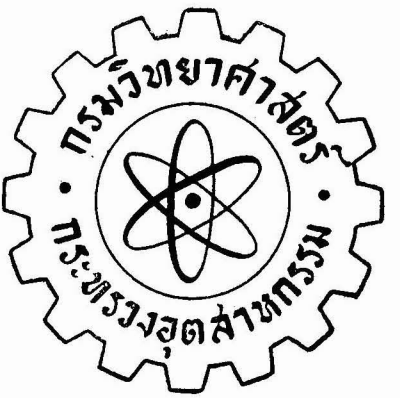

REPORT UPON THE WORK OF THE

DEPARTMENT OF SCIENCE

Ministry of Industry
Bangkok, Thailand

No. 16

FOR THE YEARS B.E. 2494 (1951) AND B.E. 2495 (1952)

FOREWORD

This is the sixteenth report upon the work of the Department of Science covering the activities for the years 1951 and 1952. It has always been my intention to bring both editions, (Thai and English) up-to-date, but, unfortunately, circumstances have not so far permitted its realization. The English edition, having to follow its Thai prototype, has, however, caught up with the Thai edition in this present volume. From now on publications in both languages it is hoped will follow one another in a more rapid succession.

Charng Ratanarat
Dr. phil. nat. (magna cum laude), Dip. Chem.
Director-General

STAFF

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Members :

Administrative Chiefs of Sections	4
Administrative Assistant Chiefs of Sections	5
Chemists, Chiefs of Sections	11
Chemists	14
Assistant Chemists	33

GENERAL REVIEW

Towards the end of the period covered by this report the main construction work at the new site, Rama VI Road, was completed. Laboratory furnishing was so well under way that almost the entire work of the Department could be transferred to the new premises by the end of March 1953. Despite much time and labour required in dismantling, moving, and reassembling apparatus and furniture, the volume of work carried out during this period was favourably comparable to that of the last report. Increased facilities through greater working space, better power, gas, and water supplies in its new laboratories had more than accounted the loss of time. With the Royal Decree for its reorganization (impending), the Department should be in a much better position to render its service more efficiently and extensively than previously possible.

During this period the total number of technical personal has decreased by 4 persons. Comparatively more staff members were sent abroad on study-tours and as delegates to various international conferences than previously, in order to broaden their outlook and bring about closer relationships with other scientific institutions and organizations. This policy of encouragement should be more strengthened in future, since the benefit, reaped through this means, has proved very effective beyond all doubts.

In its execution of administrative duty, the Office of the Secretary had reviewed its classical procedures and introduced newer systems in filing, recording, and other clerical routines with notable improvement in efficiency. The Library acquired more books and periodicals, but still, it fell far too short of its predetermined goal as the central scientific library of the country due to limited budget appropriations. This period, however, had seen a considerable increase in the number of its users—an increase of more than 25 percent.

The School of Analytical Chemistry Training has not yet been able to satisfy the yearly popular demand of various organizations of its graduates. More incentives have been con-

sidered to promote greater enrollment of undergraduates in the near future.

The Division of Chemistry, which has been entrusted mostly with routine analytical work, has recorded a few noteworthy results of analysis typical of its task. The survey and study of natural springs were continued unabated, the results of which will be compiled and published as a technical document in due course.

The work of the Division of Industrial Chemistry may broadly be subdivided into two main themes—research and routine analysis. In this period an important study was made on the composition of a great many varieties of Thai foods and diets. Relationships between market prices and nutritive values of staple foodstuffs were investigated with a view to provide guidance in the selection of food of the best value and to bring to light misunderstandings with respect to the qualities of certain foods, which are traditionally popular. Examinations of raw materials for industry were also undertaken, and appraisals were made on feasibilities of paper pulp and natural lac resins as industrial materials.

The Division of Industrial Research was principally concerned during this period with industrial research problems and its workshop service. Its repair and maintenance facilities saved the Department quite a considerable sum in the yearly expenditure, apart from the provisions of the right materials and special designs according to specific needs, which, naturally and constantly, were required in the work of this nature. In this report many interesting research problems are recorded under appropriate headings i.e. Hydrogenation of the Destructive Distillates from Rubber Smoked Sheet and Yang (Dipterocarpus spp.) Oil, Lignite Cleansing and Briquetting, Destructive Distillation of Wood, and Aluminium Sulphate from White Clay—one of the nation's abundant resources.

Closer co-operation with foreign and internal scientific institutions and organizations was intensified during this period, exemplified by increased activities in foreign study-tours, participation in international conferences, and active support given to the Science Society of Thailand under Royal patronage.

Popularization of Science was also encouraged through various channels such as regular broadcasting, publications in popular science magazines and journals, lectures, demonstrations, and exhibitions. Information service on scientific problems and queries was rendered gratis to interested individuals as well as private concerns whenever needed.

CERTIFICATION OF LOCALLY-MANUFACTURED PRODUCTS

A total of 75 articles were received for certification, 46 in B.E. 2494 (1951) and 29 in B.E. 2495 (1952), out of which 41 were new products, the remainders were duly sent in for the annual renewal of certification. There was a marked increase in the number of soft drinks requested for this purpose, particularly in the year 1951 following the Public Health Regulation on standards and sale of non-alcoholic beverages. Unfortunately, all of these types of products were not up to the standard requirement, and, therefore, could not be accepted for certification. However, it was definitely a good sign that the public and producers alike were beginning to realize the importance of certification.

OFFICE OF THE SECRETARY

Registration Section :

Its volume of work had showed a slight increase over that of the same period in the last report. Apart from its routine functions, this Section was heavily burdened with extra clerical work, resulting from a great many commissions and boards, in which one or more officials of the Department were active participants. Statistical records of the work of the whole Department were also entrusted to this Section; this rendering its task much harder in proportion to its limited staff.

Finance Section :

In the period covered by this report the Finance Section had seen a considerable increase in the budget appropriation of more than 5,000,000 Baht. This sum was earmarked for the

construction of our new site, the foundation of which was completed before the last World War. The greater allocation, coupled with need stricter fiscal regulations, naturally involved so much more extra-work for this Section that the limited number of its staff was very keenly felt as never before.

Store Section :

Heavier responsibility was placed on this Section with respect to the transfer of furniture, chemicals and equipment to the new site. This task, however, necessitated the assistance and co-operation of the Work Shop Section, which provided skilled labour in the dismantling and reassembling of equipment and furniture, too cumbersome for ease of handling. The work, nevertheless, proved to be so laborious that it had to be continued a few months longer than its originally planned completion period.

Library Section :

The Library made appreciable progress during this period. Book Exchange was instituted as an additional policy in the operation of its service. Assistance and co-operation with UNESCO and United States Book Exchange were also solicited. The new venture made available, from internal as well as foreign exchanges, an additional total of 3,635 volumes in the two years covered by this report.

The number of periodicals has, however, not been increased, since the budget appropriated for this purpose remained the same as previously. In kinds the periodicals under subscriptions were 26 from the United Kingdom and 42 from the United States.

More interest in the Library was shown by the steady increase in the number of its users and the number of books on loan for use outside the Library.

In order to render its service more expediently and to keep in pace with the fast growing requirement in its capacity, the Librarian was granted permission to study and be trained abroad in the science librarianship for a period of 11 months. Most of her time was, however, spent in various technical libraries in the U.S., made possible through the kind assistance of the U.S.

Government Authority concerned — to whom the Department of Science wishes to acknowledge here its grateful appreciation.

SCHOOL OF ANALYTICAL CHEMISTRY TRAINING

Calendar and Syllabus of the School still remained the same as in the previous report. The number of graduates, totalling 11 in this period, failed far short to meet the increasing demands of industries and laboratories. Much as the School would have liked to enroll to its full capacity of 20 students, it had to keep up its prestige and reputation, which it has enjoyed since its establishment, in the dependable quality of its graduates. Only the successful and promising candidates were, therefore, selected to the School. That this policy of quality before number has always had public approval, has been repeatedly shown by past records of full employment and constant surplus demand its graduates. More incentives, however, have been felt needed to promote capacity enrollment of the more promising candidates, who generally seek university entrance as their first priority before coming here. It is believed that one way is to extend the present 2 year course to 3 years, so that at the end of 3 years the graduate will be entitled to a higher scale of salary basically equivalent to those graduating from the Cadet School of the Army.

DIVISION OF CHEMISTRY

Forensic Chemistry Section :

The following samples were examined:—

B.E. 2494 (1951)

	No. of Samples	Negative	Positive
Human Blood Stains	150	90	60
Seminal Fluid Stains	3	—	3
Firearms (Indication of Firing after the last cleaning)	1	1	—

B.E. 2495 (1952)

	No. of Samples	Negative	Positive
Human Blood Stains	106	65	41
Seminal Fluid Stains	16	4	12
Firearms (Indication of Firing after the last cleaning)	1	—	1

Officials of this Section attended the Criminal Court as witnesses in 35 cases during this period.

The Chief of the Section, Mr. Prem Bhanijpol, was invited to give two series of lectures on Forensic Chemistry to two classes of police officers at the School of Criminal Investigation, Police Department.

Metals and Alloys Analysis Section :

This Section has, in this period, analysed a total of 492 samples of metals and alloys. Special analysis was undertaken on gold bullions of the National Bank of Thailand for the purpose of issuance of gold coinage in redemption of the Government Gold Bond B.E. 2485 (1942). 5 metric tons of gold were used in making coins and only 0.05% was lost in the process — an achievement never before possible without the technical control, rendered by this Section.

During this period the Chief of the Section, Mr. Vongse Naewbhanij, was also requested to supervise and arrange for the training of naval officers on analytical technique for 4 months.

Opium Analysis Section :

A total of 1,173 samples was sent in for analysis during the two years, covered by this report. More than half of them were suspected raw opium samples and about a quarter officially-prepared opium samples. Court exhibits, amounting to 56 samples. were also identified for their morphine contents, out of which only 3 were proven negative.

Water Analysis Section :

Water analysis was conducted on many types of water collected from different sources, raw as well as treated. This period hae seen a considerable increase in the number of sea water

samples, sent in by the Ministry of Communication as a part of its Dredging Project for the Bangkok Port Authority. In these two years a total of 690 samples was analysed for various purposes, drinking, industrial, and other.

From the results of chemical analysis of samples from the municipal waterworks, it may be noted that water from underground sources was generally clear, colourless, and odourless. It contained considerable amounts of saline matters, imparting higher degrees of hardness than water from rivers or streams. Although it needs very little treatment or none at all for drinking purposes, its hardness is usually too high to be used in some types of industry.

Apart from analytical service, its advice was frequently sought after with regards to suitability and treatment of many types of water for drinking as well as industrial purposes.

Mineral Springs

The Project of Mineral Spring Survey was continued right through this period. 7 provinces and 17 districts were explored by 6 teams of scientists over a total time of 78 days. Preliminary tests were conducted at sites and samples were collected for detailed examination in the laboratory.

Based on analytical results, those springs may be classified into 4 categories:—

1. *Hot and Sulphuretted :*
   Locations. a. Ban Huey Po, Tambol Mae Sin, Amphur Sri Suchanalai, Changvad Sukhothai.
   b. Tambol Tanoh Mae Roh. Amphur Baetong, Changvad Yala.
2. *Hot. Siliceous, and Sulphuretted :*
   Locations. a. Ban Mae Jok Nai, Tambol Mae Park, sub-Amphur Bang Shin, Changvad Prae.
   b. Ban Pa Ka, Tambol Ban Kaeng, Amphur Sri Suchanalai, Changvad Sukhothai.
3. *Hot. Siliceous, and Bicarbonated : (muddy odour)*
   Locations. a. Pong Lumpang, Tambol Mae Sin, Amphur Sri Suchanalai, Changvad Sukhothai.
   b. Ban Mae Poh, Tambol Mae Sin, Amphur Sri Suchanalai, Changvad Sukhothai.

4. *Cold Slightly Mineral :*

Locations. a. Tambol Shon Soradej, Amphur Kok Samrong, Changvad Lopburi.

b. Tambol Shon Kaew, Amphur Kok Samrong, Changvad Lopburi.

As indicated in the general review, details of the Survey complete with analytical fendings will be compiled and published as a special report later.

Fuel and Lubrication Section :

Special note is to be made of its study on the properties of local lignite in addition to its routine analyses.

Two samples of local lignite from major deposits were investigated and their analyses were as follows:—

Lab. No.	*Locations of Samples*
BT. 692	Amphur San Pa Tong, Changvad Chiengmai.
BT. 693	Tambol Mae Moh, Changvad Lumpang.

	B.T. 662	B.T. 693
Moisture, %	17.2	20.3
Ash, %	4.1	11.7
Volatile Matter, %	50.7	56.0
Sulphur		
1. Pyritic Sulphur, %	0.9	1.5
2. Organic Sulphur, %	0.8	1.0
3. Sulphate Sulphur, %	0.2	0.2
Calorific Value, cal./gm.		
1. Sample as received	5461	4703
2. Calculated on moisture-free basis	6596	5901

Prior to these samples, 3 lots from other sources were also examined, one (BR.442) from His Excellency the Minister of Industry and the other two (BS.905 and BS.906) collected by the Director-General of this Department during his tour in the South from Tambol Bang Poo Dum, Amphur Muang, Changvad Krabi. Analyses of the last two mentioned above were as detailed below:—

	BS. 905	BS. 906
Ash, %	9.1	6.4
Volatile Matter, %	77.5	77.2
Fixed Carbon, %	13.4	16.4
Sulphur		
1. Pyritic Sulphur, %	1.97	1.62
2. Organic Sulphur, %	1.40	1.39
3. Sulphate Sulphur, %	0.01	0.03
Calorific Value, cal./gm.	6200	6313

(All calculations were made on moisture-free basis)

Rough estimation indicated at least 20 million tons deposit at that location, and experts agreed that its quality was intermediately between lignite and bituminous coal. But the main difficulty in the way of its development lay in the problem of transportation. Railroad was thought the only solution to bring this rich deposit of good quality to usefulness.

General Analysis Section :

Milk and dairy products were the main themes of work in this Section. In B.E. 2494 (1951) 266 and in B.E. 2495 (1952) 256 samples were analysed in compliance with the Food Act. Out of these samples more than 95 per cent were sent for the purpose of Quality Control by the Customs Department.

In addition, the Section carried out analysis of miscellaneous samples such as chemicals, lac, and seedlac. It may be noted here that the work of this Section embraces nearly all routine analysis other than those undertaken by special sections or divisions.

DIVISION OF INDUSTRIAL CHEMISTRY

The work of this Division in the period, covered by this report, was varied and extensive. It encompassed research, analysis, and certification within its sphere. Its analytical work, however, was mainly concerned with industrial samples or raw and finished products, which were outside the scope of the Division of Chemistry, thus avoiding unnescessary duplication. During this period a fairly thorough study of quality of foodstuffs

and dietetic patterns of various representative communities was also undertaken in conjunction with other departments. Some results were used in the drafting of the Ministry of Health Regulations, regarding Quality and Standards, issued in accordance with the Food Act B.E. 2484 (1941).

A total of 1411 samples was analysed, and advice was given on 12 different problems. The following are some of the more interesting records, typical of its work:—

Ceramics Section :

1. *Appraisal of Local Ceramic Works at Changvad Chiengmai*

Surveys and evaluation of local and neighbouring deposits of raw materials were conducted with a view to promote and encourage development of the existing small industries. Available machinery and equipment were also inspected as to their suitability. After repeated examinations it could be shown that the raw materials were suitable only for the production of earthen wares, and that the plants were designed for such a product only. In our report it was pointed out, nevertheless, that, in view of the country's major need of this type of ceramic wares, the local works at Chiengmai should be supported financially and technically in their future development and expansion by the Government through aids under the Industrial Promotion Scheme.

2. *Quality of White Clay for the Government Paper Mill*

Previously white clay analysis had been requested for its alumina content only. Its moisture and iron contents have been entirely overlooked. As these properties bear much importance in the quality of the finished paper and add useless extra weight in commercial transaction, the Mill's management was advised to have the samples analysed for these contents as well. Moreover, they were notified by us also that its suitableness did not depend on chemical analysis alone but physical characteristics also have far-reaching effects on the finished materials.

3. *Survey of Ceramics Raw Materials*

From the results of country-wide surveys for suitable raw materials which were conducted during these two years, only 2

samples from Tambol Nasan, Changvad Surasdhani, were found suitable as body for Porcelain type of wares. The following are their analyses:—

	BS. 775	BS. 776
	%	%
Loss on Ignition	12.2	12.4
SiO_2	45.9	46.3
Al_2O_3	38.1	37.7
Fe_2O_3	1.6	1.5
CaO	0.8	0.9
MgO	0.9	1.0

Laboratory tests had shown their remarkably, satisfactory properties, as clay body for porcelain wares. However, the deposits will require a thorough study before any conclusion can be definitely reached with respect to its abundancy and notable properties.

4. *Research in Ceramics*

With the available facilities a satisfactory progress could never be achieved in this field of research. Suitable kilns, jiggers, presses, and skilled shapers and moulders are prerequisites in order to fulfil this function. Towards the end of this period this Section received a small appropriation for procurement of some equipment necessary in its work. It is hoped, therefore, that the Section will be in a better position to do its duty next year.

Laboratory tests, with whatever facilities then available, were, however, undertaken on all samples received or collected during the surveys. There were no other results of particular interest besides those recorded previously.

Foods Section :

Samples of foods and beverages, totalling 312, were analysed for various purposes indicated below:—

1. For standard & quality purposes in accordance with the then existing acts and regulations pertaining thereto.

2. For evaluation of standards and qualities of foodstuffs with a view to future regulative measures.

3. For their nutritive values in order to provide the public with technical guidance in the selection of foods relative to their market values.

4. For mainly technical purposes with respect to suitable methods of analysis, preparation, processing, and food research.

The following are summarized accounts of the more interesting topics, representative of the work covered by this period.

1. *Carbonated Beverages, Syrup, and Concentrates*

A total number of 169 samples was analysed under this category. Only 4-5 samples were found to have satisfactory quality comparable to those of recognized standard requirements. Most of them contained saccharine as sweetening agent in addition to sugar. Some were preserved by harmful chemicals, such as salicylic and boric acids, and in such concentrations that might prove dangerous to the health of consumers. Moreover, uncleanliness and lack of necessary precautions in their processing were very often indicated by the presence of sediments and scums in the majority of products; remains of insects were also found in a considerable number of samples.

Resumé of all these findings and recommendation therefore, were sent to the Ministry of Health for careful consideration, and necessary control measures were strongly advised within the immediate future.

2. *Ice Cream*

Analysis, chemical as well as bacteriological, was made on different types of ice cream on sale in the market. Results had shown that cleanliness and nutritional value had borne no resemblance whatsoever with their prices. The higher the prices the dirtier were the products. It was very surprising noted that generally the low-priced ice cream was cleaner and more nutritious than that of higher price. The attention in this matter of the Authority concerned was requested upon the light of these findings.

3. *Food Table*

Since the end of the last war prices of foodstuffs have risen alarmingly, out of proportion to the average increase in the capacity of earning, with the end result that more and more percentages of income have had to be spent on foods, leaving very little for the other daily needs of life. Although a general scheme of attrition has been advocated, majority of the public is still in the dark as to what food should be chosen. So that it will provide nutritionally the best buy. Traditions, tastes, customs, and faddism have all along played very important roles in food selection. Technical guiding principles had been neglected. In order to provide technical guidance in this connection, a Table of Compositions of Thai Foods is of fundamental importance. A comprehensive programme was, therefore, launched in this period to achieve such a provision.

In the period, covered by this report, a tabulation of 28 kinds of prepared foodstuffs of popular varieties was published, giving relationships between prices and useful components of the foods together with comments and recommendations.

The preparation of the Food Table has not been completed yet during this period. The work will be carried through until completion as early as possible in the next period.

4. *Methods of Analysis*

Investigation into the then existing methods of analysis was undertaken with a view to modification and improvement. Increased rapidity in the determinations of iron, calcium, phosphorus and protein was attained as the result. Trace elements in foodstuffs were also examined inspite of the lack of the more modern necessary equipment. Funds for the procurement of these apparatus were requested through the appropriate channel for future work.

5. *Study on Fish Sauce*

Results of a study on various brands of fish sauce in the market showed the following facts :—

5.1 The more popular brands contained higher proportions

of Total, Organic, and Amino-acid Nitrogens. They were also of superior flavour and less salty in taste.

5.2 Popularity and Chemical properties generally were closely related to one another. There were only few exceptions, which proved contrariwise.

5.3 Samples that have been analysed before the last war had better qualities than those of recent manufactures. It is believed that this was due to intervention in the handling of distributors rather than that of manufacturers—the practice, which has become, unfortunately, routine in present commercial business.

6. *Rice Bran Oil*

As already recorded in the previous report, the work on the preservation of rice bran to prevent it from becoming rancid during normal storage was continued. Rice bran oil was extracted from bran of various milled ages by different procedures, and its properties were studied.

The oil was found to be greenish dark in colour, rancid in odour, and to contain an appreciable quantity of wax. The yield varied from 15% to 20% according to age and type of bran used in the extraction. Study on the purification and separation of wax is to be made in the next period.

7. *Fruit Juice Concentrates*

The great abundancy of fruits of different varieties to the point of overflowing in almost any season the whole year round has presented a very promising picture in industrial utilization as beverage bases. Study was, therefore, made on various surplus fruits with special emphasis, during this period, on citrus products, such as orange, grapefruit, tangerine, lime, and on pineapple. So far the results obtained have been very encouraging and highly satisfactory. Further study will be made on other fruits not only for beverage bases but for other useful purposes as well.

Fermentation Section :

In this period this Section analysed a total of 265 samples of alcoholic beverages. The majority was sent by the Department of Industrial Factories for quality control purposes.

1. *Lead Poisoning*

Some of these samples were found to contain more than the legal limit allowed for lead, and caused very acute lead poisoning in many cases. In these particular cases, later investigation indicated the improper use of lead alloy in the construction of the distilling column in one of the provincial distilleries. When the faulty column was replaced with a new one, no trace of lead was found in the liquor.

2. *Fradulent Liquors*

60 samples of liquors were sent in for examination for frauds by the Police Department, nearly all of which were bad imitations or very poor substitutes of the most popular brand that was having the best sale in the market.

3. *Alcoholic Fermentation*

Ethyl alcohol, then available in the market, was of such low quality and unsuitable for our specific requirements that we had to produce it ourselves from a small pilot unit of our own design. This experiment proved so successful that production is to be continued as long as it is necessary.

4. *Pineapple Wine*

Experiments and study were made on the fermentation of pineapple juice, using our own yeast culture. Laboratory fermented samples were obtained under varied conditions, and results were evaluated in comparison with good grade wines. It was found that a very satisfactory fermented product could be readily obtained from pineapple juice. Its quality was comparable to those of high class wines. The development work has been given a very careful and serious consideration.

Minerals and Ores Section :

344 samples were requested for analysis during this period, out of which the followings were of economic importance:—

Types of Ores	*No. of Samples*
Wolfram	152
Tin	47
Lead	55
Antimony	38
Manganese	11
Iron	1

1. *Pyrites*

Three samples of pyrites were analysed, and the results of their analyses are recorded as under:—

Lab. No.	*Location*
BS. 903	Tam Talu Mine, Changvad Yala.
BS. 904	Lampu Mine, Changvad Yala.
BS. 923	Tambol Boh Namron, Amphur Kantang, Changvad Trang.

	BS. 903	SB. 904	BS. 923
	%	%	%
Silica and Insoluble Matter in acids	37.2	16.6	2.4
Total Iron	28.8	41.5	45.9
Total Sulphur	24.5	27.6	48.9
Soluble Sulphate, calculated as sulphur	0.44	0.02	0.38
Sulphide Sulphur	24.1	27.6	48.6
FeS_2, calculated from sulphide sulphur	45.0	51.6	90.6
Arsenic	0.06	1.8	0.02

From the analyses as shown BS. 923 may prove suitable for sulphuric acid manufacture.

2. *Monazite Sand*

2 samples of monazite sand were sent for analysis. The average analysis is recorded below:—

Thoria	about	8 %
Ceria	„	50 %
P_2O_5	„	18 %
SiO_2	„	1 %

General Analysis

The activity of this Division also covered miscellaneous analysis of samples, which could not be classified under any one of the preceding sections. The number totalled 483, and may be subdivided into the following categories:—

	No. of Samples
1. Certification of Merchandise	39
2. Damaged Cargo	41
3. Fraudulent goods	105
4. Oil-bearing seeds	14
5. Evaluation for Import Duty	86
6. Industrial Raw Materials	175
7. Common Salt for Export	23

The following points are noteworthy and representative of the industrial trends of that period:—

1. *Industrial Raw Materials*

That there was an appreciable increase in the samples of this type during this period was a very good indication that the industries were beginning to recognize the importance of quality of raw materials as an indispensable factor in successful production. It also reflected that government organizations have depended more and more upon the service of this Department in their purchase of materials. If this trend continues with increasing strength then there will not be any more haphazard and costly risks in future procurement as has happened rather frequently before.

2. *Fraudulent Goods*

The then prevalent scarcity of some kinds of manufactured articles, mostly imported, caused relatively wide spread fraudulent practices. The products, which were popularly imitated, were cosmetics and wellknown brands of DDT insecticides. Generally they were very poor and crude substitutes, and readily recognized as such by simple laboratory tests; but for the lay consumers

this proved otherwise due to their perfect simulation in outward appearance and packaging. At the time of writing this report, however, the practice is dying out, for the public has been warned and has had enough experience to distinguish between the genuine and imitated articles before making purchase.

3. *Typical Analysis of Common Salts*

Salt farming is an old established industry and one of the principal exports of the country. In order to encourage and stimulate the export of common salt, a co-operative concern and salt-farming community have been set up to promote the industry. Quality Control of exported salt has been one of the measures taken in this connection.

In the period covered by this report a great many samples were analysed, representative samples of those are recorded as under:—

Lab No.	*Exported per Steamer*
BS. 994	S.S. Yukikawa Maru
BS. 995	S.S. Meiten Maru
BT. 28	S.S. Shinko Maru

	BS. 994	BS. 995	BT. 28
	%	%	%
Moisture	6.24	6.30	5.40
Total Sulphate, calculated as SO_4^{--}	0.55	0.54	—
Total Calcium, calculated as Ca^{+}	0.16	0.17	—
Total Magnesium, calculated as Mg^{++}	0.18	0.17	—
Matters, insoluble in water	0.20	0.18	0.33
Matters, insoluble in acid	0.15	0.13	0.28
$CaSO_4$, calculated from total calcium	0.54	0.58	0.32
$MgSO_4$, calculated from sulphate left over from $CaSO_4$	0.21	0.16	0.11
$MgCl_2$, calculated from magnesium left over from $MgSO_4$	0.63	0.63	0.16
Total chloride calculated as Cl^{-} . .	56.24	56.30	—

	BS. 994	BS. 995	BT. 28
NaCl, calculated from chloride left over from $MgCl_2$	91.87	91.07	93.2
Total Iron and Aluminium, calculated as $Fe_2O_3 + Al_2O_3$.	0.11	0.05	0.18

It may be seen from the results of analysis shown above that the quality of the exported salt compared very favourably with those on the world market. On the other hand, prices were still relatively high inspite of the comparative by shorter distance, required for shipment. A special commission, however, has been set up to make a thorough study of the causes and effects in this problem. It is hoped that, by the time of the next report, it will be possible to record results of their findings.

4. *Pulp for Paper*

Since its establishment, the Government Paper Mill has been relying solely on bamboo for its pulp. As the distance necessary for its transport to the mill has increased very considerably due in part to mismanagement in replanting, it has become more and more difficult to obtain bamboo economically. The Division, therefore, made investigations into other materials, which might be utilized in its place. 4 kinds of plant were examined during this period. They were

(i) Rain Tree (Pithecolobium saman, Benth.)

(ii) Arundo Donax, Linn. (Syn. Donax arundinaceno, Beauw., and Arundo bengalensis, Retz.)

(iii) Saccharum fuscum, Roxb. (Syn. Eriochrysis fusca, Trin., and Miscanthus fuscus, Benth.)

and (iv) Hisbiscus pungens, Roxb.

Every one of them is very easy to propagate, has relatively rapid growth, can be made into pulp very readily, is capable of replanting with minimum of care and attention, finds no other important economic uses, and yields itself very suitably for to pulp making both in economic and technical aspects.

The results, obtained from laboratory experiments, were very satisfactory and encouraging Development on a pilot scale was being seriously considered at the time of writing this report.

5. *Lacquered Ware (from Varnish Tree, Melanorrhoea usitata, Wall.)*

Resinous exudation from the tree has been utilized (for ages) in varnishing a certain type of classical utensils. The body to be varnished or lacquered with this resinous paste is generally made from closely latticed network of very thin and long needle-like bamboo pieces. They are usually shaped into various popular forms of flower vases, wash bowls, water decanters, vanity cases, etc. Their highly glossed appearance, artistic coloured decorations, and very light weight have attracted popularity from tourists and connoisseurs alike.

Although artistry and workmanship in the ware have long been appreciated and given considerable study, no evaluation of the tree varnish has ever been made.

Following a scheme of cottage and small scale industry promotion, a comparative study of the resinous matter from the locally grown tree and that of Japanese origin was undertaken. Polish powder and decorative colours, essential in this handicraft, were also examined.

Chemical analyses are shown as followed:—

BU. 447 . . . . . Home grown sample.
BU. 448 . . . . . Japanese sample.

	BU. 447	BU. 448
	%	%
Ash	0.07	1.40
Volatile Oils (by Steam Distillation)	3.54	39.03
Refractive Index at 30°C	1.5101	1.4998
Insoluble Matters in hot 90% alcohol	30	38
Nature of Sample	resinous	resinous
Nature of Residue after extraction	resinous	fine powder

It is apparent that the Japanese sample has been artificially conditioned with other varnish materials and plasticisers, and is not genuinely natural like the Thai sample. It was therefore no

wonder that on practical application the local product proved itself far inferior to that of the foreign origin, and yielded very much less to subsequent decoration than the other.

However, further detailed study is needed before definite conclusion can be derived.

DIVISION OF INDUSTRIAL RESEARCH

Most of the work, carried out in this Division was industrial research and investigation. In this period, however, analytical work was also undertaken on 127 samples, and repair and maintenance were carried out on 555 items of equipment. Some of the more interesting research work, out of a total of 26, are recorded hereunder:—

Separation of Lead and Zinc Sulphides from Galena-Sphalerite

Attempts were made to separate lead and zinc sulphides out of the locally occurring ore by using flotation method, employing NaCN, Na_2CO_3, $ZnSO_4$, sodium ethyl xanthate, copper sulphate, and pine oil as conditioners. Results are as below:—

Samples	*Weight* gm.	*Lead Sulphide* %	*Zinc Sulphide* %
Original Ore	1000	42.4	8.3
After Separation:			
Pb Conc. I	181	75.9	4.2
Pb Conc. II	86	68.0	7.5
Zn Conc.	160	30.2	22.1
Tailing	540	24.7	7.4

Citronella Oil

Locally grown Citronella grass was steam-distilled, and its oil was separated. The oil was found to be pale yellow in colour, and to have a specific gravity of about 0.9 at 30° C. A yield of about 0.28% was obtained.

Hydrogenation of Destructive Distillate from Rubber Smoked Sheet

Hevea brasiliensis is an economic plant indigenous to the southern and eastern parts of Thailand. Its latex is usually processed and marketed as rubber smoked sheet. During the second World War, use was made of its destructive distillation products as crude gasoline for internal combustion engines, e.g. automobiles and motor boats. The crude distillate was found to have many undesirable properties. The most objectionable was, however, spontaneous gumming upon standing. This tendency was greatly increased at high temperature, resulting in tenacious adhering of pistons and rings to cylinders after relatively short operation.

Polymerization of unsaturated hydrocarbons, contained in the distillate, has been considered to be the major cause of this phenomenon. Experiments have, therefore, been designed to overcome this obstacle by catalytic hydrogenation. Although the investigation has not yet been completed during this period. The progress is worth recording here as follows:

On destructive distillation of rubber sheet, 3 fractions were collected:—

1. 60°C — 100°C . . . . . yield 5.2 %, and composed mostly of isoprene.

2. 101°C — 200°C . . . . . yield 31.0%, and composed mostly of dipentene.

3. 201°C — 300°C . . . . . yield 40.3%, and composed mostly of heveene.

The residue appeared as very heavy and viscous black tarry pitch.

All the three fractions were combined, and catalytic hydrogenation was applied under various conditions as indicated below:

I. Low Pressure and Low Temperature Hydrogenation

Using a pressure of 50 p.s.i. and a temperature of 30° C; and employing Raney Nickel as catalyst and ethyl alcohol as solvent, the following results were obtained:—

I. Low Pressure and Low Temperature Hydrogenation

Expt. No.	Distillate Vol. used (c.c.)	Time of Hydrogenation		Total Pressure Applied (p.s.i.)	% H_2 Absorbed (by wt.)	Remark
		Hr.	Min.			
1	160	76	35	74.3	1.086	Change catalyst 1 time
2	70	76	—	38.8	1.298	— do — 1 „
3	100	80	40	50.6	1.184	— do — 3 times
4	100	103	5	43.7	1.022	— do — 4 „
5	85	40	—	44.1	1.213	— do — 1 time, and no solvent.

Yield: 42 % of gasoline-like hydrogenated product.

II. High Pressure and High Temperature Hydrogenation

Method 1. Hydrogenation was conducted immediately after destructive distillation in ordinary glass still.

Expt. No.	Time of Hydrogenation		Max. Temp. °C.	Pressure of Hydrogen (p.s.i.)		Decreased in Pressure	% H_2 Absorbed (by wt.)	No. of Times of Catalyst Renewal
	Hr.	Min.		Before Hydrogenation	After Hydrogenation			
1	2	5	135	1850	900	950	0.877	1
2	2	21	128	2000	500	1500	1.384	2
3	1	40	130	1950	940	1010	0.932	3
4	3	45	127	2000	1280	720	0.665	4
5	2	8	127	2000	1075	925	0.854	1

Yield: 43% of gasoline-like hydrogenated product.

II. High Pressure and High Temperature Hydrogenation

Method 2. Hydrogenation of Samples, obtained from destructive distillation in an iron retort

Expt. No.	Time of Hydrogenation		Max. Temp. °C.	Pressure of Hydrogen (p.s.i.)		Decreased in Pressure	% H_2 Absorbed (by wt.)	No. of Times of Catalyst Renewal
	Hr.	Min.		Before Hydrogenation	After Hydrogenation			
1	2	5	122	1750	475	1275	1.177	1
2	2	5	112	1650	330	1320	1.218	2
3	2	15	113	1850	1010	840	0.775	3
4	2	5	115	1600	376	2214	1.130	1
5	3	—	115	1700	852	848	0.783	2

Yield : 20% of gasoline-like hydrogenated product.

II. High Pressure and High Temperature Hydrogenation

Method 3. Hydrogenation of Combined Sample, collected from Laboratory distillations

Expt. No.	Time of Hydrogenation		Max. Temp. °C.	Pressure of Hydrogen (p.s.i.)		Decreased in Pressure (p.s.i.)	% H_2 Absorbed (by wt.)	No. of Times of Catalyst Renewal
	Hr.	Min.		Before Hydrogenation	After Hydrogenation			
1	2	46	104	1410	200	1210	1.117	1
2 a.	2	26	100	1600	1000	600	1.569	1
2 b.	3	42	118	1600	500	1100		
3	3	20	120	1700	350	1350	1.246	1
4	3	30	130	1600	400	1200	1 107	1

Yield: 25 % of gasoline-like hydrogenated product.

It may be seen from the foregoing results that to get a good yield of gasoline-like product, hydrogenation has to be carried out immediately after destructive distillation, so that polymerization during the interval is minimised. The destructive distillation also plays very important role in this respect. Easily volatile constituents, should be prevented from escaping out of the condensate, and thus lowering the lighter fraction of the product.

It may, however, be concluded that by catalytic hydrogenation under high pressure and at high temperature until saturation, the tendency to polymerise or gum upon standing can be removed, or at least kept to the minimum. Further study, using more drastic conditions is being undertaken.

Hydrogenation of Yang Oil (Dipterocarpus spp.)

Yang oil is composed of volatile oils and resins, and obtained by making incisions into the trunk. The flow of exudation is greatly increased if the tree has a very slow-burning fire heaped around it at ground level. This heat treatment, however, has to be controlled so that the heat will not prove too excessive and cause death of the tree. Before the last World War the oil found only a few uses—as Torches and Waterproofing compound for sealing small holes, cracks, and joins in wooden boat or water utensils. During the last War a great shortage of fuel and diesel oils, put Yang Oil into general use as the only substitute for the mineral oils; and, in that capacity, it achieved quite wide popularity. However, the same problems as those of the rubber destructive distillate were met with in this case, but to a lesser degree and only after long and repeated use of this oil in diesel engines; gumming property was the major disadvantage. The object of this study was therefore, to hydrogenate the distillate, obtained, in order to prevent polymerization upon keeping and during use in the engine.

Results of the investigation are tabulated as follows:—

Expt. No.	Pressure of Hydrogen (p.s.i.)	Temp. (°C)	% H_2 Absorbed (by wt.)	I Value before Hydrogn	I Value after Hydrogn	Decrease in I Value	% age of Saturated Oil	Remark
1	40–50	30	0.130	243.22	240.01	3.21	1.32	Low Pressure App.
2	400–500	80–100	0.114	243.22	207.63	35.59	14.63	High — do —
3	1000–1500	80–100	0.534	243.22	127.00	122.89	49.18	High — do —
4	1000–1500	120–140	0.599	243.22	119.93	123.29	50.69	High — do —
5	1000–1500	160–180	0.670	243.22	115.29	134.60	53.86	High — do —

The following are two tables, comparing the properties of the hydrogenated products, obtained from the above experiments, and those of standard diesel oil : –

Properties	Before Hydrogenation	Expt. No. 2 Product	Expt. No. 3 Product	A.S.T.M. S.andards for Diesel Oil
Flash Point, (°C)	48.06	9.101	105	43.3–110
Pour Point, (°C)	below–10	below–10	below–10	–6.7 max.
Sediment, %	nil	nil	nil	0.10 max.
Carbon Residue, %	0.20	0.01	0.02	0.15 max.
Ash, %	nil	nil	nil	nil
Viscosity, Sec.	45.6	44.2	43.0	45 max.
Sulphur, %	0.06	0.06	0.02	0.75 max.
Distilling Temp., 10 % (°C)	255.0	257.0	261.0	–
Distilling Temp., 90% (°C)	264.4	261.1	271.0	315.56–357.22

Properties	Before Hydrogenation	Fxpt. No. 4 Product	Expt. No. 5 Product	A.S.T.M. Standards for Diesel Oil
Flash Point, (°C)	48.06	93.0	105	43.3–110
Pour Point, (°C)	below–10	below–10	below–10	–6.7 max.
Sediment, %	nil	nil	nil	0.10 max.
Carbon Residue, %	0.20	0.01	0.02	0.15 max.
Ash, %	nil	nil	nil	nil
Viscosity, Sec.	45.6	42.5	42.8	45 max.
Sulphur, %	0.06	0.05	0.02	0.75 max.
Distilling Temp., 10 % (°C)	255.0	252.0	261.0	–
Distilling Temp., 90 % (°C)	264.4	260.0	272.0	315.56–357.22

Results of analysis have shown that hydrogen absorption is increased by the increase of pressure and temperature; and that the quality of the hydrogenated product, as compared with standard diesel oil, is considerably improved. The most important of all is that the tendency of gumming is entirely removed by this process.

Cleansing and Briquetting of Lignite

In the cleansing process two methods were employed as follows:—

1. *Water Cleansing*

Local lignite was ground and graded into 3 samples viz.

a. Up to 1.5 cm. lumps.
b. Up to 0.5 cm. lumps.
c. Fine powder.

Each lot was then cleansed by the following method.

Put the sample in a tall cylindrical container. Almost fill it with water. stir well, and allow to stand until completely settled. Skim off lignite, which floats on the surface, carefully avoiding disturbing the sediment at the bottom. This procedure should be repeated 4 or 5 times until no further sediment occurs.

By this method the yield of cleansed lignite was about 80%

The cleansed samples then were dried and analysed. The following is typical analysis of lignite, cleansed by this process.

Properties	Before Cleansing	After Cleansing (1.a.)	After Cleansing (1.b.)	After Cleansing (1.c.)
	%	%	%	%
Ash (moisture-free basis)	12.1	10.3	10.6	10.3
Volatile Matter	57.0	55.1	56.5	—
Fixed Carbon	15.5	16.3	14.6	—
Sulphur: (moisture-free basis)				
1. Pyritic Sulphur	1.82	1.87	1.63	1.48
2. Sulphate Sulphur	0.48	0.25	0.25	0.12
3. Organic Sulphur	0.85	0.88	1.13	1.23
Total Sulphur	3.15	3.00	3.01	2.83
Calorific Value				
1. As received, cal./gm.	4460	4599	4570	—
2. Moisture-free, cal./gm.	5406	5778	5740	—

2. *Ammonium Chloride Solution Cleansing*

A similar procedure to the above was used, but instead of water, ammonium chloride solution sp.gr. 1.45—1.46 was employed as floating agent. Another sample of local lignite was ground and graded and only the lot, having a size of 1—3 mm. was used in the flotation. The yield of the cleansed lignite was about 84 per cent. Its analysis is as followed.

	Before Cleansing %	*After Cleansing* %
Moisture	26.8	16.2
Ash (moisture-free basis)	8.6	5.3
Sulphur (moisture-free basis)		
1. Organic Sulphur	1.97	1.66
2. Pyritic Sulphur	2.14	1.31
3. Sulphate Sulphur	0.34	0.36
Total Sulphur	4.45	3.33
Calorific Value, cal./gm.		
1. As received	4344	4894
2. Moisture free	5934	5840

Briquetting without binder was carried out by using compressions at 4, 6, 8, and 10 tons per sq. in.. in a cylindrical mould of 2.5 in. in diameter and 1.4 in. in height.

A compressive strength of 8-10 tons per sq. in. was found to be very satisfactory for the briquetting of this particular sample of lignite.

Drying Properties of Some Oils

1. *Dipterocarpus spp. Oil*

Study was made on the distilled fraction at 250-260° C of Yang Oil. Driers and boiling were used to increase its drying property. Optimum conditions were 2-3 boiling, followed by another hour boiling with a siccative, manganese resinate. The oil, thus prepared, became dry to touch in 8 hours, and completely dry within 24 hours.

2. *Para Rubber Seed Oil*

The experiment was carried out in 5 steps as follows:—

(i) Pressing of the seed was done by a hydraulic press after it had been dehulled by hand. The expressed oil was filtered dry and analysed.

Sp. gr. at 15° C	0.9215
Acid Value	16.2

Iodine Value	150.1
Saponification Value	191.1

(ii) Preparation of siccatives was made by the two following methods.

a. Resinates of cobalt and manganese were prepared by precipitation.

b. Metallic soap of the oil itself was obtained by treating the boiling oil with appropriate metallic hydroxides.

(iii) Drying of the oil was conducted by gradually heating the oil for half an hour and adding the prepared driers in small quantities at a time. Air was blown in continuously; and the liquid was constantly agitated. The temperature was controlled at 160·200°C for 3 hours in the case of resinates, and at 200—240° C for 6 hours, if the metallic soap was used.

(iv) Drying properties of the oil, thus treated, were tested by practical application after mixing with zinc pigment and common thinner. Results in both cases were unsatisfactory. The treated oil could not be used as a paint vehicle due to its slow drying and its bad adhering properties.

(v) Separation of its rubber content was attempted by precipitating with acetone, centrifuging the rubber content off, and filtering through a Gooch crucible. The separated oil was then treated as in (iii), and tested again as in (iv).

The oil thus treated was very satisfactory as a drying oil.

3. *Safflower Seed Oil*

The safflower seed oil is classified as a semi-drying oil with the following characteristics:—

Specific Gravity at 31.5°C	0.92
Refractive Index at 28°C	1.419
Acid Value	1.81
Iodine Value	144.78
Saponification Value	190.00
Unsaponifiable Matter	0.79%

Modes of Preparation	*Yield* %
By Expression of Whole Seeds	32.8
By Expression of Dehulled Seeds	16.1
By Extraction with Petroleum Ether	27.0

Experiments were conducted with a view to improve the drying property of the oil, specifically for its use as waterproofing oil for a kind of tissue paper, *Sa*, employed in the umbrella industry as sheeting. Results are recorded as below:—

Expt. No.	Procedure	Drying Time (Hours)
1	Heating for 1 hr. at 150-250°C	Over 48
2	Heating and air-blowing for 1.5 hr. at 150-250°C	do.
3	Heating and air-blowing for 2.0 hr. at 150-250°C	do.
4	Heating for 1 hr. at. 150-250°C, then, adding 2% each of manganese and cobalt resinates, and air-blowing for another 2 hr.	do.
5	Heating for 1/2 hr. at 130-180°C, then, adding the driers each 0.5%, and air-blowing for 1 hr. more.	do.
6	Heating and air-blowing for 1/2 hr. at 200-240°C, before adding 0.5% each of the driers, and then continuing heating and air-blowing for 1 hr. more.	Before 48
7	Heating and air-blowing for 1 hr. at 200-240°C, before adding 0.3% each of the driers. Heating and air-blowing was continued 1 hr. more.	Before 48
8	Heating and air-blowing for 1 hr. at 200-240°C, before adding 0.5% each of the driers, and then continuing heat and air-blowing treatment for a further 1.5 hr.	Before 36

Destructive Distillation of Wood

During the period, covered this report, study on the destructive distillation of mangrove was undertaken. Results of the study are given as follows:—

Expt. No.	Wt. of Mangrove Kg.	Volume of Pyroligneous Acid		Wt. of Charcoal	
		Litre	Litre/100 kg.	Kg.	% by wt.
1	37.80	17.98	54.95	14.0	37.03
2	40.00	17.00	49.62	14.0	35.00
3	41.60	18.50	52.36	13.6	32.69

Fractional Distillation of Pyroligneous Acid

Distillation No.	Acetic Acid % (wt./vol.)	Methanol % (vol./vol.)
1	9.56	19.16
2	10.23	15.33
3	9.56	16.54

Calorific Values of Wood Charcoal (Mangrove)

Charcoal from Expt. No.	Girth Circumference cm.	Calorific Values, cal./gm.	
		As Received	Moisture-Free
1	12-17	7,068	7,471
2	23-30	6,707	7,112
3	17-25	6,931	7,405

Calorific value of mangrove charcoal is slightly higher than that of wood charcoal obtained from the Wood Distillation Plant, Ministry of Agriculture, which averages about 7,200 cal./gm.

Aluminium Sulphate from White Clay

As no bauxite deposit was found within the country, experiments were conducted to find out whether other alumina-bearing clays could be substituted economically in the manufacture of aluminium sulphate. After few preliminary investigations it has been found that white clay, and abundant natural resource, can be made into alum by reacting with concentrated sulphuric acid after it has been properly calcined.

Further detailed study is, however, needed before definite conclusions can be drawn as to its feasibility as an industrial project.

APPENDIX A

Lectures : Two lectures were delivered at the Department's auditorium by Dr. Svasti Srisukh on "An Introduction to Absorption Spectrophotometry", on 6th and 13th October B. E. 2494 (1951).

Broadcasts :

1. Mr. Nara Boon-Long on "Lac Industry of India."
2. Mr. Pue Rochanapurananda on "Lac and Shellac Conference in U.S.A." in 4 parts.

Publications : Members of the Department published articles in various publications as follows:—

1. "Problems of Housing and Food for Industrial Workers" by Pue Rochanapurananda in "The Industrialist".
2. "Questions and Answers on Shellac" by Nara Boon-Long in "The Industrialist."

3. "Mirror Making" by M.L. Anong Nila-Úbol in "The Industrialist."

4. "Chestnut Glacé" and "Canned Oyster" by Virada Thisayamondala, both in "The Industrialist"

5. "Rubber, Plastic, and Celluloid Toys" by Rabieb Prachankadee in "The Industrialist."

6. "Drying Oils" by Tweelak Boonkong in "The Industrialist."

7. "3 M" by Dr. Charng Ratanarat in both "The Industrialist" and "Science."

8. "Fire-Hazard Materials" by Puan Pruoy-suwan in both "The Industrialist" and "Science."

9. "Food Control" and "Ice cream" both by Yos Bunnag in "Science" and "The Industrialist."

10. "Forgotten Elements in Foods" by Suradi Bupaves in both "Science" and "The Industrialist."

11. "Sweetening Agents and Preservatives in Foods" by Dr. Svasti Srisukh and Rungtawan Bunnag in "Pharmacy", "Science", and "The Industrialist."

12. "Flying Saucers Again" by Dr. Charng Ratanarat and Pue Rochanapurananda in "Science" and "The Industrialist."

13. "Citronella Grass" by Vilai Devakul in "Science" and "The Industrialist."

14. "Development of the Atomic Energy Commission in 1953" by Dr. Charng Ratanarat and Pue Rochanapurananda in "Science" and "The Industrialist."

Science Conferences: In December in both of the two years covered by this report an Exhibition and a Conference, sponsored by the Science Association of Thailand, were held at Chulalongkorn University. The Department

participated in both by giving exhibitions, representing its progress in scientific work. A paper on "Hydrogenation of Para-Rubber Oil" was also read by Miss Priya Chandravakindr, a scientific officer of the Department. A yearly Government appropiation of 25,000 Baht was donated to the Association through incooperating the sum with the Department annual budget.

APPENDIX B

Co-operation With Other Organizations

(apart from analysis)

1. 75 Police Officers of the Bureau of Investigation visited the Department. They were conducted around laboratories and offices.

2. Advice and recommendation were given to Chumsaeng School, Changvad Nakornsawan, on the purchase of scientific instrument and chemicals for its science teaching.

3. Some instruments and instruction were made available on loan to Sourksanari School for demonstration of Vitamin C in Thai fruits.

4. Food Analysis Equipment was loaned to the University of Agriculture for demonstration purposes.

5. The Administrative Committee of Amphur Suwanaphum, Changvad Roi-Ed, was advised on the construction of Lightning Conductors.

6. Provision of a water manometer was made for the Thai Airways Co., Ltd. for its experiments with aviation instruments.

7. Officers of the Military Arsenals were received for further training in the Department's School of Analytical Chemistry Training.

8. Top members of the Department were allowed to teach in various universities and institutions, as indicated under special duties.

APPENDIX C

Total number of samples examined in the Department of Science for the years B.E. 2494 (1951) and B.E. 2495 (1952).

Source Classification

	Number of Samples B.E. 2494 (1951)	B.E. 2495 (1952)
Ministry of Defence		
Water, artesian well	6	—
Fuel Oils	5	10
Lubricants	14	26
Fire-Arm and Ammunition	1	—
Metals and Alloys	7	—
Ores	4	—
Chemicals	50	3
Vegetable Oils	2	—
Mineral Oil	1	—
Miscellaneous Foodstuff	—	1
Refractories	—	2
	90	42
Ministry of Agriculture		
Water, artesian well	—	1
Coke	3	13
Tin	—	3
Copper	3	—
Metals and Alloys	2	—
Miscellaneous Foodstuffs	5	—
	13	17

	Number of Samples B.E. 2494 (1951)	B.E. 2495 (1952)
Ministry of Finance		
Fuel Oils	1	2
Lubricants	—	4
Miscellaneous fuel	—	1
Morphine or Opium Suspects	379	449
Ferrous Metals	3	5
Tin	—	5
Tin, coinage	12	—
Lead	—	16
Antimony	—	2
Copper	7	6
Metals and Alloys	36	17
Gold	225	—
Ores	41	32
Chemicals	1	7
Opium	76	126
Fat	—	2
Vegetable Oils	5	—
Mineral Oils	1	1
Alcoholic Liquors	20	25
Milk	11	11
Milk, evaporated	54	69
Milk, sweetened, condensed	149	129
Milk, powdered	57	49
Food	—	1
Animal Feed	1	—
Pharmaceutical	1	—
Fabrics	3	8
Lacs and Shellac	19	4
Fertilizers	—	4
Dyestuffs	2	—
Paints	—	7
Colours	—	5
Soap	—	1
Tar	16	4
Miscellaneous	—	8
	1121	999

	Number of Samples B.E. 2494 (1951)	B.E. 2495 (1952)
Ministry of Health		
Water, artesian well	1	1
Water	18	8
Blood Stain	—	1
Morphine or Opium Suspects	—	2
Non-Alcoholic Beverages	—	107
Milk, powdered	12	—
Rice	2	—
Fish Sauce	1	—
Food	4	6
	38	125
Ministry of Communications		
Water	1	4
Sea Water	—	291
Fuel Oils	2	—
Lubricants	—	6
Coke	1	—
Ferrous Metals	2	4
Tin	5	1
Lead	3	1
Copper	1	5
Metals and Alloys	4	6
Chemicals	5	8
Vegetable Oils	22	—
Paint	1	—
Asphalt	3	—
	52	326
Ministry of Interior		
Water, drinking, Bangkok	—	13
Water, provincial drinking	113	78
Water, artesian well	16	6
Water	3	2

	Number of Samples B.E. 2494 (1951)	B.E. 2495 (1952)
Fuel Oil	—	1
Blood Stains	145	130
Fire-Arm and Ammunition	—	1
Morphine or Opium Suspects	1	7
Seminal Stains	2	14
Exhibits	31	58
Silver	6	—
Chemicals	5	2
	322	312
Ministry of Economic Affairs		
Chemicals	2	—
Dyestuff	1	—
Food	—	9
	3	9
Ministry of Industry		
Water, artesian well	1	—
Water	2	7
Coal	2	2
Charcoal	—	1
Tin	1	4
Lead	1	—
Antimony	1	—
Copper	9	3
Metal and Alloy	—	1
Ores	12	8
Chemicals	40	34
Alcoholic Liquors	111	69
Sugar	40	2
Molasses	—	26
Fruits	2	—
Vegetables	10	—
Food	7	36
Pharmaceuticals	2	—

	Number of Samples B.E. 2494 (1951)	B.E. 2495 (1952)
Rock	1	—
Refractories	22	13
Resin	1	—
Colours	—	3
Tannin	4	—
Certification	12	43
Miscellaneous	1	6
	282	258
Bangkok Municipality		
Water, Bangkok Waterworks	55	25
Water, artesian well	—	1
Preparation of Solutions	2	—
	57	26
Banks and Government Organization		
Water, artesian well	1	—
Gold	7	—
	8	—
Semi-Governmental Companies		
Water, artesian well	1	1
Water	—	1
Charcoal	1	—
Ores	6	—
Milk, evaporated	1	—
Miscellaneous	1	1
	10	3
Non-Governmental and Private Companies		
Water, drinking	3	—
Water, artesian well	5	12
Water	1	7
Fuel Oil	—	1
Lubricants	4	3
Miscellaneous Fuels	2	1

	Number of Samples B.E. 2494 (1951)	B.E. 2495 (1952)
Seminal Stain	1	—
Tin	1	—
Lead	2	—
Copper	—	1
Metals	—	2
Silver	36	32
Ores	88	95
Chemicals	5	12
Edible Oils	1	1
Tallow	—	4
Vegetable Oils	2	4
Mineral Oil	—	1
Non-Alcoholic Beverages	—	2
Milk	—	1
Milk, evaporated	—	2
Milk Product	—	1
Flour	—	2
Sugar	1	1
Molasses	17	1
Food	5	6
Rice Bran	1	1
Animal Feeds	5	3
Pharmaceuticals	1	2
Clay	—	1
Refractories	—	3
Fibre and Fabrics	1	2
Shellac	4	—
Stick Lac	1	—
Lacs and Seed Lacs	4	—
Damaged Cargo	35	—
Paint	1	—
Tannin	2	—
Tar	1	4
Preparation of Solutions	12	17
Miscellaneous	6	—
	248	225
Total	2244	2342

With the Compliments

of

Department of Science

Ministry of Industry

Bangkok, Thailand