centre. If the outline satisfies certain criteria, it is approved, followed by approval of a member of the surveyor who will then actually conduct the calibration work. After confirming that calibrated standards will be used for the work, the calibration of the client's bulk storage tanks, etc. then commences.

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 the scope of calibration work includes gas meters, there is currently no statutory requirement for the calibration of household gas meters. In fact, the installation of gas meters for charge purposes is limited to certain areas, such as Sarawak, Terengganu, Johor and Kuala Lumpur. At present, some 10,000 gas meters are estimated to be in operation. The question of calibrating household gas meters has not so far arisen, partly because of the low monthly gas rate of around 10 M$.

Fuel gas with a pressure of 50 atm is supplied by PETRONAS to the substations of Malaysia Gas which reduce the gas pressure to 8 atm before supply of the gas to factories and other places of consumption. The pressure is further reduced at factories to around 1 atm for actual use. During these processes, a need for calibration arises to ensure the accurate flow of gas from one place to another. In other words, the flow meters used under high pressure must be calibrated. The existence of requests for this type of calibration was confirmed during visit to accredited calibration organizations. The Volume and Flow Laboratory cannot meet these requests because of the lack of appropriate standards.

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.

Requests for volume or flow-related calibration are often received from Singapore and Brunei. This is due to the fact that while the SISIR, the organization responsible for the management of measurement standards, is well equipped with electrical calibration equipment, it is weak in regard to the calibration of other physical quantities.

Although the number of calibration requests lodged with the Volume and Flow Laboratory is not particularly large compared to the other laboratories, the income from calibration work is the highest among all the laboratories. The calibration charges of the Volume and Flow Laboratory are listed in Table 5-7.

(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.

5.2.3.2 Current Problems

(1) Shortage of Technical Staffs

It is apparent that the present number of technical staffs working in the Volume and Flow Laboratory is insufficient as the work to approve the calibration results of others is only sustained by assistance from other laboratories. Increased manpower is essential to meet the growing calibration demand in the future.

(2) Response to Diverse Calibration Demands

There are some types of equipment, such as large flow meters and gas meters, for which the social need for calibration is increasing but which cannot be adequately met by the Volume and Flow Laboratory because of a lack of the corresponding facilities. It is desirable in the upgrading project to give priority to the acquisition of those facilities with a high degree of accuracy together with the preparation of a manpower development programme to train highly specialised staff.

5.2.4 Force and Pressure Laboratory

5.2.4.1 Current Conditions

(1) Standards and Other Equipment

The calibration equipment and instruments owned by the Force and Pressure Laboratory are listed in Table 5-8. 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. The traceability at the Force and Pressure Laboratory is shown in Fig. 5-5.

(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.

There are many areas in which the received calibration requests cannot be met by the Force and Pressure Laboratory simply because of the lack of the relevant facilities and/or equipment. Some of these areas are described below.

1) The maximum range for the calibration of a force gauge is currently 200 tf. Strong requests have been made to raise this ceiling to 500 tf.

2) Proton, a Malaysian car manufacturer, has requested the calibration of torque wrenches. Proton is not the only manufacturer using torque wrenches. In fact, a large number of torque wrenches and torque drivers are in use throughout Malaysia and their accuracy is an important factor to ensure product quality. It is, therefore, necessary to develop calibration capability vis-a-vis these tools.

3) Calibration requests have also been made for hardness testers. The hardness test is one of the most frequently conducted mechanical tests. It appears that no calibration of hardness testers is conducted or that standard hardness test pieces are used to check these testers by their owners.

4) Only a small number of enquiries have so far been received from universities and others in regard to the capability of the Force and Pressure Laboratory to calibrate barometers. Barometers are widely used in many places, including various laboratories, and the necessity for their calibration is well recognised. There is a potential high demand for such calibration if the Force and Pressure Laboratory can acquire the capability to conduct barometer calibration.

5) Vacuum pressure is currently calibrated using a mercury column manometer. No calibration requests have so far been made in regard to the high vacuum standard even during the factory visits by the Study Team members. However, it will be necessary to acquire such capability in the future in accordance with industrial development in Malaysia.

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.

The calibration charges set by the Force and Pressure Laboratory are listed in Table 5-9. Different charge calculation methods are employed for the in-house calibration of pressure gauges and others and for the on-site calibration of testing machines and other equipment. In the case of the latter, an estimate is prepared and submitted to the client and the actual calibration is only conducted when the estimate has been approved by the client. The same procedure is, in fact, followed by the Volume and Flow Laboratory for its on-site calibration service.

(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 present research officers were assistant research officers before the previous research officer retired in 1992 following long service at the SIRIM.

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.

5.2.4.2 Current Problems

(1) Shortage of Technical Staffs

The Force and Pressure Laboratory is the only laboratory in Malaysia conducting force calibration. It is, therefore, constantly flooded with calibration requests. Some clients use AIROD which is currently in the process of applying for SAMM accreditation and lacks official traceability.

The Force and Pressure Laboratory has proving rings for the calibration of tensile testing machines but only one set of proving rings is available for each testing range. As the calibration of tensile testing machines is conducted on-site, the appropriate sets of proving rings for the testing ranges are taken on-site by the assigned technical staff. When more than one calibration request involving the standard force gauge of the same range are received, only one of the requests can be dealt with at a time, reducing the work efficiency. It is, therefore, necessary for the laboratory to have more than one set of proving rings for each testing range. The vast geographical coverage (all of Malaysia) of the Force and Pressure Laboratory means that the 3 technical staffs travel extensively, reducing the time used for actual calibration work. On-site calibration at Johor or Pinang requires 3 days: 2 days travelling and one working day. Calibration requires the operator of the testing machine and a reader of the values indicated by the standard equipment. The Force and Pressure Laboratory technical staff is generally responsible for reading the values but is often obliged to teach the operator how to gradually increase the load due to the latter's unfamiliarity with the calibration procedure.

The frequency of on-site calibration work naturally allows less time for the technical staffs to write up their reports at the laboratory. The resulting lengthy process from the acceptance of a calibration request to the issue of the certificate is the source of many client complaints. The research officers are now considering the use of a lap-top computer for on-site calibration work so that the calibration report can be prepared and issued on the spot.