(1) That the measuring instrument is of a kind of the measuring instruments prescribed by Cabinet Order;

(2) That the measuring instrument is of the construction (including the quality of material, hereinafter the same) prescribed by MINECOM Ordinance;

(3) That the instrumental error does not exceed the verification tolerance prescribed by Cabinet Order.

(Term of Validity of Verification)

The term of validity of the verification of a taximeter, gas-meter, water-meter, gasoline measure, electric meter and another measuring instruments prescribed by Cabinet Order are the periods prescribed by Cabinet Order counting from the first day of the month following the month in which the verification mark has been affixed.

(Verification Mark, Etc.)

The verification mark shall be affixed to the measuring instruments which have passed the verification.

2. On the verification mark to be affixed, in accordance with the provision of the preceding Paragraph, to the measuring instruments provided for in the preceding Article, the expiration date of the term of validity of the preceding Article shall be indicated.

(Time Limit for Verification)

The Minister of MINECOM, the governor of Province or the designated verification bodies shall, when they have received an application for verification, perform the verification of measuring instruments applied for and dispose of its qualification or disqualification within twenty days from the date of the receipt of the application.

(Notice of Reasons for Disqualification)

The Minister of MINECOM, the governor of Province or the designated verification bodies shall notify the reasons for disqualification to the person who applied for the verification when the disposal of disqualification was taken after performing the verification of measuring instruments.

(Deletion of Verification Mark, Etc.)

In case a measuring instrument which has been disqualified in the verification bears a verification mark, a calibration mark or a matching number in the same paragraph, such a verification mark, calibration mark .cp3
shall either be removed or cancelled with an obliteration
mark.

(Subject of verification): Verification organizations specified by the Economy Minister will become a body responsible for verification. One or several organizations should be specified for each division decided in the decree, and it is necessary to clearly specify organizations verificating equipment and facilities to be owned by the specified organizations, qualification of verification inspectors, the number of staff, and the duty to calibrate standards device for verification according to the national standards in, for instance, a decree by the Ministry of Economy.

The (term of validity of verification) should be decided in a range from 5 years to 10 years. The term of validity of verification for meters for electricity, gas meters and water supply meters should be 10 years, and such devices as taxi meters in a range from 3 to 7 years because of the necessity of calibration, usage and life of the measuring instruments. Note that the term of validity of taxi meters is 1 year in many countries. Also note that generally a term of validity is not specified for length meters and weight meters because of usage of such devices.

The allowable error in verification specified in a decree for (conditions for passing the verification) varies according to structure of, restrictions, and expected performance of the measuring instruments, but generally the allowable error should be in a range from 1 to 2 %.

Section 2. Model Certification

(Model Certification)

Provisions shall be made to enable manufacturers of measuring equipment to be eligible for Certification by the Minister of MINECOM as an alternative to verification for model testing, provided that the measuring equipment of said manufacturers complies with the following items.

(1) Said manufacturers of said measuring equipment shall manufacture the equipment concerned in factories certified by a certification entity approved and accredited by the Minister of MINECOM (hereinafter referred to as Quality System Certification Body) in pursuance with the classification laid down by Government Decree or Ordinance and on the basis of certification procedures conforming to the certification criteria laid down by Ministry of MINECOM decree.

(2) Said manufacturers of said measuring equipment shall have passed the testing and inspection procedures conducted by a designated verification/inspection body in accordance with the model testing criteria laid down by Ministry of MINECOM decree.

(Period of Validity for Model Certification)

The period of validity for model certification shall be determined on the basis of the (Term of Validity for Verification/ Inspection).

(Model Certification Mark)

A certification mark taking the form of specific stamp shall be affixed to measuring equipment having passed the model certification procedures.

2) The model certification mark affixed under the provisions of the previous sub-section to the measuring equipments designated in the previous section shall display the final date of validity of model certification as defined above.

Any further or other details, including the "scope of model certification" and "notification of non-conformity with statement of reasons(s)", shall be ruled by Ministry of MINECOM Decree.

As a principle, devices for legal measuring instrument should be verified individually. For this reason, of the measuring instruments, those not used in transaction nor in certification are not always required to be verified, but such devices as meters for electricity, water supply meters, gas meters, and taxi meters and measuring instruments for health care should be verified before delivery. For this reason, as a vast quantity of works is required for verification, and also because of the economical rationality that unnecessary cost burden should not be put on shoulders of manufacturers having the capability to correctly manufacture measuring instruments, so it would be reasonable to introduce a system of type approval in place of verification.

This certification is for factories certified by organizations certifying quality systems and measuring instruments produced in the factories, and is issued only to manufacturers who passed model testing by specified verification organizations.

Accordingly, manufacturers not satisfying the conditions, repaired or modified measuring instruments, and measuring instruments with the term of validity for certification of verified model already terminated are objects for verification.

As measuring instruments for health care are used by consumers or in hospitals, it is difficult to be verified again, and life of such devices as clinical thermometers and asphygmomanometers is not so long because of their construction, so that it is not necessary to specify the term of validity, and only verification before delivery is enough for restriction over such devices.

It will be necessary to employ the "criteria for certification" for quality systems specified in a decree by a ministry according to the ISO 9000 series so that the provisions will be accepted internationally. In addition, this "criteria for certification" must include provisions concerning adjustment of instrument errors between each unit, compulsory inspection, acquisition, proper maintenance and control of standard devices used for that purpose.

As organizations certifying quality systems for measuring instruments are required to have special technological knowledge in addition to knowledge on quality control, certification for the organizations should be different from that for industrial products.

Section 3. Inspection of Verification Standards

(Subject of Inspection of Verification Standards)

The inspection of verification standards shall be performed by the Minister of MINECOM, the National Metrological Laboratory or the body designated by Ministry of MINECOM (hereinafter referred to as "designated calibration body") according to the classification of standards as determined by Cabinet Order.

(Conditions for Qualification of Inspection of Verification Standards)

When a verification standard which has received the inspection of verification standards is in conformity with all of the item (1) to (3), it shall be regarded as qualified:

(1) That the verification standard is of a kind of standards prescribed by the Cabinet order;

(2) That the verification standard is of the construction prescribed by the Ministry of International Trade and Industry Ordinance;

(3) That the instrumental error does not exceed the tolerance of verification standards prescribed by Cabinet order.

(Term of Validity of Inspection of Verification Standards)

The term of validity of the inspection of verification standards shall be three years. Provided, however, that the verification standard prescribed by Cabinet Order shall follow the stipulation thereof.

(Mark of Inspection of Verification Standards)

A verification standard which has passed the inspection of verification standards shall be affixed with a mark of inspection of verification standards.

(Certificate of Inspection of Verification Standards)

When a verification standard is qualified in the inspection thereof, a certificate of the inspection of verification standards, on which its instrumental error is recorded, shall be delivered to the person who applied for the inspection.

2. On the certificate of the verification standard under the preceding Paragraph, there shall be written the method of correction for its instrumental error and the term of validity.

A verification standard which has passed the inspection of verification standards shall not be assigned or lended unless it is accompanied with the certificate of the inspection of verification standards.

2. A verification standard which has passed the inspection of verification standards shall be used by correcting the instrumental error in accordance with the method mentioned in the certificate of the inspection of verification standards.

(Mutatis Mutandis Application)

The provisions of (Place of Performing Verification), (Time Limitation for Verification) and (Notice of Reasons for Disqualification) shall apply mutatis mutandis to the inspection of verification standards.

The reference devices are tools, machines and devices used as references for quantities concerning physical state in verification and type approval by administrative organizations for measurement, or in in-house inspection of measuring instruments by manufacturers, repair shops and users of measuring instruments (general manufacturers and institutes).

For this reason, as these measuring instruments are used as references for quantities concerning physical states, the most strict inspection is required for these devices. Bodies for verification should be limited to national metrology laboratory or certifying/calibrating organizations performing fine calibration for industrial metrology, because specific and high level knowledge concerning advanced metrology is required for this inspection.

The allowable errors for standard devices vary according to purpose of use of each device, grades such as classes 1 and 2 should be introduced.

Also it is needless to say that the standard devices must be traceable to national standard devices.

Chapter V Measurement Certification Business

(Registration of Measurement Certification Business)

Any person who intends to engage in the business of certifying any measurement by using the legal measuring units (hereinafter referred to as "measurement certification") stated in the following, shall be registered for every workshop classified by the MINECOM Ordinance to the governor of Province exercising jurisdiction over the place of the said business. Provided, however, that the same shall not apply in the case when the government or a local public entity engages in the said measurement certification business and in the case when the person, who has been registered, designated or disposed in other ways, for doing the business according to the provisions prescribed by Cabinet Order, engages in the said business of measurement certification.

(1) The business of measurement certification of the length, mass, area, volume or amount of heat of the goods at the time of loading, unloading or warehousing of the said goods with the object of forwarding, depositioning or selling.

(2) The business of measurement certification of concentration, noise level and other physical quantities prescribed by Cabinet Order.

(Duty to Receive Inspection)

The measurement certifier shall receive the inspection with respect to the measuring instrument used for measurement certification each year from the date of obtaining the registration.

(Subject of Inspection)

The inspection under Paragraph 1 of the preceding Article shall be performed by the governor of Province who has registered the business under (Registration of Measurement Certification Business).

(Place of Performing Inspection)

The place of performing inspection under (Inspection of Registered Measuring Instrument) shall be the place wherein the said measuring instrument is located. Provided, however, that it shall be the designated place by governor of Province in case there is an application from the measurement certifier.

(Conditions for Qualification of Inspection)

The measuring instrument which received the inspection under (Inspection of Registered Measuring Instrument) shall be considered to be qualified when it conforms to all the following items:

(1) That the verification mark or the calibration mark is affixed thereto;

(2) That it has the structure provided for by the MINECOM Ordinance;

(3) The instrumental error does not exceed the tolerance in use provided for by Cabinet Order;

(4) That the term of validity of verification has not yet expired in the case of the measuring instrument which is provided for by (Term of Validity of Verification) and has been qualified in the verification.

2. Whether the measuring instrument conforms to Item (3) of Paragraph 1 shall be determined by the method provided for by the MINECOM Ordinance and by using the verification standard which has passed the inspection of verification standards.

(Inspection Mark)

The measuring instrument which has passed the inspection under Paragraph 1 (Inspection of Registered Measuring Instruments) shall be affixed with the inspection mark and the figures which indicate the

year when the inspection in the same paragraph has been performed.

(Deletion of Inspection Mark, Etc.)

When a measuring instrument which has failed in the inspection under Paragraph 1 (Inspection of Registered Measuring Instruments) bears a verification mark or a calibration mark, such an inspection mark or a calibration mark shall be either removed or cancelled with an obliteration mark.

Services for certification of measurement have been developing in association with marine transportation, and in recent years the services are frequently utilized also in transportation by railways or trucks.

Also in recent years, social interests in environment have been becoming increasingly intense, and in association with progress of projects for protection of environment, the number of service providers in the field of certification for measurement of density of hazardous materials and noise level has been increasing.

The services are also related to environmental restrictions which have been becoming increasingly strict, and now certification for weight and volume of cargoes, density of hazardous materials in air and water, and levels of noise and vibration are extremely important.

For these reasons, as it can be considered that general controlling methods such as simple site inspection are inadequate for accuracy of measuring instruments used by such service providers, persons hoping to provide services in the field of certification must make a registration to local government offices, file provisions for the enterprise concerning methods for implementation of the registered services after registration and receive inspection for measuring instruments used in the registered certification services once a year.

Chapter VI Supervision

Section 1. On-the-spot Inspection

(On-the-spot Inspection, Questioning and Taking Away)

Minister of MINECOM, or the governor of Province may within the limit necessary for the enforcement of this Law, cause his officials to enter the factory, workshop, shop, business office, office or warehouse of the manufacturer, mender, seller or the person who transacts or certifies in measuring units, to examine measuring instruments, the equipment for the inspection of measuring instruments, net content indicated commodities, quality indicated commodities, books, documents, or the method of measurements in transaction or certification, to question the persons concerned, or to take away, within the minimum necessary quantity for purposes of inspection of quality, the commodities transacted in density, concentration or viscosity in the legal measuring units.

2. When an official enters the premises in accordance with the provision of the preceding Paragraph, he shall carry with him his identification card and show it to the persons concerned.

3. The authority of on-the-spot inspection, questioning and taking away provided for in Paragraph 1 shall not be construed as being authorized for criminal investigation.

(Presentation of Measuring Instruments, Etc.)

The Minister of MINECOM or the governor of Province may, when they have caused their officials to inspect under the provision of the preceding Article Paragraph 1 and found there are measuring instruments, goods with indication of net quantity or goods with indication of quality which are recognized to be extremely difficult to inspect at the places where they are located, order the owner or the possessor thereof to present

them by fixing a period of time.

2. The state, the governor of Province shall compensate for a loss caused by the order under the preceding Paragraph to the owner or the possessor.

(Removal of Verification Mark, Etc.)

The Minister of MINECOM or the governor of Province may, when they have made their officials to inspect the measuring instruments used for measurement by the legal measuring units under the provision of Paragraph 1 (On-the-spot Inspection, Questioning and Taking Away) either remove the verification mark or cancel them with an obliteration mark:

(1) That the measuring instrument does not conform the structure which is provided for by the MINECOM Ordinance;

(2) That the instrumental error exceeds the tolerance in use provided for by Cabinet Order;

(3) That the term of validity of verification has expired in the case of the measuring instrument provided for by (Term of Validity of Verification) and had passed the verification.

2. Whether or not the measuring instrument conforms to Paragraph 1 Item (2) shall be determined by the method provided for by the MINECOM Ordinance and by using the verification standard which has passed the inspection of verification standards.

3. The Minister of MINECOM or the governor of Province shall, when they take action under the provision of Paragraph 1, notify the reason for such action to the owner or the possessor thereof.

To secure implementation of correct and fair measurement and achieve the purpose s specified in the measurement law, various systems defined in the measurement must be followed. So it is necessary to give

staff of the administrative organizations for measurement the power for site inspection.

As for the inspection, it is not necessary to decide times and intervals, but periodical inspections to sites where instruments are used is required for measuring instruments used in business transaction, such as taxi meters, gas meters, water supply meters, gasoline meters, liquefied oil weight meters, and length meters.

> Section 2. Order for Improvement, ..., etc.
>
> The Minister of MINECOM may, when he recognizes that the manufacturer provided for by Paragraph 1 (Duty to Conform to Provisions in Manufacturing) or the person who is provided for by the same Article Paragraph 2 (Duty to Conform to Provisions In Case of Selling) is violating the provision of Paragraph 1 or Paragraph 2 of the same Article, order such a violating person to take necessary measures to render the measuring instrument to be manufactured or sold conform to the technical provisions provided for by the MINECOM Ordinance mentioned in the said Article Paragraph 1.

Items to be enacted when enacting the measurement law are as described above. In addition, the following items should be provided in the measurement law.

1) Chapter 7 Specified Verificating Organization, Accredited Calibrating Organizations

   It is necessary to define qualification of a specified verificating organization and an accredited calibrating organization and procedures for specification and accreditation, but these items are closely related to tradition and legal restrictions in Chile, so concrete recommendations are not presented here.

When studying contents of the restrictions, the following items should be taken into considerations.

In association with development of economical transaction and progress in industrial technologies, measuring instruments have been becoming increasingly advanced and complicated. For this reason, in the specific fields where specific capability is required for authorization and calibration, organizations in the private section should efficiently be utilized to supplement capacities of the central and local governments for verification.

So specified authorizing organizations and accredited calibrating organizations must satisfy the following requirements.

(1) The organizations must be official-interest corporations engaged in research of testing and technical matters for measuring instruments and similar machines or tools and not searching for profit.

(2) The organizations must have machines and tools specified in a decree by the Ministry of Economy, and in the organizations staff having knowledge and experience satisfying the conditions decided in a decree by the Ministry of Economy must perform works for verification.

(3) The organizations must have accounting systems required to accurately and smoothly carry out works for verification.

(4) Configuration of executives or employees, and, if the organizations are engaged in jobs other than those specified in (1), contents of the jobs should not give any bad influence the organizations' function to carry out accurate and fair verification.

As works for verification are very important for securing safety in measurement, it will be necessary to study whether provisions on the jobs, stop or abolishment of the jobs, and project plans should be put under control by the Economy Minister or not.

2) Chapter 8 Re-examination and Claims

Administrative measures based on the measurement law include such matters as registration, verification, type approval, standard devices, and inspections, but it is necessary to establish a system so that any person can apply for re-examination or present claims. The administrative measures are related to legal control, so it is necessary to study administrative procedures in similar laws and clarify the procedure in the measurement law.

Items to be provided as legal provisions when the measurement law is enacted were described above with reference to recommendation by OIML for the measurement law.

After the measurement law is enacted and physical and qualitative requirements for administrative organizations for measurement are satisfied, the following systems should be studied to further improve the metrological system in the future.

1) Metrological engineer

A national qualification should be given to people who have special knowledge concerning metrology, and it is preferable to both the country and users to assign certain jobs based on the measurement law to the people for promoting implementation of correct and accurate measurement.

(2) Job sites using measuring instruments

By specifying private facilities using measurement instruments and having a necessary capability for measurement control and utilizing capabilities of the facilities, reduction of work load to government officials and establishment of various measurement systems can be expected.

When specifying the jobs sites using measuring instruments, measurement control by metrological engineers is essential, so it

is necessary to study the possibility of introducing the system in the system.

(1) The metrological engineer system (general metrological engineers and environmental engineers) should be introduced to each type of measuring instruments to be used, and the metrological engineers must take charge of control of measuring instruments allocated to the person.

(2) The job sites must have equipment and facilities required for inspection of measuring instruments to be used.

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

The DOM should conduct R & D with a view to controlling the national mass standard in its required accuracy range and should establish traceability with the primary standards of the KIM-LIPI for other quantities in cooperation with the latter.

In regard to the vibration quantity (of electrical quantities) and chemical quantities, the KIM-LIPI has not yet developed the relevant primary standards. Consequently, the DOM is required to cooperate with appropriate research organizations overseas to conduct mutual calibration work using the round robin system or other methods to maintain the required accuracy of legal metrology standards.

(1) Building Plan

The key component of the proposed building plan is the substantial remodelling of the present DOM building and the neighbouring Metrological Training Centre building with a view to relocation of the laboratories and offices, etc. In planning the floor area, the first priority is given to calculating the laboratory size required for each quantity, followed by calculation of the required floor area for such common facilities as meeting rooms, offices, storage, toilets, entrance hall, corridors and lifts, etc. and for such auxiliary facilities as the machine room, monitoring room and dust space, etc. Using foreign metrological institutes as examples, the ratio between the total laboratory area and total common area is roughly set at 1 to 0.5. The total area of auxiliary facilities is also set at a proportional ratio of 0.5 of the total laboratory area.

It has been decided to use the common module system for the laboratories. A single module size of 6m by 8m is proposed here to harmonise with the present building size and to ensure reasonable working space. In general, the laboratory size is equivalent to 2 modules. For those laboratories requiring much more space, the size should, in principle, be a multiple of the basic module size. Closely related laboratories will be located near each other. A building height of approximately 4-4.5m appears appropriate in view of convenience for plumbing and wiring and the special characteristics of laboratory equipment. The design floor load should be around 500 kg/m^2 on average. While a single storey building is desirable to avoid vertical vibration, the present multi-storey building can be used by its refitting and the skilful relocation of the laboratories within the

building. The building design, particularly the laboratory design, must take the following aspects into consideration.

1) Air-Conditioning System

   a) The temperature and relative humidity specifications should, in principle, be based on the relevant international and domestic standards.

   b) The general building temperature and relative humidity are set at 27°C ± 5°C and 65% ± 20% respectively based on the Indonesian standards.

   c) The laboratory temperature and humidity should be based on the ISO 554-1976 (international standards for laboratory environment) and the concrete values should be set in accordance with the specific quantity dealt with by each laboratory. Should special conditions be required, the relevant international standards should be referred to.

   d) The circulation and ventilation rates of indoor air should be calculated on the basis of relevant data obtained from similar research facilities.

2) Vibration Proofing and Sound Insulation

   a) Vibration Proofing

      The DOM must introduce measures to contain the transfer of ground vibration to the building to ensure fine testing in a quiet environment. Vibration proofing measures should be introduced at the sources to prevent the travelling of vibration from the machine room and equipment used by the laboratories. Those laboratories which are particularly vulnerable to vibration should be located on the ground floor and extra vibration proofing measures may be required to protect the operation of precision equipment.

   b) Noise Insulation

      It is generally desirable to select the correct location at the planning stage to avoid external noise and air vibration. In the case of the remodelling of the existing building, the best method is to locate those laboratories which are particularly vulnerable to noise as far as possible from the sources of noise. Sound insulation must be added to the building structure, setting a target noise level of 50 dB or lower for such laboratories.

3) Water Supply and Drainage

The capacity of the water supply and drainage facilities must be far above the standard requirements. The installation of an exclusive cooling water (neutral water) system devoid of chlorine and foreign matters is preferable to prevent corrosion and blockage, etc. of the cooling system and equipment. A central treatment facility is required to deal with drainage water which may be contaminated by harmful substances. It is desirable for the rainwater drainage system to have a drainage capacity which is based on torrential rain with a 100 year return period. All the above requirements must be carefully taken into consideration in the remodelling design.

4) Miscellaneous Laboratory Facilities

a) Earthing

Earth cabling of sufficient capacity should be installed for each laboratory. An independent earthing system is particularly important for electrical laboratories with an earth resistance of not more than 1 Ω.

b) Dust Proofing

The mass laboratory and length laboratory should be Class 10,000 clean rooms. The remodelling design should include features which permit upgrading of the clean room status of laboratories and the provision of clean benches, etc. to meet possible future requirements.

c) Draft Chamber

A draft chamber and exclusive ducting should be installed for those laboratories which may produce volatile or harmful gases to ensure external discharge or proper treatment prior to discharge.

d) Shielded Room

A shielded room structure should be employed for those laboratories which demand a low level of electromagnetic interference from outside.

5) Safety Measures and Facility Control

a) Fire Prevention Facilities

Fire protection walls and doors should be introduced in appropriate locations to prevent the spread of fire and each laboratory should be

provided with a fire alarm and basic fire-fighting equipment. While the installation of a sprinkler system for common areas is desirable, a fire-fighting system using inactive gas should be installed for those laboratories where water should not be used for fire-fighting.

b) Measures Vis-a-Vis Black-Outs and Water Cuts

Even if the likelihood of a black-out or water cut is minimal, an emergency power supply system and water tank must be provided.

c) Centralised Control of Facilities

A central monitoring system and monitoring centre should be introduced to ensure constant monitoring of the power supply equipment and air-conditioning equipment, etc. which operate around the clock in those laboratories dealing with length and mass, etc.

d) Access Control

Automatic locking doors which can only be unlocked using an authorised ID card or other means should be installed in appropriate locations to control access to the laboratories and other facilities.

e) Maintenance

A reasonable number of technical staff should be appointed to be responsible for the simple repair of equipment/instruments and for maintenance of the building and building services.

f) Workshop

The introduction of a workshop should be considered to conduct the repair of equipment/instruments and to prepare samples.

6) Miscellaneous

Some of the following special specifications may be required depending on the specific purposes of the laboratories and the building design must permit such specifications if required.

a) Special floor (ceiling) height; special floor load

b) Installation of such transportation equipment as cranes and hoists

c) Laboratory flooring and tables which are independent from the floor pit or building structure

All the laboratories should be located in such a way as to avoid direct sunlight, following the example set by metrological research organizations abroad. It may be appropriate to locate certain laboratories in a different building in view of their creation of vibration, handling of heavy items and/or necessity for a special building structure.

(2) Building Floor Area

The required floor area and necessary building facilities are estimated taking the following into consideration.

① Confirmation of the DOM's functions/role and related work.

② Estimated work volume in the future (some 10 years' time) based on the past and present work volumes.

③ Range of required equipment based on ① and ② above and the personnel plan to meet the estimated work volume.

④ Estimation of the total floor area of such main rooms as laboratories, standard rooms, calibration rooms and offices, etc. (the floor area of each room is decided by the floor area occupied by the equipment to be installed and the required work space, etc.) to be added to the floor area of such auxiliary and common facilities as meeting rooms, library, consultation rooms, corridors, staircases, toilets and rest rooms, etc.

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	: ¥17,000,000
	(calibration subjects: reference standards for watt-hour meters and el	¥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	: ¥134,850,000
b)	Pressure	: ¥64,410,000
c)	Force	: ¥53,950,000
d)	Volume	: ¥62,790,000
e)	Length	: ¥94,905,000
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 current manpower strength of the DOM appears appropriate in view of its expected role and functions and is by no means inferior to that of similar organizations overseas. However, the frequent business trips required to provide metrological guidance for industrial circles and to supplement the manpower shortage of local verification laboratories certainly reduce the efficiency of the current workforce in conducting the key functions of the DOM. It is, therefore, deemed necessary to increase the number of technical staff to approximately 70.

When recruiting new technical staff, a new staff hierarchy should be introduced to create senior positions of metrological scientists and metrological engineers which are higher than the present position of inspector so that the DOM can fully perform its functions and role. These senior staff members with expert knowledge and experience in their respective fields can be internally promoted or externally recruited.

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

An appropriate personnel cost must be accounted for in the budget of the DOM together with other necessary costs. In addition to government funding, revenue sources can include fees charged for the calibration services provided by the DOM for the private sector and funds from the private sector to cover the cost of requested research. As the control of national standards and the implementation of scientific research relating to metrology are the responsibility of the central government, it is generally the case for the cost of such work to be accounted for in the national budget.

The salary level of the DOM may have to be drastically improved to narrow the salary gap between the public and private sectors in view of the recruitment and long service of highly capable engineers. The level of income from such services as the calibration of reference/working standards may considerably vary depending on many factors and the fee level, etc. but may total some 3% of the total running cost in the best case.

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

At present, short group training courses of approximately 2 weeks to one month are regularly held by the Metrological Training Centre for the technical staff members of local verification laboratories and those of such law enforcement organizations as the police. Similar short training courses are also provided whenever new measuring instruments become subject to the legal verification regime or provisions of the Law or when related regulations are revised. The continuous provision of this type of practical training when deemed necessary should prove effective.

In the case of the implementation of the DOM project, it will be necessary for the DOM to send its technical staff abroad for training and also to invite experts on metrology from industrialised countries in order to improve the technical ability in line with the expansion and upgrading of the DOM's technical work. The subject fields for overseas training and guidance by foreign experts are proposed below. Those sent abroad for training will be metrological engineers and inspectors of the DOM.

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

As described in Chapter 3, the deterioration of the reference standards, calibration equipment and verification equipment, etc. owned by the local verification laboratories is quite obvious and some equipment is already well past the intended life-span, resulting in problems in terms of the reliability of accuracy. About half of the laboratories borrow part of the building belonging to the local branch of the Department of Trade or rent a private wooden house to conduct their business.

The local verification laboratories improvement project is outlined below, mainly based on the findings of the interview survey conducted in Indonesia, bearing in mind the difficulty of obtaining a comprehensive picture of these laboratories with only 8 of the laboratories actually visited and the lack of data to evaluate the floor area and building quality for all the laboratories.

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 Estimated Verification Volume and Manpower Level of Local Verification Laboratories

Here, the necessity to construct an additional building and/or to remodel the existing building is examined for 40 local verification laboratories as such work for the 7 key laboratories has already been proposed in 6.4 - Key Laboratories Improvement Project.

Using 1994 as the base year, the verification volume and manpower level required for such verification volume in 2002 were estimated taking the likely socioeconomic development (changes of the social structure and annual rate of economic growth, etc.) deriving from the actual verification volume between 1990 and 1992 into consideration. The following preconditions were adopted for the estimate.

① The volume in 1994 is estimated based on the average growth rate of the verification volume in the last 4 years (1990, 1991, 1992 and 1993). (In the case of a negative growth rate, the volume is assumed to remain the same.) The present detection rate for verification is roughly between 60% and 70% with minor variations between laboratories and annual improvement of 3% is assumed to increase the estimated verification volume in 1994 and there onwards. The growth rate expressed as a percentage is rounded to the nearest decimal point.

If the annual growth rate of one laboratory is more than 1.2 times the national growth rate, this may be attributed to a boundary change (or extension) of the area concerned. The annual growth rate for individual laboratories is capped at 1.2 times the national growth rate.

With regard to those measuring instruments of which the national average growth rate in the last 4 years is negative while the overall verification volume is believed to be decreasing, the verification volume is fixed at the 1993 level. This means that the above decreasing trend is compensated for by the improving detection rate. The growth rate for watt-hour meter verification since 1994 is estimated based on changes of the number of end users shown in Table 2-23 rather than the average growth rate for the previous 4 years.

② The manpower level is estimated for each laboratory, assuming annual productivity improvement of 2%/person due to the improved verification facilities and improved ability of the verification staff through training. The number of staff (manpower) is rounded below the decimal point.

③ The staff allocation for each year is rounded below the decimal point.

④ Such environment-related measuring instruments as densitometers, noise meters and vibration meters, etc. which are expected to become subject to the legal metrology regime are not discussed here as it is impossible to estimate the future use of these instruments. Their future is discussed from the qualitative point of view in a separate section.

(1) Estimated Verification Volume and Required Manpower Level for Each Quantity/Instrument

1) Details of the estimated verification volumes are given in Table 6-3, Table 6-4, Table 6-5, Table 6-6, Table 6-7 and Table 6-8, while data for 1993 and 2002 are reproduced.

(Unit: 1,000 pieces)

	Mass	Volume	Watt-Hour Meters	Water Meters	Others	Total
1994	5,767	1,415	1,854	342	186	9,564
2002	10,507	2,978	2,950	855	387	17,677

2) Details of the estimated manpower level required are given in Table 6-4 while data for 1993 and 2002 are reproduced.

	Inspectors, etc.	Administrative Staff	Total
1994	1,069	387	1,456
2002	1,779	634	2,414

(2) Estimated Verification Volume of Local Laboratories

The expected verification volume of the local laboratories is estimated below, assuming the implementation of the various improvement programmes discussed in Chapter 5..

1) The introduction of the Designated Measuring Instrument User System will greatly rationalise re-verification which accounts for some 75% (1993 result)

of the entire verification volume relating to mass and the verification volume in 2002 will be likely contained at around 7,900,000.

2) In the case of volume-related verification, the introduction of the Designated Manufacturer System, as well as the relatively large business size of each manufacturer, will make it easier to establish an effective quality control system. It should be possible to contain the verification volume in 2002 around 2,400,000.

3) In the case of watt-hour meters, the concentration of large manufacturers in Jakarta will facilitate the introduction of the Designated Manufacturer System so that initial verification can be omitted. As most of the recorded verifications are initial inspections, the verification volume in 2002 will be likely contained at around 1,000,000.

4) Other measuring instruments include length gauges, gasoline meters, taxi meters and gas meters, etc. and their verification volume is expected to rapidly increase in the future in accordance with Indonesia's economic development. At present, however, many gasoline meters, gas meters and taxi meters are imported. The likely increase of the demand of these measuring instruments will stimulate their domestic production by joint ventures or local enterprises. As these instruments require a high level of manufacturing technology and market competitiveness through mass production, they are suitable for large enterprises. Other measuring instruments also include those which should be dealt with under industrial metrology. All these characteristics will facilitate the introduction of the Designated Manufacturer System and it should be possible to contain the verification volume at around 200,000 in 2002. In total, the estimated verification volumes in 2002 are as follows.

(Unit: 1,000 pieces)

	Mass	Volume	Watt-Hour Meters	Water Meters	Others	Total
2002	7,900	2,400	1,000	800	200	12,300

(3) The estimated manpower level required by local verification laboratories to meet the above verification volumes is given below based on the same estimation method previously used.

	Inspectors, etc.	Administrative Staff	Total
2002	1,238	442	1,680

(4) The estimated verification volumes and required manpower level so far are for the 47 laboratories. After deducting the figures for the 7 key laboratories proposed in 6.4 – Key Laboratories Improvement Project, the estimated verification volumes and manpower level for the remaining 40 laboratories are as follows.

1) Estimated Verification Volume

(Unit: 1,000 pieces)

	Mass	Volume	Watt-Hour Meters	Water Meters	Others	Total
1994	4,778	960	1,363	181	112	7,394
2002	6,705	1,465	735	453	72	9,430

2) Estimated Manpower Level Required

	Inspectors, etc.	Administrative Staff	Total
1994	862	277	1,103
2002	986	325	1,311

6.5.3 Current Building Floor Area of Local Laboratories

In the case of the key local verification laboratories, the current floor area is an average of 19m^2 per laboratory worker although the exact figure slightly varies from one laboratory to another. In the case of the remaining 40 laboratories, the average floor area per laboratory worker is 26.3m^2 for the 15 laboratories of which the floor area is known. This relatively high figure is the result of the high percentage of common facilities and metrology standards laboratories, the floor areas of which are not greatly affected by the overall laboratory size (see Table 6-9).

Table 6-9 shows the floor areas of 6 Japanese verification laboratories (small, medium size and large) for reference purposes. According to this table, the average floor area per laboratory worker is approximately 72m^2. When the taxi meter verification facilities are excluded, the average floor area drops to approximately 55m^2.

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

Estimation of the required floor area for each laboratory is difficult given the limited scope of the field survey and the inadequacy of the gathered data. Such estimation is also beyond the scope of the present Study.

The construction of an additional building or the remodelling of the existing building of each laboratory must fully take its environment, site size and special requirements of the verification work to be conducted, etc. into proper consideration. When the 40 laboratories are considered together under a single project to improve their verification capability, however, the special requirements of individual laboratories are buried under the average requirements of the subject laboratories. In short, the key issue is the desirable floor area per laboratory worker. 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
1994	1,103	22,440m^2	38,605m^2
2002	1,311		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 23,445 m^2 = 28,138 MRp

Remodelling Work:	0.6 MRp/m^2 x 11,220 m^2 =	6,732 MRp
Total		34,866 MRp

6.5.5 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. The required level of verification equipment and machinery to conduct the present level of verification of measuring instruments subject to the legal metrology regime is described below.

Main Verification Equipment and Machinery by Subject Item

A)	Length		(yen)
	① Standard Linear Scales (1m)	2	400,000
	② Standard Tape Measures (5m, 30m)	2	700,000
	Sub-Total		1,100,000
B)	Taxi Meters		
	① Travelling Tester (fixed, both wheels resting)	1 set	5,000,000
	② Head Tester	1	500,000
	Sub-Total		5,500,000
C)	Mass		
	① Standard Direct Reading Balances (2kg, 200g, 20g, 5g)	4	4,000,000
	② Standard Manual Balances (20kg)	2	3,000,000
	③ Standard Manual Platform Scales (500kg)	2	4,000,000
	④ Standard Weights (1mg - 20kg, F1 Class)	1 set	3,000,000
	⑤ Standard Weights (1mg - 20kg, M Class)	2 set	800,000
	⑥ Weights (cast iron, 20kg)	50	750,000

⑦	Weights (cast iron, 500kg)	3	600,000
⑧	Weights (upto 2kg assembly weights)	2 sets	100,000
⑨	Forklift (one ton)	1	100,000
	Sub-Total		17,250,000

D) Thermometers

①	Standard Glass Thermometers (-56/0°C, 0/50°C, 50/100°C, 100/150°C, 150/200°C)	10	2,000,000
②	Constant Temperature Air Tank (-10/50°C)	1	1,500,000
③	Constant Temperature Water Tanks (-60/20°C, 0/100°C)	2	3,000,000
④	Constant Temperature Oil Tank (100/300°C)	1	3,000,000
⑤	Clinical Thermometer Verification Unit (with hot water tank and standard glass thermometer)	1 set	3,000,000
⑥	Ice Maker	1	300,000
	Sub-Total		12,800,000

E) Volumeters

①	Standard Flasks (1 litre, 2 litre, 5 litre, 10 litre)	8	800,000
②	Standard Tanks (5 litre, 10 litre, 20 litre)	3	500,000
③	Standard Tanks with Truck (50 litre, 200 litre, 500 litre)	3	6,000,000
④	Tank Lorry Verification Unit (with 1,000 litre standard tank)	1 set	8,000,000
⑤	Water Meter Verification Unit (with 500 litre standard tank)	1 set	5,000,000
⑥	Gas Meter Verification Unit	1 set	3,000,000
⑦	Standard Wet Type Gas Meters (20 litre, 10 litre, 5 litre)	3	2,000,000
⑧	Standard Density Buoy	1 set	500,000
	Sub-Total		25,800,000

F) Pressure Gauges (manometers)

①	Standard Dead Weight Pressure Gauges (200 MPa, 50 MPa, 10 MPa, 5 MPa)	4	8,000,000
②	Standard Liquid Column Manometer (0.2 MPa, vacuum)	1	700,000
③	Sphygmomanometer Verification Unit (with 300 mmHg standard liquid column manometer)	1	500,000
	Sub-Total		9,200,000

G) Watt-Hour Meter Verification Facilities

(40 meters at one time)	1	40,000,000

(1) Rough Estimate of Verification Equipment Procurement Cost to Improve Verification Facilities of Local Laboratories

A rough estimate of the verification equipment procurement cost is made here based on the conditions described above.

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 6-11. 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 Machines and Equipment for Type Tests

1. MECHANICAL SCALES

	Equipment Name	Quantity
(1)	Standard Weights	3
(2)	Standard Scales	1
(3)	Air Conditioned Oven	1
(4)	Static Discharge Testing Equipment	1
(5)	Interruption Testing Equipment	1
(6)	Power Spruce Noise Characteristics Test Equipment	1
(7)	Weighting Repeating Equipment	1

2. TAXI METER TESTING EQUIPMENT

	Equipment Name	Quantity
(1)	Vibration Testing Equipment	1
(2)	Pulse Generator	1
(3)	Constant Temperature Device	1
(4)	DC Power Unit	1
(5)	Static Discharge Testing Equipment	1
(6)	Impulsive Noise Testing Equipment	
(7)	Electromagnetic-wave Interference Testing Equipment	1
(8)	Pressure Gauge	1

3. CITY WATER METER TESTING EQUIPMENT

	Equipment Name	Quantity
(1)	Reference Tank	1
(2)	Pressure Gauge	1
(3)	Pressure Proof Testing Equipment	1
(4)	Pressure Loss Testing Equipment	1
(5)	Mechanical Shock Testing Equipment	1
(6)	Air Conditioned Testing Equipment	1
(7)	Supply Voltage Fluctuation Testing Equipment	1
(8)	Supply Voltage Drop Testing Equipment	1
(9)	Anti Impulsive Noise Testing Equipment	1
(10)	External Magnetic Field Testing Equipment	1

4. CITY GAS METER TESTING EQUIPMENT

	Equipment Name	Quality
(1)	Water column pressure gauge testing equipment	1
(2)	Wet standard	1
(3)	Inspection equipment	1
(4)	Air blower	1
(5)	Leak testing equipment	1

5. GLASS-MADE CHEMICAL THERMOMETER

	Equipment Name	Quality
(1)	Glass-made Reference Thermometer	1
(2)	Reference Beckman Thermometer	1
(3)	Thermometer Inspection Oven	1
(4)	Alkali Elusion Testing Equipment	1
(5)	Testing Oven for Heat Processing	1
(6)	Length Meter	1

6. GLASS-MADE CLINICAL THERMOMETER

	Equipment Name	Quantity
(1)	Glass-made Reference Thermometer	1
(2)	Thermometer Inspection Oven	1
(3)	Alkali Elusion Testing Equipment	1
(4)	Testing Oven for Heat Processing	1
(5)	Length Meter	1
(6)	Centrifugal Separator	1

7. RESISTANCE CLINICAL THERMOMETER

	Equipment Name	Quantity
(1)	Glass-made Reference Thermometer	1
(2)	Thermometer Inspection Oven	1
(3)	Air Conditioned Oven	1
(4)	Simplified Bath	1
(5)	Constant-current and Constant-voltage Equipment	1
(6)	Voltmeter	1
(7)	Ammeter	1
(8)	Electric Resistance Measuring Equipment	1
(9)	Time Meter	1
(10)	Non-automatic Scale	1

8. ANELOID HEMADYNAMOMETER

	Equipment Name	Quantity
(1)	Reference Water-column Pressure Gauge	1
(2)	Voltage Withstanding Device	1
(3)	Voltage Regulator	1

9. AIR POLLUTION METER

	Equipment Name	Quantity
(1)	Reference Gas Meter	2
(2)	Reference Glass-Made Thermometer	5
(3)	Voltage Regulator	1
(4)	AC Voltmeter	1
(5)	Insulating Resistance Meter	1
(6)	Voltage Withstanding Device	1
(7)	Moisturizer	1
(8)	Time Meter	3
(9)	Gas Regulator for Inspection	4

10. PH METER

	Equipment Name	Quantity
(1)	Reference Direct Reading Balance	1
(2)	Reference Glass-made Thermometer	5
(3)	Reference Full-volume Flask	10
(4)	Reference Voltage Generator	1
(5)	DC Voltage Generator	1
(6)	DC Voltmeter	1
(7)	Constant Temperature Bath	1
(8)	Constant Temperature Device	1
(9)	Voltage Regulator	1
(10)	Insulating Resistor Meter	1
(11)	Voltage Withstanding Device	1
(12)	Variable Resistor	1

11. CUMULATIVE WATT-HOUR METER

	Equipment Name	Quantity
(1)	DC Motor AC Generator	2
(2)	Three-phase Meter Testing Equipment	2
(3)	Standard Watt-hour Meter	6
(4)	AC Meter Testing Equipment	1
(5)	Voltage Withstanding Device	1
(6)	Over Current Testing Equipment	1
(7)	Impulse Voltage Testing Equipment	1
(8)	Impulse Generator	1
(9)	Constant Temperature Device	1
(10)	Recording Device	1
(11)	Magnetic Field Generator	1
(12)	Vibration Tester	1
(13)	Impulse Tester	1
(14)	Oscilloscope	3
(15)	Environment Testers (constant temperature, high temperature, pouring, neutral salt spray devices, etc.)	1

12. NOISE METER

	Equipment Name	Quantity
(1)	Standard Condenser Microphone	3
(2)	Anechoic Chamber	1
(3)	Frequency Characteristic Testing Equipment	1
(4)	Coupler	1
(5)	Tone Burst Generator	1
(6)	Air Conditioned Oven	1
(7)	Vibration Testing Equipment	1
(8)	Turn Table	1
(9)	Intermittent Sine Wave Generator	1
(10)	Effective Value Testing Equipment	1

13. VIBRATION METER

	Equipment Name	Quantity
(1)	Reference Surbo-type Pickup	3
(2)	Agitating Equipment	1
(3)	Frequency Characteristic Testing Equipment	1
(4)	Tone Burst Generator	1
(5)	Air Conditioned Oven	1
(6)	Intermittent Sine Wave Generator	1
(7)	Cross Sensitivity Testing Equipment	1
(8)	Effective Value Testing Equipment	1

Specific Standard Substance Manufacturing Equipment and Testing Equipment

1. SPECIFIC STANDARD GAS MANUFACTURING EQUIPMENT AND TESTING EQUIPMENT

	Equipment Name	Quantity
(1)	Precision Balance (capacity: 30 kg, sensitivity: 1 mg)	1
(2)	Standard Gas Adjusting Equipment (charging stand) (CO, SO2, NO2, OS)	1
(3)	Gas Chromatograph (for measurement of impurities)	1
(4)	Nondispersive Infrared Densitometer (for CO)	1
(5)	Nondispersive Infrared Densitometer (for SO2)	1
(6)	Chemiluminescence Nitrogen Oxide Measuring Equipment	1
(7)	Oxygen Densitometer	1

2. SPECIFIC STANDARD LIQUID MANUFACTURING EQUIPMENT AND TESTING EQUIPMENT

	Equipment Name	Quantity
(1)	Precision Balance (capacity: 3 kg, sensitivity: 1 mg)	1
(2)	Electronic Balance (capacity: 205 kg, sensitivity: 0.01 mg)	1
(3)	Pure Water Manufacturing Equipment	1
(4)	High-precision pH Meter (to read 1/10000 pH)	1

Table 6-2 Outline of the Training in the Institute

Course	Object	Requirements for admission	Duration	Number of times	Capacity
General Measurement Course (1)	1. Training for the official of the government and public inspection office. 2.Training for personels of the obtaining qualification of certified public measurers (from private company) etc.	High school graduate and success in an entrance examination of the Institute	5 months	2 times/year	ca 50/(1 time)
General Measurement Course (2)	Training for the official of periodical inspection of measuring instrument and net quantity inspection of goods.	High school graduate	2 months	1 time/year	ca 20
Environmental Measurement Course(1)	1. Training for the official of the government and public inspection office. 2.Training for the obtaining qualification of certified public environmental measurers	General Measurement Course(1) graduate	2 months	1 time/year	ca 30
Environmental Measurement Course(2)	Training for the succesful candidate of national examination of certified public environmental measurers.	Succesful candidate of national examination of certified public environmental measurers.	2 weeks (lecture: 1 week) (practice: 1 week)	Lecture 2 times/year Practice ca 6 times/ year	Total ca 150
Special short course	Training for the official of the local goverment measurement office	----------	1 week	ca 4 times/ year	ca 30/(1 time)

Appendix I

Curriculum of the general measurement course (1)

Subject		Time (h)
Lecture	Physics and mathematics	55
	Measurement law	51
	Instrumentation	101
	Metrology (Principle,structure and calibration of measuring instruments)	184
	Special lecture for measurement official of goverment	each 24
	Special lecture for personels of the obtaining qualification of certifyed public measurers	
		(415)
Practice	Basic practical training	12
	General practical training	60
	Applied practical training	42
		(114)
Special lecture for all student, plant visit, test etc.		(71)
Total		(600)

Lecture curriculum of the general measurement course(1)

Lecture subject			Time (h)	Remarks
Physics and mathematics			55	
Measurement Law		Legal common sense	9	
		Measurement Law	24	
		Technical Law and ordinances	12	
		Foreign laws	6	
Instrumentation	Primary subject	Instrumentation(1)	16	Instrumentation control system, traceability, analysis of measurement data etc.
		Instrumentation(2)	16	Statisical test, design of experiment, analysis variance etc.
		Instrumentation(3)	16	Signal-to-noise ratio and calibration, control chart method, sampling inspection etc.
	Application subject	Electronics company	3	Instrumentation control system in electronics, food, department store companies etc.
		Food company	3	
		Dpartment store company	3	
		Safty operation in comp.	3	
	SI Unit		6	
	Electronic instrument and computer		20	
	Automatic control		15	

Metrology	Introduction of metrology		8	
	Length meter		18	
	Taximeter		6	
	Mass meter	Basis of mass measurement	12	
		Balance	12	
		Pan scale and platform scale etc.	12	
		Electronic scale and industrial scale	14	
	Thermometer	Glass Thermometer	14	
		Electric Thermometer	16	
	Volume meter	Volumetric glass ware	12	
		Gas and water meters	16	
		Integrating flow meter	15	
	Pressure meter		15	
	Density and concentration meters		14	

Measurement law related supervision exercise	8	Personnels of central and local goverment measurement offices
Measurement administration affairs in local goverment	8	
Supervision exercise of net quantity of goods	8	
Flow measurement	8	Personnels of intending to be a certified public measurers
Viscosity measurement	8	
Material testing machine	8	
	(415)	

Practice curriculum of general measurement course(1), 1988

Practice training	Training time (h)	Remarks
Basic practice training		
Calibration of industrial length meter	4	
Data analysis of dimension measurement	4	
Mass measurement by precise balance	4	
Instrument practice training		
Taximeter 1. Test of head	4	
2. test of distance traveled	4	
Calibration of weight	8	
Pan scale, platform scale etc.	8	
Electronic scale	8	
Industrial scale	4	

Gas and water meters	8	
Gasoline meter	4	
Glass and electric thermometers	8	
Barometer and dead weight pressure gauge	4	
Applied practice training		
Comparative measurement of standard scale	8	
Precise measurement of liquid density	8	
Stress measurement of elastic material	8	
Experiment of electronic measuring device	8	
Test of net quantity of goods by statiscal method	10	
	(114)	

Curriculum of the general measurement course(2)

Subject			Time (h)	Remarks
Lecture	Physics and mathematics		32	
	Measurement Law	Legal common sense	9	
		Measurement Law	24	
		Technical laws and ordinances	12	
	Instrumentation		8	
	Mass meter	Basis of mass measurement	12	
		Balance	12	
		Pan scale and platform scale etc.	12	
		Electronic and industrial scales	4	
	Taximeter and others	Taximeter	6	
		Gas and water meters	6	
		Gasoline and LPG meters	6	
		Clinical thermometer	2	
		Spygmomanometer	2	
	Measurement administration affairs in Local Goverment		13	
			(161)	
Practice	Mass meter(Calibration of balance,pan scale etc.)		28	
	Taximeter		8	
	Volume meter(Calibration of gas and water Meters etc.——.)		9	
	Clinical thermometers		2	
	Sphygmanometer		2	
	Supervision of net quantity of goods etc.———.		12	
			61	
	Special lecture, technical visit,test etc.		28	
Total			(250)	

Curriculum of the environmental measurement course (1)

Subject		Time (h)
Lecture	General Chemistry	23
	Analytical chemistry	21
	Related environmental laws	18
	Instrumental analysis	39
	Measurement of air pollution	27
	Measurement of water pollution	24
	Measurement of Noise and Vibration	18
	Standard Reference Materials for calibration of Measuring Instrument	6
	Verification and Inspection of Measuring Instrument	6
	Guide-lines for Environmental Measurement	6
	Flow measurement of air and water pollution	3
	Instrumentation	5
		(196)
Practice	Measurement of Air and Water Pollution	33
	Measurement of Noise and Vibration	6
		(39)
Technical visits and observation tours		6
Tests and group discussion etc.		32
Total		(273)

Curriculum of the environmental measurement course (2)

Subject		Time (h)
Lecture	Environmental problem and measurement administration	2
	Present and problem of environmental administration	2
	Reference standard materials for calibrating pollution measurement	2
	Air pollution and environmental chemistry	3
	Method of measuring dust content in flue gas	2
	Present and problem of the measurement of water pollution	2
	Testing method of industrial water	2
	Present and problem of noise pollution	2
	Calibration method of noise pollution meter	2
	Calibration method of vibration pollution meter	2
	Cotrol of continuous pollution meter	2
	Tracerbility of measurement standards	2
	Training of the control and education of measurement	3
		28
Practice	Analytical method in gas chromatography	8
	Absorptiometric analysis	8
	Determination of sulfer oxides in flue gas by neutralization titration	8
	Noise pollution measurement and calibration of the meter	6
	Vibration pollution measurement and calibration of the meter	3
	Video telecast of envionmental measurement	2
		35
Total		(63)

Table 6-3 Estimated Numbers of Mass (1994-2002)

	Branch Name	Actual Number				1994	1995	1996	1997	1998	1999	2000	2001	2002
		1990	1991	1992	1993									
1	Banda Aceh	39,723	41,381	42,911	49,051	54,149	59,777	65,990	72,848	80,420	88,778	98,005	108,191	119,435
2	Langsa	8,670	9,020	9,347	9,836	10,554	11,324	12,150	13,037	13,989	15,010	16,105	17,280	18,541
3	Medan	123,408	118,528	125,562	48,806	50,270	51,778	53,332	54,932	56,580	58,277	80,025	61,826	63,681
4	P.Siantar	26,361	25,675	25,434	25,304	26,063	26,845	27,650	28,480	29,334	30,214	31,121	32,054	33,016
5	Padang	55,125	52,802	49,612	49,827	51,322	52,861	54,447	56,081	57,763	59,496	61,281	63,119	65,013
6	Pekanbaru	41,684	45,157	44,101	43,883	46,004	48,227	50,558	53,001	55,563	58,248	61,063	64,015	67,108
7	Jambi	15,765	16,235	16,323	18,179	19,627	21,190	22,878	24,700	26,667	28,791	31,084	33,560	36,233
8	Palembang	28,804	27,517	26,538	27,033	27,844	28,679	29,540	30,426	31,339	32,279	33,247	34,245	35,272
9	Lampung	56,430	59,465	60,328	59,228	61,993	64,888	67,917	71,088	74,407	77,881	81,517	85,322	89,306
10	Bengkulu	10,916	11,012	11,347	11,830	12,507	13,224	13,981	14,781	15,628	16,523	17,469	18,469	19,526
11	Jakarta	99,038	96,211	105,829	87,873	90,509	93,224	96,021	98,902	101,869	104,925	108,073	111,315	114,654
12	Bandung	182,039	187,635	185,396	202,814	216,521	231,155	246,778	263,457	281,263	300,272	320,567	342,232	365,362
13	Serang	39,224	40,508	41,972	50,023	55,871	62,402	69,696	77,844	86,944	97,107	108,458	121,137	135,298
14	Purwakarta	50,123	50,032	50,908	58,011	62,753	67,882	73,431	79,433	85,926	92,950	100,547	108,766	117,656
15	Bogor	78,494	100,847	107,047	87,651	95,103	103,189	111,962	121,481	131,809	143,016	155,175	168,368	182,683
16	Tasikmalaya	195,660	207,232	220,254	235,583	257,695	281,882	308,339	337,279	368,936	403,564	441,443	482,876	528,199
17	Cirebon	125,189	140,957	143,549	168,465	191,371	217,392	246,951	280,530	318,674	362,004	411,226	467,141	530,659
18	Semarang	246,454	273,925	296,593	301,975	332,410	365,913	402,793	443,390	488,078	537,270	591,421	651,029	716,645
19	Tegal	126,965	142,012	148,101	148,956	161,725	175,588	190,639	206,981	224,724	243,987	264,902	287,610	312,264
20	Pati	838,643	740,452	890,910	934,683	1,004,861	1,080,309	1,161,421	1,248,623	1,342,373	1,443,161	1,551,517	1,668,009	1,793,247
21	Purwokerto	142,646	124,506	130,531	155,570	166,099	177,341	189,344	202,160	215,842	230,451	246,048	262,702	280,482
22	Surakarta	398,974	440,839	436,808	404,702	419,843	435,550	451,844	468,748	486,285	504,478	523,351	542,930	563,242
23	Magelang	129,103	140,861	142,657	149,610	161,707	174,781	188,913	204,188	220,697	238,542	257,829	278,676	301,208
24	Yogyakarta	244,324	238,001	209,228	292,068	325,087	361,839	402,746	448,277	498,956	555,364	618,150	688,033	765,817
25	Surabaya	366,804	330,126	312,681	302,390	311,462	320,806	330,430	340,343	350,553	361,069	371,902	383,059	394,550
26	Jember	271,521	275,361	267,109	258,337	266,087	274,070	282,292	290,761	299,483	308,468	317,722	327,254	337,071
27	Malang	245,267	241,534	245,856	246,972	254,975	263,237	271,767	280,574	289,666	299,052	308,743	318,747	329,076
28	Madiun	131,444	139,722	137,951	131,683	135,847	140,143	144,574	149,146	153,862	158,728	163,747	168,925	174,267
29	Kediri	172,002	172,922	171,243	171,756	176,909	182,216	187,682	193,313	199,112	205,086	211,238	217,575	224,103
30	Bojonegoro	60,315	91,982	92,821	93,116	111,739	134,087	160,904	193,085	231,702	278,043	333,651	400,382	480,458
31	Pontianak	25,155	25,182	26,963	25,229	26,049	26,895	27,769	28,672	29,603	30,565	31,559	32,584	33,643
32	Singkawang	13,501	16,080	17,168	17,876	20,199	22,825	25,791	29,144	32,932	37,212	42,049	47,514	53,689
33	Palangkaraya	23,342	22,621	22,732	25,300	28,793	28,373	30,047	31,820	33,697	35,685	37,790	40,020	42,381
34	Banjarmasin	62,088	66,435	63,690	69,760	74,744	80,085	85,807	91,937	98,506	105,544	113,085	121,165	129,822
35	Samarinda	29,410	31,682	37,771	39,044	44,161	49,948	56,494	63,897	72,271	81,742	92,454	104,570	118,273
36	Manado	22,662	23,324	23,871	23,202	24,089	25,009	25,965	26,957	27,987	29,057	30,167	31,320	32,516
37	Palu	14,584	15,981	17,956	17,871	19,688	21,685	23,887	26,312	28,984	31,928	35,170	38,741	42,675
38	U.Pandang	48,599	46,119	46,319	52,473	55,554	58,817	62,271	65,927	69,799	73,897	78,237	82,831	87,695
39	Kendari	10,415	12,333	12,657	50,838	61,006	73,207	87,848	105,418	126,501	151,801	182,162	218,594	262,313
40	Dempasar	108,923	113,514	112,729	115,172	120,812	126,728	132,933	139,443	146,271	153,434	160,947	168,829	177,096
41	Mataram	46,753	49,600	56,700	58,756	65,225	72,406	80,378	89,228	99,052	109,958	122,064	135,503	150,422
42	Kupang	16,827	18,464	18,407	19,606	21,235	23,000	24,912	26,982	29,225	31,654	34,285	37,134	40,221
43	Ambon	7,124	8,457	8,004	7,770	8,273	8,809	9,380	9,987	10,634	11,323	12,056	12,837	13,669
44	Ternate	4,855	5,010	5,102	6,154	6,865	7,658	8,542	9,529	10,629	11,857	13,226	14,754	16,457
45	Jaya Pura	9,315	9,865	10,102	10,784	11,649	12,583	13,592	14,682	15,859	17,131	18,505	19,989	21,592
46	Sorong	7,663	9,094	8,731	11,633	13,840	16,466	19,590	23,307	27,730	32,991	39,250	46,697	55,558
47	Dili	3,409	4,652	5,267	6,778	8,134	9,760	11,712	14,055	16,866	20,239	24,287	29,144	34,973
	Total	5,007,720	5,060,670	5,243,116	5,383,461	5,767,220	6,186,053	6,643,891	7,145,185	7,694,989	8,299,051	8,963,919	9,697,073	10,507,089

Table 6-4 Estimated Numbers of Volume (1994-2003)

	Branch Name	Actual Number				1994	1995	1996	1997	1998	1999	2000	2001	2002
		1990	1991	1992	1993									
1	Banda Aceh	2,329	2,851	3,221	3,504	4,125	4,855	5,716	6,729	7,921	9,325	10,978	12,923	15,214
2	Langsa	631	505	668	727	799	880	968	1,065	1,172	1,289	1,418	1,561	1,717
3	Medan	8,809	7,631	6,372	6,931	7,139	7,353	7,574	7,801	8,035	8,276	8,524	8,780	9,044
4	P.Siantar	36,973	29,291	33,503	36,443	37,825	39,259	40,748	42,294	43,897	45,562	47,290	49,084	50,945
5	Padang	8,489	8,596	6,116	6,653	6,852	7,058	7,270	7,488	7,712	7,944	8,182	8,427	8,680
6	Pekanbaru	974	1,369	1,338	1,455	1,727	2,050	2,433	2,888	3,428	4,068	4,829	5,731	6,802
7	Jambi	3,269	1,473	1,404	1,627	1,573	1,620	1,669	1,719	1,770	1,824	1,878	1,935	1,993
8	Palembang	12,147	3,104	1,208	1,314	1,353	1,394	1,436	1,479	1,523	1,569	1,616	1,665	1,714
9	Lampung	22,064	23,583	26,968	29,334	33,149	37,460	42,331	47,836	54,057	61,087	69,030	78,007	88,152
10	Bengkulu	2,992	3,101	3,329	3,621	3,968	4,349	4,766	5,223	5,724	6,273	6,874	7,534	8,256
11	Jakarta	198,032	188,330	184,710	200,918	208,903	217,206	225,839	234,815	244,148	253,852	263,941	274,431	285,339
12	Bandung	36,225	32,197	28,137	30,606	31,524	32,470	33,444	34,447	35,481	36,545	37,641	38,771	39,934
13	Serang	24,856	49,809	51,217	55,711	66,853	80,224	96,269	115,523	138,627	166,353	199,623	239,548	287,457
14	Purwakarta	28,319	40,371	45,901	49,929	59,914	71,897	86,277	103,532	124,239	149,086	178,903	214,684	257,621
15	Bogor	15,647	4,054	4,851	5,277	5,435	5,598	5,766	5,939	6,117	6,301	6,490	6,684	6,885
16	Tasikmalaya	229,550	168,269	210,725	229,215	241,677	254,816	268,669	283,275	298,675	314,913	332,033	350,084	369,117
17	Cirebon	3,390	2,576	2,218	2,413	2,485	2,560	2,636	2,715	2,797	2,881	2,967	3,056	3,148
18	Semarang	18,179	80,423	138,943	151,135	181,362	217,634	261,161	313,393	376,072	451,286	541,543	649,852	779,822
19	Tegal	3,510	3,380	3,330	3,622	3,774	3,933	4,098	4,270	4,449	4,636	4,830	5,033	5,244
20	Pati	4,288	4,282	3,851	4,189	4,315	4,444	4,577	4,715	4,856	5,002	5,152	5,306	5,466
21	Purwokerto	26,589	15,765	2,202	2,395	2,467	2,541	2,617	2,696	2,777	2,860	2,946	3,034	3,125
22	Surakarta	354,575	234,381	284,193	309,130	318,404	327,956	337,795	347,929	358,368	369,117	380,191	391,597	403,345
23	Magelang	3,171	4,044	3,217	3,499	3,789	4,103	4,443	4,811	5,210	5,641	6,109	6,615	7,163
24	Yogyakarta	2,392	2,101	1,463	1,591	1,639	1,688	1,739	1,791	1,845	1,900	1,957	2,016	2,076
25	Surabaya	30,758	25,545	20,983	22,824	23,509	24,214	24,941	25,689	26,459	27,253	28,071	28,913	29,780
26	Jember	40,169	35,230	34,403	37,422	38,544	39,701	40,892	42,119	43,382	44,684	46,024	47,405	48,827
27	Malang	20,564	19,590	16,548	18,000	18,540	19,096	19,669	20,259	20,867	21,493	22,138	22,802	23,486
28	Madiun	4,128	4,290	3,410	3,709	3,820	3,935	4,053	4,175	4,300	4,429	4,562	4,699	4,840
29	Kediri	6,298	6,237	5,926	6,446	6,700	6,964	7,238	7,523	7,820	8,128	8,448	8,781	9,127
30	Bojonegoro	3,990	5,124	4,686	5,097	5,737	6,457	7,267	8,179	9,205	10,361	11,661	13,124	14,771
31	Pontianak	984	1,236	1,366	1,486	1,753	2,068	2,439	2,878	3,395	4,005	4,724	5,573	6,574
32	Singkawang	236	691	859	934	1,121	1,345	1,615	1,938	2,325	2,790	3,348	4,018	4,821
33	Palangkaraya	859	857	840	914	961	1,011	1,063	1,119	1,177	1,238	1,302	1,369	1,440
34	Banjarmasin	6,321	6,093	6,015	6,543	6,824	7,117	7,423	7,742	8,074	8,421	8,783	9,160	9,554
35	Samarinda	1,145	1,132	1,835	1,996	2,395	2,874	3,449	4,139	4,967	5,960	7,152	8,583	10,299
36	Manado	7,345	11,698	8,397	9,134	10,620	12,349	14,358	16,695	19,411	22,570	26,243	30,514	35,480
37	Palu	4,010	3,766	3,620	3,938	4,056	4,177	4,303	4,432	4,565	4,702	4,843	4,988	5,138
38	U.Pandang	26,028	26,687	26,621	28,957	30,893	32,959	35,162	37,514	40,022	42,698	45,553	48,599	51,848
39	Kendari	9,806	10,561	11,577	12,593	14,066	15,711	17,549	19,602	21,895	24,457	27,318	30,513	34,083
40	Dempasar	1,649	1,831	1,477	1,607	1,657	1,710	1,764	1,819	1,877	1,936	1,997	2,061	2,126
41	Mataram	568	577	751	817	952	1,109	1,292	1,505	1,753	2,043	2,380	2,773	3,231
42	Kupang	828	922	828	901	957	1,018	1,082	1,150	1,223	1,300	1,382	1,470	1,562
43	Ambon	200	214	221	240	263	287	314	344	376	411	449	491	537
44	Ternate	1,982	1,920	2,376	2,584	2,915	3,288	3,709	4,184	4,720	5,324	6,005	6,773	7,640
45	Jaya Pura	2,482	2,997	2,950	3,209	3,604	4,048	4,547	5,107	5,736	6,443	7,236	8,128	9,129
46	Sorong	1,236	1,825	1,593	1,733	2,037	2,395	2,816	3,311	3,893	4,577	5,381	6,327	7,438
47	Dili	784	1,139	1,300	1,414	1,697	2,036	2,444	2,932	3,519	4,222	5,067	6,080	7,296
	Total	1,217,770	1,081,648	1,207,687	1,313,636	1,414,676	1,529,219	1,659,630	1,808,725	1,979,859	2,177,032	2,405,015	2,669,501	2,977,288

Table 6-5 Estimated Numbers of Watthour Meter (1994-2003)

	Branch Name	Actual Number				1994	1995	1996	1997	1998	1999	2000	2001	2002
		1990	1991	1992	1993									
1	Banda Aceh	0	0	0	6,631	9,821	10,865	11,384	12,915	12,660	13,444	14,228	14,912	15,627
2	Langsa	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Medan	0	0	30,691	29,044	43,017	47,588	49,862	56,567	55,453	58,887	62,321	65,314	68,447
4	P.Siantar	0	0	11,781	34,969	51,792	57,296	60,033	68,107	66,766	70,900	75,035	78,638	82,410
5	Padang	0	0	0	4,119	6,101	6,749	7,071	8,022	7,864	8,351	8,838	9,263	9,707
6	Pekanbaru	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Jambi	0	0	0	4,119	6,101	6,749	7,071	8,022	7,864	8,351	8,838	9,263	9,707
8	Palembang	0	0	0	9,551	14,146	15,649	16,397	18,602	18,236	19,365	20,494	21,478	22,508
9	Lampung	0	0	0	12,756	18,893	20,900	21,899	24,844	24,355	25,863	27,371	28,686	30,061
10	Bengkulu	0	0	0	4,265	6,317	6,988	7,322	8,307	8,143	8,647	9,152	9,591	10,051
11	Jakarta	0	657	37,737	99,315	147,095	162,725	170,500	193,429	189,621	201,363	213,105	223,340	234,051
12	Bandung	12,621	96,508	123,143	120,656	178,703	197,691	207,137	234,993	230,367	244,632	258,898	271,332	284,344
13	Serang	0	0	0	53,354	79,022	87,419	91,596	103,914	101,868	108,176	114,484	119,983	125,737
14	Purwakarta	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Bogor	0	11,516	88,699	6,290	9,316	10,306	10,798	12,251	12,009	12,753	13,497	14,145	14,823
16	Tasikmalaya	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Cirebon	0	17,434	76,351	96,039	142,243	157,357	164,876	187,049	183,366	194,721	206,078	215,973	226,330
18	Semarang	0	2,946	29,278	37,214	55,117	60,974	63,887	72,479	71,052	75,452	79,852	83,687	87,709
19	Tegal	0	0	16,357	36,190	53,801	59,296	62,130	70,485	69,097	73,376	77,655	81,384	85,287
20	Pati	0	0	11,639	46,393	68,712	76,014	79,646	90,356	88,577	94,063	99,548	104,329	109,332
21	Purwokerto	0	0	16,996	36,827	54,544	60,340	63,223	71,725	70,313	74,667	79,022	82,817	86,788
22	Surakarta	0	0	21,615	80,878	119,788	132,516	138,848	157,521	154,419	163,982	173,544	181,879	190,601
23	Magelang	0	0	6,108	32,900	48,728	53,906	56,481	64,077	62,816	66,705	70,595	73,986	77,534
24	Yogyakarta	0	0	19,189	22,200	32,880	36,374	38,112	43,237	42,386	45,011	47,636	49,923	52,318
25	Surabaya	0	4,813	26,476	110,162	163,160	180,497	189,122	214,555	210,331	223,355	236,380	247,733	259,613
26	Jember	0	0	12,340	47,277	70,022	77,462	81,163	92,078	90,265	95,855	101,445	106,317	111,415
27	Malang	0	0	11,024	55,218	81,783	90,473	94,798	107,544	105,427	111,955	118,484	124,174	130,129
28	Madiun	0	0	1,984	50,880	75,358	83,365	87,349	99,095	97,144	103,160	109,176	114,419	119,906
29	Kediri	0	0	33,680	62,654	92,796	102,657	107,562	122,027	119,624	127,032	134,440	140,897	147,654
30	Bojonegoro	0	0	0	23,326	34,548	38,219	40,045	45,430	44,536	47,294	50,052	52,456	54,971
31	Pontianak	0	0	0	13,759	20,378	22,544	23,621	26,797	26,270	27,897	29,523	30,941	32,425
32	Singkawang	0	0	0	7,246	10,732	11,872	12,440	14,113	13,835	14,691	15,548	16,295	17,076
33	Palangkaraya	0	0	0	5,093	7,543	8,345	8,743	9,919	9,724	10,326	10,928	11,453	12,002
34	Banjarmasin	0	0	0	6,420	9,509	10,519	11,022	12,504	12,258	13,017	13,776	14,437	15,130
35	Samarinda	0	0	0	3,998	5,921	6,551	6,864	7,787	7,633	8,106	8,579	8,991	9,422
36	Manado	0	0	0	10,602	15,703	17,371	18,201	20,649	20,242	21,496	22,749	23,842	24,985
37	Palu	0	0	0	6,785	10,049	11,117	11,648	13,215	12,955	13,757	14,559	15,258	15,990
38	U.Pandang	0	3,281	31,766	26,822	39,726	43,947	46,047	52,239	51,211	54,382	57,553	60,317	63,210
39	Kendari	0	0	4,116	11,274	16,698	18,472	19,355	21,958	21,525	22,858	24,191	25,353	26,569
40	Dempasar	0	0	0	19,090	28,274	31,278	32,773	37,180	36,448	38,705	40,962	42,930	44,988
41	Mataram	0	0	0	4,979	7,374	8,158	8,548	9,697	9,506	10,095	10,684	11,197	11,734
42	Kupang	0	0	0	5,146	7,622	8,432	8,834	10,023	9,825	10,434	11,042	11,572	12,127
43	Ambon	0	0	0	4,224	6,256	6,921	7,252	8,227	8,065	8,564	9,064	9,499	9,954
44	Ternate	0	0	0	1,253	1,856	2,053	2,151	2,440	2,392	2,540	2,689	2,818	2,953
45	Jaya Pura	0	0	0	0	0	0	0	0	0	0	0	0	0
46	Sorong	0	0	0	0	0	0	0	0	0	0	0	0	0
47	Dili	0	0	0	1,859	2,753	3,046	3,191	3,621	3,549	3,769	3,989	4,181	4,381
	Total	12,621	137,155	610,970	1,251,777	1,854,000	2,051,000	2,149,000	2,438,000	2,390,000	2,538,000	2,686,000	2,815,000	2,950,000

Table 6-6 Estimated Numbers of Water Meter (1994-2002)

	Branch Name	Actual Number				1994	1995	1996	1997	1998	1999	2000	2001	2002
		1990	1991	1992	1993									
1	Banda Aceh	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Langsa	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Medan	1,538	4,252	5,109	5,671	6,358	7,128	7,992	8,960	10,046	11,263	12,628	14,158	15,873
4	P.Siantar	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Padang	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Pekanbaru	0	0	42	0	0	0	0	0	0	0	0	0	0
7	Jambi	457	458	2,847	2,210	2,478	2,778	3,115	3,492	3,915	4,389	4,921	5,517	6,186
8	Palembang	0	0	0	138	155	173	194	218	244	274	307	345	386
9	Lampung	0	0	40	0	0	0	0	0	0	0	0	0	0
10	Bengkulu	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Jakarta	17,167	8,311	7,745	14,067	15,771	17,682	19,825	22,227	24,920	27,939	31,324	35,119	39,374
12	Bandung	75,880	103,350	117,276	127,092	142,491	159,755	179,111	200,812	225,143	252,421	283,005	317,294	355,737
13	Serang	624	20,300	28,906	2,137	2,396	2,686	3,012	3,377	3,786	4,244	4,759	5,335	5,982
14	Purwakarta	0	0	0	339	380	426	478	536	601	673	755	846	949
15	Bogor	0	0	0	10	11	13	14	16	18	20	22	25	28
16	Tasikmalaya	0	0	0	114	128	143	161	180	202	226	254	285	319
17	Cirebon	0	0	391	806	904	1,013	1,136	1,274	1,428	1,601	1,795	2,012	2,256
18	Semarang	3,803	5,344	14,970	15,791	17,704	19,849	22,254	24,951	27,974	31,363	35,163	39,423	44,200
19	Tegal	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Pati	0	76	0	583	654	733	822	921	1,033	1,158	1,298	1,455	1,632
21	Purwokerto	8	0	1,018	967	1,084	1,216	1,363	1,528	1,713	1,921	2,153	2,414	2,707
22	Surakarta	848	50	409	0	0	0	0	0	0	0	0	0	0
23	Magelang	0	0	742	941	1,055	1,183	1,326	1,487	1,667	1,869	2,095	2,349	2,634
24	Yogyakarta	1,013	5,530	3,193	5,906	6,622	7,424	8,323	9,332	10,462	11,730	13,151	14,745	16,531
25	Surabaya	109,245	107,894	53,823	104,251	116,882	131,044	146,921	164,722	184,680	207,056	232,143	260,270	291,804
26	Jember	587	724	498	537	602	675	757	848	951	1,067	1,196	1,341	1,503
27	Malang	2,916	584	571	4,771	5,349	5,997	6,724	7,538	8,452	9,476	10,624	11,911	13,354
28	Madiun	303	101	639	408	457	513	575	645	723	810	909	1,019	1,142
29	Kediri	0	483	628	1,092	1,224	1,373	1,539	1,725	1,934	2,169	2,432	2,726	3,057
30	Bojonegoro	0	62	0	300	336	377	423	474	531	596	668	749	840
31	Pontianak	1,525	750	1,472	4,276	4,794	5,375	6,026	6,756	7,575	8,493	9,522	10,675	11,969
32	Singkawang	451	440	300	470	527	591	662	743	833	933	1,047	1,173	1,316
33	Palangkaraya	108	51	120	20	22	25	28	32	35	40	45	50	56
34	Banjarmasin	1,878	3,814	6,038	4,464	5,005	5,611	6,291	7,053	7,908	8,866	9,940	11,145	12,495
35	Samarinda	61	214	731	147	165	185	207	232	260	292	327	367	411
36	Manado	0	0	1,150	1,474	1,653	1,853	2,077	2,329	2,611	2,928	3,282	3,680	4,126
37	Palu	629	300	384	318	357	400	448	502	563	632	708	794	890
38	U.Pandang	587	2,197	120	38	43	48	54	60	67	75	85	95	106
39	Kendari	0	237	0	392	439	493	552	619	694	779	873	979	1,097
40	Dempasar	919	141	802	3,526	3,953	4,432	4,969	5,571	6,246	7,003	7,852	8,803	9,869
41	Mataram	0	591	2,703	1,525	1,710	1,917	2,149	2,410	2,702	3,029	3,396	3,807	4,269
42	Kupang	0	0	0	0	0	0	0	0	0	0	0	0	0
43	Ambon	0	1	0	367	411	461	517	580	650	729	817	916	1,027
44	Ternate	215	7	15	188	211	236	265	297	333	373	419	469	526
45	Jaya Pura	0	0	0	0	0	0	0	0	0	0	0	0	0
46	Sorong	0	0	0	0	0	0	0	0	0	0	0	0	0
47	Dili	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	220,762	266,262	252,682	305,336	342,331	383,808	430,310	482,447	540,901	606,437	679,913	762,292	854,652

Table 6-7 Estimated Numbers of Technician and Administrator (1994-2002)

No.	Branch Name	1993			1994			1995			1996			1997			1998			1999			2000			2001			2002		
		Tech.	Admi.	Total	Tech.	Admi.	Total	Tech.	Admi.	Total	Tech.	Admi.	Total	Tech.	Admi.	Total	Tech.	Admi.	Total	Tech.	Admi.	Total	Tech.	Admi.	Total	Tech.	Admi.	Total	Tech.	Admi.	Total
1	Banda Aceh	14	6	20	16	7	23	17	7	25	19	8	27	20	9	29	22	9	31	24	10	34	26	11	37	28	12	40	30	13	43
2	Langsa	9	0	9	9	0	9	10	1	11	11	1	12	11	1	12	12	1	13	12	1	14	13	1	14	14	1	15	15	1	16
3	Medan	31	17	48	36	20	56	38	21	59	39	21	60	41	22	63	41	22	63	42	23	65	43	24	67	45	24	69	46	25	71
4	P. Sientar	21	7	28	25	8	33	26	9	34	26	9	35	28	9	37	28	9	37	28	9	38	29	10	39	30	10	40	30	10	41
5	Padang	20	7	27	21	7	28	21	7	29	21	7	29	22	8	30	22	8	30	22	8	30	23	8	30	23	8	31	23	8	31
6	Pekanbaru	27	10	37	28	10	38	29	11	39	30	11	41	31	11	42	32	12	44	33	12	45	34	13	47	35	13	48	37	14	51
7	Jambi	15	5	20	17	6	22	18	6	24	19	6	25	20	7	27	21	7	28	22	7	30	24	8	31	25	8	33	26	9	35
8	Palembang	20	7	27	22	8	30	23	8	31	24	8	32	25	8	33	24	9	33	25	9	34	26	9	34	26	9	35	28	9	38
9	Lampung	28	5	33	31	6	36	33	6	39	35	6	41	37	7	43	38	7	45	41	7	48	43	8	51	46	8	54	48	9	57
10	Bengkulu	17	4	21	19	5	24	20	5	25	21	5	26	23	5	28	23	5	29	24	6	30	25	6	31	28	6	33	28	6	34
11	Jakarta	42	23	65	47	26	73	50	27	77	51	28	79	54	30	84	55	30	85	57	31	88	59	32	91	61	33	94	62	35	98
12	Bandung	29	14	43	34	16	50	36	17	54	38	18	56	41	20	61	42	20	63	45	22	67	48	23	71	50	24	75	52	26	78
13	Serang	20	4	24	25	5	30	28	6	33	31	6	37	35	7	42	38	8	45	42	8	50	47	9	56	52	10	63	59	12	70
14	Purwakarta	20	3	23	22	3	26	25	4	29	28	4	32	32	5	36	36	5	41	40	8	48	46	7	53	52	8	60	59	9	68
15	Bogor	24	5	29	26	5	31	27	6	33	29	6	35	30	6	37	32	7	39	34	7	41	36	7	43	37	8	45	40	8	48
16	Tasikmalaya	25	7	32	28	7	34	28	8	36	29	8	38	31	9	40	33	9	42	35	10	44	37	10	47	39	11	49	41	11	52
17	Cirebon	20	7	27	25	9	33	27	10	37	29	10	40	33	11	44	35	12	47	38	13	51	41	14	55	45	16	60	49	17	66
18	Semarang	34	18	52	39	21	59	43	23	66	48	25	73	54	28	82	59	31	91	66	35	102	74	39	114	83	44	128	94	50	143
19	Tegal	18	7	25	21	8	29	22	9	30	23	9	32	25	10	35	26	10	36	27	11	38	29	11	40	31	12	43	32	13	45
20	Pati	21	5	26	23	5	28	24	6	30	25	6	31	27	6	33	28	7	35	29	7	36	31	7	38	33	8	40	34	8	43
21	Purwokerto	22	5	27	25	6	30	26	6	32	27	6	33	29	7	36	30	7	36	31	7	38	33	7	40	34	8	42	35	8	43
22	Surakarta	32	9	41	34	10	43	35	10	45	35	10	45	36	10	47	37	10	47	37	10	48	38	11	49	39	11	49	39	11	50
23	Magelang	18	6	22	18	7	25	19	7	27	20	8	28	22	8	30	23	9	31	24	9	33	25	9	35	27	10	37	28	11	39
24	Yogyakarta	32	9	41	36	10	46	39	11	50	42	12	54	46	13	60	50	14	64	55	15	70	60	17	76	65	18	83	71	20	90
25	Surabaya	41	8	49	46	9	55	48	9	57	50	10	59	53	10	63	54	10	64	58	11	67	58	11	69	60	12	72	63	12	75
26	Jember	18	12	28	17	13	30	18	13	31	18	13	31	18	14	32	18	14	32	19	14	33	19	14	33	19	14	34	20	15	34
27	Malang	27	12	39	29	13	42	30	13	44	31	14	45	32	14	46	32	14	46	33	15	47	33	15	48	34	15	49	35	15	50
28	Madiun	17	5	22	19	6	25	20	6	26	20	6	26	21	6	28	21	6	27	22	6	28	22	7	29	23	7	29	23	7	30
29	Kediri	15	5	20	17	6	23	18	6	23	18	6	24	19	6	25	19	6	25	19	6	25	19	6	26	20	7	26	20	7	27
30	Bojonegoro	15	4	19	18	5	23	21	6	27	24	7	31	28	8	36	32	9	41	37	10	47	43	12	55	50	13	63	58	15	74
31	Pontianak	18	8	26	22	10	33	23	11	34	24	11	35	26	12	38	26	12	38	27	13	40	28	13	41	29	14	43	30	14	44
32	Singkawang	7	4	11	8	5	13	9	5	15	10	6	16	11	8	19	12	7	19	13	8	21	15	8	23	18	9	25	17	10	27
33	Palangkaraya	14	4	18	15	4	20	16	5	21	17	5	22	18	5	23	18	5	23	19	5	24	20	6	25	20	6	26	21	6	27
34	Banjermasin	17	6	23	18	6	25	19	7	26	20	7	28	22	8	29	22	8	30	24	8	32	25	9	34	26	9	35	27	10	37
35	Samarinda	23	6	29	26	7	33	29	8	37	32	8	41	36	9	45	40	10	50	44	11	55	49	13	61	54	14	68	60	16	76
36	Manado	16	5	21	18	6	24	20	6	26	21	6	27	22	7	29	23	7	30	24	8	32	26	8	34	28	9	36	29	9	38
37	Palu	19	9	28	22	10	32	24	11	35	25	12	37	27	13	40	28	13	41	30	14	44	32	15	47	34	16	50	36	17	53
38	U. Pandang	25	15	40	29	17	46	30	18	48	31	19	50	33	20	53	34	20	54	35	21	56	37	22	59	38	23	61	39	24	63
39	Kendari	16	12	28	19	14	34	22	17	39	25	19	44	29	22	51	33	25	58	38	29	67	44	33	77	51	38	89	59	44	103
40	Denpasar	22	9	31	24	10	34	25	10	35	26	11	36	27	11	38	27	11	38	28	12	40	29	12	41	30	12	43	31	13	44
41	Mataram	20	7	27	22	8	30	24	9	33	26	9	36	29	10	39	31	11	42	34	12	46	37	13	50	40	14	54	44	15	59
42	Kupang	13	6	19	15	7	22	16	7	23	17	8	24	18	8	26	19	8	27	20	8	28	21	10	30	22	10	32	23	11	34
43	Ambon	10	7	17	12	8	20	13	9	21	13	9	22	14	10	24	14	10	24	15	10	25	16	11	26	16	11	27	17	12	29
44	Ternate	8	0	8	9	0	9	10	1	11	11	1	12	12	1	13	13	1	14	14	1	16	15	2	17	17	2	18	18	2	20
45	Jaya Pura	12	6	18	13	6	19	14	7	21	15	7	22	16	8	24	17	8	25	18	9	27	19	10	29	21	10	31	22	11	34
46	Sorong	9	1	10	10	1	12	12	1	14	14	2	16	17	2	19	19	2	22	23	3	25	26	3	29	31	3	34	38	4	42
47	Biti	11	1	12	14	1	15	16	1	17	18	2	20	21	2	23	24	2	26	26	3	30	32	3	35	37	3	41	44	4	47
	Total	949	343	1.292	1.069	387	1.456	1.142	415	1.556	1.207	438	1.645	1.301	471	1.772	1.362	491	1.852	1.453	522	1.975	1.552	557	2.109	1.660	593	2.253	1.779	634	2.414

Table 6-8 Estimated Number of Total Verification (1994-2002)

	Branch Name	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	Banda Aceh	69,230	76,781	84,541	94,145	102,873	113,683	125,653	138,825	153,494
2	Langsa	11,571	12,446	13,389	14,406	15,502	16,686	17,963	19,342	20,832
3	Medan	108,799	116,068	121,192	130,975	133,080	140,005	147,188	154,214	161,701
4	P.Siantar	116,948	124,764	129,873	140,453	141,628	148,422	155,317	161,783	168,530
5	Padang	65,438	67,879	70,047	72,904	74,702	77,211	79,782	82,355	85,014
6	Pekanbaru	48,644	51,225	53,976	56,913	60,055	63,425	67,046	70,949	75,166
7	Jambi	30,330	32,918	35,341	38,576	40,887	44,060	47,464	51,056	54,941
8	Palembang	44,476	46,912	48,616	51,820	52,461	54,644	56,862	58,968	61,158
9	Lampung	115,444	124,754	133,749	145,491	154,642	166,782	180,010	194,259	209,928
10	Bengkulu	23,223	25,028	26,573	28,862	30,087	32,088	34,198	36,362	38,675
11	Jakarta	504,515	538,362	565,621	609,645	628,332	664,522	702,732	741,672	783,603
12	Bandung	576,895	629,343	675,314	743,331	782,415	844,792	911,850	982,235	1,058,928
13	Serang	207,228	236,169	264,367	304,926	335,896	381,092	433,152	492,526	561,797
14	Purwakarta	124,743	142,097	162,302	185,877	213,443	245,736	283,639	328,203	380,686
15	Bogor	131,058	141,098	151,368	163,400	174,583	187,691	201,810	216,928	233,265
16	Tasikmalaya	504,829	542,604	583,406	627,489	675,133	726,641	782,342	842,596	907,794
17	Cirebon	341,223	383,100	420,935	477,670	512,999	568,816	630,676	697,935	773,468
18	Semarang	598,890	678,652	766,684	873,571	985,707	1,121,714	1,278,829	1,460,176	1,670,881
19	Tegal	221,641	241,547	259,773	284,878	361,575	325,531	351,161	378,054	407,096
20	Pati	1,088,576	1,172,284	1,258,020	1,357,057	1,450,116	1,557,623	1,672,785	1,795,467	1,927,222
21	Purwokerto	226,678	244,086	259,341	281,106	293,767	313,204	333,667	354,663	377,009
22	Surakarta	867,426	906,001	939,050	985,513	1,011,019	1,050,353	1,090,788	1,131,139	1,173,094
23	Magelang	217,818	236,755	254,191	277,906	294,003	316,724	340,991	366,430	393,845
24	Yogyakarta	370,475	412,011	456,074	508,340	559,904	620,904	688,506	763,117	846,015
25	Surabaya	627,355	670,086	706,168	761,580	789,705	838,157	889,862	943,499	1,001,898
26	Jember	379,582	396,410	409,752	430,667	439,048	455,212	471,702	487,806	504,488
27	Malang	364,878	383,235	397,554	420,761	429,379	447,149	465,372	483,230	501,863
28	Madiun	217,744	230,336	239,015	255,679	258,683	269,888	281,263	292,035	303,236
29	Kediri	281,074	296,824	307,766	328,550	332,524	346,608	360,915	374,495	388,621
30	Bojonegoro	154,156	181,207	211,006	249,919	289,117	339,933	400,260	471,630	556,780
31	Pontianak	54,246	58,211	61,234	66,552	68,331	72,510	76,943	81,455	86,363
32	Singkawang	33,402	37,593	41,824	47,248	51,443	57,407	64,079	71,452	79,787
33	Palangkaraya	35,737	38,196	40,345	43,382	45,143	47,825	50,629	53,484	56,501
34	Banjarmasin	97,316	104,642	111,928	120,712	128,301	137,497	147,333	157,762	168,968
35	Samarinda	53,646	60,688	68,286	77,494	86,752	97,934	110,591	124,870	141,087
36	Manado	53,905	58,516	62,628	68,769	72,488	78,405	84,926	91,979	99,882
37	Palu	35,110	38,388	41,339	45,571	48,219	52,225	56,545	61,108	66,085
38	U.Pandang	129,139	138,849	146,757	159,151	164,641	174,773	185,335	195,943	207,166
39	Kendari	93,596	109,425	127,018	149,525	172,767	202,323	237,298	278,576	327,650
40	Dempasar	157,035	166,643	175,087	186,850	193,833	204,263	215,150	226,232	237,926
41	Mataram	76,208	84,618	93,479	104,051	114,321	126,546	140,071	154,966	171,493
42	Kupang	30,585	33,257	35,672	39,043	41,195	44,353	47,720	51,235	55,019
43	Ambon	15,604	16,902	17,906	19,609	20,214	21,542	22,928	24,312	25,785
44	Ternate	12,329	13,769	15,256	17,101	18,792	20,887	23,214	25,782	28,647
45	Jaya Pura	15,779	17,215	18,788	20,511	22,399	24,469	26,739	29,229	31,962
46	Sorong	16,304	19,327	22,917	27,179	32,242	38,255	45,397	53,880	63,958
47	Dili	12,906	15,212	17,769	21,093	24,489	28,868	34,078	40,249	47,623
	Total	9,563,735	10,352,433	11,103,034	12,116,248	12,868,833	13,909,375	15,052,760	16,294,461	17,676,726

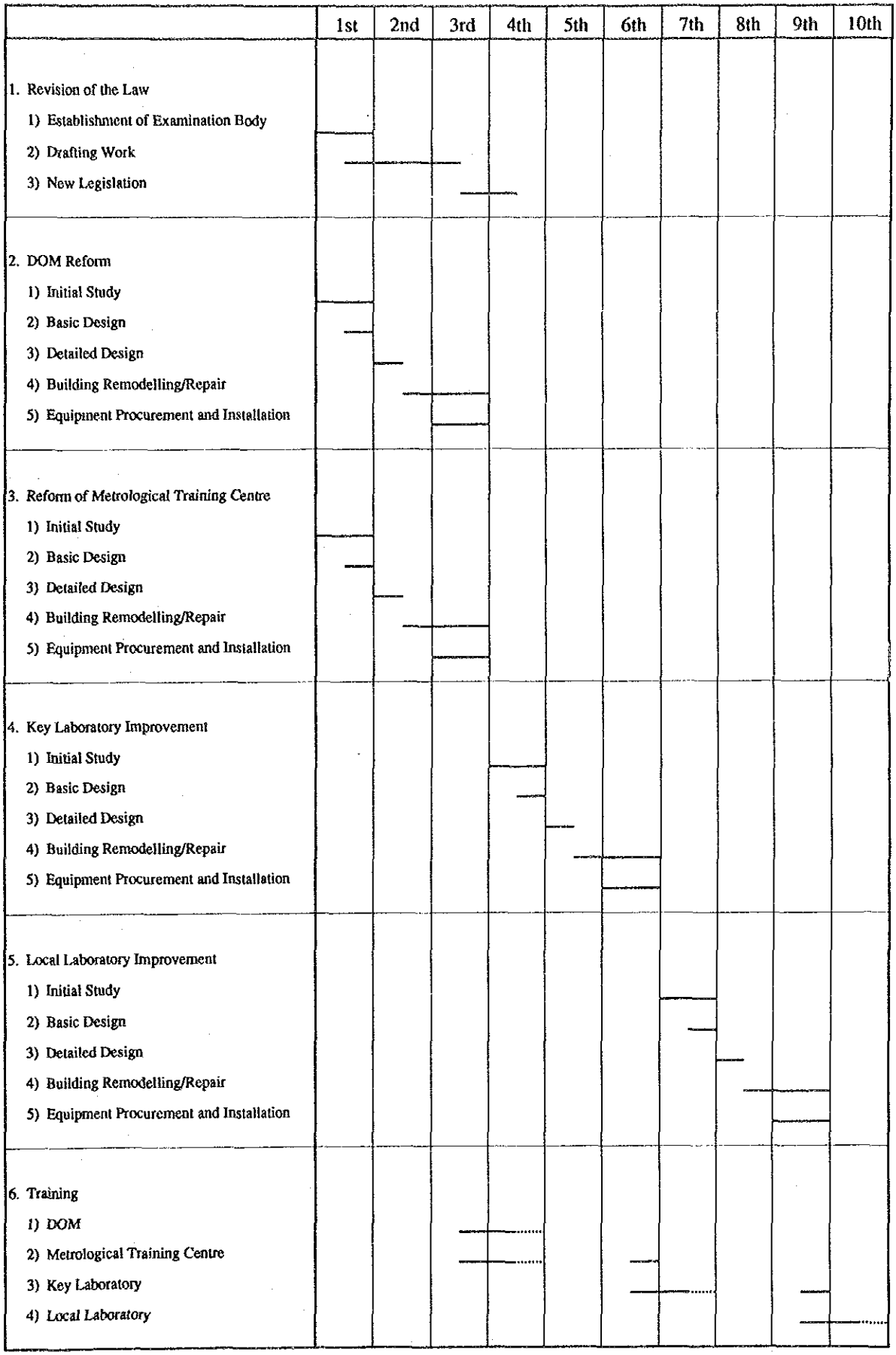
Table 6-8 Japan's Measuring Inspection Stations at a Glance (From 1992 Data)

		A	B	C	D	E	Average
Revenues		277,278	72,393	17,708	12,955	11,026	78,272
Expenses		1,461,643	399,209	113,219	105,144	75,754	430,994
Revenues : Expenses		19.0 %	18.1 %	15.6 %	12.3 %	14.6 %	18.2 %
No. of Employees		146	44	12	11	8	44
Area of Buildings (m^2)	Taxi Meter Inspection Rooms	2,752	1,284	63	169	98	873
	Others	5,228	2,686	552	984	444	1,979
	Total	7,980	3,970	615	1,153	542	2,852
Area Per Person (excluding taxis)		36 (m^2)	61 (m^2)	46 (m^2)	89 (m^2)	55 (m^2)	58 (m^2)
Area Per Person (including taxis)		55 (m^2)	90 (m^2)	51 (m^2)	105 (m^2)	68 (m^2)	74 (m^2)

Table 6-9 Indonesia's Main Inspection Stations at a Glance (From 1992 Data)

	Medan	Palembang	Jakarta	Semarang	Surabaya	Ujung Pand	Denpasar	Average
Revenues (×1,000 RP)	98,421	37,899	206,388	182,270	169,245	43,208	29,733	767,164
Expenses (×1,000 RP)	166,448	138,659	159,934	161,474	152,206	151,315	127,667	1,057,703
Revenues : Expenses	59.1 %	27.3 %	129.0 %	112.9 %	111.2 %	28.6 %	23.3 %	72.5 %
No. of Employees (1993)	48	27	65	52	49	40	31	45
Area of Buildings (m^2)	1,090	475	1,175	1,088	890	651	550	846
Area Per Person (including taxis)	23 (m^2)	18 (m^2)	18 (m^2)	21 (m^2)	18 (m^2)	16 (m^2)	18 (m^2)	19 (m^2)

Table 6-11 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 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 Benefits of Introducing a Metrology System

In the Manufacturing industries, metrological control is an absolutely essential factor in all processes, including product development, design, material purchasing, production control, quality control, production process technology, delivery and sales. There is at present no method for calculating and quantifying the benefits arising from the metrological control to the national economy, and it is also unavoidably true to say that it is strictly impossible to calculate the benefits by concentrating only on one particular model for the calculation of the very diversified commercial activities.

However, the following example on ball bearing will demonstrate how big the economic effect of accurate calibration for ball bearing production is.

The economic loss (L) due to measurement errors is given as being proportional to the square of the size (magnitude) of the error, according to the theory of quality control. Generally, however, it is found that the economic loss (L) can be expressed by the

equation $L = k\sigma^2$, because the average "error distribution σ^2" of the square of the error is used, when a measurement is repeated several times, rather than the square of the magnitude of the error. Here, K is a proportionality constant. It is expressed by the values obtained by dividing the loss (harm) in price terms A associated with the repair of the down-graded product or the scrapping thereof by the square of the permissible error tolerance [Δ], that is, the magnitude of the permissible error (i.e., $K = A/\Delta^2$). From this definition of the proportionality constant K, we can now express the economic harm or loss (L) due to measurement error as:

$$L = A\sigma^2/\Delta^2$$

Let's use an example to make this clear:

Suppose the dimensional errors that must be strictly adhered to in the production of ball bearings are:

- inner diameter error (tolerance) [Δ] 30mm ± 5μm
- each instance of deviation from this tolerance causes a loss of due to scrapping (Loss A) 400 yen/each
- error distribution for measuring equipment [σ^2] 1μm
- with an annual production output 1 million bearings

The loss due to inner diameters deviations associated with measurement errors is:

$L = 400/5^2 \times 1^2 \times 100$ million = 16 million yen

Let us next consider the loss L' which arises when the measuring instrument has a poorer accuracy because it has not been calibrated and is used in this condition because no information has been given saying that the error distribution has doubled. This loss L' is four times the value of the loss L, that is, 64 million yen.

This demonstrates that the loss taken as the loss L is 4% if the value of annual output is 400 million yen but the loss L' is 16%.

The initial error distribution 1m of the measuring equipment is appropriate in this case, but it will eventually lead to the above economic loss, when this equipment becomes less accurate with the frequency and duration of use and when used in this condition without calibration and checking. Yet, if it is calibrated at regular intervals of

appropriate length, this loss can be prevented, thereby making a substantial contribution to improving production efficiency and lowering production costs. But this is not all. It will also help the manufacturer establish a reputation for product reliability and thus open up a potential for market expansion.

7.3 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.

Table 6-8 and Table 6-9 are included here for reference purposes.