CHAPTER 5

MASTER PLAN OF DEVELOPMENT ON LEGAL METROLOGY SYSTEM

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5.1 Revisions of the Law, Government Ordinances and Ministerial Ordinances

Indonesia joined the Convention of Metre in 1890 and introduced the Law on Metrology in 1923 based on the metric system of units. The verification of legal measuring instruments relating to length, mass and volume commenced in 1938. The present Law on Legal Metrology (the Law) was enforced in 1975, incorporating the OIML recommendations after several revisions of the preceding Law on Metrology.

Although the Law and related government and ministerial ordinances at least cover all the items to be included in a national legal metrology system as recommended by the OIML, the subject items of legal metrology are not clearly defined. Moreover, the division between legal metrology (commercial metrology) and industrial metrology is unclear because of the lack of concrete descriptions of the measuring instruments to be controlled.

A review of the Law is, therefore, necessary from the viewpoints of fair trade, consumer protection and assistance for growing industrial activities. One important requirement of such a review is the clear division of industrial metrology and commercial metrology to establish appropriate methods of metrological control which reflect the actual conditions of use of measuring instruments.

The desirable revisions of the Law have already been discussed in Chapter 3 – Current Conditions and Pending Problems of Legal Metrology in Indonesia and can be summarised as follows.

① Extension and establishment of the subject units as national standards, including derived units. In general, more than 50 units, including base units, are stipulated by the measurement law of an industrialised country and are firmly established in the form of national standards.

② Clarification and extension of the measuring instruments subject to verification and clear indication of the limits of error for inspected measuring instruments.

③ Diversification and rationalisation of the verification method.

④ Establishment of a traceability system for measuring instruments in the field of industrial metrology.

5.1.1 Introduction of Designated Verification Organization System

Under the Law, the DOM has the central administrative authority for all matters pertaining to verification. Both the quantitative and qualitative inadequacy of the DOM in terms of facilities and manpower, however, means that the actual verification of watt-hour meters, water meters and gas meters relies on the local electricity, water and gas boards respectively.

From the viewpoint of environmental conservation, it is likely that the Law will be amended in the future to include provisions on the verification of such environment-related measuring instruments as air densitometers (NOx, SOx, CO and other meters), pH meters, noise meters and vibration meters, etc. in conjunction with environmental laws. The establishment of national measurement standards and verification facilities for these meters will require substantial investment and it will be uneconomical for these verifications to be functions of the present local verification laboratories.

A rational choice appears to be the introduction of the designated verification organization system to reflect the realities of the current verification work vis-a-vis watt-hour meters, water meters and gas meters, etc. and also to ensure maximum economy vis-a-vis those environmental measuring instruments of which verification will be required in the near future.

5.1.2 Introduction of Designated Manufacturer System

With the increasing use of modern, mass-production manufacturing facilities reflecting rapidly advancing technologies, coupled with the wide spread of strict quality control practices, many products now meet the quality criteria set by the ISO 9000 series based on a reliable TQC system, posing a question regarding the necessity for the DOM or its local verification laboratories to conduct 100% initial verifications. It is now a standard practice for measuring instrument manufacturers

to conduct the adjustment of all instruments manufactured as the final test to uniformatise their measurement performance prior to official verification.

In the case of those manufacturers (factories) which have established a quality control system of a high level which is supported by modern facilities, it should prove rational from the socioeconomic point of view to introduce the designated manufacturer system under which compulsory 100% in-house verification is regarded as the official initial verification. Imported products should be omitted from this system due to the difficulty of verifying the status of factory verification while the designation criteria for exemption from the initial verification must be strict enough for international approval. Given the present conditions of the manufacture of measuring instruments, this designated manufacturer system can be applied to part of watt-hour meter production.

5.1.3 Introduction of Designated Measuring Instrument User System

The current verification system is quite fair in the sense that initial verification and re-verification are conducted regardless of the instrument users. However, it is physically quite difficult, if not impossible, to re-inspect all the measuring instruments used for commercial/trade purposes at department stores, large supermarkets and large enterprises, etc. because of the conditions of their actual use. It is more appropriate to make these organizations establish an adequate control system, the approval of which will remove the need to re-inspect all instruments.

Should such a system be introduced, it is necessary for the organizations to establish a rational in-house verification/calibration system for measuring instruments and to appoint measurement experts, certified as metrological engineers by the Department of Commerce after completing classroom and practical training courses on metrology and measurement, to be responsible for control, verification and calibration work. The successful introduction of an in-house verification/calibration system assumes the consolidation of metrological training centres with a view to training and certifying a large number of metrological engineers in the private sector. Some time will be required for the positive effects of the system to be visible even if the relevant training programmes are quickly consolidated.

5.1.4 Extension of Standard Units and Promotion of Measurement Standards Supply System

The clear indication of measurement units based on SI units is the basis of a measurement law. While the Law provides such indication for base units, it is inadequate in terms of indicating and establishing standard quantities for derived units.

There is a strong need for the extension of measurement units in Indonesia due to the further progress of industrialisation and this need must be fulfilled as soon as possible. In addition, increasing standardisation and quality control in the industrial sector in recent years now demand traceability between the measuring instruments and testing equipment used in the field of industrial metrology and national measurement standards. There is, in fact, a strong demand that the establishment of a traceability system in the field of industrial metrology be clearly demanded by the Law. For the establishment of such a traceability system, the introduction of the designated calibration organization system and certified calibrator system should prove useful.

(1) Designated Calibration Organizations

The development, establishment and maintenance of national measurement standards are assigned to the KIM-LIPI of the Department of Science and Technology (the DOM is responsible for weights). The system is reasonably established despite the inadequate number of standards. Designated calibration organizations are responsible for the calibration of the secondary standards owned by certified calibrators using sub-standards which are calibrated by national standards. While it is desirable to assign the responsibility for the maintenance of national standards to these organizations in order to maintain and improve the level of measurement technology of the organizations, it appears appropriate, in principle, to designate a single organization for each quantity. The designation of a single organization for multiple quantities, however, must be permitted for the convenience of certified calibrators provided that it has sub-standards equivalent to national standards and the relevant technical ability.

As Indonesia currently has no specialised calibration organizations with the relevant technical ability, the KIM-LIPI (the DOM for weights) can be assigned

this role. It may also be possible to designate universities with a metrological laboratory, such as the Bandung Institute of Technology, for certain quantities.

(2) Certified Calibrators

Certified calibrators calibrate the measuring instruments, including standards (tertiary standards, reference standards and working standards, etc.) owned by manufacturers, schools and research institutes, etc. using secondary standards which are calibrated by designated calibration organizations.

The certification of calibrators naturally requires the introduction of certification criteria. It is essential that certification be conducted on the basis of fair assessment of the calibration facilities and technical ability, etc. pursuant to these criteria and the scope and accuracy of calibration must be specified for each quantity.

5.2 Review of Roles and Organizational Structure of DOM and Local Verification Laboratories and Consolidation of Their Facilities and Technical Expertise of Engineers

The DOM is currently expected to play the following roles.

(1) Metrological Administration

The DOM is authorised to issue Director's Decrees on administrative and technical issues relating to the execution of verification in view of the uniformity of verification at both the central and local levels. From the organizational point of view, local verification laboratories belong to the local offices of the Department of Commerce and the DOM cannot control the budgetary appropriation for and work of these laboratories, resulting in problems of unbalanced manpower distribution and uncoordinated establishment of new facilities and their renewal.

Nevertheless, 20% of the verification fees collected by local laboratories are forwarded to the DOM which is redistributed to local laboratories for new facilities or facility renewal based on its assessment results of the relevant applications made by local laboratories. This feedback system is designed to supplement the independent budgeting system of each laboratory. The DOM is also authorised to give direct instructions on such technical issues as the distribution of inspectors and guidance on practical verification work.

The present administrative structure places local laboratories under the jurisdiction of the DOM and the centralisation of the authority and responsibility relating to legal metrology to the DOM should prove very effective in improving the uniform nature of verification and the verification achievement rate. Therefore, it is preferable to review the roles and organizational structure of the DOM and local laboratories.

(2) Type Approval Testing

While the DOM is supposed to conduct type approval testing, some tests are actually conducted by local verification laboratories. The type approval tests conducted by local laboratories are not fully satisfactory, however, because of the inadequate facilities and technical expertise of the testers.

The present situation calls for consolidation of the type approval facilities of the DOM and key local laboratories in areas in which measuring instrument manufacturers are consolidated and the proper execution of type approval testing to ensure the continuous accuracy of legal measuring instruments. In view of such necessity, a project will be proposed in the next chapter to consolidate the DOM.

(3) Calibration of Standards

Reference standards, which are the metrological standards currently in use by local verification laboratories, are calibrated by the DOM at regular intervals (every 5 years). The working standards used for verification by local laboratories are made by the multiplication or division of reference standards.

While the technical capability varies from one local laboratory to another, the graduation accuracy at all local laboratories is not fully reliable because of inadequate technical ability and inaccuracy of the media used for graduating working standards.

In general, the verification or graduation of working standards requires excellent skills and it is desirable for this work to be centralised to the DOM or key local laboratories in addition to the DOM so that ordinary local laboratories can concentrate on verification work.

(4) Diffusion of Measurement Techniques and Cooperation for Training of Metrological Engineers

The DOM gathers international information on metrology as the Indonesian representative in such international organizations as the OIML and APMP. It is also making efforts to diffuse measurement techniques through conferences for local laboratories and other channels while indirectly assisting the training of metrological engineers through its cooperation with the Metrological Training Centre which also belongs to the Department of Commerce but which is independent from the DOM.

From the viewpoint of diffusing measurement techniques in the private sector and the training of metrological engineers in the private sector, however, few systematic efforts have been made except for the diffusion of measurement techniques and the training of metrological engineers to a very limited degree through verification and calibration work involving the private sector. In the future, it may be necessary to assign the DOM the responsibility of training instructors at the Metrological Training Centre and senior metrological engineers together with the possible training of similar engineers working in the private sector.

5.3 Establishment of New Metrological Engineer Training Centre and Upgrading/Consolidation of Training Facilities

At present, the training of metrological engineers (inspectors, assistant inspectors and controllers) is conducted by the Metrological Training Centre which is located on the premises of the DOM and which is controlled by the Department of Commerce.

Each class consists of some 50-60 students who usually qualify as inspectors after 3 years of training. Hence, the total number of students at the Centre is approximately 150-180. Two courses are provided, i.e. continuous training for 3 years and training for 5 years with at least one year of practical work after the first year and second year.

The Centre has accommodation facilities for only 50 students (some 30% of the total number of students), making it necessary for other students to live in private accommodation or lodgings with the financial assistance of the government.

The relocation of the Centre is planned and the following points must be carefully examined prior to finalising the relocation plan. Concrete proposals are given in Chapter 6 of the present report.

1) Suitability of the training duration and training method.
2) Widening of the student background and increase of the training capacity. The acceptance of (fee-paying) trainees from the private sector is necessary to ensure the proper operation of the metrology system (creation of the metrological engineer certification system). It may be a good idea to establish an academy responsible for the current 3 year training course with a view to granting the graduates a different qualification from those granted by other training courses.
3) Training curriculum
4) Various conditions, including the environmental conditions, of the new site and transport access to the new site.
5) Size of the training building, auxiliary facilities and dormitory building.
6) Training facilities (equipment) in terms of general group training as well as practical verification training.

5.3.1 Upgrading of Training Instructors

At present, the instructors at the Metrological Training Centre are mainly external instructors, many of which are university lecturers. If an academy is founded at the Centre, full-time instructors will be required. The instructors in charge of practical verification and calibration must include metrological engineers with practical experience in addition to the relevant scientists.

It is essential for the DOM to try to upgrade its own metrological engineers and external instructors. One way of achieving such upgrading is to send appropriate persons abroad through technical cooperation with industrialised countries to undergo upgrading training in addition to domestic training at the KIM-LIPI, universities and the DOM, etc.

5.3.2 Development of Private Sector Metrological Engineer Training Programme, Implementation of Training and Creation of New Qualification

The need to train private sector metrological engineers in both legal metrology and industrial metrology has been clearly stated in 5.1. Any attempt to train metrological engineers from among engineers working for private enterprises is necessarily constrained by the limited amount of time that these engineers can afford to undergo such training. Therefore, it is necessary to restrict applications for training to those science/engineering graduates with the necessary basic knowledge and engineers with similar knowledge to graduates. An appropriate course duration is some 6 months and those successfully completing the course should be awarded a new qualification (certified metrological engineer). Needless to say, it is necessary to develop a training programme which has an appropriate curriculum. Moreover, an effective, efficient training method must also be developed.

The introduction of a national examination system should prove useful to upgrade the metrological engineers with a view to granting the qualification of certified metrological engineers to those with sufficient basic knowledge and rich practical experience in their work for private enterprises who successfully pass the said examination.

5.4 Establishment of Manufacturers' Association

The establishment of an association of manufacturers of measuring instruments should greatly contribute to the development of the measuring instrument industry. The main activities of such an association should be as follows.

1) Gathering, analysis and statistical processing of the latest data on measuring instruments and wide dissemination of the findings to not only those in the measuring instrument industry but also to everyone related to the industry.
2) Establishment of committees and/or working groups to solve the common problems of the industry.
3) Cooperation for government efforts to publicise the metrological administration and representation of the industry to reflect the industry's opinions on the metrological administration.

5.5 Establishment of Private Association for Certified Metrological Engineers

The training of private sector metrological engineers (certified metrological engineers) is essential to diffuse the principles of measurement throughout socioeconomic activities, for the flexible management of legal metrology (verification) and for widespread traceability in the field of industrial metrology.

When the number and quality of private sector metrological engineers reaches a certain level, it is necessary to establish an association of private sector metrological engineers with government assistance for its activities. The main areas of activity of the said association should be as follows.

1) Introduction of a scheme to use of understanding of the role of certified metrological engineers and also of the standardised operation of the scheme.
2) Provision of training relating to metrological technologies/measurement techniques and the provision of technical information.
3) Representation of certified metrological engineers to voice their opinions to the administration.

5.6 Metrology Promotion Organization

It is desirable to establish a metrology promotion organization to form a federation with the manufacturers' association and certified metrological engineers' association in order to further diffuse the principles of metrology and the measurement system. This organization should invite metrology-related government agencies, the proposed designated calibration organizations and certified calibrators, etc. to participate in its activities. The main areas of activity of the said organization should be as follows.

1) Diffusion of the principles of metrology throughout socioeconomic activities with government assistance.
2) Representation of all related parties to voice their opinions on national measurement standards for industrial circles and the designation of legal measuring instruments for consumer protection, etc. to the administration.
3) Gathering and analysis of both domestic and international information on metrology and the provision of the analysis findings to its members.

5.7 Miscellaneous

Table 5-1 shows in detail the programmes proposed for the different levels as outlined below.

- Government Level - Diffusion of Principles of Metrology and Consumer Education
- Enterprise Level - Upgrading and Promotion of Metrological Standards (Measurement Techniques) and Control Standards
  - Diffusion and Promotion of Industrial Metrology
- ASEAN Level - Promotion of Regional Cooperation for Metrology and Measurement

As these programmes are very important for the future development of the metrology system in Indonesia, it is hoped that they will all be implemented in the near future.

Table 5-1

		Present situations and problems	Countermeasures	Number	
Legal Regulations	1	Inconsistency between OILM recomendation and Measurement Law	Normalizations of regulations by revision of Measurement Law	Official	1
	2	Inconsistency among regulations of Measurement Law, official orders, deparement orders and OILM recomendation	Systematization and unification of regulation of Measurement Law, official orders, department orders and OILM recomendation	Official	2
	3	Identification of body of implementation and its authority	Introduction of institution designation system	Official · Private	3
Legally Designated Measurement Equipments	1	Unclear legal basis of applicable measurement equipments	Specification of applicable measurement equipments through Measurement Law	Official	4
	2	Unclear ranges of applicable measurement equipments	Addition / deletion of applicable measurement equipments	Official · Private	5
	3	Inconsistency between the purposes of legal regulations			
	4	Unreasonable and uneconomic examination method	Normalization of examination method	Official · Private	6

National Standards	1	Insufficient amount of measurement standards	Normalization of number of national standards through Measurement Law	Official	7
	2	Non-arrangement of measurement system	Development and maintenance of national standards, specification and expansion of authority for control institutions	Official	8
			Arrangement and expansion of measurement standard system	Official · Private	9
Measurement Performance System	1	Non-identification of examination performance body and its unreasonableness	Identification of examination performance body	Official	10
	2	Descrepancy between the function and capacity of local examination institutions	Introduction of "designated institution" system	Official · Private	11
	3	Incapacity and aging of examination institution buildings	Identification and specification (distinction) of functions for each examination institution	Official · Private	12
	4	Insufficient accuracy control and aging of examination equipments	Reconstruction and air-conditioning of buildings for examination institutions	Official · Private	13
	5	Insufficient amount of office work equipments	Streamlining of office work through provision of equipments	Official · Private	14
	6	Insufficient quality and number of examiners	Normalization of quality and number of examiners	Official · Private	15

	7	Insufficient number of training institutions and training facilities	Renewal of training facilities	Official·Private	16
			Diversification in function and streamlining of training equipment and examination equipment (in actual use)	Official·Private	17
			Establishment and expansion of training institutions	Official	18
Industrial Measurement Calibration	1	Insufficient standard supply amount (Especially assembly amount)	Expansion of national standard assembly amount	Official	19
	2	Insufficient quality and number of calibration institutions	Arrangement of tracability system and streamlining of approval of calibration institutions	Official	20
	3	Non-arrangement of legal system	Arrangement of legal system for industrial measurement	Official	21
Promotion Measurement	1	Insufficient number of measurement engineers	Training of measurement engineers for private sectors	Official·Private	22
	2	Insufficient promotion of measurement idea	Establishment of various private measurement institution	Official·Private	23
	3	Insufficient number of promotors for measurement	Secureness of budget for promotion	Official	24

		Promotion program	Applicable promotion program No.
Government Level	1	Revision of Law Measurement, official order and ministry order	1 ~ 11
	2	Introduction of "designated examination institution" system and making of designation criteria	2,6,11,12
	3	Introduction of "designated manufacturer" system and making of designation criteria	1,6
	4	Introduction of "designated office for use of measurement equipment" system, and making of designation criteria	
	5	Expansion of amount of measurement standards and promotion for arrangement of measurement standard supply system (Introduction of "designated calibration institution" and "designated calibrator" system and making of designation criteria)	7,8,9.19
	6	Promotion for expansion of equipment at DOM and local examination institutions and expansion of capacities of measurement engineers	8 ~ 14,20,21
	7	Establishment of training institutions for measurement engineers and improvement and expansion of existing institution facilities	15,16,17,18
	8	Improvement of ability and training for trainers	15
	9	Development of training programs for measurement engineers for private sectors, performance of traing and establishment of qualifications	
	10	Promotion and assistance for establishment of groups, per business, of measurement-related manufacturers	3,4,22,23,24

	11	Promotion and assistance for establishment of groups of measurement engineers in private sectors	
	12	Promotion of measurement idea and consumer enlightment	22,23,24
Private Sector Level	13	Establishment of private groups for promotion of measurement	
	14	Promotion for establishment of groups, per business, of measurement-related manufacturers	
	15	Establishment of groups of measurement engineers in private sectors	3,4,22,23,24
Company Level	16	Promotion for improvement of mensurement technique and control levels	16,17,18
	17	Promotion for industrial measurement	21,22,23,24
ASEAN Level	18	Promotion of ASEAN area co-operation in measurement	7,8,9,21,22

		Projects to be promoted		Applicable promotion program No.
PHASE 1	1	Revision of weights and Measurement Law and inovation of verification performance system		1,2,3,4,5
	2	Inovation of DOM	Improvement of R&D	6,7
			Type testing	
			Calibration of reference standard	
	3	Inovation of training center	Arrangement of training apparatus	7,8,9,11,12
			Construction of buildings of training center	
			Plan making (including equipments and buildings)	
PHASE 2	1	Arrangement of equipments at the core verification for measurement & calibration at laboratories	Improvement in equipments at the core verification laboratories	5, 6, 17, 18
	2	Introduction of officially "Designated verification organization" system	Establishment of official designated verification organization of electricity, gas and water supply meters	2,3
	3	Promotion of propaganda of law and regulations for metorology	Establishment of private measurement institutions	9 ~ 17
PHASE 3	1	Arrangement of equipments at local verification laboratories	Reform of local verification laboratories and improvement in equipments	6
	2	Introduction of qualification system for measurers	Introduction of qualification system for metorology engineer, for excellent factories and retail shops, and improvement of measurement system	3,4,7,8,11, 12,15

CHAPTER 6

OUTLINE OF INDIVIDUAL PROJECTS

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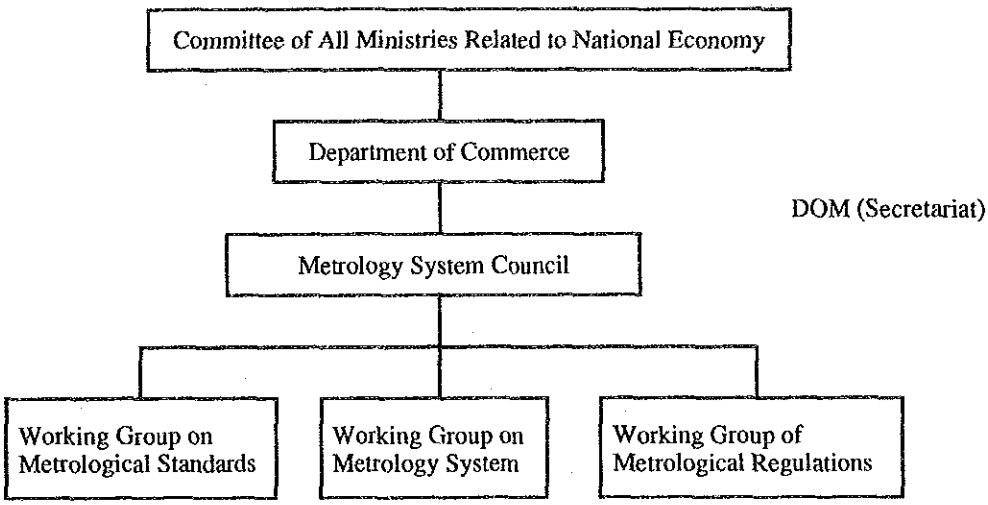
6.1 Project to Revise the Law on Legal Metrology (the Law)

(1) Organization to Examine Possible Revisions of the Law

The DOM will be responsible for preparing the actual draft of the revised Law and draft enforcement rules while coordinating with all interested parties.

Position of DOM in Proposed Structure
to Examine Possible Revisions of the Law



(2) Project Components

1) Revisions of the Law

The Metrology System Council will be established within the Department of Commerce to examine possible revisions of the Law and to submit draft revisions to the Minister of Commerce. It is highly desirable that the members of the Council consist of representatives of the following organizations and academics in order to fairly reflect the opinions of those involved in metrology in Indonesia and to clarify the most appropriate metrology system for Indonesia in view of the recent international trends of metrology.

① Related government ministries and agencies

② Industrial associations

③ Consumer groups

④ Testing, verification and certification organizations and universities (particularly those which can function as metrological laboratories)

The DOM will assign at least 5 staff members with the appropriate expertise to form the secretariat for the council.

2) Points to Note in Revising the Law

The points to be noted in efforts to revise the Law are outlined below.

① Protection of Users of Measuring Instruments and General Consumers

One of the purposes of regulating measuring instruments is to provide users with high quality, inexpensive measuring instruments through the imposition of certain regulations as it is virtually impossible for general consumers to check the accuracy and performance of such instruments.

② Response to Technological Innovation

It is necessary to establish a metrology system which incorporates such results of technological innovation as the improved accuracy and performance of measuring instruments through the development of electronic instruments and the improved production and quality control ability of manufacturers and which will not hinder technological innovation in the future.

③ Response to Globalisation

The continuing development of the borderless economy is expected to demand the introduction of international standards and uniform certification/ verification procedures, etc. The regulations on measuring instruments must reflect such globalisation trends.

It should be recognised that any regulation has possible adverse side effects and efforts to determine the scope of the measuring instruments to be controlled and the control method is no exception. What must at least be taken into account in this context are the preservation of the life and health of the public, the stability of commercial trade and social fairness.

The selection of regulatory measures for measuring instruments is strongly related to the fundamental principles of the metrology system of a country and, therefore, public debate must be ensured to achieve a national consensus.

6.2 DOM Upgrading Project (Organizational Reform, New Buildings and New Equipment)

As the required improvement/upgrading of the DOM was discussed earlier, a brief summary is given below.

(1) Metrological Administration

Centralisation of the budget for the administration of legal metrology, including the budget for local verification laboratories, to the DOM is desirable from the viewpoints of improving the verification implementation system and both improving and standardising the technical level. Consequently, a new set of office equipment (computers, copiers and facsimiles, etc.) will be required to handle the expected centralised work volume and to both quantitatively and qualitatively improve the manpower.

(2) Consolidation of R & D

It is necessary to consolidate the R & D function to maintain national mass standards, to develop/introduce new equipment for the rationalisation of verification and to maintain/improve the technical level of verification. It is also necessary to consolidate the provision of national standards for the maintenance and control of the traceability system of legal metrology and for the verification/calibration of the reference standards used by verification laboratories. The facilities for verification and calibration should also be upgraded and expanded. At present, the technical staff members of the DOM are classified as inspectors, assistant inspectors and controllers, etc. as in the case of ordinary verification laboratories. In view of the proposed and actual functions and role of the DOM, it is necessary to place metrological scientists and engineers above the position of inspector and these senior positions should be filled by people with expert knowledge, recruited either internally or externally.

(3) Type Approval Testing

In order to centralise type approval testing at the DOM (and some key local verification laboratories), new investment in testing facilities is essential in

addition to the possible new recruitment and practical training of testing staff depending on the level of speciality required.

(4) Inspection and Verification of Reference Standards

In addition to the establishment of the traceability system for legal metrology and the consolidation of national standards, an important role of the DOM is to inspect/calibrate the reference standards owned by local verification laboratories. In order to establish traceability between legal metrology standards (national standards) and reference standards, it is necessary to consolidate the calibration equipment/facilities. Such equipment/facilities are operated by those responsible for R & D referred to in (2) above.

6.2.1 Improvement of DOM's Buildings and Procurement of New Equipment

The required conditions of the DOM's buildings depend on the perceived role of the DOM, including the types and accuracy level of the quantities to be controlled. Any decision on the types of quantities to be controlled must take into account the likely development of the verification system in the near future. The maximum accuracy for each quantity should preferably be ensured by the DOM by adopting the same level of accuracy for those national standards (primary standards) to be controlled by the KIM-LIPI as the national standards for legal metrology.

In the case of mass, as the 1 kg prototype supplied by the International Bureau of Weights and Measures is available, the national standard for Indonesia and its calibration equipment must be accurate enough to achieve international acceptance.

In view of the current facility and manpower levels and the expected improvement of the technical strength, adoption of the following types of quantities and maximum accuracies to be controlled by the DOM appears appropriate.

①	Length	:	1 ppm
②	Mass	:	0.001 ppm
③	Volume/Flow Volume	:	10 ppm/0.2%
④	Force/Pressure	:	0.25%
⑤	Temperature	:	0.01 °C
⑥	Electrical Quantities		

a) DC and Low Frequency : 10 ppm

b) High Frequency : 10%

c) Sound : 0.1 dB

d) Vibration : 0.5%

⑦ Chemical Quantities :Establishment of Reference Materials

(1) Building plane

Prior to the commencement of the remodelling work, both a basic design and detailed design are obviously required. For the present purposes, however, the calculation results using the information collected to estimate the necessary floor areas are given below under the heading of Required Floor Area and Remodelling Cost by Individual Function to be Performed by DOM. Using the actual examples of Japan and other countries, the following floor area per person (total floor area ÷ total numbe r of staff members) can be considered the standard floor area for each specific purpose of the building.

① Office (ordinary administration office): 20-30 m^2/person

② Laboratory (product testing and chemical analysis, etc.): 30-40 m^2/person

③ Metrological verification laboratory or certified calibration organization (requiring a reasonable level of equipment and facilities): 40-50 m^2/person

④ Designated calibration organization or applied research organization (requiring advanced equipment and facilities): 50-70 m^2/person

⑤ National metrological research institute or basic research institute (involved in research work requiring heavy investment in equipment and facilities): 70-120 m^2/person

[Required Floor Area and Remodelling Cost by Individual Function to be Performed by DOM]

1. *Required Floor Area*

① Testing Laboratory (for type approval testing and calibration of reference standards)

a) Mechanical scale : 96 m^2

b) Taxi meter : 48 m^2

c) Water meter : 96 m^2

d) Gas meter : 96 m^2

e) Glass chemical thermometer : 48 m^2

f)	Resistance clinical thermometer	:	48 m^2
g)	Aneroid sphygmomanometer	:	48 m^2
h)	Environmental measuring instrument	:	144 m^2
i)	Watt-hour meter	:	192 m^2
Sub-Total		:	816 m^2

② Standard Calibration Laboratory

a)	Mass	:	144 m^2
b)	Pressure	:	48 m^2
c)	Force	:	96 m^2
d)	Volume	:	144 m^2
e)	Length	:	144 m^2
f)	Temperature	:	96 m^2
g)	Density (standard gas)	:	96 m^2
h)	Water quality (pH meter)	:	48 m^2
i)	Electricity (including an anechoic chamber to be jointly used by the watt-hour meter testing laboratory:		288 m^2
Sub-Total		:	1,104 m^2

③	Director's Office	:	48 m^2
④	Office No. 1 (metrological administration, general affairs, accounting and personnel, etc.)	:	960 m^2
⑤	Office No. 2 (technical issues)	:	480 m^2
⑥	Lecture Hall	:	480 m^2
⑦	Rest Rooms	:	144 m^2
⑧	Library (with stack room)	:	192 m^2
⑨	Canteen	:	480 m^2
⑩	Storage	:	144 m^2
⑪	Corridors, staircases and toilets, etc.	:	1,296 m^2
	Total	:	6,144 m^2

2. Remodelling Cost

As it is essential that the remodelled building be capable of advanced research, it must be equipped with new or upgraded air-conditioning, vibration proofing, sound insulation, water supply and drainage, fire-fighting and emergency (in the

case of black-outs or water cuts) systems together with auxiliary laboratory (testing) facilities and maintenance equipment. With further instrumentation and a new workshop, the total remodelling cost of the DOM is estimated to be far above the standard remodelling cost of an ordinary office building.

Here, the remodelling cost is estimated to be half of the cost to construct the same facility from scratch using a recent project in Malaysia as an example. The resulting unit cost of remodelling is 800,000 Rp/m^2. The total cost is, therefore, 4,915.2 MRp (800,000 Rp/m^2 x 6,144 m^2).

(3) Equipment Plan

The general conclusions of the examination of the technical specifications, including the level of accuracy, of the equipment required by the DOM in view of the DOM's expected functions and role are given below under the heading of General List of Equipment Required by DOM. A more detailed equipment list and costs are given in Table 6-1.

[General List of Equipment Required by DOM]

1) Type Approval Testing

a)	Mechanical scale (calibration subjects: reference standards for watt-hour meters and el	: ¥17,000,000 ¥17,000,000
b)	Taxi meter	: ¥25,000,000
c)	Water meter	: ¥25,500,000
d)	Gas meter	: ¥15,000,000
e)	Glass chemical thermometer	: ¥ 6,500,000
f)	Resistance clinical thermometer	: ¥22,200,000
g)	Aneroid sphygmomanometer	: ¥10,000,000
h)	Environmental measuring instrument	: ¥23,500,000
i)	Watt-hour meter	: ¥317,000,000
j)	Noise meter (including anechoic chamber and standards):	¥81,800,000
k)	Vibration meter (including standards)	: ¥32,600,000
Sub-Total		: ¥576,100,000

2) Calibration Equipment for Metrological Standards

a)	Mass	: ¥92,150,000
b)	Pressure	: ¥64,410,000
c)	Force	: ¥53,950,000
d)	Volume	: ¥62,790,000
e)	Length	: ¥93,505,000
f)	Temperature	: ¥86,100,000
g)	Density (standard gas)	: ¥87,500,000
h)	Water quality (pH meter)	: ¥8,800,000
i)	Electricity (DC, low frequency and part of high frequency)	: ¥151,500,000
j)	Time	: ¥2,500,000
Sub-Total		: ¥747,305,000

3)	Office Equipment (main items)	: ¥20,000,000
4)	Vehicles (1,500 x 4)	: ¥6,000,000
	Total	: ¥1,349,405,000

(4) Personnel Plan

The DOM currently employs 144 staff members, of which 87 are administrative staff which are responsible for metrological administration, general affairs, accounting and personnel, etc. and 57 are technical staff which are further divided into 32 inspectors, 2 assistant inspectors, one controller (metrological police) and 22 technical assistants.

The tentative guidelines for the technical staff requirements are given below to ensure the proper functions of the DOM in terms of the control of standards, calibration of reference standards and type approval testing, etc. for each speciality field.

[Technical Staff Requirements of DOM and Their Specialised Fields]

	Metrological Scientist	Metrological Engineer	Inspector	Assistant Inspector	Technical Assistant	Total
1. Type Approval Testing/Calibration of Reference Standards						
a. Mechanical Scale (standard weights and chemical balance for calibration, etc.)		1	2	1	1	5
b. Taxi Meter						
c. Water Meter		1	2		1	4
d. Gas Meter		1	1		1	3
e. Glass Chemical Thermometer			1		1	2
f. Resistance Clinical Thermometer			1		2	2
g. Aneroid Sphygmomanometer		1	1			2
i. Watt-Hour Meter		1	1	1	1	4
		2	3	2	1	8
Sub-Total		7	13	4	8	32
2. Calibration Equipment for Metrological Standards						
a. Mass	1	1	2	1	1	6
b. Pressure		1	1		1	3
c. Force	1	1				2
d. Volume		1	1			2
e. Length (including industrial metrology)	1	1	1			3
f. Temperature		1	1			2
g. Density (standard gas)		1	1			2
h. Water Quality (pH meter)		1	1			2
i. Electricity	2	2	2	2	2	10
Sub-Total	5	10	10	3	4	32
3. Metrology Adviser		4	4			8
Total	5	21	27	7	12	72

(5) Running Cost

The main expenditure items, excluding the personnel cost, and estimation bases are given below for reference purposes.

Main Item	Estimation Base
- Equipment Repair and Depreciation, etc.	Some 3% of the equipment investment amount (Note 1)
- Transport and Communication	Some 2% of the personnel cost
- Insurance, Corporate Tax and Welfare, etc.	Some 3% of the personnel cost
- Office Consumables and Meetings, etc.	Some 1% of the personnel cost
- Utilities (Electricity and Water, etc.)	Estimated consumption volume to be multiplied by the unit cost
Note: The repair cost is fairly low in the early years because of free after-service and few breakdowns	

(6) Technical Staff (Metrological Engineer and Inspector, etc.) Training Plan

① Guidance by Foreign Experts

Subject Field	No. of Long Stay Experts	No. of Short Stay Experts
Physical Quantities	1	7 (basic 7 quantities)
Electrical Quantities	1	1

② Training in Industrialised Countries

Subject Field	No. of Trainees	
Physical Quantities	14	(basic 7 quantities x 2 trainees each)
Electrical Quantities	2	(DC/low frequency: 1, high frequency: 1)
DOM Management	2	

6.3 Metrological Training Centre Reform Project

The Metrological Training Centre is currently located on the premises of the DOM and trains some 150 engineers a year as described earlier.

6.3.1 Strengthening of Training Function and Expansion of Trainee Background

In accordance with the need to strengthen the training function of the Centre and to expand the trainee background explained in Chapter 5, several concrete measures are proposed here.

(1) The current continuous 3 year course should be provided by the Metrology Academy, a school which is independent from but affiliated to the Centre. The

annual student intake should be approximately 30 with the training emphasis on practical training. It is believed that the creation of this Academy is appropriate in view of the present conditions of metrological education and training, the level and size of Indonesian industry and the actual need for trained metrology engineers by the industrial circle.

(2) The present inspector course requires one year of practical experience between the academic years, resulting in a course length of 5 years. This appears too long given the general speed of industrial development today and the conditions of similar training courses in other countries.

Review and improvement of the training curriculum, teaching hours and training equipment, etc. are required to enable students to qualify as inspectors after 3 years with school training in the first and third years and practical work in the second year. A curriculum example of a Japanese metrological training centre is shown in Table 6-2 for reference purposes.

(3) The training course should be open to engineers working for private enterprises. The manpower basis will be consolidated through granting the qualification of metrology engineer to successful students, facilitating the introduction of a new metrology system which utilises the vigour of such private sector organizations as designated verification organizations, designated manufacturers and designated measuring instrument users.

6.3.2 Consolidation of New Metrological Training Centre (including Affiliated Metrology Academy)

The Department of Trade has already acquired the necessary site in the relocation plan for the present Centre and is currently at the stage of planning the new Centre's construction. The concrete plan for the new Centre is proposed here to facilitate the actual planning of the Department of Trade.

(1) Building Size

The annual student intake should be 60-80, consisting of Metrology Academy students (approximately 30) and metrology trainees (metrology engineers working for local verification laboratories or in the private sector), resulting in a total number of students/trainees of approximately 200. All are required to complete the training curriculum currently in force. If it is possible to shorten

the training duration for metrology trainees to 2 years, it will be possible to accept more engineers from the private sector to improve the metrology engineer output rate.

[Floor Size by Functional Division of Metrological Training Centre]

1) Laboratories and Classrooms, etc.

a)	Length Laboratory	96 m^2
b)	Taxi Meter Laboratory	48 m^2
c)	Precision Balance Laboratory	48 m^2
d)	Ordinary Balance Laboratory	48 m^2
e)	Chemical Volume Laboratory	48 m^2
f)	Integrating Volumetric Meter Laboratory	48 m^2
g)	Pressure Laboratory	96 m^2
i)	Temperature Laboratory	48 m^2
j)	Classroom Type 1 (144 m^2 x 2)	288 m^2
k)	Classroom Type 2 (96 m^2 x 5)	480 m^2
l)	Library/Study Room (144 m^2 x 2)	288 m^2
m)	Director's Office	48 m^2
n)	Administration Office, Reception Room, Reference Room	480 m^2
o)	Meeting Rooms (48 m^2 x 3)	144 m^2
p)	Lecturers' Rooms and Consultation Room (48 m^2 x 5)	240 m^2
q)	Clinic	96 m^2
r)	Corridors, Staircases and Toilets, etc.	720 m^2
Sub-Total		3,264 m^2

2) Accommodation Building

a)	Bedrooms (24 m^2/room x 60 rooms)	1,440 m^2
b)	Canteen	384 m^2
c)	Rest Room	96 m^2
d)	Meeting Rooms (48 m^2 x 2)	96 m^2
e)	Warden's Office	48 m^2
f)	Administration Office	48 m^2
Sub-Total		2,112 m^2
Total		5,376 m^2

Depending on the size of the planned construction site, the construction of a 3-4 storey building is possible in view of the possible introduction of such sporting facilities as tennis courts and a football pitch.

(2) Construction Cost

The architectural specifications for an ordinary office should be adequate for the Centre building and the accommodation building although a noise proofing structure may be required depending on the surrounding environment. Based on recent examples in Malaysia and Thailand, etc., the unit cost is set at 1,200,000 Rp/m^2. The total construction cost is 6,451.2 MRp (1.2 MRp/m^2 x 5,376 m^2).

(3) Training Equipment

The following range of metrological training equipment is proposed based on the range of equipment at a Japanese metrological training centre and taking the likely training requirements in Indonesia into consideration.

[Training Equipment and Procurement Cost (Unit: 1,000 yen)]

	Unit Price	Quantity	Cost
1) Length Laboratory			
a) Precision Comparators (various types)	7,000	6	42,000
b) Stainless Steel Standard Scales	2,500	6	15,000
c) Brass Standard Scales	200	6	1,200
Sub-Total			58,200
2) Taxi Meter Laboratory			
a) Taxi Meter Test Unit	2,000 one set		2,000
b) Travelling Test Unit	5,000 one set		5,000
Sub-Total			7,000
3) Precision Balance Laboratory			
a) Direct Reading Balances	250	20	5,000
b) Large Mechanical Balances	1,000	3	3,000
c) Standard Weight Sets	500	5	2,500
d) Barometer	500	1	500
Sub-Total			11,000

4) Ordinary Balance Laboratory

a)	Manual Balances	100	10	1,000
b)	Electronic Balances	100	18	1,800
c)	Industrial Balances	400	4	1,600
Sub-Total				4,400

5) Chemical Volumetric Laboratory

a)	Chemical Flow Meters	500	4 sets	2,000
b)	Standard Chemical Balances	250	5	1,250
c)	Standard Flasks	200	5	1,000
d)	Barometer	500	1	500
Sub-Total				4,750

6) Integrating Volumetric (Flow) Meter Laboratory

a)	Gas Meter Test Units	2,000	2	4,000
b)	Water Meter Test Units	2,000	2	4,000
c)	Gasoline meter Test Units	2,000	2	4,000
Sub-Total				12,000

7) Pressure Laboratory

a)	Static Load Piston Gauges	4,000	6	24,000
b)	Liquid Column Manometer	600	1	600
c)	Standard Balances	250	3	750
d)	Barometer	500	2	1,000
Sub-Total				26,350

8) Temperature Laboratory

a)	Thermometer Test Chambers	8,000	5	40,000
b)	Electric Furnaces	1,000	2	2,000
c)	Radiating Temperature Test Unit	2,000	1	2,000
d)	Thermometer	200	1	200
e)	Barometer	500	1	500
f)	Ice-Making Machine	1,250	1	1,250
Sub-Total				45,950

9) General Training and Office Equipment

Personal Computers, Word-Processors and Projectors, etc. 30,000

10) Vehicles	1,500	2	3,000
Total			202,650
			(¥202,650,000)

(4) Running Cost

With regard to the running cost of the Centre, it is a standard practice in most countries for the tuition fee and accommodation charge for trainees sent by such institutions as the DOM or local verification laboratories to be paid by the central government in view of their status as civil servants. In the case of students of the Metrology Academy and trainees sent by private enterprises, an appropriate tuition fee should be charged although some form of subsidy by the central government is hoped for due to the importance of these students/trainees to uphold the legal metrology system after completing the course.

While it is admittedly difficult to estimate the actual running cost of the Centre, including the salaries for lecturers and other personnel, it is necessary to appropriate some 10% of the original equipment procurement cost in the annual budget to cover the repair or renewal of training and office equipment as well as the cost of expendables and utility services (electricity, water and gas). Needless to say, the maintenance cost of the buildings and building services must be appropriated in the annual budget and must be supplemented by a special provision to cover the cost of repairs when deemed necessary.

(5) Personnel Plan and Training

It appears possible that the likely administrative workload of the Centre can be dealt with by some 15 staff members through the mechanisation and rationalisation of the work. In the case of professors and lecturers, many are likely to be invited from outside the Centre as visiting lecturers. If the Metrology Academy is established, however, it will be necessary to appoint full-time professors, assistant professors, lecturers and assistant lecturers, etc. In any case, upgrading of the general teaching standard is essential. It will, therefore, be necessary to make prospective lecturers undergo training at domestic universities, the DOM and the KIM-LIPI, etc. as well as overseas training in industrialised countries. It may also be necessary to invite foreign

experts on metrology for further guidance and training. A proposal is made here on the subject fields for guidance by foreign experts and the overseas training of lecturers.

① Guidance by Foreign Experts

Physical Quantities	3 short stay experts
Electrical Quantities	2 short stay experts

② Overseas Training of Lecturers

Physical Quantities	5 lecturers
Electrical Quantities	2 lecturers

6.4 Key Verification Laboratories Improvement Project

Although the DOM is supposed to conduct the inspection and calibration of the reference standards owned by local verification laboratories, it cannot fully meet this responsibility because of its inadequate calibration ability. The reality is that multiplications and divisions are conducted by local verification laboratories. Unfortunately, however, these laboratories can be said to lack sufficient ability to calibrate reference standards even though some laboratories are superior to others in terms of the personal abilities of inspectors and the level of calibration equipment owned. In general, it appears appropriate for the local verification laboratories to be assigned to conduct the calibration of working standards in view of their technical ability and level of available equipment. Even if these laboratories can be reasonably expected to calibrate reference standards in certain fields, such as mass, it would be both difficult and economically wasteful, given the present work volume, to allocate highly capable metrology engineers to each laboratory to cover all quantities.

In the field of industrial metrology, those laboratories (mainly large laboratories) located near industrial areas are often requested by provide a calibration service for the reference standards used by factories, universities and testing institutions, etc. This calibration need has, in fact, been steadily increasing following the gradual global acceptance of quality control systems complying with the ISO 9000 series.

Against this background, it is proposed that the following functions be added to these key, large-scale verification laboratories (which will act as the central laboratory in

the region) in addition to the conventional verification work and that the necessary equipment be provided.

① The proposed key verification laboratories to calibrate the reference standards owned by other local verification laboratories (excepting those calibrated by the DOM) in their respective regions are located in Medan, Jakarta, Semerang, Surabaya, Ujang Pandang, Denpasar and Palembang.

② The key laboratories will conduct the calibration of industrial measuring instruments in response to the strong request by the industrial circle for such calibration and will act as certified calibrators in the field of industrial metrology, ensuring the traceability of these instruments to national standards.

(1) Building Size and Expansion Cost

Based on the current regional industrial activities, these key laboratories will be assigned to conduct industrial metrology and the calibration of reference standards of the following quantities.

① Medan/Jakarta/Semarang/Surabaya: mass, pressure, force, volume, length, temperature, environmental measuring instruments and electrical

② Ujang Pandang/Denpasar: mass, length, volume and electrical

③ Palembang: mass and volume (flow)

The required floor area by subject quantity and the expansion cost of the existing laboratories are given below.

1. Medan/Jakarta/Semarang/Surabaya

1) Standard Calibration Rooms

a) Mass	48 m^2
b) Pressure	48 m^2
c) Force	96 m^2
d) Volume (Flow)	48 m^2
e) Length	96 m^2
f) Temperature	48 m^2
g) Environmental Measuring Instruments	48 m^2
h) Electrical	48 m^2
Sub-Total	480 m^2

2) Office	96 m^2
3) Meeting Room	48 m^2
4) Director's Office	48 m^2
5) Rest Room	48 m^2
6) Corridors/Staircases and Toilets, etc.	144 m^2
Sub-Total	384 m^2
Total	864 m^2

2. Ujang Pandang/Denpasar

1) Standard Calibration Rooms	
a) Mass	48 m^2
b) Volume (Flow)	48 m^2
c) Length	96 m^2
d) Electrical	48 m^2
Sub-Total	240 m^2
2) Office	98 m^2
3) Meeting Room	48 m^2
4) Rest Room	48 m^2
5) Corridors/Staircases and Toilets, etc.	98 m^2
Sub-Total	288 m^2
Total	528 m^2

3. Palembang

1) Standard Calibration Rooms	
a) Mass	48 m^2
b) Volume (Flow)	48 m^2
Sub-Total	96 m^2

2)	Office	96 m^2
3)	Meeting Room	48 m^2
4)	Director's Office	48 m^2
5)	Rest Room	48 m^2
6)	Corridors, Staircases and Toilets, etc.	96 m^2
	Sub-Total	336 m^2
	Total	432 m^2

Note: The Palembang laboratory currently plans to acquire land to construct a new laboratory building. The total floor size, including the new verification laboratory, will be approximately 1,000 m^2 (part of the new facilities can be used for verification purposes).

4. Remodelling Cost

Building specifications equivalent to an ordinary office should be sufficient for most of the new facilities although some areas will require higher specifications associated with a research facility. The proposed unit cost is 600,000 Rp/m^2 and the total remodelling cost is 2,702.2 MRp (600,000 Rp/m^2 x 4,512 m^2). In the case of the new building of the Palembang laboratory, a unit cost of 1.2 MRp/m^2 (based on office level specifications) is applied with a total cost of 1,200 MRp (1.2 MRp/m^2 x 1,000 m^2). Out of the 1,000 m^2, 432 m^2 is allocated for the calibration of standards.

The total remodelling and construction cost of the 7 key laboratories is estimated to be 3,907.2 MRp.

(2) Calibration Equipment for Reference (Secondary) Standards

In order for the key verification laboratories to fulfil their role and functions, secondary standards which are traceable to national standards and equipment to calibrate the reference standards used by the laboratories for verification purposes and working standards used by industries and universities, etc. to the said secondary standards should be procured as essential equipment for the key verification laboratories.

The estimated cost of the equipment to be procured for the key verification laboratories is given below.

Secondary Standards/Calibration Equipment	Cost (Unit: ¥1,000)
1. Medan/Jakarta/Semarang/Surabaya	
1) Mass	32,450
2) Pressure	6,960
3) Force	10,950
4) Volume (Flow)	60,950
5) Length	37,505
6) Temperature	20,100
7) Environmental Measuring Instruments	115,400
8) Electrica	89,650
Sub-Total	303,965
2. Ujang Pandang/Denpasar	
1) Mass	32,450
2) Volume (Flow)	60,950
3) Length	37,505
4) Electrical	89,650
Sub-Total	220,555
3. Palembang	
1) Mass	32,450
2) Volume (Flow)	60,950
Sub-Total	93,400
Total	

The total equipment procurement cost is estimated to be ¥1,750,370.

Although equipment to rationalise and modernise the administration work is also required, similar equipment is needed to improve the local verification laboratories. Therefore, the equipment required for the new calibration facilities is considered under the Local Verification Laboratory Improvement Project in view of the fact that the same equipment will serve for both calibration and verification-related administration work.

(3) Personnel Plan

The required staff strength of each of the 7 key verification laboratories depends on the scale of the calibration demand for the reference standards owned by the local verification laboratories and the volume of calibration requests made by private enterprises and universities, etc. As the calibration staff can also act as verification staff, it is appropriate to commence with the minimum manpower level. The appointment of one metrology engineer and one inspector for each quantity is proposed while ensuring their proper training.

(4) Training Programme

The need to appoint specialised metrology engineers for calibration work necessitates their intensive domestic training. In addition, overseas training is also likely to be necessary. Furthermore, it may also prove necessary to invite foreign metrology experts with a view to their providing guidance for the key verification laboratories.

The invitation of the following number of foreign experts is proposed in addition to the dispatch of Indonesian engineers abroad for training.

1) Guidance by Foreign Experts

Physical Quantities	one long stay expert	8 short stay experts
Electrical Quantities	one long stay expert	2 short stay experts

2) Dispatch of Indonesian Engineers to Industrialised Countries for Training

Physical Quantities	5 engineers
Electrical Quantities	2 engineers

(5) Running Cost

An additional personnel cost (based on the salary equivalent of a metrology engineer) and extra general expenses will be added to the current running cost of the verification laboratories to reflect the inclusion of the calibration service. Moreover, an amount equivalent to some 10% of the investment in new equipment must be additionally appropriated in the budget to cover the cost of expendables, equipment repair and equipment renewal.

6.5 Local Verification Laboratories Improvement Project

6.5.1 Measuring Instruments Verified by Local Verification Laboratories

The current verification work volume of the local verification laboratories considerably varies from one laboratory to another depending on the size and characteristics of the area and there is no specific differentiation between the laboratories in terms of the subject measuring instruments for verification. From the viewpoint of rationalising the verification volume, manpower and facilities, there is no strong justification for all 47 laboratories to be equipped to verify all measuring instruments under the compulsory verification regime. Consequently, the following scopes of subject measuring instruments and verification facilities are proposed as part of the project outline for laboratories of different types.

(1) All 47 Laboratories

1) Length: Linear scales and tape measures, etc. (currently in use throughout Indonesia)

2) Taxi Meters: At present, the taxi meter verification volume greatly varies from one laboratory to another depending on the number of local taxis and the availability of verification facilities. Motorisation will, however, spread throughout Indonesia with the progress of economic development with taxis being introduced everywhere in the future.

3) Mass Meters: Currently in use for trade purposes throughout Indonesia.

4) Volumeters: The verification of volumeters for ordinary trade appears appropriate, excluding tank lorries, water meters and gas meters.

(2) 27 Division-Class Laboratories in Provinces

In addition to the facilities for all 47 laboratories, the following facilities are also proposed.

1) Thermometer verification facilities

2) Volumeter verification facilities (for tank lorries, water meters and gas meters)

3) Pressure meter verification facilities

4) Watt-hour meter verification facilities

(3) Key Laboratories

Here, verification facilities for environmental measuring instruments (air densitometers, pH meters, noise meters and vibration meters) are added to the above. Further details of the required equipment are given in 6.3 in the case that these meters become newly subject to legal metrology.

6.5.2 Required Floor Area for 40 Local Verification Laboratories and Construction Cost

Here, the required floor area per laboratory worker is set at 35m^2 based on the present floor area for a laboratory worker in Indonesia and the required floor area to support the functions of a verification laboratory discussed in 6.2.

(1) Required Floor Area for 40 Laboratories

Based on the estimated manpower level required for the 40 local verification laboratories given in 6.5.2 - (4) - 2), the required floor area is calculated as follows.

	Laboratory Workers	Estimated Floor Area *	Estimated Floor Area Required
1993	1103	22,440m^2	38,605m^2
2002	1311		45,885m^2

* This estimate is based on the assumption that the current average floor area of the 40 laboratories is the same as the average floor area of the 15 laboratories of which the current floor area is exactly known. The resulting current floor area shortage is 16,165m^2 which will increase to 23,445m^2 in 2002 if no additional floor area is provided in the 10 year period. According to Table 3-2, half of the current buildings require improvement. If environment-related measuring instruments (densitometers, noise meters and vibration meters) and others become subject to the legal metrology regime in the future, the verification of such instruments will be conducted by the 7 key laboratories, removing the necessity to consider these instruments in the estimation of the floor area for the 40 laboratories.

(2) *Rough Estimate of Construction/Remodelling Cost for 40 Laboratories*

The unit cost of a new building is set at 1,200,000 Rp/m^2 assuming office level specifications for a permanent building. In the case of improvement or

remodelling, half of the unit cost of a new building is assumed, i.e. 600,000 Rp/m^2. The estimated total cost is as follows.

New Construction Work:	1.2 MRp/m^2 x 23,445m^2 =	28,138 MRp
Remodelling Work:	0.6 MRp/m^2 x 11,220 m^2 =	6,732 MRp
Total		34,866 MRp

6.5.3 Improvement of Verification Equipment

The verification equipment and machinery at all 47 local verification laboratories show signs of deterioration and many have already exceeded the expected life-span. It is assumed that some 50% require renewal in the next 10 years in addition to the procurement of other equipment and machinery which are currently unavailable. The following estimate of the required verification equipment and machinery assumes that the inspection and calibration of standards will only be conducted by the 7 key laboratories.

1) 20 Laboratories (Other than 27 Division Level Laboratories of the 47 local laboratories).

①	Length Verification Facilities		1,100,000
②	Taxi Meter Verification Facilities		5,500,000
③	Mass Meter Verification Facilities		17,250,000
	(Out of those listed in 6.5.5, the following items will be procured.)		
	a. Standard Flasks (1 litre, 2 litre, 5 litre, 10 litre)	4 sets each	400,000
	b. Standard Tanks (5 litre, 10 litre, 20 litre)	2 sets each	340,000
	c. Standard Tanks with Truck (50 litre, 200 litre, 500 litre)	2 sets each	4,000,000
	d. Standard Density Buoy	1 set	500,000
	Sub-Total		5,240,000
Total			29,090,000

The total cost for the 20 laboratories will be 581,800,000 yen (29,090,000 x 20). With the maximum use of the existing equipment, the above cost for

replacement and completely new equipment is assumed to be halved to 290,000,000.

2) 27 Division Level Laboratories

①	Length Verification Facilities	1,100,000
②	Taxi Meter Verification Facilities	5,500,000
③	Mass Meter Verification Facilities	17,250,000
④	Thermometer Verification Facilities	12,800,000
⑤	Volumeter Verification Facilities	25,800,000
⑥	Manometer Verification Facilities	9,200,000
⑦	Watt-Hour Meter Verification Facilities	40,000,000
Total		111,650,000

The total cost for the 27 laboratories will be 3,014,550,000 yen which is halved to 1,507,275,000 yen to cover the procurement of both replacement and new equipment.

The total procurement cost to improve the verification facilities of the 47 laboratories will be 1,789,175,000 yen.

(2) Additional Acquisition of Office Equipment and Vehicles to Rationalise Verification Work

In addition to new office equipment to rationalise and improve the verification work productivity, new vehicles will be required to increase the number of venues for collective verification (re-verification) and the verification frequency to improve the verification detection rate. The minimum requirements for each laboratory are as follows.

①	Personal Computers and Printers	2 sets	1,000,000
②	Copier	1	1,000,000
③	Facsimile	1	500,000
④	Vehicle	1	1,000,000
Total			3,500,000

Assuming that each laboratory is provided with the above equipment and vehicle, the total cost will be 164,500,000 yen. The new equipment and vehicles must, however, be allocated to the laboratories taking the laboratory size, local characteristics of the verification work and current equipment level, etc. into consideration.

6.6 Summary of Projects and Implementation Schedule

The implementation of the projects described in 6.2 through 6.5 is proposed here in 3 phases with the respective cost estimates.

6.6.1 Total Investment in Facilities and Equipment

1) Phase 1

① DOM Improvement Project

a) Building repair and remodelling	4,915.2 MRp
b) Expansion of facilities/equipment	1,302,805,000 yen

② Metrological Training Centre Reform Project

a) Additional Building	6,451.2 MRp
b) Expansion and renewal of facilities/equipment	202,650,000 yen

2) Phase 2: Key Laboratory Improvement Project

a) New buildings	6,614.4 MRp
b) Expansion of facilities/equipment	1,750,370,000 yen

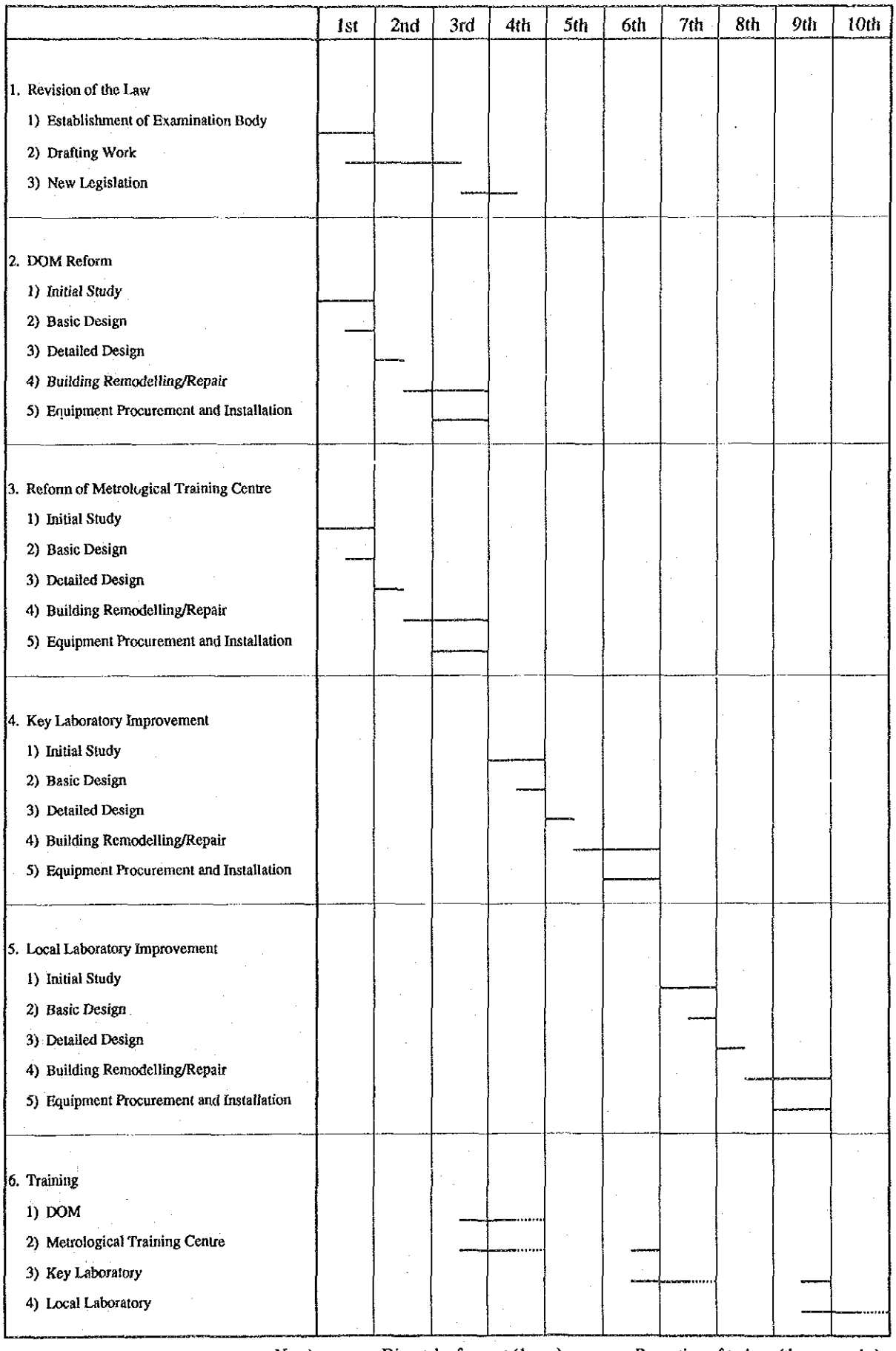
3) Phase 3: Local Laboratory Improvement Project

a) Additional buildings and repair	34,866 MRp
b) Expansion and renewal of facilities/equipment	1,962,675,000 yen

6.6.2 Project Implementation Schedule

The suggested project implementation schedule is shown in Table 6-1. While the proposal introduces 3 phases of 3 years each, an early start is without doubt desirable to assist economic development and to deal with environmental problems as soon as possible.

Table 6-1 Project Implementation Schedule



Note) ___ Dispatch of expert (1year) ..... Reception of trainee (three months)

CHAPTER 7

EXPECTED POSITIVE EFFECTS OF THE PROJECTS

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The projects proposed in Chapter 6 to improve the legal metrology system, including revision of the Law, and to upgrade the facilities and equipment to enforce the legal metrology system and the Legal Metrology Promotion Programme described in Chapter 5 are designed to not only protect consumers through fair trade practices but also to promote Indonesian exports of highly value-added products, replacing the traditional export structure which relies heavily on primary products. The implementation of these projects and the Programme is also vital for the modernisation of Indonesian industries.

The reform of the metrology system proposed in this report covers a wide area and requires the substantial input of both human and material resources. Given the current socioeconomic conditions in Indonesia, a selective and step-by-step approach is required to achieve such profound reform. While the projects are described in Chapter 6 in order of priority, the project to reform the metrology system, including the Law, should be conducted concurrently with other projects. Those projects requiring investment need not necessarily be implemented in a linear order and, provided that sufficient budgetary appropriation is made, it is preferable for them to be implemented as soon as possible to achieve their positive effects.

7.1 Expected Positive Effects

7.1.1 Upgrading of Indonesian Socioeconomy to World Level Trough Establishment of National Metrological Standards and Traceability System

(1) Metrology is often said to be the staple food of industry. Regardless of the main industrial player in a country, be it primary, secondary or tertiary industry, metrology is the basis for all industrial activities.

The recent progress of globalisation, through which industries and physical distribution, etc. are becoming increasingly borderless, puts forward a strong case for unification of the international metrology system with the International System of Units and the establishment of both national and international traceability systems. Real progress in such international mutual certification systems as the quality control regime based on the ISO 9000 and the CB scheme of the IECEE,

etc. is only feasible through the global unification of metrology systems. This need for international unification is equally strongly felt in the field of legal metrology against the background of a growing acceptance of product liability throughout the world. Improvement of the metrology system should prove to be a great step for Indonesia in its upgrading of its socioeconomic activities to the level of those of the world community.

(2) Fair Trade Practices

Correct measurement is the basis for the fair trade practices of both retail and wholesale businesses. An improved metrology system is also significant for a country in terms of planning and introducing various measures for industrial development, consumer protection, environmental conservation and fair taxation, etc.

(3) R & D of Science and Technology

The metrology system forms an objective base for scientific and technological R & D activities to understand natural phenomena and to verify theories. The establishment of correct, reliable measurement standards and the supply of highly accurate standard quantities can reduce the uncertain factors in the application of new technologies, stimulating the development of products using these new technologies and the modernisation of manufacturing facilities.

7.2 Cost of Establishing Improved Legal Metrology System and Verification Fee

It will be a costly exercise to establish and maintain an improved legal metrology system. The work related to the legal metrology system will be conducted by various specialist organizations as described below.

① Consolidation of legal framework and establishment of legal metrology system ..... Department of Trade/DOM

② Metrological research institutes: establishment and maintenance of national standards ..... KIM-LIPI/DOM

③ Central legal metrology verification laboratory: establishment of standards for national legal metrology and central control of verification work ..... DOM

④ Metrological training centre: training of metrology engineers, technicians and inspectors, etc. ..... Training Centre of Department of Trade

⑤ Verification laboratories: actual implementation of verification and calibration of some industrial measurements
..... local verification laboratories/designated verification organizations

The cost of establishing and maintaining the legal metrology system is borne by the central government, local governments and applicants for verification/calibration. As the beneficiaries of the wider enforcement of the legal metrology system will be general consumers and enterprises in view of the objectives of the system, these consumers and enterprises will be regarded as indirectly paying the said cost through national and local government taxes.

In general, the economic cost of the legal metrology system is shared in the following manner in many countries, including Japan and Indonesia.

① Consolidation of legal framework and establishment of legal metrolog system
..... central government

② (National) Metrological research institutes .....central government

③ (National) Central legal metrology verification laboratory central government

④ Metrological training centre ....central government

The tuition fees are paid by the central government for verification staff working for the government. Ordinary students and those sent by private enterprises to obtain the qualification of metrology engineer are in many cases asked to pay some 50% of the tuition fees.

⑤ Verification laboratories

a) Local verification laboratories (run by local government)
..... central government

In the case of many industrialised countries, the revenue from and applicants verification accounts for some 20% of the total budget which increases to some 40-50% in developing countries.

b) Designated verification organizations
..... central government

It should prove feasible to introduce the designated verification and applicants organization system for the verification of watt-hour meters, gas meters, water

meters and environment-related measuring instruments where the scope of applicants is limited to rationalise the cost of verification in view of the huge investment required to establish a verification facility. By designating non-profit organizations (including public enterprises and corporations, the inefficiency originating from the scattering of skilled engineers and inspectors, etc. can be avoided. In Indonesia, the applicants for the verification of these meters are utility companies and large enterprises whose financial capability suggests that it is possible to cover the entire running cost of verification by the verification fees payable by the applicants. Moreover, the prospective applicants can be approached to contribute part of the initial investment cost.