(2) Insufficient Technical Experience

The previous research officer who retired in 1992 was fully conversant with the technical requirements of the Force and Pressure Laboratory because of his overseas training as part of several technical cooperation projects. While the present technical staffs work very hard, their insufficient calibration work experience is a bottleneck to efficient performance. The research officer newly assigned to the Force and Pressure Laboratory 5 months ago has an electrical engineering background. This officer works extremely hard and his achievements so far include the semi-automisation of measuring processes and the introduction of a more efficient way of conducting calibration work.

(3) Lack of Facilities and Equipment

As described earlier, the Force and Pressure Laboratory is unable to accept certain types of calibration requests made by the industrial circle simply because of the lack of the relevant facilities and equipment. A manpower increase is required to meet these requests in addition to the procurement of the necessary facilities and equipment, making the preparation and phased implementation of a master plan necessary.

5.2.5 Temperature Laboratory

5.2.5.1 Current Conditions

(1) Standards and Other Equipment

The standards and other equipment currently owned by the Temperature Laboratory are listed in Table 5-10. The majority of these were donated in 1985 under the technical cooperation project. Between 1988 and 1991, standard thermometers, thermal comparison baths and several other pieces of equipment were added using the SIRIM's own budget. A total of some 90 pieces of equipment and instruments are maintained in a fairly good condition and are assumed to retain their original performance. The shortage of manpower, i.e. only 3 technical staffs are assigned to the Temperature Laboratory, means that only some equipment and instruments are regularly used for calibration work. The Temperature Laboratory has liquid-in-glass thermometers, thermal baths for the calibration of such contact thermometers as thermocouples, electric furnaces, standard resistance thermometers and electric meter-recorders, etc. The traceability at the Temperature Laboratory is shown in Fig. 5-6.

(2) Calibration Work

The calibration service currently provided by the Temperature Laboratory consists of comparison calibration where readings on a standard thermometer and the thermometer subject to calibration are compared with each other in a thermal bath or electric furnace. The subject temperature range is between -80°C and 1,400°C. The equipment and instruments mainly dealt with by the Temperature Laboratory and the relevant temperature range are shown in Table 5-11.

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

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

Of the fixed point temperature devices required to establish the ITS-90, the Temperature Laboratory currently has the triple point of water, the freezing point of tin and the freezing point of zinc. Only the triple point of water is used for calibration purposes and other fixed points of temperature (freezing points of metals) have not yet been established. While it is impossible to indicate the accuracy of the present calibration service (accuracy of absolute values) in objective numerical values because of the lack of comparative measurement data vis-a-vis other calibration organizations and other relevant data, the following values are suggested by the Temperature Laboratory as typical values for calibration accuracy.

- High precision class liquid-in-glass thermometer : ± 0.1°C - 2 °C
- High precision class Type S thermocouple : ± 0.5°C - 5°C
- High precision class platinum resistance thermometer : ± 0.01°C - 5°C

The standards used for calibration work are standard platinum resistance thermometers (SPRT) and high precision class mercury thermometers (set of 8, temperature range of each: 50°C - 60°C), both of which are calibrated by the National Research Laboratory of Metrology in Japan and other similar institutions. To achieve the highest target accuracy listed above, it is essential for the Temperature Laboratory to establish the main fixed points of temperature by itself so that the variation in characteristics of standard thermometers can be properly checked in-house to confirm the calibrated values. As the Temperature Laboratory is currently unable to do this, the temperature calibration accuracy of the Temperature Laboratory appears inadequate to fully meet the level of accuracy required by the industrial circle. The procurement of new equipment is required to improve the situation together with training to equip the technical staffs with the necessary calibration skills to use fixed points of temperature.

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

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

(3) Technical Staffs

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

The recent full-scale re-assignment of the SIRIM Measurement Centre's employees appears to have resulted in the assignment of staff members who are not fully conversant with the thermal calibration requirements to the Temperature Laboratory. The insufficient transfer of technology from their predecessors is also responsible for the present inability to realise the potential of the Temperature Laboratory. As the calibration of thermometers, involving complex technologies/techniques, is delicate and risky, the laboratory should have at least one technical staff with 5 or more years' experience in this field. It is also essential for appropriate training and education to be provided for new staff members. In reality, however, the Temperature Laboratory or the SIRIM Measurement Centre itself appears to be incapable of providing such training and education for a number of reasons.

(4) Laboratory Space

The main laboratory space relating to temperature is located on the ground floor and consists of 2 laboratories. The larger laboratory (approximately $100m^2$) contains such large equipment as the water thermal bath, oil thermal bath, salt bath and electric furnace and their control devices. The neighbouring smaller laboratory (approximately $30m^2$), which is separated from the larger laboratory by a solid wall, contains the platinum resistance thermometer and other precision instruments for the measurement of resistance. While it is sensible to separate large pieces of equipment which produce heat and vibration from sensitive precision instruments from the viewpoint of air-conditioning, the absence of wiring and conduits, including those for measuring purposes, directly connecting the 2 laboratories must constitute a large obstacle to the smooth running of laboratory operation. The presence of many large pieces of equipment and the need for space to allow the safe passage of dangerous substances and temporary wiring or piping suggest that the present laboratory space is far from satisfactory. The minimum enlargement of the present space by some 50% and re-arrangement of the equipment layout are deemed urgent to upgrade the current required work and services to a satisfactory level.

5.2.5.2 Current Problems

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

The most critical problem of the Temperature Laboratory at present is the shortage of technical staffs and their lack of sufficient experience in the subject field. The management of thermal standards requires a wide range of knowledge and technological competence and special consideration must be given to the training of experts and the transfer and maintenance of technologies. Training centering on relatively basic technologies/techniques was provided under the technical cooperation project as temperature was a completely new field for Malaysia's measurement system. Those receiving the relevant training at the time, however, no longer work at the Temperature Laboratory. The future upgrading project should emphasise the development of technical staff, particularly the provision of technical training, with a view to establishing a system of regularly conducting the comparative measurements with other organizations.

(2) Insufficient Use of Existing Facilities and Equipment

The existing standards and other equipment at the Temperature Laboratory are not fully utilised. A national metrology laboratory is expected to regularly conduct the realization of fixed points of temperature based on the ITS-90, the international temperature scale, within at least the moderate temperature range. The Temperature Laboratory finds this difficult because of constraints in terms of both facilities and technological capability. However, it is still possible to achieve the ITS-90 in the temperature range of between 0°C and 419.527°C using the triple point of water, freezing point of tin and freezing point of zinc. Any immediate task faced by the Temperature Laboratory should be conducted through the proper use of thermal baths and electric furnaces, confirmation of their performance and acquisition of techniques to reproduce fixed point temperatures.

The current industrial requirements suggest that the next stage of development for the Temperature Laboratory should be the acquisition of facilities and equipment to reproduce the freezing point of silver (961.78°C) in the high temperature region and the triple point of argon (-189.3442°C) as well as the triple point of mercury (-38.8344°C) in the low temperature region.

Although the Temperature Laboratory currently offers a temperature calibration range of between -80°C and +1,400°C, only thermocouples are calibrated by comparison in the temperature range of more than 600°C. It is desirable that the electromotive force around the freezing point of palladium (1,552°C) be confirmed by a simple method (such as the wire method) in order to check variations of the calibrated values of thermocouples in the high temperature region. It is also necessary to expand the calibration range upto around 1,600°C.

5.2.6 Electrical Laboratory

5.2.6.1 Current Conditions

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

(1) DC Voltage Standards

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

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

In the research and development field, a plan to establish the Josephson voltage standard system is in progress and a liquid helium dewar vessel for very low temperature use and a cryogenic control device, etc. have already been purchased using the SIRIM's own budget. The possession of a quantum standard is important to not only improve the measurement accuracy but also to upgrade the status and credibility of the Electrical Laboratory. Fig. 5-8 and Table 5-12 show the present traceability system for the DC voltage standards and the main equipment owned by the Electrical Laboratory respectively.

The matters related to Time and Frequency Laboratory and Acoustics Laboratory are described separately later.

(2) Resistance Standards

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

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

At present, international comparison of resistance standards uses the quantized Hall resistance standard. As the normal value of the quantized Hall resistance standard is approximately 10 KΩ, it is customary to conduct build-up or build-down of the standard resistance system using 10 KΩ as the datum level.

The current resistance standard system at the Electrical Laboratory is based on 1Ω but preparations are underway to change to the 10 KΩ-based system in the future and a new SR104 standard resistance (10 KΩ) has already been procured as part of such preparations. To cite the Japanese example for reference purposes, while the national standard is established based on the quantize Hall resistance standard, the calibration of resistance has long been based on 1Ω. Secular changes of the SR104 (10KΩ) are being investigated, however, as part of the management and control efforts for resistance standards. The SISIR in Singapore has established resistance standard systems based on both 1Ω and 10 KΩ and is currently studying the compatibility of these systems. Fig. 5-9 shows the traceability of the present resistance standards at the Electrical Laboratory.

(3) LC Standards

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

The management and control of capacitance standards rely on hand-made equipment throughout the world and the 1404 type standard condenser is the only suitable item for use as a standard. As a result, emphasis is placed on the level of management technologies/techniques rather than on equipment. The Electrical Laboratory's technical staff responsible for LC standards was only recently assigned and his calibration experience is not yet adequate enough for him to be fully conversant with the conditions and histories of the present standards and equipment. Fig. 5-10 shows the traceability of the present capacitance standards at the Electrical Laboratory.

(4) AC Voltage Standards

The AC voltage standard and AC/DC disparity standard are supplied by the AC calibrator and AC/DC thermal transfer standard, etc. which use the AC/DC disparity values established by the AC voltage standard and transfer standard.

All the standards and equipment involved in the above processes are of the highest class. Their regular calibration and appropriate analysis and evaluation of calibration data should establish and maintain sufficiently accurate AC standards. Fig. 5-11 shows the traceability of the present AC voltage standards at the Electrical Laboratory.

(5) Time and Frequency Standards

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

Some 200 calibration requests were dealt with in fiscal 1992. The subject items were mainly stop watches and digital timers. The number of calibration requests in this field has been increasing with a higher level of accuracy demanded. While it may be necessary to procure several new pieces of equipment to meet the increasing calibration demand, immediate emphasis should be placed on improving the technical competence of the technical staffs and on establishing a reliable accuracy control system. Fig. 5-12 shows the traceability of the present time and frequency standards while Table 5-13 lists the main equipment owned by the laboratory.

(6) High Frequency-Microwave Standards

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

The survey on the calibration need in the private sector conducted as part of the present Study found that the SIRIM Measurement Centre's lack of a calibration service for microwave standards forces private companies to commission calibration to Singapore (SISIR), Australia, US and Japan which involves much time and a high cost (see Chapter 6 for further details). The SIRIM Measurement Centre's urgent acquisition of high frequency and microwave standards calibration capability is necessary as part of the SIRIM Measurement Centre's overall upgrading with special emphasis on the fostering of technical staffs with adequate technical competence. It is against this background that technical guidance by UNIDO experts will shortly be provided in this field.

(7) Acoustic Standards

A pistonphone is currently used as the reference sound source and a standard microphone determines the standard field for the comparison calibration of noise meters. While the necessary facilities for comparative measurement are in place, the standard microphone has not been calibrated for some time. The Acoustics Laboratory is the only laboratory in Malaysia capable of conducting the calibration of acoustics. While the calibration demand has so far been weak, it is expected to increase in the future as the need for noise measurement from the viewpoint of environmental conservation and anti-pollution measures becomes stronger. Fig. 5-13 shows the traceability of the present acoustic standards while Table 5-14 lists the equipment owned by the Acoustics Laboratory.

(8) Technical Staffs

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

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

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

(9) Standards and Other Equipment

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

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

(10) Laboratory Space

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

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

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

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

Control of the temperature and relative humidity is an essential precondition for the proper management of national standards and a special air-conditioning system capable of concurrently running a refrigerator and a reheater should be installed for those laboratories keeping important standards. As the continuous operation of such a system, which consumes a large volume of energy, results in a very high running cost, the provision of general, central air-conditioning for the entire building is desirable with precision laboratories requiring special air-conditioning placed within the centrally air-conditioned environment.

The effects of electrical noise generated by power sources or earthing on the measurement accuracy takes various forms. It is important to carefully examine the characteristics of such effects in order to accurately judge the reliability of measurement results. The performance characteristics of power sources and earthing must be thoroughly checked and, if necessary, improved for the further improvement of calibration accuracy. Improvements can be made by the separation and proper shielding of ordinary power circuits and power circuits for measuring instruments to avoid interference and also by providing special earths with low earthing resistance for measuring instruments.

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

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

The encouragement of flexible ideas and trial manufacture, proper repair and/or remodelling of equipment are necessary for successful R & D and calibration work. The smooth implementation of such work can only be ensured by the adequate provision of worktables, electric/electronic spare parts and a variety of tools and machine tools. It is also desirable to provide a room (library) with reference books and manuals which is separate from the laboratories for the easy access of all staff of the Electrical Laboratory.

(11) Calibration Work

The Electrical Laboratory has been conducting more than 1,000 calibrations a year since fiscal 1991 and the actual number of calibrations in fiscal 1992 totalled 1,538, confirming the increasing trend in recent years. Table 5-15, Fig. 5-14 and Table 5-16 all show the increasing demand for electrical calibration while Table 5-17 shows the calibration charges.

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

5.7.2 Current Problems

(1) Management of Standards and Other Equipment

Prior to the organizational break-up of the Measurement Standard Research Unit and Measurement Service Unit, the provision of a calibration service to meet the demand of the industrial circle was given priority over the management of standards, resulting in the inadequate periodic calibration and maintenance of standards and other equipment. Under these circumstances, it was impossible to confirm the accuracy of those standards supplied by the calibration section. While some national standards have been calibrated abroad from time to time and the calibration data has been kept, the lack of calibration data using such standards at the SIRIM Measurement Centre makes it difficult to evaluate the accuracy of the calibration results. The SIRIM Measurement Centre is currently participating in international comparisons (China, Philippines, Singapore, Malaysia, Thailand and Australia, etc.) by the APMP (Asia Pacific Metrology Programme) and UNDP (United Nations Development Programme), etc. to verify the calibrated values of national standards. However, this participation alone is not sufficient for the proper management and control of national standards. In general, the management of national standards or measuring instruments of a similar level requires their regular calibration at their place of use so that calibration data can be analysed, evaluated and recorded in a register for easy understanding of their latest conditions by those responsible for their management. It is no exaggeration to say that a standard without a proper calibration record is useless for practical purposes because any user of the standard must know its real accuracy. This inadequate control of records is also apparent in the case of the standards used for calibration work. Even under the new arrangement of the functional division of R & D and the calibration service, the management of standards still appears not to be on the proper track.

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

The quality standard ISO 9000, which is increasingly used as the international industrial standard for quality assurance, has had many repercussions in Malaysia where a large number of foreign subsidiaries have been established in recent years. The ISO 9000 demands that the measuring instruments used in manufacturing processes must be traceable to national standards. As this is an important criterion to qualify for the ISO 9000, the number of requests for the calibration of standards and measuring instruments has been rapidly increasing, flooding the Measurement Service Unit of the Electrical Laboratory. The inability of the Electrical Laboratory to deal with all the calibration requests is also the result of the shortage, as well as inexperience, of technical staffs and the shortage of equipment in addition to the overwhelming number of requests. Some of these problems, however, can be reasonably solved by rationalising the management system of the SIRIM in general and of the SIRIM Measurement Centre in particular. Likely improvement measures include the introduction of an advanced booking system for the calibration service, standardisation of the calibration work and data recording and processing processes and adoption of innovative ideas and inventions to compensate for the equipment shortage. In fact, it appears possible to solve some of the problems identified during interviews with staff of the Electrical Laboratory through the skilful and/or innovative use of the existing equipment.

(3) Insufficient Space

As already mentioned earlier, the floor space of the Electrical Laboratory is limited to start with and this limited availability has been made worse by the piling up of equipment and instruments to be calibrated. Calibration systems are installed in the calibration laboratory to separately deal with different types of calibration work. The lack of overall coordination, however, hampers the implementation of efficient calibration. For example, there is a general shortage of lead wires and connectors, etc. which are essential to conduct applied measurement and testing. The lack of such OA equipment as word processors for the on-site recording of calibration data or the preparation of calibration reports means that it is difficult to check the appropriateness of data on the spot. This prevents on-site calibration work from achieving high efficiency. The lack of an appropriate lead wire could adversely affect calibration accuracy. For the future upgrading and consolidation of the Electrical Laboratory, improvements in the so-called software field should be made prior to improvement of the equipment list. Software improvements include the flow of equipment for calibration, flow of calibration work and flow of data processing, etc.

One of the SIRIM Measurement Centre's problems which must be pointed out is that the absence of a central office to accept equipment for calibration makes it impossible to conduct the uniform handling of such equipment. At present, the technical staff responsible for the requested calibration field directly receives the equipment from the client at the entrance area of the building. The conditions of the equipment brought to the SIRIM Measurement Centre are diverse, reflecting the attitude of users to and handling of the equipment or instruments. Some equipment is properly maintained while other equipment is covered in dust or even mud. Dusty equipment and instruments can create unfavourable conditions in the laboratories to which they are taken although these laboratories should be kept clean and free of dust. The introduction of a reception area is required to solve this problem and the receptionist should be responsible for cleaning the equipment before it is taken to a laboratory. Those clients bringing dirty or dusty equipment to the SIRIM Measurement Centre should be taught its proper use and cleaning requirements, etc. In addition, the presence of auxiliary components/parts, lead wires and manuals, etc. should be checked so as not to cause any delay in the calibration work. Guidance on the proper use of equipment and measuring instruments will become one of the most important aspects of the SIRIM Measurement Centre if the SIRIM Measurement Centre is to lead the industrial circle in the field of industrial metrology.

Table 5-1 Major Equipment List (Dimensional)

NAME OF EQUIPMENT	MAKER	YEAR
1. Micrometer Stand	Mitutoyo	1976
2. Gauge Block Set	Mitutoyo	1976
3. Micrometer	Mitutoyo	1976
4. Dial Gauge	Mitutoyo	1976
5. Sine Bar (100 mm)	Tsugami	1982
6. Gauge Block (Wedge)	Tsugami	1982
7. Inside Micrometer	Mitutoyo	1976
8. Micrometer Head	Mitutoyo	1976
9. Dial Indicator (0.1, 1, 10, 20, 50 mm)	Mitutoyo	1982
10. Vernier Caliper	Tokyo	1976
11. Coordinate Measuring Machine	Mitutoyo	1985
12. Standard Scale (1 m, H-shaped)	Tsugami	1984
13. Gauge Block Set	Tesa	1993
14. Microscope	Tsugami	1985
15. Surface Plate (2x1.5 m)	Mitutoyo	1985
16. Testing Machine (Dial Indicator)	Carl Mahr	1980
17. Standard Tape (10, 20 m)	Yamayo	1983
18. Length Comparator (10 m)	Kansai	1985
19. Length Comparotor (1 m)	Kansai	1983
20. Height Gauge (500 mm)	Tesa	1991
21. Gauge Block (Ceramic)	Tesaramic	1991
22. Measuring Machine (UMM)	Carl Mahr	1981
23. Gauge Block Comparator (0-250 mm)	Tsugami	1982
24. Calibration Tester (Dial Gauge)	Mitutoyo	1983
25. Laser Micrometer	Zygo	1992
26. Calibration Tester (Dial Indicator)	Sylvac	
27. Gauge Block Comparator (0-100 mm)	Tesa	
28. Dial Gauge Calibrator	Mahr	1982
29. Angle Gauge Block	Tsugami	1982
30. Sine Bar	Tsugami	1982
31. Autocollimator	Nikon	1985
32. Autocollimator	Nikon	1982
33. Micrometer (0-300 mm) 1 set	NSK	1982
34. Calibration Tester	Mitutoyo	1983
35. Bore Gauge (50-100 mm) 1 set	Mitutoyo	1983

Table 5-1 Major Equipment List (Dimensional) (Cont'd)

NAME OF EQUIPMENT	MAKER	YEAR
36. Profile Projector	Mitutoyo	1984
37. 12 Sided Mirror	Nikon	1985
38. Indexing Table	Baldex	1984
39. Roundness Measuring Machine	Tokyo Seimitsu	1985
40. Toolmakers Microscope	Mitutoyo	1985
41. Mu-Checker	Mitutoyo	1985
42. Surface Table (0.3x0.3 m)	Fujita	1985
43. Rotary Table	Tsugami	1985
44. Roughness Measuring Machine	Mitutoyo	1985
45. Offset Unit	Anritsu	1985
46. Displacement Meter	Anritsu	1985
47. Precision Level	Asahi	1982
48. Universal Measuring Machine	Mahr	1982
49. Granite Surface Plate	Mitutoyo	1982
50. Inside Micrometer (50-300 mm) 1 set	NSK	1982
51. Dial Test Indicator	Mitutoyo	1983
52. Height Master	Mitutoyo	1983
53. Bore Gauge (20-50 mm) 1 set	Mitutoyo	1983
54. Dial Caliper (150 mm)	Mitutoyo	1976
55. Digital Micrometer (0-100 mm)	NSK	1983
56. Precision Level (0.1 mm/m)	Riken	1985
57. Precision Level (0.02 mm/m)	Fujita	1985
58. V-Block (60 deg.)	Fujita	1985
59. V-Block (90 deg.)	Fujita	1985
60. V-Block (120 deg.)	Fujita	1985
61. Magnetic V-Block	Kanetsu	1985
62. 3 Wire Thread Measuring Machine	Tsugami	1985
63. Cylindrical Measuring Machine	-	1985

(Source : SIRIM)

Table 5-2 Number of Calibration Works (Dimensional)

	No. of Units received		
	1991	1992	*1993
1. Gauge Block Units	1396	4024	3043
2. Micrometers	79	91	36
3. Calipers	121	193	140
4. Pin Gauges	362	2312	703
5. Ring Gauges	13	31	30
6. Tapes	132	210	160
7. Others (Rulers, Dial Indicators, etc.)	26	100	47
Total No. of Units	2129	6961	4159
No. of Companies	129	262	250
Total Income (M$)	47,680	109,539	70,445

* From January to June 23 in 1993

(SOURCE : SIRIM)

Table 5-3 Calibration Fee (Dimensional)

1. Linear Scale	
* Ruler (up to 500mm)	M$ 40 per unit
* Ruler (500 to 1000mm)	M$ 50 per unit
* Ruler (1000 to 2000mm)	M$ 60 per unit
* 1m Working Standard	M$ 80 per unit
* 1m Tertiary Standard	M$ 90 per unit
2. Measuring Steel Tape	
* Up to 10m	M$ 80 per unit
* 10 to 30m	M$ 100 per unit
* 30 to 50m	M$ 130 per unit
* 50 to 100m	M$ 150 per unit
* 100m and above	M$ 170 per unit
3. Pin Gauges (in sets)	
* Not more than 3 units	M$ 40 per set
* Not more than 10 units	M$ 100 per set
* Not more than 50 units	M$ 200 per set
* Not more than 100 units	M$ 300 per set
* 101 units or more	M$ 350 per set
4. Micrometer	M$ 70 per unit
(additional standard rods)	(M$ 40 per unit)
5. Vernier Caliper	M$ 60 per unit
6. Dial Thickness Indicator	M$ 70 per unit
7. Ultrasonic Thickness Measuring Unit	M$ 70 per unit
8. Feeler Gauge	M$ 60 per unit
9. Height Gauge	M$ 150 per unit
10. Angle / Bevel Protractor	M$ 80 per unit
11. Caliper Checker	M$ 200 per unit
12. Depth Micro-Checker	M$ 200 per unit
13. Calibration Tester	M$ 250 per unit
14. Miscellaneous Standard Block or Plate	M$ 70 per unit
15. Straight Edges	M$ 80 per unit
16. Ring Gauges	M$ 70 per unit
17. Glass Scale	M$ 100 per unit
18. Square Master or Block / Try Square	M$ 90 per unit

(SOURCE : SIRIM)

Table 5-3 Calibration Fee (Dimensional) (Cont'd)

GAUGE BLOCK CALIBRATION FEES

Nominal Values (mm)	No. of pieces	Calibration Cost (M$) w.r.t grades			
		00 (AA)	0 (A)	1 (B)	2 (C)
1 - 100	112	600	540	490	430
1 - 100	103	550	500	450	400
0.5 - 100	87 - 88	480	440	400	350
0.5 - 100	76	440	400	370	320
0.5 - 100	56	370	340	300	270
0.5 - 100	46 - 47	320	290	260	240
1 - 100	32 - 33	260	240	220	200
1 - 60	32 - 33	260	240	220	200
1 - 50	16	220	200	180	160
1 - 25	10	200	180	160	140
25 - 200	8	180	160	140	120
0.991-1.009	18	230	210	190	170
0.991-1.000	9	190	170	150	130
1.001-1.009	9	190	170	150	130
Loose units	1	70	60	50	40

DEMAGNETISATION COSTS :

Set consist of	Cost per Set
87 - 112 pieces	M$ 80.00
32 - 86 pieces	M$ 50.00
8 - 31 pieces	M$ 40.00

(SOURCE : SIRIM)

Table 5-4 Major Equipment List (Mass)

NAME OF EQUIPMENT	MAKER	YEAR
1. Equal Arm Balance (5 g/0.05mg)	Chyo	1980
2. Direct Reading Balance (20 g/ 0.001 mg)	Chyo	1982
3. Direct Reading Balance (200 g/0.1 mg)	Chyo	1985
4. Direct Reading Balance (1 kg/0.1 mg)	Chyo	1985
5. Stainless Steel Weights (1 mg - 1 kg)	Chyo	1982
6. Stainless Steel Weights (1 mg - 20 kg)	Kansai	1980
7. Electronic Mass Comparator (200 g)	Mettler	1989
8. Electronic Mass Comparator (2 kg)	Satorius	1989
9. Stainless Steel Weights (1 mg - 1 kg)	-	1990

(Source : SIRIM)

Table 5-4 Major Equipment List (Mass) (Cont'd)
(Service Unit)

NAME OF EQUIPMENT	MAKER	YEAR
1. Stainless Steel Weights	Kansai	1982
2. Stainless Steel Weights	Chyo	1975
3. 20 kg Cast Iron Weights	-	1975
4. 2 kg Stainless Steel Weights	Chyo	1975
5. Stainless Steel Weights (1 mg - 200 g)	Chyo	1975
6. 10 kg Stainless Steel Weights	Chyo	1975
7. Direct Reading Balance (3 kg/ 10 mg)	Jupiter	1975
8. Direct Reading Balance (160 g/1 mg)	Stanton	1975
9. Top Pan Balance (1200 g/1 g)	Shimadzu	1977
10. Top Pan Balance	Satorious	1977
11. Equal Arm Balance (20 kg/200 mg)	-	1975
12. Equal Arm Balance (50 kg/10 mg)	-	1983
13. Platform Scale (1000 kg)	Kamacho	1975
14. Platform Scale (100 kg/5 g)	Murayama	1984
15. Platform Scale (30 kg/1 g)	Chyo	1985
16. Direct Reading Balance (3 kg/10 mg)	Chyo	1975
17. Direct Reading Balance (200 g/1 mg)	Chyo	1980
18. Equal Arm Balance (200 g/ 0.1 mg)	Chyo	1985
19. Direct Reading S.G. Balance (1 kg/0.1 mg)	Chyo	1984
20. Stainless Steel Weights (1 mg - 20 kg) Secondary Standard	Chyo	1985
21. Stainless Steel Weights (1 mg - 20 kg) Tertiary Standard	Chyo	1980
22. Stainless Steel Weights (1 mg - 500 mg) Working Standard	Chyo	1975
23. Muliti-Range Platform Weighing Scale (1500 kg)	Mettler	1989

(Source :SIRIM)

Table 5-5 Calibration Fees (Mass)

CALIBRATION FEES Loose Pieces of Standard Weights (OIML Class E2, F1, M1 & M2)							
No.	Nominal Values (Ranges)	Class E2 & F1 (S.Steel)		Class F2 & M1 (S.Steel/Brass)		Class M2 (Cast Iron)	
		First Piece	Add. Piece	First Piece	Add. Piece	First Piece	Add. Piece
1.	1 mg - 500 mg	M$ 50	M$ 10	M$ 50	M$ 7		
2.	1 g - 500 g	M$ 50	M$ 10	M$ 50	M$ 7	M$ 50	M$ 6
3.	1 kg - 5 kg	M$ 50	M$ 10	M$ 50	M$ 7	M$ 50	M$ 7
4.	10 kg	M$ 60	M$ 15	M$ 50	M$ 10	M$ 50	M$ 9
5.	20 kg	M$ 70	M$ 15	M$ 60	M$ 15	M$ 55	M$ 12
6.	50 kg	M$ 80	M$ 25	M$ 70	M$ 20	M$ 60	M$ 20
7.	100 kg					M$ 70	M$ 50
8.	200 kg					M$ 80	M$ 60
9.	300 kg					M$ 90	M$ 70
10.	500 kg					M$ 110	M$ 90
11.	1000 kg					M$ 160	M$ 140
12.	1500 kg					M$ 210	M$ 190

CALIBRATION FEES Balances and Weighing Scales (Electronics & Mechanical)							
Readability	Capacity						
	500 g	1 kg	2 kg	5 kg	10 kg	20 kg	50 kg
0.1 mg	M$ 200	M$ 220	M$ 220	M$ 240	M$ 260	M$ 280	M$ 300
1 mg	M$ 200	M$ 220	M$ 220	M$ 240	M$ 260	M$ 280	M$ 300
10 mg	M$ 180	M$ 200	M$ 200	M$ 220	M$ 240	M$ 260	M$ 280
100 mg	M$ 160	M$ 180	M$ 180	M$ 200	M$ 220	M$ 240	M$ 260
1 g	M$ 150	M$ 170	M$ 170	M$ 190	M$ 210	M$ 230	M$ 250
10 g	M$ 150	M$ 160	M$ 170	M$ 180	M$ 190	M$ 220	M$ 240
100 g	M$ 150	M$ 160	M$ 170	M$ 170	M$ 180	M$ 220	M$ 230
500 g	M$ 150	M$ 160	M$ 170	M$ 170	M$ 170	M$ 220	M$ 230

(SOURCE : SIRIM)

Table 5-5 Calibration Fees (Mass) (Cont'd)

CALIBRATION FEES Balances and Weighing Scales (Electronic & Mechanical)				
Readability	Capacity			
	100 kg	200 kg	300 kg	400 kg
1 g	M$ 290	M$ 310	M$ 330	M$ 350
10 g	M$ 280	M$ 300	M$ 320	M$ 340
50 g	M$ 270	M$ 290	M$ 310	M$ 330
100 g	M$ 260	M$ 280	M$ 300	M$ 320
500 g	M$ 250	M$ 270	M$ 290	M$ 310

Readability	Capacity			
	500 kg	600 kg	700 kg	800 kg
1 g	M$ 370	M$ 390	M$ 410	M$ 420
10 g	M$ 360	M$ 380	M$ 400	M$ 420
50 g	M$ 350	M$ 370	M$ 390	M$ 410
100 g	M$ 340	M$ 360	M$ 380	M$ 400
500 g	M$ 330	M$ 350	M$ 370	M$ 390

Readability	Capacity			
	900 kg	1000 kg	1100 kg	1200 kg
1 g	M$ 460	M$ 480	M$ 500	M$ 520
10 g	M$ 450	M$ 470	M$ 490	M$ 510
50 g	M$ 440	M$ 460	M$ 480	M$ 500
100 g	M$ 430	M$ 450	M$ 470	M$ 490
500 g	M$ 420	M$ 440	M$ 460	M$ 480

(SOURCE : SIRIM)

Table 5-5 Calibration Fees (Mass) (Cont'd)

CALIBRATION FEES Deadweights for Pressure Gauge Tester				
(Ranges)	Number of Pieces			
	10 Pieces	15 Pieces	20 Pieces	25 Pieces
Up to 3 kg	M$ 110	M$ 130	M$ 150	M$ 170
Up to 5 kg	M$ 120	M$ 140	M$ 160	M$ 180
Up to 10 kg	M$ 140	M$ 160	M$ 180	M$ 200
Up to 13 kg	M$ 150	M$ 170	M$ 190	M$ 210

CALIBRATION FEES Capacity Measure / Measuring Cylinder / Volumetric Flask		
VOLUMETRIC METHOD		
Nominal Value	First Piece	Additional Piece
200 ml	M$ 50	M$ 10
500 ml	M$ 50	M$ 12
1 litre	M$ 60	M$ 15
2 litre	M$ 60	M$ 16
5 litre	M$ 60	M$ 17
10 litre	M$ 60	M$ 18
20 litre	M$ 60	M$ 20
30 litre	M$ 60	M$ 23
40 litre	M$ 70	M$ 26
50 litre	M$ 70	M$ 30
GRAVIMETRIC METHOD		
Nominal Value	First Piece	Additional Piece
500 ml	M$ 60	M$ 60
5 litre	M$ 70	M$ 70
10 litre	M$ 80	M$ 80

(SOURCE : SIRIM)

Table 5-5 Calibration Fees (Mass) (Cont'd)

CALIBRATION FEES BELOW ARE EFFECTIVE
JUST FOR MINISTRY OF DOMESTIC TRADE AND CONSUMER AFFAIRS.

CALIBRATION FEES
Loose Pieces of Standard Weights (OIML Class E2, F1, M1 & M2)

No.	Nominal Values (Ranges)	Class E2 & F1 (S.Steel)		Class F2 & M1 (S.Steel/Brass)		Class M2 (Cast Iron)	
		First Piece	Add. Piece	First Piece	Add. Piece	First Piece	Add. Piece
1.	1 mg - 500 mg	M$ 40	M$ 5	M$ 35	M$ 4		
2.	1 g - 500 g	M$ 40	M$ 6	M$ 35	M$ 5	M$ 35	M$ 5
3.	1 kg - 5 kg	M$ 40	M$ 8	M$ 35	M$ 7	M$ 35	M$ 7
4.	10 kg	M$ 50	M$ 12	M$ 40	M$ 10	M$ 35	M$ 9
5.	20 kg	M$ 50	M$ 18	M$ 40	M$ 15	M$ 40	M$ 10
6.	250 kg					M$ 70	M$ 40
1.	1 kg - 1 mg	M$ 175.00		M$ 150.00			
2.	5 kg - 1 mg	M$ 200.00		M$ 170.00			
3.	10 kg - 1 mg	M$ 215.00		M$ 180.00			
4.	20 kg - 1 mg	M$ 230.00		M$ 195.00			

CALIBRATION FEES
Capacity Measure

	Nominal Value	First Piece	Add. Piece
1.	200 ml - 500 ml	M$ 50.00	M$ 12.00
2.	1 litre - 5 litre	M$ 60.00	M$ 17.00
3.	5 litre - 10 litre	M$ 60.00	M$ 20.00
1.	2 litre - 200 ml (4 pcs) - Conical		M$ 100.00
2.	5 litre - 200 ml (5 pcs) - Conical		M$ 115.00
3.	20 litre - 200 ml (8 pcs) - 5 litre Con. & 5 litre Cyl.		M$ 175.00
4.	20 litre - 200 ml (7 pcs) - 5 litre Cylinder		M$ 160.00
5.	20 litre - 200 ml (7 pcs) - 5 litre Conical		M$ 155.00

Table 5-6 Major Equipment List (Volume/Flow)
(Service Unit)

NAME OF EQUIPMENT	MAKER	YEAR
1. Sonic Flow Nozzles		
2. Flow Standard Device (50 litre)	Kimmon	1984
3. Gas Meters (Wet type)	Shinagawa	1976
4. Prover Tank (50 litre)	Kimmon	1978
5. Prover Tank (200 litre)	Kimmon	1984
6. Prover Tank (500 litre)	Kimmon	1976
7. Weighing Scale	Murayama	1984
8. Piston Prover (100 litre)	Kimmon	1983
9. Electronic Platform Scale (60 kg)	Mettler	1984
10. Electronic Platform Scale (300 kg)	Mettler	1992
11. Electronic Platform Scale (600 kg)	Mettler	1992
12. Liquid Flow Meter (60 m^3/h)		
13. Constant Temperature Chamber		

(Source : SIRIM)

Table 5-7 Calibration Capability (Volume/Flow)

CALIBRATION/MEASUREMENT	RANGE	ACCURACY	LOCATION
1. Volumetric Tanks (Any Vessels, Volumetric Calibration)	1-500 litres >500 litres	±0.01-0.02% ±0.02%	SIRIM Laboratory SIRIM Endorsed Surveyers
2. Prover Tanks	≦500 litres >500 litres	±0.02% ±0.02%	SIRIM Laboratory SIRIM Endorsed Surveyers
3. LPG/Pressure Vessels	≦500 litres	±0.02%	SIRIM Laboratory (Max. Press 10bar)
4. Standard Tanks (Gravimetric)	50-200 litres	±0.01%	SIRIM Laboratory
5. Volumetric Measures	1,2,5,10,20 litres	±0.01%	SIRIM Laboratory
6. Gasmeters (Domestic & Industrial)	<5 m^3/h <60 m^3/h >60 m^3/h	±0.05% ±0.2% ±0.2%	SIRIM Laboratory SIRIM Laboratory In-Situ Cal.
7. Air Flow Devices			
7.1 Rotameter	<60 m^3/h	±0.5%	SIRIM Laboratory (Max. 1 bar)
7.2 Anemometer	<10 m/s	±0.5%	SIRIM Laboratory
7.3 D.P. Devices	<60 m^3/h	±0.5%	SIRIM Laboratory
8. Ref. Gasmeters			
8.1 Wet-Type Meter	< 5 m^3/h	±0.05%	SIRIM Laboratory
8.2 CVM, Rotary	<60 m^3/h	±0.2%	SIRIM Laboratory
8.3 Diaphragm Meters	<60 m^3/h	±0.1-0.2%	SIRIM Laboratory
9. Gravimetric Calibration			
9.1 Mass Flowmeter & Devices	Max. 600 kg/min.	±10 g	SIRIM Laboratory
9.2 Volumetric Vessels	Max. 600 kg	±10 g	SIRIM Laboratory
10. Meter Proving			
10.1 P.D. Meter (Liquid)	Max. 3 m^3/h	±0.05%	SIRIM Endorsed Surveyers
10.2 Turbine (Liquid)	—	±0.05%	SIRIM Endorsed Surveyers
10.3 Turbine (Gas)	—	±0.25%	SIRIM Endorsed Foreign Lab.
10.4 Orifice (Gas)	—	—	SIRIM Endorsed Validation
11. Bulk Storage Tanks 11.1 Vertical Tank 11.2 Spherical Tank 11.3 Horizontal Tank 11.4 LPG, LNG Tank & Ships 11.5 Barges 11.6 Pipelines	Any Capacity	±0.05%	SIRIM Endorsed Surveyers
12. Flowmeter (Liquid) Master Provers			
12.1 Pipe Provers	Any Capacity	±0.02%	SIRIM Endorsed Surveyers
12.2 Compact Provers	Any Capacity	±0.02%	
12.3 Master Meters	Any Capacity	±0.02%	

(Source : SIRIM)

Table 5-8 Calibration Fees (Volume/Flow)

(Unit : Ringgit)

1. TANK CALIBRATION

	Echelon I	Echelon II
	<0.01%	<0.02%
1.1 TRIAL CALIBRATION		
(a) Up to 50 litres	$ 50.00	$ 40.00
(b) Up to 100 litres	$ 70.00	$ 60.00
(c) Up to 200 litres	$ 90.00	$ 80.00
(d) Up to 500 litres	$150.00	$140.00
1.2 NORMAL TANK CALIBRATION		
(a) Up to 50 litres	$150.00	$100.00
(b) Up to 100 litres	$200.00	$150.00
(c) Up to 200 litres	$350.00	$300.00
(d) Up to 500 litres	$450.00	$400.00
1.3 STANDARD TANK CALIBRATION		
(a) Up to 50 litres	$300.00	
(b) Up to 100 litres	$450.00	
(c) Up to 200 litres	$600.00	

2. METER CALIBRATION

	Initial Charge (3 point cal.)	Additional Charge (per point)
2.1 GAS METER		
(a) Diaphragm Meter (<0.2 bar, max. 6 m^3/h)	$150.00	$ 50.00
(b) Rotary Meter (max. 60 m^3/h)	$300.00	$ 50.00
(c) Rotameter (<1 bar, max. 6 m^3/h)	$ 60.00	$ 20.00
(d) Standard Meter (<1 bar, max. 6 m^3/h)	$350.00	$ 50.00
(e) Gas Meter Verification		
Up to 10 unit, per unit	——	$ 15.00
Up to 200 unit, per unit	——	$ 10.00
Up to 500 unit, per unit	——	$ 8.00
More than 500 unit, per unit	——	$ 5.00
2.2 WATER METER		
(a) Max. 3 m^3/h, per unit	$300.00	$ 50.00
(b) Max. 10 m^3/h, per unit	$450.00	$ 50.00
(c) Max. 30 m^3/h, per unit	$600.00	$100.00

(Source : SIRIM)

Table 5-9 Major Equipment List (Force/Pressure)
(Service Unit)

NAME OF EQUIPMENT	MAKER	YEAR
1. Air Dead Weight Tester 100 psi	Budenberg	1986
2. Calibration Box 200 kN	Amsler	1982
3. Calibration Box 600 kN	Maekawa	1984
4. Calibration Box 1000 kN	Amsler	1982
5. Calibration Box 3000 kN	Maekawa	1984
6. Dead Weight Tester 125 kg/cm²	Hardwood	1982
7. Dead Weight Tester 750 kg/cm²	Hardwood	1982
8. Dead Weight Tester 1000 kg/cm²	Nagano	1985
9. Dead Weight Tester 8000 psi	Budenberg	1982
10. Dead Weight Tester 16000 psi	Budenberg	1986
11. Dead Weight Tester 40000 psi	Budenberg	1982
12. Floor Crane 1 ton	Enerpac	1982
13. Load Column 250 kN	M.Smith	1988
14. Load Column 500 kN	M.Smith	1988
15. Load Column 1000 kN	M.Smith	1986
16. Load Column 2000 kN	M.Smith	1986
17. Mercury Column Vacuum Tester	-	1989
18. Pressure Gauge Tester 8500 psi	Budenberg	1989
19. Proving Ring 1 kN	L.Farenell	1986
20. Proving Ring 5 kN	Amsler	1982
21. Proving Ring 10 kN	Amsler	1982
22. Proving Ring 50 kN	Maekawa	1985
23. Proving Ring 100 kN	Maruto	1982
24. Proving Ring 300 kN	Maruto	1982
25. Reference Proving Ring 50 kN	Morehouse	1982
26. Reference Proving Ring 100 kN	Morehouse	1990
27. Reference Proving Ring 250 kN	Morehouse	1990
28. Reference Proving Ring 270 kN	Morehouse	1982
29. Reference Proving Ring 500 kN	Morehouse	1990
30. Reference Proving Ring 600 kN	Morehouse	1982
31. Reference Proving Ring 1200 kN	Morehouse	1982
32. Reference Proving Ring 2700 kN	Morehouse	1982
33. Rockwell Hardness Machine	Avery	1982
34. Short Load Column 1000 kN	M.Smith	1988
35. Short Load Column 2000 kN	M.Smith	1988
36. Standard Barometer	Haas	1982
37. Universal Calibration Machine 300 kN	Morehouse	1982
38. Universal Calibration Machine 1000 kN	Morehouse	1990
39. Universal Calibration Machine 2500 kN	Morehouse	1982

Table 5-10 Calibration Fees (Force/Pressure)

1. PRESSURE

1) Pressure Gauge < 10,000 psi	M$ 80.00
2) Pressure Gauge 10,000 - 15,000 psi	M$ 90.00
3) Pressure Gauge reading in load, (kN, ton etc.)	M$ 90.00
4) Pressure Transducer	M$ 90.00
5) Oxygen Gauge / Oil Free Gauge	M$ 90.00
6) Pressure Switch	M$ 100.00
7) Pressure Recorder	M$ 100.00
8) Test Gauge (Oil Operated)	M$ 100.00
9) Test Gauge (Air Operated)	M$ 110.00
10) Calibrator / Manometer > 0.1% accuracy	M$ 130.00
11) Calibrator / Manometer ≤ 0.1% accuracy	M$ 150.00

2. FORCE

Proving Ring / Load Cell / Hydraulic Jack	
* Less than 300 kN	M$ 170.00
* 300 kN to 1000 kN	M$ 250.00
* 1000kN to 2000 kN	M$ 300.00

3. FIELD WORK

1) Local	
* Minimum excluding travelling	M$ 350.00
* Additional range calibrated	M$ 50.00
2) Ipoh	
* Minimum excluding travelling	M$ 750.00
* Additional range calibrated	M$ 50.00
3) Penang / Johor Bahru	
* Minimum excluding travelling	M$ 1400.00
* Additional range calibrated	M$ 50.00

(SOURCE : SIRIM)

Table 5-11 Major Equipment List (Temperature)

NAME OF EQUIPMENT	MAKER	YEAR
1. Standard Platinum Resistance Thermometer	L&N, USA	1980
2. Standard Platinum Resistance Thermometer	Chino	1985
3. Standard Platinum Resistance Thermometer	Chino	1985
4. Standard Platinum Resistance Thermometer	Chino	1985
5. Standard Platinum Resistance Thermometer	Chino	1985
6. Standard Platinum Resistance Thermometer	Chino	1985
7. Standard Pt/Rh Thermocouple	L&N, USA	1980
8. Standard Pt/Rh Thermocouple	Chino	1985
9. Standard Pt/Rh Thermocouple	Chino	1985
8. Standard Pt/Rh Thermocouple	Chino	1985
9. Standard Pt/Rh Thermocouple	Chino	1985
10. Standard Pt/Rh Thermocouple	Chino	1985
11. Standard Pt/Rh Thermocouple	Chino	1985
12. Standard Pt/Rh Thermocouple	Chino	1985
13. Standard Pt/Rh Thermocouple	Chino	1985
14. Standard Mercury-in-glass Thermometer	Shinnihon Keisoku	1988
Range : -50 to 0 ℃		
-50 to 0 ℃		
0 to 50 ℃		
0 to 50 ℃		
50 to 100 ℃		
50 to 100 ℃		
100 to 150 ℃		
150 to 200 ℃		
200 to 250 ℃		
15. Standard Mercury-in-glass Thermometer	Toa Keiki Seisakusho	1985
Range : 0 to 50 ℃		
50 to 100 ℃		
100 to 150 ℃		
150 to 200 ℃		
200 to 250 ℃		
250 to 300 ℃		
300 to 350 ℃		

Table 5-11 Major Equipment List (Temperature) (Cont'd)

NAME OF EQUIPMENT	MAKER	YEAR
16. Primary Standard Fixed Point Cells		
1) Triple Point of Water Cell (3 sets)	Foxboro, USA	1980
2) Zinc Fixed Point Cell	Chino	1985
3) Tin Fixed Point Cell	Chino	1985
17. Platinum Resistance Thermometers (Pt 100)	Okazaki	1985
18. Thermocouples	Chino	1985
19. Standard Thermocouple Wire	Chino	1985
20. Thermocouple Wire	Yamari	1985
21. Radiation Pyrometer	Topcon	1985
22. Temperature Control Unit	Chino	1985
23. Vertical Furnace Unit	Chino	1985
24. Oil Bath	Chino	1985
25. High Temperature Control Unit	Chino	1985
26. High Temperature Horizontal Furnace	Chino	1985
27. Water Bath	Heto, Denmark	1985
28. Low Temperature Bath	Yoshida	1985
29. Precision Digital Multimeter	YEW	1985
30. Precision Digital Multimeter	Fluke, USA	1988
31. Calibration Instrument Controller	Tektronik	1988
32. Transformer Unit for Oil Bath & Furnaces	Chino	1985
33. Cold Junction Units (2 sets)	Chino	1985
34. Salt Bath Unit	Yoshida	1985
35. Precision DC Potentiometer	YEW	1985
36. Electronic Galvanometer	YEW	1985
37. Standard Cell	YEW	1985
38. Resistance Thermometer Bridge with Selector Switch & Standard Resistor	Tinsley, UK	1985
39. Portable Volt-Ammeter	YEW	1985
40. Selector Switch	YEW	1985
41. Vertical Pen Recorder (2 sets)	YEW	1985
42. Selector Switch	Guildline	1980
43. Thermocut & Stainless Steel Container	Nippon Sanso	1985
44. Air Dryer (Low Temp.)	Hitachi	1985

Table 5-11 Major Equipment List (Temperature) (Cont'd)

NAME OF EQUIPMENT	MAKER	YEAR
45. Battery Charger	Japan Storage Battery	1985
46. Zero Con	Komatsu	1985
47. Digital Thermometer (240 V)	Takeda Riken	1985
48. Digital Thermometer (Handheld with Probe)	Chino	1985
49. Water Distiller	Furukawa	1985
50. Multi Tester	Hioki	1985
51. Liquid Gas Container	Kelvin Vessel	1980
52. Decade Resistor	General Radio	1980
53. Electronic Polyrecorder	TOA	1985
54. 10Ω Standard Resistors	YEW	1985
55. 100 V Transformer	Matsunaga	1985
56. Digital Multimeter (2 sets)	HP, USA	1990
57. Precision DC Voltage Generator	Fluke, USA	1989
58. Calibration Bath (Oil Bath)	Heto, Denmark	1989
59. Advanced Temperature Logger	Chino	1989
60. Low Temperature Calibrator	Jofra, Denmark	1990
61. High Temperature Calibrator	Jofra, Denmark	1990
62. Platinum Resistance Thermometer (2 sets)	Rosemount, USA	1990
63. Temperature/Humidity Chamber	Tabai Espec	1991
64. Resistance Therm & Controller	Chino	1991
65. Surface Calibrator	Hart Scientific	1991
66. Humidity Temperature Recorder	Chino	1991
67. Low Temperature Bath	Heto, Denmark	1991

Table 5-12 Calibration Capability (Temperature)

Principle	Type	Temperature Range (℃)	Typical Accuracy (℃)
Resistance	Platinum Resistance Thermometer	-80 to 1000	0.01 to 5
	Thermistor Thermometer	-50 to 350	0.3 to 5
Thermo-Electric Thermometer	B	600 to 1400	4 to 7
	S	0 to 1400	0.5 to 5
	R	0 to 1400	0.5 to 5
	K (CA)	-80 to 1200	2 to 10
	E (CRA)	-80 to 800	3 to 5
	J (IC)	-80 to 800	3 to 10
	T (CC)	-80 to 350	2 to 5
Thermal Radiation	Radiation Thermometer	200 to 1400	2 to 20
Expansion	Mercury-in-glass Thermometer	-50 to 650	0.1 to 2
	Alcohol-in-glas Thermometer	-80 to 200	1 to 4
	Bimetal Thermometer	-50 to 500	0.5 to 5
Pressure	Liquid filled Thermometer	-30 to 600	0.5 to 5
	Vapor Pressure Thermometer	-20 to 350	0.5 to 5

(Source : SIRIM)

Table 5-13 Major Equipment List (Electrical)

List of Exsisting Equipment
in Electric Lab. of Measurement Standards Research Unit

No.	Lab.	Equipment	Pieces	Maker	Model
1	DC	DC Null Voltmeter	1	HP	419A
2	DC	DC Reference Standard	1	Fluke	731B
3	DC	Digital Platinum Thermometer	1	Guildline	9450
4	DC	Instrument controller	1		
5	DC	Nanovolt Amplifier	1	Guildline	9460A
6	DC	Nanovoltmeter	2	Keithley	181
7	DC	Null Detector	1	Fluke	845AR
8	DC	Potentiometer	1	L & N	7556
9	DC	Precision Digital Thermometer	1	Guildline	9540
10	DC	Scanner	2	Data Proof	160A
11	DC	Scanner	1	Keithley	705
12	DC	Ploter	1	Roland	DXY1300
13	DC	DMM	1	Datron	1281
14	DC	Air Bath	1	YEW	2748-02
15	DC	Standard Cell Enclosure	2	Guilline	9152/12
16	DC	Standard Cell Enclosure	1	Guilline	9152/6
17	DC	Voltage Standard	1	Statronic	SVS4
18	DC	Voltage Standard	1	Tinsley	5646
19	DC	Performance Divider	1	Fluke	750A
20	DC	Liquid Helium Dewar	1		CM
21	DC	Voltage Standard	1	Fluke	732B
22	R	Build-up Resistor	1	YEW	3946-01
23	R	High Resistance Standard 10^8	1	TR	TR45
24	R	High Resistance Standard 10^9	1	TR	TR45
25	R	High Resistance Standard 10^10	1	TR	TR45
26	R	High Resistance Standard 10^11	1	TR	TR45
27	R	High Resistance Standard 10^12	1	TR	TR45
28	R	Resistance Transfer Standard 10Ω	1	L & N	4321
29	R	Parallel Comp.Network	3	esi	PC101
30	R	Resistance Transfer Standard 100Ω	1	esi	SR1010
31	R	Resistance Transfer Standard 10kΩ	2	esi	SR1010
32	R	Resistance Transfer Standard 100kΩ	1	esi	SR1010
33	R	Resistance Transfer Standard 10 MΩ	2	esi	SR1050
34	R	Series Conn. Transfer Standard	1	esi	Gold Plated
35	R	Series Parallel Com.Net	3	esi	SPC102
36	R	Standard Resistor 1 Ω	5	L & N	4210
37	R	Standard Resistor 10 kΩ	1	esi	SR104
38	R	Oil Bath	1	Guildline	9730CR4
39	R	Digital Teraohmmeter	1	Guildline	6500
40	R	kelvin Varley Voltage Divider with Lead Con	1	Fluke	720A
41	R	Standard Resistor 1 mΩ	2	L & N	4223-B
42	R	Standard Resistor 10 mΩ	2	L & N	4222-B

43	R	Standard Resistor 100 mΩ	2	L & N	4221-B
44	R	Standard Resistor 10Ω	2	L & N	4025-B
45	R	Standard Resistor 100Ω	2	L & N	4030-B
46	R	Standard Resistor 1 kΩ	2	L & N	4035-B
47	R	Standard Resistor 10kΩ	2	L & N	4040-B
48	R	Standard Resistor 100kΩ	2	L & N	4045-B
49	R	Standard Resistor 1 MΩ	2	L & N	4050-B
50	R	DCCP	1	Guildline	9930
51	LC	Capacitance Bridge	1	GR	1615A
52	LC	Standard Capacitor	4	GR	1404-A
53	LC	Standard Capacitor	1	GR	1404-B
54	LC	Standard Capacitor	1	GR	1404-C
55	LC	Standard Capacitor Set (1,10,100,1000 pF)	1	HP	16380A
56	LC	Standard Capacitor Set (0.01,0.1,1 μF)	1	HP	16380C
57	LC	Standard Inductor 100 μH	1	GR	1482-B
58	LC	Standard Inductor 10 mH	1	GR	1482-H
59	LC	Standard Inductor 100 mH	1	GR	1482-L
60	LC	Standard Inductor 1 H	1	GR	1482-P
61	LC	LCR Meter	1	HP	4284A
62	AC	AC Reference Standard	1	Fluke	510A
63	AC	DC Voltage Standard	1	Fluke	335A
64	AC	AC / DC Thermal Transfer	1	Holt	Holt II
65	AC	TVC Resistance Module with Thermoelement	1	ETL	
66	AC	AC Calibrator	1	Fluke	5200A
67	AC	Watt Converter	1	YEW	2885
68	AC	Thermal Transfer Standard	1	Fluke	540B
69	AC	Calibrator	1	Fluke	5700A
70	AC	Decade Transformer	2	esi	DT72A
71	AC	AC / DC Transfer Standard	1	Fluke	792A
72	AC	Calibrator	1	Fluke	5200A
73	AC	Power Amplifier	1	Fluke	5205A
74	AC	Isolation Transformer	2	Tegam	ST-248A
75	AC	System Multimeter	1	HP	3458A
76	AC	Phase Meter	1	Clarke-Hess	6000
77	RF	Universal Counter	1	HP	5335A
78	RF	Synthesizer / Function Generator	2	HP	3325A
79	RF	Rubidium Frequency Standard	1	NEC	RB-1007
80	RF	Cesium Beam Frequency Standard	3	HP	5061B
81	RF	Power Supply	3	HP	5089A
82	RF	Phase Comparator	1	HP	K34-59991A
83	RF	Degausser	1	HP	10638A
84	RF	Spectrum Analyzer	1	Anritsu	MS2601B
85	RF	Radio Transformer	3	Tegam	RT-60
86		Illuminator	1	Bentham	IL1
87		Current Stabilized Lamp	1	Bentham	505
88		Intergrating ADC	1	Bentham	228

List of Exsisting Equipment
in Electric Lab. of Measurement Services Unit

No.	Lab.	Equipment	Pieces	Maker	Model
1	DC	DC Null Voltmeter	1	HP	419A
2	DC	DC Reference Standard	1	Fluke	731B
3	DC	Current Shunt	1	Guildline	9211A
4	DC	High Voltage Digital Meter	1	T/DENSOKU	TDV-20ADS
5	DC	Cut-off Current Calibrator	1	T/DENSOKU	TLC-501B
6	DC	Null Detector	1	Fluke	845AR
7	DC	DMM	1	YEW	2501A
8	DC	DMM	2	HP	3458A
9	DC	Autocal Multi / FN STD.	1	Datron	4708
10	DC	Potentiometer	1	SULLIVAN	T7100
11	DC	DC Calibration System	1	Fluke	7105A
12	DC	a) DC Voltage Std.			335A
13	DC	b) Reference Divider			750A
14	DC	c) Null Detector			845AR
15	DC	Current Shunt 2 A	1	YEW	2743
16	DC	Current Shunt 5 A	1	YEW	2743
17	DC	Current Shunt 10 A	1	YEW	2743
18	DC	Current Shunt 20 A	1	YEW	2743
19	DC	Current Shunt 50 A	1	YEW	2743
20	R	Decade Resistance Box 1111 Ω	1	YEW	2793-01
21	R	Decade Resistance Box 111 MΩ	1	YEW	2793-03
22	R	Decade Resistance Box	1	YEW	2786
23	R	Decade Resistance Box	1	GR	1433-X
24	R	High Resistance Box	1	MEGADEK	HRRS-B-4
25	R	Kelvin-Varley Voltage Divider	1	Fluke	720A
26	R	Electric Galvanometer	2	YEW	2709
27	R	High Resistance Standard 10^8	1	TAKEDARIKEN	TR45
28	R	High Resistance Standard 10^9	1	TAKEDARIKEN	TR45
29	R	High Resistance Standard 10^10	1	TAKEDARIKEN	TR45
30	R	High Resistance Standard 10^11	1	TAKEDARIKEN	TR45
31	R	High Resistance Standard 10^12	1	TAKEDARIKEN	TR45
32	R	Standard Resistor 1 mΩ	1	YEW	2792
33	R	Standard Resistor 10 mΩ	1	YEW	2792
34	R	Standard Resistor 100 mΩ	1	YEW	2792
35	R	Standard Resistor 1 Ω	1	YEW	2792
36	R	Standard Resistor 10 Ω	1	YEW	2792
37	R	Standard Resistor 100 Ω	1	YEW	2792
38	R	Standard Resistor 1 kΩ	1	YEW	2792
39	R	Standard Resistor 10 kΩ	1	YEW	2792
40	R	Standard Resistor 100 kΩ	1	YEW	2792
41	R	Standard Resistor 1 MΩ	1	YEW	2792
42	R	Standard Resistor 10 MΩ	1	YEW	2781
43	R	Wheatstone Bridge	1	BIDDLE	71-433
44	R	Double Bridge	1	YEW	2752
45	R	DCCB with Extender	1	Guildline	9975

List of Exsisting Equipment
in Electric Lab. of Measurement Services Unit

No.	Lab.	Equipment	Pieces	Maker	Model
1	LC	LCR Meter	1	GR	1689
2	LC	Standard Capacitor 1 μF	1	GR	1409-Y
3	LC	Standard Capacitor 0.1 μF	1	GR	1409-T
4	LC	Standard Capacitor 0.01 μF	1	GR	1409-F
5	LC	Standard Capacitor 0.001 μF	1	GR	1409-L
6	AC	AC Power Cal. System	1	YEW	2558 set
7	AC	AC / DC Cal. Standard	1	RFL	829G
8	AC	A/Slope W/Standing Voltage Tester	1	DENSOKU	TP-5110AMP
9	AC	AC/DC Current Source	1	California Instru.	3213K
10	AC	Digital PF Meter	1	YEW	2524
11	AC	AC Power Meter	1	YEW	2503
12	AC	Calibrator	1	Fluke	5700
13	AC	AC VA Meter	1	YEW	2014
14	AC	Differential Voltmeter	1	Fluke	931B
15	AC	AC Shunt 1 A	1	Fluke	A40
16	AC	AC Shunt 5 A	1	Fluke	A40
17	AC	AC Shunt 10 A	1	Fluke	A40
18	AC	Auto AC Measurement STD.	1	Fluke	5790A

Table 5-14 Major Equipment List (Electrical - Time/Frequency)

NAME OF EQUIPMENT	MAKER	YEAR
1. Rubidium Frequency Standard	NEC	
2. Quartz Oscillator	HP	1981
3. Distribution Amplifier	HP	
4. Frequency Difference Meter	Tracor	
5. Universal Counter	HP	
6. Synthesizer/Function Generator	HP	
7. Dual Trace Amplifier	Tektronix	
8. Delaying Time Base	Tektronix	
9. Time Base	Tektronix	
10. AC Auto Voltage Regulator	Stably	
11. UPS		
12. RMS Differential Voltmeter	Fluke	
13. Digitizing Oscilloscope	HP	1990
14. Measuring Amplifier	Bruel & Kjear	
15. Regulating Transformer	TDGC	
16. Pen Recorder	YEW	
17. Sampling Unit	Tektronix	
18. Amplifier	Tektronix	
19. 50Ω Delay Line	Tektronix	
20. Sampling Sweep Unit	Tektronix	
21. Dual DC Power Supply	HP	

(Source : SIRIM)

Table 5-15 Major Equipment List (Electrical - Acoustic)

NAME OF EQUIPMENT	MAKER	YEAR
1. Dummy, 1"	Bruel & Kjear	1989
2. Dummy, 1/2"	Bruel & Kjear	1989
3. Microphone Power Supply	Bruel & Kjear	1989
4. Microphone Preamplifier (2 sets)	Bruel & Kjear	1989
5. Microphone, 1" (2 sets)	Bruel & Kjear	1989
6. Microphone, 1/2" (2 sets)	Bruel & Kjear	1989
7. Pistonphone (2 sets)	Bruel & Kjear	1989
8. Power Amplifier	Bruel & Kjear	
9. Sound Level Calibrator	General Radio	
10. Band Pass Filter	Bruel & Kjear	
11. Ratiotransformer (2 sets)	Eaton	
12. 1:1 Special Purpose Transformer	Eaton	
13. Programmable Oscilloscope Calibrator	Time Electronic	1991
14. 1/3-1/1 Octave Filter Set	Bruel & Kjear	1991
15. Pre. Inter. Sound Level Meter	Bruel & Kjear	1991
16. Sound Level Calibrator	Bruel & Kjear	1991
17. Barometer	F.D. & Co.	
18. Computer (CPU)	HP	
19. Video Graphics Color Display	HP	
20. Think Jet printer	HP	
21. Printer	Brother	
22. Microphone Preamplifier	Bruel & Kjear	1990
23. Microphone Power Supply	Bruel & Kjear	1991
24. Programmable Pulse Function Generator	Wavetek	1990
25. Programmable RC Oscillator	Panasonic	
26. Universal Counter	Iwatsu	
27. AC Voltage Stabilizer	Zenith	
28. Regulated Power Supply	Labornetzerat	
29. Temperature-Humidity Recorder	Chino	
30. Multimeter	HP	1990
31. AC Voltage Stabilizer	Claude Lyons	
32. AC Auto Voltage Regulator	Stably	

(Source : SIRIM)

Table 5-17 Number of Calibration Works (Electrical - Time/Frequency)

EQUIPMENT	QUANTITY/YEAR		
	1990	1991	1992
1. Osciolloscope	12	7	15
2. Stop watch/Digital Timer	15	43	121
3. Frequency Counter	6	12	14
4. Universal Counter	6	2	13
5. Calibration Fixture	1	2	2
6. Time Mark Generator	2	2	2
7. Calibration Generator	2	2	2
8. Leveled Sine Wave	2	2	3
9. Audio Generator	0	0	2
10. Oscillator	0	0	7
11. Wow-Flutter Meter	1	0	3
12. Pulse/Function Generator	1	3	8
13. Meter Simulator	0	1	5
14. Scope Calibrator	0	4	2
15. Audio Tester	0	2	0
16. Carrier Checker	0	1	0
17. Pistonphone	0	0	4
18. Sound Level Calibrator	0	0	5
19. Sound Level Meter	0	0	5
20. Protpn Electrical Side Mirror	0	0	8
21. Noise Generator	0	0	1
T O T A L	48	83	222

Table 5-18 Calibration Fees (Electrical)

Calibration Fee of Electrical Equipment in SIRIM

	Category of Instrument	Range / Level	Cal. Fee(M$)
1	Digital Multimeter	3 1/2 digits	100
		4-5 1/2 digits	240
		5 1/2 - 6 1/2 digits	300
		more than 6 1/2 digits	360
2	Calibrator / Power Supply	Low Accuracy	100 - 250
		High Accuracy	250 - 800
3	Insulation Testers	Single Range	130
		Multi Range	160
4	Megohm,Milliohm Meters		130 - 200
5	Resistance Bridge		150 - 250
6	LCR Meter		100 - 300
7	Impedance analyzer		100 - 300
8	Capacitance Meter		100 - 300
9	Inductance Meter		100 - 300
10	Indicating Meters	DC Volt/Ammeter	100 - 200
		AC Volt/Ammeter	90 - 150
		Single Phase Wattmeter	90
		Three Phase Wattmeter	200
11	Standard Resistor / Decade Resistor		60 - 200
12	Standard Capacitor / Decade Capacitor		60 - 200
13	Standard Inductor / Decade Inductor		60 - 200
14	Clamp Meter		100 - 160
15	High Voltage Tester	Voltage only	100
		V,Timer & Cut-off Current	210
		V,Timer , Cut-off & Insulation	250
		V,Timer	150
16	High Voltage Probe		80
17	Smoke Meter		80 - 100
18	Photo Cell		100

Fig.5-1 Traceability Chart (Dimensional)

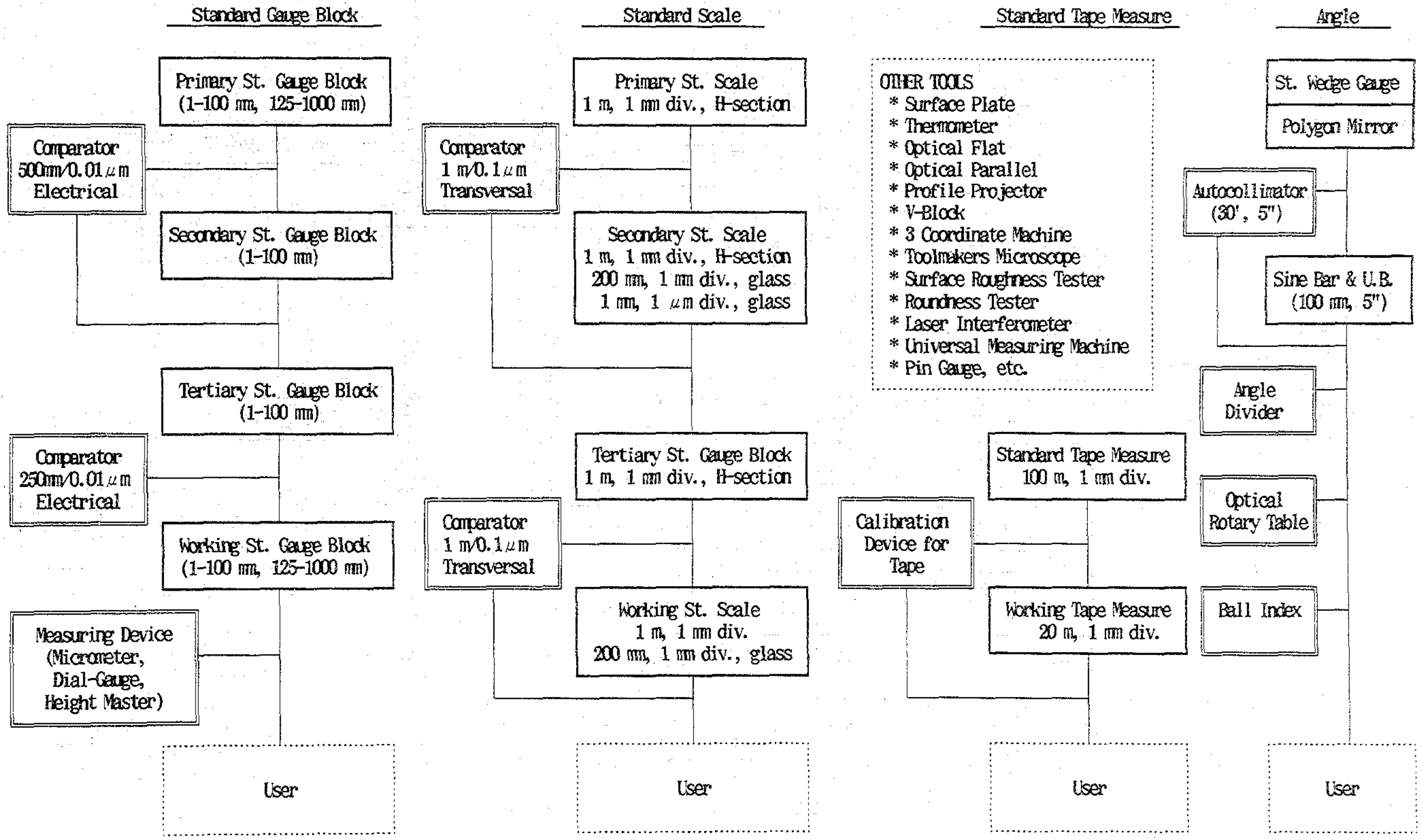


Fig.5-2 Traceability Chart (Mass)

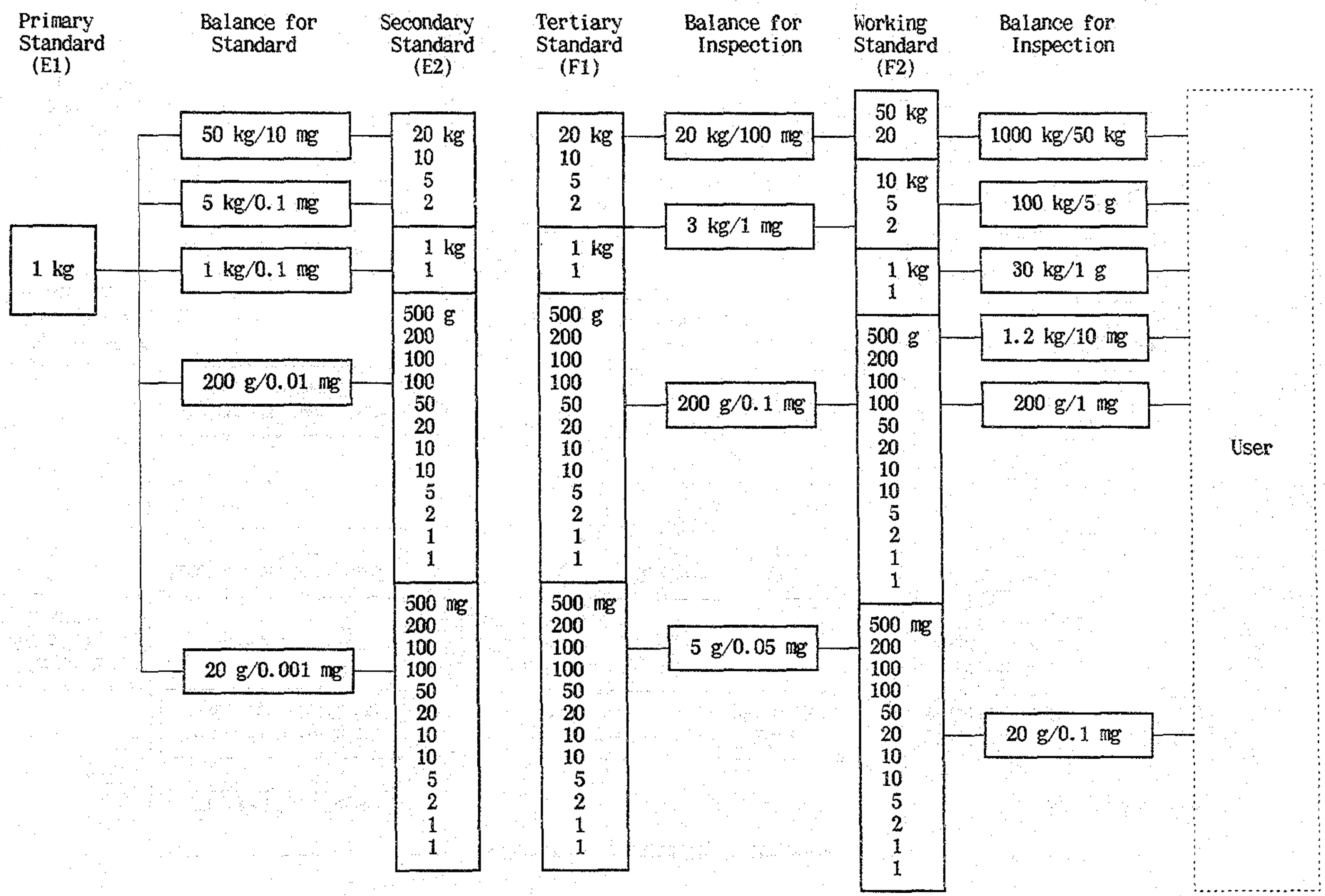


Fig.5-3 Traceability Chart (Volume/Flow)

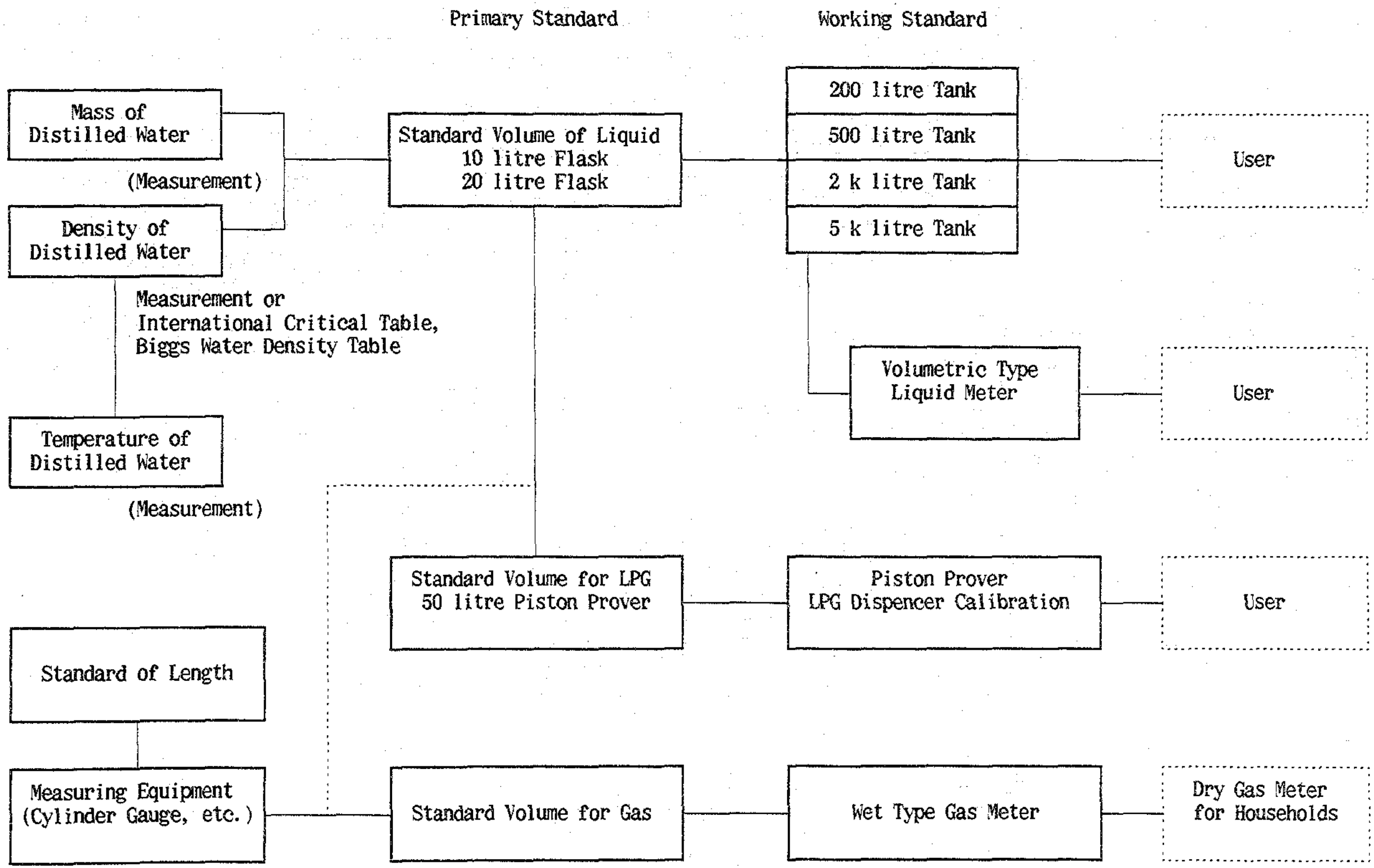


Fig. 5-4 Traceability Chart (Force/Pressure)

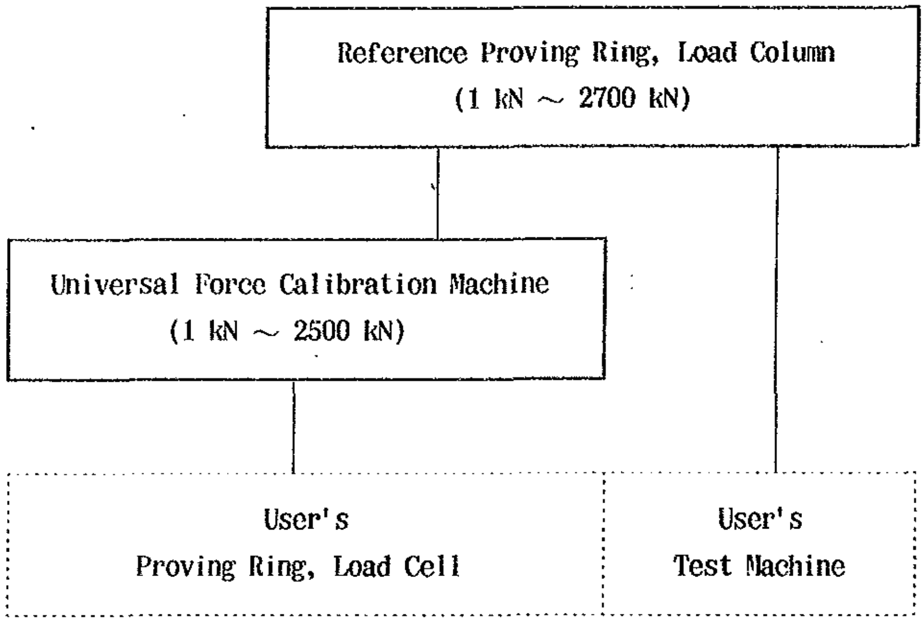


Fig. 5-5 Traceability Chart (Temperature)

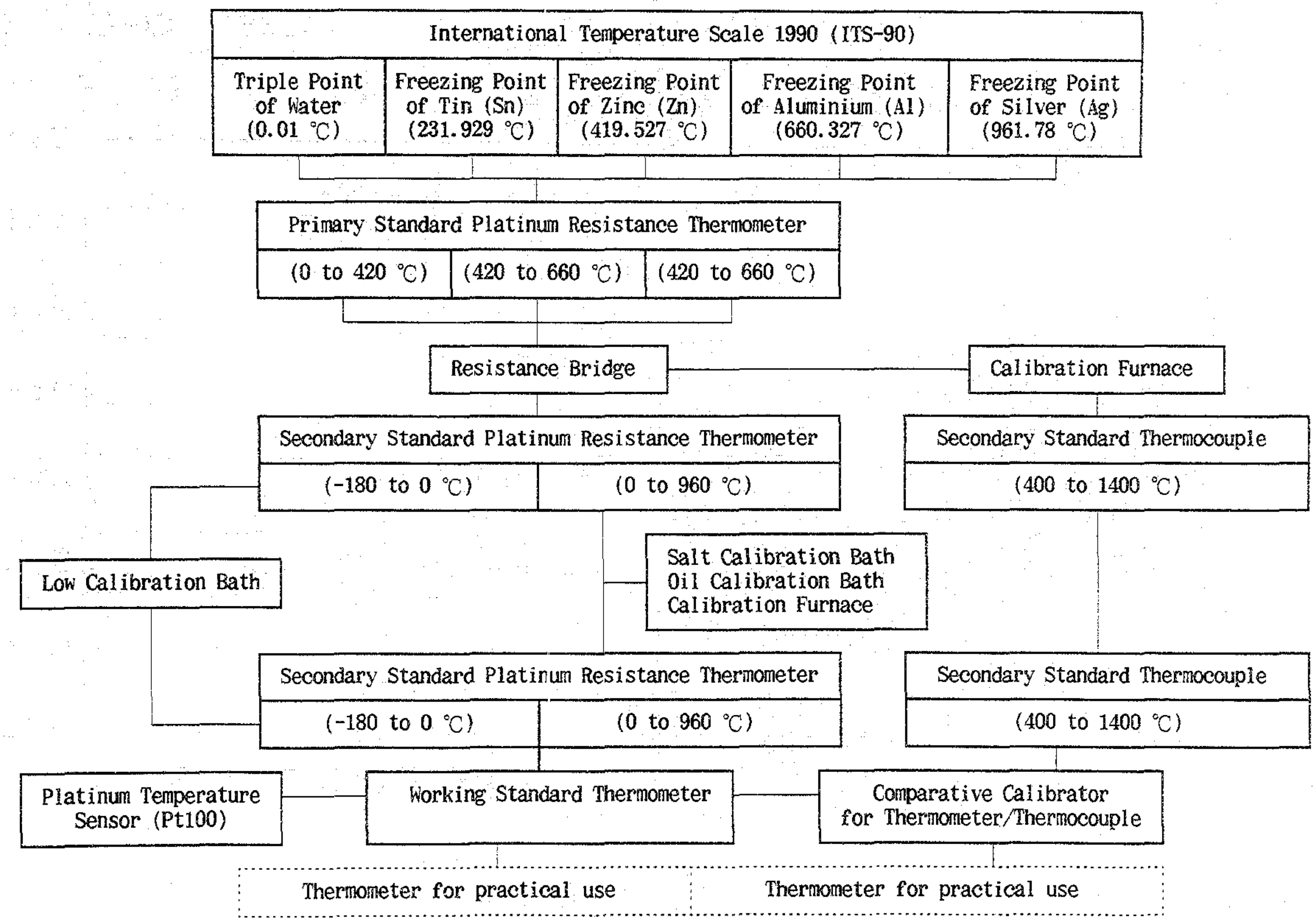
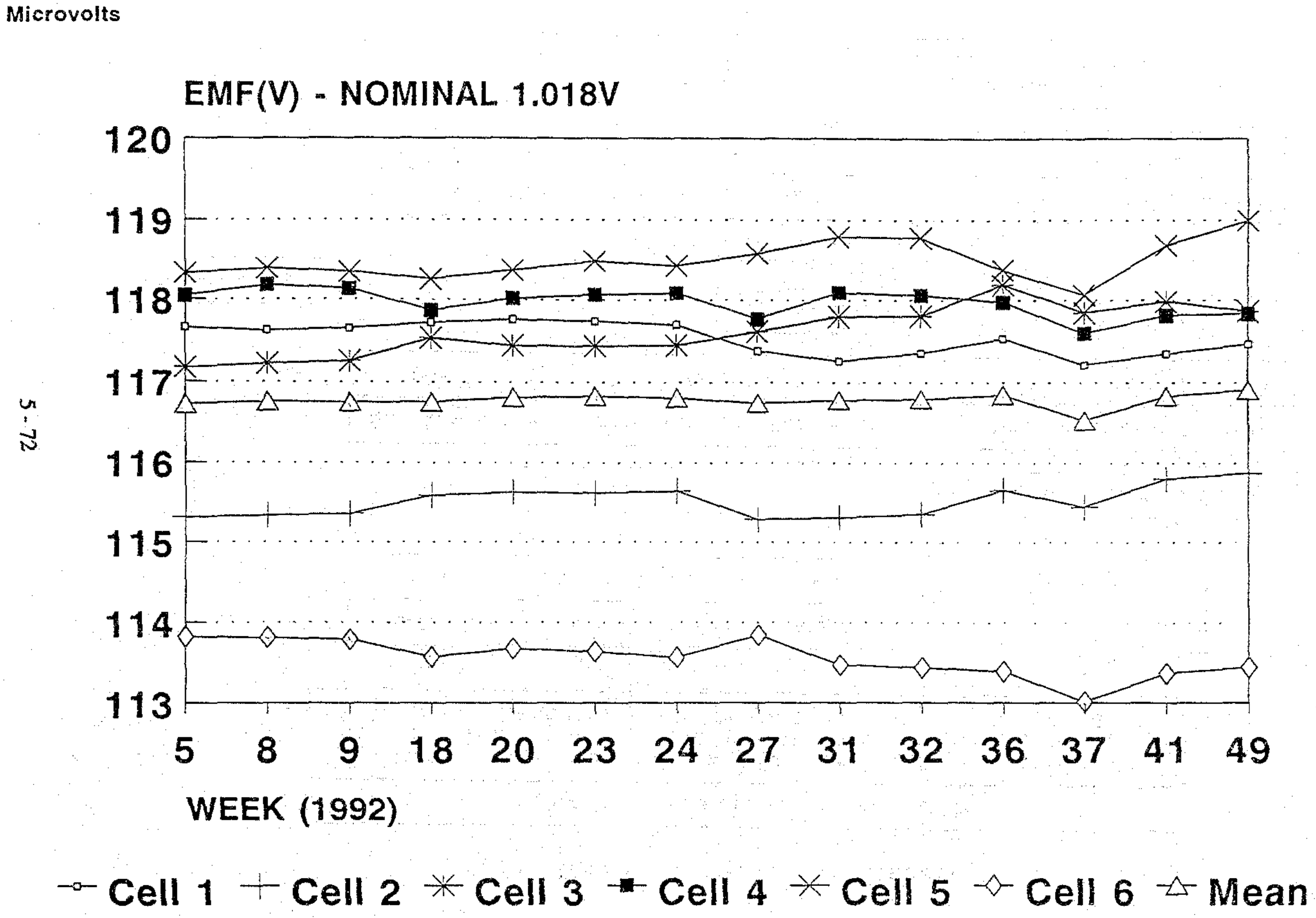


Fig. 5-6 Maintenance of Std. Cell 1992

MAINTENANCE OF STD. CELL 1992
PRIMARY GROUP



4 DEC 1992

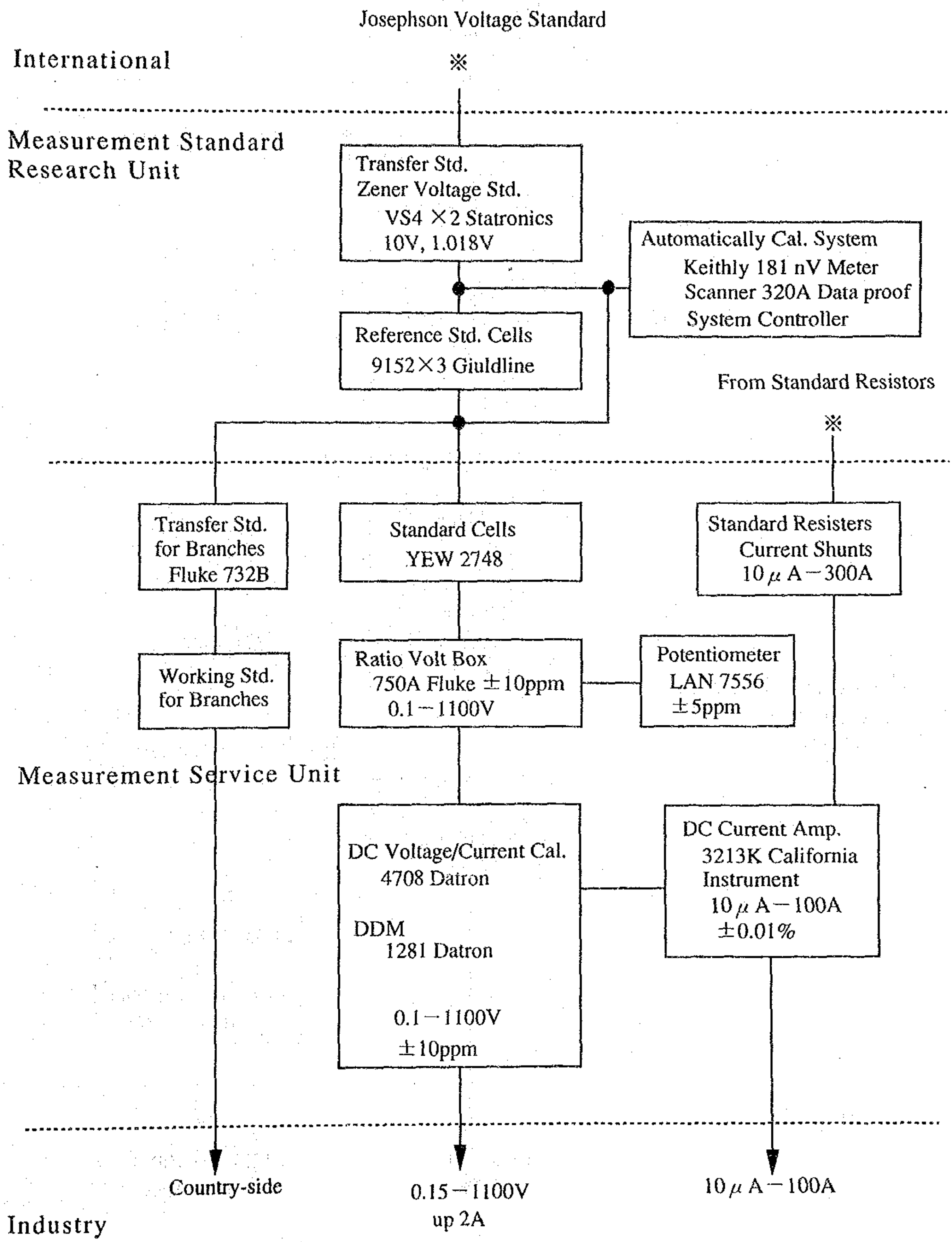


Fig. 5-7 Traceability Chart (Electrical - DC V & A)

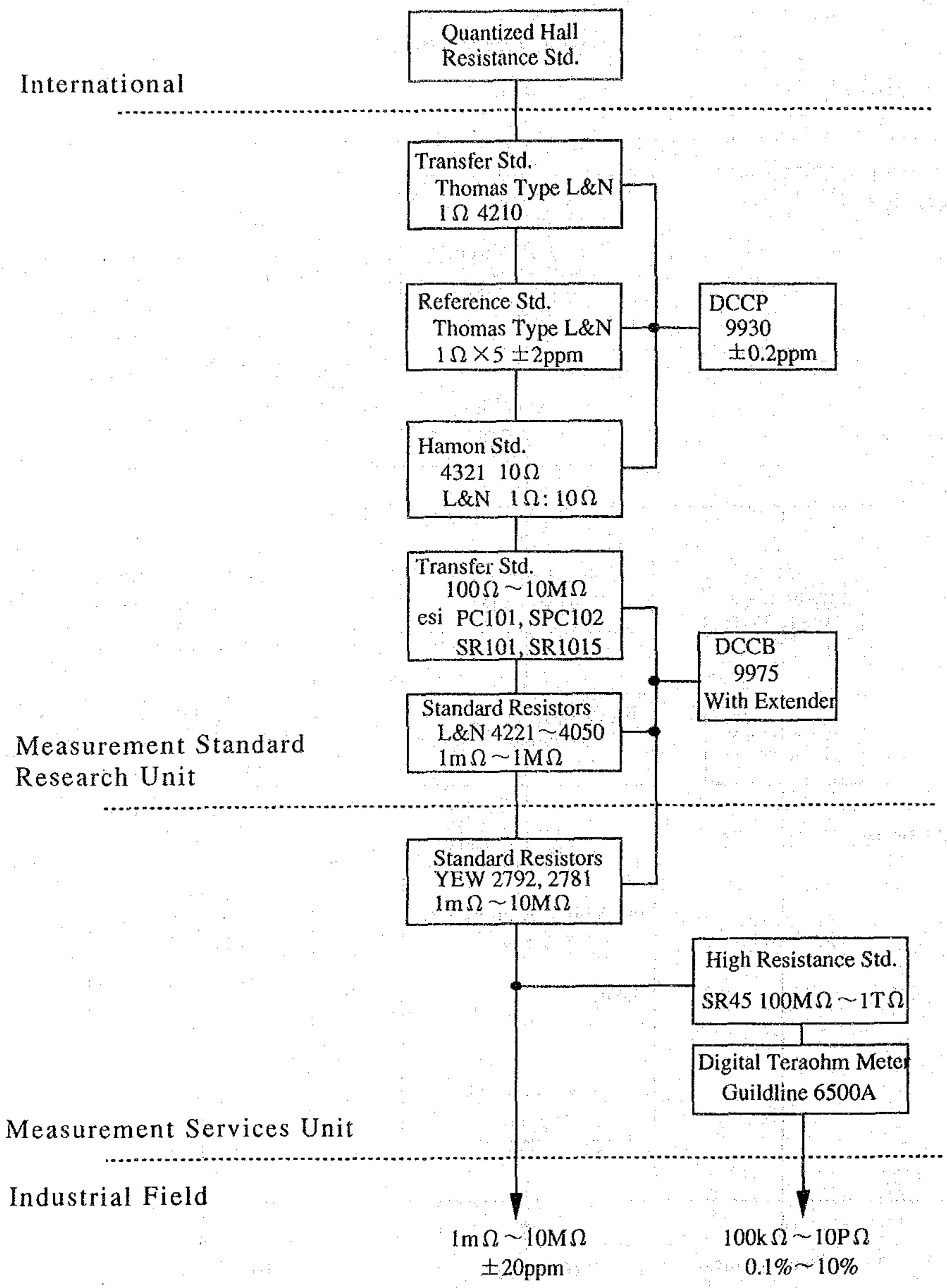


Fig. 5-8 Traceability Chart (Electrical - Resistance)

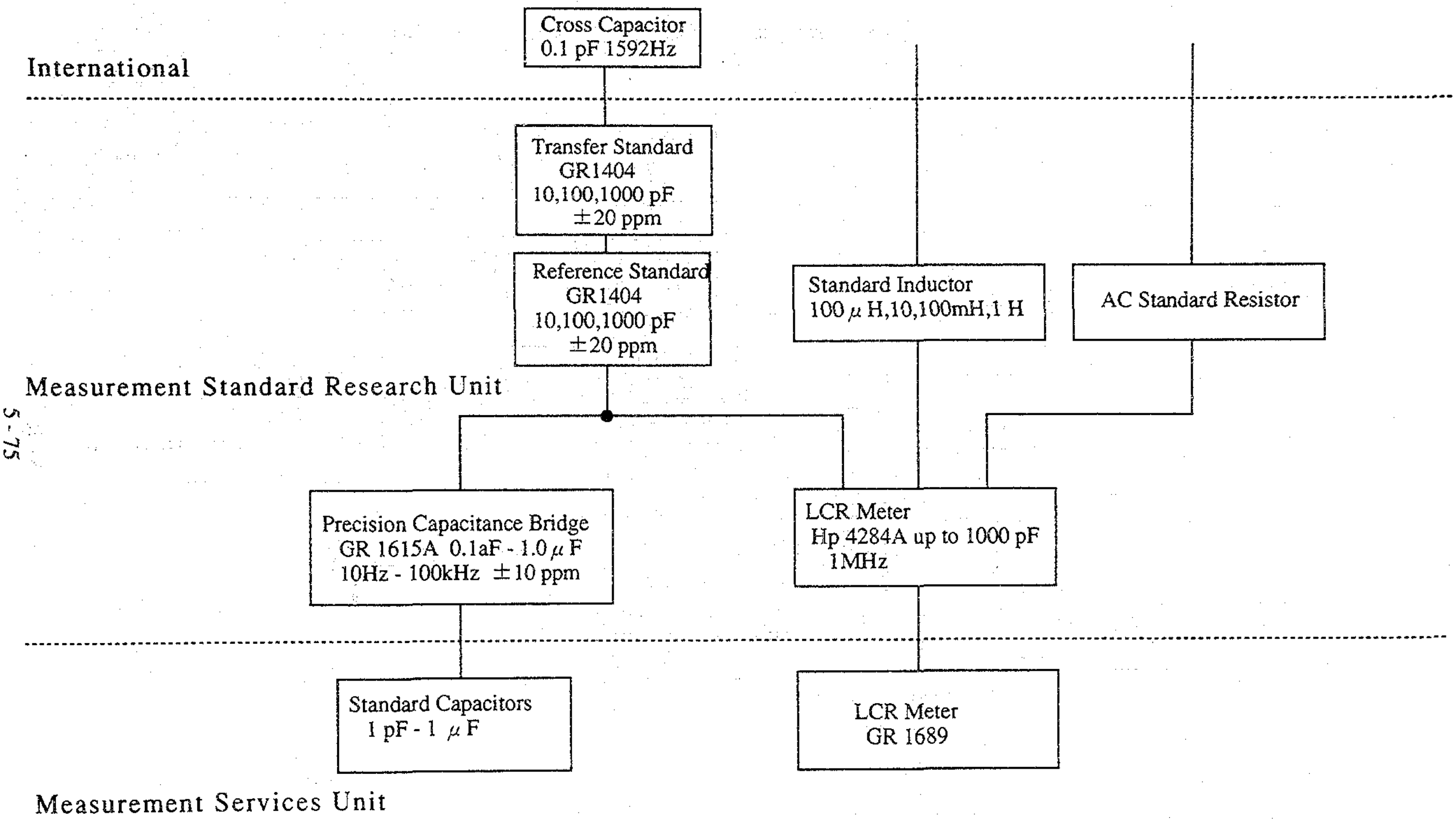


Fig. 5-9 Traceability Chart (Electrical - Cpacitance)

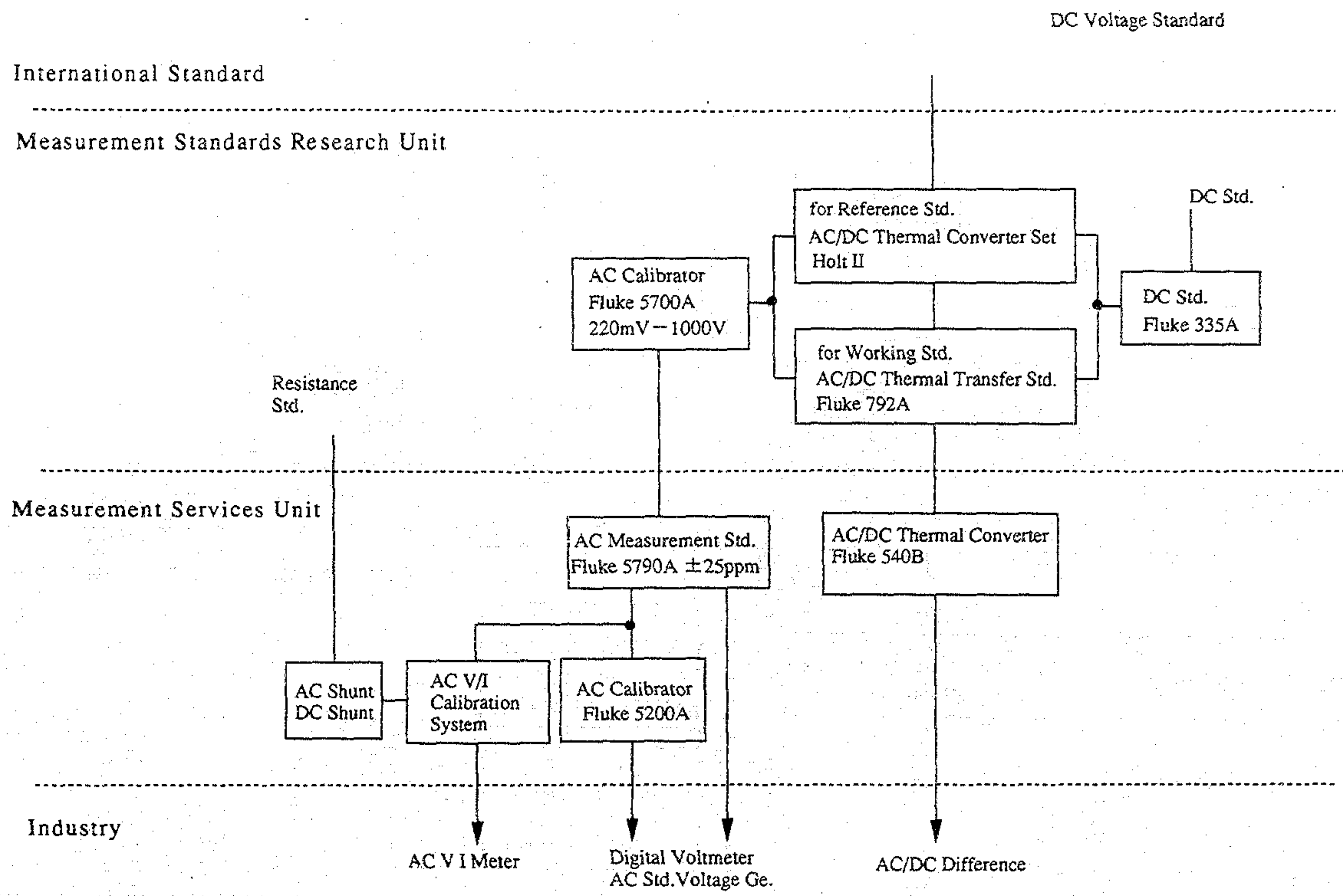


Fig. 5-10 Traceability Chart (Electrical - AC)

Fig. 5-11 Traceability Chart (Electrical - Time/Frequency) a)
(R & D Unit)

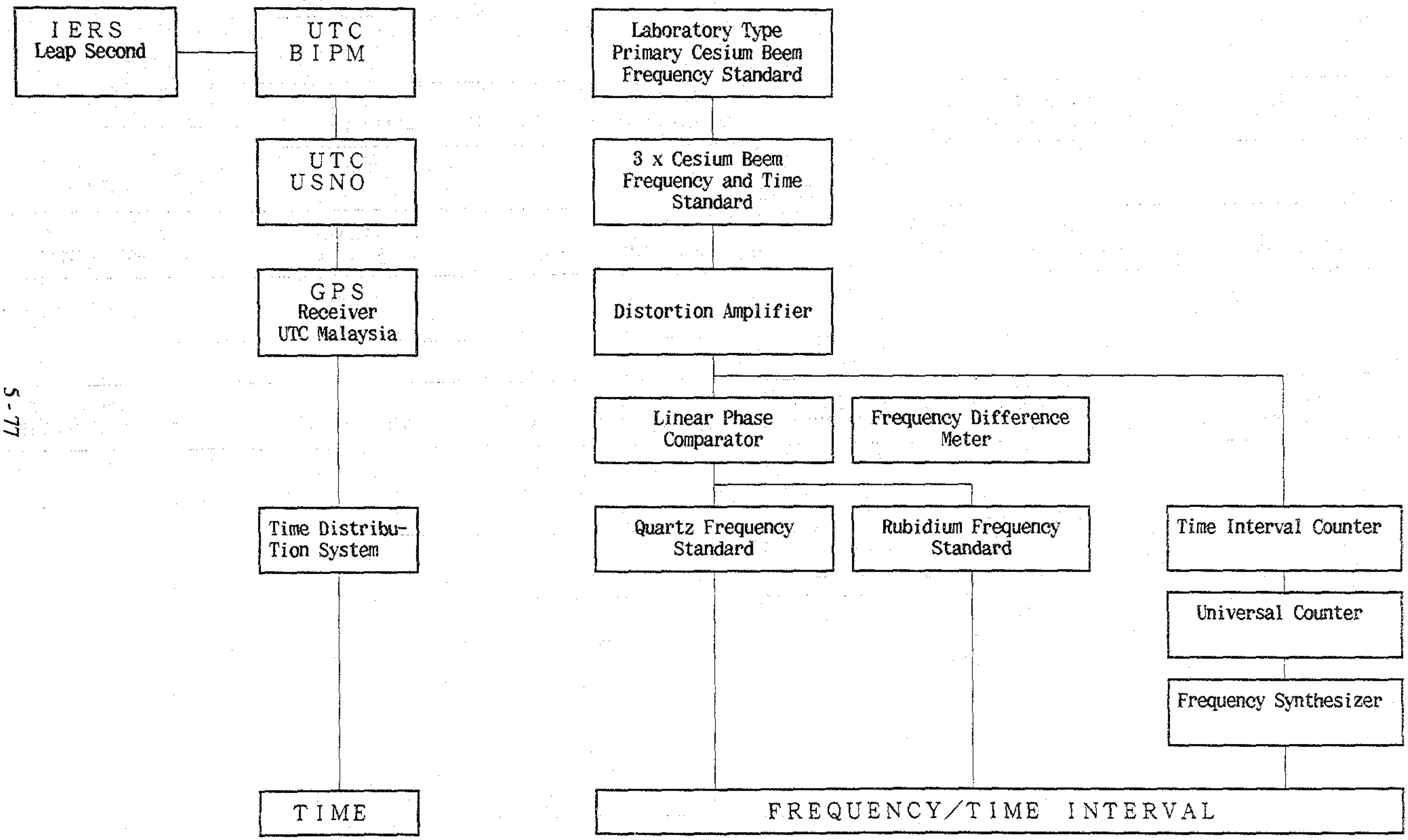
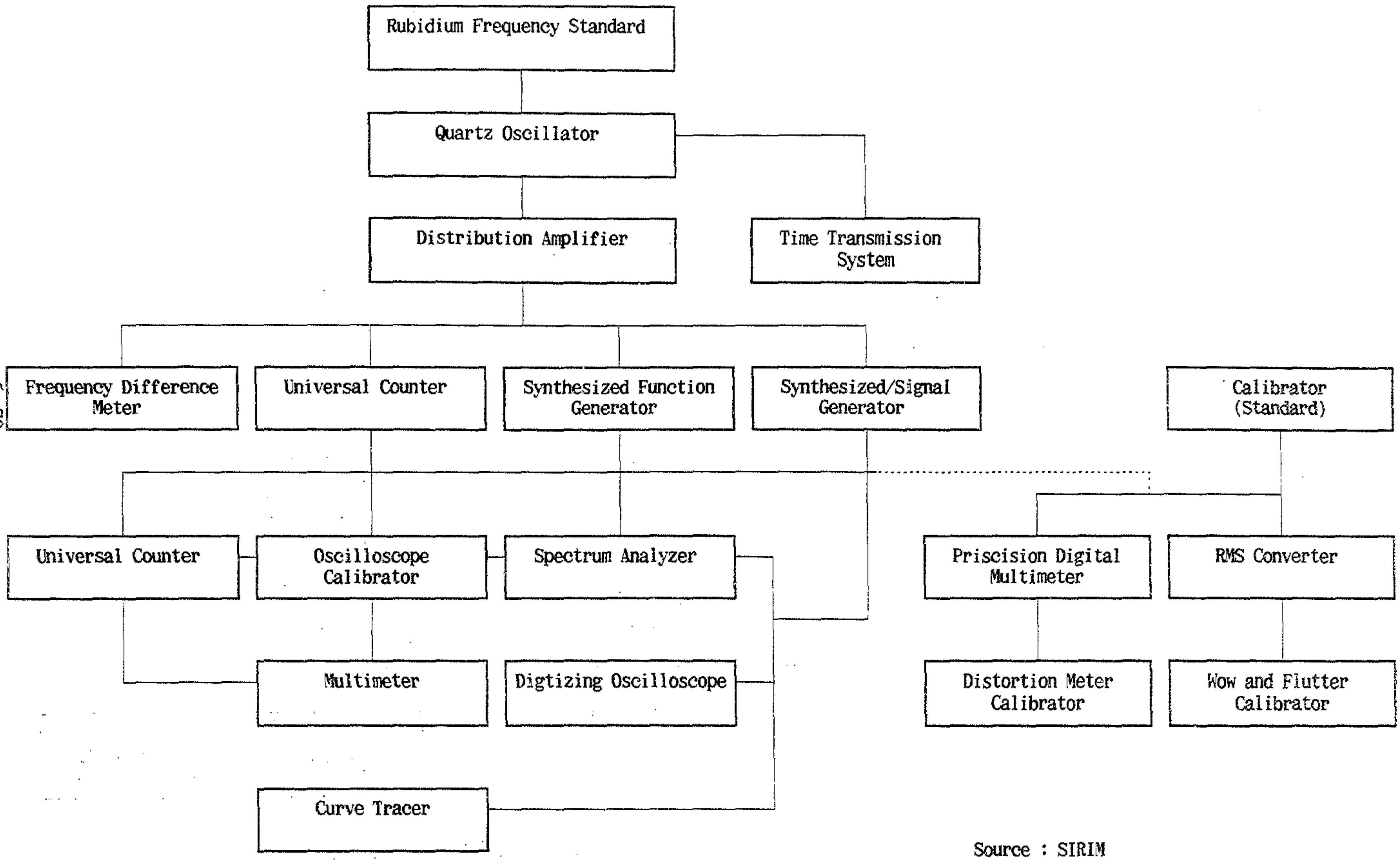


Fig. 5-11 Traceability Chart (Electrical - Time/Frequency) b) (Calibration Unit)



Source : SIRIM

Fig.5-12 Traceability Chart (Electrical - Acoustic)

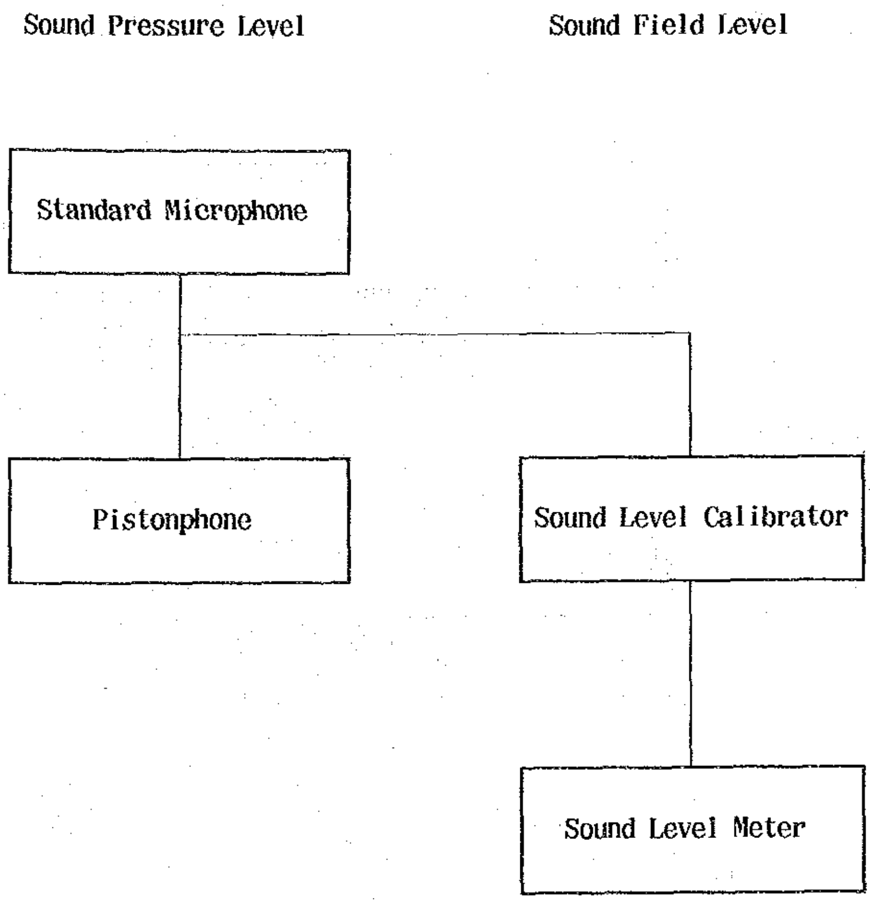
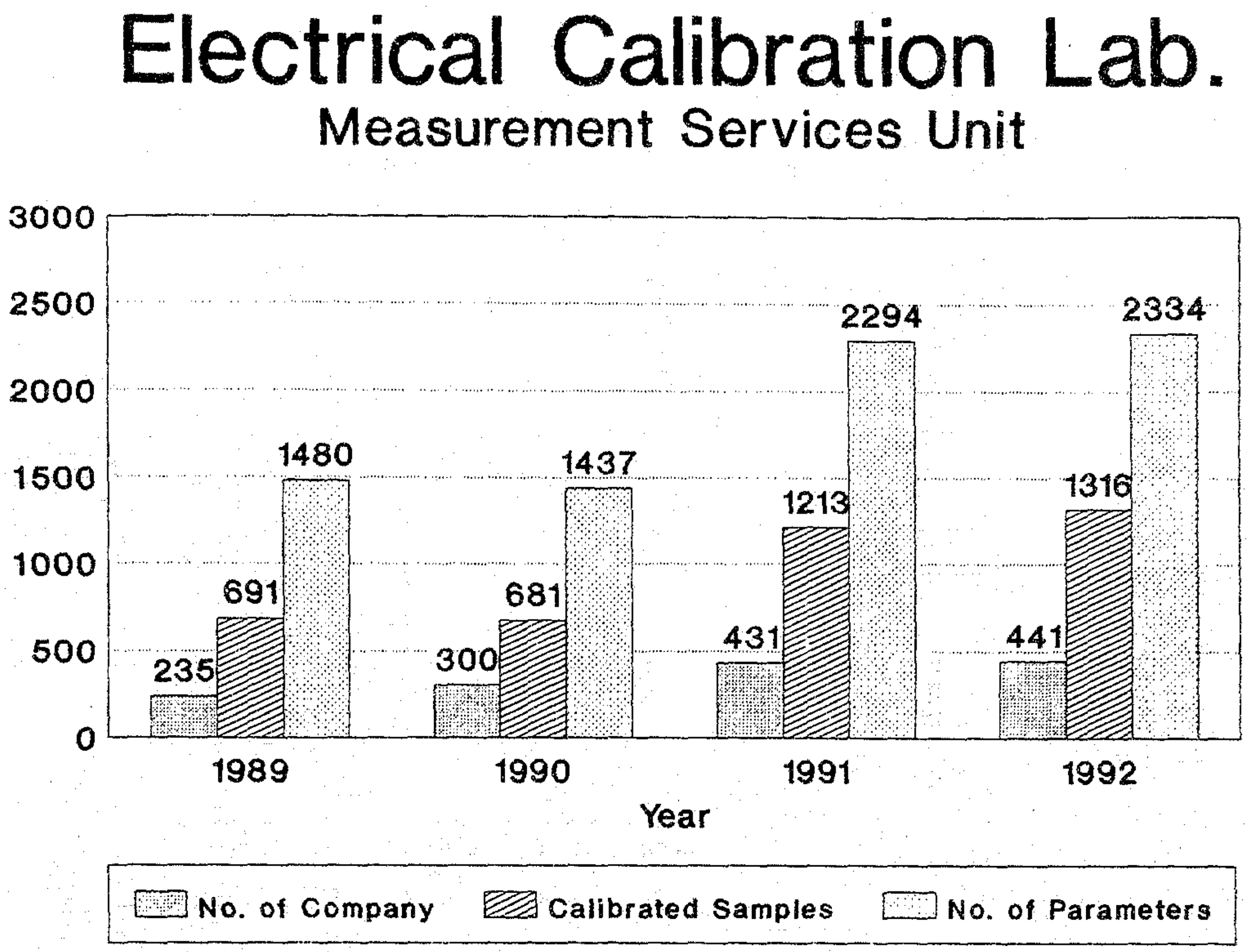


Fig. 5-13 Electrical Calibration Lab.



CHAPTER 6

SURVEY ON INDUSTRIAL REQUIREMENTS

6. SURVEY ON INDUSTRIAL REQUIREMENTS

6.1 Objectives

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

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

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

6.2 Survey Items and Outline of Survey Results

(1) Survey Items

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

1) Company Outline

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

2) Management System for Measurement Standards

In-house management system for measurement standards and other aspects

3) Standards

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

4) Shop Floor Instruments

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

5) Requests for SIRIM (SIRIM Measurement Centre)

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

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

(2) Outline of Survey Results

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

1) Companies Visited

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

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

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

2) Management System for Measurement Standards

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

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

3) Standards

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

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

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

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

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

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

4) Shop Floor Instruments

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

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

5) Requests from Industries to the SIRIM Measurement Centre

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

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

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

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

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

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

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

(3) Survey Conclusions

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

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

6.3 Survey Findings for Each Company

The findings of the survey, which was conducted based on the check list shown in Table 6-2, are described here for each company.

6.3.1 Electrical Industry

The following 8 companies in the electrical industry were visited.

- Yokogawa Electric

  Sale of measuring instruments and electrical calibration service

- JVC, Innopower Keidenki, Crystal Precision and Sanyo

  Manufacturers of audio equipment

- Sharp-Roxy, Sony and Matsushita Electric

  Manufacturers of household electrical appliances

(1) Yokogawa Electric

1) Company Outline

Yokogawa Electric is the Malaysian subsidiary of Yokogawa Denki, a manufacturer of measuring instruments. The parent company in Japan has delegated the head office functions to those subsidiaries in Singapore, the US and Holland. Consequently, Yokogawa in Malaysia has a close ties with Yokogawa in Singapore.

Yokogawa Electric in Malaysia is engaged in the sale of measuring instruments and the provision of a calibration service for measuring instruments. Its annual turnover in fiscal 1992 totalled some 30 million M$. It has some 100 employees, 25 of which are assigned to the calibration service. The in-house standards are managed and maintained by 6 technical staffs.

2) Management System for Measurement Standards

The in-house traceability of electrical standards and equipment is well established as shown in Fig. 6-1 and Fig. 6-2.

3) Standards

Of the standards owned by Yokogawa Electric, the electric voltage and current standards are calibrated every year by the SIRIM Measurement Centre and these standards are used for the company's own calibration service. Most of the company's other standards (some 90% in all) are, in fact, calibrated by the SIRIM Measurement Centre with the rest calibrated by the Yokogawa factory in Singapore. As the SIRIM Measurement Centre does not conduct high calibration in high frequency, the calibration requirements in this field are dealt with by Yokogawa, Japan.

4) Requests to the SIRIM Measurement Centre

As Yokogawa sells measuring instruments, it has a wide range of requests for the calibration service provided by the SIRIM Measurement Centre. Some concrete requests are given below.

- It is hoped that an electrical calibration service in the high frequency range (500 KHz - 300 MHz) with improved accuracy of 0.025% will be introduced.

- Flow calibration is currently entrusted by the SIRIM Measurement Centre to a private inspection organization and the client must go through a complex application procedure. It is hoped that this procedure will be simplified or that calibration will be arranged by the SIRIM Measurement Centre. Accuracy of around 0.5% should prove adequate for the time being.

- The long time required for calibration at the SIRIM Measurement Centre causes many difficulties in the running of the company. The company is willing to pay a higher fee if the calibration certificate can be issued within approximately 2 weeks of application.

(2) JVC Electronics Malaysia Sdn. Bhd. (JVC)

1) Company Outline

Established in March, 1988, the company is the local subsidiary of Japan Victor Co. and manufactures such audio products as radios, cassette recorders and mini-components, all of which are exported to the US and Europe, etc. It has some 2,000 employees.

2) Management System for Measurement Standard

The in-house traceability is well established in the mechanical and electrical fields as shown in Fig. 6-3 and Fig. 6-4.

3) Standards

Equipment meeting the JEM (Japan Electrical Manufacturers' Association) standards are used as the sub-standards for comparison and are calibrated annually by the SIRIM Measurement Centre.

Gauge blocks and weights in the mechanical field and 10 items, including standard resistors and digital multimeters, in the electrical field are calibrated by the SIRIM Measurement Centre. The SIRIM Measurement Centre's calibration accuracy satisfies the company's requirements. There are 16 pieces of equipment which cannot be calibrated by the SIRIM Measurement Centre. These are either calibrated by the parent company in Japan or by calibration organizations outside Malaysia.

4) Shop Floor Instruments

The measuring instruments used on the shop floor are annually calibrated using the above-mentioned sub-standards. All instruments relating to product safety are calibrated every 6 months. The measuring instruments owned by JVC are listed in Table 6-3.

5) Requests to the SIRIM Measurement Centre

JVC expressed many requests to the SIRIM Measurement Centre as listed below.

- It is hoped that an electrical calibration service in the high frequency range (upto 200 MHz) will be introduced.

- It is hoped that a calibration service for DC and low frequency withstanding voltage testers upto 10 KV will be introduced.

- It is hoped that a calibration service for AM/FM signal generators will be introduced.

- It is hoped that a calibration service for distortion meters, wow and flutter meters, offset meters and jitter meters, etc. will be introduced.

- The current calibration time of more than one month should preferably be shortened to approximately 2 weeks.

- It is hoped that the specifications of the standards used for calibration work at the SIRIM Measurement Centre will be shown on the calibration certificate. The SIRIM official present at the interview confirmed that these specifications will be shown on calibration certificates issued in fiscal 1993 onwards.

- It is hoped that the calibration charge system of the SIRIM Measurement Centre will be clarified.

(3) Innopower Keidenki Sdn. Bhd. (Innopower)

1) Company Outline

Innopower was established in 1988 as a joint venture between a local company and Tokyo Keidenki in Japan. It has some 600 employees and manufactures transformers for audio equipment. Its clients include Sony, Sharp, Kenwood and Yamaha. The turnover in fiscal 1992 was approximately 57 million M$. The company is currently undergoing the ISO 9002 assessment and is expected to be registered shortly.

2) Management System for Measurement Standard

Separate traceability system has been established for the mechanical, AC current, AC voltage, DC voltage and resistance fields as shown in Fig. 6-5 (a) - (e).

3) Standards

Innopower currently has 8 standards, including AC current and AC voltage standards, most of which are calibrated every year by the SIRIM Measurement Centre. Some standards are calibrated by the SISIR in Singapore. The resistance box, which is a sub-standard, is calibrated every six months by the SIRIM Measurement Centre.

4) Shop Floor Instruments

Sixteen instruments, including the digital multimeter, are annually calibrated by the SIRIM Measurement Centre while 10 instruments, including the withstanding voltage tester, are calibrated in-house every 6 months. The standards and measuring instruments owned by Innopower are listed in Table 6-4.

5) Requests to the SIRIM Measurement Centre

The following concrete requests were made by Innopower.

- While the currently calibration accuracy provided by the SIRIM Measurement Centre satisfies the level required by Innopower, the long calibration time of some 2 months must be shortened. The calibration charges of the SIRIM Measurement Centre are low compared to the charges of other calibration organizations.

- It is hoped than an on-site calibration service will be introduced to redress the currently lengthy process of calibration work at the SIRIM Measurement Centre.

- It is hoped that the SIRIM Measurement Centre will organize a training course for the wheatstone bridge.

- It is hoped that the specifications of the standards used for calibration work at the SIRIM Measurement Centre will be shown on the calibration certificate. As in the case of JVC, the accompanying SIRIM official told the company that the specifications will be shown on calibration certificates issued in fiscal 1993 onwards.

- The metrological terminology used by the SIRIM Measurement Centre is not standardised. It is hoped that the metrological terminology will be standardised for use throughout Malaysia and in view of compatibility with international terminology.

- Innopower's technical staffs are unsure of the environmental conditions (temperature and relative humidity) required of a place (laboratory) in which calibration work is conducted. It is hoped that the SIRIM Measurement Centre will supply a list of such conditions (or criteria).

(4) Crystal Precision (M) Sdn. Bhd. (Crystal)

1) Company Outline

Crystal is a joint venture of Clarion, Japan which was established in Penang in 1986. It has some 500 employees and manufactures printed circuit boards for car audio systems. The turnover in fiscal 1992 totalled approximately 10.5 million M$.

2) Management System for Measurement Standard

The traceability system has been established for 6 different instruments, including the standard signal generator, as shown in Fig. 6-6.

3) Standards

Five items, including the oscilloscope, are calibrated by the Penang Branch of the SIRIM Measurement Centre while 4 items, including the measuring receiver, another 4 items and 2 items are calibrated by Hewlett Packard, Nusantara which is an accredited calibration laboratory and Seel in Singapore respectively. All calibrations are conducted annually. The standards owned by Crystal are listed in Table 6-5.

4) Shop Floor Instruments

Fifty-two different measuring instruments are used on the shop floor and these are all calibrated every year using the standards referred to in 3) above. The measuring instruments owned by Crystal are listed in Table 6-6.

5) Requests to the SIRIM Measurement Centre

- It is hoped that the SIRIM Measurement Centre will be expanded and upgraded for the calibration of all measuring equipment and instruments owned by Crystal. At present, the company has no choice but to send some instruments to Singapore or elsewhere for calibration at considerable cost and time. Those items calibrated by the Penang Branch are returned in one to 2 weeks at approximately half the cost of the charge of all accredited calibration organizations.

- The calibration accuracy meets Crystal's required level.

(5) Sanyo Electric (Penang) Sdn. Bhd. (Sanyo)

1) Company Outline

Sanyo is a joint venture of Sanyo, Japan and was established in Penang in 1964. It has some 540 employees and manufactures car radios, car stereos and cordless telephones, etc. The turnover in fiscal 1992 totalled approximately 71 million M$. As the company has received many enquiries regarding its registration status under the ISO 9000, preparations to apply for registration are underway.

2) Management System for Measurement Standard

Although the traceability system is in place, no traceability chart has been prepared.

3) Standards

Twelve items are calibrated by the Penang Branch of SIRIM. The other standards are calibrated by either accredited calibration laboratories or instrument manufacturers. Calibration is conducted every 6 months.

4) Shop Floor Instruments

As many as 1,017 measuring instruments are used on the shop floor. All these instruments are calibrated in-house every 6 months excepting those referred to in 3) above.

5) Requests to the SIRIM Measurement Centre

- The calibration accuracy meets Sanyo's required level. However, the calibration time of more than one month should be shortened. The level of the SIRIM Measurement Centre's calibration charges appears to be reasonable.

- It is hoped that the SIRIM Measurement Centre will introduce an on-site calibration service.

- The express calibration service is requested.

(6) Sharp-Roxy Appliances Corporation (Sharp)

1) Company Outline

Sharp is a joint venture between Roxy, established in 1965, and Sharp and was established in 1985. The capital investment ratios are 51% for Malaysian capital, 25% for Hong Kong capital and 20% for Sharp, Japan. The company management is entrusted to Sharp, Japan. The company has some 600 employees, manufactures such household electrical appliances as colour TVs, washing machines and cleaners and is preparing to apply for ISO 9002 registration.

2) Management System for Measurement Standard

The in-house traceability system is well established for (i) resistance, (ii) DC voltage and current and (iii) AC voltage, current and power as shown in Fig. 6-7.

3) Standards

Three standards, i.e. the digital multimeter, high voltage meter and cut-off current, are annually calibrated by the SIRIM Measurement Centre. Thirteen types of sub-standards, including the standard resistors and Wheatsone bridge, are calibrated every year by Yokogawa, an instrument manufacturer which also conducts repair work.

Sharp's calibration room has a controlled temperature of 20°C and 3 technical staffs are assigned to calibration. The standards owned by Sharp are listed in Table 6-7.

4) Shop Floor Instruments

Seven instruments, including the insulation tester, which act as working standards are calibrated in-house every 6 months. The working standards owned by Sharp are listed in Table 6-8.

5) Requests to the SIRIM Measurement Centre

Sharp expressed a number of requests as listed below, including concrete enquiries regarding the future calibration capability of the SIRIM Measurement Centre.

- It is hoped that the SIRIM Measurement Centre will acquire the calibration capability for vacuum meters (-30 mmHg or lower) for industrial Bourdon-tube gauges.

- It is hoped that the SIRIM Measurement Centre will acquire the calibration capability for vibration meters in the future. Sharp's vibration meter currently calibrated in the US.

- The company currently entrusts the calibration of mainly electrical standards and instruments to the SIRIM Measurement Centre but is planning to entrust pressure calibration relating to cleaners and also dimensional calibration involving micrometers and block gauges, etc. to the SIRIM Measurement Centre in the future.

- It is hoped that the current calibration time of more than one month will be shortened to approximately 2 weeks.

(7) Sony TV Industries (M) Sdn. Bhd. (Sony)

1) Company Outline

Sony was established in 1988 as a joint venture between Sony Corporation in Japan and a local company. It has some 2,000 employees and manufactures colour TVs and tuners, etc.

2) Management System for Measurement Standard

While the traceability system is in place, no traceability chart has been prepared.

3) Standards

Some standards, including the noise meter, are calibrated by the SIRIM Measurement Centre. Those relating to radiation are calibrated by the SISIR while others are calibrated in the US or by Sony Corporation in Japan. While most standards are calibrated annually, some are calibrated every 6 months.

A quality assurance division was recently established and the new calibration room maintains several standards. It is planned to establish a new calibration room for the design division in the near future.

4) Shop Floor Instruments

Some 500 measuring instruments are used on the shop floor and are calibrated by Airod, Asia Radio, Concode, Nusatek, Pyrometro, Scimdt, Seel and Tescon. In addition, some are calibrated by such manufacturers as Hewlett Packard and Vokogawa. Only a small number of instruments are calibrated in-house. The calibration frequency for all instruments is once a year. Half of the instruments are calibrated on-site over the weekend to minimise the disruption of manufacturing activities. Stand-by instruments are required for the remaining half of the instruments as they must be taken to the calibration laboratories. Table 6-9 lists the main instruments which are calibrated by the SIRIM Measurement Centre.

5) Requests to the SIRIM Measurement Centre

- The calibration of DC/AC high voltage (50 KV) is hoped for.

- The calibration of impact accelerometers is hoped for.

- The calibration of vibration meters used for the vibration tests of colour TVs is hoped for.

- It is hoped that the current long calibration time will be shortened to approximately 2 weeks.

- The calibration certificates issued by the SIRIM Measurement Centre are currently written in Malay. It is hoped that the language will be changed to English in view of the worldwide acceptance of these certificates.

- It is hoped that training courses on calibration technologies/techniques will be provided.

- The present calibration accuracy is satisfactory. The calibration charges are half or one-third of those imposed by other calibration organizations.

(8) Matsushita Electric Co., (M) Bhd. (Melcom)

1) Company Outline

Melcom was established in 1965 as the first Matsushita Group company in Malaysia. It has some 2,200 employees and manufactures such household electrical appliances as colour TVs, refrigerators, washing machines and irons. While irons were awarded the JIS mark in 1991, most products have been awarded the MS mark.

The company is currently preparing its application for ISO 9000 registration. Melcom has an excellent in-house quality control system and the company can be regarded as a role model for all the visited companies in terms of the promotion of quality control and in-house education/training.

2) Management System for Measurement Standard

The traceability of standards managed by the SIRIM Measurement Centre to in-house primary, sub and working standards is well established. In addition, Melcom has a control system to rectify unsatisfactory instrument control or calibration results by means of the relevant manuals. Melcom's traceability system is shown in Fig. 6-9.

3) Standards

Melcom has a total of 37 different types of standards, i.e. 14 mechanical, 16 electrical, 2 thermal and 5 mass/pressure standards. Half of these are annually calibrated by the SIRIM Measurement Centre will the rest are also annually calibrated by Yokogawa and Mitutoyo. The calibration room has a controlled temperature of 23°C and maximum relative humidity of 60%. The standards owned by Melcom are listed in Table 6-10.

4) Shop Floor Instruments

All the measuring instruments used on the shop floor are calibrated in-house every 6 months. The calibration work is conducted by 4 technical staffs, all of which have internal qualifications based on regular training in Japan and Singapore.

5) Requests to the SIRIM Measurement Centre

Two concrete requests were made.

- The calibration of manometers is hoped for. In the opinion of the survey team, while the SIRIM Measurement Centre currently has the technologies to meet this request, there is a problem in regard to transporting a whole set of calibration equipment.

- It is expected that new statutory regulations in the coming years will require private companies to test possible interference caused by electromagnetic waves. However, it will be difficult for private company to comply with such regulations due to the prohibitive cost. It is hoped that the SIRIM (SIRIM Measurement Centre) or another government organization will be made responsible for the tests concerned.

6.3.2 Semiconductor Industry

The survey team visited 4 companies in the semiconductor industry, i.e. Hitachi Semiconductor and Motorola in Penang and Rohm Wako and Toshiba Electronics in Kuala Lumpur.

(1) Hitachi Semiconductor (M) Sdn. Bhd. (Hitachi)

1) Company Outline

Hitachi was established in Penang in 1972 as a local subsidiary of Hitachi, Japan. It has some 2,000 employees and manufactures various types of ICs, diodes and transistors. The company is scheduled to undergo assessment for ISO 9000 registration.

2) Management System for Measurement Standard

The traceability system is established in the electrical, thermal and mechanical fields.

3) Standards

Hitachi has 13 standards. Five standards, including the decade register, are calibrated by the SIRIM Measurement Centre while the other 8 standards are calibrated by instrument manufacturers, including Hewlett Packard. All calibrations are conducted annually. These standards are listed in Table 6-11.

4) Shop Floor Instruments

All measuring instruments used on the shop floor are calibrated in-house every 6 months in accordance with the calibration manuals.

5) Requests to the SIRIM Measurement Centre

- The range of the present calibration service and its accuracy level satisfy Hitachi's requirements but it is hoped that the lengthy calibration time of one to even 2 months will be shortened to approximately 2 weeks. The calibration charge level is appropriate.

- It is hoped that training courses on calibration technologies/techniques will be provided by the SIRIM Measurement Centre.

(2) Motorola (M) Sdn. Bhd. Penang (Motorola)

1) Company Outline

The company was established in 1972 by Motorola, US. It has some 2,400 employees and manufactures semiconductor-based products and a variety of mobile phones. Motorola has already acquired registered status under the ISO 9002 and application for the ISO 9001 is currently being processed.

2) Management System for Measurement Standard

The in-house traceability system is well established.

3) Standards

All standards are annually calibrated by the parent company in the US or in Britain and by Hewlett Packard or the SISIR and the SIRIM Measurement Centre is not used. The calibration room has a controlled temperature of 20°C - 21°C and relative humidity of 65% - 70%. In addition to calibration work, the room is also used for the repair of measuring instruments and calibration-related training.

4) Shop Floor Instruments

While Motorola does not use the SIRIM Measurement Centre for the calibration of its instruments at present, it hopes to place a request for high frequency calibration (4.3 GHz) provided that the work can be completed in some 10 days together with the issue of the calibration certificate.

(3) Rohm-Wako (Malaysia) Sdn. Bhd. (Rohm)

1) Company Outline

The company was established in 1987 as a joint venture between a local company and Rohm, Japan. It has some 440 employees and manufactures diodes and LEDs. Rohm plans to commence application preparations for ISO 9000 registered status in September, 1993.

2) Management System for Measurement Standard

The traceability system is well established although no traceability chart is available.

3) Standards

The standard weights and block gauges are annually calibrated by the parent company and, therefore, are unavailable for approximately 3 months every year. The resistance standards and multimeter are annually calibrated by the SIRIM Measurement Centre.

4) Shop Floor Instruments

All the measuring instruments used on the shop floor are calibrated every 6 months by the 9 technical staffs responsible for measurement. The work regulations stipulate that those instruments failing the verification criteria are sent to the manufacturers for repair and cannot be used until they have been calibrated on their return from repair.

5) Requests to the SIRIM Measurement Centre

- The calibration of the degree of vacuum is hoped for to ensure the removal of dust from diodes.

- The calibration of thermocouples is hoped for.

- The calibration of the TG meter reading of temperature for the measurement of glass transfer temperature is hoped for.

- The calibration of anemometers is hoped for.

- Calibration by the SIRIM Measurement Centre sometimes requires as long as 3 months. With a further delay in the issue of the calibration certificate, the production programme of the company can be seriously affected. It is hoped that calibration will be completed in 2 - 3 weeks together with the issue of the certificate.

- The criteria relating to brightness standards should be clearly defined. (Japan also lacks clearly stated criteria relating to brightness standards.)

- The range and details of the calibration service provided by the SIRIM Measurement Centre are unclear. (Other companies also pointed out this shortcoming. More thorough public relations activities, including the posting of relevant brochures, should be conducted.)

(4) Toshiba Electronics (M) Sdn. Bhd. (Toshiba)

1) Company Outline

The company was established in 1973 by Toshiba, Japan. It has some 1,300 employees and manufactures various semiconductor-based products such as ICs and transistors, some 85% of which are exported to various Asian countries.

The company is preparing for ISO 9002 registration and the assessment is expected to be conducted in September, 1993.

2) Management System for Measurement Standard

In-house measurement control commenced in fiscal 1991 and the traceability system has so far been established in the mechanical, electrical and other fields together with the relevant traceability charts.

3) Standards

Toshiba has 8 standards which are annually calibrated by the parent company in Japan or the SISIR via such manufacturers as Yokogawa and Hewlett Packard. The calibration room has a controlled temperature of 23°C and relative humidity of 60%. The standards owned by Toshiba are listed in Table 6-12.

4) Shop Floor Instruments

Most of the measuring instruments used on the shop floor are annually calibrated in-house in accordance with the calibration manuals. Some are calibrated by their original manufacturers. The in-house calibration has 3 grades, i.e. total calibration, partial calibration and point check, and all instruments undergo one of these calibration processes depending on their requirements. All the calibration technical staffs have undergone a 1 - 3 month training programme at the parent company in Japan.

5) Requests to the SIRIM Measurement Centre

- It is hoped that thermal calibration for the range between -72°C and 400°C and pressure calibration will be provided. (The SIRIM official accompanying the survey team explained the current scope of the corresponding service.)

- It is hoped that high frequency calibration upto 100 MHz will be provided.

- It is hoped that calibration of the modulating frequency will be provided.

- Calibration at the SIRIM Measurement Centre currently takes more than one month. It is hoped that this time will be shortened to around 10 days.

- It also takes some time for the calibration certificate to arrive following the completion of the calibration work. As no measuring instruments can be used without the calibration certificate, it is hoped that the certificate will accompany the calibrated instrument. It is further hoped that the calibration certificates will carry an English translation of the original Malay.

- It is hoped that the SIRIM Measurement Centre will plan and provide training courses and seminars to foster calibration technical staffs. Training courses on calibration technologies/techniques and also on calibration control methods will be particularly useful.

6.3.3 Chemical Industry

The survey team visited 3 companies in the chemical industry, i.e. Ajinomoto in the food processing sector, Usra Tampi in the plastic moulding sector and Maica Laminates in the melamine board sector.

(1) Ajinomoto (Malaysia) Bhd. (Ajinomoto)

1) Company Outline

Ajinomoto was established in 1961 as the first subsidiary of a Japanese company in Malaysia. It has some 350 employees and manufactures chemical seasonings and others. The turnover in fiscal 1992 totalled some 95 million M$.

2) Management System for Measurement Standard

As a processing company, Ajinomoto does not have many measuring instruments. However, a certain degree of traceability has been established without a traceability chart.

3) Standards

One 50kg standard weight and five 2kg standard weights are annually calibrated by the SIRIM Measurement Centre.

4) Shop Floor Instruments

Most of the measuring instruments used on the shop floor are calibrated in-house while a small number of flow meters and thermometers are calibrated by Yokogawa, their manufacturer.

5) Requests to the SIRIM Measurement Centre

Ajinomoto did not make any specific request for the SIRIM Measurement Centre, probably because the company knows little of the SIRIM Measurement Centre's actual activities, indicating insufficient public relations activities on the part of the latter.

(2) Usra Tampi (M) Sdn. Bhd. (Usra)

1) Company Outline

Usra was established in 1989 as part of the local Usra Group. It has some 200 employees who work 3 shifts. The company manufactures injection mould plastic car components, components for audio equipment and TV cabinets, etc. It is preparing to acquire registered status under the ISO 9002 in October, 1993.