a fully modernized industrial structure that relies extensively on subcontracted production by factories in this size category.

Table 2.1-5 Numbers of Registered Factories in Each Product and Size Category

| Size Category | Cottage | Small | Medium | | Total Med./Small | Large | Total |
|---|---|---|---|---|---|---|---|
| | (-9) | (10 - 49) | (50 - 99) | (100-199) | (10 - 199) | (200-) | |
| I. Consumer goods category | 8,189 | 4,615 | 459 | 254 | 13,517 | 261 | 13,778 |
| Foodstuffs | 5,270 | 2,382 | 200 | 110 | 7,962 | 114 | 8,076 |
| Beverage | 78 | 62 | 9 | 24 | 173 | 19 | 192 |
| Tobacco | 64 | 173 | 36 | 22 | 295 | 36 | 331 |
| Apparel | 210 | 988 | 138 | 67 | 1,403 | 55 | 1,458 |
| Leather/leather goods | 161 | 97 | 7 | 6 | 271 | 7 | 278 |
| Footwear | 107 | 94 | 6 | 4 | 211 | 9 | 220 |
| Furniture | 695 | 399 | 39 | 9 | 1,142 | 9 | 1,151 |
| Printing/ publishing | 1,604 | 420 | 24 | 12 | 2,060 | 12 | 2,072 |
| II. Intermediate goods category | 4,970 | 3,670 | 607 | 296 | 9,543 | 250 | 9,793 |
| Textile | 342 | 693 | 121 | 80 | 1,236 | 119 | 1,355 |
| Wooden products | 1,774 | 1,017 | 184 | 59 | 3,034 | 19 | 3,053 |
| Paper products | 279 | 118 | 23 | 16 | 436 | 16 | 452 |
| Chemical products | 393 | 414 | 80 | 36 | 923 | 25 | 948 |
| Petroleum products | 10 | 9 | 5 | 1 | 25 | 4 | 29 |
| Rubber products | 401 | 249 | 50 | 40 | 740 | 25 | 765 |
| Plastic products | 930 | 462 | 35 | 18 | 1,445 | 9 | 1,454 |
| Ceramic products | 58 | 129 | 30 | 10 | 227 | 10 | 237 |
| Glass products | 4 | 22 | 9 | 4 | 39 | 6 | 45 |
| Non-metallic/ mineral products | 779 | 557 | 70 | 32 | 1,438 | 17 | 1,455 |
| III. Capital goods category | 10,279 | 2,660 | 282 | 140 | 13,361 | 116 | 13,477 |
| Base metals | 29 | 93 | 26 | 18 | 166 | 9 | 175 |
| Non-metallic products | 194 | 102 | 7 | 5 | 308 | 4 | 312 |
| Metal products | 3,651 | 915 | 80 | 40 | 4,686 | 30 | 4,716 |
| Machinery | 4,206 | 776 | 58 | 17 | 5,057 | 9 | 5,066 |
| Electric equipment | 524 | 283 | 49 | 26 | 882 | 23 | 905 |
| Transport equipment | 1,644 | 463 | 58 | 31 | 2,196 | 37 | 2,233 |
| Precise/scientific equipment | 31 | 28 | 4 | 3 | 66 | 4 | 70 |
| Other categories* | 1,904 | 587 | 56 | 17 | 2,564 | 14 | 2,578 |
| Total | 25,342 | 11,532 | 1,404 | 707 | 38,985 | 641 | 39,626 |

*) Other categories: Include 2,182 motor repair shops

Source: Data on Registered Factories, Industrial Provincial Office, MOI.

Considering the geographic distribution of manufacturing industries, the distribution of registered factories is presented in Table 2.1-6, in terms of the numbers of factories registered in Bangkok City, in the Bangkok Metropolitan District, in the 5 provinces surrounding the Metropolitan District, and outlying regions, and separately for the different factory size categories.

It is seen that concentration around the Metropolitan District is the most prominent for the large size factories. The percentage of factories located in this region is 72.4 percent for large factories, 68.7 percent for those of upper medium size, and 66.3 percent for those of lower medium size. For smaller factories the concentration is further reduced, 63.5 percent for small, and 54.7 percent for cottage factories.

It is, however, to be noted that the relatively large size factories are more numerous in the surrounding provinces than within Bangkok City.

In the outlying regions, on the other hand, the predominant percentage of factories is of small size, 69.4 percent are cottage factories.

To summarize, the basic geographical distribution of industry is characterized by a high concentration in and around Bangkok Metropolis.

Table 2.1-6 Geographical Distribution of Registered Factories of Different Size Categories -- As of 1984

| Factory Size Category | Metropolitan District | Bangkok City | Surrounding Provinces* | Outlying Regions | Total |
|---|---|---|---|---|---|
| Cottage (~9) | 13,854 (60.1) | 12,188 (63.8) | 1,666 (42.1) | 11,488 (69.4) | 25,342 (64.0) |
| Small (10 ~ 49) | 7,328 (31.8) | 5,933 (31.0) | 1,395 (35.3) | 4,204 (25.4) | 11,532 (29.1) |
| Medium (50 ~ 199) | 1,417 (6.1) | 794 (4.2) | 623 (15.8) | 694 (4.2) | 2,111 (5.3) |
| (50 ~ 99) | 931 (0.4) | 576 (3.0) | 355 (9.0) | 473 (2.9) | 1,404 (3.5) |
| (100 ~ 199) | 486 (2.1) | 218 (1.2) | 268 (6.8) | 221 (1.3) | 707 (1.8) |
| Total smaller (9 ~ 199) | 22,599 (98.0) | 18,915 (99.0) | 3,684 (93.2) | 16,386 (98.9) | 38,985 (98.4) |
| Large (200 ~ ) | 464 (2.0) | 195 (1.0) | 269 (6.8) | 177 (1.1) | 641 (1.6) |
| Total | 23,063 (100) | 19,110 (100) | 3,953 (100) | 16,563 (100) | 39,626 (100) |

*) Surrounding provinces: Samutpraharn, Nonthaburi, Pathumthani, Nakhonpathom, Samutsakorn

Source: Data on Registered Factories, Industrial Provincial Office, MOI.

## 2-1-5 Future of Thai Industry and of Export Products

The Thai industry would further grow by increasing the consumption of domestically produced raw and intermediate materials, and by enhancing the value added to articles manufactured, no longer as primary, but as secondary products. Manufactured articles, which have so far increased production to satisfy the domestic market, would now further expand to serve the international market. Typical product categories that can be expected to follow this future path of development would include those of agro-industry, machinery, electrical equipment, metal working, and electronics.

Since Thai workers are of good staff to induce a rising demand for their service, an increasing number of foreign enterprises would come to consider profiting from the advantageous position held by Thailand as a base of production. In readiness to take advantage of this favourable development, continuing efforts need to be directed toward further enhancing the technological level of Thai industry.

Envisioned in this light, future Thai industry would head toward the production and export of products presenting progressively higher value added, and toward further diversification of products, including those to be newly developed.

Product categories considered promising by the Thai Government and hence eligible for active promotion measures are, according to data from various studies:-

(1) Machinery

1. Motor components: Car engine components, including piston rings; disc wheels, exhaust pipes; motorcycle components including spokes, nipples, rims; tooling, dies for motor manufacture; rubber products;

2. Agricultural machinery and components;

3. General machinery: Machinery assembly, including manufacture of cast/forged/machined components; bearings;

(2) Electrical Machinery

Radio/television sets; air conditioning equipment; refrigerator compressors; batteries/accumulators; wiring/cabling;

(3) Electronic Equipment

Integrated circuits; electronic components/circuitry; office automation equipment; computers, computer keyboard; facsimile sets; copying machines; optical fibre;

(4) Chemicals

Synthetic resins; pharmaceuticals; caustic soda; chlorine, etc.

As an important means for promoting these product categories, as set forth in the Report entitled "Study on Development Programmes of Industrial Standardization, Testing and Metrology in the Kingdom of Thailand", the indispensable factors are:

- Promotion of industrial standardization
- Dissemination and promotion of quality control practice
- Acceleration of certification testing operations
- Establishment of adequate industrial metrological system, and of effective calibration service
- Implementation of testing associated with research and development.

The involvement of standardization, quality control, certification, testing, and the metological system, in the process from manufacture to domestic or export sale of industrial products is as schematized below.

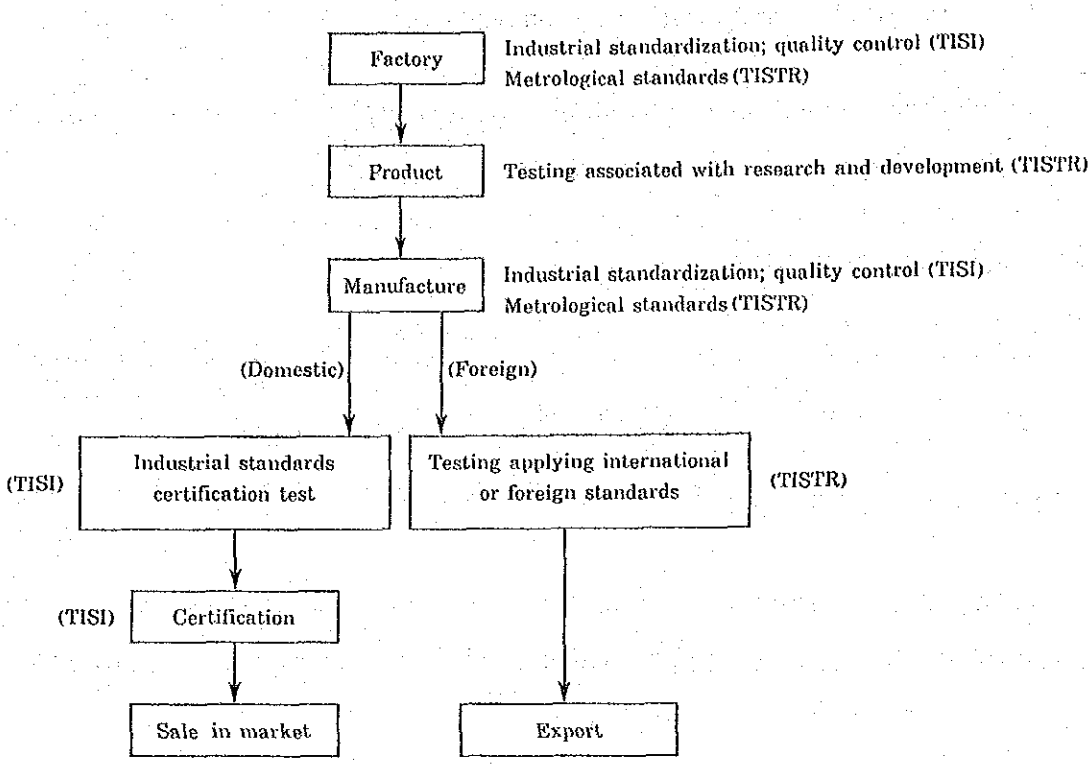


Fig. 2.1-3 Process from Manufacture to Sale

## 2-2 Outline of Related National Policy

### 2-2-1 National Policy for Industrial Development

The policy adopted by the Thai Government in the past for fostering industrial development can be considered to have undergone changes in 6 phases as described below.

The 1st phase extended from 1945 to 1960, during which industrialization was fostered under government lead, based on the Establishment of National Enterprises Act of 1953 and the Act on the Promotion of Industries of 1954.

The 2nd phase covered the decade from 1961 to 71, corresponding to the period of the 1st and 2nd five-year National Economic and Social Development Plan (NESDP), and which was characterized by encouragement of private initiative with emphasis on substitution of imported goods by domestically produced articles.

The 3rd phase coincided with the 3rd NESDP, from 1972 to 76, and was marked by multiplication of imports of capital goods as well as of raw material and intermediate products, brought about as a result of the encouragement given during the preceding period to industries manufacturing substitutes for imported goods. To overcome this setback, the Thai Government was obliged to modify its industrial policy to one of promoting exports.

The 4th phase lasted from 1977 to 81 - the period of the 4th NESDP. The promotion of export industries was continued, but the Plan was modified to give consideration to remedying the inequalities brought to the distribution of income by the preceding industrialization projects, and this NESDP was characterized by emphases on rectification of the industrial structure, and on decentralization of industry toward the outlying regions.

Priority was also accorded to agro-industry, which was contributing effectively to earning foreign currency, backed with the advantage already possessed by Thailand as an exporter of primary agricultural products.

The 5th phase was that of the 5th NESDP (1982-86), in which prospects of exploiting the newly discovered natural gas in the Gulf of Thailand permitted the adoption of a policy aspiring to achieve the status of a newly industrialized country. During this 5th NESDP, the manufacturing industries surpassed agriculture in total value produced.

Finally the 6th phase (1987-1991) - that of the 6th NESDP - places highest weight on the export promotion based on the industrialization and on the solution of the problem concerned with poverty and unemployment in the outlying regions. Overall economic growth target is held at 5 percent, barely exceeding what was actually recorded in the past periods, but growth for industry has been established at 6.6 percent,significantly higher than the above-cited 5 percent average covering all sectors. This 6th NESDP is oriented toward readjustment, and no longer toward extension in quantity. Industry is to diversify in market-oriented products and in the productive structure. Product categories accorded priority consideration are notably agro-industry, machinery, electrical equipment and metal working. Extension of industry in the outlying regions and the promotion of smaller scale enterprises is another question given serious consideration.

Six phases of economic development and industrial policy stated above are shown in Table 2.2-1.

Table 2.2-1 Six Phases of Economic Development and Industrial Policy

| Phase | Period | Economic Development Plans | Industrial Policy | | Relevant Legislation |
|---|---|---|---|---|---|
| 1 | 1945 - 60 | | Industrialization under government initiative | | 1953 - National Enterprise Act<br>1954 - Act on the Promotion of Industries |
| 2 | 1961 - 71 | 1st NESDP (1961 - 66)<br><br>2nd NESDP (1967 - 71) | Encouragement of industrialization under private initiative | Modernization of productive equipment; Substitution of imported goods | 1960 - Industrial Investment Promotion Act<br>1962 - Revision of above<br>1968 - Industrial Product Standards Act |
| 3 | 1972 - 76 | 3rd NESDP | | Promotion of export industries | 1972 - Promotion of Investment Act 1972 (Declaration)<br>- Alien Business Act<br>- Alien Work Permit Act |
| 4 | 1977 - 81 | 4th NESDP | | Export industries favoured; Encouragement of agrorelated industries | 1977 - Promotion of Investment Act 1977<br>1978 - Alien Work Permit Act 1978<br>1979 - Revision of Industrial Standards Act |
| 5 | 1982 - 86 | 5th NESDP | | Aspiration toward quasi-industrialized nation | |
| 6 | 1987 - 91 | 6th NESDP | | Diversification of products and of productive structure Export promotion policy | |

Source: International Development Center of Japan

### 2-2-2 National Policy for Developing Industrial Standardization, Testing and Metrology

The importance of extending and reinforcing industrial standardization and the national systems for certification and metrology was given recognition already in the 5th NESDP, and this awareness has been reflected in the 6th NESDP (1987 - 1991) in more clear and concrete terms.
In the 5th NESDP, the targets set for promoting industry and technology were;

- Application of advanced scientific techniques to ensure more effective utilization of soil and water resources, for enhancement of productivity in agriculture

- Enhanced utilization of domestically occurring resources, by imparting higher value added to mineral products, and to this end, promotion of technological research in mineral dressing and material processing, with a view to developing domestic technology to serve in promoting export industries

- Promotion of research and development in measures for conserving energy, with a view to economizing energy consumption

Achievement of the above targets was considered to be premised upon establishment of a situation favorable to the promotion of science and technology, and to the enhancement of research and development capability. Measures envisaged to this end and concerned with TISI and TISTR were:

- To reinforce TISTR to play a leading role in research and development

- To reinforce TISI for the purpose of extending the system of industrial standardization, testing and quality control, in order to enhance the competitiveness of industrial products in the international market

The 6th NESDP has been drawn up in consideration of the successes and failures of the preceding 5th NESDP. The economic and social objectives set forth in this Plan are to be achieved through the strategies of:

- Increasing the country's efficiency in development
- Improving production and marketing systems and raising the quality level of basic economic inputs
- Distributing income and prosperity to regional and rural areas

The measures to be adopted for implementing the foregoing strategies are;

- To ensure the reliability of product quality in the international market
- To promote industrial standardization
- To extend and reinforce the techniques of testing and metrology

Thus, the importance of developing industrial standardization, testing and metrology was duly recognized in the 5th NESDP, and in the ensuing 6th NESDP the question has continued to be acknowledged as a subject of vital and indispensable importance in the national policy for promoting industry.

## 2-3 Current Status of Industrial Standardization, Certification, Testing and Metrology

Industrial standardization is a measure for enhancing the economic effectiveness of industrial production and the benefits accruing to consumers, through improvement brought to the quality of industrial products and through interchangeability ensured of equipment components, which are realized by promoting the establishment of industrial standards and the dissemination of quality control practice.

The national metrological system is a measure for promoting industrialization and for ensuring equitable commercial transactions, through establishment of industrial and legal metrological standard system and through adequate calibration of measuring instruments based on such system. This is premised upon establishment of requisite national metrological standards, implementation of verification system for quantities such as weight, length, which are used for commercial transaction, and of calibraton services for industrial metrological quantities.

### 2-3-1 Relevant Regulations

(1) Industrial Product Standards Act

The Industrial Product Standards Act was enacted in 1968 and subsequently amended in 1979. The Act aims at;

1. Enhancing the reliability of manufactured product quality
2. Promoting exports to the international market
3. Ensuring equitability of commercial transactions
4. Protecting the safety and interests of consumers
5. Developing the industries

1) Outline of the Act

1. Establishment of Standards Governing Mineral and Industrial Products

The standards may apply not only to industrial products, but to any product considered calling for standardization on grounds of national interest including agricultural, forestry, fisheries, medical and pharmaceutical products.

2. Certification

All products for which an industrial standard has been established are subject to certification under the Thai Industrial Standards Certification System, certain among them deemed pertinent are further subject to designation by the Minister of Industry for compulsory certification to the relevant industrial standard. The Certification Mark (TIS Mark) is attached to articles that have been certified upon inspection in conformity with the relevant industrial standard and the prescribed mark must be displayed on all authorized articles. Subsequent to authorization, follow-up inspections are regularly performed.

2) Competent Agency

The Industrial Product Standards Act is administered under the authority of the Ministry of Industry by the Ministry's subordinate agency, TISI, which administers the Act through its functions of;

1. Receiving applications for certification from domestic manufacturers and importers

2. Inspection of domestically manufactured and imported articles covered by the Act and regulation of manufacturers of such articles

3. Supervision of certification mark usage

4. Other items entrusted to TISI by the Industrial Product Standards Council

(2) Law of Weight and Measures

The Law of Weights and Measures was enacted in 1923, with the aim of ensuring a uniform standardized and legalized system of weights and measures, principally envisaging the domain of commerce.

1) Outline of Law

1. Units of Measure

Thailand acceded to the Convention of Metre in 1912, to adopt the metric system as its basis, but traditional units also are legally authorized. Five units are defined that are length, surface area, volume, mass and capacity.

2. Manufacture, Importation, Sale and Repair of Measuring Instruments

The manufacturers, importers, dealers and repairers of weighing and measuring instruments should be registered by the Ministry of Commerce.

3. Verification

- Verification is performed in 2 forms; "initial verification" and "secondary verification".

- Weighing/measuring instruments used in commercial transactions required to undergo initial verification bear a certification mark attesting to satisfactory verification.

- A repaired weighing/measuring instrument is required to be submitted to secondary verification, and cannot be returned to its

owner or resold without satisfactory secondary verification.

- Manufacturers, importers and repairers of weighing/measuring instruments are required to register their private marks, which are to be affixed to weighing/measuring instrument in order to obtain certification.

- The verification of weighing/measuring instruments comprises judgement of conformity with legal prescriptions presented by the weighing/measuring instrument in respect of type of instrument, structural arrangement/materials, and permissible error.

- Holders of weighing/measuring instrument licenses are subject to inspection regularly twice a year, as well as at any time by authorized inspection officers.

2) Competent Agency

The Law of Weights and Measures is administered under the authority of the Ministry of Commerce by the Ministry's Weights and Measures Division, Department of Commercial Registration, which has custody of the prototype of the metre and kilogramme assigned under the Convention of Metre.

3) Industrial Metrology

There are no special articles regulating industrial metrology in the Law of Weights and Measures. However, TISTR undertakes responsibility for management, maintenance and supply of industrial metrology standard under the Thailand Institute of Scientific and Technological Research Act (TISTR Act).

## 2-3-2 Government Authorities Concerned

Fig. 2.3-1 is describing the mutual relation between concerned organizations and government authorities concerned in the field of nation's industrial standardization, testing, inspection and metrology.

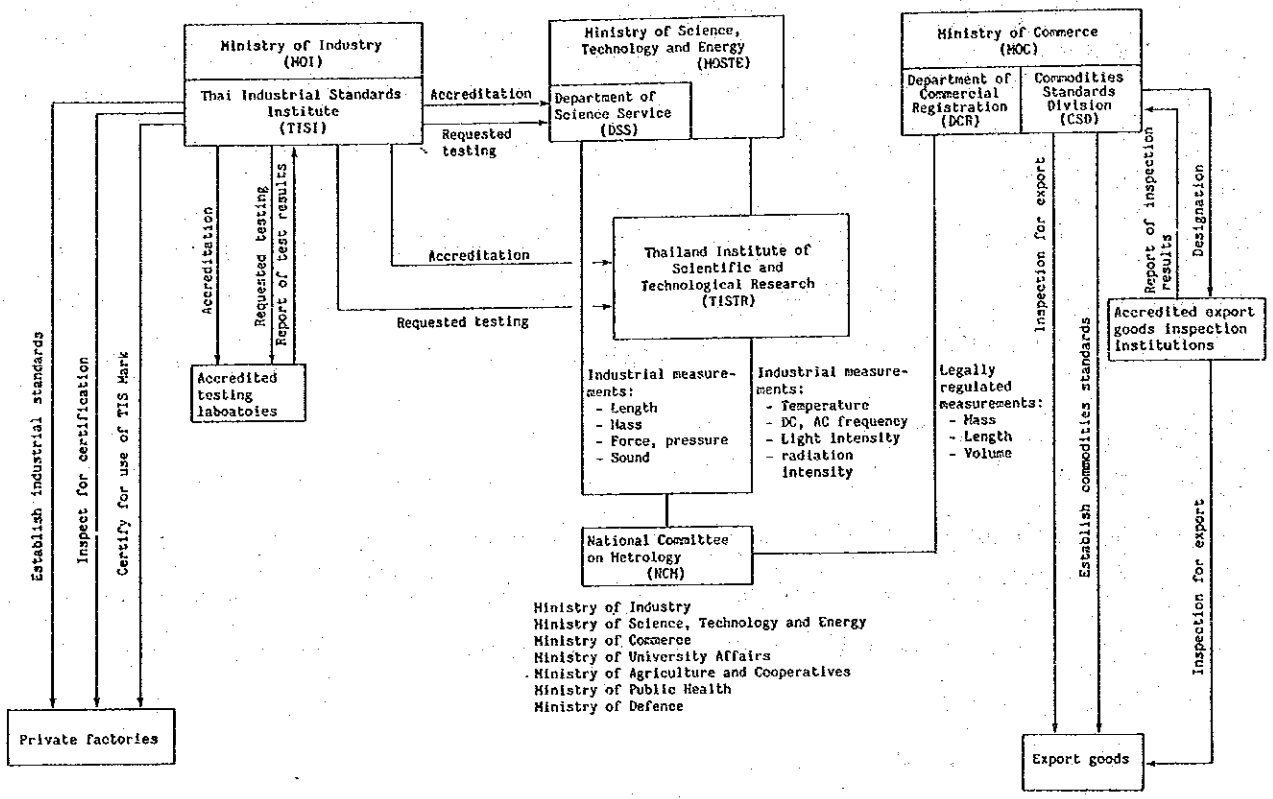


Fig. 2.3-1 Government Authorities Concerned

(1) Industrial Standardization and Certification

1) TISI (Thai Industrial Standards Institute)

TISI was established as a department of Ministry of Industry under the Industrial Product Standards Act.

1. Ogranization

TISI consists of Office of the Secretary, Technical & Foreign Relations Division, Standardization Division, Certification Division, Standardization Promotion Division and Office of the National Codex Alimentarius Committee, and has 420 officials.

2. Functions

- To prepare and publish industrial standards;
- To grant licences for use of Certification Mark;
- To promote the implementing of standards;
- To represent Thailand in international organizations for standardization;
- To be responsible for international food standards activities in Thailand and to cooperate with the Joint FAO/WHO food standards programmes.

TISI conducts certification for 29 compulsory standards and all other voluntary product standards.

For examining directly the products to be used in the field of architecture, civil, household and metals (the articles listed in Table 2.3-1 below), TISI owns a testing unit at Bang Yee-Khan in Bangkok, whose function is to test the articles when destined for export.

Table 2.3-1 Articles Subject to Test at the Bang Yee-Khan Testing Unit

| Field | Product |
|---|---|
| Architecture | Clay floor tiling, Clay wall tiling, Mosaic tiling |
| Architectural fittings | Dormer windows, Teak fittings, Window frames |
| Household articles | Aluminium ware, Artificial flowers, Canvas shoes, Leather gloves, Vinyl boots, Polyethlene rope, Polyester fibre, Rubber boots, Rubber sandals, Safety boots, Toys, Zip fasteners. |
| Metal articles | Hollow extruded-aluminium alloy articles, Aluminium and aluminium alloy plating and sheeting, Anodized aluminium articles, Galvanized steel stable conduits, Threaded-end galvanized steel piping, Steel piping, Steel water piping, Structural steel, Tinned steel plating |

Source: TISI

2) Accredited Testing Laboratories

TISI, the juridical body of the Industrial Product Standards Act, has all power in execution of testing/inspection specified by the Act. TISI, however, accredits other national organizations, national testing laboratories and other public institutions as accredited testing laboratories to entrust necessary testing pursuant to Article 5 of the Act in view of the inadequate testing faciliteis of its own. So far 49 organizations listed in Attached Table 5 have been accredited by TISI. TISTR and DSS shown below perform many certification testings every year.

TISTR (Thailand Institute of Scientific and Technological Research)

TISTR was founded in 1963 as a public corporation under the Thailand Institute of Scientific and Technological Research Act, placed under the jurisdiction of the Ministry of Science, Technology and Energy (MOSTE).

1. Organization

TISTR consists of Office of Governor, Office of Policy and

Planning, Office of Administration, Service Group, and Research and Development Group, and have 726 personnel.

2. Function

- To conduct research and provide technological services to public and private organizations, thus contributing to the economic and social development of the country.

- To conduct scientific and technological research aimed at effective utilization of natural resources, with a view to enhancement of the health and welfare of the people, conservation of the environment, and development of the national economy.

- To disseminate the results of scientific and technological research, with a view to enhancing productivity in accordance with national policy in the interests of the country's agriculture, industry and commerce.

- To train research engineers in different domains of science and technology.

- To provide testing, metrological and other scientific and technological services.

DSS (Department of Science Service)

DSS was founded in 1891 as a branch of the Royal Development of Mine and Geology and it was subsequently placed under the Ministry of Finance, then transferred to MOSTE in 1979. The Department discharges, notably, the following functions.

- To serve as the Government's scientific and technological research institute.

- To provide services to public and private organizations in chemical, physical and biological analyses.

- To conduct scientific and technological research to contribute to the effective utilization of the nations' natural resources and industrial/agricultural water sources.

- To provide analysis and testing services for certifying and controlling the quality of industrial products, foodstuffs and beverages.

- To provide public and private laboratory personnel with training in chemical analysis.

- To provide information services in scientific and technological fields.

3) Quality Control

Dissemination of quality control practices in private enterprises is undertaken by TISI through enforcement of the industrial standard certification system, in the form of initial inspection effected prior to grant of licence, on quality control practices in the factory, and in follow-up inspections effected thereafter. Training and dissemination activities in quality control are also undertaken by the following organizations:

1. Thailand Management Development and Productivity Centre
2. Thai/Japan Technology Promotion Association
3. QC Association
4. Thai Management Association
5. QC Headquarters

The two organizations heading the above list are those that are dedicating the active efforts in the dissemination of quality control practices.

(2) Metrology

1) Weights and Measures Division, Department of Commercial Registration, Ministry of Commerce

Matters relevant to legally regulated metrology are administered by this Division under the Law of Weights and Measures.

1. Organization

The Division comprises the four Subdivisions of Registration, of Standards, of Verification, and of Inspection, and it further operates 23 provincial branch offices.

2. Functions

The Division performs such functions as registration of enterprises engaging in metrological activities, maintenance and management of metrological standards, verification and periodical/on-the-spot inspections of measuring instruments.

3. Maintenance and management of the prototype

The prototype of the metre and the prototype of the kilogramme assigned from the International Bureau of Weights and Measures are entrusted to the maintenance and management of the Weights and Measures Division.

2) National Committee on Metrology

The committee was established in 1985 to constitute the central authority administering the establishment, maintenance and management of national metrological standard.

1. Organization

The Committee comprises 8 members, 7 Vice Ministers representing relevant Ministries, and the Vice Minister of MOSTE who is the chairman of this committee.

2. Functions

The Committee operates in two Sub-Committees. The Sub-Committee on Metrology is engaged mainly in assembly of information and data on metrological standards, and the Sub-Committee on laboratory accreditation is concerned mainly with determining the institutions to be charge with maintenance and management of metrological standards.

3. Assignement of metrological standards to various institutions

Currently, the different metrological standards have been assigned by the National Committee on Metrology to the various institutuions as set forth in Table 2.3-2.

Table 2.3-2 Assignments of Metrological Standards to Institutions

| Standard Unit | Prototype & primary standard | Secondary standard | Working standard |
|---|---|---|---|
| Length | DSS | DSS TISTR | DSS MOC |
| Mass | MOC DSS | DSS TISTR | TISTR MOC |
| Electric | | | |
| DC, Low Frequency | TISTR | TISTR DSS | TISTR DSS |
| High Frequency | TISTR | TISTR DSS | TISTR DSS |
| Temperature | TISTR | TISTR DSS | TISTR DSS |
| Volume, Flow | DSS | MOC | MOC |
| Pressure | DSS | TISTR | TISTR |
| Force | DSS | TISTR | TISTR |
| Density | | TISTR | TISTR |
| Viscosity | | TISTR | TISTR |
| Hardness | | TISTR | TISTR |
| Acoustics | DSS | TISTR | TISTR |
| Photometry | TISTR | TISTR | TISTR |
| Non-Ionizing Radiation | TISTR | TISTR | TISTR |
| Ionizing Radiation | | | AEP |
| Standard Gas | | | |

Source : NCM
AEP : Office of Atomic Energy for Peace
Note : The underlined institutions will be responsible for maintenance and management of metrological standards in the future.

3) Institutions Designated for Maintenance and Management of Industrial Metrological Standards

The two institutions designated for maintenance and management of industrial metrological standards are TISTR and DSS. Among the functions attributed to TISTR is that of maintenance and management of metrological standards, and Testing and Standards Centre of TISTR currently undertakes these functions for the domains of electricity, thermometry, photometry and radiation. On the other hand, while not officially so empowered, in consideration of equipment and capability, DSS is expected to take responsibility for the metrological standards related to mass, length, force, pressure and acoustics in future.

## 2-3-3 Industrial Standardization

### (1) Industrial Standards

It is prescribed by the Industrial Product Standards Act that industrial standards are to be established, amended or modified on the authority of the Industrial Product Standards Council, with the practical groundwork undertaken by the Technical Committees and the Standardization Division of TISI.

Since 1970, when the first industrial standard was established, a total of 700 standards have been set up, and capability of formulating standard is about 100 standards per year. The standards so far established are as set forth in Table 2.3-3, classified by field of application.

Table 2.3-3 Status of Establishment of Industrial Standards Classified by Field

| Field | '70 ~ '71 | '72 ~ '76 | '77 ~ '81 | '82 ~ '86 | '87 | Total |
|---|---|---|---|---|---|---|
| Chemical | 1 | 15 | 22 | 38 | 9 | 85 |
| Mechanical engineering | – | 14 | 42 | 33 | 6 | 95 |
| Agricultural products | – | 3 | 15 | 14 | 1 | 33 |
| Plastic products | – | 8 | 6 | 10 | – | 24 |
| Electrical engineering | 5 | 15 | 18 | 14 | 5 | 57 |
| Consumer products | 3 | 21 | 17 | 27 | 4 | 72 |
| Pulp & paper | – | 3 | 10 | 6 | – | 19 |
| Metallurgical | – | 18 | 21 | 20 | 6 | 65 |
| Civil engineering & construction materials | – | 18 | 10 | 22 | – | 50 |
| Architectural | 1 | 20 | 4 | 13 | 1 | 39 |
| Textiles | 1 | 13 | 2 | 9 | – | 25 |
| Non-metallic products | – | 3 | 9 | 23 | 5 | 40 |
| Food | 2 | 34 | 20 | 20 | 3 | 79 |
| Electronics/Communications | – | 1 | – | 4 | – | 5 |
| Others | – | 1 | 4 | 7 | – | 12 |
| Total | 13 | 187 | 200 | 260 | 40 | 700 |

Source: TISI
Note: Excluding sub-standards

The problems underlying industrial standards in their relation to the current status of industry are, notably, that:

1. The rate at which industrial standards are being developed is below the needs of developing industries. This may lead to the lag of industrial standardization.

2. The existing organization for drawing up industrial standards is inadequate, and calls for enhancement of capabilities, in order to permit the setting of appropriate industrial standards matched to the needs of industry.

3. There is a shortage of personnel possessing requisite knowledge for developing industrial standards, i.e. versed in relevant foreign standards as well as in the differences between the currently attainable levels of domestic and foreign product qualities.

4. There is need of modifying the current practice of giving equal weight, e.g. in terms of testing method, to requirements dictated by considerations of safety and of product performance. Separate provisions should be formulated according to the purpose for which each particular industrial standard is being drawn up.

5. Industrial standards currently established differ in their form from standard to standard, and lack consistency in form.

6. Practical application of industrial standards needs to be diffused to factory level.

Thus, continuing efforts need to be directed in the first instance to testing for the purpose of assembling the basic data needed for developing essential industrial standards to constitute the foundations of industrial standardization. To this end, the current insufficiencies in testing facilities and in proficient personnel call for supplementation through acquisition of requisite equipment and through expansion of personnel as well as effective training programmes.

(2) Industrial Standard Certification System

Industrial standard certification system applies to all product standards which cover roughly 80 percent of all industrial standards. Of these products standards, compulsory certification is applied on those governed by the 29 standards listed in Attached Table 1, enforced for such reasons as consumer protection, public welfare and economic efficacy. And the

products listed in Attached Table 2 are to be compulsory in the near future.

(3) Quality Control

The dissemination of quality control practices among private enterprises is being actively promoted by TISI through extension of the certification system. Dissemination has attained a fair level among foreign affiliated and export oriented manufacturers, and among others manufacturing for the domestic market, concern for quality control is emerging in the large scale enterprises, but further efforts are needed for diffusion down to medium and small scale enterprises.

The problems underlying the dissemination and promotion of quality control are, notably, that:

1. There is a shortage of instructors and of suitable teaching aid documentation and materials.

2. Factory workers need to be trained. Necessary education for promotion of standardizatoin activities emphasizing the notion of quality control is not established within enterprises.

3. The concept of quality control circle activity which is very effective for promotion of quality control has not diffused to smaller factories with less than 200 workers.

Accordingly, it is urgent need to train personnel who are able to promote standardization and quality control. The role of training personnel should be played mainly by TISI. And for this reason, TISI is required to obtain appropriate training capability.

(4) Testing Associated with Research and Development

Research and development in industrial field is among the functions attributed to TISTR by the TISTR Act. TISTR is actively contributing with efforts aimed at enhancing the level of Thai industrial products. Tests performed on request have doubled between 1981 and '85 in terms of revenue from fees and cases, to attain 3 million BT and 3,500 cases. The equipment available at the TISTR can be seen that the majority represents instrumentation of a general nature e.g. ammeter, voltmeter and multi-meter. Specialized equipment remains to be acquired. Best use is being made of available facilities, but the limitation in available equipment is prolonging the time between application for testing and issue of results, while inadequate calibration is impairing the accuracy of results.
The current situation, however, is that manufacturers are obliged to accord priority in their investment plans to extending and improving their productive equipment, with little surplus funds available to them for acquiring and extending their testing facilities. For this reason, it behooves upon TISTR to extend its testing equipment, to permit furnishing accurate and rapid results of testing.

## 2-3-4 Industrial Standard Certification System

(1) Outline of Industrial Standard Certification System

All production associated with industrial standards governing products are subject to certification, of which, those governed by the 29 standards are further subject to compulsory certification, and this latter category of standards is gradually being extended.
The industrial standard certification system is administered by TISI, but limitations in available testing equipment have led TISI to accredit other

government and public institutions for undertaking tests on request from and on behalf of TISI.

(2) Current Status of Certification Test Execution

1) Applications Field and Licenses Issued

The statistics covering the execution of certification testing TISI performed are as reproduced in Table 2.3-4. Over 70 percent of the applications issued relate to agricultural products, mostly limited to tapioca. Thus, while quantitatively the certification activities are currently largely limited to agricultural products, in qualitative terms, the coverage of product categories represented by the applications and license issues is seen to extend over all areas fields covered by the standards, which attests to the diffusion already achieved by the industrial standard certification system.

Table 2.3-4 Number of Certificaton Applicants and Licenses

1988.3.31

| No. | Field | No. of product standard published | No. of product standard implemented | | No. of product certified | | Number of applicants | Number of licensees |
|---|---|---|---|---|---|---|---|---|
| | | | in No. | % | in No. | % | | |
| 1 | Chemistry | 74 | 71 | 95.95 | 20 | 10.10 | 104 | 93 |
| 2 | Mechanical engineering | 100 | 87 | 87.00 | 14 | 7.07 | 80 | 62 |
| 3 | Agricultural products | 38 | 37 | 97.37 | 9 | 4.55 | 2,084 | 1,639 |
| 4 | Plastic and Plastic products | 31 | 31 | 100.00 | 4 | 2.02 | 10 | 5 |
| 5 | Electrical engineering | 54 | 51 | 94.44 | 20 | 10.10 | 152 | 111 |
| 6 | Consumer's products | 64 | 64 | 100.00 | 21 | 10.61 | 94 | 73 |
| 7 | Fundamental standards | 34 | 19 | 55.88 | 0 | 0.00 | 0 | 0 |
| 8 | Plup and paper | 25 | 24 | 96.00 | 6 | 3.03 | 16 | 16 |
| 9 | Metallurgy | 76 | 61 | 80.26 | 24 | 12.12 | 162 | 135 |
| 10 | Civil engineering and construction materials | 79 | 54 | 68.35 | 19 | 9.06 | 200 | 170 |
| 11 | Architectural | 39 | 35 | 89.74 | 22 | 11.11 | 191 | 160 |
| 12 | Textiles | 54 | 28 | 51.85 | 1 | 0.51 | 1 | 1 |
| 13 | Non-metal products | 80 | 43 | 53.75 | 13 | 6.57 | 170 | 94 |
| 14 | Food | 73 | 72 | 98.63 | 25 | 12.63 | 126 | 117 |
| | total | 821 | 677 | – | 198 | 30.76 | 3,390 | 2,676 |

Note: including basic standard

Source: TISI

2) Certification Testing Performed in the Past 4 Years

Records of certification testing commissioned to various accredited testing laboratories during the past 4 years from 1984 to 87 - reproduced in Attached Table 3 - indicate an annual increase of around 20 percent, with the exception of 1987, and reached almost 5,000 cases handled in 1986. The corresponding figures for TISI - Attached Table 4 - indicate a figure of 6,215 samples tested in 1987.

However, considerable number of the samples were tested by using testing facilities of the applicant manufacturers under the supervision of TISI officials, because of insufficient capacity of the accredited testing laboratories

It is notable that, of the 49 accredited testing laboratories, less than half were actually entrusted with testing during the past 4 years, and even those laboratories called upon covered only a limited range of testing work. The predominant part of certification testing has been performed in the hands of DSS and TISTR. DSS, in particular, has actually undertaken testing in all of the domains covered by industrial standards, and in terms of quantity also, it handled more than 40 percent of the testing work. This is followed by TISTR, which also has a range of testing capability second only to DSS, and it handled over 30 percent of the work in 1986.

Classified by domain, the applications for certification testing - reproduced in Table 2.3-5 - have progressed steadily in such product categories as chemical, mechanical, electrical, metal, civil engineering, architecture, non-metallic and foodstuffs, with agricultural products considered a category apart.

Table 2.3-5 Trend of Applications for Industrial Standard Certification Testing Classified by Industrial Fields·

| Industrial field | 1984 (%) | | 1985 (%) | | 1986 (%) | | 1987 (%) | |
|---|---|---|---|---|---|---|---|---|
| Chemical | 126 | (3.6) | 222 | (5.4) | 335 | (6.8) | 217 | (5.0) |
| Mechanical | 335 | (9.6) | 273 | (6.6) | 354 | (7.1) | 167 | (3.8) |
| Agricultural products | 867 | (24.9) | 369 | (8.9) | 233 | (4.7) | 257 | (5.9) |
| Plastics | 8 | (0.2) | 12 | (0.3) | 47 | (0.9) | 31 | (0.7) |
| Electric | 572 | (16.4) | 639 | (15.4) | 673 | (13.6) | 598 | (13.7) |
| Consumer products | 388 | (11.1) | 444 | (10.7) | 424 | (8.6) | 363 | (8.3) |
| Pulp/paper | 26 | (0.7) | 23 | (0.6) | 38 | (0.8) | 56 | (1.2) |
| Metallic | 472 | (13.5) | 1,089 | (26.3) | 1,051 | (21.2) | 1,081 | (24.8) |
| Civil engineering | 310 | (8.9) | 306 | (7.4) | 934 | (18.9) | 544 | (12.5) |
| Construction | 93 | (2.7) | 139 | (3.4) | 285 | (5.8) | 287 | (6.6) |
| Textiles | 6 | (0.2) | 2 | (0.0) | 0 | | 0 | |
| Non-metallic | 38 | (1.1) | 350 | (8.5) | 248 | (5.0) | 453 | (10.4) |
| Food | 228 | (6.5) | 269 | (6.5) | 328 | (6.6) | 306 | (7.0) |
| Electronics/communications | 18 | (0.5) | 4 | (0.1) | 2 | (0.0) | 2 | (0.0) |
| Total | 3,487 | (100.0) | 4,141 | (100.0) | 4,952 | (100.0) | 4,362 | (100.0) |

Source: TISI

Further itemization of the figures in Table 2.3-5 into tests under compulsory and non-compulsory standards results in Table 2.3-6, which reveals that the tests performed under the 29 compulsory standards have significantly exceeded 2,500 per year, with the exception of 1987. The marked diminution noted in agricultural products (i.e. tapioca from 844 in 1984 to 208 in 1988) can be attributed to the fact that most eligible factories had already obtained the licenses applied for. All the remaining product categories have seen significant increases from year to year in applications for certification. The corresponding figures for non-compulsory standards also have increased, which further reflects the rising number of industrial standards that have been established during this period, as indicated between parentheses in the same Table.

Table 2.3-6 Trend of Applications for Industrial Standard Certification Testing and Applicable Standards Classified by Industrial Fields and by Compalsory/Non-compulsory

| Industrial field | 1984 | | 1985 | | 1986 | | 1987 | |
|---|---|---|---|---|---|---|---|---|
| | Compulsory | Non-compulsory | Compulsory | Non-compulsory | Compulsory | Non-compulsory | Compulsory | Non-compulsory |
| Chemical | 53 | 73 | 121 | 101 | 151 | 180 | 140 | 77 |
| | (2) | (14) | (4) | (20) | (3) | (14) | (3) | (14) |
| Mechanical | 194 | 141 | 161 | 112 | 205 | 149 | 86 | 81 |
| | (6) | (10) | (6) | (15) | (6) | (16) | (6) | (14) |
| Agricultural products | 844 | 23 | 335 | 34 | 202 | 31 | 208 | 49 |
| | (2) | (3) | (2) | (4) | (2) | (6) | (2) | (7) |
| Plastics | | 8 | | 12 | | 47 | | 31 |
| | | (3) | | (4) | | (7) | | (6) |
| Electric | 422 | 150 | 444 | 195 | 496 | 177 | 459 | 139 |
| | (5) | (15) | (3) | (18) | (6) | (20) | (6) | (16) |
| Consumer products | 295 | 93 | 341 | 103 | 331 | 93 | 249 | 114 |
| | (3) | (18) | (4) | (13) | (4) | (15) | (4) | (19) |
| Pulp/paper | | 26 | | 23 | | 38 | | 56 |
| | | (7) | | (4) | | (5) | | (4) |
| Metallic | 323 | 149 | 922 | 167 | 763 | 288 | 460 | 621 |
| | (3) | (17) | (3) | (17) | (3) | (17) | (3) | (23) |
| Civil engineering | | 310 | | 306 | | 934 | | 544 |
| | | (12) | | (11) | | (14) | | (18) |
| Construction | | 93 | | 139 | | 285 | | 287 |
| | | (10) | | (13) | | (15) | | (20) |
| Textile | | 6 | | 2 | | | | |
| | | (2) | | (2) | | | | |
| Non-metallic | | 38 | 193 | 157 | 130 | 118 | 75 | 378 |
| | | (5) | (2) | (8) | (2) | (12) | (2) | (17) |
| Food | 66 | 162 | | 193 | 101 | 227 | 77 | 229 |
| | (1) | (17) | 76 | (18) | (1) | (26) | (1) | (17) |
| Electronics | | 18 | (1) | 4 | | 2 | | 2 |
| | | (1) | | (1) | | (1) | | (1) |
| Total | 2,197 | 1,290 | 2,593 | 1,548 | 2,383 | 2,569 | 1,754 | 2,608 |
| | (22) | (134) | (25) | (148) | (27) | (168) | (27) | (176) |

Note: Figure in ( ) shows the number of applicable standards
Source: TISI

While the number of approved enterprises is seen from Table 2.3-7 to be increasing every year, it has barely reached 3 percent of registered factories, and cannot be considered to indicate a rapid diffusion of the Certification System. The number of products certified per licensed factory also averages only 2, indicating much room left for enhancement of product quality to the level demanded by the industrial standard system.

Table 2.3-7 Data on Industrial Standard Certification Mark

| | Up to 1984 | Up to 1985 | Up to 1986 | Up to 1987 |
|---|---|---|---|---|
| Number of enterprises applied | 3,756 | 4,062 | 4,386 | 3,457 |
| Number of enterprises approved | 2,071 | 2,232 | 2,352 | 2,702 |
| Number of approvals | 4,255 | 4,531 | 4,774 | 5,658 |

Source: TISI

3) Expected and Actual Time for Obtaining Test Results

Table 2.3-8 reproduces - from data furnished by TISI - the time from application to issue of test results, on 19 compulsory and 18 non-compulsory standard products. The Table gives the expected and actual figures, the latter in time of average and worst cases.

It is revealed from this Table that the actual time exceeds what is expected in almost all cases. The ratio of time between what is the worst actual case and what is expected exceeds a factor of 3 for 8 out of 12 products in the electrical, for 5 out 8 products in the metallic, and for 5 out 7 products in the machinery lines. The corresponding factors never reach 3 in the lines of pulp, chemical and non-metallic products.

Table 2.3-8 Expected Time and Actual Time of Testing

| TIS No. | Category | Product | Expected time | Actual max. time | Ratio | Actual mean time | Mean ratio |
|---|---|---|---|---|---|---|---|
| 11 | Electric | PVC Insulated cables and flexible cords | 30 | 300 | 10.0 | 194 | 0.72 |
| 17 | Consumer products | Polyvinyl chloride pipes for drinking | 60 | 102 | 1.7 | 86 | 1.5 |
| 20 | Metallic | Steel bars for reinforced concrete (round) | 15 | 99 | 6.6 | 45 | 3.0 |
| 23 | Electrical | Ballast fluorescent lamps | 20 | 186 | 9.3 | 99 | 5.0 |
| 24 | Metallic | Steel bars for reinforced concrete (deformed) | 15 | 71 | 4.7 | 39 | 2.6 |
| 27 | Mechanical | Gas cylinders | 94 | 253 | 2.7 | 47 | 0.50 |
| 30 | Chemical | Nitrous oxide for medical purpose | 30 | 66 | 2.2 | 66 | 2.2 |
| 78 | Chemical | Laundry detergent powder | 42 | 52 | 1.2 | 52 | 1.2 |
| 196 | Mechanical | Automotive safety glasses (laminated) | 28 | 261 | 9.3 | 261 | 9.3 |
| 211 | Metallic | Steel bars for reinforced concrete (re-rolled) | 15 | 141 | 9.4 | 40 | 2.6 |
| 293 | Electrical | PVC insulated aluminium cables | 30 | 288 | 9.6 | 127 | 309 |
| 309 | Consumer products | Mosquito coils and sticks | 30 | 29 | 1.3 | 34 | 1.1 |
| 366 | Electrical | Electric irons | 90 | 58 | 0.64 | 58 | 0.64 |
| 369 | Mechanical | Safety helmets for road user | 30 | 127 | 4.2 | 127 | 4.2 |
| 496 | Non-metallic | Lacquer thinner | 20 | 34 | 1.7 | 29 | 1.5 |
| 520 | Non-metallic | Automotive nitrocellulose lacquer thinner | 30 | 39 | 1.3 | 30 | 1.0 |
| 531 | Consumer products | Plastic containers for sterile pharmaceutical products | 35 | 79 | 2.3 | 71 | 2.0 |
| 539 | Chemical | Carbon dioxide for medical use | 30 | 35 | 1.2 | 35 | 1.2 |
| 540 | Chemical | Oxygen for medical use | 30 | 85 | 2.8 | 85 | 2.8 |
| 7 | Electrical | Battery containers | 45 | 84 | 1.9 | 84 | 1.9 |
| 49 | Metallic | Arc welding electrodes | 45 | 42 | 0.93 | 47 | 1.0 |
| 64 | Electrical | Copper conductors | 25 | 177 | 7.1 | 177 | 7.1 |
| 86 | Electrical | Aluminium conductors | 35 | 232 | 6.6 | 88 | 2.5 |
| 92 | Electrical | Table-type fans | 30 | 141 | 4.7 | 121 | 4.0 |
| 118 | Electrical | Automotive low voltage cables | 29 | 89 | 3.1 | 89 | 3.1 |
| 146 | Mechanical | V-belts | 7 | 60 | 8.6 | 60 | 8.6 |
| 226 | Electrical | Polyester enamelled copper wires | 22 | 53 | 2.4 | 53 | 2.4 |
| 236 | Electrical | Fluorescent lamps | 96 | 165 | 1.7 | 165 | 1.7 |
| 248 | Metallic | Corrugated sheets | 50 | 91 | 18 | 91 | 1.8 |
| 254 | Mechanical | Bicycle frames | 28 | 72 | 2.6 | 72 | 2.6 |
| 276 | Metallic | Steel pipes | 45 | 135 | 3.0 | 95 | 2.1 |
| 279 | Electrical | Insulators | 15 | 68 | 4.5 | 41 | 2.7 |
| 291 | Mechanical | Hexagon bolts | 45 | 175 | 3.9 | 58 | 1.3 |
| 300 | Mechanical | Truck pins | 25 | 456 | 18.2 | 456 | 18.2 |
| 325 | Metallic | Aluminium foil | 14 | 59 | 4.2 | 49 | 3.5 |
| 343 | Metallic | Water taps | 90 | 38 | 0.42 | 23 | 0.26 |
| 476 | Pulp | Stencil paper | 65 | 77 | 1.2 | 77 | 1.2 |

4) Testing Equipment in Relation to Rate of Testing

Testing must obviously be performed using equipment adequate for the prescribed requirements, and the equipment manipulated by personnel of adequate proficiency, but there exist clear limits to the rapidity with which testing can be performed by a given set of equipment. Execution of testing at a rate beyond these limits cannot be accomplished without multiplication of the testing equipment.

The equipment currently available at DSS and TISTR is largely adequate in terms of performance but insufficient in quantity, and this latter factor is tending to lengthen the time between application and issue of test results. In addition, some of the equipment has become worn and can no longer ensure the accuracies required for testing in conformity with relevant standards.

Thus, while the certification system is in itself well established, the problem lies in the time required between application and issue of test results, which in turn has impeded the desirable spread of the system through industry. The lengthy time produces corresponding delays in letting the test results be reflected in product quality for effective enhancement of the technological level of industry.

The accredited testing laboratories are all loaded with their own testing work, which has to be performed with their limited available equipment. Thus, these laboratories are not always in a position to respond readily to requests for testing from outside. As number of testing for certificatoin is increasing by 700 annually, testing time will further be lengthened if testing capacity remains at present level. To solve this problem, it is important for TISI to have testing facilities of its own and carry out certification testing directly. And testing time will be expected to shorten.

## 2-3-5 Standard and Calibration Services in Industrial Metrology

### (1) Maintenance and Management of Primary Metrological Standards

As mentioned in Section 2-3-2 (2) 2), the National Committee on Metrology serves as the central authority that assigns to different government offices the responsibility of maintaining and managing national metrological standards. The metrological standards of interest to industry, relevant to scientific and technological research, have been assigned mainly to TISTR.

### (2) TISTR

#### 1) Metrological Standards

The metrological standards in each level and set-up of measuring instruments owned by TISTR are as listed in Attached Table 8. The levels of the standards in the custody of TISTR are:-

- Primary standards — Electricity (DC, AC - low and high frequency), thermometry, photometry
- Secondary standards — Mass, length, pressure
- Working standards — Force, hardness, viscosity, density.

In respect of primary standards, in addition to three quantities cited above, radiation also has been assigned by the National Committee on Metrology, but relevant equipment is yet to be acquired. It is planned to acquire the requisite equipment, and to furnish calibration service, the same applies to other quantities similarly assigned by TISTR law, but for which the relevant standards and calibrating equipment are not available.

In the first instance, TISTR should undertake establishing the primary standards covering the quantities assigned to TISTR, and to have the

standards made available as necessary to other institutions, and the relevant techniques also need to be enhanced.

2) Calibration Service

Calibration services are provided by TISTR on a wide range of instrumentation, including industrial, electrical and electronic measuring instruments, illuminometers and thermometers, etc. Requests for calibration, however, are not frequent, and moreover are mostly for field use instruments of relatively low precision.

(3) Present Status of Metrological Standard

1) Electrical

TISTR is on the whole well equipped with facilities for accurate calibration work in DC and low-frequency AC.

Calibration services actually demanded of TISTR, however, have numbered only 212 during 1986, but this still represented an increase of 49 over 1984. The instruments brought in for calibration were mostly for field use, of relatively low precision, which could well have been calibrated in-house, if appropriate equipment were available within enterprises.

This is a domain where a rapidly increasing number of calibration requests and a rising level of calibration work is to be expected in future, accompanying industrial development. With respect to DC and low-frequency AC, the calibration equipment calls for supplementation, and for high-frequency AC, the standards need to be established, as well as the equipment for calibration.

The current technical level of calibration service proved quite adequate for responding to the requests from outside owing to the project of Institute for Transfer of Industrial Technology (ITIT project) which was carried out from 1975 through 1982 between TISTR and the Electrotechnical Laboratory of Japan, but should require

further enhancement to cover future demands in the domain of high-frequency measurements, expected to progress in both number and precision with the advance of Thai industry.

2) Thermometry

The thermometric standards and calibrating equipment includes fixed-point systems conforming with the 1968 International Practical Temperature Setting, as well as other equipment such as variable temperature vessel and standard resistance thermometers.

The instruments brought in for calibration have been mostly for field use, of relatively low precision. The demand for calibrating instruments of higher quality and in increasing quantity can be expected in future, with the progress in quality and reliability that will come to be demanded of products. Facility for calibration in the range below 0°C is yet unavailable, and demands involving this range are currently answered by calculated estimates, but relevant equipment can be expected to become indispensable with progress of sophistication in industry.

The technological level of calibration service has been raised to a quite high level through Japanese and Australian technical assistance and training programmes.

3) Photometry

The equipment related to photometry is currently nearly quite adequate.

The primary standards for photometry has been supplied and is being maintained and managed by the Electrotechnical Laboratory (Japan). The Institute for Transfer of Industrial Technology (ITIT) project on photometry, undertaken since 1975, has been brought to the level of calibration accuracy close to that of the Japanese source laboratory.

4) Physical Quantities

Condition of maintenance for currently available equipment include those covering mass, length, pressure, force, etc. are as follows:

1. Mass

The currently established mass standards, while accorded status of standards for scientific research, are of accuracy that would rank them as secondary standards.

2. Length

Standard measuring equipment covers very little more than micrometers and height gauges.

3. Pressure, Force

Force standards are available in the form of proving rings and a number of loading weights, and for pressure, deadweight pressure testers and aneroid barometers are available, but all outdated and worn.

4. Volume, Flow

No facilities at all are available in these domains.

Calibration services furnished relative to physical quantities numbered 65 in 1986. The technological level is low, as instanced by the absence of capability for fractionation and multiplication of calibrating standard masses, and it should be raised.

Physical quantities constitute the basic units not only in commerce but also in industry. TISTR is a sole organization which provides these quantities, and for this reason, while it is not assigned custody of the primary standards in this domain, it should be equipped with standards equivalent to primary, in order to let TISTR adequately ensure its function of providing calibration service, and consequently to contribute to industrial development.

5) Radiation

Currently no equipment is available for performing calibration services. Establishment of metrological standard is projected under a 5-year plan that started in 1986, training of personnel is under way in Japan and other countries.

To ensure this function adequately, TISTR should in the first instance establish the primary standards in a wide range from infrared to ultraviolet rays, and acquire calibration equipment for illumino-meters.

6) Acoustic, Vibration

No equipment is available to cover these domains and measuring techniques need to be acquired.

It should be equipped with standards and calibrating equipment to cover acoustics, in view of the rising demand for calibration for the noise level meter.

7) Hardness, viscosity, Density

Working standards are currently at disposal, but not calibration service has yet been furnished. Such service can be expected to come to be demanded in future, with enhancement of the technological level, and therefore, TISTR is expected to establish a calibration system by which it can adequately provide calibration service corresponding to such emerging demand.

## 2-3-6 Technical Personnel

### (1) TISI

#### 1) Certification Testing

Certification testing is under the charge of the Certification Division. Actual testing operations, however, are entrusted to accredited testing laboratories, to cover the insufficiently available facilities at TISI, and no certification testing is currently practiced within TISI.

It is planned in TISI to extend its organization to cover certification testing undertaken in its own testing facilities, with the view to shortening the time between request for testing and issue of test result, and to recruit testing engineers for this purpose.

The new centre to be established is envisaged to undertake the training of this freshly recruited engineers, as well as in other testing/inspection institutions and in private enterprises. Such training will also constitute part of the technical cooperation programme.

#### 2) Development of Industrial Standards

The development of industrial standards is under the charge of the Standardization Division. This Division conducts simple testing for development of industrial standards for products of daily use by 15 engineers. But lack of requisite testing equipment is hampering the assembly of data needed for the work of developing the standards.

It behooves upon TISI to contribute to improvement of quality of Thai industrial products by being equipped with requisite testing facilities and to train technical personnel, in order to become fully capable of drafting industrial standards that are matched to the

current level of industrial development while taking into account the envisaged future attainment of industrialization.

3) Quality Control

Quality control is under the care of the Quality Control Sub-Division of the Certificaiton Division, where 20 officials are in charge. Seminars and symposia are organized by the Sub-Division, but their activity is hampered by the shortage of proper instructors and of instruction material, and demands emanating from industry cannot be fully satisfied.

To this end, TISI, as the national centre for promoting industrial standardization, should take the lead by training its own personnel to serve as leaders capable of training personnel from outside in the matter of standardization including quality control, and in this manner to contribute to disseminating and promoting standardization and quality control.

(2) TISTR

1) Testing Associated with Research and Development

The technical personnel in TISTR engineering in testing associated with research and development numbers 33. Such personnel are called upon to undertake the study of new products from every angle, and to devise testing methods suited to individual needs, and to establish appropriate criteria for the tests. Specialists capable of such exercise need to be considerably increased in number particularly in the domains of electrical, electronic and mechanical engineering. This should call for the provision of an ample period of training administered under a systematic programme to be developed for the purpose.

2) Metrology

The technological personnel in the TISTR number 4 in electrical quantities, 3 in the physical quantities of length, mass, pressure and force, and 3 in photometry, thermometry and radiation, totalling 10. Of these 10, 2 in electrical, 1 in physical, and 1 in photometric/thermometric quantities are engaged in providing calibration service. Many of the staff have been sent abroad for training including trainig under the ITIT project, and possess high technical proficiency. Nonetheless, further administration of systematically planned training should be advisable in readiness for increased demands for calibration in widening ranges and domains that should be expected in future.

## 2-4 Background Circumstances and Substance of Request for Assistance

The development of industrial standardization, the dissemination and promotion of quality control, the acceleration of certification testing, the establishment of an adequate metrological system to serve industry, the provision of an efficient calibration service, and the performance of testing for research and development are all measures that have been accorded due importance for the industrial development of Thailand, and adopted in national policy.

The current status of these measures, however, still retains a number of problems calling for improvement, and these circumstances have led to TISI and TISTR filing requests for assistance, as noted in Chapter 1.

The two requests were subsequently merged into a single request. The Preliminary Study Team for Grant Aid and Contact Team for Technical Cooperation, in consultation with the Thai Government, confirmed the following points on the matter of establishing the two Centres - for the Industrial Standardization, Testing and Training Centre and for the Industrial Metrology Testing Service Centre.

(1) Objective

The objective of the Project is to construct necessary facilities and to provide necessary equipment to implement development programmes of industrial standardization, testing and metrology in Thailand.

(2) Administering Government Offices

- Ministry of Industry
- Ministry of Science, Technology and Energy

(3) Implementing Agencies

- Thai Industrial Standards Institute
- Thailand Institute of Scientific and Technological Research

(4) Project Site

- Bangpoo Industrial Estate, Km 34, Sukhumvit Road, Samutprakarn Province

(5) Principal Project Components

1) Buildings

- Industrial Standardization, Testing and Training Centre
- Industrial Metrology Testing Service Centre

2) Equipment

1. TISI

Equipment of basic and urgent need for the use of formulating national industrial standards, and for implementing certification (testing and quality control).

The domains of application to be covered are industrial standardization, and testing on material and mechanical properties, electrical and electronics, and chemical.

2. TISTR

Equipment of basic and urgent need for the use of national metrology (excluding commercial metrology) and testing for industrial research and development.

The domains of application to be covered are:

- For metrology : Mass, length, force, pressure, volume, fluid flow, photometry, radiation, acoustics, vibration, electrical, electronics, temperature

- For testing : Materials, and mechanical properties, electrical and electronics, chemistry and biochemistry.

# CHAPTER 3 CONTENTS OF THE PROJECT

# CHAPTER 3 CONTENTS OF THE PROJECT

## 3-1 Objectives

The objective of this project is to promote industrial development in Thailand by establishing the following two Centres as nuclei of promoting industrial standardization and certification, and industrial metrology and calibratoin service, etc. respectively;

1. Establishment of the Industrial Standardization, Testing and Training Centre: as nucleus for promoting industrial standardizaiton and certification
2. Establishment of the Industrial Metrology Testing Service Centre: as nucleus for establishment of industrial metrological standards, promoting calibration services and conducting testing associated with research and development

## 3-2 Examination of the Request for Assistance

The above request received from the Thai Government has been examined for determining the expected volume of certification testing work, the substance of training programmes, the metrological standards requiring to be established, maintained and managed, the expected demand for testing associated with research and development, the estimated staffing and budgetary requirements for effective operation and maintenance of the establishments, and other relevant aspects. Concordance with other technical cooperatoin project was also taken into consideration, which led to the adoption of a period of 5 years as the duration of the immediate project, i.e. to furnish capacity sufficient to cover demand to be expected at the end of 5 years from establishment. With particular

respect to training facilities, however, it is necessary to be facilitated that these Centres are able to act as permanent national centres for training.

The foregoing examination resulted in plans for the two Centres as presented in what follows, to provide the functions and activities during the first years of operation as described in Section 3-3-1.

## 3-3 Project Outline

### 3-3-1 Functions and Activities of the Centres

(1) The Industrial Standardization, Testing and Training Centre

1) Testing for Development of Industrial Standards and for Certification

Testings for development of industrial standards and for certification are to be conducted. Priority should be given during the first years to tests for development of industrial standards in industrial sectors which are expected to develop remarkably in the near future, and certification tests relevant to compulsory standards and to those expected to be compulsory in the near future.

Estimated figures for certification testing in a year is shown in Table 3.3-1, and estimated figures for development of industrial standards in a year are 150.

Table 3.3-1 Estimated Figures of Testing by Industrial Fields

| Industrial Field | Figures |
|---|---|
| Chemical | 200 |
| Mechanical | 200 |
| Agricultural Products | 230 |
| Plastics | 25 |
| Electrical | 500 |
| Consumer Products | 325 |
| Pulp/Paper | 30 |
| Metallic | 850 |
| Civil Engineering | 470 |
| Construction | 185 |
| Textiles | 5 |
| Non-metallic | 280 |
| Food | 250 |
| Electronics/Communications | 5 |
| Total | 3,555 |

Source: Study Report on Development Programmes of Industrial Standardization, Testing and Metrology in the Kingdom of Thailand.

2) Training for Standardization and Quality Control

With the view to enchancing technical capability for quality control, training is to be conducted for the personnel to become leaders for industrial standardization and quality control in TISI, in accredited testing laboratories, and in private enterprizes. Priority should be given during first years to TISI personnel and to trainees sent from accredited testing laboratories. For this purpose, 6 lecturers are estimated to be trained during the first years.

Expected numbers for personnel training by each course in a year are shown in Table 3.3-2.

Table 3.3-2 Expected Numbers for Personnel Training by Each Course

| Courses | Numbers |
|---|---|
| Industrial Standardization | $15 \times 4^{\text{times}} \times 2^{\text{CP}}$ |
| Quality Control Leader | $15 \times 4^{\text{times}} \times 2^{\text{CP}}$ |
| Quality Control Staff | $15 \times 4^{\text{times}} \times 2^{\text{CP}}$ |
| Design of Experiments | $15 \times 2^{\text{times}} \times 2^{\text{CP}}$ |
| On-Line QC | $15 \times 2^{\text{times}} \times 2^{\text{CP}}$ |

Note: CP means Thai counterparts
Source: Study Report same as referred to in Table 3.3-1

3) Training for Promoting Enhancement of Testing Techniques and Skill

Training courses are to be organized for personnel from private enterprises and accredited testing laboratories, with the view to enhancing testing techniques and practices. Priority should be given during the first years to basic testing practice and to practical applications of testing.

Expected numbers for personnel training by each course in a year are shown in Table 3.3-3.

Table 3.3-3 Expected Number for Personnel Training by Each Course

| Course | Numbers |
|---|---|
| Electrical | $5 \times 1^{\text{time}} \times 4^{\text{CP}}$ |
| Electronic | $5 \times 1^{\text{time}} \times 4^{\text{CP}}$ |
| Machinery | $5 \times 1^{\text{time}} \times 8^{\text{CP}}$ |
| Materials; Properties of Matter | $5 \times 1^{\text{time}} \times 4^{\text{CP}}$ |
| Chemical | $5 \times 1^{\text{time}} \times 3^{\text{CP}}$ |

Note: CP means Thai counterparts

Source: Study Report same as referred to in Table 3.3-1.

4) Technical Guidance and Consultancy Services in Industrial Standardization, Quality Control and Testing

Visiting guidance and consultancy services are to be conducted on factories intending to apply for certification license, those actively furthering standardization and quality control practice, and those desiring to enhance their in-house testing capability. Priority should be given during the first years to factories manufacturing products governed by compulsory standards.

Expected figures in a year are shown in Table 3.3-4.

Table 3.3-4 Expected Figures for Technical Instruction

| Field | Figures |
|---|---|
| Standardization, Quality Control<br>Factory Survey,<br>Roving Consultancy | 25 |
| Testing<br>Factory Survey,<br>Technical Guidance | 15 |

Source: Study Report same as referred to in Table 3.3-1.

5) Planning

Surveys and studies are to be conducted on methods best adapted to current domestic conditions for promoting standardization and quality control practice.

Procedure and method are shown below.

1. Implementing study of presently adopted method in Thailand in each field.
2. Implementing study of method in industrialized countries on the same kind of field of item 1 above.
3. Examining of the correspondint method to current state of Thai industries.

6) Technical Information Service

Information on standardization, quality control and testing is to be served.

7) Testing on Request

In addition to the tests referred to under Section 3-3-1, (1), 1) above, chemical analysis of samples, testing of specimens and other testing work requested by private enterprises are to be performed for assisting their efforts in improving product quality. Priority should be given during the first years to requests brought in from public

testing institutions and from factories manufacturing products governed by compulsory standards.

Expected figures in a year are shown in Table 3.3-5.

Table 3.3-5 Expected Figures for Testing Service by Each Field

| Industrial Field | Figure |
|---|---|
| Chemical | 100 |
| Mechanical | 100 |
| Agricultural Products | 100 |
| Plastics | 10 |
| Electrical | 300 |
| Consumer Products | 150 |
| Pulp/Paper | 10 |
| Metallic | 450 |
| Civil Engineering | 200 |
| Construction | 200 |
| Textiles | 5 |
| Non-metallic | 150 |
| Food | 150 |
| Electronics/Communications | 5 |
| Total | 1,830 |

Source: TISI

(2) The Industrial Metrology Testing Service Centre

1) Metrology

1. Establishment of a National System for Ensuring Availability of Industrial Metrological Standards

A national system adapted to national needs and conditions is to be established for ensuring proper availability of the metrological standards assigned to TISTR, and within the scope covered by the Centre's calibration services, to establish the corresponding in-house system for the relevant metrological standards. Priority should be given during the first years to establishing a national system in electrical, thermometric, photometric and radiation quantities.

2. Establishment, Maintenance and Management of Industrial Metrological Standards

Primary standards which are assigned to TISTR by NCM are to be established, maintained, and made available to other laboratories and sectors within the Centre, as well as to other public institutions and private enterprises. Further, standards are to be established and made available covering viscosity, density, hardness and other quantities, as necessary. Priority should be given during the first years to establishing, maintaining and making available primary standards covering electrical, thermometric, photometric and radiation quantities.

3. Improvement of Calibration Accuracy; Extension of the Scope of Calibration Services; Development of New Calibration Techniques

The metrological standards and calibration equipment of various levels is to be modernized, to enhance the accuracies obtainable in calibrating metrological standards within the Centre, as well as in public institutions and private enterprises. Further, new calibration methods and techniques are to be developed. Priority should be given during the first years to calibration of instruments for measuring physical quantities (length, mass, volume, force and pressure) and temperature, as well as electrical, acoustic and photometric quantities, which are in significant demand of calibration.

4. Calibration Services

Calibration services are to be provided to other sectors within the Centre, to public institutions and private enterprises. Visiting calibration service is to be provided, with coverage gradually extended to an increasingly wide range of private enterprises. Priority should be given during the first years to calibration of instruments for measuring physical quantities (length, mass, volume, force, pressure) and temperature, as well as electrical, acoustic and photometric quantities, which are in significant demand of

calibration.

Expected figures for calibration service by each quantity in a year are shown in Table 3.3-6.

Table 3.3-6 Esxpected Figures for Calibration Service by Each Quantity

| Quantities | Figures |
|---|---|
| Physical Quantity | 300 |
| Electrical | 750 |
| Thermometric | 180 |
| Photometric | 50 |
| Acoustic | 50 |
| Total | 1,330 |

Source: Study Report same as referred to in Table 3.3-1.

5. Technical Information Service

Technical information service is to be provided to other sectors within the Centre as well as to public institutions and private enterprises, in such forms as publication of reports on technical research and circulation of technical information.

6. Technical Guidance and Dissemination Services

Technical guidance and dissemination services are to be provided in such forms as technical consultancy, training courses and seminars, with the aim of disseminating metrology-mindedness. Exchanges and international comparisons are to be made with the ASEAN countries and with advanced nations. Priority should be given during the first years to supplying public institutions and private enterprises with opportune and pertinent technical information.

2) Testing

1. Testing Associated with Research and Development

Various testings are to be performed in conformity with international and foreign standards, and for research and development in industrial field, with a view to promoting exports. Priority should be given

during the first years to testing in the domains of electrical and electronics, materials and mechanical engineering, chemical and biochemical.

Expected figures for testing service by each field in a year are shown in Table 3.3-7.

Table 3.3-7 Expected Figures for Testing Service by Each Field

| Field | Figures |
|---|---|
| Electrical/Electronic | 1,000 |
| Material/Machanical | 1,500 |
| Chemical/Biochemical | 2,500 |
| Total | 5,000 |

Source: TISTR

2. Testing on Request

Testing is to be performed in response to requests from private enterprises, public institutions and testing laboratories. Priority should be given during the first years to requests received from public institutions and testing laboratories in the domains of electrical and electronics, materials and mechanical engineering, chemical and biochemical.

Expected figures for testing service by each field in a year are shown in Table 3.3-8.

Table 3.3-8 Expected Figures for Testing Service by Each Field

| Field | Figures |
|---|---|
| Electrical/Electronic | 250 |
| Material/Machanical | 350 |
| Chemical/Biochemical | 600 |
| Total | 1,200 |

Source: TISTR

3. Training

Training is to be administered with the aim of letting personnel acquire and improve their testing capability, and of enhancing their capability for dealing with new products and processes. The activity is to be extended to other testing institutions and to private enterprises. Priority should be given during the first years to basic testing practice and to practical applications of testing in the domains of electrical and electronics, materials and mechanical engineering, chemical and biochemical.

Estimated numbers for personnel training in a year are shown in table 3.3-9.

Table 3.3-9 Numbers for Personnel Training

| Field | Numbers |
|---|---|
| Electrical | $5 \times 1^{time} \times 4^{CP}$ |
| Electronics | $5 \times 1^{time} \times 4^{CP}$ |
| Materials/Machanical | $5 \times 1^{time} \times 4^{CP}$ |
| Chemical/Biochemical | $5 \times 1^{time} \times 4^{CP}$ |

Note: CP means Thai counterparts

Source: Study Report same as referred to in Table 3.3-1.

4. Technical Information Service

Technical information service is to be provided to public institutions and private enterprises.

## 3-3-2 Organization

(1) The Industrial Standardization, Testing and Training Centre

The envisaged personnel organization of the Industrial Standardization, Testing and Training Centre is presented in Fig. 3.3-1.

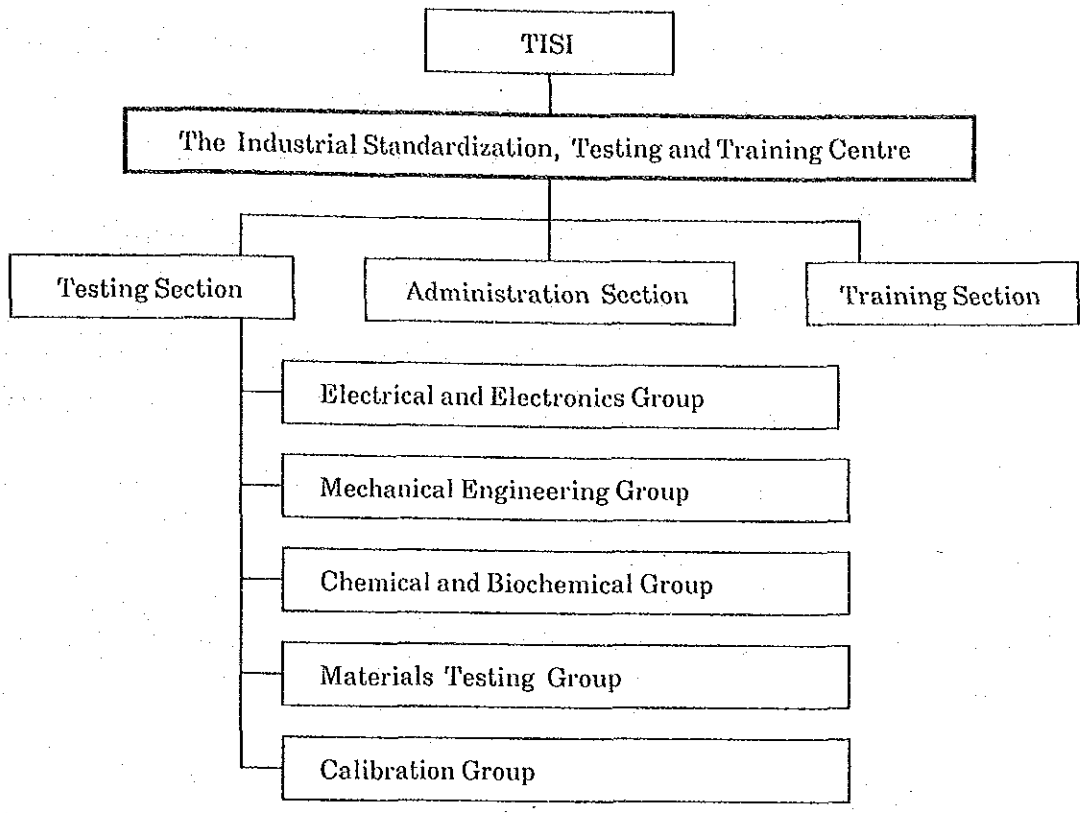


Fig. 3.3-1 Organization of The Industrial Standardization, Testing and Training Centre

1) Functions

The functions of the three sections constituting the Centre are as described below.

1. Testing Section

In order to shorten the excessive time currently incurred between application for certification testing and issue of test results, and considering the expected future additional demands for certification, the Testing Section is to have 4 Groups separately covering the different domains indicated by their designations. The Calibration Group is to ensure maintenance of requisite accuracies in the measuring equipment operated by the foregoing 4 Groups.

2. Administration Section

The Administration Section is to be charged with operations relevant to certification and licensing (except actual testing), to training (except actual training work), as well as general administrative and clerical work.

3. Training Section

The Training Section is to be charged with activities for training for standardizaton including quality control, together with ancillary operations.

2) Staff

The personnel required to staff the Centre has been estimated as given below.

1. Testing Section

Statistics covering the past several years indicate an annual increase of around 700 applications for certification testing, meaning that in 5 years an additional 3,500 testing would have to be handled over and above the current demand. The number of testing handled by a staff could be expected to be about 35 (cf. 40 - 50 in same kind of laboratories in Japan), with adequate training, to be administered also to freshly recruited personnel. This assumption has yielded the figure of 98 indicated below in Table 3.3-10.

2. Administrative Section

This Section is to be charged also with the work of receiving applications for certification testing and of technical information service, which should call for assignment of a staff of 3 as indicated in Table 3.3-10.

3. Training Section

Considering that this Section is to engage in the actual work of organizing training courses, a staff of 6 as indicated in Table 3.3-10 is considered indispensable.

Table 3.3-10 Staffing - The Industrial Standardization, Testing and Training Centre

| Section & Group | Senior/ Intermediate Grade | Junior Grade |
|---|---|---|
| Administration Section | 2 | 1 |
| Training Section | 4 | 2 |
| Testing Section<br>Electrical and Electronics Group | 20 | 8 |
| Mechanical Engineering Group | 22 | 16 |
| Chemical and Biochemical Group | 7 | 6 |
| Materials Testing Group | 10 | 8 |
| Calibration Group | 1 | |
| Total | 66 | 41 |

Note: The Calibration Group staff is to be joined by 2 others (1 senior/ intermediate, 1 junior grade) assigned to other Group but who will come over to undertake the actual calibration work as and when called upon.

Source: Study Report same as referred to in Table 3.3-1.

(2) The Industrial Metrology Testing Service Centre

The envisaged personnel organization of the Industrial Metrology Testing Service Centre is presented in Fig. 3.3-2.

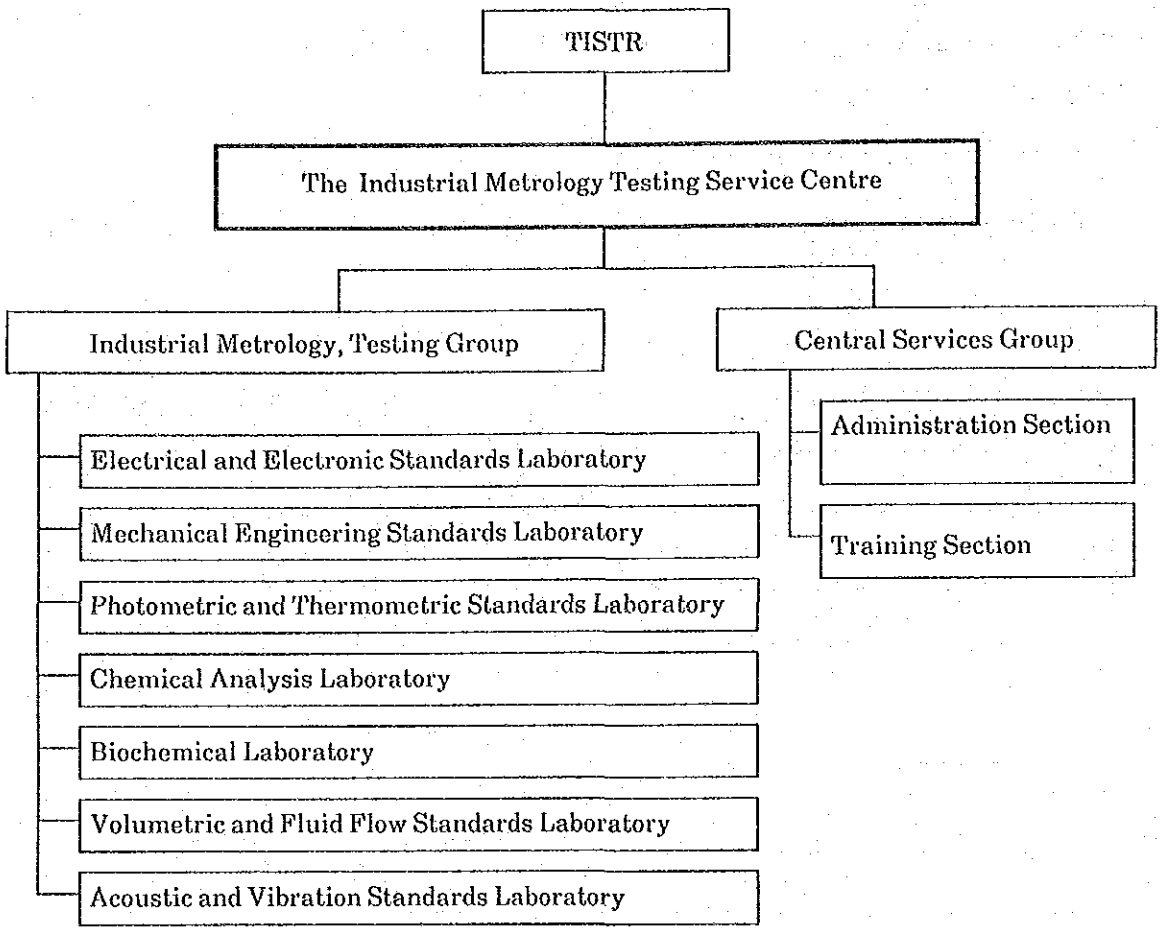


Fig. 3.3-2 Organization of The Industrial Metrology Testing Service Centre

1) Functions

The functions of the different subdivisions constituting the Centre are as described below.

1. Industrial Metrology, Testing Group

The Industrial Metrology, Testing Group is to be charged with practical operations of testing for research and development, with establishing metrological standards, with their maintenance and management, and with calibration service work, and also, training in testing and metrological practice is to be administered by the Group.

The Group is to have 7 Laboratories covering the different domains indicated by their designations.

2. Central Services Group

The Central Services Group is to comprise the Administration Section which is to be charged with administrative and clerical work, and the Training Section which is to be charged with activities for trainig.

2) Staff

The personnel required to staff the Centre has been estimated as given below.

1. Industrial Metrology, Testing Group

Currently in TISTR, 33 technical staff specializing in different domains are charged with testing work. Considering that industrial growth is set at 6.6 percent per year in the 6th NESDP, that testing associated with research and development will increase its importance with intensification of new product standard development and with sophistication of industrial activity, and that the current staff is already overloaded with work, the annual increase of workload has been estimated at 8 percent, to result in the total number of 53 representing an increase of 20 over the current strength of 33.

For operations related to the establishment, maintenance and management of metrological standards, the current TISTR technical personnel number 4 in electrical quantities, 3 in the physical quantities of length, mass, pressure and force, and 3 in photometry, thermometry and radiation, totaling 10 all. Of these 10, 2 in electrical, 1 in physical, and 1 in photometric/thermometric quantities are engaged in providing calibration service. To cover extension of the range in thermometry and in electrical measurements during the 5 years to come, and to maintain and manage the relevant metrological standards, reinforcement of personnel is considered necessary to the extent of 4 in electrical, 5 in the physical

quantities, and 3 in photometry, thermometry and radiation.

As to calibration service, because the annual growth of workload was set at 20 percent, 750 ca. additional calibrations in electrical, 300 ca. in physical, and 230 ca. in thermometry and photometry would be expected by the end of 5 years. The number of calibrations performable in a year would vary greatly according to the ability of personnel and to the required accuracy of work, but considering that during the period of expansion of calibration service, a relatively large portion of the workload would be on standards owned by enterprises, which tend to require much time in calibration, and that the personnel will not yet have gained full proficiency in the work, 120 calibrations per year per person might be adopted as a reasonable estimate (cf. corresponding Japanese figures are ca. 100 for metrological standards and ca. 500 for on-site calibration).

To cover the future workload estimated above, additional personnel amounting to 7 in electrical, 2 in physical, and 3 in thermometry/photometry might be necessary.

2. Central Services Group

The current TISTR staff of 6 is estimated to require reinforcement with further 3 members, to handle the additional work incurred with the increase of personnel.

Table 3.3-11 Staffing - The Industrial Metrology Testing Service Centre

| Group and Section | Senior/Inter-mediate Grade | Junior Grade |
|---|---|---|
| Central Services Group | | |
| Administration section | 2 | 2 |
| Training Section | 2 | 3 |
| Industrial Metrology, Testing Group | | |
| Electrical and Electronic Standards Laboratory | | |
| (Testing) | 5 | 6 |
| (Metrology) | 8 | 6 |
| Mechanical Engineering Standards Laboratory | | |
| (Testing) | 5 | 10 |
| (Metrology) | 8 | 4 |
| Photometric and Thermometric Standards Laboratory | | |
| (Metrology) | 5 | 3 |
| Chemical Analysis Laboratory | | |
| (Testing) | 14 | 5 |
| Biochemical Laboratory | | |
| (Testing) | 6 | 2 |
| Volumetric and Fluid Flow Standards Laboratory | | |
| (Metrology) | | |
| Acoustic and Vibration Standards Laboratory | | |
| (Metrology) | | |
| Total | 55 | 41 |

Note: The Volumetric and Fluid Flow Standards and the Acoustic and Vibration Standards Laboratories are envisaged to start with no personnel exclusively assigned at the initial stage, and to have staff assigned to other Sections come over to undertake whatever work that may come to be required.
Source: Study Report same as referred to in Table 3.3-1.

## 3-3-3 Outline of the Proposed Project Site

### (1) Construction Site

The site is located in the Bangpoo Industrial Estate, one of the five large-scale industrial estates developed in areas surrounding Bangkok. The Bangpoo Industrial Estate was developed in 1977 as a public/private sector joint project by the Industrial Estate Authority of Thailand (IEAT) and the Thailand Industrial Real Estate Development Co., Ltd. (TIDC). It is located in Amphor Muang, Samutprakarn Province, about 34km south of Bangkok. It faces the Gulf of Thailand across the national road. The province has the Bangplee Industrial Estate in addition to the Bangpoo Industrial Estate. It is expected that there will be a sharp increase in the number of large-scale industries in the province in the near future. In light of this projection and the functions of the prospective Centres, it can be said that the site is favorably situated.

It is about 50 minutes by car from the central part of Bangkok to the site, partially by way of express way. There is heavy traffic on the route in the morning and evening. Traffic jams are common on the route. In 1989, however, a road connecting this industrial estate to Route 34 via the Bangplee Industrial Estate will be fully opened to traffic, which will greatly contribute to a dramatic easing of traffic congestion on the route to this industrial estate. Currently, company employees working within this industrial estate take their companies' buses to their respective work places. Prospective employees of the Centres are expected to use similar means of transport.

The site is located near the entrance of the Bangpoo Industrial Estate adjacent to the administrative office of the industrial estate. It is surrounded by roads on the north, east and south. The road on the northern side of the site is a trunk road, which provides both vehicles and pedestrians with access to the prospective facilities.
The site is currently a swamp, but its ground level will be raised by 1.5 meters in accordance with the construction regulations of the industrial estate. Thus its final ground level will be about 1.7 meters above the mean sea level. In addition, rain water drainage will be constructed. All of this will serve to prevent the ground from being flooded.

On the other hand, ground leveling and road construction work are under way in areas surrounding the site. It is expected that factories for various types of light industries will be built in these areas. It is necessary, therefore, to incorporate measures against noise and dust from these factories in the site layout plan.

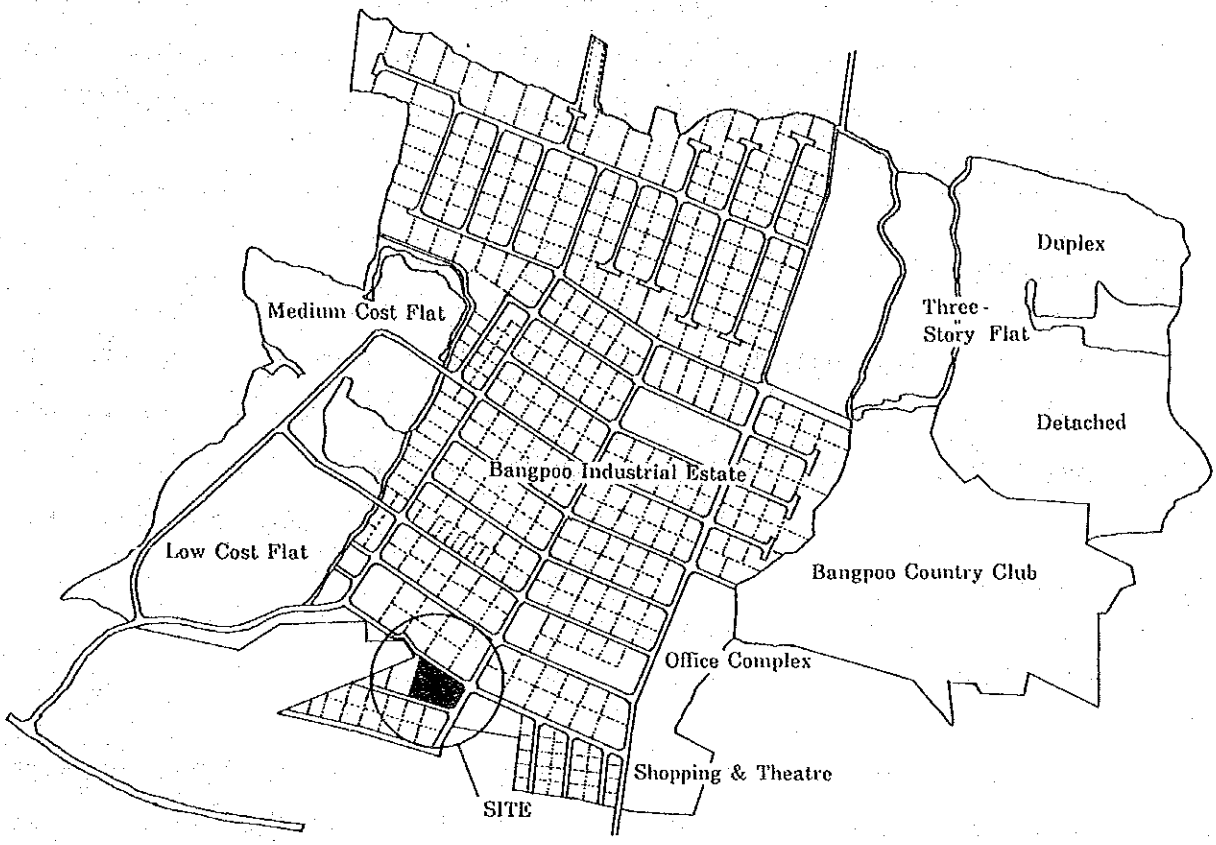


Fig. 3.3-3 The Proposed Construction Site

(2) Infrastructure

1) Electricity

An overhead line (3-phase, 3-wire 50Hz 24kV) which can supply electric power to both plots runs along the road on the eastern side of the site. Application to the Metropolitan Electricity Authority (MEA) for power receiving is necessary

According to the information from MEA, the frequency of power failure

in and around the site is about 5 times a year, which are caused mainly by lightning. It takes 1 to 2 hours to recover power supply. Although the voltage regulation is between 21.8 kV and 23.6 kV which can be considered relatively stable, it is necessary to take preventive measures against power failure and voltage regulation for some testings and equipment in both Centres which require highly stable power source.

2) Telephone

An overhead telephone line from the Telephone Organization of Thailand (TOT) which is supported on electric poles of MEA is led to the administratoin office of the Bangpoo Industrial Estate. It is possible to lead the telephone line to both Centres upon the application to TOT.

3) Water Supply

IEAT is now in the process of constructing a water supply network which will utilize well water within the industrial estate. At present water pipes are not laid in or around the site, but water pipes with a diameter of 300mm, which can be connected to both Centres, will be laid along the road on the northern side of the site by the end of 1988.
Maximum of $9m^3$/day of water per rai (1 rai=1,600$m^2$) of site area will be supplied to the site upon the application to IEAT.

4) Sewage Disposal

Sewer pipes are being laid within the industrial estate. Waste water from the facilities of both Centres can be discharged into the public sewerage to be laid along the road on the southern side of the site by the end of 1988. An application of sewerage connection to IEAT will be required. The waste water will eventually be discharged into the

sea after treated at the sewerage plant within the industrial estate. Values for the quality of the waste water from the facilities of both Centres shall be smaller than the standard values to be regulated by IEAT.

5) Rainwater

Rainwater can be discharged into the open ditches to be laid between the site and the roads surrounding it.

6) Gas

Propane gas, not town gas, is supplied to the industrial estate.

7) Garbage Disposal

Municipal garbage trucks will collect garbage about 3 times a week. The garbage collection charge will be required.

(3) Miscellaneous Site Environment

The Bangpoo Industrial Estate, which has 4,000 acres in total area consists of industrial zone, commercial zone, residential zone and recreation zone.

Access roads connect the industrial estate to Route 3 which runs along the Gulf of Thailand at two points about 34km and 37km away respectively from the central part of Bangkok. Route 3 serves as a waterbreak as well.

Within the industrial estate runs a main road (south to north) and branch roads (unpaved at undeveloped area) leading to specific districts.

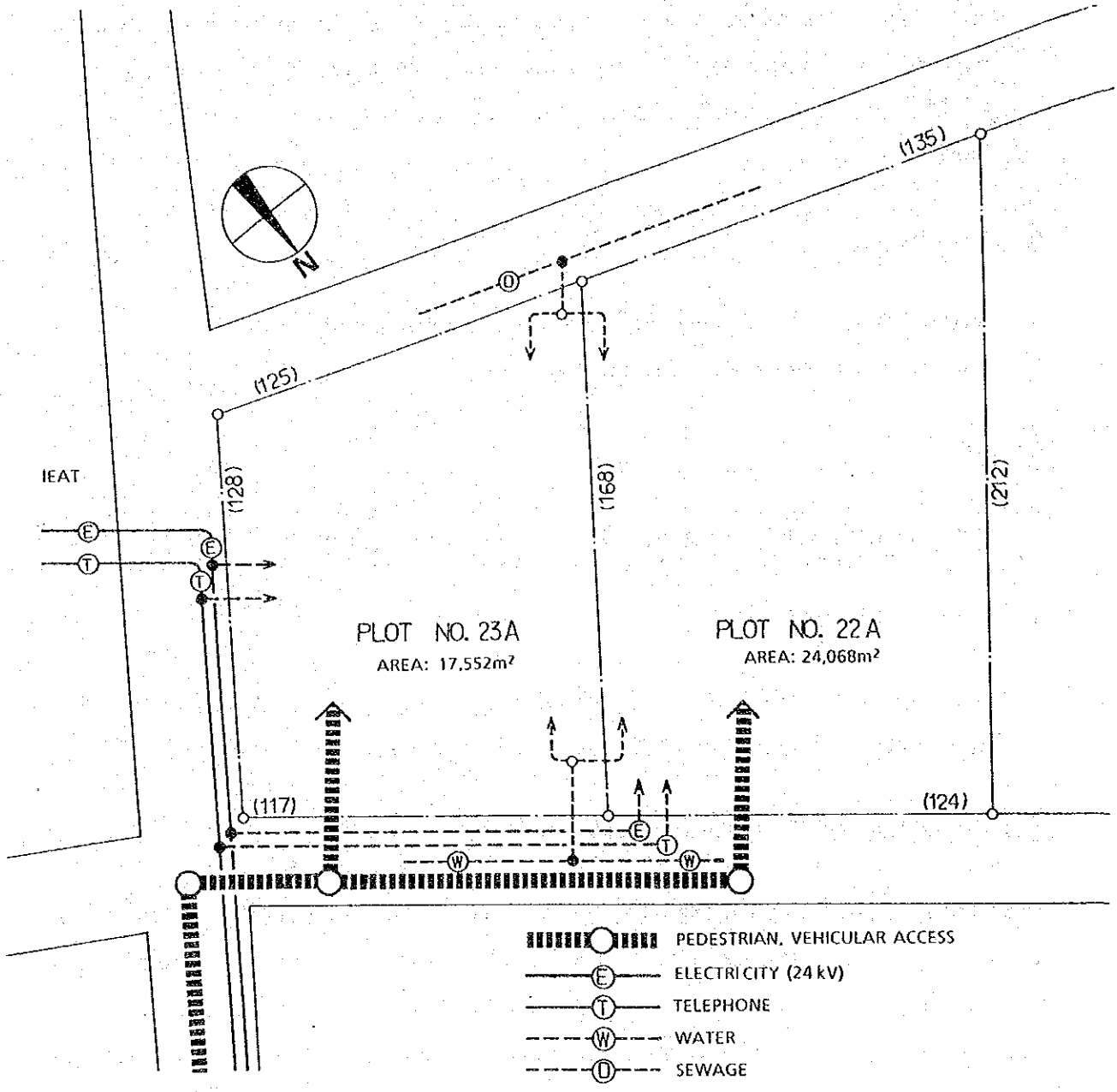


Fig. 3.3-4 Infrastructure

### 3-3-4 Outline of the Facilities and Equipment

The following facilities and equipment are considered necessary for both Centres to fulfill their respective functions.

(1) Facilities

The Industrial Standardization, Testing and Training Centre and the Industrial Metrology Testing Service Centre will be planned as independent two Centres and each of them needs the following rooms respectively.

1) The Industrial Standardization, Testing and Training Centre

1. Testing facilities:
   mechanical testing laboratory, environment testing laboratory, air delivery room, rainproof testing laboratory, chemical testing laboratory, N.D.T. laboratory, electrical testing laboratory, electronics testing laboratory, anechoic room, electronic auto-parts testing laboratory, calorimeter room, flame testing laboratory, etc.

2. Training/conference facilities:
   seminar rooms (two 50 seating rooms and one 15 seating room) conference room, canteen

3. Administrative facilities:
   director's room, administration office, staff room, lecturers' room (for 9 lecturers), library, CPU room

2) The Industrial Metrology Testing Service Centre

1. Testing facilities:
   Laboratories
   length laboratory, volume laboratory, mass laboratory, vibration laboratory, pressure laboratory, force laboratory, temperature

laboratory, photometry and radiation laboratory, electrical and electronic laboratory, anechoic room, etc.

Testing laboratories

mechanical testing laboratory, electrical testing laboratory, environment testing laboratory, chemical testing laboratory, biochemical testing laboratory, N.D.T. laboratory, flame testing laboratory, precision measurement laboratory, etc.

2. Administrative faciliteis:

director's room, administration office, staff room, library, CPU room, technical consultation room

(2) Equipment

1) The Industrial Standardization, Testing and Training Centre

1. For Certification Testing

The main testing equipments required for certification testing are given below. Testings for development of industrial standards are also conducted by using these equipments.

- Electrical and electronics:

  Basic measuring equipment, thermal measuring equipment, voltage regulators, calorimeter room, air delivery measuring equipment, recorders, vibration testing equipment, testing equipment for material, etc.

- Mechanical:

  Basic equipment, bending testing machine, vibration testing equipment, NDT testing equipment, tool machines, automobile parts testing equipment, etc.

- Chemical:

  Various analyzing equipment, central analytical table, balances, etc.

2. For Certification

For operations associated with execution and promotion of certification, the following equipment are required.

- Office machines, such as photo copying machine, computer, etc.

3. For Standardization

In order to carry out training for standardization and for quality control, the following materials and equipment are required.

- for training, such as audio-visual system, over-head projector, etc.

- for making training materials, such as a video editing machine, printing machine, etc.

- vehicles for factory survey and roving consultancy, etc.

2) The Industrial Metrology Testing Service Centre

1. For Metrology

The equipment required for metrological field are given below.

- Standards:

  Standards and their maintenance and managing systems on electrical, thermometric, photometric and radiation quantities.

- Calibration:

  Standards and their maintenance and managing systems on physical

quantities (length, mass, volume, force, pressure), thermometric, electrical, acoustic and photometric quantities, and vehicles for roving.

2. For Testing

In order to conduct the number of testing specified in 3-3-1 in the domains of mechanical engineering, electrical, electronics and chemistry, which are being promoted by the Thai Government, the main equipment required for testing are as given below.

- Electrical and electronics:
  Thermal measuring equipment, stabilized power supplies, endurance testing equipment, shield room, testing equipment for materials, recorders, etc.

- Mechanical:
  Impact testing equipment, NDT testing equipment, tool machines, etc.

- Chemical and biochemical:
  Various analyzing equipments, pre-conditioning equipment, balance, central analytical tables, etc.

3. For Technical Training

In order to carry out technical training, the following equipments are required.

- audio-visual systems, over-head projector, etc.

### 3-3-5 Staffing

As stated in Section 3-3-2, it is planned that the Industrial Standardization, Testing and Training Centre will have 107 staff, and the Industrial Metrology Testing Service Centre will have 96 staff, in order to cope with the expected workload. The importance of securing the requisite personnel has been emphasized also in the preceding study, and is fully recognized at both TISI and TISTR. The reinforcement plan has been drawn up with full consideration given to concordance with the currently existing staff at the two Institutes.

Annual plan for increasing personnel at the Industrial Standardization, Testing and Training Centre and the Industrial Metrology Testing Service Centre is shown in Table 3.3-12 and 3.3-13 respectively.

Table 3.3-12 Annual Plan for Increasing Personnel at The Industrial Standardization, Testing and Training Centre

| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|
| Senior/Intermediate Grade | 17 | 27 | 41 | 55 | 61 | 66 |
| Junior Grade | 4 | 14 | 23 | 31 | 37 | 41 |
| Total | 21 | 41 | 64 | 86 | 98 | 107 |

Source: TISI

Table 3.3-13 Annual Plan for Increasing Personnel at The Industrial Metrology Testing Service Centre

| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|
| Senior/Intermediate Grade | 28 | 33 | 38 | 43 | 49 | 55 |
| Junior Grade | 21 | 25 | 29 | 33 | 37 | 41 |
| Total | 49 | 58 | 67 | 76 | 86 | 96 |

Source: TISTR

## 3-4 Technical Cooperation

### 3-4-1 The Industrial Standardization, Testing and Training Centre

For the Industrial Standardization, Testing and Training Centre to function fully as envisaged, personnel training in the domains of industrial standardization and of testing should indispensably calls for technical cooperation. In this connection a request emanating from TISI had earlier been received by the Japanese Government, based on which the Contact Mission was sent in December 1987 by the Japan International Cooperation Agency, which led to agreement that the technical cooperation should be provided in the form of project-type technical cooperation, and in the following form;

- The technical cooperation should hold as objective the transfer of technology to the Thai counterpart personnel in the field of industrial standardization and testing

- The duration of cooperation should be 5 years from the date of signature of R/D , and

- Based on a schedule to be agreed between the parties, Japanese experts should be sent to Thailand, and Thai counterpart personnel should be sent Japanese for training.

The agreement was duly communicated to the respective Governments, and it was further agreed to have a mission sent from Japan to discuss more details of technical cooperation. Based on this agreement, Preliminary Survey Team visited Thailand in April 1988, which agreed with the Thai Government for the implementation of project-type technical cooperatoin. It was requested on this occasion from TISI to have project-type technical cooperation lasting 5 years from the date of signature of R/D on the following fields;

1. Standardization
   - Standardization including quality control
   - Certification

2. Testing for the formulation of industrial standards and the implementation of certification in the fields of;
   - Electrical and electronics
   - Mechanical engineering
   - Chemical and biochemical
   - Materials testing

(1) Outline of Technical Cooperation

The technical cooperation to be provided on the basis of the foregoing TISI request will cover the following;

Standardization

1) Standardization including quality control

   1. Objectives and Benefits of Standardization

   2. Functions of and relations between the following standards
      - International standards
      - National standards
      - Industry standards
      - Company standards

   3. Quality control
      - Objectives of quality control
      - Methodology of quality control
        - Statistical quality control
        - Total quality control

4. Application of standards
   - Relation with certification
   - Relation with metrology

5. Development of standards
   - Basic standards (vocabulary, symbols)
   - Standards for design
   - Standards for products
   - Standards for test methods
   - Standards for processing

6. Planning of standardization
   - Short term scheme
   - Long term scheme

2) Certification

1. Objectives and benefits of certificaton

2. Foundation and systems of certification

3. Certification schemes
   - Voluntary certificatoin
   - Mandatory certification
   - GATT Standards Code
   - Case study of national certificatoin schemes
     - quality improvement
     - Safety
     - Consumer protection
     - Others

4. Implementation of certification
   - Testing and inspection
     - Product tests

- Type tests
- Factory inspection

- Management of inspection bodies and testing laboratories

Testing

1. Operation of testing equipment

2. On the job training through testing services

3. Technical consultation and guidance to the facilities for certification and testing

(2) Dispatch of Expeerts and Counterparts Training

The programme for assigning Japanese experts to Thailand and for receiving Thai counterpart personnel for training, based on the TISI request, is tentatively given as below;

1) Dispatch of Japanese Experts

1. Long-term experts

| | |
|---|---|
| Chief adviser | 5 years from 1990 |
| Coordinator | 5 years from 1990 |
| Standardization | 5 years from 1990 |
| Quality control | 5 years from 1990 |
| Electrical | 1.5 years from 1990 |
| Electronics | 1.5 years from 1990 |
| Mechanical Engineering | 1.5 years from 1990 |
| Material Testing | 1.5 years from 1990 |
| Chemical | 1.5 years from 1990 |

2. Short-term

Short-term experts will be dispatched on specific fields, if necessary.

2) Receiving Thai counterparts

Thai counterparts will be received in Japan during 5 years from 1990.

Based on the foregoing considerations, the present Basic Plan envisages training curricula that are realistic and practicable, and the requisite equipment and classrooms for accommodating the envisaged numbers of trainees, have been carefully derived. The resulting outline of technical cooperation is presented in what follows, giving an example of training courses.

1. Industrial Standardization and Quality Control

- Standardization: To impart basic notions and to provide practical training in the means of promoting standardization with the ultimate aim of efficiently manufacturing good quality products.

- Quality control: To impart basic notions and to provide practical training in what quality control consists of and how it is practiced. Courses are to be administered separately for leaders, for staff, for design of experiments, and for on-line QC.

2. Testing

- Electrical: To provide guidance in testing practice applicable to wiring fittings, components, household appliances (heating, lighting, motors-operated).

- Electronics: To provide guidance in testing practice applicable to audio equipment, visual equipment, office equipment and electronic components.

- Mechanical Engineering: To provide guidance in testing practice applicable to automobile and industrial machinery components.

- Materials Testing: To provide guidance in analysis and analytical interpretation applicable to metallic and non-metallic materials.

- Chemical: To provide guidance in analysis and analytical interpretation applicable to pharmaceuticals, chemicals.

### 3-4-2 The Industrial Metrology Testing Service Centre

For the Industrial Metrology Testing Service Centre to function fully as envisaged, it is indispensable to have technical cooperation provided in the matter of training of personnel charged with industrial metrology and testing. A request for such technial cooperation emanating from TISTR has earlier been received by the Japanese Government. The Contact Mission sent in December 1987 by the Japan International Cooperation Agency led to agreement that the technical cooperation should be provided in the form of individual technical cooperation to be provided during a period lasting 3 years taking into consideration that TISTR has already acquired technical capability to some extent for implementation of this project. Subsequently, in April 1988, on the occasion of the visit of the Basic Design Study Team, a further request was received in this connecton from TISTR, of the following substance.

(1) Fields where technical cooperation is requested;

1) Industrial metrology

1. Length
2. Mass
3. Volume
4. Force
5. Pressure
6. Temperature
7. Electrical
8. Acoustic
9. Photometric
10. Radiation
11. Others

2) Testing

1. Mechanical (including NDT)
2. Electrical
3. Electronics
4. Chemical
5. Biochemical
6. Others

(2) Proposed experts dispatch and counterparts training schedule

| Field \ Year | 1st | | 2nd | | 3rd | |
|---|---|---|---|---|---|---|
| | Expert | Counterpart | Expert | Counterpart | Expert | Counterpart |
| Metrology | | | | | | |
| Electricity (AC,DC) | 1 | 1 | 1 | | | |
| Temperature | 1 | 1 | | | | |
| Photometory and Radiation | 1 | 1 | 1 | 1 | | |
| Mass and Length | 1 | 1 | | | | |
| Volume-flow | | 1 | 1 | | | |
| Pressure-Force | 1 | 1 | | | | |
| Sound | 1 | | | | | |
| Sub-total | 6 | 6 | 3 | 2 | | |
| Testing | | | | | | |
| Electrical | 1 | 1 | | | | |
| Electronics | 1 | 1 | 1 | | | 1 |
| Mechanical | 1 | 1 | | | | |
| Chemical | 1 | 1 | | | 1 | 1 |
| Biochemical | 1 | 1 | | | 1 | 1 |
| Sub-Total | 5 | 5 | 1 | | 2 | 3 |
| Total | 11 | 11 | 4 | 2 | 2 | 3 |

Note: The stay of expert is envisaged to be of short duration
Source: TISTR

Since the success of this plan depends on training of personnel as similar with the Industrial Standardization, Testing and Training Centre, it will be necessary to provide technical cooperation by dispatching experts, etc. when this project is implemented in the near future.

# CHAPTER 4 BASIC DESIGN

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## 4-1 Basic Design Concept

### 4-1-1 Basic Design Concept for the Facilities

The following points should comprise the basic design concept of the facilities.

1. To make the facilities fit the types of activities in the highly specialized technical fields and the types of equipment to be used. Facility planning shall be made while paying special attention to operability of the equipment and to the safety of technical staff

The facilities are designed for various technical fields, including physics, chemistry and electricity. In addition, each of these technical fields is highly specialized. Each field involves specialized equipment which are highly sensitive to physical conditions, such as vibration and environmental conditions. It is also expected that some dangerous chemical reagents will be used within the facilities. Therefore, it is necessary to have a clear grasp of prospective activities in each technical field in working out the basic design concept for the facilities. Utmost emphasis should be placed on the operability of the equipment and on the safety of the technical staff so as to ensure efficient activities within the facilities.

2. To make the facilities flexible enough to cope with future changes in activity and increases in work load

One of the objectives of this project is to contribute to the strengthening of the industrial base and to the promotion of exports for Thailand. It is expected, therefore, that the Centres' workload will increase in keeping with the future expansion of Thai industry.

Consequently, it is probable that the facilities will be changed and expanded gradually in the future.

For the reasons mentioned above, the facility planning shall be done with emphasis on flexibility of site use, architectural plans and structural plans so that the facilities may cope with future changes in activity and increases in workload.

3. To minimize the maintenance and operation costs of the facilities

The architectural plan should be made with consideration for adopting natural ventilation and natural lighting as much as possible so that energy costs may be minimized. Also, priority should be given to durability when selecting construction materials so that the facilities may function satisfactorily over a long period with a minimum of repair work and lower costs for maintenance and operation.

4. To make the facility planning fit the project implementation system

This project consists of two independent Centres with distinct functions, and each Centre is operated under the jurisdiction of two different government agencies of Thailand, namely, the Ministry of Industry and the Ministry of Science, Technology and Energy. Accordingly, the contents and scale of the facility shall be suitable for the project implementation plans of the Thai side, such as the budgetary and personnel assignment plans required for operation and maintenance of each Centre.

5. To make the architectural plan fit the natural and cultural conditions as well as construction situation of Thailand

In drafting the architectural plans, it is necessary to adopt architectural designs, materials and construction methods which fit the physical conditions of the surrounding facilities, taking into account natural and artificial conditions, such as climate and culture, and as well as the construction situation of Thailand. In light of the fact that

these facilities are to serve in the public interest, the architectural design should harmonize with surrounding facilities.

### 4-1-2 Principles Adopted for Equipment Planning

The principles adopted in planning the equipment are to be the followings:

1. To provide equipment indispensable for letting the Centres function to full effect as soon as possible upon completion of construction

2. To take due account of requirements for personnel training

To permit the Centres to ensure the vital function of creating proficient technical personnel to staff its own as well as other testing laboratories, equipment is to be provided for audio-visual and other training aids that are easy to manipulate. Provision will be made for preparing in-house materials to be used for the training programmes.

3. To give due consideration to matching the equipment to the curricula envisaged for the technical cooperation

As project-type technical cooperation is planned to be provided to the Industrial Standardization, Testing and Training Centre, equipment is to be considerd to matching the training curricula.

4. To give due consideration for visiting guidance and calibration services

Roving consultancy for standardization and quality control, and visiting guidance for testing are to be done by the Industrial Standardization, Testing and Training Centre staff. Visiting guidance for calibration,

and simple calibration service on the spot is to be made by the Industrial Metrology Testing Service Centre staff.
The necessary equipment for above mentioned activities is to be considered.

5. To seek rationalization of clerical operations associated with certification, testing and calibration

To cope with the rapidly increasing work load envisaged for both Centres in this connection, consideration is to be given also to rationalization of the necessary clerical operations associated with this work.

6. To utilize effectively the equipment owned currently

To have the equipment currently installed in TISI and TISTR transferred to the new Centres in so far as they serve the functions intended for the Centres, and with the exception of those that are worn, or incur unjustifiable expenditure for the transfer.

## 4-2 Design Conditions

### 4-2-1 Design Conditions of the Facilities

In drafting the basic design, the following conditions should be examined carefully.

(1) Functions Required of the Facilities

The main functions required of the two Centres can be classified as follows:

1) The Industrial Standardization, Testing and Training Centre

The primary objective of this Centre is to promote the industrial standardization including quality control and to improve the capabilities of certification test, and therefore the following functions are required of this Centre building.

1. Testings for preparation of draft industrial standards and certification test programmes

Testings for preparation of draft industrial standards and certification test will be implemented.

2. Training of technical staff

Trainings on standardization and quality control will be given to technical staff of TISI, accredited testing laboratories and private enterprises. Priority will be given to TISI personnel and trainees sent from accredited testing laboratories.

3. Trainings in testing techniques

Training programs for improving the capabilities in testing techniques of the test engineers at private enterprises and accredited testing laboratories will be implemented.

4. Planning for the promotion of quality control

Research and study on ways to promote the concept of quality control throughout Thailand will be conducted.

5. Dissemination of technical information

This centre will disseminate information on standardization, quality control and testing techniques and issue survey reports, bulletins and brochures.

6. Implementation of commissioned testings

Priority will be given to testings commissioned by public organizations and factories manufacturing compulsory standard products.

2) The Industrial Metrology Testing Service Centre

Tasks of this Centre will be to establish metrological standards allocated to TISTR by the National Committee on Metrology (NCM), to keep and supply all industrial standards, to offer calibration services and to give technical guidance to engineers of private enterprises. In addition, the Centre, as a comprehensive testing institution, will be engaged in activities for improving the capabilities of engineers and transferring the testing techniques developed in the Centre to other testing institutions and private enterprises, as well as technical information services and research and development activities.

The major functions required of this Centre are as shown below:

Metrology

1. Establishment of a system for providing metrological standards

This Centre will be responsible for establishing a system for providing metrological standards, based on primary standards designated as TISTR's scope of work by NCM, suited for the current

technical level of Thai industry and an in-house metrological standards supply system necessary for calibration services offered by the Centre.

2. Establishment, maintenance and supply of metrological standards

This Centre will establish and maintain primary standards designated by NCM and at the same time supply them to government organizations and private enterprises.

3. Improvement of the precision of calibration, expansion of the scope of calibration and development of calibration techniques

This Centre will be responsible for modernizing measuring and calibration equipment with the aim for improving the precision of calibration of the standard measuring equipment installed in the Centre, government organizations and private enterprises and expanding the scope of calibration service. This Centre will also be engaged in development of calibration methods and techniques.

4. Implementation of calibration service

This Centre will be engaged in calibration of the standard equipment for use in routine work and the measuring instruments for field use.

5. Dissemination of technical information

This Centre will offer technical information service to government organizations and private enter-prises. The service will include publication of the results of technical research works and dissemination of technical information.

6. Technical guidance and dissemination of information on metrology

This Centre will give technical guidance to government organizations and private enterprises, hold technical seminars and lecture meetings and promote the spread of the concepts of metrology

Testing

1. Conducting testings for purposes of research and development

This Centre will conduct, from the viewpoint of export promotion, a wide variety of testings for purposes of research and development of product standard, as well as testings based on foreign and international industrial standards.

2. Conducting testings on request

This Centre will conduct various testings commissioned by private enterprises, government organizations and other testing institutions.

3. Training of technical staff

This Centre will be engaged in activities for training technical staff responsible for basic and applied testing techniques.

4. Technical information service

This Centre will provide technical information to government organizations and private enterprises.

(2) Natural Conditions

In preparing the basic design, the following natural conditions peculiar to Thailand should be taken into consideration.

1. Heavy Rainfall

The project site is located in a savannah, which has two seasons, namely, the rainy season which lasts from May to October and the dry season which lasts from November to April. In the area where the project site is located, it rains often in May and September. During this period the area is hit by localized torrential downpours for a short time.

Accordingly, it is necessary to design the facilities taking into account

their resistance to rainwater and water leakage, as well as their resistance to secondary effects on the facilities caused by heavy rainfall. Soundproofing during the time of heavy rainfall and measures against the rise of water level in the surrounding area will be necessary.

2. High Temperature and High Humidity

It is usually hot around the area where the project site is located. The average annual temperature is 28.4°C and the average annual maximum temperature is 30.3°C. In addition, it is very humid in the area. The average annual humidity is 75.5% and the average annual maximum humidity is 83.2%. This natural condition causes damage to facilities such as mold and rust. Therefore, construction materials should be selected carefully to avoid damages such as corrosion. Artificial air-conditioning is also necessary for maintaining laboratory equipment.

3. Thunder

During the rainy season it often thunders, and damages by lightning are reported. It thunders annually 92.8 days on average in Bangkok. Since the project site is located in a flat area, it is essential to incorporate measures against lightning in the facility planning.

4. Sunlight

As Thailand is situated at a low latitude, the solar radiation angle is high and therefore sunlight is strong. According to the solar path diagrams for 14° north latitude which is close to the project site, the relatively comfortable time of day is limited to 2 to 3 hours in the morning and also after 4.00 p.m. In the daytime one suffers from high temperatures and high humidity. It is necessary, therefore, to incorporate measures against strong sunlight in the daytime, including adopting deep eaves in the architectural design.

(3) Construction Situations

In Thailand construction activities are basically well organized. Production of construction materials is brisk with a wide variety and in large quantities. Foreign-made materials are also available. Many of the local construction companies are large-sized and own a wide range of construction machinery. Also Thailand has a highly skilled construction labor force. As a result, high-quality buildings are being built in Bangkok. The specific construction situation that deserves careful attention is as shown below:

1. Construction Materials

Most of the essential construction materials are manufactured in Thailand. It is expected that in executing this project, a high percentage of the necessary construction materials will be procured in Thailand. As a result of the current construction boom, however, some materials such as reinforcing bars are now in short supply, bringing about sharp rises in the prices of such materials. It is necessary therefore to examine carefully both quantities and prices of materials to be procured locally.

2. Building Code

Thailand has well-established building-related regulations such as the building and fire codes. There is also a well-defined building law enforcement system, in which each building-related law or regulation is enforced by a relevant government agency. Furthermore, the Industrial Estate Authority of Thailand, which is responsible for control of the construction site for the project, issues its own notes on buildings. Accordingly, it is essential to draft the basic design which complies with these laws and regulations.

3. Local Construction Techniques

Most of the local construction companies are large-sized and own a wide range of heavy construction machines. Some critics maintain that the Thai construction companies is lacking, to some extent, in capabilities for construction management including schedule control and coordination in architectural works, mechanical works and electrical works. However, it excels in construction work and is capable of completing high-quality construction work in a short time in collaboration with a Japanese contractor. This should be considered a favorable condition in working out the execution plan for this construction project.

(4) Ground Conditions

According to the results of a boring survey conducted at the construction site, the ground of the construction site is soft and the groundwater level is high. In addition, soil is saline. It is necessary, therefore, to take note of the following ground conditions in working out the execution plan of the construction.

1. Ground Subsidence

On the construction site, which is currently a swamp, the ground level is to be raised by 1.5 meters before the construction work starts. It should also be noted that Bangkok and surrounding areas are being plagued by subsidence due to the continuing fall of the groundwater level. In consideration of the above, there will be land subsidence on the construction site. Therefore, it is essential to prepare measures against ground subsidence, particularly portions where the buildings are in contact with the ground.

2. Soft Ground Condition

The ground at the site is soft, composed of very soft clay with an N-value of less than 5 extending down to 17m from the ground level. The groundwater level is as high as 1.2 to 1.3m below ground level. Therefore, the structural plan of the building foundation system and the construction method for foundations should be made with careful consideration to meet the soft ground conditions.

### 4-2-2 Conditions for Selection of Equipment

1. Testing Equipment

Preference is to be given to equipment that is:

- Easy to manipulate
- Rugged and durable, to withstand frequent and intensive operation
- Easy to maintain, with servicing available locally
- Of grade adequate for the envisaged level of testing

2. Metrological Equipment

Metrological Standards

Preference is to be given to equipment that is:

- Of grade that is already used in a established system in advanced nations
- Familiar to the present TISTR personnel, or on which training has been conducted.

Calibration

Preference is to be given to equipment that is:

- Rugged and durable to withstand frequent and intensive operation
- Easy to maintain, with servicing available locally
- Familiar to the present TISTR personnel, or on which training has been conducted.

3. Standardization Equipment

Equipment for industrial standardization is to be selected on the criteria of:

- Suitability for the envisaged curricula
- Ruggedness and durability.

4. Equipment for Certification and Other Equipment

Preference is to be given to equipment that is:

- Interchangeable with equipment currently installed at TISI, with which to permit exchange of data
- Conducive to acceleration and rationalization of administrative work associated with certification
- Easy to maintain.

## 4-3 Basic Plan

### 4-3-1 Layout Plan

(1) Site Utilization Plan

The Industrial Standardization, Testing and Training Centre

The plot for this Centre is surrounded by roads on the north, east and south. The west side of the plot borders the plot for the Industrial Metrology Testing Service Centre. It is difficult, therefore, to expand the site itself when it becomes necessary to expand the facilities in keeping with increases in the work load of the Centre. It is necessary to secure an extra space within the plot for future expansion of the facilities in working out the basic design for this Centre.
The site utilization plan is worked out taking into account the following points based on the above mentioned considerations.

1. Building area should be minimized so that sufficient extra space for future expansion of the facilities can be secured.

2. The northern end of the plot faces a trunk road. Therefore the main entrance of the Centre should be located on the northern side of the plot and the space between the road and the building should be utilized as a front yard and parking lot for guests.

3. An open space for future expansion of the facilities should be secured at the back of the building, namely, on the southern side of the plot.

4. Since equipment, materials and test specimens will be carried directly into the laboratories on the first floor, service roads should be constructed around the building.

5. Buffer zones should be provided around the building to minimize the effects of noise and dust from surrounding areas of the site. These buffer zones can be utilized as planted areas.

The Industrial Metrology Testing Service Centre

The northern and southern sides of the plot for this Centre face roads. The plot borders the Industrial Standardization, Testing and Training Centre on the east and a factory construction site on the west. The area of the plot is about 40% larger than that for the Industrial Standardization, Testing and Training Centre, which means that this plot is spacious enough to accommodate the required facilities.

In light of the above conditions for the plot, the main points of the site utilization plan are as follows.

1. Although there are few constraints on facility planning for this Centre because of the spaciousness of the plot, the basic design should allow for future expansion of the facilities.

2. The main entrance of the building should face the trunk road on the north of the plot. The space between the trunk road and the building can be utilized as a front yard and parking lot for guests.

3. An open space for the future expansion of the facility should be secured on the southern side of the plot.

4. Service roads should be provided around the building to facilitate carrying in and out of equipment and materials to the building.

5. There should be planted areas which are to serve as buffer zones around the building. Since it is expected that a factory will be constructed in an area bordering the site on the west, the buffer

zones should be wide enough to minimize the effects of noise and dust from the prospective factory.

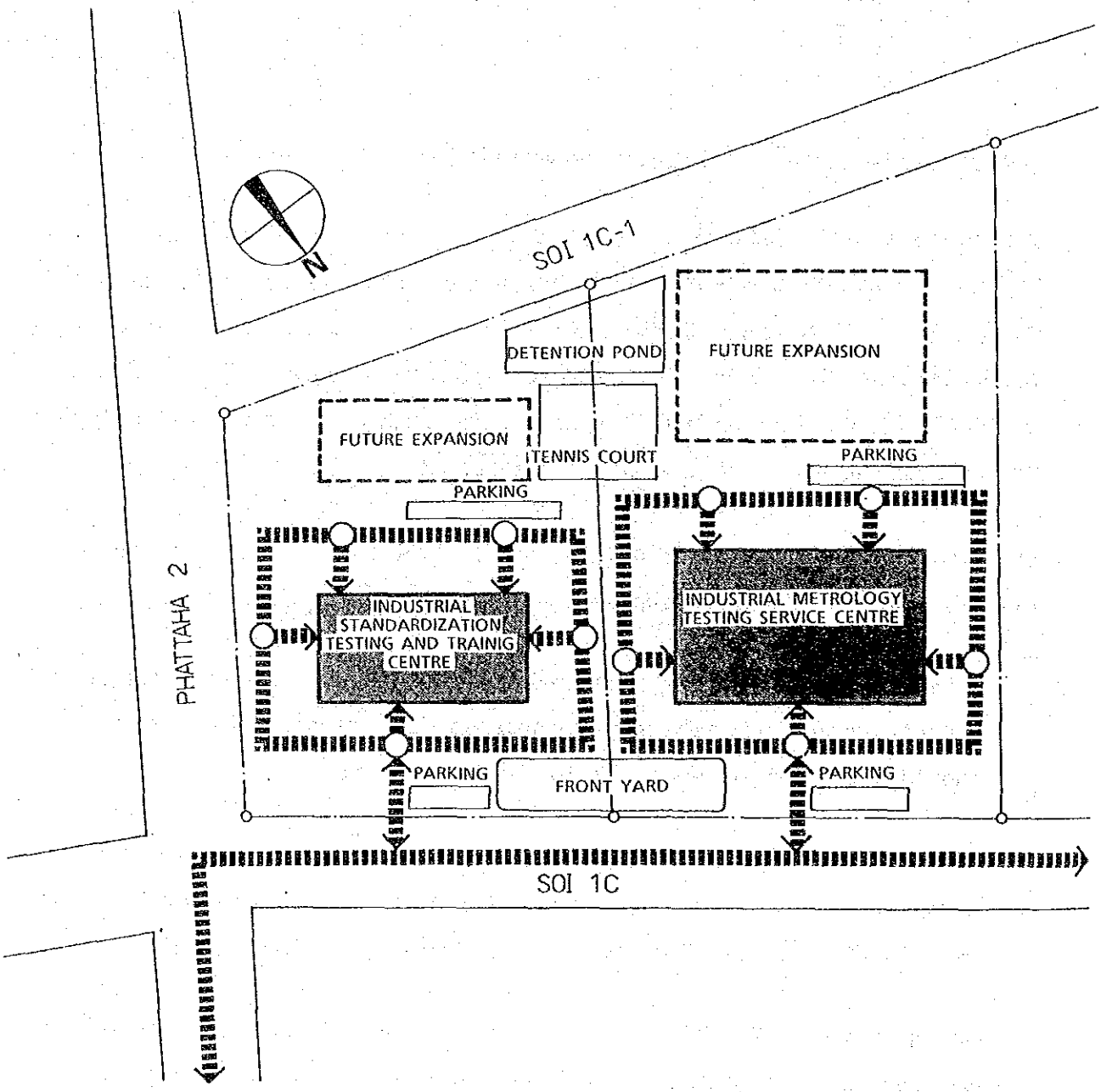


Fig. 4.3-1 Site Utilization Plan