JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF SCIENCE, TECHNOLOGY AND
HUMAN RESOURCES DEVELOPMENT,
THE DEMOCRATIC SOCIALIST REPUBLIC
OF SRI LANKA

# BASIC DESIGN STUDY REPORT
# ON
# THE PROJECT FOR
# IMPROVEMENT OF INDUSTRIAL STANDARDIZATION AND METROLOGY EQUIPMENT OF THE SRI LANKA STANDARDS INSTITUTION
# IN
# THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

MARCH 1995



UNICO INTERNATIONAL CORPORATION



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## PREFACE

In response to a request from the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Industrial Standardization and Metrology Equipment of the Sri Lanka Standards Institution and entrusted the study to the Japan International Cooperation Agency(JICA).

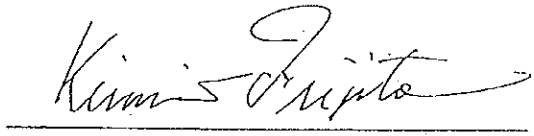
JICA sent to Sri Lanka a study team headed by Mr.Yasujiro Suzuki, Study Review and Coordination Division, Grant Aid Study and Design Department of JICA and constituted by members of International Trade and Industry Inspection Institution, Ministry of International Trade and Industry, National Research Laboratory of Metrology, Ministry of International Trade and Industry, Japan Electrical Testing Laboratory and UNICO International Corporation, from December 3 to December 18, 1994.

The team held discussions with the officials concerned of the Government of Sri Lanka, and conducted a field study at the study area. After the team returned to Japan, further studies were made and, as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the team.

March 1995



Kimio Fujita
President
Japan International Cooperation Agency

March 1995

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

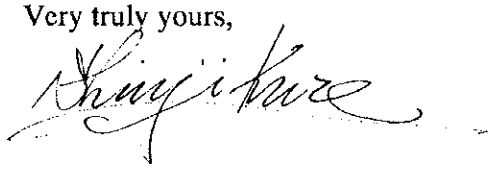
We are pleased to submit to you the basic design study report on the Project for Improvement of Industrial standardization and Metrology Equipment of the Sri Lanka Standards Institution in the Democratic Socialist Republic of Sri Lanka.

This study was conducted by UNICO International Corporation, under a contract to JICA, during the period from December 1, 1994 to March 28, 1995. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Sri Lanka and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA , the Ministry of Foreign Affairs and the Ministry of International Trade and Industry. We would also like to express our gratitude to the officials concerned of the Minsitry of Science, Technology and Human Resources Development, Sri Lanka Standards Institution, JICA Sri Lanka Office and the Embassy of Japan in Sri Lanka for their cooperation and assistance throughout our field survey.

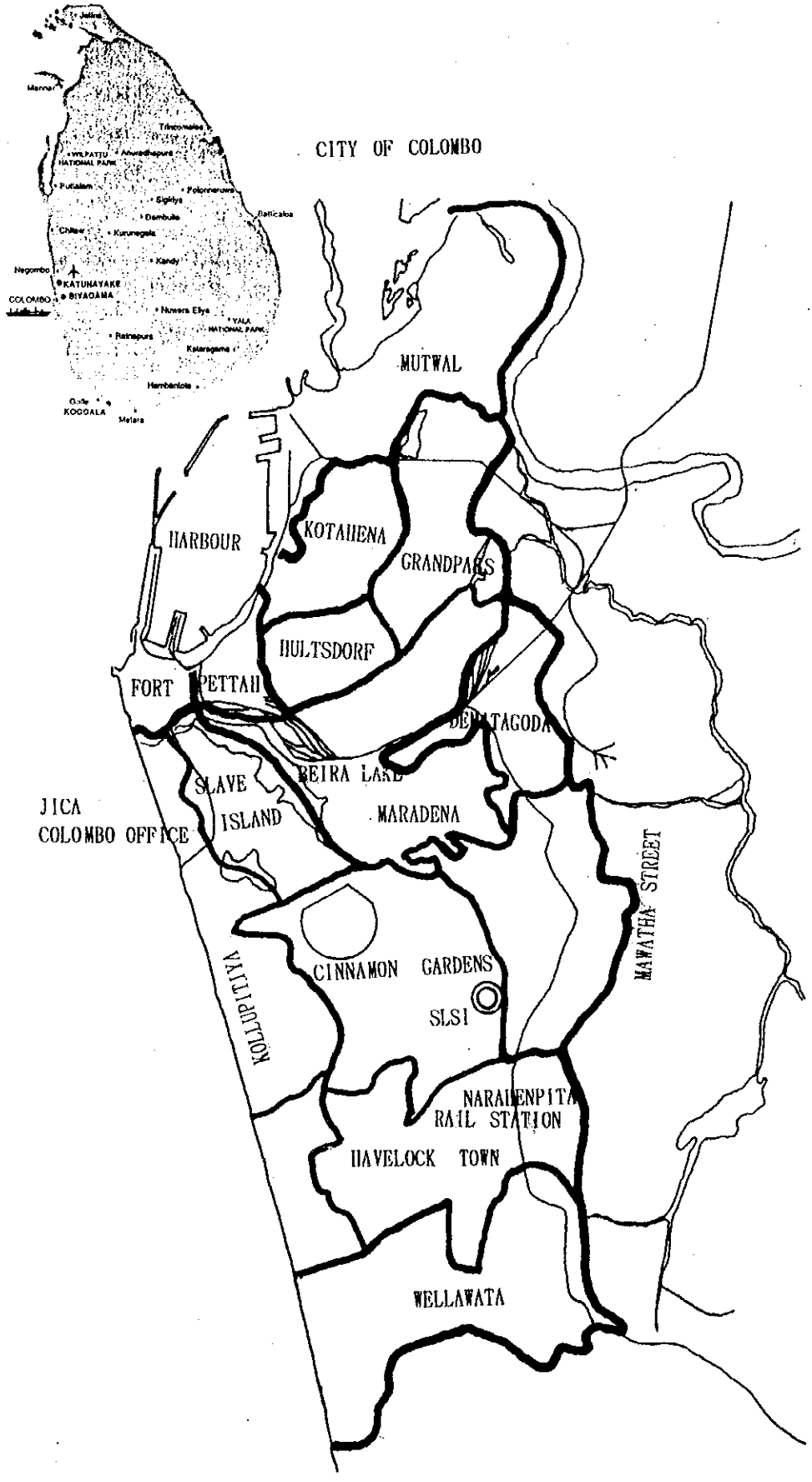
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,



Shinji Kure,
Project manager,
Basic design study report on
the Project for Improvement of Industrial
Standardization and Metrology Equipment
of the Sri Lanka Standards Institution,
UNICO International Corporation

## 4. Location Map



# SUMMARY

## SUMMARY

Since 1989, the Sri Lanka government has been undertaking its structural adjustment program aiming at export-oriented industrial development, attraction of foreign capital investment, and privatization of state-run enterprises. In line with above adjustment program, the government has been reviewing the results of its five-year public investment plan each year, with necessary adjustments being made for further implementation.

The Sri Lanka government has been actively promoting exports of industrial products through the development of physical infrastructure including the development of industrial estates and the establishment of export processing zones. However, one essential aspect of industrialization efforts required in any country has been left behind. The country has still to develop a proper set of industrial standards, export certification and import inspection systems, and metrology and calibration systems. The deficiency in generally accepted standards and systems that serve as the basis of promoting quality improvement of industrial products may cause a great hindrance to the development of international competitiveness. In order to maintain steady growth of product exports and achieve the target GDP growth rate, 6.4% on average, the government feels the need for reinforcement of the industrial standardization scheme, export certification and import inspection systems, metrology and calibration systems, which are also required for the interest of consumer safety and protection.

At present, Sri Lanka Standards Institute (SLSI) is the only public organization that conducts examination, inspection, and quality control related to exports and imports of industrial products from and to the country, as well as deliberation and establishment of national standards. However, as its equipment and machinery have been deteriorated due to aging and have become outdated, SLSI is increasingly facing difficulty in meeting the anticipated increase in work load as well as demand by the industry for higher levels of inspection and testing. Under these circumstances, the Sri Lanka government has requested the Japanese government to supply SLSI's equipment and materials for inspection and testing, and measurement and calibration under a grant aid project.

At the request of the Sri Lanka government, the Japanese government has decided to conduct a feasibility study and instructed Japan International Cooperation Agency (JICA) to undertake the study. JICA sent the Basic Design Study Team to Sri Lanka from December 3, 1994 to December 18, 1994.

The study team undertook a series of discussion with Sri Lanka counterparts, visited and collected data from SLSI's facilities, related government agencies, public research institutes, and related industries. It confirmed the scope of the grant aid project, preparedness of the Sri Lanka's counterparts for project implementation, operation and maintenance plans, and the ability to perform associated work and service that forms an integral part of the project, including necessary budgeting. It also studied the demarcation of responsibilities with other government agencies in respect of testing and inspection related to textile products, and metrology and calibration services and collected relevant data.

Outline of the Study result is explained below.

SLSI is the only one organization authorized to establish national standards in Sri Lanka and has been originated as Bureau of Ceylon Standards. The bureau functioned as the organization to establish national standards up until 1984. In that year, it was renamed as Sri Lanka Standards Institution and expanded its business and power under the Ministry of Industries, Science and Technologies. Under the organizational reform in 1994, SLSI came under supervision of the Ministry of Science, Technology and Human Resources Development.

Historically, SLSI has made full contribution to the country's development, but, rapid development of the industrial sector in recent years, coupled with increasingly strict quality requirements for industrial products in the export market and a market increase in imports in consequence of economic liberalization policy, urges SLSI to adjust its policy, including diversification of its service areas and replacement or upgrading of equipment.

SLSI has its headquarters, a laboratory services division (under it, various laboratories are operated), a standard formulation division, a quality control division, a library and a training center, and they are separately located in 5 locations including a newly completed building in Colombo. By March 1995, laboratories will move to the new building and will be integrated as one laboratory. Note that the new building has no room for other departments.

On the contrary, existing equipment are old and outdated as majority of equipment being more than ten years old and some of them past twenty years. Also,

tools and jigs are not enough in quantities.

The equipment and materials requested by the Sri Lanka government are those used for inspection and testing of industrial products, measurement and calibration, and machining that are conducted at various laboratories of SLSI, totaling 132 units. They vary greatly in terms of the levels of need and urgency, and major purposes. Some are used for compulsory inspection and testing of imported and domestic products, others for voluntary inspection. Some are used to replace existing equipment, or to provide additional or new services. On the other hand, some of existing equipment are serviceable for a significant period of time.

Based on the conditions identified above, the basic design process to select and identify appropriate equipment to SLSI. In developing the equipment plan, the following criteria has been used to prioritize necessity and urgency of equipment. In addition to the criteria, equipment plan corresponds to the rolls of SLSI in the country as well as the needs of time as technological innovation era.

a) Equipment required for inspection under compulsory standards
b) Equipment required to perform highly demanded tests with high levels of accuracy that cannot be met by existing equipment
c) Equipment that is deteriorated or outdated significantly and requires replacement or upgrading
d) Equipment essential in complying with established industrial standards and/or quality standards

The execution agency in this project is Sri Lanka Standards Institution under the Ministry of Science, Technology and Human Resources Development.

The principal objectives of the project is therefore to supply equipment used for inspection and testing, and measurement and calibration for SLSI's laboratories, thereby contributing to the development and promotion of the basis for quality improvement initiatives for Sri Lanka products, while serving the interest of consumer safety and protection.

Table 1 lists major equipment planned for each lab and its quantities.

## Table 1 Major Planned Equipment and Its Quantities

| Name of Laboratory | Number of Equipment | Major Planned Equipment |
|---|---|---|
| (1) Material Testing Laboratory | 4 | Helmet testing equipment, Cement/concrete testing equipment, Mini-lathe machine, Profile projector. |
| (2) Electrical and Electronic laboratory | 18 | Continuously variable DC power supply, Voltage stabilizer, Plug and socket outlets test equipment, Inductive load for switch testing, Tracking test apparatus, Glow wire test apparaus, Torque tester, Endurance test machine for switches, Multi-channel temperature recorder, Flexing machine for cables, Impact test apparatus, Resistive load, Earth leakage circuit break tester, Test fingers & Test pins. |
| (3) Food and Chemicals laboratory | 6 | Atomic absorption spectrophotometer, Capillery gas chromatograph, Carbon/sulphur analyzer, IR spectrophotometer, Ionizer, Flame photometer. |
| (4) Microbiology laboratory | 17 | Top loading autoclave, pH meter, Horizontal laminar flow cabinet, Air sampler, Precision pressure gauge, Multi-channel temperature recorder, Sterilizing oven, Top pan electronic balance, Voltex mixer, Stomacher laboratory blender, Refrigerator/freezer, Laboratory glassware washing machine, Binocular microscope, Stainless steel blender, Colony counter, Bench top centrifuge, Pipette plugging machine |
| (5) Textile Laboratory | 9 | Flammability tester (vertical), Flammability tester (45 degrees), Flammability tester (horizontal), Flammability tester(hot nut), Bundesman water repellency tester, Air permeability tester, Seam slippage tester, Yarn eveness tester, Microprocessor controlled color matching/measuring system. |
| (6) Metrology/ calibration laboratory | 12 | 3-D coordinate measuring machine, Fixed point temperature calibration system, Automatic gauge block calibrating system, Air conditioned vehicle-mobile for calibration purpose, Four terminal resistance bridge, Portable dry bath for calibration, Horizontal universal length measuring machine, Portable micro-computer with printer, Surface texture measuring equipment, Mass comparator, High accuracy analytical balance, Proving rings. |
| (7) Engineering Workshop | 3 | Lathe machine, Metal sheet working machine, Shaping machine |
| (8) General | 2 | Compuetr systems, Standard reference materials |
| Total | 71 | |

Project period considered as three months for detailed study and about nine months for procurement , installation and others.

Following major benefits are expected from implementation of the Project.

(1) Improvement of testing and inspection equipment will contribute to the following:

1) To facilitate the formulation of new standards, the improvement of technology and quality levels, thereby contributing to the improvement of international competition and the development of industries.
2) To improve reliability of the results of both compulsory and voluntary tests and to reduce time required for the tests, thereby to expand SLSI's service.
3) To improve product safety which leads to consumer protection.
4) Latest equipment that reflects today's technological innovation will require engineers and technicians to learn and understand various technologies and techniques related to each equipment, not to mention operation and maintenance, which will revitalize the institution as a whole and spur the rise in technological levels. This will raise SLSI's leadership among industrial circles to increase quality awareness of corporate managers and to improve quality of local products.

(2) Improvement of calibration and metrological equipment will contribute to the following:

1) The expanded range of calibration, the increase in the number of calibration items, and improved accuracy will help establish credibility of SLSI among industries and help expand SLSI's service base. Business practice based on accurate measurement adopted by Sri Lanka industries, together with improved industry technology levels in the country, will help gain confidence of trade partners, that will boost exports and the economy. At the same time, automated calibration in some parts will increase SLSI's capacity for calibration service, leading to industrial development.

2) Improved accuracy of finishing due to improved measurement accuracy of processing equipment calibrated at factories will lead to the improvement of product quality, then to the increase in exports and economic development.

Operation and maintenance of the project can be evaluated as follows:

1) SLSI, execution body for the project has a long history and well organized.

Therefore, they will correspond maintenance and operation of equipment properly.

2) Director general of the SLSI takes full responsibilities for final administrative issues of the equipment and maintenance and, finance and supplies division covers operational costs. Daily operation and maintenance of equipment will be covered by the assistant director of lab, and staff and technicians will assist him. Therefore, maintenance and operation of equipment will be properly conducted only if appropriate training is given after the installation.
3) After 1995, governmental subsidy , the major income of SLSI, is planned to increase by 9 percent each year. So that, operational and maintenance cost will be covered within the budgetary support.

As discussed above, the project is expected to generate many benefits. Moreover, the project is expected to built up the basis of quality improvement required for promotion of standardization, improvement of export/import inspection and calibration system, and is expected to contribute to product quality, the increase in exports, and protection of consumers' safeties and property in the country. As a result, the project shows high levels of needs and urgency that make the project eligible for implementation as grant aid of the Japanese government.

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## Appendix

# CHAPTER 1 BACKGROUND OF THE PROJECT

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## 1.1 Background of the Project

Since 1989, the Sri Lanka government has been undertaking its structural adjustment program aiming at export-oriented industrial development, attraction of foreign capital investment, and privatization of state-run enterprises. In line with above adjustment program, the government has been reviewing the results of its five-year public investment plan each year, with necessary adjustments being made for further implementation.

The Sri Lanka government has been actively promoting exports of industrial products through the development of physical infrastructure including the development of industrial estates and the establishment of export processing zones. However, one essential aspect of industrialization efforts required in any country has been left behind. The country has still to develop a proper set of industrial standards, export certification and import inspection systems, and metrology and calibration systems. The deficiency in generally accepted standards and systems that serve as the basis of promoting quality improvement of industrial products may cause a great hindrance to the development of international competitiveness. In order to maintain steady growth of product exports and achieve the target GDP growth rate, 6.4% on average, the government feels the need for reinforcement of the industrial standardization scheme, export certification and import inspection systems, metrology and calibration systems, which are also required for the interest of consumer safety and protection.

At present, Sri Lanka Standards Institution (SLSI) is the only public organization that conducts examination, inspection, and quality control related to exports and imports of industrial products from and to the country, as well as deliberation and establishment of national standards. However, as its equipment and machinery have been deteriorated due to aging and have become outdated, SLSI is increasingly facing difficulty in meeting the anticipated increase in work load as well as demand by the industry for higher levels of inspection and testing. Under these circumstances, the Sri Lanka government has requested the Japanese government to supply SLSI's equipment and materials for inspection and testing, and measurement and calibration under a grant aid project.

## 1.2 Outline of the Request and Main Components

The equipment and materials requested by the Sri Lanka government are those used for inspection and testing of industrial products, measurement and calibration, and machining that are conducted at various laboratories of SLSI, totaling 132 units. They vary greatly in

terms of the levels of need and urgency, and major purposes. Some are used for compulsory inspection and testing of imported and domestic products, others for voluntary inspection. Some are used to replace existing equipment, or to provide additional or new services. Table 1.1 lists equipment requested by each lab and its quantities.

## Table 1. 1 Main Equipment Requested by Each Lab and Its Quantities

| Name of Laboratory | Number of Request | Major Requested Equipment |
|---|---|---|
| (1) Material Testing Laboratory | 13 | Helmet testing equipment, Cement/concrete testing equipment, Micro-lathe, Profile projector, Plastic/ rubber testing equipment, Paint testing equipment, NDT equipment |
| (2) Electrical and Electronic Laboratory | 30 | Continuously variable DC power supply, Voltage stabilizer, Plug and socket outlets test equipment, Inductive load for switch testing, Tracking test apparatus, Glow wire test apparaus, Torque tester, Endurance test machine for socket outlet, Multi-channel temperature recorder, Flexing machine for cables, Impact test apparatus, Resistive load, Earth leakage circuit break tester, Integrating photometer and standard lamps for testing fluores-cent lamps, Vertical rain test apparatus |
| (3) Food and Chemicals Laboratory | 9 | Atomic absorption spectrophotometer, Capillery gas liquid chromatograph, Carbon/sulphur analyzer, IR spectrophotometer, Ionizer, Flame photometer, Polarograph, Microwave oven, Analytical balance |
| (4) Microbiololgy Laboratory | 18 | Top loading autoclave, pH meter, Horizontal laminar flow cabinet, Air sampler, Precision pressure gauge Multi-channel temperature recorder, Sterilizing oven, Top pan electronic balance, Voltex mixer, Stomacher laboratory blender, Refrigerator/freezer, Laboratory glassware washing machine, Binocular microscope, Stainless steel blender, Colony counter Bench top centrifuge, pipette plugging machine |
| (5) Textile Laboratory | 18 | Flammability tester (vertical), Flammability tester (45 degrees), Flammability tester (horizontal), Flammability tester(hot nut), Bundesman water repe-age tester, Seam slippage tester, Yarn eveness tes-ter, Microprocessor controlled color matching/measu-ring system, Fibrograph, Weatherometer, Drape test-er |
| (6) Metrology/ calibration Laboratory | 39 | 3 D coordinate measuring machine, Fixed point temp-erature calibration system, Automatic gauge block calibrating system, Air conditioned vehicle-mobile calibration purpose, Four terminal resistance brid-ge, Portable dry bath for calibration, Horizontal universal length measuring machine, Portable micro-computer with printer, Surface texture measuring equipment, Mass comparator, High accuracy analyti-cal balance, Proving rings, Dead-weight pressure gauge tester, Ceramic gauge blocks, Laser interfer-ometer, Load cell systems, Standard Rockwell hard-ness tester, Dead-weight / lever force calibrating machine |
| (7) Engineering Workshop | 3 | Lathe machine, Metal sheet working machine, Shaping machine |
| (8) General | 2 | Compuetr systems, Standard reference materials |
| Total | 132 | |

# CHAPTER 2 OUTLINE OF THE PROJECT

# Chapter 2 Outline of the Project

At the request of the Sri Lanka government, the Japanese government has decided to conduct a feasibility study and instructed Japan International Cooperation Agency (JICA) to undertake the study. To verify the background of the project, the contents of the request, and local conditions, JICA sent the Basic Design Study Team headed by Yasujiro SUZUKI – (Study Review and Coordination Division, Grant Aid Study and Design Department, JICA) to Sri Lanka for 16 days from December 3, 1994 to December 18, 1994.

The study team undertook a series of discussion with Sri Lanka counterparts, visited and collected data from SLSI's facilities, related government agencies, public research institutes, and related industries. It confirmed the scope of the grant aid project, preparedness of the Sri Lanka's counterparts for project implementation, operation and maintenance plans, and the ability to perform associated work and service that forms an integral part of the project, including necessary budgeting. It also studied the demarcation of responsibilities with other government agencies in respect of testing and inspection related to textile products, and metrology and calibration services and collected relevant data.

Member list of survey team, survey schedule, member list of party concerned in Sri Lanka, minutes of discussion and country data are attached in "Appendices" as Appendix 1 to 5 respectively.

## 2.1 Objectives of the Project

As stated in 1.1 "Background of the Project," the Sri Lanka government has been undertaking the economic structural adjustment program, under which it promotes the fostering of export–oriented industries, foreign capital investment, and the privatization of state–run enterprises. On the other hand, the development of industrial infrastructure required for quality improvement, including an industrial standardization system, export certification and import inspection systems, and measurement and calibration systems, lags behind other parts of industrialization efforts and is increasingly becoming hindrance to the strengthening of international competitiveness of the country's products.

Sri Lanka Standards Institution (SLSI) – the only public organization responsible for inspection and testing, and quality control required for exports and imports of industrial products, as well as the development and establishment of national standards – can hardly meet the anticipated increase in work load and higher levels of accuracy for inspection and testing from the industrial circle. The principal objectives of the project is therefore to supply equipment used for inspection and testing, and measurement and calibration for SLSI's

laboratories, thereby contributing to the development and promotion of the basis for quality improvement initiatives for Sri Lanka products, while serving the interest of consumer safety and protection.

## 2.2 Study and Examination on the Request

(1) Five-Year Public Investment Plan

Since 1989, the Sri Lanka government has been undertaking the structural adjustment program that focuses on development of export-oriented industries, attraction of foreign capital investment, and the privatization of state enterprises. The program is currently driven under "Five-Year Public Investment Plan (1993 - 1997).

The plan sets the target economic growth rate of 6.4% on average over the period. Provided that weather conditions remain favorable and political stability is maintained, the plan is expected to bring abut a significant decline in unemployment rate, accompanied by higher standards of living. In fact, the economy recorded impressive growth during the past five years. In particular, sectors including manufacturing, exports, investment and international balance of payments have remarkably grown and have contributed greatly to the improvement of the national economy. In particular, the manufacturing sector in 1992 registered the most remarkable growth, measuring at 9% in real terms. Within the sector, textile and apparel industries showed rapid growth in terms of production and export. The government's industrial policy gives priority to accelerated growth of the industrial sector and the improvement of productivity with an aim to boost real revenue and employment. In particular, the government decides on its policy to put emphasis on economic and social infrastructure indispensable for expansion of the private sector.

To this end, the government will spend about 314 billion rupees out of about 325 billion rupees to be totally invested in the public sector during five years between 1993 - 1997. Of total approximately 35% will be allocated to construction of economic infrastructure including electricity and other energy sources, transportation and communication sectors, while about 13% will go to social infrastructure including education and health.

The government also plans to improve international balance of payments and increase employment opportunities through the development of industries and export expansion by inducing foreign capital.

To promote the industrialization process in cooperation with foreign companies, however, the country cannot rely on low-cost labor supply alone. Instead, it has to meet

basic requirements for attracting foreign investment, including political stability, infrastructure, investment incentives, quality of labor force, availability of raw materials, processing technology, and means of transportation.

To boost exports, the improvement of product quality is prerequisite, and the development of industrial standards, export certification and import inspection systems, and measurement and calibration system should be given of high priority. For this purpose, SLSI, the only national institute to establish and promote these systems, needs to be strengthened by supplying or replacing necessary equipment.

(2) Sri Lanka Standards Institution Corporate Plan

1) General profiles of SLSI

SLSI is the only one organization authorized to establish national standards in Sri Lanka and has been originated as Bureau of Ceylon Standards organized under the Bureau of Ceylon Standards Act. No.38 of 1964. The bureau functioned as the organization to establish national standards up until 1984. In that year, it was renamed as Sri Lanka Standards Institution under The Sri Lanka Standards Institution Act No.6 of 1984 and expanded its business and power under the Ministry of Industries, Science and Technologies. Under the organizational reform in 1994, SLSI came under supervision of the Ministry of Science, Technology and Human Resources Development.

Major objectives of establishing SLSI are as follows:

a) To establish national and internationally acknowledged standards and to revise, alter and adjust them are required;
b) To promote standardization and quality control in respect of industry and trade;
c) To establish and maintain laboratories, libraries and other facilities necessary for promotion of standardization and quality control;
d) To prepare or supply facilities necessary for inspection and examination of domestic or imported products, daily necessities and, materials;
e) To provide or supply facilities and equipment required for examination and calibration of precise measurement equipment as well as to issue examination certificates;
f) To provide or supply facilities and equipment required for research and study on standardization and quality control;

g) To implement a marking and certification scheme and to guarantee quality of domestic and imported materials and products;
h) To provide education, consulting and other services for promotion of standardization and quality control;
i) To cooperate with foreign experts and institutes pursuing same purposes; and
j) To try to keep harmony between manufacturers and consumers in respect of materials, products and those usage and method of production.

SLSI has its headquarters, a laboratory services division (under it, various laboratories are operated), a standard formulation division, a quality control division, a library and a training center, and they are separately located in 5 locations including a newly completed building in Colombo. By March 1995, laboratories will move to the new building and will be integrated as one laboratory. Note that the new building has no room for other departments.

Historically, SLSI has made full contribution to the country's development, but, rapid development of the industrial sector in recent years, coupled with increasingly strict quality requirements for industrial products in the export market and a market increase in imports in consequence of economic liberalization policy, urges SLSI to adjust its policy, including diversification of its service areas and replacement or upgrading of equipment.

2) SLSI Corporate Plan (1993 – 1997)

To fulfill its mission, SLSI has been active since its establishment, and starting in 1981, it has been devising a five-year plan each year, which is proposed as an annual operation plan to reflect economic conditions and demand for its services, called "Sri Lanka Standards Institution Corporate Plan."

SLSI's current policy is to promote standardization, the measurement system, and quality control in every aspect of the Sri Lankan economy.

Its objectives are:

a) Improvement of productivity and efficient use of national resources
b) Facilitation of internal and external trade
c) Achievement of socio-economic development
d) Enhancement of international competitiveness in products and services
e) Safeguard of the interest of consumers

To achieve above objectives, following activities are planned:

a) To formulate National Standards required for the development of the National Economy.
b) To promote the use and application of national standards in all spheres of economic and social activity.
c) To promote standardization at Association and Company levels in all sectors of the economy.
d) To promote Quality Assurance in all sectors of the economy.
e) To promote and disseminate valid measurement practices at national level.
f) To provide consumer education and consumer protection.
g) To educate and train Industry/service personnel on concepts, practices and techniques of standardization and quality management.
h) To provide test facilities and develop the National test capability.
i) To provide documentation and information services on standards, technical regulations and related publications.
j) To participate in international and regional standardization activities to safeguard national interest.
k) To constantly develop and upgrade the institution and its resources.

The present national standards, inspection system and measurement system are described below.

(3) Current situation related to national standards, inspection and measurement systems

1) General outline of industrial standards

One of primary objectives of industrial standards is to promote exports of local products. The first step to secure reliability on the quality of Sri Lankan products in the export markets should be accomplished by preventing low quality products being exported to overseas. At the same time, it is important to support the improvement of technology and quality at a national level. To achieve these purposes, internationally acceptable specifications for materials and products must be established together with proper quality, performance, inspection method and safety standards. It should be kept in mind that it is not easy to recover the reliability once lost in export markets. It is very difficult to reverse the negative image as a country

exporting cheap products, once established. This means, once reputation is established as to quality, the country's products will be able to lead price negotiation.

Another objective of maintaining industrial standards is to promote import substitution, particularly materials and components used for industrial production. At present, poor quality of domestic products necessitates export industries and major manufacturers to rely on imported materials and components. Quality of local materials and components must be improved if they are to replace imports, and standardization constitutes the first and necessary step.

Further, safety and protection of consumers can only be achieved through warranty of product quality and performance, standardization of materials and components, and unification of industrial standards.

a) Current state of Sri Lankan Industrial Standards (SLS)

The history of industrial standards in Sri Lanka dates back to the Bureau of Ceylon Standards established in 1964. Its mission is to ensure sound development of the country's entire industry through the promotion of standardization in industries and commercial fields. The Bureau of Ceylon Standards was renamed to Sri Lanka Standards Institute in 1984, followed by series of expansion of business and power to this date.

The number of standards established by the end of 1993 totaled 1,000, including 28 to be revoked and replaced with new ones. The standards have simple serial numbers, as seen in BS, without classification symbols. "Sri Lanka Standards Yearbook" publishes general description of standards established annually. SLS sets forth basic terms and their definitions, units of measurement, measurement and testing methods, specifications for materials and products, and control systems related to performance and safety.

The currently available standards are directly associated with major export items such as textile products, food, construction, and electrical products, as well as consumer products and product safety. Many of them contain direct reference to various international standards, including ISO (160 standards), IEC (60), and BS (6). As a result, they are considered to be at international levels. Other standards cover the country's agricultural products, including tea and its package, coconut palm products, and spices.

SLS seems to have weakness in standards for processing of raw materials and parts. If SLS is to be adopted as national industrial standards, it should cover the entire process of manufacturing final products from raw materials to inspection

and testing, forming a systematized set of standards.

b) Quality Control

Ensuring the quality of products made in Sri Lanka is a major mission of SLSI mandated by the government, which can only be achieved when quality control systems are established by individual enterprises. SLSI's primary role is therefore to disseminate and promote quality control standards and practices to industries and to verify and certify product quality through official inspection and testing.

At present, international markets are increasingly demanding quality assurance for industrial products in the form of third party's certification on quality control systems of manufacturers, in addition to quality assurance on individual products. In 1988, SLSI introduced a scheme to certify quality control systems according to SLS 825/ISO 9000. It issued the first certificate on 15 December 1994, making Sri Lanka the 77th country to adopt ISO 9000. At present, the country has four companies which received ISO 9000 certification.

The need for quality assurance is also on the rise in the domestic market, as a result of growing demand for consumer products and increasing competition. The situation entails the increasing need for certification of quality control systems as an integral part of assured product quality. In fact, industries are increasingly recognizing the importance of the SLS label certification as the government and public organizations give priority in their procurement policy to products bearing the SLS quality mark.

At present, SLS covers almost all the industrial areas, including civil and architectural construction, electrical and electronics, agricultural products, marine products, ferrous and nonferrous metals, textile, mineral products, ceramics, paper and pulp, household products and chemicals. Nevertheless, its scope measured by the number of items is very limited.

In Sri Lanka, industrial standards are in principle established as voluntary standards that companies are free to adopt or neglect, except for some compulsory standards for the purpose of consumer protection (in the interest of safety, health and environment). In particular, export products are subject to 56 compulsory standards relating to safety and other aspects of food, electric appliances, fabric materials, construction materials, that require certification through SLSI inspection. Appendix 9 lists items subject to compulsory inspection.

c) Major issues related to standardization

The most important issue related to standardization is found in testing equipment owned by SLSI, the principal implementing body of this project. Despite its prestigious status as only one public organization authorized to perform testing, inspection, and quality control associated with exports and imports of industrial products and to develop and establish national standards, SLSI does not have equipment capable of meeting an anticipated increase in work load as well as increasingly higher accuracy levels of inspection and testing demanded by industries. In fact, most of testing and inspection equipment owned by SLSI is more than 10 years old – some have been purchased 20 years ago – and are deteriorated or outdated. There is also a lack of jigs and tools. As a result, some of tests conducted by SLSI lack reproducibility and reliability. For instance, SLSI performs make–and–break tests for electric appliances manually, which should be done mechanically.

Needless to say, the lack of reproducibility and repeatability may lead to loss of reliability in the test itself and the product covered by it. In particular, repeatability becomes critical in certification tests. While SLS contains a sufficient degree of reproducibility and repeatability as it refers to international standards in many parts, its requirements cannot be solely covered by testing skills, reinforcement and modernization of equipment are most urgent if SLSI is to enforce standards throughout the country.

2) Outline of export and import inspection

Sri Lanka has previously required SLSI, by law, to conduct compulsory inspections on specific export and import items in accordance with SLS. However, the shift of economic policy toward market economy adopted in July 1977 has lessened requirements for export inspection. In 1991, SLSI discontinued compulsory inspection on export products and has been conducting quality tests and issuing certificates upon the request of exporters, for the following reasons:

a) Export products are usually required to satisfy contract specifications of buyers and thus have to comply with standards in the importing country. Since buyers conduct acceptance inspection, no compulsory inspection is required.
b) It takes some time to issue the certificate of export inspection. (About 3 days.)

Generally the exporter is held responsible for quality of its products. As an exemption, SLSI is responsible for marine products to be exported from Sri Lanka, mainly shrimps, lobsters, crabs, shell, oysters, fish and squids, because SLSI urges companies processing these products to comply with hygienic standards set forth in SLS208 through registration of these processors.

Note that major exporters maintain their own quality control systems, whereas smaller exporters do not have inspection facilities and rely on outside laboratories including SLSI.

For import inspection, there are 56 compulsory standards, under which SLSI performs inspection and issues certificates. The import inspection is designed to serve the following purposes:

a) Protection of consumer safety and health, and the environment; and
b) Protection of domestic industries.

The import inspection covers a variety of products including food such as canned fish, dairy products, and edible oil, electric appliances and components, fabric materials such as cotton and yarn, steel materials including bars and shape steel, cement, asbestos and other construction materials. Many inspection items are related to protection of consumer safety and interest.

Major issues related to import inspection are as follows:

a) Due to the lack of testing equipment in terms of quantity and variety, safety and other aspects of new products cannot be inspected, prohibiting a further increase in inspection items.

b) Due to limited capabilities of existing equipment, inspection takes a relatively long period of time which results in long waiting time for the issuance of certificate.

In addition to import inspection, SLSI conducts voluntary inspection on raw materials and products for domestic use upon the request of governmental agencies as well as private enterprises, which bring additional revenues to SLSI.

3) Current situation of metrology and calibration

Accurate metrology and calibration of measuring instruments is indispensable for all the industries and should bring benefits to consumers.

Industrial products – whether a domestic or international market they serve – are required to have a certain level of quality that must be uniform among the products. In addition, final products must satisfy requirements in the areas of design, safety and ease of use, and other aspects. At present, Sri Lanka aims to develop components processing and assembly industries into export industries. These industries involve high precision processing and accurate assembly that can only be achieved by accurate measurement in addition to refinement of processing technology. Levels of measurement accuracy and processing techniques affect product yield. SLSI is capable of evaluating operating conditions of production equipment and processing accuracy at its metrology and calibration service arm, in addition to calibration of measuring instruments. Also, it can render measuring services for products manufactured. Other departments are capable of testing and inspecting raw materials and processed goods. If these resources are used properly, SLSI is in a good position to help modernization of industries and the improvement of product quality. In other words, the effective use of SLSI by industries serves as an effective tool to improve industrial levels in the country, ultimately leading to export promotion.

Assuring product quality must be supported by comprehensive standards for products, components and parts, and raw materials, together with standardization of their dimensions. Components having uniform quality achieved through proper quality control lead to a better yield of final products that have cost competitiveness. The market only accepts products and components with uniform quality and free of defect. Sufficient accuracy levels meeting quality requirements start from calibration of production equipment. At the same time, functional performance of products comes from design and production technologies owned by each company. Though SLSI is not able to involve in the design process, it can contributes to the improvement of quality and functional performance of individual companies by identifying problems inherent in design and manufacturing through product testing and evaluation of production equipment and by issuing advice. In particular, the industry without sufficient expertise and experience can learn a lot from proper advice of a third party organization for quality improvement. Thus, SLSI can contribute greatly to industrial development in many respects, resulting in export promotion and ultimately leading to consumer safety and benefit.

As widely known, measuring instruments have to be properly maintained through calibration using primary, secondary and quasi-secondary standards that are based on standards kept by International Weights and Measuring Bureau in Paris.

In Sri Lanka, Measurement Standards and Services Division (MSSD) under the Ministry of Trade, Commerce and Food maintains secondary standards as national

standards that are linked to International Weights and Measuring Bureau. SLSI, under the Ministry of Science, Technology and Human Resources Development provides measuring standards for the market through quasi-secondary standards copied from the secondary standards. Each factory brings its factory standards or working standards periodically (say, once a year) to SLSI for comparison and calibration against SLSI's quasi-secondary standards. These standards cover essential units for industrial use, including length, mass, pressure (force), volume, and temperature.

Nevertheless it is very troublesome and not practical to dismantle measuring instruments incorporated into production equipment and processing machinery. As offsite calibration service is not available, calibration of large measuring instruments and machinery (to maintain machining accuracy) is very difficult to conduct.

Another issue is the limited range of calibration. For instance, the range of certification and calibration is limited to 0.6m in length and 50kg in weight. It is important to expand the range as early as possible. Also, the lack of accuracy is observed in some instruments, including thickness gauge below 10cm (manufactured in the 1970s) that is aged or lacks accuracy, and the lack of a thermometric substance (a pure substance having a fixed melting point) that serves as the basis of temperature measurement.

Recently, government policy and advertisement on the need for industrialization have raised the interest in metrology and calibration among industries, and SLSI's calibration activity has become brisk accordingly. SLSI has been adding calibration equipment under its Corporate Plan, but demand for calibration service exceeding capability of existing equipment is on the rise. To meet demand in terms of quality and quantity, it is the time for SLSI to consider modernization of its facilities and equipment.

While SLSI's existing equipment is old and/or rudimentary, they are well maintained. The facility is located far from the sea and is not affected by sea breeze. Temperature is high, but the equipment to maintain constant temperature and humidity is installed where needed. As a result, SLSI has the ability to use and maintain new equipment.

In conclusion, SLSI is expected to meet demand from industries by reinforcing its resources in terms of quality, quantity and mobility, thereby to contribute to industrial development. But it lacks equipment to achieve the purpose.

The need for equipment modernization is also seen in the testing and inspection department to replace unreliable manual work with machinery, to improve accuracy levels, and to streamline testing procedures so as to produce test results that are acceptable to importing countries.

## 2.3 Project Description

### 2.3.1 Execution Agency and Operational Structure

(1) Execution Agency

The execution agency in this project is Sri Lanka Standards Institution.

(2) Operational Structure in SLSI

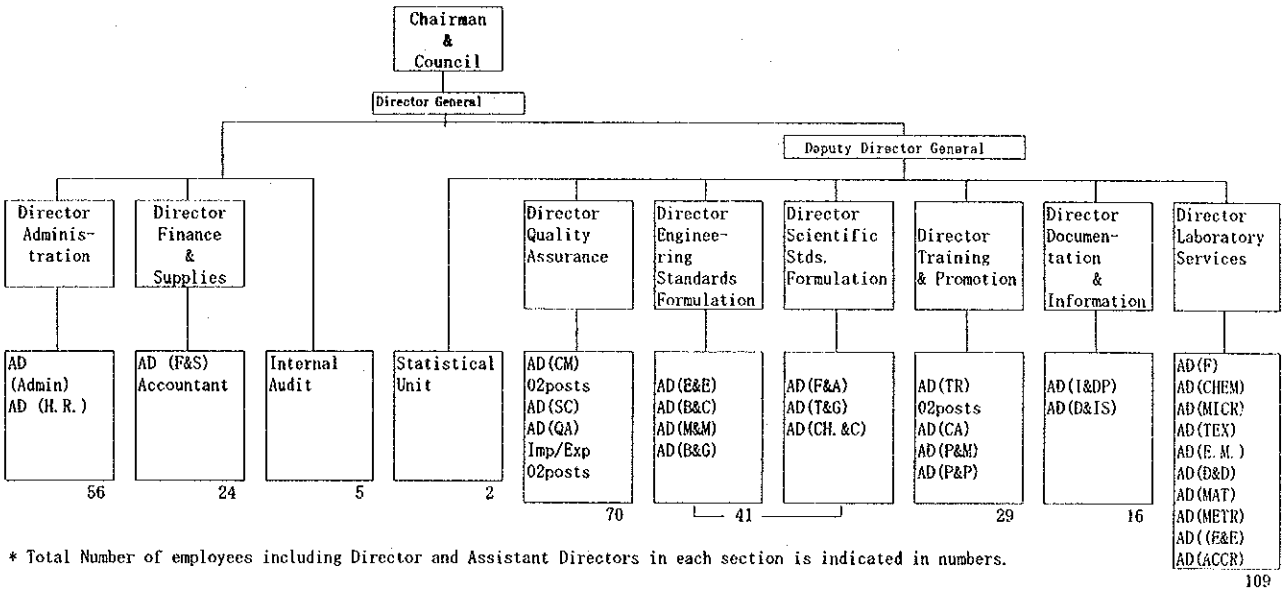
Fig.2.1 shows an organizational chart of SLSI and its staffing by department.

SLSI is controlled and managed by a council consisting of 12 members including a chairman and a vice chairman appointed by the minister concerned pursuant to The Sri Lanka Standards Institution Act. No.6 of 1984. Director General of SLSI, also the vice chairman of the committee, is responsible for operation and management of the institution.

At present SLSI has 354 staff. 101 persons (not including Director General and Deputy Director General) or 29% of the total, consisting of 30 with postgraduate degrees, 66 university graduates and 5 holding diplomas constitute the brain of the institution. They are engineers who have expertise on standardization, quality control or other areas of technology and who are able to provide technical guidance, advice and assistance for industries. There is no other research institute that has such competent talent.

Under Director General there are administration divisions including general affairs and accounting, and technical divisions supervised by Deputy Director General, including laboratory services requesting equipment for this project, documentation and information, training, promotion, engineering and non-engineering standards, quality assurance, as well as statistical unit.

Table 2.1 summarizes staffing by division and educational level.




* Total Number of employees including Director and Assistant Directors in each section is indicated in numbers.

**Fig. 2. 1 Organization Chart**

**Table 2. 1 Number of Staff by Section and Academic Career**

| | Adminis-tration Division | Technology Division | | | | | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| | | Laboatory Services | Documentation & Information | Training & Promotion | Scientific Standards Formulation | Quality Assurance | Standards Formulation | Sub-total | |
| Graduate School | 1 | 10 | 2 | 2 | 3 | 9 | 2 | 29 | 30 |
| University Graduate or Equivalent | 1 | 22 | 2 | 3 | 19 | 19 | - | 65 | 66 |
| Diploma | 4 | - | 1 | | - | - | - | 1 | 5 |
| Others | 79 | 77 | 11 | 23 | 19 | 42 | - | 172 | 251 |
| Total | 85 | 109 | 16 | 29 | 41 | 2 | 2 | 267 | 352 |

Source: SLSI

Remark: Chairman and Director General is not counted

### 2.3.2 Plan of Activity

Duties of each division, its activity and object are briefly described as follows.

(1) Laboratory Services

This division will receive direct benefits from the project if implemented.

The laboratory is responsible for all the services (including planning and coordination) related to testing and inspection of materials and products as well as metrology for the purpose of promoting standardization, a uniform metrology system and

quality control practice.

Laboratory Services Division plays a critical role in assisting formulation of national standards. It is also indispensable in activities related to standardization, the national metrology system and quality control. Furthermore, it provides testing, inspection, measurement, and inspection services for manufacturing and trading industries, thus contributing to product development and quality assurance.

The Laboratory Services Division consists of laboratories for material testing, electrical and electronic, food, chemical, microbe, textile, and metrology and calibration, and two workshops in mechanical and electrical/electronic fields. The laboratory performs testing and inspection of materials and products related to compulsory standards, as well as those related to voluntary standards at the request of public organizations and private enterprises.

Up to 1991, the laboratory performed testing and inspection of materials and products pursuant to compulsory standards, both for exports and imports. In 1991, however, compulsory inspection on export products was terminated and replaced with voluntary inspection, that was conducted at the request of exporters to check quality before export.

Annual revenues from export and import inspections total approximately 1.5 million rupees (approximately 3 million yen). While revenues from export inspection has been gradually decreased, those from import inspection have been on the rise. Coupled with revenues from testing services related to product development by private enterprises and other contract testing services, total revenues reached approximately 2 million rupees (approximately 4 million yen) in 1993. Revenues from SLS mark certification have also been on the rise and amounted to approximately 1.3 million rupees (approximately 2.6 million rupees) in 1993. Revenues from certification and calibration of measuring instruments have also been increasing and in 1994 reached around 350,000 rupees (700,000 yen). (According to SLSI, 281,000 rupees in 1992, 305,000 rupees in 1993, 356,000 rupees in 1994)

Table 2.2 shows revenues of the laboratory between 1898 and 1993.

**Table 2. 2 Income Balance of SLSI**

Unit: RS.1,000

| JOB | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|
| Pre-export Inspection | 1,204 | 2,038 | 1,232 | 774 | 126 |
| Import Inspection | 93 | 229 | 186 | 282 | 1,483 |
| Inspection on Commssion and Calibration Test | 801 | 1,261 | 1,689 | 1,506 | 2,262 |
| SLS Verification | 510 | 681 | 679 | 1,109 | 1,306 |
| Total | 2,608 | 4,209 | 3,786 | 3,671 | 5,177 |

Source:SLSI

In order to enhance testing and inspection capabilities of national laboratories, SLSI is currently developing plans to promote "National Laboratory Certification Project," under which laboratories having specific capabilities are accredited as public laboratories. As a result, manufacturing and trading industries will gain access to a large number of publicly recognized testing facilities. SLSI, as part of its Corporate Plan, intends to further expand measuring and calibration services for industries, in an attempt to nurture a good measuring practice in industrial and commercial circles and to make accurate metrology conducive to the improvement of reliability of Sri Lankan products in international trade .

(2) Documentation and Information Division

Documentation and Information Division handles all the businesses relating to information and publication. It is responsible for publication and marketing of standards and other books, and operation and management of SLSI's library.

The division provides and disseminates information mainly in the fields of standardization and quality control for public organizations, private enterprises and establishments, as well as general citizens and thus plays an important role in implementation and promotion of standardization and quality control efforts.

SLSI's library is the only one in Sri Lanka that has vast collection of standards in most of countries and international standards, not to mention Sri Lanka standards. It also has a large number of technical publications, literature, periodicals, and computer databases that are widely used by industrial and commercial circles. It plans to expand its services to focus on export industries in the near future.

(3) Training and Promotion Division

Training and Promotion Division provides education and guidance on the concept of quality control and standardization among industries. It is responsible for necessary services required to encourage adoption of and compliance with the systems. It also provides education and guidance for other economic circles and consumers.

The division plans training programs and holds seminars on standardization and quality control for industrial workers in order to teach them fundamental knowledge on production of quality products. The seminars offer various courses designed for different job ranks from top management to factory workers. Courses include human resources development, industrial metrology, statistical methods, quality control (ISO9000) and random sampling method. The outline of the training program on quality control is attached in Appendix 10.

SLSI has been conducting these courses during the past fifteen years, which have helped industrial circles to recognize the importance of standardization and quality control in their activities. It also provides technical consultation service in various fields including the installation of equipment and quality control circles. The activity will be continued with some refinement.

(4) Standards Formulation Division

At present, national standards are developed by Non-Engineering Standards Formulation Division and Engineering Standards Formulation Division. The two divisions handle all the services related to the development and establishment of national standards. The former primarily covers basic science and technology areas and the latter applied areas concerning industries, including engineering.

The division collects data from industrial and commercial enterprises as well as overseas, entrusts testing, prototyping and research contracts to laboratories, sort out the results and prepare basic data for standards to be developed, and assist the technical committee in technical aspect. It is also in charge of reviewing, adjustment and revision of old standards.

(5) Quality Division

The division is responsible for all the matters relating to certification of product quality, production process and method. It also provides services related to promotion of SLS adoption. In particular, it carries out export and import inspection and sampling, performs simple tests, and provides quality assurance after confirming compliance with SLS through detailed testing being assigned to laboratories as required.

It periodically visits factories under the "quality certification system," and inspects various records, and collects and analyzes samples. It encourages manufacturers to introduce quality control systems in order to have better production control.

The division also sends engineers of workshops to exporters and manufacturers for the improvement of process technology and guidance and education on compliance with SLS.

As for product quality assurance, it promotes the SLS mark certification system under which it certifies factories eligible for SLS mark in terms of production equipment and machinery, management method and/or product quality.

In an effort to introduce international quality control systems, SLSI adopted a quality control system certification scheme based on ISO 9000 in 1988, as discussed in "2.2. (3) 1) General outline of industrial standards." In December 1994, it certified the first round of qualified export industries as part of its efforts to boost international competitiveness. At the same time, it intends to introduce and promote nationwide quality control systems.

(6) Statistical Unit

Statistical Unit is responsible for all the undertakings required to ensure the effective use of statistical techniques in the standardization and quality control initiatives of industries and public organizations. For this purpose, it provides training and consulting services to diffuse the concept of statistical quality control to industries at large.

(7) Administration Division

Administration Division is divided into financial, general affairs, and audit sections. The financial section is responsible for financial management, the general affairs section handles personnel management, labor relations, and other administrative tasks, and the audit section conducts internal auditing of financial affairs.

### 2.3.3 Location and Conditions of Project Site

(1) Geographical conditions

Annual variations of temperature and relative humidity in Colombo are as follows:

**Table 2. 3 Annual Temperature and Humidity in Colombo**

| | | Temperature (℃) | | | Humidity (%) | |
|---|---|---|---|---|---|---|
| Year | Month | Max. | Min. | Average | Day time Ave. | Night time Ave. |
| 1993 | 11 | 30.5 | 23.9 | 27.2 | 79 | 93 |
| | 12 | 30.3 | 23.5 | 26.9 | 77 | 91 |
| 1994 | 1 | 30.8 | 23.2 | 27.0 | 72 | 87 |
| | 2 | 31.1 | 23.4 | 27.3 | 73 | 88 |
| | 3 | 31.7 | 24.5 | 28.1 | 71 | 87 |
| | 4 | 31.9 | 25.0 | 28.5 | 74 | 89 |
| | 5 | 31.3 | 25.8 | 28.6 | 80 | 88 |
| | 6 | 30.5 | 26.0 | 28.3 | 79 | 88 |
| | 7 | 30.4 | 25.6 | 28.0 | 78 | 87 |
| | 8 | 30.3 | 25.5 | 27.9 | 76 | 86 |
| | 9 | 30.2 | 24.7 | 27.5 | 78 | 89 |
| | 10 | 29.8 | 23.4 | 26.6 | 81 | 95 |
| | 11 | 30.3 | 23.4 | 26.9 | 78 | 94 |

(2) Current situation of social infrastructure

1) Site location

SLSI is located approximately 8km south-south-west of Port of Colombo, with the following address:

No.17, Victoria Place, Elvitigala Mawatha, Colombo -08, Sri Lanka

The project site has good transportation access. The new laboratory is in close proximity to Mawatha Street, an arterial road running north-south in the east side of Colombo, and is approximately 500m from the Narahenpita station. At the same time, it is 30m off Mawatha Street at the end of a small allay to protect the site from vibration produced by road traffic. With no factory or other facility producing vibration adjacent to the site, the laboratory is considered to be ideally located.

2) Facility outline

The new laboratory was planned to reinforce inspection and testing resources as well as operational structure of SLSI. Its construction was started in 1985 and completed at the end of 1992. Of laboratories previously located in five locations throughout Colombo, Material Testing Laboratory, Food and Chemicals Laboratory,

Metrology and Calibration Laboratory, Engineering Workshop, and Electrical and Electronic Workshop have moved to the new facility and have started their services. Textile Laboratory, Electrical and Electronic Laboratory, and Microbiology Laboratory will move to the facility by the end of March, 1995, as soon as interior finishing and instrumentation work, currently under way, is completed.

General layout of laboratories in the building is as follows.

(a) Total floor area of the laboratory building: 2,370m2 (3-story)

1st floor - Administrative division, office of the Director of Laboratory Services Division, Material Testing Laboratory, Metrology and Calibration Laboratory (already in operation, environmental control is under way: 23℃ and 60-65% R.H.), Textile Laboratory (preparation work for air-conditioning and utilities has been completed), workshops, and warehouse

2nd floor - Food and Chemicals Laboratory, Microbiology Laboratory (utilities work, except for sinks and stacks, has been completed), meeting rooms, and library

3rd floor - Electrical and Electronic Laboratory (basic building equipment work including lighting, electrical wiring and piping has been completed), and Electrical and Electronic Workshop

Roof: Water tank, lift motor room

(b) Power supply

Three phase: 400V ± 6%
Single phase: 230V ± 6%
Frequency: 50Hz ± 1%

Power outage is rare throughout the year, and daily voltage fluctuation is ± 6%, so that no automatic voltage regulator will be required excepting special testing equipment. Sri Lanka is highly dependent upon hydropower which supply is largely affected by weather conditions, and in particular, has to compete with irrigation water during dry season. In fact, cutbacks in power supply during the season is warned due to the shortage of water supply, although no cutback has

been made in the past three years.

(c)Power consumption at each laboratory (daily average)

Food and Chemicals Laboratory, Material Testing Laboratory, Metrology and Calibration Laboratory: 625kWh

Electrical and Electronic Laboratory: 138kWh
Textile Laboratory: 47kWh
Microbiology Laboratory: 49kWh

(d) Water supply

Water used by testing equipment is supplied by water supply corporation.

(e) Gas supply

Oxygen, nitrogen, carbon dioxide, and other gases used for testing operations at the laboratory facility are all locally available.

### 2.3.4 Outline of Facility and Equipment

(1) Material Testing Laboratory

Material Testing Laboratory is at the south end of first floor of the new building. Testing equipment currently owned by the laboratory includes a drying oven, an analytical balance, a hardness tester, a metallographical microscope, a compression test equipment, and a constant temperature and humidity tank. Among them, large equipment such as a universal testing machine and a universal impact machine is more than 20 years old and is still in operation. Generally, equipment is well maintained. Most frequently requested testing and inspection items at the laboratory are "strength test for helmets," "strength tests for cement, mortar, and aggregate," and "strength test for pipe joints." Note that the strength test for helmets is conducted by using an impact machine or similar due to the lack of appropriate equipment. The impact test can affect operation of Metrology and Calibration Laboratory, which does not generate continuous vibration and is currently avoided by prior notification.

(2) Electrical and Electronic Laboratory

Due to low ownership of household appliances in the country, there is not much testing and inspection requested to the laboratory, both domestic and imported products. In Sri Lanka, there are slightly more than ten domestic manufacturers who exports products such as decorative light bulb sets for Christmas and miniature light bulbs, but variety and quantity are limited. For imported products, only 15 tests are conducted annually at the laboratory. Products subject to compulsory certification are cables, wiring fixture, and some household appliances. In addition to compulsory standards, there are safety standards for household appliances and standards for electronic components.

The laboratory will be accommodated within the building and partitioning work was under way as of December 1994. It is scheduled to move in by March 1995. The laboratory is primarily responsible for quality inspection on both domestic and imported products under compulsory standards. It owns a set of testing equipment for electrical cables, switches, plugs, outlets, sockets, tungsten-filament lamps, and electrical cooking stoves, which lack variety and do not include sophisticated equipment. In fact, due to the shortage of adequate equipment, jigs and tools, tests are conducted in a manner that does not warrant reproducibility, e.g., repetitive switching tests that should be done mechanically are conducted manually, and the constant temperature tank is substituted for by a plastic bucket and hot water from a kettle.

The new laboratory has a sufficient space to accommodate requested equipment. To ensure tests with reproducibility, provision of adequate jigs and tools, measuring instruments, and machine bases is essential. On the other hand, existing measuring instruments are maintained in good condition. Supply of sufficient testing equipment to SLSI is the first step of promoting the electrical and electronics industry in the country.

(3) Food and Chemicals Laboratory

Major objectives of Food and Chemicals Laboratory are (1) to check safety of imported and locally produced foodstuff for the purpose of protecting domestic consumers, (2) to assure quality and safety of exported food so as to improve confidence in the international market, (3) to assist domestic food manufacturers in improving their product quality. Food is subject to compulsory standards in many respects due to the fact that it directly affects consumers and their health, resulting in strong demand for food testing. Principal inspection items at the laboratory are residual agricultural chemical, heavy metal, additives, preservatives, antiseptics, as well as decomposition of food. At present, 23 items of food are subject to compulsory testing.

Major testing equipment currently owned by the laboratory is an atomic absorption spectrophotometer, a spectrophotometer, a centrifugal separator, a viscosity meter, a distillation unit, a titration apparatus, a melting-point apparatus, and a fat extractor. Similar to other laboratories, most equipment at the laboratory is ten years or older after procurement. They are relatively well maintained. Nevertheless, it is apparent that existing equipment is not capable of analyzing increasingly diverse food that is highly processed or is not able to assure required accuracy levels of analysis.

The laboratory is located on the second floor, north side of the building. It is simply decorated and uses self-made wood furniture including draft chambers, balance tables, and stocks, which generally function well.

(4) Microbiology Laboratory

The laboratory is currently located in a building in Colombo (the same building accommodating Textile Laboratory) as of December 1994. The present facility is not suitable for laboratory purposes in terms of shading, dust-proofing, and drainage, and is scheduled to move to the new laboratory building by the end of March 1995. Existing equipment includes a centrifuge, an electronic balance, microscopes, pH meters, refrigerators, ovens, constant temperature and humidity chamber, sterlizers, small distillation unit, anaerobic chambers, and glasses. Approximately 70% of the total are 10 years or older after installation. They are all well maintained and can be used for additional five years if properly maintained. Major testing and inspection items are classification and reproduction of microorganisms and bacteria. It also performs testing and inspection to check bacteria contamination of agricultural and marine products imported or exported.

At the new facility, the laboratory will be accommodated in 3 rooms on the second floor facing south. At present, interior work has been completed except for sinks, lighting fixture, and equipment bases. Floor is water-proofed. The floor area is more than twice that used at present and thus can accommodate new equipment with ease.

(5) Textile Laboratory

At present, the laboratory is accommodated in the same building with Electrical and Electronic Laboratory as of December 1994. The laboratory is filled with a variety of fabric and yarn testers, including a fabric thickness tester, a weatherometer, a color matching tester, a weathering tester, a bursting strength tester, a tensile strength tester, a yarn twist tester, a yarn strength tester, a yarn elongation tester, and microscopes, scales

and other devices, amounting to more than 30 units. Most of them were made in the 1980s, and some of them are 20 years old. They are well maintained excepting some that show performance degradation and 3 units that are inoperable.

The laboratory is staffed by 4 engineers and 7 technicians and is capable of conducting a variety of tests and inspections by using the above equipment. Note that the assistant director of the textile laboratory also serves as Acting Director of Laboratory Services Division. Between January 1 and the end of November 1994, the laboratory conducted 211 tests (358 items) at the request of outside organizations.

(6) Metrology and Calibration Laboratory

National metrological standards are controlled by MSSD under the Ministry of Internal and External Trade, Commerce, and Food. SLSI is responsible for actual services for users (factories and other industrial facilities).

SLSI's metrological service that is an integral element of industrial development has been helping improve technical levels of domestic industries. At the same time, demand for SLSI's service has grown rapidly. As a result, SLSI fails to provide quality service in terms of equipment size and calibration accuracy and cannot meet demand in a quantitative term. This is due to the fact that SLSI cannot provide flexible service including field calibration to improve accuracy of industrial machinery, in addition to metrological service at the laboratory.

SLSI's dissemination of accurate metrological standards based on secondary standards maintained by MSSD is well established and coordinated and is accepted widely. SLSI has quasi-secondary standards for length, mass, force (pressure), angle, and temperature, and provides service for industries within its capacity and resources. Now, as mentioned above, it is expected to improve its service quality and capacity, including the ability to provide flexible service including on-spot calibration.

Existing equipment, although its capacity is less than sufficient, is well maintained. In particular, metrology standards are kept in fairly good conditions with consideration to dust-proofing as well as dump-proofing. Thus, the laboratory is capable of using new equipment to be supplied under the project for the purpose of industrial development.

(7) Engineering Workshop

Engineering Workshop has already moved to an allocated space on the first floor of the new laboratory building, and machine tools have been installed. It is equipped with

a lathe, a milling machine, a sawing machine, a drilling machine, an air compressor, and a welding machine, accompanied by a small woodworking shop at a corner. All of the equipment is more than 10 years old, and half of them were purchased 20 years ago. They are kept in good working condition, except for the lathe that is inoperable.

The workshop is primarily responsible for preparing test specimen, assembling testing devices, repairing general machinery and tools, and maintaining air-conditioners.

The workshop is staffed by one engineer and seven mechanics.

While the request for the project covers only Engineering Workshop, the laboratory has Electrical and Electronic Workshop that has moved to the third floor of the new building. With one engineer and two technicians, the workshop provides a variety of services for SLSI as a whole, including repairing service, prototyping and the improvement of metrology methods.

Existing equipment in each laboratory is listed in Appendix 7.

### 2.3.5 Operation and Maintenance Plan

(1) Existing equipment and operation and maintenance

Most of equipment owned by SLSI's laboratory is 15 – 20 years old and has been fully depreciated in terms of book value. Despite of age, 80% of equipment are operated, except for those that are unable to meet industrial demand and are stored in a warehouse, and unserviceable ones. This clearly shows high levels of concern about maintenance at SLSI. In fact, equipment at every laboratory is well maintained.

Each laboratory is headed by a Assistant Director and staffed by 2 – 4 engineers and 7 – 12 technicians who perform daily inspection and minor repairing of equipment. The Assistant Director of each laboratory is responsible for operation and maintenance of its equipment. For any equipment failure which is beyond the ability of the laboratory, the Assistant Director submits a request to Director of Laboratory Services Division who instructs either workshop to perform repair. Major repair is carried out by an outside contractor.

Table 2.5 shows equipment repair budget and expenditure trends between 1989 and 1993.

**Table 2. 4 Budget and Results for Repairing Equipment**

| | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|
| Budget | 300 | 500 | 500 | 500 | 900 |
| Results | 323 | 460 | 485 | 857 | 971 |

Source:SLSI

The equipment repair cost has been on the rise each year due to the increase in equipment and deterioration due to aging, totaling 1 million rupees (approximately 2 million yen) in 1993. It is funded by government subsidy, and budget and actual outlay are kept in balance.

Table 2.5 shows current operating expenditures of SLSI as a whole between 1989 and 1993.

**Table 2. 5 Current Operating Expenditures of SLSI**

Unit:Rs.1,000

| **Expenditure** | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|
| Manpower | 14,838 | 14,925 | 16,004 | 16,898 | 20,396 |
| Equipment Maintenance | 1,139 | 1,559 | 2,215 | 2,382 | 2,994 |
| Utility | 1,002 | 981 | 1,145 | 1,174 | 1,757 |
| Consumables | 1,563 | 1,355 | 1,765 | 1,819 | 1,797 |
| Miscellaneous | 9,370 | 12,767 | 13,787 | 18,843 | 21,492 |
| Subtotal | 27,912 | 31,587 | 34,916 | 41,116 | 48,386 |
| **Income** | | | | | |
| Governmental Subsidy | 21,600 | 31,400 | 28,300 | 35,000 | 38,600 |
| Own Income | 4,886 | 8,230 | 10,941 | 10,915 | 14,175 |
| Subtotal | 26,486 | 39,630 | 39,241 | 45,915 | 52,775 |
| **Equipment Procurement** | 4,296 | 2,517 | 2,075 | 10,546 | 5,190 |

Source:SLSI

As seen in the above table, labor cost increased by approximately 40% over the past five years, while the equipment maintenance cost including that for newly purchased equipment grew 2.6 times during the same period. On the other hand, government subsidy increased 80% while own revenues grew 2.9 times due to expansion of its project.

Overall, revenues and expenditures have been well balanced.

For reference, the equipment acquisition cost that forms a part of capital expenditures is shown on the bottom line. The annual average equipment purchase cost is around 5 million rupees (10 million yen).

# CHAPTER 3 BASIC DESIGN

# Chapter 3 Basic Design

## 3.1 Design Policy

Sri Lanka has been making efforts for export promotion and quality improvement of industrial products as part of the government's economic structural adjustment policy. To achieve the objective, the development of infrastructure for quality improvement, including an industrial standardization scheme, export certification and import inspection systems, and a nationwide metrology system, is an urgent task and important from the interest of consumer protection. However, SLSI, due to deterioration and obsoleteness of existing equipment, is facing difficulty in meeting increasing demand for the institution as well as improving accuracy levels of testing and inspection demanded by the industry.

The major objective of the project is to replenish and reinforce SLSI's equipment for testing and inspection, metrology and calibration, and other purposes. Equipment requested by the Sri Lankan counterpart can be classified into (1) equipment required for compulsory testing of imported and domestic products, (2) equipment used for testing and inspection that is strongly demanded by industries, (3) equipment required to meet increasing work load, and (4) equipment to replace existing equipment that has been deteriorated or has become obsolete. Thus, the request is generally in line with the objective of the project.

On the other hand, some of existing equipment are serviceable for a significant period of time. To identify equipment that is suitable for the intent of the project, namely whether it serves the interest of (1) consumer protection, (2) industrial development, or (3) export promotion, each equipment on the request list has been evaluated according to the following criteria:

a) Equipment required for inspection under compulsory standards
b) Equipment required to perform highly demanded tests with high levels of accuracy that cannot be met by existing equipment
c) Equipment that is deteriorated or outdated significantly and requires replacement or upgrading
d) Equipment essential in complying with established industrial standards and/or quality standards

The result of evaluation indicates that the request generally conform to the intent of the grant aid project of Japan. Now, the project is assumed to be implemented under grant aid of the Japanese government, and basic design is conducted hereunder.

## 3.2 Study and Examination on Design Criteria

The list of equipment requested by SLSI is attached as Appendix 8. As shown in Table 1.1 "Number of Items and Major Equipment Requested, by Laboratory," a total of 132 items is requested. These equipment will be used for compulsory and voluntary inspections on imported and domestic products, the upgrading of existing deteriorated equipment, the expanded service, and the new procurement. Based on comparison with testing laboratories and similar facilities responsible for establishing national standards in industrialized countries, and with reference to SLSI's future plans, the request seems to be reasonable and justifiable.

It should be noted, however, that overall evaluation of the current status of SLSI and its foreseeable future, together with a general outlook for industries in Sri Lanka and the feasibility to secure necessary manpower for SLSI, indicates that the requested equipment can be divided into those that are required urgently and those which procurement can be extended until feasibility becomes clear in the future.

The need for requested equipment is evaluated for each laboratory as follow.

(1) Material Testing Laboratory

13 items in total are requested by Material Testing Laboratory.

The helmet testing equipment is designed to measure strength of motorcycle helmets and consists of testing devices for shock absorption, penetration resistance, oblique impact, chin guard strength, and strength of retention. This is the equipment for testing and inspection required under compulsory standards, which is not owned by any research institute in the country. Previously, an impact tester has been used as a surrogate to measure impact strength only, leaving items required for measurement of helmet strength intact to result in incomplete testing. Thus, it is reasonable to obtain the equipment.

Securing sufficient concrete strength is essential in protecting personal life from the collapse of buildings due to shearing or fatigue destruction of reinforcing bars or steel frames, and is currently included in compulsory inspection items. At present, the compression tester is used in place of concrete testing equipment, but it cannot cover all the inspection items required in applicable standards. Thus it is acceptable to include cement/concrete testing equipment in the project.

The mini-lathe machine is required to prepare test specimen for tensile and impact tests on metallic materials. In particular, the strength test for reinforcing bars and steel pipes for construction purposes is subject to compulsory testing, which heightens the need for the micro-lathe machine.

The profile projector is essential in checking the accuracy of finishing of tools and metalworking materials, especially scalpels and ball points. In particular, local ball-point pen manufacturers attempt to improve quality in order to obtain the SLS certification. Given strong demand from industries, priority should be given to the purchase of the profile projector.

On the other hand, plastic/rubber testing equipment, also used for compulsory inspection on local products, can be substituted for by existing equipment that can produce sufficient test results, thus the degree of urgency is relatively low. Similarly, the paper / packaging material test equipment, the mini-load hardness tester, the distill water plant, the metallographic equipment, the equipment for viscosity measurement are rarely demanded and thus do not indicate a high degree of urgency. Finally, the reference hardness blocks and NDT equipment are highly demanded, but existing equipment can be used for the time being.

(2) Electrical and Electronic Laboratory

The laboratory is requesting 30 items of equipment, most of which are related to consumer protection against electricity and performance testing of electrical equipment and components.

The continuously variable DC power supply is used for load tests on switches. The voltage stabilizer is used to check service life of light bulbs and is capable of supplying constant voltage on a continuous basis. Testing of switches and light bulbs is compulsory for both imported and local products and is highly demanded. SLSI does not have the continuously variable DC power supply and the existing stabilizer was procured in 1973 and shows performance degradation. Besides, voltage fluctuation of commercial power supply in Sri Lanka reaches 10% at maximum, while power supply for testing purposes must provides the range of voltage fluctuation within $\pm 0.5\%$. Thus, both of them show a reasonable level of urgency.

The plugs and socket outlets testing equipment is used for checking standard plugs and sockets for household use and consists of many testing devices that can be used for the durability test against make-and-break operation, the temperature test, the pull force test required for make-and-break operation, and the drop test. Plugs and sockets are electrical components that are subject to compulsory testing, regardless of whether imported or local products, due to compatibility requirements. SLSI does not have the plugs and socket outlets testing equipment, and its procurement is highly needed to meet increasing demand and to protect consumer safety and interest.

The shutter endurance testing machine for socket outlets performs repeat switch-

on and off tests by using a reciprocal movement mechanism to insert and pull out a plug into a socket. Since the testing method is done worldwide and is based on compulsory standards, the request for the equipment is reasonable.

The inductive load for switch testing is used to perform make-and-break endurance tests for standard switches. Similarly, the resistive load is used for durability testing of switches and outlets. The two are sometimes used in combination. Both the tests are required under compulsory standards. On the other hand, the endurance test machine for switches has a reciprocal movement mechanism similar to that of the shutter endurance testing machine for socket outlets, capable of testing durability of a switch by repeating on-off operation. The test is compulsory to require the equipment. Note that the two tests can be performed by sharing the same reciprocal movement mechanism.

The tracking test apparatus is designed to check the ease of formation of a carbonized tracking path due to moisture attached to the surface of an insulator. The carbonized tracking path caused by micro-current flowing through moisture attached to the surface often causes fire. The test intends to prevent the phenomenon and thus is designated as a compulsory testing item for consumer protection. On the other hand, the glow wire test apparatus is used to check ignitability and flammability of an insulating material and housing of electrical equipment. The flexing machine for cables evaluates flexibility of cords and cables by checking poor insulation of sheathing or line breakage. Both of them are compulsory tests.

Test fingers and pins are used to check the risk of electric shock when a hand, a pin held by a hand, or a decorative chain contacts a live part of electrical equipment. The test is compulsory.

The multi-channel temperature recorder is a widely used temperature recorder that records output voltage from 12 thermocouples (representing temperature). On the other hand, the digital thermometer indicates electromotive force of multiple thermocouples upon request. The chart recorders are capable of recording voltage and current for long hours and are used to test durability of tungsten lamps. Three of them are basic instruments, and in particular, the multi-channel temperature recorder is important for improvement of testing efficiency.

The torque tester checks tightening strength of terminal screws for electrical products and wiring accessories. The impact test apparatus checks impact strength of socket outlet housing by using a pendulum impact tester. The push pull gauge is used to check that electrical wires do not contact a live part or a moving part of electrical equipment by mechanically pushing and pulling the wires. All of them are used for compulsory tests. The earth leakage circuit break tester measures leak characteristics of earth leakage breakers (leak current and acting time) , a test required for securing

consumer safety.

The integrating photometer and standard lamps for testing fluorescent lamps is a large apparatus measuring total luminescence from fluorescent lamps for evaluation of luminescence performance. However, there is not much demand for the equipment and the test itself does not affect consumer safety, so that there is no urgency to obtain it.

The climatic chamber is used for cold tests, high temperature operation tests for electrical equipment (70℃ for equipment, 170℃ for components), and humid resistance tests (−20～30℃, 95% R.H.). There is no need for cold test in Sri Lanka, while other two tests can be substituted for by existing equipment. Thus priority for the chamber is very low. Similarly, functions of the earth resistance measuring equipment and the X−Y chart recorder (flat bed type) can be performed by SLSI's existing equipment. Finally, the charger and DC constant voltage/current power supply can be substituted for by existing DC power units (6V and 10V).

At present, there is little need for the spray test apparatus that can be replaced by a shower set. It may have to be considered when certification tests for outdoor equipment are conducted on a regular basis. The same situation applies to the splash test apparatus. There is little need for the vertical rain test apparatus that is used to test drip−proof electrical equipment.

TV/radio frequency interference measuring equipment requires advanced techniques to handle, and there is few demand for such test. If electrical equipment requiring the test is to be imported, the government should require its importer to submit a test certificate issued at the country of origin. The need may be reconsidered when the test is conducted regularly. The needle flame test apparatus is designed to simulate combustion of components of household appliances, and its purchase should be reconsidered when certification tests for household appliances become full−fledged. Finally, the hot mandrel test apparatus can be substituted for by with the glow wire test apparatus that will be procured if the project is implemented and is capable of conducting ignitability tests for insulating materials and housing of electrical products.

(3) Food and Chemicals Laboratory

9 items are requested by the laboratory.

Major objectives of Food and Chemicals Laboratory are (1) to check safety of imported and local foodstuff to protect consumers, (2) to assure quality and safety of exported food so as to improve confidence in the international market, (3) to assist domestic food manufacturers in improving their product quality. Food is subject to compulsory standards in many respects due to the fact that it directly affects consumer

health, and there is strong demand for food testing.

The atomic absorption spectrophotometer, the capillary gas chromatograph, the carbon/sulfur analyzer, the IR spectrophotometer, the ionizer, and the flame photometer should be given high priority in terms of need and urgency. These equipment is essential in analyzing residual agricultural chemicals, heavy metals, additives, and preservatives contained in food, which are subject to compulsory testing. The laboratory has an atomic absorption spectrophotometer and an IR spectrophotometer that are outdated and need to be upgraded for accurate analysis.

The analytical balance and microwave oven are used in preparation work for testing and inspection and are frequently used. However, existing equipment can meet requirements. The polarograph is seldom used at present since the atomic absorption spectrophotometer and the IR spectrophotometer can provide the same functions.

(4) Microbiology Laboratory

18 items are requested by Microbiology Laboratory.

The major objective of the laboratory is to help maintain public health through testing and inspection services focusing on classification and reproduction of microorganisms and bacteria. It also performs testing and inspection to check bacteria contamination of agricultural and marine products imported or exported. In this sense, this is a unique facility that functions as a public health office and a quarantine. Equipment requested by the laboratory is intended (a) to maintain present testing and inspection services, (b) to meet increasing demand for inspection, and (c) to streamline testing and inspection services. These objectives are basically in line with the intent of the project. Among equipment requested, the refrigerator/freezer, the bench top centrifuge, and the pipette plugging machine need to be upgraded because the present inspection method and equipment cannot attain required accuracy levels, although demand for these equipment is low. On the other hand, the bench top pipette deplugging unit will not be included in the final list, because it can be replaced with the pipette plugging machine, and there is small demand for it.

(5) Textile Laboratory

The laboratory requests 18 items, all of which will be newly introduced. Some of them are needed to meet recent demand for testing and inspection services in the textile industry, while others do not have much demand. Also, some are not suitable for the textile industry focusing on knitting.

From the viewpoint of consumer protection, 4 types of flammability testers are strongly demanded. 3 types are designed to test flammability of textile products that are held vertically, horizontally or at 45 degrees. Another flammability tests inflammability of textile products placed on floor, such as carpet, by dropping fire, supposedly a cigarette. They are much needed with urgency for the interest of consumer protection.

Tests frequently requested by government agencies include air permeability of uniforms and water repellence tests for raincoats after water-proofing. Thus, equipment to perform these tests makes sense. Also, the seam slippage tester is needed frequently because of high demand for testing the slippage of seams due to pulling or rubbing.

There is an increasing need for checking variation of raw yarn sizes. Cotton yarns are imported and subject to compulsory inspection. However, yarn evenness is not checked due to the lack of the tester. Thus, the request for the yarn evenness tester is reasonable.

Growth of the apparel industry increases color matching demand for textile products. Color matching for dyed goods has been a very difficult job to do. Today, computers allow designers to obtain blending proportions of dyes and other relevant information easily. Introduction of the latest equipment symbolizing the age of technological innovation to the public organization promoting standardization is desirable from the viewpoint of improvement of technical levels, thus the purchase of the microprocessor controlled color matching/measuring system suits the purpose.

The Elemendorf tear resistance tester is used to check tear resistance of cloth with a break. However, the laboratory already has a tensile strength tester and a bursting strength tester that can substitute for the Elemendorf tear resistance tester and provide relevant data. For this reason, the purchase of the tester is not recommended.

The fibrograph is used to check length of fabrics of short-fiber cotton used for textile blend, while the trash analyzer detects cotton seeds and shells contained in raw cotton. However, the textile industry in Sri Lanka mostly imports cloth and sewing yarns for knitting and do not handle raw cotton. Similarly, the pilot knitting machine, which is used to knit yarns and compare them with standard yarns to check unevenness of raw yarn dyeing, does not much demand for the same reason eliminating the need for the fibrograph.

The viscometer is used to measure viscosity of raw materials for synthetic fibers, dyeing agents, and sizing agents. It is rarely used by the knitting industry. Also, there is little need or urgency for the other requested equipment and, the microtome used to prepare test specimen for microscopic inspection of raw yarns, and similar equipment.

(6) Metrology and Calibration Laboratory

1) Equipment for dimensional and shape measurement and calibration

The 3-D coordinate measuring machine is used to measure dimensions of parts and prototypes as well as three-dimensional shapes, and identify and measure slits, surface damages, and external appearance of welding beads. On the other hand, the horizontal universal length measuring machine is requested to measure and record finishing accuracy of products. It performs two-dimensional measurement and is thus intrinsically different from the former. Similarly, although the surface texture measuring equipment is classified as the equipment to check finishing accuracy, it is specialized in measuring flatness of metal and plastics as well as accuracy of machinery, thus basically different from the above two. In fact, all of them are indispensable for quality control and standardization of products.

The automatic gauge block calibrating system measures the degree of wearing and error in gauge blocks that are standards for measurement of length and thickness. Gauge blocks are frequently used in many industries because of the ease of use, and a significant error in measurement accuracy adversely affects products. Thus, the calibrating system is much needed.

As for equipment to measure dimensions and finish levels of industrial products, ceramic gauge blocks, an autocollimator, a laser interferometer, and a precision bench center are requested. Ceramic gauge blocks have high wearing resistance and are essential equipment for calibration and inspection. Nevertheless, metal gauge blocks are still serviceable and do not require replacement with ceramic ones for the time being. The autocollimator is a precision measurement device covering smoothness, angle and other attributes. The laser interferometer measures length, displacement, smoothness, angle and other features by using interference of light. They can be substituted for by the horizontal universal length measuring machine and the surface texture measuring equipment. The precision bench center is usually used in combination with the 3-D coordinate measuring machine or the surface texture measuring equipment. However, these equipment generally comes with a precision work bench as one of standard features, and there is no need for an additional precision bench center.

2) Equipment for pressure and force measurement and calibration

The proving rings are standards related to force to measure loads

(compressive and tensile) and basic calibration equipment to secure accuracy of industrial meters and gauges as well as testing equipment such as compression and tensile testers.

The direct indicating standards test gauges (pressure) and dead-weight pressure gauge tester are pressure measuring instruments of hydraulic and fluid types, respectively. There is not much demand for these equipment and tests using them. On the other hand, procurement of the load cell system will expand the scope of calibration related to compressive and tensile loads, but current demand can be sufficiently met by existing equipment. The dead-weight/lever force calibrating machine is a large capacity dynamometer but can be replaced with the set of proving rings.

The variable AC/DC power supply is requested to supply power to the load cell system. Given the lack of need for the systems, there is no reason to obtain the power supply.

3) Equipment for temperature measurement and calibration

The fixed point temperature calibration system is indispensable for calibration of heat related industrial equipment such as heat sources and temperature sensors. The system uses a substance with stability and reproducibility to obtain reference temperature, against which equipment and devices are calibrated. On the other hand, the four terminal resistance bridge is designed to measure resistance of a platinum resistance element precisely. It uses temperature and resistance curves of the platinum resistance element to measure the range that cannot be covered by the fixed point temperature calibration system. For temperature calibration, the reference equipment and the calibrated equipment should be set under the identical temperature environment (conditions), which is accomplished by using the portable dry bath for calibration. Thus, temperature calibration requires a fixed point temperature calibration system, a four terminal resistance bridge, and a portable dry bath for calibration as a set.

The deep freezer is primarily used to keep temperature sensors including platinum resistance elements, but actual demand seems to be very limited. The temperature and humidity recorder, the 8 channel temperature recorder, and the X-Y plotter are used for temperature measurement and recording, rather than calibration of instruments. The thermometers and temperature recorders are currently available. Finally, demand for the precision multimeter and the platinum resistance elements (PRT 100) can be met by existing equipment.

4) Equipment for mass measurement and calibration

The mass comparator and the high accuracy analytical balance are essential reference equipment for measurement and calibration of mass. The former is a comparison calibrator using reference weights and has a wide range of applications. Reference weights are widely used in various markets and industries and are essential in ensuring fair commercial trade. Thus, the mass comparator used to calibrate the reference weights is important to help maintain sound commercial trade. On the other hand, the high accuracy analytical balance is required for precision measurement including small weights and is thus frequently used. The slotted weight is the standard weight and plays a very important role. However, the existing weight is still serviceable and it is too early to replace it at present.

5) Equipment for measurement and calibration of volume, flow rate, specific gravity and viscosity of fluid

There is not much demand for testing fluid using the general purpose reference hydrometer set, the reference hydrometer set, the specific gravity balance, the volume calibration test equipment, and the set of reference alcohol meters, thus no priority is given. Similarly, the drying oven, which is requested for drying glass containers, is essential equipment related to fluid, thus much demand cannot be expected.

6) Engineering certification equipment

The tachometer calibrator is designed to calibrate a rotator with reference to synchronization with a stroboscope. The torque wrench calibrator is used to calibrate clamping capacity of torque wrenches. Neither of them need to be purchased urgently. In particular, the torque wrench calibrator with 0 – 1,000 N is too large and will not be needed for a while.

7) Other equipment

The air-conditioned vehicle for mobile calibration is intended for visiting certification and calibration services. Many instruments and measuring equipment incorporated into factory lines are difficult to be removed or moved. If they are to be

brought into SLSI for calibration, the production line has to be suspended. The situation discourages factories to inspect and certify their instruments although many of them feel the need. To meet such potential demand, field certification and calibration services are called for.

The laboratory requests portable microcomputer that are required for streamlining of data calculation, assortment, and analysis in the certification and calibration process, thus they will be used frequently.

The standard Rockwell hardness tester will not be used frequently and are already owned by Material Testing Laboratory.

The stabilized power supply is requested for general purpose. However, the existing power supply is still serviceable and there is no need for a reserve unit in light of electricity supply in the country and low demand for the stabilized power source.

(7) Workshop

Engineering Workshop requests 3 items, a lathe machine, a metal sheet working machine, and a shaping machine.

The lathe is the basic metalworking equipment. The lathe owned by the workshop is aged and unserviceable. The workshop requests a small numerical control (NC) lathe that is sufficient to replace the old one.

The workshop manufactures a variety of prototypes, test specimen, components and jigs for testing and inspection, and assembles small equipment. These activities frequently involve machining of thin metal plates. The metal sheet working machine requested by the workshop is of multi-functional type capable of performing a variety of machining operations, and thus is suitable for the purpose of the project.

The shaping machine is used to cut flat surface and grooves on a small workpiece and is one of basic metalworking equipment. The workshop does not have the one and uses a milling machine for flat work. However, it takes long hours and the workshop is unable to meet increasing demand for metalworking due to the increase in the number of testing and inspection services conducted by SLSI. The purchase of a shaping machine will reduce work time considerably and thus overall time for testing and inspection at SLSI, thereby to meet demand by industries.

(8) General

Computer systems and standard reference materials are requested as general

equipment. The former can be effectively used for preparation of reports and data analysis, and thus will be most frequently used among other equipment and show cost effectiveness. The latter is highly needed and many of them are not locally available. Although they are consumable, they should be included in the list of urgently needed items.

## 3.3 Basic Plan

### 3.3.1 Site and Layout Plans

(1) Design criteria

Major factors related to Sri Lanka and SLSI that are taken into account in the basic design process are identified and analyzed as follows.

1) Environmental conditions

Colombo is located in the tropical rain forest climate zone with a mild dry season. Partly due to its geographical setting surrounded by ocean, the annual maximum temperature is limited to around 32℃. Humidity is high throughout the year in the range between 80% and 90%.

2) Interior environment

SLSI's laboratories are selectively air-conditioned as required and are considered to be suitable for accommodating various equipment. Environmental conditions in SLSI's laboratories (temperature and relative humidity) are summarized below.

**Environmental conditions in SLSI's laboratories**

| Location | Temperature (℃) | Relative Humidity (%) |
|---|---|---|
| Calibration Lab. | | |
| Precision Measurement Area | 20.0 ± 0.5 | 65 ± 5 |
| Other Areas | 20.0 - 27.0 | 65 ± 5 |
| Food and Chemical Lab. | | |
| Instrument Room | 20.0 ± 2.0 | 60 - 70 |
| General Lab. | 28.0 - 32.0 | 80 - 90 |
| Electric and Electrical Lab. | 20.0 ± 2.0 | 60 - 70 |
| Micro-biology Lab. | 20.0 ± 2.0 | 60 - 70 |
| Material Testing Laboratory | | |
| Air-conditioned Area | 20.0 - 23.0 | 60 - 70 |
| Other Areas | 28.0 - 32.0 | 80 - 90 |
| Textile Laboratory | | |
| Nomal Rooms | 27.0 ± 2.0 | 65 ± 5 |
| Special Rooms | 27.0 ± 2.0 | 65 ± 2 |
| Engineering Workshop | 28.0 - 32.0 | 80 - 90 |

3) Water supply

Water used by SLSI, including water consumed by testing equipment, is obtained from public water supply. Drinking water is supplied in abundant throughout the year, and water supply is rarely cut off during the dry season except for accidents. According to SLSI's analysis, current water supply conforms to water quality standards in the country.

Supply pressure is 13kg/cm2, and the average water temperature is 27℃ 29℃ at maximum and 25℃ at minimum.

4) Electricity

SLSI does not have an emergency power generation system and relies on electricity supply from a power company.

Power outage is rare throughout the year, and daily voltage fluctuation is ± 6%. No automatic voltage regulator is required excepting special testing equipment. Although cutbacks in power supply during the dry season is warned due to the shortage of water supply, no cutback has been made in the past three years.

Major power sources and power consumption at each laboratory are follows.

Three phase: 4000V ± 6%
Single phase: 230V ± 6%
Frequency: 50Hz ± 1%

Power consumption at laboratories (daily average)
Food and Chemicals Laboratory, Material Testing Laboratory, Metrology and Calibration Laboratory: 625kWh
Electrical and Electronic Laboratory: 138kWh
Textile Laboratory: 47kWh
Microbiology Laboratory: 49kWh

5) Locally available equipment and materials

Equipment to be supplied under the project is not manufactured in the country. There are service agents for some of analytical equipment, computers, and vehicles in Colombo, which can be used to obtain spare parts, consumable and repair

parts, as well as maintenance service. Thus it is recommended to procure these equipment within the country.

6) Project period

SLSI plans to complete the moving of laboratories that are scattered in various locations to the new building by the end of March 1995, thus it will be able to receive the requested equipment within the same year. Delivery schedule of equipment is 5 – 6 months at maximum. Thus, the project can be implemented in a single year.

Based on environmental conditions identified above and the objective of the project, the basic design process to select and identify appropriate equipment was started.

(2) Design policy

In developing the equipment plan, industrial development policy of the Sri Lanka government, priority industries, and the current situation and future outlook for industries, and SISI's facilities, resources and technical levels have been considered. In particular, equipment has been selected under the following criteria.

1) Equipment required to maintain national standards

In Sri Lanka, there are around 1,000 national standards, including both compulsory and voluntary, based on which tests are conducted. In addition, the development of new international standards will urge research and study on new national standards. The project will then focus on equipment that will be required for inspection, testing and research that serve the above purpose.

2) Equipment urgently required (covering inspection items under compulsory standards)

As discussed earlier, compulsory standards are enforced to a limited extent in Sri Lanka. Compulsory standards are in principle established for consumer protection. Inspection under compulsory standards has been intensified in recent years in response to the increase in number of new products and growth of imports. Selecting equipment to meet diverse testing requirements serves the objective of the project and

requires utmost attention.

3) Equipment that can be easily operated and maintained

Priority should be given to the type of equipment that can be maintained with ease in Sri Lanka, including reliable backup service and supply of spare parts. Also, it should preferably require the least practicable operation and maintenance costs, in addition to user-friendliness in terms of operation and maintenance.

(3) Equipment layout plan

The equipment layout plan was developed in consideration to major factors including (1) existing equipment, (2) power supply, (3) water supply, (4) drainage, (5) emission, and (6) space availability. The preliminary layout plan is shown in Appendix 11.

### 3.3.2 Equipment Plan

In the equipment selection process, contents of currently available test and inspection services, and compliance with SLS were taken into consideration. Naturally, equipment specifications vary with the purpose of equipment, i.e., particular equipment is used for which test and which SLS standard, then the SLS standard corresponds to which international standards (JIS, BS, ISO).

In particular, equipment used by Electrical and Electronic Laboratory, Metrology and Calibration Laboratory, and Material Testing Laboratory is expected to conform to SLS requirements. On the other hand, Textile Laboratory primarily deals with voluntary inspection that is related to quality improvement of local products. On the other hand, Food and Chemicals Laboratory and Microbiology Laboratory emphasize compulsory inspection that is used for preservation of consumer health and the securing of safety.

Since each laboratory has a different focus and purpose of testing and inspection, it is important to select equipment that suits the purpose of the laboratory it will be installed. At the same time, priority should be given to equipment used for compulsory testing from the viewpoint of consumer protection.

(1) Equipment plan

The following sections describe equipment selected for each laboratory together

with major reasons for selection.

1) Material Testing Laboratory

For Material Testing Laboratory, equipment used for compulsory testing has been chiefly selected.

First of all, securing sufficient strength for helmets and concrete is very important to protect people from traffic accidents and the collapse of buildings due to shearing or fatigue destruction of reinforcing bars or steel frame. The mini-lathe machine is required to prepare test specimen for tensile and impact tests on metal materials. In particular, the strength test for reinforcing bars and steel pipes for construction purposes is subject to compulsory testing, which heightens the need for the mini-lathe machine. On the other hand, the profile projector has been selected as it is essential in checking the accuracy of finishing of tools and metalworking materials, especially scalpels and ball points, and there is increasing demand among industries.

Table 3.1 shows equipment to be supplied to Material Testing Laboratory and their basic specifications.

**Table 3. 1 Main Specifications for Material Testing Laboratory**

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 1 | Helmet testing equipment | 1 | Based on ISO R1511, BS6658,JIS8133 | Compulsory Testing for Imports<br>Inspecting demand is very high |
| 2 | Cement/concrete testing equipment | 1 | Capacity of Concrete Mixer:15 litter<br>Revolution:85r.p.m<br>Number of Molds:Minimum 9 pcs. | Compulsory Testing for Imports<br>Inspecting demand is very high |
| 3 | Mini-lathe machine | 1 | Max. dia of chuck work: 60 mm<br>Swing over bed: 120 mm<br>Swing over cross table: 64 mm | Compulsory Testing for Imports<br>Inspecting demand is very high |
| 4 | Profile projector | 1 | Screen Diameter:approx.600mm<br>Magnifications:5,10,20,50&100 | Compulsory Testing for Imports<br>Indispensable for SLS certification |

2) Electrical and Electronic Laboratory

In Sri Lanka, daily voltage fluctuation of commercial power supply reaches 10% at maximum, while power supply for testing purposes must provides the range of

voltage fluctuation within $\pm 0.5\%$. For this reason, the continuously variable DC power supply has been selected for DC load tests on switches, and the stabilized power supply for durability test for light bulbs.

The plugs and socket outlets testing equipment has been selected for checking safety and strength, including temperature tests on standard plugs and sockets for household use, the pull force test required for make-and-break operation, and the drop test. The shutter endurance testing machine for socket outlets and the endurance test machine for switches have been selected for repeat switch-on and off tests by using a reciprocal movement mechanism, which is shared by the two machines.

Endurance tests for switches and socket outlets also require the inductive load and the resistive load.

The tracking test apparatus has been selected to check the ease of formation of a carbonized tracking path due to moisture attached to the surface of an insulator - an important test from the viewpoint of consumer safety. The glow wire test apparatus has been selected for the purpose of checking ignitability and flammability of an insulating material and housing of electrical equipment. The flexing machine for cables will evaluate flexibility of cords and cables by checking poor insulation of sheathing or line breakage. Test fingers and test pins will be used to check the risk of electric shock, and the earth leakage circuit break tester will be used for checking operating characteristics of earth leakage breaker as the compulsory test for consumer protection.

The multi-channel temperature recorder and the digital thermometer have been selected as the fundamental means of temperature measurement. The chart recorder for voltage and current will be used for long-hour recording, namely testing durability of tungsten lamps.

The torque tester and the push pull gauge have been selected to check safety of electrical equipment and appliances after assembly. The former is designed to check that terminal screws are securely tightened, and the latter will check wiring conditions, i.e., electrical wires do not contact a live part or a moving part of electrical equipment by mechanically pushing and pulling the wires. Finally, the impact test apparatus has been selected to check strength of sheathing of socket outlets. Three of them are all indispensable for securing safety against electric shock.

Table 3.2 lists equipment to be supplied to Electrical and Electronic Laboratory and their basic specifications.

## Table 3. 2 Main Specifications for Electrical and Electronic Laboratory

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 1 | Continuously Variable DC power supply | 1 | Input:230V± 10%,50Hz<br>Output:DC200 to 300V ± 1%, Maximun 30A, Continuous | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Inspecting demand is very high |
| 2 | Voltage stabilizer | 1 | Input:230V± 10%,50Hz<br>Output:220 to 270V AC ± 5%, 10KVA, Continuous | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Inspecting demand is very high |
| 3 | Plugs and Socket outlets testing equipment | 1 | Test equipment for plugs and sockets for houses. Including jigs and other equipment | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products |
| 4 | Inductive load for switch testing | 1 | 3 units for one set, 15KVA<br>Voltage:230 to 300V, 50Hz<br>Current:0.5 to 17A(at 300Vot)<br>Power factor:0.2 to 1.0(valuable)<br>Current and power factor should have 2stage-valuable devices. Minimum adjustment should lower than 0.2A. | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Inspecting demand is very high |
| 5 | Tracking test apparatus | 1 | Appararus to test characteristics of flamability and insulator's-breakdown by small leakage of electrical insulation materials. Based on IEC112.<br>Input:230V, 50Hz Output:100 to 600V, 1A:constant, with electro-indicator, titlator and counter. | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Inspecting demand is very high |
| 6 | Glow wire test apparatus | 1 | Ignitible test apparatus for electrical insulator when contuct to any heat sources. Based on IEC695-2,JIS C-0061.<br>Power source:230V, 50Hz.<br>Output voltage valiable transformer: secondary:150A, with heater | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Demand for inspection is high |
| 7 | Test fingers & test pins | 1 | Apparatus to check electrical shock prevention. Test fingers:4 varieties<br>Test pins:4 var., Test Brades:1 var.,<br>Test proves:3 var., Chain:1 var.,<br>Fuck:1 var., Balls and cone:1 each | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Demand for inspection is high |
| 8 | Torque tester | 2 | Torque testing equipment for screws .<br>Accuracy:± 2% of Max. division<br>Torque driver:1.0Nm & 3Nm, 2pcs./each | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Inspecting demand is very high |
| 9 | Endurance test machine for switches | 1 | Round friction mechanizm for on-off switching operation<br>Power source:230V, 50Hz<br>Air cylinder:5 pcs<br>Round friction: 6 times/min.<br>Cylinder speed:150/300 mm/sec.<br>On-Off Indication:50,000 times | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Inspecting demand is very high |
| 10 | Shutter endurance testing machine | 1 | Compensatory used with the above equipment | Compulsory Testing for Imports<br>Compulsory Testing for indigenous products<br>Inspecting demand is very high |

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 11 | Multi-channel temperature recorder | 1 | Dotmatrix type temperature recorder with 12 thermocouples.<br>Power source:230V, 50Hz<br>Temperature:150/300℃, cahngeable | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products<br>Demand for inspection is high |
| 12 | Flexing machine for cables | 1 | S-shaped vending tester, based on IEC245.<br>Power source:230V, 50Hz<br>Flexing indicator:30,000 to 60,000 | Compulsory Testing for Imports<br>Demand for inspection is high |
| 13 | Chart recorder | 2 | to test life of bulbes<br>Power source:230V, 50Hz<br>Recording voltage:220 to 260V | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products<br>Inspecting demand is very high |
| 14 | Impact test apparatus | 1 | Rockwell type impact test equipment<br>Steel made<br>Weight:150gram<br>Impact face: polyamid made(rockwell 100) | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products<br>Inspecting demand is very high |
| 15 | Digital Thermo-meter | 1 | Equiped with 7 exchangeable thermo-couples, digital indication, 300℃ | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products<br>Demand for inspection is high |
| 16 | Push pull gauge | 1 | Push-pull fource:0 to 100N,<br>Digital indication<br>Minimum indication:0.1N, attached with fuck when pulling | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products<br>Demand for inspection is high |
| 17 | Resistive load | 1 | 3 units for one set<br>Input:230V± 10%,50IIz<br>Load: upto 17A, available to adjust roughness and sensitiveness--2 stages<br>Minimum adjustment of 0.1A<br>Total consumption (one set total):<br>15KVA at 300V, continuous | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products<br>Demand for inspection is high |
| 18 | Earth leakage circuit break tester | 1 | Input:230V± 10%,50Hz<br>Trip current:0-25/50/250/500mA, chan-geable. Accuracy:± 2.5%<br>Trip time:0-100/1000ms, switchable<br>Accuracy:± 2.5% | Indespenssable to assure safe-ness of consumers |

3) Food and Chemicals Laboratory

Equipment urgently needed at Food and Chemicals Laboratory is used for testing and inspection directly affecting protection of consumer health and safety. The atomic absorption spectrophotometer is essential in analyzing trace metal contained in food, drugs, drinking water, cosmetics, and waste water. The capillary gas chromatograph will be used to analyze organic contents in preservatives and other agents. The carbon/sulfur analyzer will be used for analysis of carbon and sulfur

contents in metallic compounds and stuffed toys, the IR spectrophotometer for analysis of drug ingredients and dyeing fluid, and the ionizer for analysis of fluoride, lead, and other chemical contents in food, toothpaste and other consumer products. Finally, the flame photometer is essential in analysis of phosphate, soda, calcium, and magnesium. These equipment is all used for compulsory testing and are highly and urgently needed.

Table 3.3 lists equipment to be supplied to Food and Chemicals Laboratory and their basic specifications.

**Table 3. 3 Main Specifications for Food and Chemical Laboratory**

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 1 | Atomic Absorption Spectrophotometer | 1 | Photometric mode: atomic absorption and absoption and emission<br>Wave length range:190–900nm<br>Diffraction grating:1800 l/mm blazed at 200nm<br>for rapid espimation of trace metals | Compulsory Testing for Imports<br>Compulsory Testing for indigen–ous products<br>Inspecting demand is very high |
| 2 | Capillery gas chromatograph | 1 | Capable of both capillary and packed columns<br>Detectors FID, ECD, TCD, PID, MPD, FPD, TSD<br>Sampler: for 6 samples<br>Sample injection:0.1 $\mu$ l step | Compulsory Testing for Imports<br>Compulsory Testing for indigen–ous products<br>Inspecting demand is very high |
| 3 | Carbon/sulphur analyzer | 1 | for analyzing carbon and sulphur ana–lysis, Combustion:Temp.400 to 1500℃<br>Range:c:0 –5.0wt%, s:0–1–1.0wt%<br>Sensitivity:0.00001wt%(0.1 wt ppm) | Compulsory Testing for Imports<br>Compulsory Testing for indigen–ous products<br>Inspecting demand is very high |
| 4 | IR spectrophotome–ter | 1 | Furrier transform infrared spectrome–ter, for identification and estimat–ion of pharmaceuticals and etc.<br>Wave number range:4000 to 400 cm–1<br>Max. resolution:± 1cm–1 | Compulsory Testing for Imports<br>Compulsory Testing for indigen–ous products<br>Inspecting demand is very high |
| 5 | Ionizer | 1 | Ranges:pH0.00to 13.99, –1999mV to +1999mV,<br>Imput impedance:10↑ 13ohm<br>for analysis of fluoride,chloride,car , etc. | Compulsory Testing for indigen–ous products<br>Inspecting demand is very high |
| 6 | Flame photometer | 1 | Range:0 to 199.9ppm<br>Sensitivity:Na,K:3–100ppm,<br>Li,Ca:5 to 100ppm, Ba:100 to 200ppm | Compulsory Testing for Imports<br>Compulsory Testing for indigen–ous products<br>Inspecting demand is very high |

4) Microbiology Laboratory

As discussed earlier, equipment selected for Microbiology Laboratory is those that are urgently required for analysis and testing of microbes contained in agricultural and marine products and processed food and associated with food

poisoning and decaying, such as bacteria, colonbacillus, and salmonellae. In particular, equipment to directly conduct testing, inspection and analysis, and equipment required for preparation work have been selected. The centrifuge and the refrigerator/freezer, although demand is small, are required for testing bacteria resistance, deterioration of ingredients of natural food, and analyzing ingredients with no substitutive equipment. The pipette plugging machine will be used to prepare samples and will replace the currently used hand pipette that produces leakage.

Table 3.4 lists equipment to be supplied to Microbiology Laboratory and their basic specifications.

**Table 3. 4 Main Specifications for Microbiology Laboratory**

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 1 | Top loading autoclave | 1 | for drying and sterilizing of Culture and glassware<br>Working volume:50–70 litters<br>Temperature range:upto 200℃<br>Pressure range:0 to 40psi | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products<br>Inspecting demand is very high<br>Replacement of old equipment |
| 2 | pH meter | 1 | Accuracy:+/-0.01 pH<br>Range:0 to 14 pH<br>Temperature range:0 to 100℃ (accuracy: +/–0.1℃) | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products<br>Inspecting demand is very high |
| 3 | Horizontal laminar flow cabinet | 1 | Bench mounted and vibration free type<br>Prefilter(washable):5 μ<br>HEPA filter(class 100):0.3 μ<br>Air velocity:0.45m/sec. ± 20% | Compulsory Testing for Imports<br>Compulsory Testing for indigen-ous products |
| 4 | Air sampler | 1 | Single stage sliter,multi-stage plates by air centrifugations | Inspecting demand is very high |
| 5 | Precision pressure gauge | 1 | Class I.<br>psi upto 40 bar/bar upto 3.<br>for steam/air presure | Inspecting demand is very high |
| 6 | Multi-channel temperature recorder | 1 | Bench top model with facility to mon-itor upto 4 channels simultaneously<br>Accepting standard 250mm chart paper<br>Variable chart speed–accuracy± 0.35% | Inspecting demand is very high |
| 7 | Sterlizing oven | 1 | Temperature range:ambient to 200℃<br>Working volume:200 liters | Inspecting demand is very high |

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 8 | Top pan electronic balance | 1 | LED display<br>Range:upto2000/2500g<br>Accuracy:± 0.001 g | Inspecting demand is very high |
| 9 | Voltex mixer | 1 | for stirring and mixing liquids in test tube/botlles<br>Speed:upto 2600 vibrations/min. | Inspecting demand is very high |
| 10 | Stomacher laborat-ory blender | 1 | for blending of samples<br>Capacity:3500ml<br>Power:230V, 50Hz | Enhancement of services<br>Inspecting demand is high |
| 11 | Refrigertor/freez-er | 1 | for freezing of samples<br>Separate refrigerator and freezer<br>Capacity:12cubic feet | Necessary for preparation of samples<br>Necessary to store samples<br>Demand of the equipment is high |
| 12 | Laboratory glassw-are washing machine | 1 | Capacity of inner chamber:200 litter/ approx.<br>Washing mode switchable(jetspray, rotary spray, random spray) | Enhancement of services<br>Inspecting demand is high |
| 13 | Binocular microscope | 1 | Compound binocular microscope<br>Observation tubes inclined at 30°<br>Objectives of 10X, 20X, 40X,60X, 100X, Objective combination being 1.382mm, illumination:25watt(halogen bulbs) | Enhancement of services |
| 14 | Stainless steel blender | 1 | for samples homogenizing<br>Revolution 8000rpm, 45000rpm<br>Capacity:250ml,500ml,1000ml(2pcs./ each) | Necessary for sample preparation |
| 15 | Colony counter | 1 | to inspect bacteriological colony growth.<br>Used with felt tipped pen<br>Accept petridish upto 124mmϕ<br>Magnifying lens:3X | Inspecting demand is high |
| 16 | Bech top centrifu-ge | 1 | for separation of samples and compou-nds.<br>Max.RCF 6000 TO 7000xg, speed:upto 6000 rpm.<br>Capacity of rotor:upto 3-4 liters | Enhancement of services |
| 17 | Pipette plugging machine | 1 | Electrical operation type<br>Pneumatic or mechanical operate<br>Orifice taking 1ml, 2ml,5ml,10ml pip-ettes and pasteur pipettes | Enhancement of services |

5) Textile Laboratory

From the viewpoint of consumer protection, 4 types of flammability testers (vertical, 45 degree, horizontal, and hot nut) have been selected as the most critical items.

Then, the air permeability tester for uniforms, the Bundesman water repellency tester for raincoats, and the seam slippage tester have been selected to meet increasing government demand.

The yarn evenness tester has been selected to conduct size variation of imported raw cotton yarns that is subject to compulsory testing.

In light of the fact that growth of the apparel industry spurs color matching demand for textile products, and that it will be introduced to the national institution on standardization, the microprocessor controlled color matching/measuring system representing the age of technological innovation has been selected.

Table 3.5 lists equipment to be supplied to Textile Laboratory and their basic specifications.

**Table 3. 5 Main Specifications for Textile Laboratory**

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 1 | Flammability tester(vertical) | 1 | Apparatus to test flammability of textiles by hanging it vertically. Should be equivalent to JIS L-1091A-4, USA DOC FF3-71 or BS5438. | Indispensable to asure safety of consumers. Demand for inspection is big. |
| 2 | Flammability tester(45 degrees) | 1 | Apparatus to test flammability of textiles by holding it up at the angle of 45 degrees. Should be equivalent to JIS L-1091 or better. | Indispensable to asure safety of consumers. Demand for inspection is big. |
| 3 | Flammability tester(horizontal) | 1 | Apparatus to test flammability of textiles by laying it down horizontally. Should be equivalent to JIS D-1201, USAFMVSSNo.302. Or, should be equivalent or better than ISO or other regulations. | Indispensable to asure safety of consumers. Demand for inspection is big. |
| 4 | Flammability tester(hot nut) | 1 | Apparatus to test flammability of floorcloths like carpets by laying heated nuts made of steel. Should be equivalent to BS or better | Indispensable to asure safety of consumers. Demand for inspection is big. |
| 5 | Bundesmann water repellency tester | 1 | Apparatus to inspect water repellence of water-proof textiles. Rainfall area:approx.1,300c Number of nozzles approx.300 Height of rainfall nozzles 150cm | Demand for inspection is comparably big. |

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 6 | Air permeability tester | 1 | Apparatus to test peameability of textile fabrics.<br>Measurement range:approx0.5 – 300cc/c /sec.<br>Size of air ventilator:approx40cm$^2$<br>Changeable oifices<br>Should be equivalent to JIS L–1096 or better | Demand for inspection is comparably big. |
| 7 | Seam slippage tester | 1 | Distance of jaws:approx75mm<br>Manual loading<br>Apparatus to predicts the likelihood of slippage of sticked seams in woven fabrics.<br>Load of stress range:8 to 18kg<br>Should be equivalent ot BS3320 or better | Demand for inspection is comparably big. |
| 8 | Yarn evenes tester | 1 | Application range:Yarn:Nm250–Sliver: 80g/m(Max.)<br>Material feeding speed:8to 400m/min<br>Multi–channel type<br>Measuring range:0.20 to 99.99% (U% and CV%) | Demand for inspection is comparably big. |
| 9 | Microprocesor controlled color matching/ measurementsystem | 1 | Components:Computer, display, printer, and reflectance spectrophoto–meter<br>Softwares: compuetrcolor matching software and data managementsoftware | Demand for inspection is comparably big. |

6) Metrology and Calibration Laboratory

As equipment associated with dimensional and shape measurement of products and components, the 3–D coordinate measuring machine, the horizontal universal length measuring machine, the surface texture measuring equipment, and the automatic gauge block calibrating system have been selected. These equipment is reference equipment essential in quality control and standardization of industrial products and is capable of covering the range which is out of scope for existing equipment.

Among equipment for measurement and calibration of pressure and force, the proving rings have been selected as standard equipment to measure loads (compressive and tensile) and in consideration to high demand. The equipment also can cover the scope of inspection by the load cell system and has a wide range of applications.

The fixed point temperature calibration system, the four terminal resistance bridge, and the portable dry bath for calibration have been selected as equipment for

bridge, and the portable dry bath for calibration have been selected as equipment for temperature measurement and calibration. These equipment is essential in calibration of temperature control and measurement. Since they are frequently used and will be able to cover the range of service that cannot be handled by existing equipment, the procurement of these equipment will be conducive to expansion of SLSI's service.

The mass comparator and the high accuracy analytical balance are essential in measurement and calibration of mass. The former is a comparison calibrator using reference weights and has a wide range of applications. On the other hand, the latter is required for daily precision measurement and is thus frequently used.

The air-conditioned vehicle for field calibration is intended for visiting calibration services at factories to meet potential demand. Portable microcomputers are essential in data analysis and streamlining of daily work and are highly required.

Table 3.6 lists equipment to be supplied to Metrology and Calibration Laboratory and their basic specifications.

**Table 3. 6 Main Specifications for Calibration and Metrology Laboratory**

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 1 | 3-D Coordinate measuring machine | 1 | Measuring range:X-700, Y-600, Z-450mm<br>Resolution: more than 0.001mm<br>Accuracy(Repeatability for each axis)<br>:1.5m$\mu$ or better | Indispensable for calibration |
| 2 | Fixed point temperature calibration system | 1 | Temperature range:90K to 1100℃<br>Power requirement:230V/50Hz | Indispensable for calibration |
| 3 | Automatic gauge block calibrating system | 1 | Calibrate size: Nominal to 300mm<br>system accuracyand repeatability:<br>Shall be within± (0.02+0.2L)microns<br>where L is the gaugelength in meters. | Indispensable for calibration |
| 4 | Air-conditioned vehicle-mobile for calibration purpose | 1 | Air conditionedvehicle<br>Delivery van type | Indispensable for calibration |
| 5 | Four terminal resistance bridge | 1 | Range: 0to 150 ohm<br>Accuracy: 1ppm± 1 digit accuracy | Enhancement of calibration services |
| 6 | Portable dry bath for calibration | 1 | Bath for high temperature-<br>Temperature range: 30to 1100℃<br>Stability: ±0.1℃<br>Bath for medium temperature-<br>Temperature range: 60to 400℃<br>Stability: ±0.05℃ | Indispensable for calibration |

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 7 | Horizontal univer-sal length measur-ing machine | 1 | Measuring capacity:<br>External: 1000mm(minimum)<br>Internal: 2 to 800mm<br>Measuring accuracy:(0.3+0.4L)$\mu$m;L in meters | Indispensable for calibration |
| 8 | Portable micro-computer with printer | 1 | CPU:486SX(Intel)<br>Memory: more than 4MB, expandable upto 20MB<br>HDD: more than 250MB<br>Printer: Bubble-jet ink type | Necessary for data analysis and for promoting effectiveness of routine works |
| 9 | Surface texture measuring equip-ment | 1 | Traverse length: 120mm<br>Range/resolution:4.0mm /10nm | Indispensable for smoothness of analysis |
| 10 | Mass comparator | 1 | Capacity:20g, readability ± 0.001mg<br>Capacity:200g, readability ± 0.01mg<br>Capacity:2kg, readability ± 0.1mg<br>Capacity:20kg, readability ± 5mg | Indispensable for calibration |
| 11 | High accuracy analytical balance | 1 | Maximum weighing capacity:160g<br>Minimum readability:± 0.01mg | Indispensable for calibration |
| 12 | Set of proving rings | 1 | Measuring range:30,50,100,200,300kg, 5kN,20kN,50kN,100kN,500kN,1000kN, 2000kN | Enhancement ofcalibration services |

7) Workshop

The workshop has only one lathe that is in unserviceable conditions, and a small lathe machine has been selected to replace it for improved work efficiency.

The metal sheet working machine will be used to manufacture a variety of prototypes, test specimen, components and jigs for testing and inspection, and assembles small equipment.

The shaping machine has been selected to facilitate flat work and groove cutting in order to reduce machining time and streamline work.

Table 3.7 lists equipment to be supplied to Engineering Workshop and their basic specifications.

## Table 3. 7 Main Specifications for Engineering Workshop

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 1 | Lathe machine | 1 | Capacities of swing over bed: Approx. 480mm<br>Mximim distance between centers: Approx. 1500mm<br>With NC control | Replacement of existing machine |
| 2 | Metal sheet working machine | 1 | Capable of various processing of metals( i.e. cutting in various shapes, Beading, trimming, punching, seaming,flanging,nibbling,folding,etc.)<br>Capacity of metal grip:400N/m | Up-grading of working efficiency by minimizing processing time of metal sheets |
| 3 | shaping machine | 1 | Maximum stroke of tool:approx.630mm<br>Table size:approx.630x400x400mm<br>Horizontal travel of table:approx.710 mm | Up-grading of working efficiency by minimizing |

8) General equipment

Computer systems have been selected for streamlining office work and data analysis. Computers can be used as a wordprocessor to draft daily reports and a database, as well as a data analyzer if they are connected to other systems. SLSI has computers, which are not sufficient to meet requirements and do not have advanced functions. The project intends to increase the number of computers as the first step. Standard reference materials are essential in testing and inspection at Food and Chemicals Laboratory, Microbiology Laboratory, and Textile Laboratory. They are highly needed since many of them are not locally available.

Table 3.8 lists general equipment to be supplied and their basic specifications.

## Table 3. 8 Main Specifications for General Use Equipment

| | Equipment | Q'ty | Basic Specifications | Reason for Selected |
|---|---|---|---|---|
| 1 | Computer system | 1 | Clock speed: 60Mhz<br>HDD: more than 250MB<br>FDD: Built-in(more than one)<br>Accessory: printer | Enhancement of services |
| 2 | Standard reference materials | 1 | Al:1000mg<br>Ag:1000mg<br>Ba:1000mg<br>Others | Replacement of existing materials |

## 3.4 Implementation Plan

### 3.4.1 Implementation Policy

The project is designed to supply testing and other laboratory equipment to SLSI in Sri Lanka under grant aid of the Japanese government. SLSI, principal implementation body, will enter into a contract with a consultant in Japan to conduct detailed design, preparation of tender documents, tender evaluation, and supervision of equipment installation. SLSI will also use a Japanese contractor to supply, deliver, and install the necessary equipment and provide guidance and assistance in operation and maintenance. Equipment installation will be conducted under instruction of a responsible engineer and by using local workers as far as possible. Also, the engineer will perform adjustment and guidance, and teach operation and maintenance.

The project implementation organization including the implementation body is illustrated as follows.

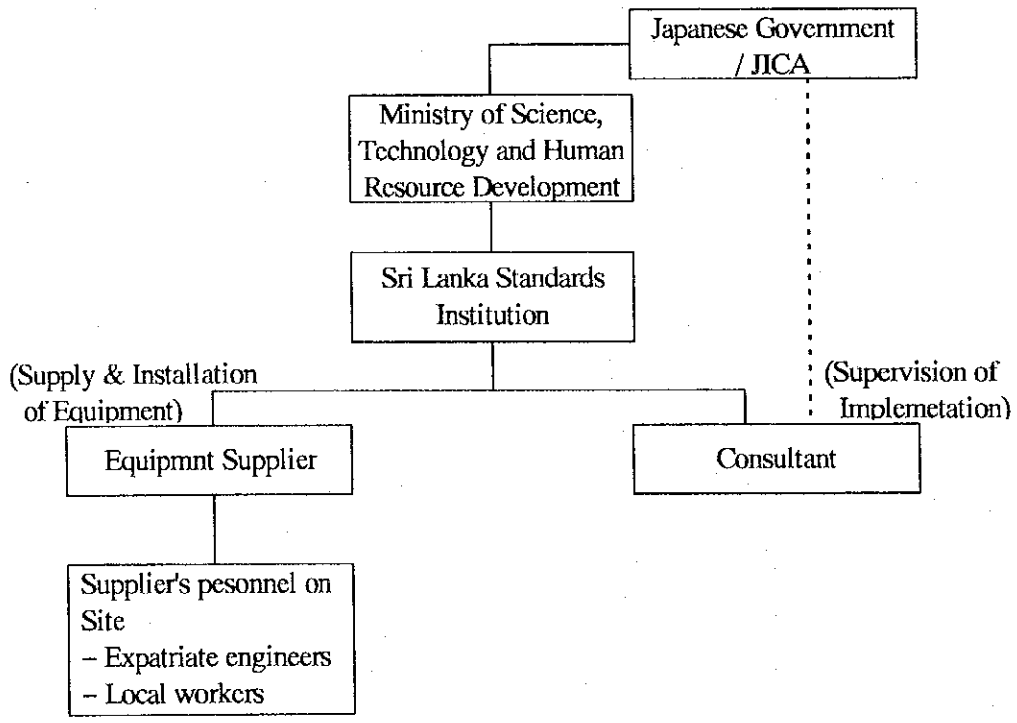



**Fig. 3. 1 Project Implementation Organization**

### 3.4.2 Important Considerations in Project Implementation

(1) Division of responsibilities

1) Services provided by the Japanese side

a) Procurement of equipment, transportation to the port of Colombo, and installation at site
b) Wiring from equipment to outlets at site (provided that outlets will be provided near each equipment, and wiring to outlets will be done by the Sri Lanka counterpart)
c) Commissioning, adjustment, guidance and advice on operation and maintenance
d) Consulting services related to preparation of tender documents, tendering, construction supervision

2) Services provided by the Sri Lanka side

a) Interior work, foundation work for equipment installation base, relocation of existing equipment within the building
b) Power receiving, transformation, wiring work
c) Water supply and sewerage, and gas piping
d) Lighting
e) Air-conditioning
f) Draft and ventilation
g) Telephone and telecommunications
h) Procurement of fixture and furniture
i) Procurement of chemical agents and drugs
j) To obtain approval and permit for landing, customs clearance, and inland transportation of imported equipment, and actual unloading, customs clearance and transportation, and bearing of related costs and expenses
k) To obtain approval and permit related to construction and installation
l) To bear commissions to a foreign exchange bank officially recognized by the Japanese Government for the banking services based on the Banking Arrangement.
m) To accord Japanese Nationals whose service may be required in connection with the project such facilities as may be necessary for their entry into Sri Lanka and stay therein for the performance of their work.
n) To maintain and use properly the equipment purchased under the Grant Aid.

o) To bear all other expenses which are not including in the Grant Aid agreement but may be necessary to carry out the project.

Cost estimation borne by the Sri Lanka side is shown in Appendix 6.

### 3.4.3 Construction and Supervisory Plan

The consultant to be appointed to the project will, in accordance with the grant aid policy of the Japanese government and the consulting agreement, organize a full-time project team to execute the project smoothly in line with the intent of basic design until its completion. Then, at the construction and supervision stage, the consultant will provide technical advice for the Sri Lanka counterpart at the kick-off meeting and upon approval of manufacturing drawings of equipment to be supplied. He will also attend factory and shipment inspection, installation, and final acceptance so as to ensure uninterrupted progress of the project. He will also be responsible for supervision of the overall progress of the project by coordinating relocation of existing equipment done by the Sri Lanka side and installation of new equipment by the contractor so as to avoid interference or disturbance.

### 3.4.4 Procurement Plan

(1) Procurement method

Some of equipment to be supplied, including cement/concrete tester, the plug/socket outlet tester, test fingers and pins, the four-terminal resistance bridge, the portable dry bath for calibration, and the horizontal universal length measuring machine are not generally available in Japan. Similar products are manufactured but they conform to JIS, not SLS. These equipment has to be custom-made in Japan, with additional cost, so that they should preferably be procured in other country.

Computers and vehicles for field calibration service can be procured in Sri Lanka, although not manufactured locally. In fact, local procurement is advantageous for the Sri Lanka side if maintenance and parts requirements are taken into consideration. However, since import duties as well as business turnover tax will be imposed on locally procured equipment, and will have additional cost impacts, it is strongly recommended to consider special tax exemption.

### 3.3.5 Implementation Schedule

Implementation schedule is listed in Fig. 3.2.

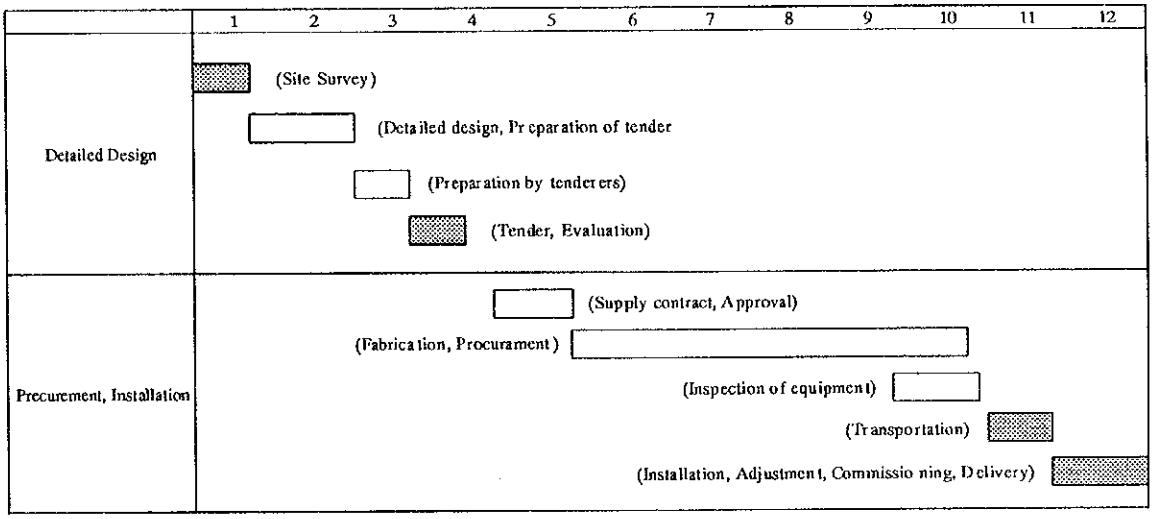



**Fig. 3. 2 Implementation Schedule**

### 3.3.6 Scope of Work

Once the project has started or after equipment is delivered or installed, SLSI cannot afford to suspend its activities, which would delay compulsory inspection of imported products and adversely affect consumers and industries. To avoid this, careful consideration is needed in planning replacement of existing equipment with the new ones, which must be done as quick as possible. The Sri Lanka counterpart will be responsible for relocation of existing equipment, which will be budgeted by the Sri Lanka government. Efforts should be made to minimize the adverse effect by minimizing suspension of SLSI's work due to replacement. This should be accomplished by carefully aligning the equipment delivery schedule with SLSI's inspection and testing schedule.

Meanwhile, the costs of work to be done by Sri Lanka side in relation with this project will be US$1,402.00. The breakdown is as follows:

| | | |
|---|---|---|
| 1) | Cost for Landing, Custom Clearance and Internal Transportation | US$ 1,100.00 |
| 2) | Re-enforcement of Material Testing Lab. | US$ 15.200 |
| 3) | Miscellaneous cost | US$ 150.00 |
| | Total | US$ 1,402.00 |

# CHAPTER 4 PROJECT EVALUATION AND CONCLUSION

# Chapter 4 Project Evaluation and Conclusion

## 4.1 Major Benefits of the Project

The Sri Lanka government has been implementing economic structural adjustment policy since 1989, which focuses on, among other things, export-oriented industrial development, attraction of foreign investment, and privatization of public enterprises. In particular, various development are under way to promote exports of industrial products, such as the development of industrial estates and the establishment of export processing zones. The progress of industrial development is contrasted by the delay in development of the industrial standardization scheme, export certification and import inspection systems, and the uniform metrology and calibration system. As these systems form the basis of improving quality of industrial products in the future, they may become a major hindrance to the improvement of international competitiveness of Sri Lanka products if they are left intact.

SLSI, the project implementation body, is only one public organization to conduct testing, inspection and quality control of industrial products in relation to export and import, and to discuss and establish national standards. Most of its laboratory equipment, however, is aged and outdated, and will not be able to meet the anticipated increase in demand for testing and other services, and demand by industries for higher levels of accuracy in inspection and testing.

The project is therefore designed to supply to SLSI equipment for inspection, testing, measurement, and calibration for the purpose of promoting industrial standardization on a nationwide basis, while assisting in development of export certification and import inspection systems as well as metrology and calibration systems, with ultimate objectives of improving quality and international competitiveness of Sri Lanka products, thereby contributing to export growth, while effectively protecting consumers. Table 4.1 summarizes these objectives and major benefits expected from implementation of the project.

## Table 4. 1 Major Benefits of the Project and Measurement of Improvement

| | Current state and issues | Measures taken under the project | Major benefits and improvements |
|---|---|---|---|
| 1) | Testing and inspection equipment owned by SLSI lacks variety and is mostly aged and outdated, thus becoming increasingly difficult to meet higher levels of testing and inspection needs. | To obtain equipment required for compulsory testing of imported and local products, as well as equipment used for highly demanded testing and inspection services. At the same time, to replace or upgrade aged equipment, and procure new equipment to meet diverse needs. | (1) To facilitate the formulation of new standards, the improvement of technology and quality levels, thereby contributing to the improvement of international competition and the development of industries.<br>(2) To improve reliability of the results of both compulsory and voluntary tests and to reduce time required for the tests, thereby to expand SLSI's service.<br>(3) To improve product safety which leads to consumer protection. |
| 2) | Most of existing equipment is outdated and discourages engineers and technicians to learn about latest technologies, resulting in lack of motivation for improvement throughout the organization. | To obtain latest equipment that meets current demand. | Latest equipment that reflects today's technological innovation will require engineers and technicians to learn and understand various technologies and techniques related to each equipment, not to mention operation and maintenance, which will revitalize the institution as a whole and spur the rise in technological levels. This will raise SLSI's leadership among industrial circles to increase quality awareness of corporate managers and to improve quality of local products. |
| 3) | Existing measuring and calibration equipment has a narrow calibration range, is aged, or does not have sufficient quantity, failing to meet industrial needs including potential demand. | (1) To provide equipment with a wider range of calibration.<br>(2) To replace aged equipment and add equipment to the existing stock. | The expanded range of calibration, the increase in the number of calibration items, and improved accuracy will help establish credibility of SLSI among industries and help expand SLSI's service base. Business practice based on accurate measurement adopted by Sri Lanka industries, together with improved industry technology levels in the country, will help gain confidence of trade partners, that will boost exports and the economy. At the same time, automated calibration in some parts will increase SLSI's capacity for calibration service, leading to industrial development. |
| 4) | Unable to maintain accuracy of finishing as measuring instruments incorporated into production lines and processing equipment are not accessible for calibration. | To provide vehicles equipped with calibration equipment for visiting certification and calibration at factories. | Improved accuracy of finishing due to improved measurement accuracy of processing equipment will lead to the improvement of product quality, then to the increase in exports and economic development. |

## 4.2 Conclusion and Recommendation

As discussed above, the project is expected to build up the basis of quality improvement, in particular the improvement of product quality, the increase in exports, and industrial development in the country. Thus, the project basically follows the ongoing industrial policy of the Sri Lanka government and shows high levels of need and urgency that make the project eligible for implementation as grant aid of the Japanese government. On the other hand, the Sri Lanka counterpart has an operational structure, manpower and funds sufficient for operation and maintenance of the project, provided that the following efforts on the Sri Lanka side are essential in enabling the project to produce the maximum practicable benefit.

(1) Undertakings by the Sri Lanka counterpart

Time is of essence in the project and the Sri Lanka counterpart is expected to execute construction as well as electricity, gas, water supply and sewerage work for each laboratory that will accommodate inspection and testing equipment, and measurement and calibration equipment, and landing, customs clearance, inland transportation, and delivery of equipment to be supplied, together with safe measures to protect equipment and workers during site installation by the Japanese contractor, and related procedures.

(2) Consistent funding for operation and maintenance

The operation cost must be funded timely and continuously to ensure the effective use of equipment supplied under the project. The government and SLSI are expected to allow for necessary costs and expenses in their budgets on a continuous basis, so that equipment can be used to fulfill the original purpose.

(3) Continuous staff training

Appropriate assignment and training of laboratory staff including assistant directors, engineers, and technicians are essential in ensuring the effective use of equipment to be supplied under the project. After the rules and organization for operation and maintenance of equipment are established, staff training should be conducted timely in line with the equipment installation plan.

(4) Maintenance organization

Spare parts and consumable supplied with equipment need to be stored in certain quantities. They must be properly maintained and monitored through inventory control and replenished as required. Also, operating instructions and manuals are distributed to operators and maintenance personnel who must read them carefully, and have to be kept under custody of appointed managers.