Table 5.1.2-8 Programme for Personnel Training - Industrial Standardization Testing and Training Centre

		Phase 1 (1st - 5th year)			Phase 2 (6th - 8th year)			Phase 3 (9th - 11th year)		
		Foreign experts on temporary assignment	Trained within Centre	Trained in foreign institution	Foreign experts on temporary assignment	Trained within Centre	Trained in foreign institution	Foreign experts on temporary assignment	Trained within Centre	Trained in foreign institution
Industrial standardization	Standardization	1		2						
	Quality control	4		4						
	Sub-total	5		6						
Testing										
	Electrical/ electronic equipment	6	20	4		14			22	
	Machinery	3	30	2		17			14	
	Chemicals	3	8	3		7			6	
	Materials; properties of matter	2	14	2		10			4	
	Calibration		1							
	Sub-total	14		11						
Total		19	73	17		48			46	

5.1.2.4 Training given to trainees from outside

Training provided to trainees from outside the Centre is to be implemented with the aim set at imparting knowledge and skills that should immediately prove to be of practical use to the trainees upon their return to their respective worksites, and to this end, classroom lectures are to be amply supplemented with observation visits to factories and with practical exercises in laboratory or shop.

Different courses are to be organized to cover (a) industrial standardization and quality control, and (b) testing.

(a) Basic principles

(1) Courses for industrial standardization and quality control

a) Trainees

Courses are to be administered principally to in-house standardization leaders, quality control leaders and staff.

b) Method of training

Training in groups is to be the basic pattern, taking such forms as classroom lectures, practical exercises, observation visits, and discussion sessions.

c) Product lines and enterprise sizes envisaged for personnel training

In so far as possible, trainees for industries manufacturing mutually similar product lines are to be grouped together in a common course. Priority is to be accorded first to courses for industries manufacturing product lines subject to Compulsory Standards -- e.g. electrical, mechanical, chemical, metallurgical, household appliance industries. Coverage could then be extended to Voluntary

Standards industries and further other promising or encouraged industries, followed by further extension to all industries.

In respect of the size of enterprises envisaged, priority might be accorded to those of medium size, for most effectively and rapidly enhancing the overall national level of industry.

(2) Courses for testing

Courses to give basic notions of testing, interpretation of standards -- with emphasis on practical exercises -- are to be organized for those to engage in testing at testing institutions and in private enterprises.

(b) Curricula of courses

The curricula will follow the general lines of the courses given to Centre personnel.

(c) Programme of training

The programme of training to be provided by the Centre in the successive phases of development are presented in Tables 5.1.2-1, -2, -3, -4.

5.1.2.5 Recommendations on future developments

(a) Function of promoting in-house standardization and quality control in private enterprises: The demand for engineers and technicians engaging in in-house standardization and quality control is expected to increase rapidly in the future. Adequately meeting this rising demand should be a key factor for the successful industrial development of the country, and this would call for expansion of the Centre's department charged with quality control and training.

Since a number of organizations established with the aim of promoting quality control are actively pursuing their aims, wasteful duplication of efforts with other existing organizations engaging in similar training activities should be avoided, and the Centre being the ultimate authority for factory certification, should hold as final aim the firm rooting of quality control practice in private industry, by organizing training courses oriented toward practical aspects.

Another important function of the Centre is to serve as a think-tank, in studying the method of promoting quality control best adapted to national needs and circumstances.

(b) Testing capability; transferring testing capability to private enterprises: Improvement of industrial product quality calls for the introduction of quality and production control techniques, to modernize and rationalize the system of production. The first step in this direction is to appropriately determine product quality through reliable tests applied to the products and judgement of their quality by reference to valid product standards. The results are then fed back into the production control system to ensure products regularly conforming with the specified quality standards.

(1) Development of product standards: Development of quality standards governing products calls for thorough familiarity with the product, throughly adequate product tests, and capability to evaluate the improvement in product quality brought by standardization.

For promoting industrial product exports, consideration requires to be given in developing industrial standards to their compatibility with international standards, but the domestic standards should be drawn up based on well-founded comparison of product quality levels between what has been attained and what is to be aimed at, through correct application of testing and analysis techniques applied to domestic products. Tests and analyses should be applied not only to the final product but also to the intermediate products and to raw materials, to effectively determine the correlation existing between the raw material quality, production process and final product quality, in order to establish the standards governing raw materials as well as intermediate and final products, with the view to establishing standards that should most effectively result in a final product of requisite quality.

(2) Transfer of testing capability to private enterprises: Industrial standards can be expected to serve their purpose of ensuring adequate quality of products only upon private enterprises directly responsible for manufacture being fully apprised of the intended meaning of the applicable standards and their properly applying correct testing techniques to determine conformity with the relevant standards. This calls for the requisite testing techniques to be effectively assimilated by the engineers and technicians at all levels and at all stage of production in private enterprises engaging in manufacture.

For this reason, the Centre should extend its training service not only to those engaging directly in quality control but also to others charged with product and production process design, and with actual production operations. to let them acquire basic and practical knowledge and skills in testing, based on curricula devised to best suit their needs.

5.1.3 Industrial Metrology Testing Service Centre

5.1.3.1 Functions and activities

In consideration of the circumstances described under Section 5.1.1, the Industrial Metrology Testing Service Centre should undertake to establish, maintain and make available metrological standards designated by the National Commission on Metrology and all other metrological standards, to ensure pertinent calibration services, and to provide apposite technical guidance to private enterprises. The Centre should also engage in enhancing its own level of testing capability and in relevant research and development activities, as well as in disseminating the techniques thus acquired to private enterprises, and in furnishing technical information.

The function and activities envisaged for the Centre are as indicated below:

(a) Industrial metrology

(1) Establishing the metrological system: To establish a system best adapted to national needs and circumstances for making available primary standards designated by the National Committee on Metrology, as well as other standards required within the Centre for providing calibration services.

(2) Operating the metrological system: To establish, maintain and seek ensuring compatibility with international standards for primary standards designated by the National Committee on Metrology, and to make the standards available within the Centre, to other government institutions and to private enterprises.

To establish, maintain and make available other internal standards for such quantities as viscosity, density, hardness, to serve in extending the coverage of the Centre's calibration services.

(3) Enhancing the accuracy and extending the coverage of calibration services; developing calibration techniques: To modernize the standards and calibration equipment, to enhance the accuracies obtainable in calibrating metrological standards within the Centre, in government institutions and in private enterprises. To develop new calibration methods and techniques.

(4) Calibration service: To provide calibration service within the Centre, for Government institutions and for private enterprises. To undertake roving calibration service, to extend the coverage of calibration services to ever wider ranges of private enterprises.

(5) Technical information service: To report results of research and development undertaken within the Centre; to furnish technical information; to ensure other technical information services within the Centre, to other Government institutions and to private enterprises.

(6) Technical guidance and dissemination services: To provide consultation service, to organize training courses and seminars, with the aim of disseminating metrology-mindedness; to exchange information, perform international comparisons with neighbouring ASEAN countries and with advanced nations.

(b) Testing

(1) Testing for research and development: To perform testing based on international and foreign standards, with a view to promoting exports; also testing for research and development, with a view to enhancing the national level of technical capability.

(2) Testing on request: Performed in answer to requests from other Government institutions, from research establishments and from private enterprises.

(3) Instruction and training: Administered to Centre personnel, to enhance their technological capability, and to personnel from other Government institutions and from private enterprises, to enhance their capability for dealing with new products and processes.

(4) *Technical information service: Provided to private enterprises.*

The foregoing activities should be taken in hand in successively extended scope, as exemplified in Figs. 5.1.3-1 and -2. The detailed substance of the activities to be undertaken should be varied to best suit the individual subject matters and objectives, as indicated in Tables 5.1.3-3 to -8.

The position of this centre is shown in Fig. 5.1.3-2

Table 5.1.3-1 Functions and Scope of Activities Progressing with Phase of Development - Industrial Metrology Testing Service Centre - Industrial Metrology

Functions	Scope of Activities in Successive Phases of Development		
	Phase 1 (1st-5th year)	Phase 2 (6th-8th year)	Phase 3 (9th-11th year)
(1) Establish national system for ensuring availability of metrological standards	Draw up plan best adapted to Thailand for ensuring requisite availability of metrological standards (match industrial metrology with legally designated metrology); ensure traceability of all quantities	Improve/extend	Set system on firm footing
(2) Establish/ maintain/make available metrological standards	Establish the metrological standards (primary) selected by the National Committee on Metrology; maintain and make available the different metrological standards	Maintain/make available metrological standards in new domains; extend scope of coverage; enhance established accuracies. - Organize international (ASEAN region) comparisons of metrological standards	Same as left Same as left (to join family of advanced nations in this respect)
(3) Improve calibration accuracy; extend scope of calibrations; develop calibration techniques	Extend facilities for calibration of instruments; develop calibration method, improve calibration accuracy; perform basic studies in measuring techniques and instruments	Extend scope of calibrations; compile manuals on calibration of different instruments; enhance accuracy of calibration techniques	Further extend activities
(4) Metrological calibration service	Provide other government institutions and private enterprises with metrological and calibration services	Roving calibration services (government institutions and private enterprises accorded priority)	Further extend services to include all applicants
(5) Technical information service	Publish and furnish on request technical information	Same as left	Same as left
(6) Technical consultancy/ dissemination service	Furnish consulting/ training services to other government institutions and private enterprises	Same as left; also disseminate metrology-mindedness at national and regional (ASEAN) levels	Same as left

Table 5.1.3-2 Functions and Scope of Activities Progressing with Phase of Development - Industrial Metrology Testing Service Centre - Testing

Functions	Scope of Activities Progressing with Phases of Development		
	Phase 1 (1st-5th year)	Phase 2 (6th-8th year)	Phase 3 (9th-11th year)
(1) Testing for research and development	Perform testing to serve in developing new standards and products	Same as left	Same as left
(2) Testing on request	Perform testing on commission from government institutions, from other testing establishments and from private enterprises	Same as left	Same as left
(3) Enhancement and dissemination of testing techniques	Assimilate and progress in basic and applied testing techniques; disseminate acquired techniques to other testing establishments and private enterprises	Adapt techniques to new products and new processes; achieve conformity with international standards. Disseminate among enterprises a large range of testing techniques adapted to new products	Same as left
(4) Information service	Furnish technical information	Same as left	Same as left

Table 5.1.3-3 Functions and Scope of Activities of Industrial Metrology Testing Service Centre in Successive Phases of Development - Phase 1

FUNCTIONS / ACTIVITIES		CLIENTS	DOMAINS: Electricity —AC, DC	Temperature	Light (radiation)	Mass	Length	Volume - flow	Force - pressure	Sound - vibration	Other quantities (new)
(1) System for making standards available	Establish system for making metrological standards available	Private enterprises	○	○	○						
		Research institute	○	○	○						
		Government institutions	○	○	○						
		Within Centre	○	○	○	○	○	○	○	○	
(2) Metrological standards	a. Establish b. Maintain c. Make available	Private enterprises	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○	
		Research institute	c ○	c ○	c ○						
		Government institutions	c ○	c ○	c ○						
		Within Centre	abc ○	abc ○	abc ○	bc ○	bc ○	bc ○	bc ○	bc ○	
(3) Calibration techniques	a. Enhance accuracy b. Extend scope c. Develop new techniques	Private enterprises	a ○	a ○	a ○						
		Research institute	a ○	a ○	a ○						
		Government institutions	a ○	a ○	a ○						
		Within Centre	abc ○	abc ○	abc ○	ab ○	ab ○	ab ○	ab ○	ab ○	
(4) Calibration service	a. Metrological standards b. Instruments	Private enterprises	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	
		Research institute	ab ○	ab ○	ab ○						
		Government institutions	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	
(5) Technical information service	a. Publish research results b. Furnish information on request	Private enterprises	ab ○	ab ○	ab ○	b ○	b ○	b ○	b ○	b ○	
		Research institute	ab ○	ab ○	ab ○	b ○	b ○	b ○	b ○	b ○	
		Government institutions	ab ○	ab ○	ab ○	b ○	b ○	b ○	b ○	b ○	
		Within Centre	ab ○	ab ○	ab ○	b ○	b ○	b ○	b ○	b ○	
(6) Technical consultancy/ dissemination	a. Technical consultations b. Seminars/ lectures meetings c. International comparisons	Advanced countries									
		ASEAN	c ○	c ○	c ○						
		Private enterprises	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	
		Research institute	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	
		Government institutions	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	

Table 5.1.3-4 Functions and Scope of Activities of Industrial Metrology Testing Service Centre in Successive Phases of Development - Phase 2

FUNCTIONS/ACTIVITIES		CLIENTS	DOMAINS: Electricity —AC, DC	Temperature	Light (radiation)	Mass	Length	Volume - flow	Force - pressure	Sound - vibration	Other quantities (new)
(1) System for making standards available	Establish system for making metrological standards available	Private enterprises	○	○	○	○	○	○	○	○	○
		Research institute	○	○	○	○	○	○	○	○	○
		Government institutions	○	○	○	○	○	○	○	○	○
		Within Centre	○	○	○	○	○	○	○	○	○
(2) Metrological standards	a. Establish b. Maintain c. Make available	Private enterprises	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○
		Research institute	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○
		Government institutions	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○
		Within Centre	abc ○	abc ○	abc ○	bc ○	bc ○	bc ○	bc ○	bc ○	bc ○
(3) Calibration techniques	a. Enhance accuracy b. Extend scope c. Develop new techniques	Private enterprises	ab ○	ab ○	ab ○	a ○	a ○	a ○	a ○	a ○	
		Research institute	ab ○	ab ○	ab ○	a ○	a ○	a ○	a ○	a ○	
		Government institutions	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
(4) Calibration service	a. Metrological standards b. Instruments	Private enterprises	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Research institute	ab ○	ab ○	ab ○	a ○	a ○	a ○	a ○	a ○	ab ○
		Government institutions	ab ○	ab ○	ab ○	a ○	a ○	a ○	a ○	a ○	a ○
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
(5) Technical information service	a. Publish research results b. Furnish information on request	Private enterprises	ab ○	ab ○	ab ○	b ○	b ○	b ○	b ○	b ○	b ○
		Research institute	ab ○	ab ○	ab ○	b ○	b ○	b ○	b ○	b ○	b ○
		Government institutions	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	a ○	a ○
(6) Technical consultancy/ dissemination	a. Technical consultations b. Seminars/ lectures meetings c. International comparisons	Advanced countries	c ○	c ○	c ○						
		ASEAN	ac ○	ac ○	ac ○	c ○	c ○	c ○	c ○	c ○	
		Private enterprises	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Research institute	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Government institutions	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○

Table 5.1.3-5 Functions and Scope of Activities of Industrial Metrology Testing Service Centre in Successive Phases of Development - Phase 3

FUNCTIONS/ACTIVITIES		CLIENTS	DOMAINS: Electricity—AC, DC	Temperature	Light (radiation)	Mass	Length	Volume - flow	Force - pressure	Sound - vibration	Other quantities (new)
(1) System for making standards available	Establish system for making metrological standards available	Private enterprises	○	○	○	○	○	○	○	○	○
		Research institute	○	○	○	○	○	○	○	○	○
		Government institutions	○	○	○	○	○	○	○	○	○
		Within Centre	○	○	○	○	○	○	○	○	○
(2) Metrological standards	a. Establish b. Maintain c. Make available	Private enterprises	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○
		Research institute	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○
		Government institutions	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○	c ○
		Within Centre	abc ○	abc ○	abc ○	bc ○	bc ○	bc ○	bc ○	bc ○	bc ○
(3) Calibration techniques	a. Enhance accuracy b. Extend scope c. Develop new techniques	Private enterprises	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Research institute	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Government institutions	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	bc ○
(4) Calibration service	a. Metrological standards b. Instruments	Private enterprises	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Research institute	ab ○	ab ○	ab ○	a ○	a ○	a ○	a ○	a ○	ab ○
		Government institutions	ab ○	ab ○	ab ○	a ○	a ○	a ○	a ○	a ○	ab ○
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
(5) Technical information service	a. Publish research results b. Furnish information on request	Private enterprises	ab ○	ab ○	ab ○	b ○	b ○	b ○	b ○	b ○	b ○
		Research institute	ab ○	ab ○	ab ○	b ○	b ○	b ○	b ○	b ○	b ○
		Government institutions	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
(6) Technical consultancy/ dissemination	a. Technical consultations b. Seminars/ lectures meetings c. International comparisons	Advanced countries	ac ○	ac ○	ac ○	c ○	c ○	c ○	c ○	c ○	c ○
		ASEAN	ac ○	ac ○	ac ○	ac ○	ac ○	ac ○	ac ○	ac ○	ac ○
		Private enterprises	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Research institute	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Government institutions	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○
		Within Centre	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○	ab ○

Table 5.1.3-6
Functions and Scope of Activities of Industrial Metrology Testing Service Centre in Successive Phases of Development - Testing - Phase 1

ACTIVITIES/ CLIENTS / DOMAIN	(1) Testing for research and development				(2) Testing on request				(3) Enhancement dissemination of testing techniques				(4) Technical information service			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Electrical equipment:-																
- Components	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Household appliances	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Electronic equipment:-																
- Equipment for popular market	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Equipment for industry																
Machinery:-																
- Metallic materials	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Industrial machinery	o				o				o				o			
Chemistry:-																
- Chemical analysis	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Biochemistry	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

A; Within Centre B: Government institutions C: Research institutes
D: Private enterprises

Table 5.1.3-7
Functions and Scope of Activities of Industrial Metrology Testing Service Centre in Successive Phases of Development - Testing - Phase 2

ACTIVITIES/ CLIENTS / DOMAIN	(1) Testing for research and development				(2) Testing on request				(3) Enhancement dissemination of testing techniques				(4) Technical information service			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Electrical equipment:-																
- Components	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Household appliances	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Electronic equipment:-																
- Equipment for popular market	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Equipment for industry	o				o				o				o			
Machinery:-																
- Metallic materials	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Industrial machinery	o	o	o		o	o	o		o	o	o		o	o	o	
Chemistry:-																
- Chemical analysis	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Biochemistry	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

A: Within Centre B: Government institutions C: Research institutes
D: Private enterprises

Table 5.1.3-8
Functions and Scope of Activities of Industrial Metrology Testing Service Centre in Successive Phases of Development - Testing - Phase 3

ACTIVITIES/ CLIENTS / DOMAIN	(1) Testing for research and development				(2) Testing on request				(3) Enhancement dissemination of testing techniques				(4) Technical information service			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Electrical equipment:-																
- Components	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Household appliances	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Electronic equipment:-																
- Equipment for popular market	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Equipment for industry	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Machinery:-																
- Metallic materials	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Industrial machinery	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Chemistry:-																
- Chemical analysis	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Biochemistry	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

A: Within Centre B: Government institutions C: Research institutes
D: Private enterprises

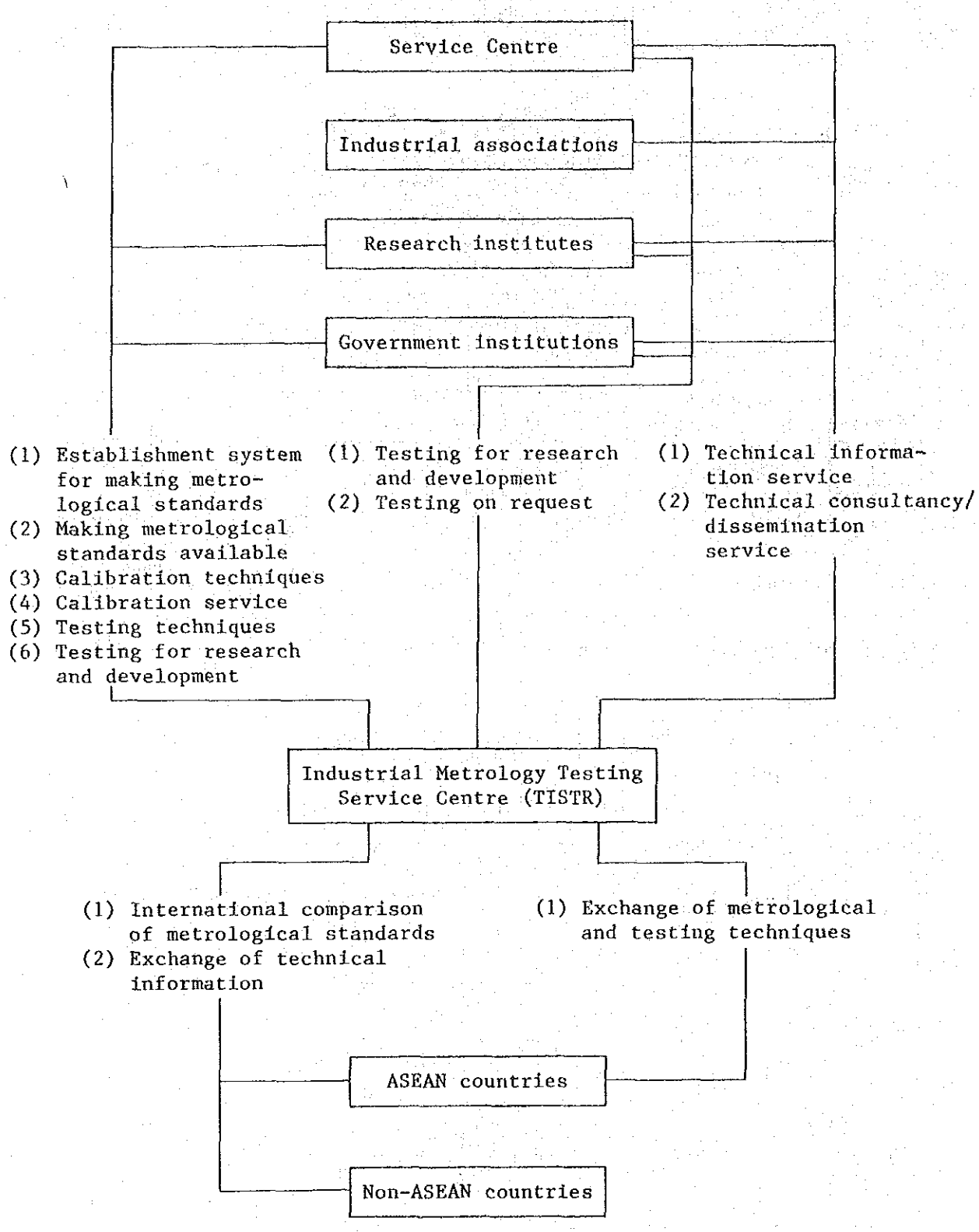

Fig. 5.1.3-1 Position to be Occupied by Industrial Metrology Testing Service Centre

5.1.3.2 Organization and personnel

(a) Organization

A tentative organization chart is presented in Fig. 5.1.3-2, comprising 2 Departments, charged respectively with central services and with industrial metrology and testing, as described below in further detail.

(1) Central Services Group

- Administration Section: To undertake overall administration, as well as clerical work for the Centre as a whole
- Training Section: To undertake work related to instruction and training.

(2) Industrial Metrology and Testing Group

- Electrical and Electronic Laboratory: To undertake measurements of electrical quantities and testing of electrical and electronic equipment.
- Mechanical Engineering Laboratory: To undertake measurements of length, mass, force and pressure, and testing of machinery
- Photometric and Thermometric Laboratory: To undertake measurements of light, temperature, non-ionizing radiation
- Analytical Chemistry Laboratory: To undertake chemical analyses
- Biochemical Laboratory: To undertake tests related to biochemistry
- Volumetric and Fluid Flow Laboratory: To undertake measurements of volume and fluid flow
- Acoustic and Vibration Laboratory: To undertake measurements of sound and vibration.

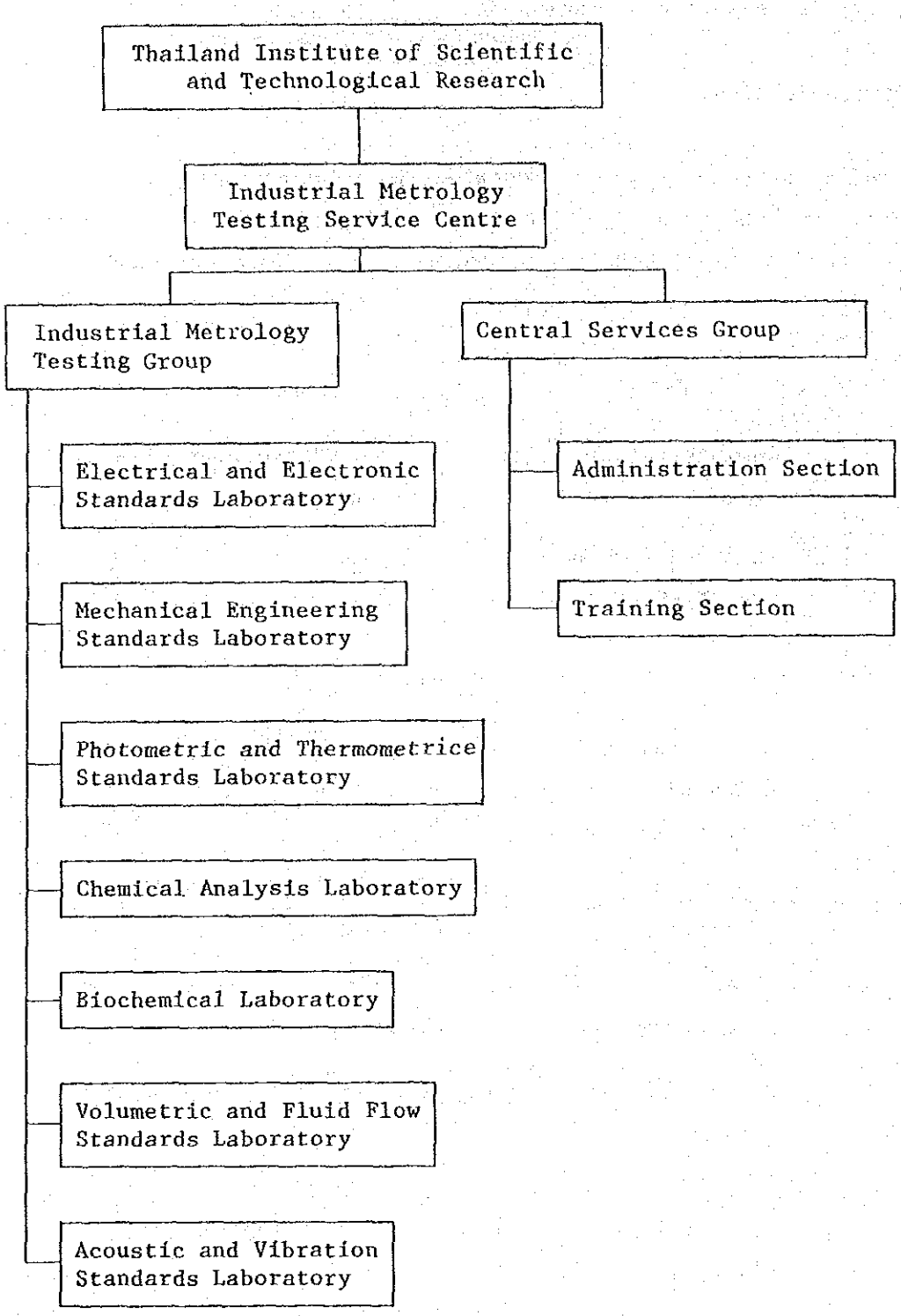

Fig. 5.1.3-2 Organization of Industrial Metrology Testing Service Centre

(b) Staffing schedule

A tentative staffing schedule covering the successive phases of development is presented in what follows.

(1) Central Services Group

The current personnel number 6 in the corresponding Division of TISTR could need increasing by 3 during Phase 1, and by further 1 each during the ensuring Phases 2 and 3.

(2) Industrial Metrology Testing Group

The current technical personnel in TISTR engaged in establishing and maintaining national metrological standards numbers 4 in the domain of electrical quantities, 3 in that of physical quantities -- length, mass, force, pressure -- and 3 in that of thermometry, photometry and inoizing radiations, together with 33 others charged with actual testing work.

Among those mentioned above to be engaged in metrological work, it can be considered from past records of actual test implementation -- referred to in Section 3.7.2(1)(g) -- that those engaging in calibration would be, perhaps, about 2 in electrical, 1 in physical, and 1 in thermometry/photometry and radiations.

As future reinforcement plan:

- Phase 1:

Metrological standard creation/maintenance: To cover the extension of coverage in thermometry and electricity and additional work related to accuracy enhancement of standards, as set forth in Section 5.1.1.3, additional personnel amounting to 4 in electrical, 5 in physical, and 3 in thermometry/photometry/radiation might be necessary.

Calibration service: From what is said in Section 3.7.2(1)(g) and Section 5.1.1.3, ca. 750 additional calibrations in electricity, ca. 300 in physical, and ca. 230 in thermometry/photometry/radiation 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/photomtry might be necessary.

- Phase 2:

To cover extension of metrological standard coverage to density, hardness, surface roughness, circularity, volume/flow rate and sound/vibration, and in respect of calibration service, in view of the expected settling down of the rate of workload increase but offset by additional demands for calibration on account of the newly extended coverage by metrological standards, the overall workload might be expected to increase by perhaps 10 percent during this phase.

To cover the foregoing workload increase, derivation similar to that for Phase 1 results in an expected requirement for additional

personnel amounting to 4 in electrical, 4 in physical, 3 in thermometry/photometry/radiation, 3 in volume/flow, and 4 in sound/vibration -- totalling 18 for both metrology and calibration -- during this phase.

- Phase 3:

  By derivation similar to above, and assuming quantitative enhancement of functions developed during the preceding phases, the expected requirement for additional personnel would amount to 2 in electrical, 3 in physical, 2 in thermometry/photometry/radiation, and 2 in volume/flow -- totalling 9 for both metrology and calibration -- during this phase.

In respect of testing personnel, taking account of the 6.6 percent target annual increase set forth in the 6th NESDP for industrial development, and of the increasingly essential part to be played by testing in research and development accompanying the progress of industry and the concomitant sophistication of industrial products, and further considering the need to eliminate the current overloading of testing service, an annual enhancement of 8 percent should have to be foreseen for the testing workload: This could mean having to increase the testing personnel by 20 during Phase 1, by 14 during Phase 2 and by 18 during Phase 3.

The foregoing tentative staffing schedule is summarized below:

	PHASE 1	PHASE 2	PHASE 3
Senior/intermediate grades:-	55	73	88
- Metrology	(21)	(30)	(34)
- Testing	(30)	(38)	(48)
- Administration	(4)	(5)	(6)
Junior grade:-	41	56	69
- Metrology	(13)	(22)	(27)
- Testing	(23)	(29)	(37)
- Administration	(5)	(5)	(5)
Total:-	96	129	157
- Metrology	(34)	(52)	(61)
- Testing	(53)	(67)	(85)
- Administration	(9)	(10)	(11)

A more detailed schedule covering the individual Divisions and Sections is presented in Table 5.1.3-9.

The foregoing staffing schedule should be coordinated with the schedule for extending the corresponding facilities and equipment. Also, in view of the lead time required between recruiting and effective reinforcement of testing capability, the estimates of workload in the forthcoming years should be reflected in regularly-revised long- and short-term staffing programms, which should serve as basis for drawing up the annual plans for implementation of the staffing schedule.

It might be mentioned in this connection that the current recruiting schedule of TISTR for 1990 is as cited below:

	Senior/Inter-mediate Officials	Junior Officials
Central Services Division	4	5
Electrical and Electronic Standards Laboratory	15	10
Mechanical Engineering Standards Laboratory	18	5
Photometric and Thermo-metric Standards Laboratory	5	3
Chemical Analysis Laboratory	15	8
Biochemical Laboratory	9	3
Total	66	52

Table 5.1.3-9 Staff Force - Industrial Metrology Testing Service Centre

		Phase 1 (1st - 5th year)				Phase 2 (6th - 8th year)				Phase 3 (9th - 11th year)			
		Senior/intermediate grade officials	Junior officials	Foreign experts on temporary assignment		Senior/intermediate grade officials	Junior officials	Foreign experts on temporary assignment		Senior/intermediate grade officials	Junior officials	Foreign experts on temporary assignment	
				Long-term	Short-term			Long-term	Short-term			Long-term	Short-term
Central Service Group													
Administration Section	Planning/administering activities of Centre; administering budget/scheduling; personnel administration; clerical services	1	2			1	2			2	2		
	Information services	1	(1)			1	(1)			1	(1)		
Training Section	Receiving services	(1)	1			(1)	1			(1)	1		
	Planning/executing training programme	1	2			2	2			2	2		
	Study method best adapted for promoting industrial metrology	1	(1)			1	(1)			1	(1)		
Subtotal		4	5			5	5			6	5		
Industrial Metrology and Testing Group													
Electrical and Electronic Laboratory:-													
	- Metrology	8	6	1	1	10	8			11	9		
	- Testing	5	6	2	2	6	7			8	9		
Mechanical Engineering Laboratory:-													
	- Metrology	8	4	2	1	10	6			11	8		
	- Testing	5	10	1	1	6	12			8	15		
Photometric and Thermometric Laboratory:-													
	- Metrology	5	3		2	6	5			7	6		
Chemical Analysis Laboratory:-													
	- Testing	14	5	1	1	18	7			22	9		
Biochemical Laboratory:-													
	- Testing	6	2		1	8	3			10	4		
Volumetric and Fluid Flow Laboratory:-													
	- Metrology	(2)	(1)	1		2	1			3	2		
Acoustic and Vibration Laboratory:-													
	- Metrology	(2)	(2)	1		2	2			2	2		
Subtotal		51	36	9	9	68	51			82	64		
Total		96		18		129				157			

NOTES: (1) Numericals given between parentheses indicate number of staff charged part-time with the duties indicated, but having their main duties in the Centre.

(2) Foreign experts may not necessarily by assigned in groups residing at Centre at the same time.

5.1.3.3 Personnel training

Establishing, maintaining and making available metrological standards call for increasingly higher levels of specialized knowledge and skills as the grades of accuracy progress, and this calls for careful planning and implementation of training programmes, separately for each domain. The same applies to testing, when increasingly accurate and reliable testing should be performed in a minimum of time.

Training of the personnel in the numbers indicated in the preceding Section (b) are to be implemented through:

- Training provided within the Centre by foreign experts

- Assignment of Centre personnel to foreign institutions for training.

The training are to be provided separately for different categories of training and for different domains of testing, as indicated below, in courses to last about 3 months whether given by foreign specialists or through assignment to institutions abroad.

The different courses to be organized are:-

- For those to engage in establishing/maintaining/making available metrological standards

- For those to engage in calibration service

- Separate courses for testing operations in different domains.

The programmes for personnel training are presented in Table 5.1.3-10 (a), (b). Detailed curriculum items are given in Tables 5.1.3-11 and -12. Examples of curricula are further detailed in the tables that immediately follow.

Training Course Curricula

- Metrology and Calibration -

Domain	Staffs	Programme	Substance
Electrical standards, Thermometric standards	Those to engage in establishing/maintaining primary standards, and making available secondary standards	Elementary notions of metrological management	Basic theory of metrology: Forms of measurement and structure of measuring instruments; measurement errors/accuracies; measurement standards and traceability; data processing and statistical analysis; design of experiments; control charts; sampling techniques; sampling tests etc.
		Metrological techniques	Units and standards in different domains; traceability system; methods of measurement; principles and structures of different measuring instruments
		Establishing/maintaining making available metrological standards	Theory and practice of techniques relevant to establishing/ maintaining/making available primary standards in different domains
		Laboratory visits etc.	Visits to pertinent laboratories; discussions with experts

Training Course Curricula

- Metrology and Calibration -
(continued)

Domain	Staffs	Programme	Substance
Quantity of electricty; temperature; mass; length; volume; flow; force; pressure Sound; vibration	Those to engage in calibration of working standards and of practical measuring instruments	Elementary notions of metrological management	Basis theory of metrology: Forms of measurement and structure of measuring instruments; measurement errors/accuracies; measurement standards and traceability; data processing and statistical analysis; design of experiments; control charts; sampling techniques; sampling tests etc.
		Metrological techniques	Units and standards for different electrical, magnetic and other physical quantities; traceability system; methods of measurement; principles and structures of different measuring instruments
		Calibration techniques	Principles governing methods, intervals, tolerances etc. for calibrating working and practical measuring instruments; manuals on calibration; lectures and practical exercises in management of metrological standards
		Laboratory visits etc.	Visits to pertinent laboratories: discussions with experts

Training Course Curricula - Testing -
Electronic Equipment

Domain	Staffs	Programme	Substance
Testing electronic equipment	Those to engage in testing for research and development of electronic equipment	Elementary notions of testing for research and development	Explanations on safety, performance, reliability, standards; key points to be held in view in research and development
		Manipulation of equipment	Guidance and explanations on manipulation of measuring/testing instruments
		Techniques of testing	Selection of test items; planning tests; procedure of compiling test reports
		Practice of testing	Preparing requisite instruments for test; preparing requisite facilities/equipment/jigs/tools; preparing procedure/manipulation manuals; testing practice; application techniques
		Analysis of test results	Guidance in evaluation of test results, and in techniques for verifying reliability of test results
		Compiling test reports	Guidance in compiling test reports

Training Course Curricula - Testing -
Electric Household Appliances

Domain	Staffs	Programme	Substance
Testing electric household appliances	Those to engage in testing for research and development of electrical equipment	Elementary notions of testing for research and development	Explanations on safety, performance, reliabilty, standards; key points to be held in view in research and development
		Manipulation of equipment	Guidance and explanations on manipulation of measuring/ testing instruments
		Techniques of testing	Selection of test items; planning tests; procedure of compiling test reports
		Practice of testing	Preparing requisite instruments for test; preparing requisite facilities/equipment/jigs/tools; preparing procedure/manipulation manuals; testing practice; application techniques
		Analysis of test results	Guidance in evaluation of test results, and in techniques for verifying reliability of test results
		Compiling test reports	Guidance in compiling test reports

Training Course Curricula - Testing - Machinery

Domain	Staffs	Programme	Substance
Testing machinery	Those to engage in testing for research and development of industrial machinery	Elementary notions of testing for research and development	Explanations on performance, reliabilty, standards; key points to be held in view in research and development
		Manipulation of equipment	Guidance and explanations on manipulation of measuring/ testing instruments
		Techniques of testing	Selection of test items; planning tests; procedure of compiling test reports
		Practice of testing	Preparing requisite instruments for test; preparing requisite facilities/equipment/jigs/tools; preparing procedure/manipulation manuals; testing practice; application techniques
		Analysis of test results	Guidance in evaluation of test results, and in techniques for verifying reliability of test results
		Compiling test reports	Guidance in compiling test reports

Training Course Curricula - Testing -
Foodstuff and Chemical Products

Domain	Staffs	Programme	Substance
Analyzing foodstuff and chemical products	Those to engage in chemical analysis for research and development of foodstuff and chemical products	Elementary notions of analysis for research and development	Explanations on performance, reliabilty, standards; key points to be held in view in research and development
		Manipulation of equipment	Guidance and explanations on manipulation of equipment used chemical analysis
		Techniques of analysis	Selection of test items of analysis; planning analysis; procedure of compiling reports of analysis
		Practice of analysis	Preparing requisite equipment and regeagents for performing analysis; preparing procedure/ manipulation manuals; practice of analysis; applicational techniques
		Analysis of results of analysis	Guidance in evaluation of results of analysis, and in techniques for verifying reliability of results
		Compiling reports of analysis	Guidance in compiling reports of analysis

Table 5.1.3-10(a) Programme for Personnel Training - Industrial Metrology Testing Service Centre

	Phase 1 (1st-5th year)			Phase 2 (6th-8th year)			Phase 3 (9th-11th year)		
	Foreign experts on temporary assignment	Trained within Centre	Trained in Forein institution	Foreign experts on temporary assingment	Trained within Centre	Trained in Forein institution	Forein experts on temporary assingment	Trained within Centre	Trained in Foreign institution
Electrical and Electronic Laboratory:-									
- Metrology	2	8	2		4			2	
- Testing	4	4	4		2			4	
Mechanical Engineering Laboratory:-									
- Metrology	3	7	2		4			3	
- Testing	2	2	2		3			5	
Photometric and Thermo-metric Laboratory:-									
- Metrology	2	5	2		3			2	
Chemical Analysis Laboratory:-									
- Testing	2	5	1		6			6	
Biochemical Laboratory:-									
- Testing	1	2	2		3			3	
Volumetric and Fluid Flow Laboratory:-									
- Metrology	1		2		3			5	
Acoustic and Vibration Laboratory:-									
- Metrology	1		2		4			4	

Table 5.1.3-10(b) Programmes of Assignments to Centre of Foreign Specialists and for Assignments Abroad of Centre Personnel for Training Abroad

DOMAIN			YEAR 1st Year	2nd Year	3rd Year	4th Year	5th Year
Metrology		Electricity —AC, DC	⇠⇢ ⟷		⇠⇢	⟷	
		Temperature			⇠⇢	⟷	
		Photometry, radiation			⇠⇢		⟷
		Mass, length	⇠⇢ ⟷				⟷
		Volume - flow	⇠⇢	⇠⇢	⟷	⟷	
		Pressure - force	⟷	⟷		⇠⇢	
		Sound - vibration			⇠⇢ 2	⟷	⟷
Testing	Electrical equipment	Components	⟷	⟷		⇠⇢	
		Household appliances	⇠⇢			⟷	
	Electronic equipment	Equipment for popular market	⇠⇢ ⟷	⟷			
		Equipment for industry			⇠⇢		⟷
	Machinery	Metallic macerials	⇠⇢ ⟷	⟷		⟷	
		Industrial machinery				⇠⇢	
	Chemistry	Chemical analysis	⇠⇢ ⟷	⟷		⟷	
		Bio-chemistry				⟷	⇠⇢ 2

⇠⇢ Assignment abroad of Centre Personnel

⟷ Assignment to the Centre of Foreign Specialists

Table 5.1.3-11 Training Course Curriculam Items - Metrology and Calibration

Subject	(1) Systems			(2) Metrological standards						(3) Calibration techniques												(4) Calibration service						(5) Technical information service						(6) Technical guidance and dissemination								
	Elementary notions			Establishing standards			Maintaining/ managing standards			Elementary notions			Enhancing accuracy			Extending scope of application			Developing calibration techniques			Elementary notions			Procedure			Elementary notions			Procedure			Elementary notions			Technical guidance			International metrology		
Domain	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Electricity --AC,DC	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Temperature	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Light (radiation)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Mass	○	○	○				○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Length	○	○	○				○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Volume - flow	○	○	○				○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Force - pressure	○	○	○				○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Sound - vibration	○	○	○				○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Other quantities (new)	○	○	○				○	○	○	○	○	○							○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

A: Practice B: Technical guidance C: Administration

Table 5.1.3-12 Training Course Curricula - Testing

Subject / Domain		(1) Testing for research and development																					(2) Enhancing/disseminating testing techniques						(3) Technical information service					
		(1) Elementary notions of research & development			(2) Elementary notions of testing			(c) Testing techniques															Elementary notions			Procedure			Elementary notions			Procedure		
								Performance			Safety			Reliability			Analysis			Nondestructive testing														
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Electrical equipment	Components	○	○	○	○	○	○	○	○		○	○											○	○	○	○	○		○	○	○	○	○	
	Household appliances	○	○	○	○	○	○	○	○		○	○		○	○								○	○	○	○	○		○	○	○	○	○	
Electronic equipment	Equipment for popular market	○	○	○	○	○	○	○	○		○	○		○	○								○	○	○	○	○		○	○	○	○	○	
	Equipment of industry	○	○	○	○	○	○	○	○		○	○		○	○								○	○	○	○	○		○	○	○	○	○	
Machinery	Metallic materials	○	○	○	○	○	○	○	○		○	○					○	○		○	○		○	○	○	○	○		○	○	○	○	○	
	Industrial machinery	○	○	○	○	○	○	○	○		○	○								○	○		○	○	○	○	○		○	○	○	○	○	
Chemistry	Chemical analysis	○	○	○	○	○	○	○	○		○	○					○	○					○	○	○	○	○		○	○	○	○	○	
	Biochemistry	○	○	○	○	○	○	○	○								○	○					○	○	○	○	○		○	○	○	○	○	

A: Practice B: Technical guidance C: Administration

5.1.3.3 Recommendations on future developments

A vital role is to be played by the Industrial Metrology Testing Service Centre in research and development activities the country over, since such activities cannot dispense with testing for factual substantiation. The establishment of metrological standards and calibration service also constitutes the basis of which all industrial development must be founded.

(a) Testing for research and development

Research and development can progress effectively only upon proper compounding of theory with experimental substantiation. This experimental substantiation is largely dependent on testing, which must be applied to objects which can range from raw material and machine components to finished products and equipment, which can also vary widely in subject matter -- properties of matter, product performance, durability, environmental conditions, safety,... Moreover, the accuracies demand of test results is far higher than in the case of acceptance tests, requiring in most cases the determination of precise quantitative values.

Consequently, those engaging in testing at the Centre will be called upon to possess up to date working knowledge on scientific methods, which will have to be acquired in the course of their instruction and training. Effective utilization of the knowledge and skills thus acquired by the personnel will further depend on their being flexibly assigned to jobs that will bring out their accomplishments to best effect.

Another important function indispensable for national industrial development is to usefully transfer the knowledge and skills acquired by personnel of the Centre to private enterprises, through such means as special courses and seminars.

(b) Firm establishment of metrological standards and extension of calibration services

Firm establishment of the metrological system is a key factor for industrial development, metrological standards being required to be in traceable conformity with internationally accepted standards. The duty of establishing and properly maintaining the national metrological standards calls for attendance by highly specialized personnel, who must be properly trained not only within the Centre but also, as necessary, through assignments to central institutions abroad.

The establishment and regular operation of a dependable metrological calibration system is also essential for industrial development, and which must be supplemented by incessant efforts in disseminating metrology-mindedness among the personnel in charge in Government institutions, testing establishments and private enterprises, through periodical instruction courses with curricula deviced specifically for different categories of measurement.

(c) Active response to requests for testing

Requests for tests in conformity with industrial standards, coming from private enterprises to substantiate their research and development activities, or to evaluate the performance of their products, will not fail to increase with further development of industry. Private industry is currently pressed with investing in production equipment, with little surplus to spare for installing testing facilities. Their aspirations toward higher quality products will on the other hand enhance their need for testing and measurements, and this should result in rapidly increasing demand for testing at the Centre.

It should be an important function of the Centre to answer this demand for testing. Active response to requests for testing should further serve usefully to prepare the ground for transferring testing techniques to private enterprises, and thus contribute effectively to development of industrial standardization.

5.1.4 Construction plan

5.1.4.1 Site

The site for constructing the two Centres i.e. Industrial Standardization Testing and Training Centre and Industrial Metrology Testing Service Centre should occupy a total area for both establishments of at least 20,000 square metres, and to be located in a quiet environment within or close to Bangkok.

Other requisite conditions for the site would include easy and ample availability or access to electric power, water supply, sewage system, gas, telecommunication system, etc., as well as convenience for personnel in their daily travel to work. A site access road freely open to large lorries will be indispensable for delivery to the site of testing equipment in the course of construction, and for transport to and from the Centres of large specimens to be tested once the Centres are in operation.

Another necessary consideration in selecting the site for the Centres is freedom from exposure to flooding, which risks critically damaging the delicate apparatus equipping the Centres. If a high ground is not found available, adequate earth filling will have to be provided.

5.1.4.2 Principal buildings and equipment

In order to permit the Industrial Standardization Testing and Training Centre and the Industrial Metrology Testing Service Centre to function and serve as envisaged in the preceding Sections, it is advised to provide equipment and buildings as set forth below.

(a) Industrial Standardization Testing and Training Centre

(1) Main Building

The floorage envisaged for this building is derived from the spaces to be occupied by the facilities and equipment considered necessary for conducting tests for certification and for instruction/training in quality control and industrial standardization. Attendant floorage for offices, meeting room sand other areas related to administration, and accessory floorage for corridors and halls, lifts, lavatories, etc. are estimated to occupy respectively 15 and 20 percent of the total building floorage, in reference to Japanese common practice.

The laboratories and other working spaces are envisaged to occupy the following floorages:

Space Designation	Floorage (m^2)
Chemical testing lab	350
Ditto Annex	90
Package testing lab	150
Packing material testing lab	30
Drenching test lab	30
Air-conditioning test lab	360
Environmental testing lab	360
Anechoic room	300
Ditto Annex	75
Flame testing lab	50
Electronic, electric power/heating/lighting appliances testing lab	450
Dark room	50
Chemical/foodstuff testing lab	175
Open space (for large mechanical testing and other uses)	350
Specimen/equipment store	75
Power supply facility	100
Computer room	75
Staff offices	350
Total	3,420

Adding to the above the attendant and accessory floorage referred to earlier, the total floorage of the Industrial Standardization Testing and Training Centre will amount to approximately 5,200 m^2.

Calculating back from the foregoing building floorage, the number of personnel that could be comfortably accommodated within the available space, taking as reference the values commonly adopted in Japan (30 - 40 m^2 per person). The building may call for extension during Phase 3.

After completion of the building, installation of equipment, and commencement of regular operation, the running expenses to cover personnel, utilities, repair and miscellaneous expenditures are estimated in rough approximation to amount to:

Unit: ¥ million

	1st Year	2nd Year	3rd Year	4th Year	5th Year
Personnel	7.9	8.3	8.6	8.9	9.3
Utilities	1.2	1.2	1.3	1.4	1.4
Repairs and miscellaneous	2.9	3.1	3.2	3.4	3.6
Total	12.0	12.6	13.1	13.7	14.4

Allocation of the amounts corresponding to the above should be foreseen the provided in the annual budget to cover operation of the Centre.

(2) Ancillary facilities

- Substation (500 kVA x 1)
- Water supply facility, reservoir
- Waste water treatment facility
- Motor-car park.

(3) Equipment

The principal equipment for the different facilities are listed in Table 5.1.4-1, for the area for testing or analyses in:-

- Mechanical
- Electromechanical
- Electrical
- Fluid pressure
- Thermal
- Climatic resistance & conditioning
- Light & sound
- Tyre & rim
- Chemical, etc
- Electric power environment testing
- Electronics, etc

(4) Audio-visual education and roving service facilities:

- Audio-visual education system
- Vehicle for roving service
- Library acquisitions (books, standards, ...)
- Microcomputer system, word processors, reproducing/printing equipment

(b) Industrial Metrology Testing Service Centre

(1) Main Building

The floorage envisaged for this building is derived from the spaces to be occupied by the facilities and equipment considered necessary for maintenance of standards and calibration services, and for R & D. Attendant floorage for offices, meeting rooms and other spaces related to administration, and accessory floorage for corridors and halls, lifts, lavatories, etc. are estimated to occupy respectively 15 and 20 percent of the total building floorage, in reference to Japanese common practice.

The laboratories and other working spaces are envisaged to occupy the following floorages:

Space Designation	Floorage (m^2)
Metrology	
- Length	220
- Mass	140
- Force	250
- Pressure	150
- Volume	300
- Sound	350
- Vibration	50
- Electricity	500
- Temperature	150
- Illuminance, radiation	120
Testing	900
Power supply facility	100
Stores, laboratory annex	60
Cumputer room	30
Staff offices	120
Total	3,440

Adding to the above the attendant and accessory floorage referred to earlier, the total floorage of the Industrial Standardization Testing and Training Centre will amount to approximately 5,200 m^2.

Calculating back from the foregoing building floorage, the number of personnel that could be comfortably accommodated within the available space, taking as reference the values commonly adopted in Japan (30 - 40 m^2 per person). The building may call for extension during Phase 3.

After completion of the building, installation of equipment, and commencement of regular operation, the running expenses to cover personnel, utilities, repair and miscellaneous expenditures are estimated in rough approximation to amount to:

Unit: ¥ million

	1st Year	2nd Year	3rd Year	4th Year	5th Year
Personnel	8.6	8.9	9.3	9.6	10.0
Utilities	1.1	1.2	1.3	1.5	1.6
Repairs and miscellaneous	3.4	3.5	3.7	3.9	4.1
Total	13.1	13.6	14.3	15.0	15.7

Allocation of the amounts corresponding to the above should be foreseen the provided in the annual budget to cover operation of the Centre.

(2) Ancillary facilities

- Substation (500 kVA x 1)
- Water supply facility, reservoir
- Waste water treatment facility
- Motor-car park.

(3) Equipment

The principal equipment for the different facilities are listed in Table 5.1.4-2, for the area for testing or analyses in:-

- Length
- Mass
- Force
- Pressure
- Volume
- Radiation
- Acoustics
- Vibration
- Electrical
- Temperature
- High frequency
- Metal testing
- Non-destructive testing
- Polymer & paint
- Gas analysis
- Organic substance
- Biochemistry, etc.

(4) Audio-visual education and roving service facilities:

- Audio-visual education system
- Vehicle for roving service
- Library acquisitions (books, standards, ...)
- Microcomputer system, word processors, reproducing/printing equipment

(c) Schedule of construction

Construction of the two Centres is expected to take 24 months from start of basic planning to initial service operation, to be occupied in operations of:-

- Basic design	Approx. 3 months
- Detail design	Approx. 2.5 months
- Site preparation	Approx. 2.5 months
- Construction of buildings	Approx. 8 months
- Installation of equipment	Approx. 8 months
- Adjustment and testing	Approx. 3 months

Table 5.1.4-1
Industrial Standardization Testing and Training Centre, TISI
Main Facilities and Equipment

Laboratory	Items	Q'ty	Remarks
Mechanical	Basic equipment		
	X-ray projector	1 set	A
	Crack inspection equipment (magnetic particles)	1	C
	Metallurgical microscope	1	A
	Three dimensional manikins	1	C
	Standard head form	1	B
	Universal tensile testing machine	1	A
	Others		
	Tensile properties		
	Universal tensile testing w/extensometer	1	A
	Others		
	Impact		
	Impact tester	1	A
	Pendulum impact tester	1	A
	Impact tester for head rest	1	C
	Others		
	Hardness		
	Hardness tester (HV, HB, HR)	1	A
	Others		
	Compression		
	Hydraulic test press	1	A
	Others		
	Torsion		
	Clutch disc testing machine	1	C
	Others		

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
	Creep		
	Creep testing machine	1 set	A
	Fatigue		
	Constant, load-elongation	1	A
	Fatigue tester (torsion bar)	1	C
	Vibration		
	Vibro tester	1	C
	Others		
	Spring characteristic		
	Leaf spring testing machine	1	C
	Automatic spring testing machine	1	C
	Friction & wear resistance		
	Friction testing machine	1	C
	Others		
	Specific equipment		
	Penetration test equipment	1	A
	Damping force tester	1	C
	Seat frame testing machine	1	C
	Front collision	1	C
	Endurance tester	1	C
	Durability test equipment	1	C
	Others		

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
Electro-mechanical	Calorimeter room	1	C
	Heating efficiency test equipment	1 set	A
	Endurance tester for ignition motor	1	C
	Performance test equipment for starter motor	1	C
	Durability test equipment for wiper motor	1	C
	Others		
Electrical	Basic equipment		
	AC single phase voltage regulator	15	A
	AC three phase voltage regulator	5	A
	Step-up transformer	1	A
	Water bath w/thermal control	1	A
	Others		
	Low voltage		
	Alternator tester	1	C
	Starter tester	1	C
	Regulator tester	1	C
	Automatic life tester	1	C
	Others		
	High voltage		
	Variable power supply	1	A
	High voltage testing device	1	A
	Others		
	Specific Equipment		
	Fuse tester w/variable current source	1	B
	Triple parallel plate plastometer	1	A

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
	Peak voltage measurement circuit	4 set	A
	Hot mandrel heat resistance tester	1	B
	Dust chamber	1	C
	Others		
Fluid pressure	Impulse test equip. for oil filter	1	C
	High pressure water pump w/pressure gauge	1	B
	Air pump/pressure gauge	1	B
	Others		
Thermal	Thermal		
	Temp./humi. oven (4500x4500x3600)	1	A
	Temp./humi. oven (4500x4500x3600)	1	C
	Vacuum oven	1	C
	Others		
	Thermal expansion coefficient		
	Dilatometer	1	A
Climatic resistance & conditioning	High-low temp. and humidity chamber	1	A
	Water spraying chamber	1	C
	Ozon aging tester	1	A
	Salt spray tester (CASS test)	1	A
	Others		

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
Light & sound	Light		
	Light projection test apparatus	1 set	A
	Others		
	Sound		
	Anechoic room	1	C
	Sound level meter	1	C
Tyre & rim	Balancing machine for tyre & wheel	1	C
	Endurance tester for tyre & wheel	1	C
	Holographic tyre test unit (NDT)	1	C
Chemical	Automatic Absorption spectrophotometer	1	A
	X-ray spectrophotometer	1	A
	Emission spectrophotometer	1	C
	UV-VIS spectrophotometer	1	C
Workshop & Maintenance	Universal thread-cutting lathe	1	A
	Universal milling machine	1	A
	Shaping machine	1	A
	Universal tool milling and boring	1	A
	Surface grinding machine	1	A
	Fork lift truck	1	A
	Others		

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
Electric power environment testing	Lighting surge simulator	1 set	C
	Others		
Electronics	Spectrum analyzer	1	B
	Shield room	1	B
	Others		
Education & roving service facilities	Video studio system	1	A
	Video editing system	1	A
	Film chain system	1	A
	Lecture room system	1	A
	Conference room system	1	A
	Meeting room system	1	A
	Portable VTR system	1	A
	Micro-computer	2	A
	Word processor	2	A
	Vehicles for roving service	4	A
	Others		

Table 5.1.4-2
Industrial Metrology Testing Service Centre, TISTR
Main Facilities and Equipment

Laboratory	Items	Q'ty	Remarks
Length	Universal measuring machine	1 set	C
	Interferometer & vacuum chamber	1	C
	Standard meter bars	1	C
	Comparator for length measurement and installation	1	C
	Comparator	1	C
	Circular angle measuring system	1	C
	Laser interferometer kit for linear measurement	1	C
	Others		
Mass	Standard mass set w/standard masses	1	C
	High precision hand-operated balances	1	C
	High precision direct reading balance	1	C
	Direct reading balance	1	C
	Testing machine track scale	1	C
	Others		
Pressure	Deadweight piston gauges	1	C
	Calibration equipment and constant volume valves	1	C
	Oscilating barometers	1	C
	Automatic controlled standard manometer & air-tight chamber	1	C
	Mass spectrometer and osciloscope	1	C
	Others		
Force	Force standard machines and accessories	1	C
	Standard proving ring (Tension & compression)	1	C

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
	Standardizing boxes	1 set	C
	Loadcell and digital test amplifire	1	C
	Others		
Volume	Weighing machine	2	C
	Weights	1	C
	Standard tank	1	C
	Flowmeter testing equipment	1	C
	Piston prover for LPG	1	C
	Piston prover for gas	1	C
	Gasmeter test equipment	1	C
	Others		
Radiation (Metrology)	Standard radiation detectors	1	A
	Others		
Acoustic	Anechoic room	1	C
	F.F.T. Analyzer	1	C
	Speaker calibration system	1	C
	Computer system	1	C
	Others		
Vibration	Vibration exciter system	1	C
	F.F.T. Analyzer	1	C
	Others		

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
Electrical	DC Voltage & current measurement		
	DC Large current cal. system differential voltmeter	1 set	A
	DC High voltage set	1	A
	Others		
	AC Voltage & current measurement		
	AC/DC Comparator	1	C
	DC Stabilized current & voltage source	1	C
	AC Standard voltage source	1	C
	Power amplifier	1	C
	Digital AC Voltmeter	1	C
	AC/DC Voltage & current supply	1	C
	Others		
	Resistance measurement		
	Standard resistor	11	A
	Oil bath	2	A
	Resistance calibration system	1	A
	High resistance calibration system 1	1	A
	High resistance calibration system 2	1	A
	Others		
	Power measurement		
	Digital power meter	4	A
	Others		
	Capacitance measurement		
	Standard capacitor	4	A
	Others		

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
Temperature	Silicon bath	1 set	A
	Resitance bulb	1	A
	Automatic reistance measuring set	1	A
	Others		
High frequency	Electronic voltmeter calibration sys. 1	1	A
	Electronic voltmeter calibration sys. 2	1	A
	Signal generator calibration system	1	A
	High frequency wattmeter	1	A
	Micro-wave wattmeter calibration system	1	A
	Attenuator calibration system 1	1	A
	Attenuator calibration system 2	1	A
	Impedance (VSWR) measurement system	1	A
	High frequency measurement system	1	A
	Oscilloscope, distortion meter and wow meter calibration system	1	A
Metal testing	Emission spectrophotometer	1	A
	Atomic absorption spectrophotometer	1	B
	Automated universal testing	1	B
	Compression testing machine	1	B
	Torsional testing machine	1	A
	Vickers hardness tester	1	B
	Impact testing machine	1	B
	Electron microscope	1	B
	Lathe	1	B
	Shaping machine	1	B
	Vertical milling machine	1	B
	Drilling & boring machine	1	B

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
	Hydraulics press	1 set	B
	Sheet-metal forming	1	B
	Others		
Non-destructive testing	Eddy current inspection	1	A
	Ultrasonic inspection	1	A
	Radiographic examination		
	Gamma ray projector	1	A
	X-ray projector	1	A
	Others		
Polymer & paint	Pyrolysis gas chromatograph - mass spectrometer	1	A
	Gel permeation liquid chromatograph	1	A
	Infrared spectrophotometer	1	A
	UV-VIS spectrophotometer	1	A
	Thermal gravimatic analyzer	1	A
	Universal testing machine	1	A
	Acceleration light fading tester	1	A
	Acceleration weathering machine	1	A
	Ozone weathering machine	1	A
	Others		
Gas analysis	Gas chromatograph	3	B
	Infrared spectrophotometer	1	B
	Mass spectrometer	1	A
	Others		

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
Organic substance	High performance GC-MS-DS	1 set	C
	Fluorometer with data system	1	A
	Infrared spectrophotometer	1	C
	High performance liquid chromatograph	1	A
	UV-VIS Spectrophotometer	1	C
	High performance thin layer chromatograph	1	B
	Amino acid analyzer	1	C
	Laser raman spectrophotometer	1	A
	Others		
Biochemistry	Facilities for microbiological assay of vitamins	1	C
	Facilities for micrological determination in water etc.	1	A
	High performance GC-MS-DS	1	C
	High performance thin layer chromatograph	1	C
	Amino acid analyser	1	C
	Fibertec system I for crude fiber analysis	1	A
	Sugar analyser	1	C
	Fats analyser	1	C
	Scanning electron microscope	1	A
	Cooled shaking bath	1	A
	Others		
Radiation	Pulse or steady-state solar simulator	1	C
	Spectroradiometer	1	C
	Others		

Main Facilities and Equipment (continued)

Laboratory	Items	Q'ty	Remarks
Testing	Hotmandrel	1 set	C
	Tracking test	1	C
	Others		
Education & Roving service facilities	Video studio system	1	A
	Video editing system	1	A
	Film chain system	1	A
	Lecture room system	1	A
	Conference room system	1	A
	Meeting room system	1	A
	Portable VTR system	1	A
	Micro-computer	2	A
	Word processor	2	A
	Vehicles for roving service	4	A
	Others		

NOTES: The symbols A, B and C noted in the remarks column have the following meanings:-

- Industrial Standardization Testing and Training Centre:

  A: Highest priority items indispensable for conducting tests related to compulsory certification

  B: Second priority items for conducting certification tests related to products expected shortly to be specified for compulsory certification.

  C: Items considered necessary for testing related to development of new industrial standards

- Industrial Metrology Testing Service Centre - Testing

  A: Basic items indispensable for adequately meeting current demands for testing

  B: Items required for replacing existing facilities/equipment that are outdated and of insufficient/unstable accuracy

  C: Items considered necessary for coping with foreseen increases of workload in the near future

- Industrial Metrology Testing Service Centre - Metrology and Calibration

  A: Items indispensable for managing/maintaining existing primary national metrological standards

  B: Items necessary for managing/maintaining primary national metrological standards expected shortly to be created in extension

  C: Items necessary for managing/maintaining secondary and further metrological standards, and for coping with foreseen future increases in calibration workload

5.1.5 Rough Estimate of Project Cost

The cost of realizing the envisaged Centres, to be incurred from acquisition of requisite land to start of service operation, is as estimated below. It is assumed that access roads and other environmental infrastrucure already exist. For imported articles, the prices have been estimated assuming a conversion rate of ¥6 = ฿1.

5.1.5.1 Industrial Standardization Testing and Training Centre

(a) Ground and buildings

Land	฿ 3.1 million
Land grading	฿ 2.5 million
Building construction	฿ 147.3 million
(b) Equipment	฿ 391.6 million
Subtotal	฿ 544.5 million

5.1.5.2 Industrial Metrology Testing Service Centre

(a) Ground and buildings

Land	฿ 3.1 million
Land grading	฿ 2.5 million
Building construction	฿ 147.3 million
(b) Equipment	฿ 477.1 million
Subtotal	฿ 630.0 million
Total	฿1,174.5 million

The foregoing master plan for the Project proposal - 1 represents an envisaged conceptual plan based on the situation observed at the time of site survey. In actually carrying out the Project, time should be taken to draw up a practical and realistic plan of implementation, in the context of national policy and measures, and with consideration given to the orders of priority in implementation and to available financial and manpower resources.

Moreover, in the course of Project implementation, any changes in financial or other circumstances governing the progress of work should be flexibly countered with realistic and practical measures apposite to the situation.

5.2 Project Proposal 2 - Establishment of Joint Private Testing Laboratories

5.2.1 Background

In parallel with the administrative and regulatory measures taken by Government for developing industrial standardization, testing and metrology, the private enterprises directly engaged in productive activity should strive on their part to enhance their capability for self-initiated testing, indispensable for quality control and research relevant to their products.

Despite this necessity, however, with the current low awareness shown by industry towards the importance of directing manpower and financial resources to testing, analysis and metrology, not to speak of research and development, private enterprises are spending most of what they can spare on increasing production. Apart from the minimum indispensable testing or analytical equipment required for routine quality control operations, individual enterprises cannot be expected to afford establishing and operating testing laboratories and training specialized personnel for advanced testing and analytical work such as for research and development, for verifying conformity with TIS or with international or internationally recognized foreign standards.

Consequently, under the current circumstances, the manufacturing industry has inevitably to rely on public institutions and universities to meet their needs for testing or analysis for export goods and other products demanded by customer to carry certification, and for purposes of research/development and quality control. The public institutions and universities on their part have other duties of their own, and besides, their equipment is not always adapted or adequate for such requested testing.

5.2.2 Objectives

The establishment of joint private testing laboratories would permit satisfying requests emanating from private enterprises for testing and analysis, and upon making the laboratory equipment widely available for joint use by individual enterprises, the resulting fuller use made of the equipment will permit lowering the charges demanded for testing, and contribute to enhancement of product quality and of productivity.

5.2.3 Outline

5.2.3.1 Location of joint laboratories

The first joint laboratory should be located in or near Bangkok, where the main concentration of industries is found -- desirably within the industrial estate. In future, with progressing dispersion of industry to outlying regions, similar joint laboratories should be established in regional centres of industry, to meet the needs of the particular industries concentrated in the respective regions.

The pattern of development followed in Japan was for the Government to establish central testing stations separately covering different branches of industry. Others were located in regional industrial centres to match particular local needs, and were paralleled by prefectural government testing centres to promote industries suited to the respective prefectures. These public institutions have been followed by private research and development institutes, established in such forms as (a) laboratories

operated by individual enterprises for their own purposes, (b) jointly operated as non-profit organizations, and (c) professional research institutes.

In Thailand, the needs of future industrial development should be met by multiplication of such joint private testing laboratories -- that might be established separately to serve different fields of technology and in different zones of industrialization promoted by the Government.

5.2.3.2 Operation of joint laboratories

At the outset, immediately following establishment, a joint laboratory should be staffed with personnel assigned from existing public institutions and/or member enterprises. It should be, in principle, financed with funds contributed by member enterprises offering donations or capital investments, with membership subscriptions, as well as with charges levied for requested tests and personnel training. Government subsidies will have to be provided for laboratory establishment and extension, as well as for equipment acquisition and renewal.

5.2.4 Functions and activities

The joint laboratories will serve the functions and perform the activities enumerated below:

(1) Undertake on request various testing or analysis of products to serve in developing new products and in evaluating product quality

(2) Undertake on request the training of personnel to engage in testing, with long- and short-term courses involving both classroom lectures and laboratory practice

(3) Undertake on request instruction and guidance service in the enterprise premises

(4) Make available to enterprises the use of certain facilities and equipment for their undertaking testing and analyses for research/ development work.

The position to be occupied by a joint private testing laboratory --in the circle of enterprises it serves and of its supporting bodies-- is illustrated in Fig. 5.2.4-1.

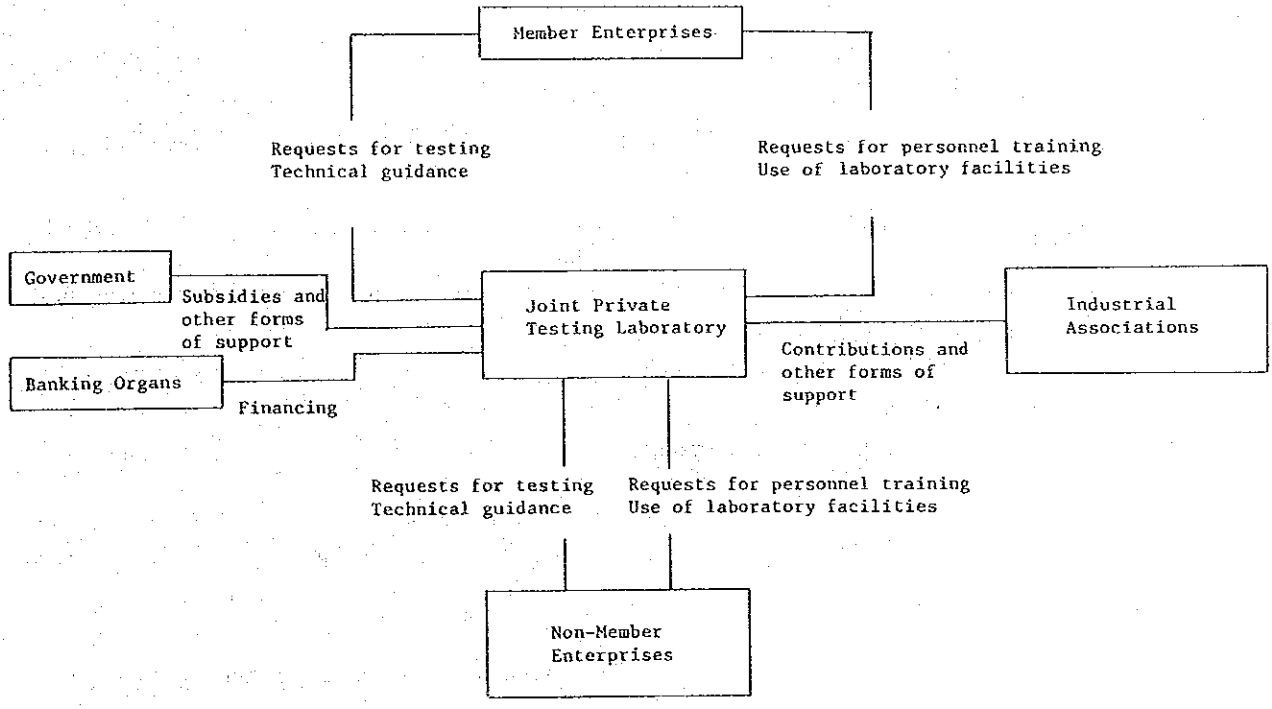

Fig. 5.2.4-1 Position of Joint Private Testing Laboratory among Client Enterprises and Supporting Bodies

5.2.5 Government Assistance

Government assistance advisably to be provided for aiding the establishment and stable operation of the joint private testing laboratories is described in what follows, in terms of financial, tas and other measures. In whichever of the above assistance is provided, it will constitute an appreciable burden on treasury, and careful scrutiny is called for in selecting the projects, the means and the extent of assistance to be extended, based on such criteria as concordance with national policy and expected contribution to enhancing the national industrial level, as well as the financial viability of the envisaged laboratory.

5.2.5.1 Financial Assistance

Conceivable forms of financial assistance to be provided by Government include:-

- Subsidizing part or whole of the costs incurred in constructing and equipping the joint private laboratories
- Acquiring and leasing to the operating entity the requisite laboratory buildings and equipment
- Making available through public financing institutions part or whole of the requisite funds under privileged terms including interest rate, term of repayment, grace period.
- Subsidizing part or whole of the interest to be paid for loans from private financial institutions.
- Purchasing an appreciable portion of shares or bonds issued by the operating entity for ensuring financial coverage.

Further, if the entity operating the laboratory does not yet enjoy adequate credit with the financial institutions for obtaining loans, Government may be called upon to furnish complementary security.

It should also be noted that the financial assistance may require coverage not only of the initial fund for establishment and equipment but also of operating expenses.

5.2.5.2 Tax Privileges

Conceivable tax privileges include:-

- Exempting part or whole of the tax imposed on donations offered to a joint laboratory by member enterprises
- Exempting part or whole of duties imposed on imported laboratory equipment
- Exempting part or whole of the registration tax imposed upon establishment of a joint private laboratory.

Additional measures would include:-

- Alleviating income tax on earned profit, to facilitate subsequent acquisition of laboratory equipment providing higher performance or renewal of equipment
- Refunding taxes upon incurrence of loss
- Privileges on equipment depreciation, including accelerated depreciation.

5.2.5.3 Other Forms of Government Assistance

(a) Assistance for Acquiring Land

Assistance in the acquisition of requisite land for establishing a laboratory could be provided in such forms as transfer at reduced price, or renting at reduced rate, of Government-owned land.

Another form of assistance would be to have tracts of land reserved for joint private laboratories, when establishing industrial estates.

(b) Assistance for Acquiring Laboratory Equipment

Assistance could be provided for acquiring laboratory equipment through information furnished in consultations on the equipment to be acquired, in such aspects as equipment performance and accuracy, prices, and sources of supply.

(c) Assistance for Laboratory Staffing

Assistance could be provided for laboratory staffing through assignments by request of testing and other technical personnel from public institutions, and through instruction and training provided in public institutions to laboratory personnel in specific subjects and techniques.

(d) Facilitation of Financing

Assistance could be provided on financial matters through references to financial institutions for arranging loans, and through consultations on tax privileges.

(e) Entrusted Tests

Some tests currently conducted at public institutions could be entrusted to joint private laboratories for activating their work, such entrusted tests could include those to verify conformity with TIS for certification purposes.

5.2.6 *Points to be Heeded in the Operation of Joint Private Laboratories*

(1) Member enterprises should be encouraged to utilize the laboratory facilities by performing the tests and measurements in their own hands. In this connection, consideration should be given to protecting trade secrets accruing from work conducted in the laboratory especially in case of developing new products.

(2) A workshop should be provided, to permit member enterprises to undertake trial manufacture of new products, with appropriate guidance and instruction furnished on the use of the workshop equipment.

(3) Study groups should be set up gathering together enterprises undertaking similar activities, for them to bring up problems of common interest for discussion on possible solutions. For instance, improvements in testing procedures and methods might be studied, for the resulting methods to be reflected in establishment and revisions of TIS.

(4) Tests could be conducted on materials and components commonly used by member enterprises, to furnish unbiased test data; the laboratory could serve as intermediary in arranging for cooperative procurement of materials and components.

(5) The facilities to equip the joint private laboratories should advisably be capable of conducting certification tests for conformity with TIS.

CHAPTER 6

BENEFITS EXPECTED FROM INDUSTRIAL DEVELOPMENT AND FOR EXPORT PROMOTION FROM DEVELOPMENT OF INDUSTRIAL STANDARDIZATION, TESTING AND METROLOGY

6. BENEFITS EXPECTED FOR INDUSTRIAL DEVELOPMENT AND FOR EXPORT PROMOTION FROM DEVELOPMENT OF INDUSTRIAL STANDARDIZATION, TESTING AND METROLOGY

Development of industry and the promotion of exports are premised upon:-

- Rationalization of production
- Effective utilization of available resources
- Reduction of production cost
- Smooth commercial transactions, ensured through an orderly market
- Intensification of industrial activity resulting from the foregoing measures.

The development of industrial standardization, testing and metrology will establish the rules to constitute the basis, and also serve as tool, for implementing the measures enumerated above.

Considered from the overall standpoint of industrial development:-

- Development of industrial standards will:-
    - Contribute to standardization of production processes
    - Serve as basis for rationalizing production
    - Provide the guiding rails for smooth commercial transactions between enterprises.

- Development of testing and metrology will:-
    - Provide the means of verifying conformity with industrial standards presented by the products in the course of their manufacture and distribution to consumer
    - Consequently serve in maintaining order in the market.

The promotion of exports is premised upon enhanced competitiveness of the exported commodities in the international market. This competitiveness is not determined solely in terms of price, but also by such factors as the extent to which the commodity satisfies the needs of the envisaged market,

and the reliability with which it will serve its intended purpose. The development of industrial standardization, testing and metrology clearly affects all these factors.

In the factor of price, as already mentioned above, development of the above system will contribute to rationalization of production processes and consequently to reduction of production cost. Standardization and testing systems will further facilitate stably manufacturing products conforming with the foreign customer's requirements in terms of performance and quality.

Compatibility realized between domestic and international industrial standards will contribute to enhancing interchangeability between equivalent components of foreign make, to serve in removing a barrier against exportation of domestically-manufactured products and components, as well as against importation of inexpensive foreign materials and components.

Also, consolidation of the system for assuring product reliability --e.g. effective functioning of the certification system-- at both industry and national levels should effectively serve in raising international reliance on exported products, to induce simplification or exemption of inspection procedures in the country of destination, and consequently contribute to smoothing the way for exports.

The development of industrial standardization, testing and metrology --with consequent spread of industrial standards and of quality control practice among individual industrial enterprises-- should provide beneficial impacts on the conduct of operations within enterprises, as analyzed in what follows.

(a) Purchasing

(1) Decrease in the variety of materials and components to be purchased will:-

- Increase the size of lots purchased of a given specification, and contribute to reducing unit price
- Reduce the stocks to be maintained
- Minimize dead stock
- Decrease the spaces and equipment required for storage
- Diminish transport and transfer operations
- Widen the range of eligible suppliers to choose from
- Minimize cases where expensive articles of particular specifications require purchasing
- Facilitate scheduling of stock replenishment and purchasing programmes
- Minimize interruptions of work while waiting for replenishment of expired stock material
- Simplify the formats of in-house processing sheets and slips
- Enhance the efficiency of ordering/purchasing/acceptance operations.

(2) In-house standardization of purchasing and subcontracting operations will:-

- Facilitate scheduling of purchasing programmes
- More precisely communicate purchase specifications and other requirements to suppliers, and minimize supplementary communications required in such connection
- Minimize interruptions of work while waiting for replenishment of expired stock material.

(b) Design

(1) Decrease in the variety of products and components to be designed will:-

- Contribute to raising design capability
- Contribute to minimizing errors in design and generation of non-conformities in product
- Reduce time to issue of drawings and smooth production planning
- Permit diverting the time saved from designing varied products toward improving product design and toward development of new products
- Facilitate management and control of drawings and design data
- Rationalize design operations.

(2) In-house standardization of design operations will:-

- Contribute to minimizing errors in design and generation of non-conformities in product
- Reduce time to issue of drawings and smooth production planning
- Facilitate management and control of drawings and design data
- Rationalize design operations.

(c) Manufacturing

(1) Decrease in the variety of products and components will:-

- Prolong the period during which a batch of given product is produced, with resulting enlargement of batch
- Reduce the time consumed in rearranging the production line for a change in product
- Permit introduction of single-purpose production equipment and processes to contribute toward enhanced product quality and production efficiency

- Diminish the quality of semi-finished products in process
- Decrease the varieties and quantities required of jigging, tooling and instrumentation
- Simplify the skills required of workers, facilitate their training, improve their proficiency for the given skills, and enhance safety in work
- Facilitate production control, and contribute to enhancement and constancy of product quality.

(2) In-house standardization of manufacturing processes will:-

- Simplify the skills required of workers, facilitate their training, improve their proficiency for the given skills, and enhance safety in work
- Minimize generation of non-conformities in product
- Facilitate bringing improvements to product processes
- Facilitate production control, and contribute to enhancement and constancy of product quality
- Reduce the time consumed in rearranging the production line for a change in product
- Diminish the frequency of troubles affecting the production equipment
- Minimize waiting time losses
- Otherwise contribute to enhancing production efficiency.

(d) Inspection

(1) Decrease in the variety of products and components to be inspected will:-

- Increase the unit size of batches, and reduce the relative quantity of products to be inspected
- Reduce the time consumed in rearranging the inspection line for a change in product
- Permit the adoption of single-purpose instruments and contribute to enhancement of inspection accuracy and efficiency

- Contribute to minimizing errors in inspection
- Diminish the quantity of products awaiting inspection
- Simplify the skills required of inspectors, facilitate their training, improve their proficiency for the given skills, and enhance safety in work.

(2) In-house standardization of inspection processes will:-

- Simplify the skills required of inspectors, facilitate their training, improve their proficiency for the given skills, and enhance safety in work
- Contribute to minimizing errors in inspection
- Facilitate bringing improvements to inspection processes
- Permit maintaining correct inspection criteria, and facilitate inspection management
- Reduce the time consumed in rearranging the inspection line for a change in product
- Contribute to enhancing maintenance of instrument accuracy
- Minimize waiting time losses.

(e) Equipment maintenance

(1) Adoption of single-purpose equipment and decrease in the variety of equipment to be maintained will:-

- Contribute to enhancement of product quality
- Contribute to enhancement of operating efficiency
- Contribute to reducing accidents in work
- Diminish the number of equipment to be maintained
- Decrease the variety and quantity of replacement components and parts to be stocked
- Facilitate maintenance operations
- Reduce maintenance work, time and cost
- Contribute to enhancing the proficiency of maintenance personnel
- Diminish the frequency of troubles affecting equipment
- Reduce time lost in equipment awaiting repair.

(2) In-house standardization of maintenance procedures will:-

- Permit systematic planning of maintenance operations
- Rational selection of maintenance equipment
- Facilitate and permit efficient performance of maintenance operations
- Simplify replacement component/parts stock control
- Reduce maintenance work, time and cost
- Facilitate the training of maintenance personnel
- Diminish the frequency of troubles affecting equipment
- Reduce time lost in equipment awaiting repair
- Minimize maintenance trouble
- Contribute to enhancement of product quality
- Contribute to enhancement of operating efficiency
- Contribute to reducing accidents in work.

(f) Sales

(1) Decrease in the variety of products and components marketed will:-

- Accelerate distribution
- Reduce the products in stock and lighten inventory financing
- Decrease the spaces and equipment required for storage
- Facilitate rationalization of packing for shipment
- Permit concentration of marketing efforts
- Permit more effective advertising
- Facilitate classifying and meeting customer demands, and contribute to improving customer service
- Minimize confusion, misunderstandings and misinterpretations about customer's intentions
- Simplify sales personnel training
- Facilitate correctly evaluating the results of marketing activity
- Simplify marketing operations and permit enhancement of marketing efficiency.

(2) In-house standardization of marketing procedures will:-

- Minimize confusion, misunderstandings and misinterpretations about customer's intentions
- Facilitate classifying and meeting customer demands, and contribute to improving customer service
- Simplify sales personnel training
- Facilitate correctly evaluating the results of marketing activity
- Simplify marketing operations and permit enhancement of marketing efficiency

(g) Administration

In-house standardization of administration operations will:-

- Liberate administration personnel from daily routine clerical operations, to permit their devoting more attention to important tactical and strategic questions of marketing
- Improve communication of managerial directives down the line of command, to contribute toward better in-house co-ordination and smoother relations among personnel
- Clarify the lines and ranges of responsibility, and eliminate overlapping of efforts among personnel
- Minimize confusion, misunderstandings, misinterpretations among personnel
- Contribute to enhancement of efficiency in administration work
- Simplify the formats of in-house processing sheets and slips.

A survey of Japanese industrial enterprises undertaken in 1969 by the Japanese Standards Association irrefutably revealed that beneficial effects were reaped from standardization. It must be noted here that standardization can effectively bring benefit only on the premise of a properly established and organized system of metrology. The answers received from enterprises further indicated that the benefits were greater for enterprises that had more correctly applied measures of standardization.

Enterprises in the lines of electrical, mechanical, metal and chemical products --and most of all those undertaking electrical and mechanical assembly work-- were the more emphatic in affirming the benefits of standardization. With respect to scale of enterprise, those of large scale employing more than 300 indicated noting the beneficial effects appreciably more clearly than the smaller scale enterprises; the difference between larger and smaller scale enterprises were particularly marked in the electrical and mechanical assembly enterprises, while this effect of size was fainter in the chemical and textile industries.

The survey also revealed that, between standardization applied to products, components, materials, equipment and other hardware, and to procedures, methods and similar software, there proved to be no appreciable difference in the beneficial effects for all industries taken as a whole, and whether for large or small enterprises; some difference was discernible, however, in certain lines of industry: With process industries --mechanical and metal materials-- and service industries --transportation, communication, utilities-- somewhat greater benefits were found to be obtained from software than from hardware standardization.

Between the different activities within an enterprise, the benefits of standardization proved to be appreciated generally in the departments charged with design, purchasing, inspection, manufacturing, maintenance, administration and sales, in that order. Viewed in more detail for different lines of industry, the enterprises engaging in electrical and mechanical assembly indicated particularly high benefit from standardization being derived by their design department, followed by their departments charged with inspection, manufacturing, and procurement. With the processing industries of chemical, metal materials and textiles, the order of beneficial effect was: Procurement, inspection, maintenance, and design.

The notable beneficial forms of standardization observed in the different lines of industry were:-

(1) With agriculture and fishing industries, diminution in the variety of equipment and materials to be purchased

(2) With mining industry, diminution of accidents, reduction of idle time waiting for arrival of replenishments

(3) With construction industry, diminution in the variety of products and components in design work, diminution in the variety of equipment and materials to be purchased

(4) With metal materials (iron/steel, nonferrous metals) industry, diminution of product rejects, enhancement of work safety, decrease of equipment trouble

(5) With mechanical (general machinery, transportation machinery and fittings, process machinery), higher efficiency in design operations, diminution in the variety of products and components, higher efficiency in inspection work by inspectors

(6) With electrical industry, higher efficiency in design operations, diminution in the variety of products and components, higher efficiency in inspection work by inspectors

(7) With chemical industry (chemical and petroleum products), diminution of overlooked nonconformities in inspection, enhancement of production control techniques, diminution of waiting time for deliveries

(8) With textile (fibre, cloth, apparel), diminution in the variety of equipment and materials to be purchased, diminution of overlooked non-conformities in inspection, decrease of equipment trouble

(9) With other secondary industries (metal processing, printing/ publishing, leather goods, wooden products/furniture, footstuff), diminution of product rejects and of overlooked nonconformities in inspection, higher efficiency in design operations

(10) With service industries (land, water and air transportation of passengers and the freight, warehousing, communication, electricity/gas/water supply), diminution in the variety of equipment and materials to be purchased, diminution of communications and contacts requiring to be made

(11) With other tertiary industries (commerce, financing, real estate, other services), diminution in the variety of equipment and materials to be purchased, diminution of communications and contacts required to be made

The development of industrial standardization, testing and metrology should contribute not only to rationalization of production processes, to enhancement of product reliability and to smoothing product distribution to consumer, as detailed above, but further also to:-

- Maintaining social and economic order
- Protecting health and safety,

as analyzed in what follows.

(a) Maintenance of social and economic order

Immense contribution to maintenance of order in society at large, in such aspects as:-

- Traffic in raw and semi-finished materials, as well as in products
- Enforcement of law
- Levying of taxes

(b) Protection of health and safety

Observations in meteorology, on river level, of earthquakes, and other measurements for disaster prevention, establishment and enforcement of rules governing medical, pharmaceutical and poison control activities, as well as of pollution control.

(c) Scientific and technical research and development

Providing the basis for all domains of science and of technology --which utilizes the fruits of scientific research-- in objectively measuring matter and phenomena for substantiating theoretical propositions.

In respect of metrological calibration, a practical example is given below of its benefits to industry.

The theory of quality control evaluates the economic loss incurred through error in measurement as proportionate to the square of the amount of error. In practice, the value of this "error" is substituted by the "variance" σ^2 --*the average of the squares of deviations from the mean* value of multiple measurements. Hence the economic loss

$$L = k\sigma^2$$

where k is a constant equal to $\frac{A}{\Delta^2}$,

where again A is the loss incurred in remedying or in discarding the product rejected on account of error, and Δ is the tolerance permitted in reference to the specified value.

Hence,

$$L = \frac{A}{\Delta^2}\ \sigma^2$$

Example:

If in the manufacture of ball bearings, a typical precision product:-

- Tolerance (Δ) covering inside diameter: 30 mm + 5 µm
  - 5 µm
- Loss (A) incurred by scrapping unconformable bearing: 400 yen per bearing

- Error variance (σ^2) of measuring instrument: 1 μm

- Annual production: 1 million units

Then, the annual loss incurred on account of measurement error

$$L = \frac{400}{5^2} \times 1^2 \times 1{,}000{,}000 = ¥16 \text{ million}$$

Now, if the measuring instruments were to have its accuracy impaired through use without recalibration, to the extent of seeing its error variance doubled, the economic loss L' will amount to 4 times L-- i.e. ¥64 million. What used to represent a loss of 4% on the annual revenue of ¥400 million would thus rise to 16%.

The original error variance of 1 μm represents a reasonable degree of accuracy for the instrument, and could have been maintained through proper recalibration. Inadequate maintenance of the instrument, to let its accuracy fall below acceptable level can cause loss to an amount such as cited above.

Regular periodical recalibration of measuring instruments used in production should thus save considerable sums by eliminating avoidable loss, and further contribute to gaining reliance for the product, and to consequent extension of the product market.

In respect of the benefits gained from in-house standardization, a striking evidence is presented by actual results reported from 12 Japanese enterprises that have won the Deming Prize during the past 4 years: Within 3 or 4 years from the time of introducing enterprise-wide quality control practice, all these enterprises have seen 50 - 60 percent enhancement of productivity, 10 - 20 percent reduction of production cost, 70 - 80 percent decrease of customer complaints, and more than 95 percent diminution of work accidents.

Abbreviations Used in the Present Report for Thai Government, Public and Other Institutions

ATI	:	The Association of Thai Industries
BOI	:	Office of the Board of Investment
BOT	:	Bank of Thailand
CSD	:	Commodities Standards Division, MOC
DCR	:	Department of Commercial Registration, MOC
DHW	:	The Department of High-Way
DIP	:	Department of Industrial Promotion, MOI
DMR	:	Department of Mineral Resources, MOC
DSS	:	Department of Science Service, MOSTE
ETL	:	Electrotechnical Laboratory
IEPD	:	Industrial Economic & Planning Division
IFCT	:	Industrial Finance Corporation of Thailand
IFRPD	:	Institute of Food Research and Product Development
MIDI	:	Metalworking & Machinery Industries Development Institute
MOC	:	Ministry of Commerce
MOI	:	Ministry of Industry
MOSTE	:	Ministry of Science, Technology and Energy
MPC	:	Office of the Maritime Promotion Commission
NCM	:	National Committee on Metrology
NESDB	:	National Economic and Social Development Board
NML	:	National Measurement Laboratory
NSO	:	National Statistical Office
STREC	:	Scientific and Technological Research Equipment Centre
TISI	:	Thai Industrial Standards Institute, MOI
TISTR	:	Thailand Institute of Scientific and Technological Research, MOSTE
TMDPC	:	Thailand Management Development and Productivity Centre
TSC	:	Testing and Standards Centre
TTC	:	Trade and Training Centre