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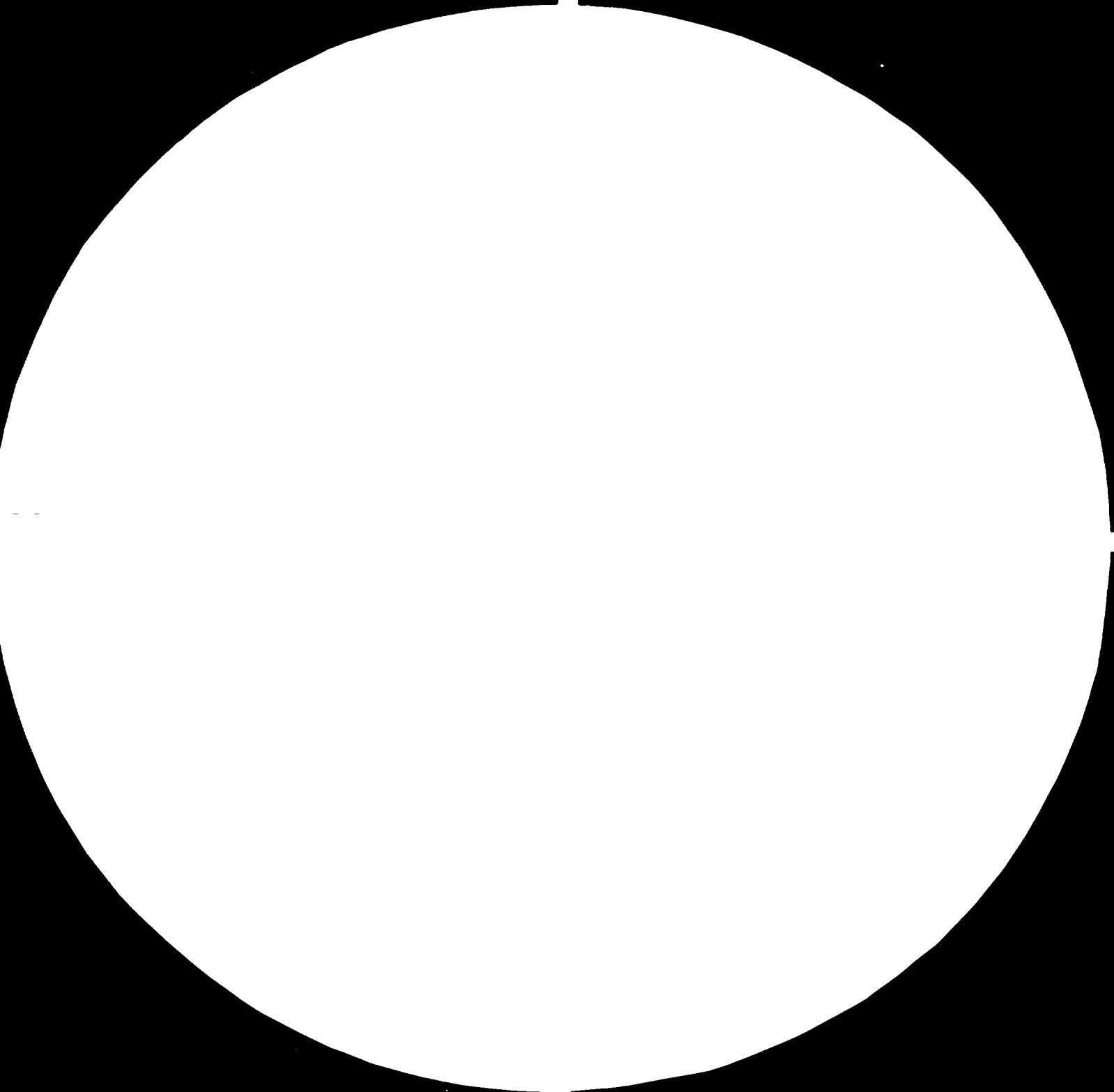

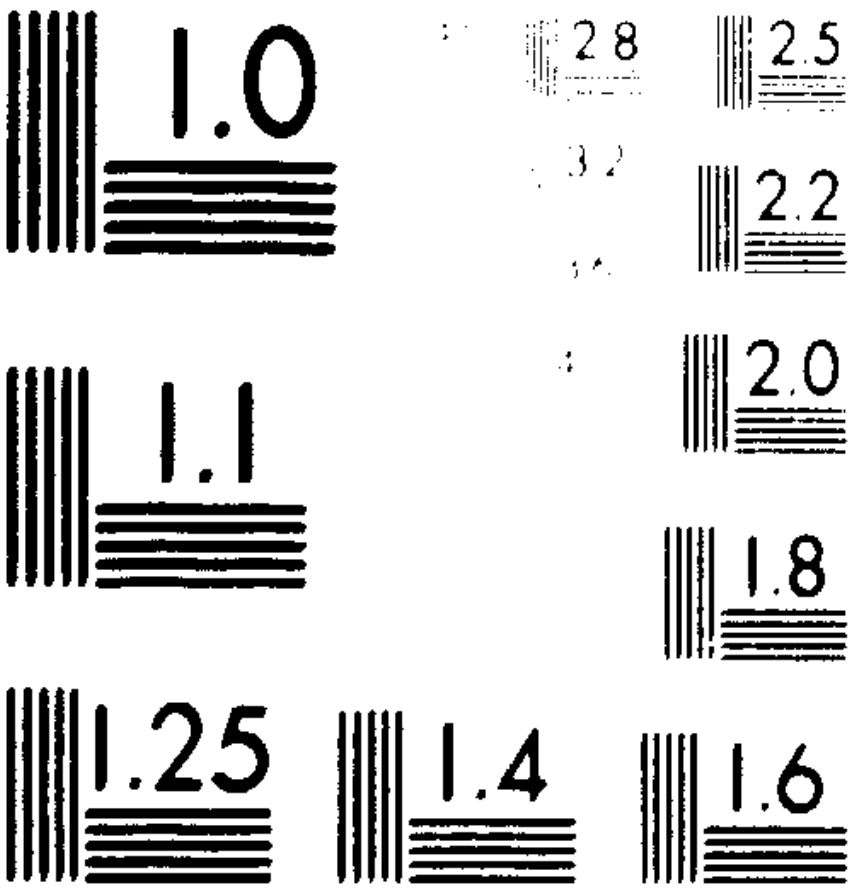
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January 1981
English

THAI INDUSTRIAL STANDARDS INSTITUTE, PHASE II

DP/THA/78/007

THAILAND

(R) Technical report: Assistance in Chemical Test Laboratories*, Thailand.

Prepared for the Government of Thailand by the
United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of W. A. STUART
Consultant on Chemical Test Laboratories

881...

United Nations Industrial Development Organization
Vienna

* this report has been reproduced without formal editing

## Abstract

In preparation for the visits paid to laboratories, some of the standards, which are in English, were studied. In some cases these require revision.

Visits were made to sixteen authorised government laboratories and to eight factory laboratories. In both categories some were very good, others not so good and some were not up to the level required for standards testing. Those laboratories which could do more work have been noted and at the same time any deficiencies have been reported.

An assessment of the present situation and the future needs has indicated the need for a T.I.S.I. laboratory and preliminary ideas for such a laboratory have been described.

Contents

## I Introduction

The Thai Industrial Standards Institute has a long history of development and a large effort has been devoted to the promotion of the basic idea of the use of standard specifications and quality control. Also many standards have been published but it is now realised that the testing facilities are not adequate for present requirements and will fall far short of future requirements as more standards are produced and more manufacturers require certification.

For this reason three experts from U.N.I.D.O. were commisioned to examine the present testing facilities and to recommend ways of improving and increasing these facilities. This report covers the chemical test facilities. The job description includes the following five tasks:-

1. Visit each of the authorized test laboratories and spend some days in each in order to evaluate suitability of equipment and personnel for T.I.S.I.'s needs.
2. Investigate the causes of some delays in testing product samples.
3. Assess wherever possible the distinction between the outputs of authorized and company laboratories.
4. Compile a list of equipment which could be retained by TISI and used to supplement the capacity of the authorized laboratories for TISI testing programme.
5. Assess T.I.S.I.'s future needs for testing facilities in the light of its rate of expansion and make recommendations.

2. Preliminary Studies to Assess the Situation

In Vienna the final report of Mr. R. Hopper, PM until 1978. was read. This gave a full picture of the publicity given to Standardisation in Thailand. Also a copy of the final report of Mr. H. Bloebaum, consultant in Electrical Test Laboratories was received and read. On arrival in T.I.S.I. Mr. Ringstrom, Consultant in Mechanical Test Laboratories handed over a copy of his final report, partly in a hand-written form.

With this knowledge in hand, and bearing in mind the short time available, it was decided that it was important to look at as many standards as possible to learn what chemical tests are required and then to inspect the laboratories with the following points in mind:-

1. Knowledge and experience of staff.
2. Adequate numbers of staff?
3. Adequate laboratory facilities and instruments?
4. Maintenance of equipment.
5. Calibration of equipment and availability of analysed standards.
6. Sufficient priority for TISI tests.
7. Adequate supervision and checking of results.

On reading some of the standards it became clear that some of them were not suitable as National Standards and/or the analytical methods to be used were not suitable. These points were discussed with Miss Kanya Sinsakul who was able to clear up one point as a mis-translation from the Thai original. However other points are still valid.

In view of the short time available, the remarks noted at the time of reading the standards are set out below without much editing and no further checking. They are in no particular order.

Standard for Sodium Hydroxide for Industrial Uses TIS 150 - 1975

In the test methods strong solutions are prepared and used. No

mention of the effect of strong concentrations of sodium hydroxide on volumetric glass-ware is made. No safety precautions are mentioned. In appendix D, "Method for the determination of matter insoluble in water", 50 g. of NaOH is dissolved in 250 ml water and poured through a No 4 sintered glass crucible. A 20% solution of NaOH will soon attack a No 4 sintered glass pad. Results will be low.

Standard for Nitrous Oxide for Medicinal Purpose TIS 30 - 2516

This standard gives a table containing limits for impurities one of which is water at 2 g/l. Others are halides and hydrogen sulphide, carbon monoxide, arsine and phosphine. Another section deals with the statistics of sampling and conformity with the test "7.2 the acceptable number of defects in each batch shall be considered as conforming with the test when the results of water vapour exceeds the requirement in Table I not more than +0.2 mg/l provided the number of defects shall not exceed those specified in column C Table 2." Nowhere does it make it absolutely clear that the following statistical table of acceptable numbers of defects applies only to water and not to such things as arsine or phosphine . This is a very loose way to write a standard. Another example of this looseness is in section 8.1 - Purity. "Immerse the gas drawn from gaseous phase in liquid air or liquid oxygen. Condense nitrous oxide by using a suitable apparatus and the amount is the purity." The remaining test methods are very loosely written with no details.

Standard for Sulphuric Acid and Oleum for Industrial Use TIS 41 - 2516 p. 12 "Determination of lead content." This describes a very tedious method for the determination of lead by dithizone. If this method is to be used on a regular basis then the persons involved must be very meticulous in their work. Also they must be very reliable and conciensious or they will need to be relieved from this task periodically. A better method now would be to use an atomic absorption spectrophotometer. The method for

arsine employs a Gutzeit test which is relatively simple but gives rather subjective results. A good spectrophotometric method employs silver diethyldithiocarbamate but the best method is probably the atomic absorption technique using hydride generation.

Standard for Water for Lead acid Batteries TIS - 19 - 1971

This water is defined in the standard as distilled water and this definition seems to preclude demineralised water which is perfectly suitable for use in storage batteries.

The electrical conductivity is defined in dionic units or micromhos per cm and not in the appropriate S.I. units of Siemens/cm.

Amongst the requirements in the English version are the statements NIL for heavy metals, calcium, and magnesium. This is scientifically impossible. However Miss Kanya Sinsakul said that the original Thai said "not to be found". It is possible to interprete this as meaning "not detectable under the conditions of the prescribed test method". This is a very poor way to set limits and depends on the solubility product which itself is temperature dependent.

The method for chloride, where the limit is 1 mg/l, is a simple visual comparison of turbidity produced in the sample and that produced in a standard. This method is suitable for routine quality control but not for a standard test method particularly in cases where the sample fails the test. A selective ion meter with a chloride electrode or the mercuric thiocyanate colorimetric method would be suitable.

The method recommended for the ammonia test requires care in the preparation and use of reagents but the detection method used is a simple visual comparison with one standard. For slightly better results a Lovibond comparator could be used. For regular testing, the automated "Indophenol Blue" method is to be prefered. Another good alternative would use a se-

lective ion meter with an ammonia selective electrode or an ammonia probe. (E.I.L. produce an ammonia probe suitable for use with a normal pH meter).

The test limit for calcium is "not to be found". For a standard specification a limit such as "not more than 1 mg/l" should be quoted. The test method, a precipitation of calcium oxalate and observation of opalescence is not quantitative. A better procedure would use a flame method, a colorimetric method using o-cresolphthalein complexone or a selective ion electrode.

The test for manganese is long and tedious. It is a sensitive method and will give no good idea of the quantity of manganese present if a colour is produced. Probably a trace of colour could be tolerated and the specification should quote a limit for manganese. The solution produced above could be measured spectrophotometrically and atomic absorption spectrophotometry is a better method.

Standard for Liquified Petroleum Gas Cylinder TIS 27 - 1980

This standard seem to be very loosely written and in one section contains a contradiction i.e.

"p 9" Note (1) Addition of other elements to obtain alloying effect is not authorised.

(4) Other alloying elements may be added and should be reported.

Standard for Cosmetics: Shampoo TIS 162 - 1975

In the test for the washing effect of the shampoo a soiled test piece of wool is washed and the required effect is stated as:-

"Weight of standard soil which is extracted by shampoo shall not be less than 32% or more than 35%".

There seems to be no good reason why the shampoo should not remove more than 35%. From the above remarks it should be clear that one of the most important tasks which should be completed as quickly as possible

is a complete review of the present standard specifications and the methods of analysis and testing. If the standards are not going to be reviewed for a long period it is advised that the methods are recommended methods and not obligatory. This would then allow the testing laboratories to use more modern, sophisticated methods as they become available. A safe way of doing this might be to recommend the methods used by some internationally recognised body e.g. for water the "Standard Methods for the Analyses of Waters and Waste Waters" of the American Public Health Department. It is also important that the head of a testing laboratory should be on the committee which draws up the standard. In one case the head of a testing laboratory pointed out, with no prompting, that some of the Thai Standards and test methods were wrong. This person seemed to be very competant and yet was not on the relevant committee. Instead the head of that department, who was not a chemist, was the member of the Standardisation committee.

3. Laboratory Visits

According to the job description, clause 1., some days should be spent in each laboratory. Since there are sixteen government laboratories and many more factory laboratories this is impossible. Also it is not possible to do more than inspect the equipment, talk with the staff and try to gather a general impression of the standard of work being carried out in a particular laboratory. Below are short reports on each of the laboratories in the order in which they were visited.

3.1 13.30 1980-12-09

Laboratory of the Division of Chemistry, Department of Science Service, Ministry of Science, Technology and Energy. TISTR

Head of Laboratory: Miss Sermsri Gongsakdi

This laboratory carries out many of the tests for T.I.S.I. including inorganic and organic chemical tests. The laboratories are large, fitted with good quality furniture and well stocked with conventional analytical equipment. Being such large laboratories, they appeared empty because of the few staff and much of the equipment appeared to be underemployed. There are sections for general wet chemical analysis, water, fuels and ores. There was little specialised equipment except an atomic absorption spectrophotometer, and a Packard gas chromatograph. The atomic absorption equipment was not seen as the laboratory was in the process of moving. The gas chromatograph which is now five years old appeared to be in good condition and the operator well experienced.

Remarks Either this laboratory has a small work load or the operators are overworked. The equipment appeared to be under-utilised. If the work load was to be greatly increased then more staff would be required or some modern automatic equipment is required.

3.2 09.00 1960-12-12

Laboratory of the Highways Department, Ministry of Communication

Head of Division: Mr. Arun Chulachambok

Head of Laboratory: Miss Rossukon Boonme

This laboratory is not an authorised laboratory for T.I.S.I. testing and at present no samples are sent here.

There are two sections; for the quality control of bituminous materials and a chemical section for the quality control of all other materials such as soil, traffic paint, aluminum alloy, water for concrete mixing, zinc coating and cement.

Bituminous laboratory:- This section appeared to be overstaffed with 2 chemists and 15 assistants with Technical School Certificates. The equipment was a rixture of new, old and obsolete units and the general state of the laboratory was not good. As an example there was a "Christian Becker" 4 figure, 2 pan, chain balance which was dirty and very sluggish in action. The excuse was that it was only required for 0.1 g. sensitivity. 3 samples per day are received for such tests as composition, percent soluble in carbon tetrachloride, flash point, penetration test and distillation for cutback. The distillation method used gas rings with manual control of the gas flow from a cylinder.

Other equipment included water and oil baths, U-tube viscometers, two Seybold viscometers for 122 $^{o}F$ and 180 $^{o}F$ a new Flash Point apparatus, an oven for conditioning and penetrometers.

Chemical Laboratory:- This section again seemed to be somewhat overstaffed and not much work appeared to be in progress. There are 6 B.Sc. chemists plus assistants. The equipment and general appearance of the laboratory was better but there were problems. Equipment is listed as seen:

Paint tester - Viscometer

Drying time tester - Simple roller on an incline - Adequate

Large centrifuge used for solids in paint

organic matter in soil

Furnace to 1600 °C

2 Fume cupboards with hot plates. Much corroded.

Becker "Cenco" single-pan balance. No separate balance room, no balance table and the bench not very rigid however it was clean and a 1 g. weight read 0.9999 g.

"EEL" 197 model, spectrophotometer. A simple instrument using a spectrum wedge. Wave band 35 nm. The calibration was said to be checked against potassium chromate.

Digicord pH meter

LECO Carbon Analyser WRIZ
" Induction Furnace
" Titrator

} This equipment is only 2 years old

but has been out of order for 3 months. The agent was called and did not send an engineer for 2 months. He only looked at the equipment and there has been no further action. When asked what further action was to be taken nothing was suggested. There was no thought of contacting the manufacturers.

"EEL" Reflectance Spectrophotometer

Pulfrich Refractometer. This instrument was pushed into a corner under its cover. The head of the section did not know what it was although it is 2 years old. It has never been used as the person who ordered the instrument had left before it arrived. Refractive index is measured by a microscope method.

Remarks:- There appeared to be a general lack of competence and drive. It is not recommended that T.I.S.I. employs this laboratory

3.3 13.45 1980-12-12

Thailand Institute of Scientific and Technology Research,
Ministry of Science, Technology and Energy

Head: Office of Scientific and Technological Service; Dr. Nara Khomnamool.

Head: Testing and Standards Division; Mr. Siri Nandhogri

This is a semi-governmental institution which carries out research work and testing on a contract basis and on its own initiative and receives royalties on products or methods taken up by industry. T.I.S.I. makes considerable use of this establishment.

After meeting with the two persons above, the library section was visited. The Chief Librarian accompanied us around a very impressive library. There are 18 librarians and 6 assistants. The main purpose is to collect all outside technological abstracts and all information published in or relating to Thailand is listed in three documents:-

Thai Abstracts: Science and Technology List of Scientific and Technical Literature Relating to Thailand; Abstracts of Master Theses in Thailand.

All documents are fully catalogued. Some microfische copies are available and a start has been made on computerised cataloguing etc.

I.S.O. documents up to 1974 are kept but after that date T.I.S.I. receives them.

X - ray Section is a 20 year old Siemens X-ray diffraction spectrometer which is in constant use. The calibration is checked regularly with standards and breakdowns are put right by instrument technicians from T.I.S.T.R. Also there was a large X-ray camera for the examination of welds, and a Zeiss projection metallurgical microscope.

Analytical Chemistry Laboratory

Laboratory Head: Mr. Chumnong Hayakijkosol

These laboratories were well stocked and the staff appeared to be busy. The equipment is obviously in constant use. Half of the staff are B.Sc. chemists and half are qualified by long experience and training. Equipment is listed

in the order seen.

Chemicals: A good stock of analytical grade chemicals from well known manufacturers is kept. Merck "Titrisol" volumetric Standards are used.

Beckman "Expandomatic SS-2" pH meter

Varian Techtron AA3 Atomic Absorption Spectrophotometer. This instrument is the speciality of Mr. Hayakijkosol who specialises in atomic absorption and has worked with Dr. Walsh, the inventor of the technique. It is in constant use and the results are compared to National Bureau of Standards (U.S.) analysed standards. Calibration solutions are prepared from Johnson-Matthey "Specpure" chemicals. Water used is double distilled demineralised water produced in the laboratory. Although this instrument is in good order and still operating it is one of the earliest models and is now obsolete. The newer techniques such as carbon furnace atomiser, automatic sample feed and recording, hydride and cold vapour atomisation and electrodeless discharge lamps cannot be used with the instrument.

Carbon Sulphur Analyser "Strohlein" for steel analysis - in regular use.

Mill for fibrous material grinding.

Digester Unit Gerhardt "Kjeldamat"

Cooling bath. A locally made circulating cooling unit for tests carried out below ambient temperature e.g. viscosity at 20 $^{o}$C

Coleman mercury Analyser

Lovibond Nesslerizer

Lovibond Comparator

Haake Viscometer - rotating cylinder type

Flash Point Apparatus Open cup

Closed cup.

Seybold Viscometer

Cannon U-tube viscometer

Demineraliser: A large capacity locally made unit with imported resins. Product used for most purposes.

Lovibond Tintometer for colour matching.

Burrell Shaker

Single cell electrolysis apparatus used for major components of alloys.

Balances Mettler Single-pan 4 figure balance

Mettler Top-pan 2 figure balance

These balances were in good condition but were on the open bench without anti-vibration tables.

Thin layer chromatography - Glass plates are coated manually and a U.V. lamp is used for detecting the spots. Column chromatography and TLC are used for vitamin measurement.

Rotary Evaporator - In use

Gas chromatography is used extensively and there are 3 Varian chromatographs and a new Perkin - Elmer Sigma-3 chromatograph. Columns for these instruments are bought dry and packed in this laboratory. Three of the chemists are experienced in this work. Hydrogen for the Varian instruments is produced from a commercial generator. These instruments are fitted with flame ionisation detectors but the Perkin Elmer instrument also employs thermal conductivity and electron capture detectors.

Pye Unicam SP200G. Grating Infra-Red spectrophotometer. This instrument is over 10 years old but is in regular use.

Beckman DG-G grating UV-Visible spectrophotometer

Carl Zeiss Polarimeter

Carl Zeiss Refractometer

in the Essential oils and cosmetic laboratory, amongst other equipment was a home-made spray chamber with extract and fume trap for the spraying of thin layer chromatography plates with acids.

Remarks: This is a very well equipped and staffed laboratory with a good sense of purpose. The head of the laboratory, Mr. Chamnong Hayakijkosol is a very good practical analyst with great drive and initiative. Much

of the equipment bore UNDP labels and are now old. It is a credit to this laboratory that they are still in good working order. However this laboratory deserves to have more up-to-date instruments such as a new atomic absorption spectrophotometer. Tests for T.I.S.I. which are now carried out by this laboratory should continue to be done so and if more work was needed some further support for this laboratory would be an advantage. It would take a new laboratory in T.I.S.I. a long time to reach the standard and experience of this laboratory.

3.4 09.45 1980-12-16

Department of Industrial Promotion, Textile Division

Head: Mrs. Sriprapan Foongkist

This laboratory is situated in a district which is subject to flooding for a period of about two months each year and flooding occurs daily with high tides. The water had risen to above one foot in height in those laboratories on the ground floor. For this reason it was not possible to make a fair assessment of their true capabilities. Much damage has been caused to benches and equipment and most chemical work is at a stand still. Further the head of the section stated that the laboratories were understaffed and their budget was too low. Amongst the equipment available in the chemical laboratory were the following:-

E.I.L. 7030 pH meter with glass and reference electrode

This was ex-UNDP equipment which is suitable for use with selective ion electrodes but none were available.

Sauter 200 g. 4 figure single pan balance in good condition but on an open bench without an antivibration table.

Bauch & Lomb spectronic 20 spectrophotometer

Beckman Acculab 8 Infra-red spectrophotometer used for dyestuffs analysis.

Harrison-Shirley Digital Colorimeter. A very large sophisticated instrument for reflectance and colour matching work which cost ₹300,000 (£14,000)

and is very much under-employed.

Verivide: Apparatus for Standardised visual assessment of colour reflectance and transmission. Used for colour-fastness testing.

E Beng Zurich Automatic dyeing bleaching and fixing tester. Colour-fastness to washing tester. The motor has been spoilt by flooding.

Atlas Weather-ometer. Colour-fastness to light tester employing a high intensity U.V. lamp. In use.

In contrast to this section the physical testing laboratory on the 1st floor was in very good condition with clean instruments well laid out and some in use. The staff of four were working. The equipment is not listed as it is not used for chemical analysis but it is interesting to see that a tensile strength tester, labelled "UNDP 75", is still in regular use.

It is difficult to recommend that this laboratory should be used for TISI testing but the staff and head of this division were quite keen that they should be given more work. It is quite possible that if the flooding was prevented or the laboratory could be relocated they could do good work. However they might need financial help also.

3.5 11.10 1980-12-16

Thai Tanning Organisation

Head of laboratory: Miss Sunantha Jittaseno

During the introductions and preliminary discussions Miss Jittaseno pointed out that some of the standards and the recommended methods are not good and should be revised. For example they use the I.U.P. method instead of the Thai method for the measurement of water absorption as it is a better method. She also intends to ask for money in the next budget to buy an instrument for a Waterproofness tester for boots and upper leather. This laboratory tests raw materials such as calcium hydroxide, sodium hydroxide, chrome tanning solutions and imported tannin, finished products and uncured rubber in the factories.

There was a staff of 4 B.Sc. standard and they were all employed. The equipment included some conventional equipment such as burettes and glass-ware and the following instruments.

Labconco 6 place Sohxlet apparatus for the determination of fat content. This was fairly new.

Gallen kamp large shaker, very old but still in use.

Gallen kamp oven

Stirrer motor

Abrasion tester

Flexing tester

Sole adhesion tester

Hardness tester

Lastometer tester for stretch and deformability

* Finish Rub-fastness tester

Curing check, for rubber

Bosch S2000 200g 4 figure single pan balance

This was on a solid bench in an office but had no antivibration table. It appeared to be in good working order.

Beckman Zero matic II pH meter

* It was pointed out that the T.I.S. stipulated "No dyestuff" should be present on the pad used for the finish rub-fastness test, after 1000 revolutions. Miss Jittaseno said that this is impossible, that every finish will leave some discoloration on the pad. The normal specification gives a less than-figure and refers to a standard set of charts. This lady also recommends that the standard for the shrinkage temperature test be changed from the Indian (TIS) standard to the I.U.P.

This laboratory appears to have enough work for the small staff but it seems to make good use of its equipment. Miss Jittaseno appeared to be a competent person and was willing to discuss her difficulties for example when

determining nitrogen in leather by a Kjeldahl method. If necessary this laboratory might receive some support from T.I.S.I.

3.6 09.30 1980-12-17

Ministry of Agriculture and Cooperatives

Laboratory of the Rubber Division,

Head of laboratory: Mr. Thanin Lapananon

There had been a misunderstanding as we had hoped to visit the fertilizer laboratory. However, since permission would be needed to visit that laboratory and rubber is an important Thai commodity produced and tested to standards it was decided to tour the laboratory. This laboratory has a staff of 14 with B.Sc. (Agriculture) and some training abroad. Tests on rubber are carried out so that it is shown to conform to the specifications for "Thai Tested Rubber - T.T.R." These standards are similar to those for "Standard Malaysian Rubber SMR" At present the tests are not carried out in this laboratory but at the factory where there are said to be suitable instruments and equipment. Inspectors visit the laboratories in the factories to check on the quality control analysis. The laboratory has the capacity for 120 samples per day. The tests carried out by the laboratory include the determination of nitrogen by Kjeldahl, ash, volatile fatty matter, dirt, plasticity index and colour.

There were three balances on solid marble benches in a separate room. 1 Mettler H35AR and 2 Mettler H18. They were clean and appeared to be in good order. However on testing with a set of standard weights there were errors with the two balances tested. One appeared to read 1% high and the other was 1% low for 1 g. and 0.2% high for 10 g.. Possibly the set of weights were not accurate but the two balances did not give the same reading for the same weights. Since one of the balances was not familiar to the auther the manual was requested. Instead the catalogue was produced and an instruction manual could not be found. This seems to be a fairly common occurence in some of the laboratories visited. Most of the work was by

conventional methods. Colour was measured against Lovibond colour comparator discs for Rubber Latex.

This laboratory seems to have plenty of spare capacity for testing but TISI would have to have more confidence in the capabilities of this laboratory than the author had after one short visit.

3.7 14.45 1980-12-17

Metropolitan Water Works Authority

This laboratory is not at present an authorised laboratory for TISI testing. It is well equipped with a mixture of conventional wet chemical equipment and modern instrumentation. The staff consists of three chemists and they have the following programme of testing:-

| | | |
|---|---|---|
| Monday | : | 10 samples of deep well water for full chemical analysis |
| Tuesday | : | 15 - 20 samples from consumers premises for residual free chlorine and bacteriological testing |
| Wednesday | : | About 10 samples of raw water for full chemical analysis |
| Thursday, Friday | : | 15 - 20 samples each day of tap water for residual free chlorine and bacteriological testing |

The methods used are the "Standard methods for the Examination of Water and Waste Water" American Public Health Association, 14th Ed 1975. The standard applied is the same as the W.H.O. "International Standards for Drinking Water" 1971. Equipment available includes

Varian AA 375 Atomic Absorption Spectrophotometer with air/acetylene and nitrous oxide/acetylene flame and a graphite furnace atomiser. The latter has not yet been used.

Hach conductivity meter

Beckman Zeromatic pH meter

Hach turbidimeter

Coleman Junior II Spectrophotometer

Fisher Electrophotometer II

The general impression was that this laboratory was very well run and made the best use of its facilities. While the head of the laboratory did not consider it necessary to acquire any automated equipment it is likely that they would make good use of such. Also they could make use of other modern equipment such as a selective ion meter or a dissolved oxygen meter.

3.8 09.30 1980-12-18

Royal Forest Department, Ministry of Agriculture and Co-operatives

Head of laboratory: Miss Tasnee Rativanich

This laboratory carries out chemical and physical testing of woods and wood products. The chemical test include determinations of:-

Extractability with solvents

Extractability with Sodium hydroxide solutions

Cellulose content

Lignin content

Pentosans content

Free sugar content

Protein

Tannin

Charcoal was also examined for its calorific value, volatile content and ash content.

Two species of pine wood were examined for their oleo-resin content.

This staff consisted of 2 chemists and 1 assistant and on average 4 samples could be analysed per day. The methods are TAPPI standards or ASTM methods. The equipment which was in reasonable condition and obviously fully utilised included.-

Sohxlet extraction equipment

Rotary Evaporator

Vacuum Oven

Large heated shaker

2 Mettler balances single pan 4 figure on anti-vibration tables and covered

Large centrifuge

Thin layer chromatography using Shandon glass plates with a hand spreader.

The head of the laboratory explained that their budget was insufficient and they could not buy new equipment or easily replace broken or damaged items. They had few micro-pipettes for the application of sample to the chromatography plates. These items cost 250 Baht each ($12.4) and are easily broken.

Paper Chromatography

2 U.V. lamps for reading chromatograms. One of these is out of order and the agent can no longer repair it. They will wait for the next budget to replace it.

The head of the laboratory was eager to show us the other sections and so these were also visited.

Paper Pulp Laboratory

This laboratory had some large scale equipment for studying the pulping properties of wood including:-

| | |
|---|---|
| a Mill - PFI (Norway) | 2 Large pressure digestors |
| Sheet formation tester | Pulper |
| Filter | Centrifuge |
| Strainer | Screener |
| Hollander | Sieve shaker & sieves |
| | Pot grinding mill |

Physical Test Laboratory for Paper

Here there was equipment for testing the moisture content, tensile strength, bursting strength, the thickness and the wet strength of papers. There was also a fibre dimension tester. All of this equipment appeared to be in good condition and to be regularly used.

This laboratory is authorised by TISI to test the following products:

Plywood TIS 178-1976

Hardboard TIS 180-1976

Wooden flush door TIS 192-1976

Solid Wood Parquet Strips with Rectangular Face TIS 193-1976

LAC Products TIS 233-1977

Only samples of the first three items have been sent to this laboratory to date.

The general impression is that this laboratory has a lot of useful equipment but could use a little more if the buiget was increased. It should be possible to do more samples if the number of staff was increased. The time for any analysis was not more than two weeks.

3.9 10.30 1980-12-18

Ministry of Agriculture and Co-operatives, Agricultural Chemistry Division, Fertilizer Laboratory

Head of laboratory: Mrs. Nongyow Thongtan

This laboratory had a staff of 17 qualified in chemistry or agriculture. On average they deal with 20 samples per day and carry out a very comprehensive analysis on each. The list of parameters measured includes:-

| | | |
|---|---|---|
| Nitrogen | Potassium | Phosphate |
| Calcium | Magnesium | Sulphur |
| Chlorine | Manganese | Iron |
| Zinc | Copper | Boron |
| Molybdenum | Arsenic | Biuret |
| Mercury | Cadmium | |

and organics:- hormones, vitamin B and pesticiles.

Samples are received from the Regulatory Division of the Ministry and from the customs section to test for compliance with the Fertilizer Control Act. This laboratory also serves farms and businesses. The methods used are

AOAC methods or Japanese O.M.A.F. methods-latest editions. All samples are analysed in Triplicate and the turn around is only three days.

The equipment included the following items:-

Large hotplate

Kjeldahl 12 place large digestor

Kjeldahl 6 place digestor

One medium size oven

One large oven not in use as the temperature control is out of order.

2 muffle furnaces

Perkin Elmer 703 atomic absorption spectrophotometer with recorder. Air/acetylene flame. B.D.H. "Standard Solutions for atomic absorption spectrophotometry" are used with this instrument.

2 single-pan balances were in an instrument room but on an ordinary bench without anti-vibration tables. This room was shared with another section and in their part of the room was a solid stone balance table not in use. The head of the laboratory was aware of the unsuitable accommodation for balances. Home made U.V. lamp chamber for thin layer chromatography.

Corning-EEL Flame Photometer. This instrument can only be used at certain times of the day because the mains voltage is too unstable at other times.

Coleman Junior II grating spectrophotometer.

Beckman model B spectrophotometer. This instrument had been given to this laboratory by another section. It is very old but the laboratory head intended to try to make use of it.

Beckman Zeromatic pH meter - an old instrument

Photovolt pH meter

Rotary evaporator

For the number of staff these laboratories were very crowded. Even so the staff was not enough for the present work. There is only one person for all the organic tests. There is no possibility of increasing the work load as

the equipment e.g. hotplate, Kjeldahl equipment, ovens, furnaces are all fully utilised. It was realised that automatic equipment such as Auto-Analysers and Automatic titrators could help. The head of the laboratory also said that they need a new ultraviolet spectrophotometer, an infra-red spectrophotometer, a spectrofluorimeter and liquid chromatography.
For fertilizer testing it would be better to expand this laboratory than to set up a new laboratory. The staff all seemed to be working well and the laboratory head said that the staff were good and devoted to the work and none had resigned since the laboratory was set up.

3.10 14.00 1980-12-18

Institute of Food Research and Product Development, Kasetsart University

Assistant Director: Miss Bulan Phithakpol

This was a more difficult laboratory to assess than the previously visited laboratories. The staff of the institute are university staff and are engaged in research and routine work. In a Thai university there are three catagories of staff: Teaching, Research and Support. The divisions are not rigid but Miss B. Phithakpol, for instance, was an assistant professor and now is designated as a Researcher. However she still does some teaching in addition to her work as Assistant Director of the Institute. Promotion is largely dependent on the results of research work but routine work does help to assess a person's capabilities. For this reason a balance between research work and routine quality control work is a good thing. The present staff is 37 Researchers and 10 newly qualified B.Sc. Research Assistants. Because of the research projects and other routine testing there is little spare capacity and T.I.S.I. work would take second place after the work of the Institute. If necessary, researchers would be asked to work overtime. This laboratory is authorised to test a total of 23 products but to-date only tapioca has been sent to this laboratory. Equipment seen included.-

4 single pan balances in an air-conditioned room on a solid bench

Kjeldahl apparatus

Coleman Nitrogen Analyser II. This equipment was donated by ASEAN but is not used since the gases required are not available pure enough. No attempt has been made to purify the locally available gases.

Beckman DB spectrophotometer. This instrument is not working. It has been sent to the agent several times but still does not work. The manufacturers have not been contacted.

Oxygen and carbondioxide meter, meßgerät A2.

L. Eschweiter v Co Kiel. This equipment is not working because some accessories never arrived and the manual is in German.

Eppendorff digital photometer 6114 S. Used for blood analysis.

Radiometer Titrator

Abbé refractometer

Vacuum Oven

Infra-red moisture balance, Mettler

Babcock centrifuge

Brookfield viscometer

This laboratory was over-crowded because equipment was being stored from another laboratory which had been flooded. It is doubtful if TISI would get enough priority for its future testing programme at this institution.

3.11 09.30 1980-12-22

Department of Mineral Resources, Ministry of Industry

Head of Laboratory: Mrs. Ambhai Iithikasem

This laboratory employs a staff of 24 B.Sc. chemists some of whom have up to 15 years of experience. The work consists mainly of the analysis of rocks and minerals and about 100,000 analyses are carried out on 3000 -

4000 samples per year. Much of the work involves gravimetric and volumetric techniques but trace metals are determined by atomic absorption spectrophotometry or colorimetry. The equipment seen is listed below:-

- Techtron A/A4 Atomic Absorption Spectrophotometer with air/acetylene, nitrous oxide/acetylene and flameless mercury atomisation. This instrument is 12 years old and is giving good performance. Servicing by the agent is good. There are 60 lamps available, BDH standard solutions are used and NBS certified standards are used to check the methods. The laboratory produces distilled water which is further purified for atomic absorption by ion exchange. In the near future this laboratory will buy a Techtron 825 atomic absorption spectrophotometer with graphite furnace, fluorescence and electrodeless discharge lamps.
- Leco apparatus for the determination of carbon and sulphur in steels. A relatively new piece of equipment which is calibrated with NBS certified standards.
- Unicam Model 600 spectrophotometer This is a very old instrument which is subject to failures.
- Unicam SP500 Mark I visible and U.V. spectrophotometer with Labgear power unit. The Unicam agent provides good service.
- Orion 701A Ionanalyser selective ion meter used for halogens, cyanide and heavy metals.
- Bauch and Lomb Spectronic 20 spectrophotometer
- 4 Metler Balances, one on a solid stone balance table and the others on anti-vibration tables. These were in a rather crowded small room with other equipment.

A number of old two pan balances were in another room. Some of these are not used but ones which are used included a Fisher 2 pan 5 figure balance and a G Longue, Paris, gold assay balance which is very old.

- Jarrell-Ash Fluorimeter for uranium determination using fused sodium fluoride.

- Fisher Titrimeter used for chloride determinations.

In another large room were 15 fume cupboards with one suitable for perchloric acid fumes.

There were several multi-place water baths.

- Eberbach Mercury cathode electrolysis equipment used for chromuim determination.
- Hoskins crucible furnace used for the analysis of carbon black.

A number of fusions were taking place in platinum crucibles and there were several evaporations being carried out in large platinum dishes.

- Thermolyne Type 1500 1200 °C furnace
- 3 Hereus large muffle furnaces; one was not in working order
- "Heavi-Duty" Tube furnace for carbon, hydrogen, nitrogen and sulphur in steel.
- Shimadzu Equipment for calorific value determination
- Beckman Zeromatic II pH meter

This laboratory is very well run and very much work which appears to be of good standard is carried out. The numbers of staff are sufficient for the present work. The budget is hardly adequate. The laboratory space is not adequate. This laboratory could take very little more work without more space, equipment and staff. It is authorised to analyse 20 products for TISI but only samples of three products have been submitted so far. These are liquified petroleum gas cylinders, steel wire for prestressed concrete and mild steel covered arc welding electrodes. If all the products listed were submitted for analysis then the laboratory could not cope.

3.12 09.30 1980-12-23

Laboratory of the Faculty of Science, Chulalongkorn University

Head of Department: Dr. Pirawan Bhanthumnarin

This laboratory does little outside service work at present and the equipment is used in the teaching of undergraduate and postgraduate students. It is also used, at times, by people from outside the department. There must be a conflict between the demands of research and outside testing work.

The staff have a heavy teaching load but they have to carry out any outside testing that is done. They have tried to recruit staff to do this type of work but so far with little success. Also the budget is always inadequate for their needs and they are now trying to set up a joint set of analytical equipment to be used by each faculty.

They have been promised a large donation of funds to buy Japanese equipment and this will be used to set up a "Central Public Analytical Laboratory". Equipment to be donated to this project include the following:-

Transmission Electron Microscope

Gas Chromatograph/Mass spectrometer

Gas Chromatograph

High Pressure Liquid Chromatograph

X-ray diffractometer

X-ray fluorescence spectrometer

C.H.N.O. Analyser

Amino Acid Analyser

Atomic Absorption Spectrophotometer

Emmission spectrograph

Spectrofluorimeter

Infra Red Spectrophotometer.

A tour of the laboratory was conducted by Dr. Siri Varothi and equipment seen included:

Packard 2 column gas chromatograph. This instrument is 12 years old and although it does at times breakdown the agent gives good service and the department has an instrument technician and a workshop. Columns are packed and coated. Capillary columns are too expensive but could be used.

Varian Model 635 UV-visible spectrophotometer with temperature control and digital readout.

Perkin Elmer 124 Double beam UV and visible spectrophotometer. This equipment is old but still in good working order.

Varian A.A.5 Atomic Absorption Spectrophotometer with air/acetylene and Nitrous oxide/acetylene flames. A wide range of hollow cathode lamps are available.

Fisher Thermogravimetric Analyser Model 462

Perkin Elmer 137 Infra Red Spectrophotometer

Unicam SP 200 G Infra Red Spectrophotometer

Princeton Applied Research. Polarographic Analyser. Although a few years old this equipment is in regular use and will do most techniques including anodic stripping voltammetry but not A.C. polarography.

Mettler H20 single pan 4 figure balance

Mettler 5 figure balance new and not yet set-up. There is a stone bench available but no anti-vibration table.

Metrohm Coulometer; Coulostat E524. Integrator E525

Radiometer "Polaritor" polarograph. A very old instrument for simple polarography.

4 Analytical single pan 4 figure balances and a 2 figure top pan balance on a stone bench

Bauch and Lomb Spectronic 20 Spectrophotometer. A fairly new instrument.

Radiometer 28 pH Meter

Orion Selective Ion Meter with halide, cyanide and silver electrodes. This equipment is not yet set up.

Eberbach 2 place electrolysis equipment.

Fisher 2 place Electro Analyser

EEL. Flame photometer. This equipment was not working. The auther returned later in the day and checked it and made adjustments to the atomiser. It was left in a working condition but the sensitivity is low and the response sluggish. A new photocell is required.

Muffle Furnace

Tube Furnace to take two tubes

This laboratory does not carry out any of the tests for TISI although the University is authorised to test a total of 97 products. At present only 4 products are submitted for testing, local fish sauce, toilet soap, canned pineapple and tapioca products. These are analysed in the Laboratory of the Department of Chemical Technology. A very quick visit was made to this laboratory. The equipment could not be seen but included the following items:-

Spectrophotometer

Refractometer

Viscometer

Standard Equipment for Petroleum Testing

Gas Chromatograph - Varian with flame ionisation detector

Freezedrier

Several incubators for microbiology
Centrifuges
Thin layer chromatography

Polarimeter

Bomb calorimeter

This laboratory is not really geared up to do large numbers of tests for standard certification. However, when they have their new equipment, and if they can recruit suitable staff, then they should be able to carry out more work for T.I.S.I.. This cannot take place for some considerable time.

3.13 13.15 1980-12-23

Laboratory of the Department of Chemistry, Faculty of Science

Mahidol University

Head of Department: Dr. Vichai Reutrakul

Guide: Dr. Yuwadee Shiowatana - Lecturer

This department has been involved for about seven years in the work of TISI but so far it has only been advising on Standards and no samples have been tested. This laboratory is authorised to test 13 products.

The main aim of the work in this laboratory is concentrated on the teaching of 3rd and 4th Year Students. Of the staff of 40, only 2 are trained in analytical chemistry. While they are interested in doing outside testing, at present such work would overload the staff. Already there is a shortage of staff.

Dr. Vichai considered that it would be difficult to put this type of service work into a section of a university since the staff would always want to move into teaching or research. He also would recommend that a laboratory should be established to do standards testing but this laboratory should become the central body for all standards, cf. the National Bureau of Standards of the U.S..

However this department has instruments which are run by technicians. They could do more work and they would be willing to accept some supervision by inspectors from TISI.

The equipment seen included:-

Varian Series 2800 Gas Chromatograph. This is a large instrument and can be used for analytical and preparative purposes. They buy commercially packed columns including capillary columns.

Hewlet-Packard Gas Chromatograph

Beckman 20 A Infra Red Spectrophotometer

Perkin Elmer Infracord 137 Infra Red Spectrophotometer

Perkin Elmer Infracord 237 Infra Red Spectrophotometer

Coleman C - H Analyser

Coleman N Analyser

Du Pont 490F Gas Chromatograph/Mass Spectrometer This instrument is about 2 years old and is giving good service. Dr. Vichai and the operator say that they know the instrument inside out, do there own repairs and have made a few modifications to improve the instrument.

Varian A 60 D Nuclear Magnetic Resonance (N.M.R.) spectrometer. This is

11 years old and in good order.

Varian EM 360 L N.M.R. Spectrometer. This is a new instrument, only 1 year old. Both these units are operated routinely by technicians and at present they do not allow students to use them.

Beckman Acta V Spectrophotometer

Unicam S.P. 800 Spectrophotometer

X-ray Diffraction Spectrometer

This department has a well equipped glass-blowing workshop.

This laboratory is well equipped and well run and T.I.S.I. could have more samples analysed here. When necessary T.I.S.I. people could inspect the work to confirm the results of this laboratory.

3.14 09.20 1980-12-24

Department of Land Development, Ministry of Agriculture and Co-operatives, Soil Analysis Division

Acting Chief of Division: Dr. Somnuk Buachanda

This laboratory has a staff of 150 of which 50 are graduates; B.Sc. M.Sc. or Ph.D.. 180,000 determinations per year are carried out in 8 separate sections. In addition to the Soil Analysis Section, the Soil Chemistry Section and the Biological Section were toured. The laboratories are mostly fairly spacious and the instruments are a mixture of old and new but most are in good condition. The equipment available includes:-

Soil Analysis Section

A separate room for digestions with three fume cupboards

Perkin Elmer 303 Atomic Absorption Spectrophotometer with air/acetylene flame. Standard solutions are prepared from Merck P.A. grade chemicals

Coleman Junior Spectrophotometer

Fisher Scientific Model 21 Flame Photometer This instrument is very old and bore an acquisition label with the date 1967 .

Perkin Elmer, Coleman 51 -Ca Flame Photometer

Beckman DB - G Grating U.V. - Visible spectrophotometer

Beckman Expandomatic SS-2 pH meters. Several of these were spread around the various rooms.

Klett-Summerson Photo-Electric Colorimeter(1967.)

Hellige "Aqua-Analyser" Photo-Electric Colorimeter

There were four single-pan 4 figure analytical balances on an ordinary bench with no anti-vibration tables.

Beckman RC 16 B 2 Conductivity Bridge. An old model.

Beckman Conductivity Bridge Portable RB4-250

Philips PW 1410 X-ray Diffraction Spectrometer about 3 years old. Standards are available for 24 elements and 14 elements are routinely determined in soils. Johnson-Mathey "Specpure" chemicals are used to prepare standards. Ancilliary equipment were a Retch sample grinder and a pelleting press.

Filtration Equipment for the simultaneous determination of cation exchange capacity of soils on many samples.

Extraction Equipment for the measurement of soluble salts in soils - 36 place.

2 Chemlab SB 4 Freezedriers

Thermolyne Muffle furnace 1200 $^{o}C$.

3 Sieve shakers, one a large one for 10" test sieves.

There was also, in this section, a Bauch and Lomb Spectronic 20 Spectrophotometer but this was at the agents for repair.

In this laboratory were 20 soil scientists. They also had another laboratory in the north of the country.

Soil Chemistry Section

24 place Kjeldahl digestion equipment for nitrogen determination.

Large filtration equipment for the measurement of cation exchange capacity of soils

Teshtron AA 100 Single Beam Atomic Absorption Spectrophotometer with air/

acetylene flame for the determination of calcium, magnesium, lead, zinc, iron and manganese (UNDP)

Corning 400 Flame Photometer for sodium and potassium

Philips X-ray diffraction spectrometer. This equipment is 10 years old but continues to give good service and the operator is very experienced.

Du Pont 990 Thermal Analyser with a DTA cell used for the characterisation of clay minerals. This equipment is only 1 year old and is used to complement the X-ray diffraction equipment.

Biological Section. This section is only 5 years old and still needs more equipment.

Metrohm Automatic Titrator E505 and 626 Recorder used for chloride determination. This requires a voltage stabilizer.

Labconco Extraction Equipment for fat determination - 6 place.

Equipment for the determination of crude fibre. This was on an open bench and it should have better cooling to reduce errors. At present it is difficult to get good duplication of results.

Small muffle furnace used in the determination of silica. More furnace capacity is required to increase the throughput of silica determinations.

Beckman Zeromatic pH meter. 17 years old but still in use.

Mettler 4 figure, single pan balance on a solid bench.

Kemmert oven.

Mettler H 15 Balance

Becker Single pan balance

Sartorius 2462 200g single pan 4 figure balance. This was new.

No standard weights were available for testing and calibrating these balances.

In general this is a well-equipped and well-run laboratory. T.I.S.I. could have much more work done by this laboratory. A little help in the shape of furnaces and ovens would increase their capacity for the testing of tapioca which is currently analysed here.

3.15 14.00 1980-12-24

Department of Medical Sciences, Ministry of Public Health,

Food Analysis Division

Director: Mrs. Chawewon Halilamian

The staff of this laboratory numbers 52 of whom some are graduates with B.Sc., M.Sc. or Ph.D.. This division tests about 18,000 samples per year for a wide variety of parameters. About 15,000 are analysed in Bangkok and the others in provincial laboratories. Like other government laboratories this division suffered from shortage of staff, equipment, finance and, much more acutely, lack of space. Literally, every inch of space was used, with work going on in corridors, offices and even on the floor. However, it is planned to move into a new building next May, 1981. Equipment seen included:-

Paper Chromatograph for the determination of food colours.

Equipment for bottled water analysis. These are tested to W.H.O. standards using mainly classical methods of colorimetry and titrimetry together with atomic absorption spectrophotometry. This latter instrument is located in another room.

Bacteriological Section. This laboratory carries out full bacteriological examination of foods-stuffs both for local foods and foods for export. Methods used;plate counts and multiple tube analysis. No membrane filter techniques. Again this room was extremely crowded and a great deal of work appeared to be in process.

3 Autoclaves were available elsewhere.

2 Varian 8500 High Pressure Liquid Chromatographs

Varian Varichrome High Pressure Liquid Chromatograph

Hewlett-Packard High Pressure Liquid Chromatograph. This was a new instrument still in its crates having arrived only the previous day. These instruments are currently used mainly for pesticide residue analysis but they are developing methods for the determination of vitamins.

Varian Aerograph Series 2700 Gas Chromatograph with electron capture detector and alkali flame ionisation detector (A.F.I.D.) used for organo phosphorus, chloride and nitrogen.

Yanaco G. 180 Gas chromatograph with flame ionisation detector. Used for amino acid analysis

Sartorius 200 g. 4 figure Single Pan Balance

Sartorius Top Pan Balance

These were on a normal bench with no anti-vibration tables.

Perkin-Elmer 403 Atomic Absorption Spectrophotometer with air/acetylene and nitrous oxide/acetylene flames and a graphite furnace. This is used for the determination of heavy metals in food, beverages and water. There are 10 hallow cathode lamps available and the sample presentation is manual.

Coleman Flameless Mercury Analyser.

The Director of this Division, Mrs. Chaweewon Halilamian was reluctant to give an opinion about the ability of this laboratory to do more work for T.I.S.I. and she invited us to meet the Deputy Director General of the Department of Medical Sciences, Dr. Sutas Guptarak M.D.. He said that at present and until some time after the move into the new building it would not be possible to undertake much more work for T.I.S.I.. Since this institution is often analysing samples of the same products which T.I.S.I. needs to be tested, the possibility of collaboration to avoid duplication was discussed. The Ministry of Public Health sets its own standards and so far has 52 such. However it is not always possible to combine the testing for the Ministry and for T.I.S.I. because the standards are different. For example, the specifications for a local fish sauce would differ from the specifications for a fish sauce for export. It would therefore need very good collaboration to avoid duplication.

As there was still some time available we accepted an invitation to look quickly at some of the other divisions which carry out analytical work.

Drug Analysis Laboratory

Head: Mrs. Preeya Kashemsant

At present there are about 200 drug manufacturers in Thailand. They buy the drugs from abroad and compound them and prepare tablets etc.. Some factories are being set up for the local manufacture of anti-biotics and the production of ampicillin has just been licensed. There are 30,000 different preparations of modern drugs and 20,000 preparations of traditional drugs to be controlled.

The budget for this work is too low partly because the work of this Division is not in the public image. For this reason they continually look for aid. In the past this has come from various sources including West Germany and the U.S. A.I.D. programme. Equipment seen included the following:-

Perkin-Elmer M.P.F. 3 Spectrofluorometer

Perkin-Elmer 421 Grating Infra Red Spectrophotometer. This instrument is about 15 years old and spare parts are no longer available.

In the Narcotics laboratory was a Hilger and Watts H1550 Atomspek Spectrophotometer.

In the Toxicology Section was a Perkin Elmer 380 Atomic Absorption Spectrophotometer with air/acetylene flame and graphite furnace.

This laboratory should be visited again when they are fully established in their new building. The standard of work must be assessed again but at present some of their work must be of doubtful accuracy. It seems likely that it must be possible to have more confidence in their results when the laboratories are not so over-crowded. Until then it does not seem possible to send more samples for TISI testing.

3.16 09.30 1980-12-25

Division of Biological Science, Department of Science Service, Ministry of Science, Technology and Energy.

Division Head: Mrs. Viengvibha Charutamra

Head of General Food Research: Mr. Somchai Nuennariritr

This Division has a staff of 50 graduates and 3 more will join in January 1981. They have recently moved into a new building with large, spacious laboratories and not all equipment is moved and set-up. Now, their main problems are equipment shortages and lack of funds. When the decision has been taken to buy new equipment the budget request takes about 18 months for approval. Ordering then takes place directly from the manufacturer and delivery, which must be by sea, takes about 8 months. This system causes some problems when servicing is required through an agent. However not many agents give good service and only one manufacturer is known to have their own service engineers for the servicing of scientific instruments in Thailand. They are Philips/Pye-Unicam. This department uses instrument technicians from the Physics Department but these people do not all have good experience.

The government does give fellowships for study abroad and when the students return they are expected to continue in government service for several years or they must refund the cost of their studies. However it is still financially worth repaying this money and joining the private sector on going to work abroad. There is a considerable "brain-drain" to Singapore or to the Middle-East.

In spite of these constraints the turn around on samples is very quick and they could do more work for T.I.S.I.

Equipment seen was:-

Sample preparation room with mills etc.

Sauter and Mettler analytical balances. These will be on a solid bench and their calibration will be done regularly 4 times per year by the calibration section of Physics Division. This same section checks and calibrates all instruments.

2 Lindberg muffle furnaces

B.T.L. Kjeldahl equipment, 6-place.

Laboonco equipment for crude fibre determination 6-place

Amylograph for the viscosity and amylase activity of flour.

Brookfield Viscometer

Lovibond Tintometer

Beckman Zeromatic pH meter

Bauch & Lomb Refractometer with a temperature controlled circulating bath.

Cento, Solubility Index Mixer

Fisher, Karl Fischer Water determination apparatus

2 Bellingham and Stanley Polarimeters

A large centrifuge

Electrothermal, Rotary Evaporator

Pye-Unicam High Pressure Liquid Chromatograph

Kontron Amino Acid Analyser

Instrumentation Laboratories (IL) Atomic Absorption spectrophotometer. This instrument had recently arrived and was being installed by a company engineer. The instrument has provision for use with air/acetylene and Nitrous oxide/acetylene flames, graphite furnace, hydride generation and flameless mercury determination. It is microprocessor controlled and has a cathode ray display. Eight hollow-cathode lamps are available and B.D.H. Standard Solutions for Atomic Absorption will be used. Double distilled water will be used and this is produced in the laboratory.

Beckman Model 4500 Digital pH Meter. Four selective ion electrodes, for lead, cadmium, zinc and iron were ordered 18 months ago from Cole-Palmer but inspite of reminders have not yet been received.

Bauch and Lomb Spectronic 20 Spectrophotometer

Perkin-Elmer 50A Mercury Analyser

Varian 635 U.V. - visible Spectrophotometer.

Varian Series 2800 gas chromatograph with flame ionization and electron capture detectors. This section packs its own columns.

2 - 6 place Sohxlet extraction equipment

There were a variety of ovens including a Heracus vacuum oven.

This laboratory was well run and T.I.S.I. has good confidence in their results. At present 13 products are tested for TISI here but more work could be done.

3.17 . 11.00 1980-12-29

Thai Theparos R.O.P. Factory

Factory Manager: Mr. Somsakdi Vacharothayangul

This factory manufactures Soy sauces from soya beans and has four grades depending on the protein content. The first grade contains 20% of protein and about 5% is exported. This grade also is the only one to be certified and to carry the standard mark.

The manager is responsible for the quality control and he has an analyst whom he is training and who is also a student of Ramkhamhaeng Open University. The manager himself is qualified in Agricultural Product Processing.

The quality control analysis is relatively simple and begins with an examination of the beans for water content, foreign matter such as sand and gravel,and protein content. The protein is extracted and oil is removed and then it is hydrolysed by digestion with hydrochloric acid. The strength of the acid is checked by hydrometer and samples are sent for heavy metal determination to the Department of Science Services, Ministry of Science, Technology and Energy. The hydrolysate is neutralised to pH 5-6 with soda ash which is periodically tested in the Department of Science Services. After filtration a sample is analysed in the laboratory for pH, S.G., Taste, Odour, Clarity, Total Nitrogen, Amino Acid Nitrogen and Sodium Chloride. The sauce is then allowed to stand in vats for one week, filtered, retested and bottled.

The laboratory was a clean air-conditioned room, small but not overcrowded and had the following equipment.

Soxlet apparatus with temperature controlled heater for the determination of fats and oil.

EIL 7010 pH Meter. This is buffered using Merck "Titrisol" buffer solutions.

2-Pan analytical balance on an open bench with a set of chromium plated weights. This balance was in good condition but they will buy an electronic balance.

6-Place Kjeldahl digestion equipment in a fume cupboard.

2 Memmert Ovens

Still to produce distilled water for the laboratory.

The laboratory was clean, tidy and adequate for the work required.

3.18 13.30 1980-12-29

Bangkok Steel Industries Company Ltd.

Head of Q.C. Dept.: Mr. Vidhaya Hankitiponggpaisarn

This factory manufactures steel reinforcing bars and compliance with the TIS Standard is compulsory. Their raw material is scrap steel which is melted and conditioned in two electric furnaces. The factory operates a three shift system and there are 16 casts per day. Each batch is tested 4 or 5 times. Formally the analysis was by conventional wet chemical methods but for the past five years they have used a Jarrell-Ash Atomcomp spectrographic analyser fitted with a PDP8/m minicomputer and teletype output. This equipment is in a well air-conditioned room and there are six operators, two for each shift. They carry out the chemical analysis and the tensile testing. The analysis gives the concentration of eight elements:-

Carbon, Silicon, Sulphur, Phosphorus, Manganese, Tin, Copper and Aluminium

They could also determine chromium, molybdenum and nickel but they do not do so at present.

The instrument is calibrated daily using an A.S.T.M. analysed steel and this is a sub-standard. The electrode is cleaned and the calibration is checked weekly using an N.B.S. analysed standard steel. There are three

minicomputer modules, one running and two for standby. Maintenance is by their own instrument engineer or by the Jarrell-Ash company in Hong-Kong or the U.S.A.. They have a maintenance contract with the company.

This laboratory was very well run and maintained. The equipment should give better and more reliable results than some of the TISI authorised laboratories. It would be better for TISI inspectors to check the calibration and analysis at the factory instead of sending samples to a laboratory which does not have such good facilities as this factory.

3.19 10.10 1980-12-30

Siam Chemical Co., Ltd.

Head of Laboratory: Miss Sunee Chotikapanich

This company manufactures sulphuric acid, oleum, aluminium sulphate, potassium alumium sulphate, fertilizer and nitrous oxide gas.

The staff for this laboratory numbered three, including Miss S. Chotikapanich, and two were from Technical School and one from Secondary School.

The laboratory was small and had some good volumetric glassware. Some equipment was new but most was old and looked very unreliable. Equipment included:-

Gas analysis equipment - Eudiometer. Very old and did not look used.

Sauter 4 figure single pan balance on a steel bench. This appeared to be in a reasonable condition.

Yellow Springs Instrument Co. conductivity and salinity meter

Heto Thermostatically controlled water bath

Oven

Muffle furnace

1 Fume cupboard with a hotplate

Ohaus Triple Beam Balance which is calibrated weekly with a set of standard weights.

Test kit for boiler water testing. In an unuseable condition.

I.R. Moisture balance looked new but not used.

Apparatus for the determination of acility and alkalinity in nitrous oxide. Gas was flowing through cylinders of dilute sodium hydroxide solution and hydrochloric acid solution but a flow meter, on the bench, was not connected. This test was relatively meaningless.

It was stated that this factory sends some samples to the Department of Science Services, Ministry of Science Technology and Energy. If sufficient samples are submitted then quality control might be reasonable but the general impression was that this laboratory would not provide adequate or reliable results.

3.20 10.50 1980-12-30

Thai Central Chemical Co. Ltd.

Production Manager: Mr. Kamol

Assistant Divisional Chief, Technical Control Division:

Mr. Pairoj Punyavut

This company manufactures a mixed fertilizer containing nitrogen, phosphate and potassium.

The staff of the laboratory is 15 with 4 graduates and 11 High School graduates.

There are two production lines which are automatically sampled every five minutes to give a bulked sample every 2 hours on a 24 hour basis.

The product is sampled in accordance with the TIS 75-1974 and analysed for Nitrogen, phosphate, potassium and moisture by the standard methods of the American Organisation of Official Analysts.

In addition raw materials, boiler feed and effluent are tested.

Equipment seen:-

Grinder

Riffles for coning and quartering

3 Shimadzu Single pan, 4 figure balances in an instrument room and on a solid stone bench. These are calibrated with standard weights.

3 Hitachi 100-10 Spectrophotometers

Hitachi 205 Flame Photometer for Potassium

Hiranuma Flame Photometer

Horiba pH Meter with Horiba buffer solutions

2 Large seive shakers

2 Fume cupboards

Digestion equipment for nitrogen in raw materials

2 Toyo Kagaku Sangyo forced circulation ovens

Labal oven

16 Place Ammonia distillation equipment

Muffle furnace

Chemicals were May & Baker, or Riedel DeHaën analytical grade and distilled water was produced by condensing some of the factory steam supply. Standards are prepared from AR chemicals. In case of breakdowns they have their own instrument mechanics.

This laboratory appeared to be well run and efficient. Although there was no spare space it was not seriously crowded. The work should be adequate.

3.21 1980-12-30

Thai-Asahi Caustic Soda Co., Ltd.

Assistant Factory Manager for Technical Division, Adviser:

Mr. Mohabir Koder

Chief Section of Quality Control: Mr. Somchai Laichilassunthorn

This factory produces sodium hydroxide, liquid chlorine, hydrochloric acid, and sodium hypochlorite solution.

The staff of nine comprises 2 graduate chemists and 7 High School graduates each with 4 - 5 years laboratory experience.

In addition to the testing of the products, the raw materials, intermediates and waste waters are analysed. Many samples are analysed each day.

The laboratory is new and consists of a laboratory for wet chemical analysis, a small room with solid stone benches for instruments and another similar for balances. The balance room has a dehumidifier and the

instrument room will have one installed soon.

Equipment seen was:-

2 Perkin Elmer - Coleman 50 Mercury analysers

Bauch and Lomb Spectronic 20 Spectrophotometer. This will be replaced by a more sophisticated instrument.

Sauter 4 figure single pan balance

Mettler 4 figure single pan balance. These are calibrated by the agents technician but they have asked for a quotation for a set of standard weights so that they can calibrate the balance.

2 Thermostated Water Baths

An oven

A Muffle furnace for 1100 $^{o}C$

3 Fume cupboards

Toa H M - TA pH Meter

Centrifuge

In addition they will buy a Varian 475 Atomic Absorption Spectrophotometer and a Shimadzu Gas Chromatograph.

They buy some concentrated standard solutions such as Merck "Titrisol", M & B "Volucon" or Riedel De Haën "Fixanal" but they prefer to make up and standardise their own reagent solutions from A.R. chemicals.

They use deionised water but where the highest purity is required they buy triple-distilled water.

This laboratory appeared to be well run and completely adequate for the required quality control analysis.

3.22 09.30 1981-1-2

Siam Cement Company Ltd.

Assistant Manager Technical Division: Dr. Bancha Udomsakdhi

Head of Material testing laboratory: Mr. Sahaschi Subsirin

This company operates four cement factories and formerly the quality control analysis employed wet chemical methods according to A.S.T.M.. Now they have replaced these laboratories by on-line X-ray fluorescence spectrometers. These are operated by a staff of chemists and a physicist who have been abroad for training. For servicing they use their electrical engineer one of whom is in each factory. They also have a service contract with the company whose workshop is located in Singapore.

They also have a central laboratory which analyses materials for import or export and to deal with customer complaints.

The staff of eight, of whom four are graduates have been with the company for 10 to 15 years. The analytical methods are mainly wet chemical methods in accordance with A.S.T.M. and atomic absorption methods. About 300 samples are analysed for about 7 parameters each per month.

Equipment seen:-

2 large distillation equipments for the determination of free lime by the glycerol-ethanol solution technique (A.S.T.M. C 114-67; 73-77). This method describes a procedure for boiling under reflux but the condensers were in the normal distillation position.

Three 4-figure single pan analytical balances, Mettler, Sartorius and Sauter on solid benches.

Mettler top pan balance on a solid bench and in a cabinet.

These balances are checked against a set of standard weights.

Two large and two small Gallenkamp muffle furnaces

Two Memmert Drying Ovens

Acid Digestion Bomb

Perkin Elmer 35 Digital Spectrophotometer

Coleman Junior II Spectrophotometer

Coleman Model 21 Flame Photometer - Not now in use.

Radiometer Model 22 pH Meter. Now old and cannot get serviced.

Radiometer PHM 61 pH Meter

Strohlein furnace equipment for carbon determination

Fisher Controlled Potential Electro-Analyser - 2 place, no longer used.

Varian A/A6 Atomic Absorption Spectrophotometer for Nitrous oxide/acetylene and air acetylene flame. Lamps for 12 elements are available. The distilled water for this equipment and for general use in the laboratory came from a Manesty Still. The service for this instrument from the agent was not good.

Wagner Turbidimeter for the measurement of fineness of cement.

Three Thermolyne 4-place magnetic stirrer/hotplates.

This was a large company and Dr. Bancha Udomsakdhi was fully aware of the importance of good quality control and the implications of standardisation. The use of X-ray fluorescence on-line is expensive but for a large company is a good investment. The central laboratory was well equipped, not crowded and everyone appeared to be working. The only reservation is concerned with the apparently wrong use of the equipment for free lime measurement. Otherwise the work appeared to be of a high standard.

3.23 13.00 1981-1-2

Thai Foods and Drinks Co. Ltd.

This is a relatively small factory which produces vinegar from molasses, sugar and glutinous rice by a combination of distillation and fermentation. When we arrived there was little activity to be seen and there was no-one in the small laboratory. Like some other laboratories this had a mixture of new and old equipment. A quick look around showed the following equipment:

Sartorius 2355 3 figure, Top-Pan Balance on an ordinary bench.

Large 2 pan balance suitable for rough work

1 small hotplate

6-place water bath

Radiometer PHM 61 pH meter with Radiometer buffer solutions and potassium chloride solution. This equipment looked new but the electrode was dry.

Hertel & Reuss Binocular Microscope with rotating objective turret. This was in a woolen case and looked as though it was not used.

Electrothermal Heating Mantle

Two 50-ml burettes

An alcohol meter

A few May and Baker Laboratory Chemicals.

It would be very doubtful if this laboratory, as seen, could do the quality control analysis required for a product which carries the TISI mark. However it is not really fair to judge too harshly when the analyst was not present. It is possible that heavy metal analysis is carried out by an outside laboratory but the test methods require some measurements at 27 $^{o}$C and there was no sign of a temperature controlled water bath or circulator.

3.23 10.00 1981-1-5

Safa Provision Industries Company Ltd.

This company originally made mono Sodium L-Glutamate Monohydrate from the raw materials. The product was certified and bore the TISI mark. However they could not compete with much better-known Japanese brand name and ceased production some time ago. Now they buy a solution from the local factory which uses this brand name. The only processing carried out is decolorising with activated carbon and crystallisation. They rely on the quality of the solution being satisfactory and the only quality control is a measurement of pH and the tests carried out by TISI. The pH Meter was a TAO Digital pH Meter HM-12-A. This looked new but the small bottles of buffer solutions were in the original carton and looked unused. Two of

the controls were taped over.

With such a simple process it is likely that the product will satisfy the tests on samples taken by TISI but the factory quality control is inadequate for a product to carry the TISI mark.

4. Problems concerned with Testing

Section 2 of the job description requires an assessment of the technical problems which might cause some delays in testing product samples. Whilst this problem is present and of importance, it is not the only problem. Administration, lack of staff, lack of budget funds, and the validity of test methods are all problems requiring investigation.

When testing is to be carried out for TISI then there should be a definite priority given to this work. The operators should be of the highest calibre available and there must be adequate equipment to do the tests to the high standard required by TISI.

One of the most serious technical problems which is constantly encountered is the lack of maintenance and service engineers. It appears that agents do not employ adequate service and maintenance engineers for the instruments which they sell. Some institutions can do simple maintenance but if serious problems arise equipment either takes a long time to be repaired or, worse still, is abandoned. A further complication is that much equipment has been ordered directly from the manufacturer and there is no-one in the country trained in the maintenance of such equipment. Outside aid agencies such as the United Nations often seem to commit this error. However it is recognised that this situation is often inevitable.

Another serious problem which seems fundamental to the whole question of standardisation is the fact that in some cases there are now two sets of standards, the standards applied by a particular institute and the T.I.S.. In certain cases e.g. leather, the standards and analytical methods of a particular institute are better than those of T.I.S.I.. It seems logical that where a given product is produced to an existing standard then this should form the basis for the Thai Industrial Standard and when the T.I.S. is promulgated then all tests should conform to this standard. This should

cut out duplication of work and speed up the testing of samples for TISI.

It seems difficult to see how an institute such as the Institute of Food Research and Product Development can reconcile the conflicting demands of its own work and T.I.S.I., whose work should have a high priority. Either a different agency should be employed by TISI or it should have its own test facilities.

One thing which was noted during the laboratory visits was the very large amounts of paperwork and files everywhere. It seems probable that improved administrative procedures could cut out sometime wastage. For example the methods of labelling and numbering of samples seemed to be poorly organised.

The most important restraint on the development of standardisation of Thailands products is the lack of funds and the lack of trained manpower. This is compounded by the fragmentation of effort into many different laboratories. However, it is not as simple as it might appear, to say that the effort should all be concentrated into one institute. Many laboratories serve two purposes, analytical control for product development studies and analytical testing for standardisation. The same equipment, instruments and staff are employed for both purposes and to remove standards testing would not liberate equipment nor, in many cases, staff.

Consideration of all of these points seems to lead one to the conclusion that TISI must continue to make the best use possible of existing facilities. This implies that priorities should be negociated, funds could be allocated to selected laboratories, and adequate payment should be made for work done. TISI might also provide funds for the training of staff. It is also important that regular checks are carried out on the authorised laboratories. These arrangements will still leave some work which must be carried only by TISI and it is recommended that a new laboratory should be set up.

5. Differences between the Test Results obtained from an Authorised Laboratory and Company Laboratory

In the time available it has not been possible to investigate an actual case of a discrepancy in results. TISI staff say that this is a difficult situation. According to the law the authorised laboratory's results should be upheld. In practice another sample would be taken and sometimes simultaneous samples are sent to two or three laboratories. Then TISI staff make a decision on the matter. It is not possible to investigate the causes of such discrepancies in an actual case.

6. List of Equipment Required to Supplement the Capacity of the Authorised Laboratories

At this stage and having seen so few Thai standards in English it is not possible to produce a comprehensive list of equipment which is required to supplement the capacity of the authorised laboratories. Instead it is possible to single out a number of types of instruments which are required. In several cases a number of each item is needed. A list with very approximate price estimates are given. This is not an exhaustive listing

| Item | Manufacturer | Estimated Price |
|---|---|---|
| Selective Ion Meters | Philips | each |
| | Orion | $1,250 |
| | E.I.L. | |
| | Tacussel | |
| | Radiometer | |
| | Beckman | |
| Selective Ion Electrodes | | $360 |
| Automatic Analysers | Technicon | The cost varies greatly |
| | Acculab | according to the manufacturer |
| | Chemlab | and the size and sophistica- |
| | Pye-Unicam | tion of the instrument. |
| | Perkin Elmer | A simple single channel |
| | Frost Instruments | system would cost from |
| | Gradko | $10,000. A large instru- |
| | Carlo Erba | ment for 12 parameters |
| | Ionics Inc | might cost $250,000. |
| U.V. visible spectro- | Perkin-Elmer | $20,000 |
| photometer | Cecil Instruments | |
| | Pye-Unicam | |
| | Zeiss | |

| Item | Manufacturer | Estimated Price |
|---|---|---|
| | Bauch and Lomb | |
| | Hitachi | |
| | Jobin Yvon | |
| | Gilford Instruments | |
| | Beckman | |
| Atomic Absorption | Perkin-Elmer | $70,000 |
| Spectro photometer | Pye-Unicam | |
| preferably suitable | Beckman | |
| for all atomising | Varian | |
| techniques and with | Instrumentation Laboratory | |
| automatic sample feed | Hitachi | |
| and recording. | Rank Hilger | |
| | Jarrel-Ash | |
| | Baird | |
| High Pressure Liquid | Hewlett-Packard | $45,000 |
| Chromatography | Pye-Unicam | |
| | Du Pont Co. | |
| | Laboratory Data Control | |
| | Tracor Inc. | |
| Spectrofluorimeter | Beckman | |
| | Perkin Elmer | |
| | Zeiss | |
| Automatic Titrator | Metrohm | $16,000 |
| | Solea-Tacussel | |
| | Radiometer | |
| | Mettler | |

| Item | Manufacturer | Estimated Price |
|---|---|---|
| Polarographic Analyser with Anodic Stripping Voltametry | Princeton Applied Research<br>Solea-Tacussel<br>Setaram<br>Mitsubishi<br>EGO Instruments | $40,000 |

Other small equipment which seems to be required in many laboratories include the following items. Names of manufacturers are not given as there are very many and most items can be found in the catalogue of any general laboratory supplier. Similarly prices are omitted since it is not possible to estimate the numbers of each item which might be required:-

Hotplates of various sizes

Stirrers

Ovens

Balance tables

Automatic dilutors

Standard certified weights

Micro pipettes

Thin layer chromatography spreaders

N.B.S. Certified Standards

Furnaces

Voltage Stabilisers

## 7. T.I.S.I.'s Future Needs for Testing Facilities

### 7.1 A New TISI Laboratory?

The general impression, after a few short laboratory tours and having read some of the standards, is that many tests cannot be carried out with the degree of confidence necessary for standard certification. Many laboratories need only more funds and they could do more good work. Others lack both funds and space. A general restraint on testing is the lack of staff and this is mainly due to the difference between government and private salaries. Finally some laboratories appear to be completely unsuitable for standards testing.

Part of the general problem must be due to the proliferation of laboratories doing very similar analytical work and having similar equipment. Under these circumstances it seems wrong to suggest that TISI should set up its own testing laboratory but it seems inevitable that this must happen if the number of standards are to be increased and if the numbers of samples tested are to increase. The other reason for setting up a TISI laboratory would be to improve the quality of work to the point where TISI staff could take their test results to a court of law with absolute confidence. These two reasons are sufficient to demand that a new T.I.S.I. Standards Testing and Certification Laboratory should be established. However this cannot be done quickly, without a lot of detailed planning and in the meantime authorised laboratories will have to continue to do the testing. As stated in Section III.iii TISTR, Ministry of Science, Technology and Energy, is a very well run laboratory and could use some support until such time as the TISI laboratory is fully operational. Several other government authorised laboratories could do more work for TISI and some of these would need some help.

### 7.2 A Chemical Testing Laboratory for TISI

As part of a TISI testing and certification laboratory the chemical

section should have the following laboratories and facilities:-

Inorganic chemical laboratories

Organic chemical laboratories

Physical chemical laboratories

Bacteriological laboratories

Technical library

Reproduction Section

In addition there must be the following support facilities:-

Workshop with qualified instrument engineers and technicians

Glass blowing workshop

Stores and Purchase section with adequate storage for chemicals, glassware and equipment and an up-to-date catalogue library with manufacturers literature

Secretarial personnel

Maintenance personnel for electrical and plumbing services etc.

The staff of this laboratory should be recruited carefully and as much weight should be given to their experience as to qualifications. The initial staff should be recruited for their knowledge and experience with a particular technique or instrumental method of analysis. The head of each section should be a working scientist and should be exempt from all unnecessary administrative work. As the laboratory grows then assistants could be employed for on-the-job training. Eventually new graduates could be employed to learn the techniques, to carry out testing and to take over at some point from the older staff.

Wherever possible, training should be provided by allowing staff to visit laboratories and standards institutions abroad or to attend short courses on a particular technique.

It is virtually impossible at this stage, and without a detailed study of the future aims and intensions of T.I.S.I. to say how much equip-

ment and instrumentation will be required for these laboratories. The whole project for the establishment of a TISI testing laboratory needs a very detailed feasibility study with all the relevant figures for numbers of samples, numbers of tests and numbers of products to be tested. However it is possible to indicate the types of equipment which will be required. These are arranged according to the branch of analysis. Costs are omitted as being almost meaningless at this stage even if the author knew them all.

Inorganic Equipment

Atomic Absorption Spectrophotometer for flame techniques, hydride generation and flameless mercury analysis

Atomic Absorption Spectrophotometer for graphite furnace operation. Automatic sample injection and recording to be included

A wide range of hollow cathode lamps will be required and provision should be made for the use of electrodeless discharge lamps. Standards should include BDH standard solutions and Johnson-Mathey specpure chemicals.

Polarographic Analyser for all the techniques of polarography especially anodic stripping voltametry Hanging mercury drop and glassy carbon electrodes should be available.

Automatic Colorimetric Analysers. It seems likely that several of these instruments could be used. Some might be multichannel instruments dedicated to a particular type of sample such as fertilizers or water and others could be single channel instruments for a variety of tests.

U.V. - Visible Spectrophotometers. Used for small batch tests, the development of analytical colorimetric methods and as a back-up for the automatic analysers.

Flame Photometers for sodium, potassium and calcium where an atomic absorption spectrophotometer is not necessary.

Selective Ion Meter with a variety of selective ion electrodes and probes.

Thermogravimetric Analyser for thermogravimetry differential thermal analysis and differential scanning calorimetry.

X-ray Diffraction Spectrometer

X-ray Fluorescence Spectrometer

Automatic Titration Equipment with provision for $pX/\Delta V$ & $p X/\Delta V$ and $\Delta^2 pX/\Delta V$ recording. Also suitable for dead-stop titrations.

Nephelometer

Carbon, Nitrogen Sulphur Analysers for steel

Conductivity meter

Organic Equipment

Spectrofluorimeter

Gas Chromatographs with a variety of detectors

High pressure liquid chromatographs

Infra-red Spectrophotometers

U.V.-Visible Spectrophotometer

Equipment for Petroleum testing such as flash-point determination, calorific value, octane number.

Equipment for Thin Layer Chromatography, paper and column chromatography

Physical Equipment including instruments used generally in all sections

pH Meters

Conductively Meters

Ovens

Hotplates

Heating Mantles

Furnaces

Stirrers

Water baths

Temperature controlled circulators

Viscometers

Density measuring equipment

Particle size analyser

Seives and seive shakers

Refractometer

Bacteriological Section

Incubators

$CO_2$ Incubators

Water baths and shaking water baths

Colony counter

Sterilizers

Autoclaves

Microscope with direct, polarising and darkfield illumination and equipped for projection and microphotography

Equipment for Membrane Filtration Techniques

In addition there must be equipment for mycology and other forms of microbiological testing of foodstuffs etc. but this is outside the knowledge of the author.

Moisture balance

Balances. There should be enough single pan 4 figure analytical balances for all the work so that no-one has to wait too long for a balance. These should be in a separate draught proof, air-conditioned balance room on stone benches and with anti-vibration tables. Certified weights should be available for calibration purposes. Some 5 and 6 figure microbalances are also necessary for micro analysis. This balance room aught to be a central facility for all the laboratories.

Automatic samplers and dilutors with variable dilution ratios.

It would probably be an advantage to instal a central voltage stabilizer for the whole laboratory since many instruments are affected by large voltage fluctuations.

Services should include adequate electrical outlets, cold and hot

tap water, piped gas and piped deionised water.

Adequate safety precautions should be provided such as laboratory coats, safety shoes, safety spectacles, goggles and face shields. First aid equipment including eye wash stations, showers and dressing stations should be provided. Fire fighting equipment such as fire extinguishers, alarm system and fire-blankets should be available and clearly marked. Fume cupboards should be regularly cleaned and maintained, perchloric acid should only be used in a fume cupboard designed for this purpose. If cyanides are used then the antidote should be prepared regularly and if hydrofluoric acid is used then magnesium oxide paste should be available. Rubber gloves and PVC aprons should also be kept. If radio-activity is used or other radiation sources such as X-rays then radiation film badges should be worn. Staff should be trained in safety measures. Unauthorised persons should not be allowed into laboratories and visitors should wear laboratory coats. No food or drink should be allowed in chemical and bacteriological laboratories. Adequate rest room facilities should be available.

7.3 Experts

It is important that these laboratories should have some expert assistance if they are to be set up and operating in a reasonably short time. The present author does not consider that any one expert would have the necessary experience to advice on all of this work. At least two experts, and preferably three should be available to help and advise in the setting up of the laboratories, the purchase of equipment and the development of test methods. The fields to be covered are; inorganic chemical analysis, organic chemical analysis, physico-chemical testing, biochemical analysis, microbiological examinations and laboratory administration.

It would be advantageous if there were some way for an expert to become familiar with the needs of the laboratory and its stage of development and to spend some time in his own (developed) country gathering information

about the current state of instrument development, modern analytical techniques and approximate costs of equipment.

Such experts should then be available at the appropriate time in the laboratory to help with the development of test methods using these instruments.

This would require careful planning and organising by the responsible agency.

7.4 Fellowships

In this kind of work it is very important that the staff carrying out analytical work are not only familiar with the technique but that they fully appreciate the accuracy and precision of those methods. They should be fully aware of the importance of regular calibration and checking of methods both by the analysis of certified standards and by checks of results by one or more different techniques. When a method is to be recommended as a standard test method, it is useful to do inter-laboratory checks to ensure that these laboratories can carry out the tests in a satisfactory manner.

Staff should be sent on short courses for new analytical techniques e.g. summer schools, industry-organised courses and short university courses. If possible some persons should visit a Standards Institute in a developed country to study their methods of operating. Unless the head of this laboratory is already well experienced in the analysis and testing to Standard Certification levels, he should be given a fellowship to visit a Standard Institute abroad for at least four months.

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