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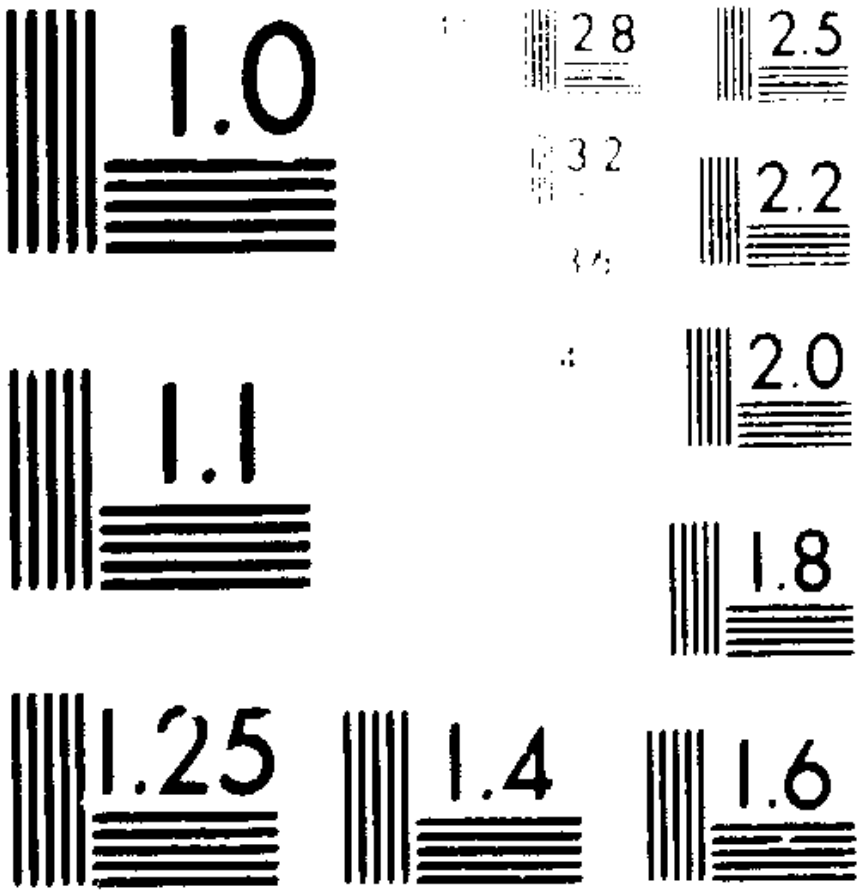
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org



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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

FINAL REPORT

THE MANUFACTURE OF SMALL INTERNAL COMBUSTION ENGINES IN THAILAND

September 1972

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INTRODUCTION

The United Nations Industrial Development Organisation retained Berenschot-Bosboom to carry out an investigation into the possibilities of the manufacture of small internal combustion engines in Thailand (Project nr. SIS 71/1163-THA-27). The aims of the survey were as follows:

a. assess the product specification and demand for small internal combustion engines in Thailand,

b. conduct a techno-economic feasibility study regarding the local manufacture of such engines through the establishment of a new plant with provision for its expansion to meet the next five years requirements,

c. formulate steps that should be taken for the development of this industry taking into account the related establishment and/or expansion of ancillary and supporting industry.

The survey was undertaken in Thailand during the period April 5th to May 20th consisting of :

Mr. G.E.G.M. Grünning	Industrial engineer	teamleader
Prof. G.J. Quast	Mechanical engineer	member
Mr. H.C.P. de Vries	Mechanical engineer	member

During the investigation the team received ready assistance from official authorities, from international organisations and from private enterprises and organisations. A list of those contacted is given in the appendix 1.

The assistance was greatly appreciated and the team should like to mention in particular the assistance given to them by Mr. Nipon Panomkarn of the Applied Scientific Research Corporation of Thailand. He assisted the team continuously in the field period and has thus made a real contribution to the work.

1. RECOMMENDATIONS AND CONCLUSIONS

1. The Third National Economic and Social Development Plan started at the beginning of 1972.
   In the first and second five-year plans the emphasis was put on the development of agriculture and of infrastructure. In the third five-year plan the emphasis is put on the stabilization of the development and on the solution of problems that became apparent during the implementation of the two previous five-year plans.

2. Up to the present the government has successfully paid great attention to financial stability of the country, especially price stability and maintenance of a high level of exchange reserves.

3. The third five year plan stresses import-substitution and promotion of exports, utilizing domestic raw materials and labor, for which factories can be established outside the metropolitan areas.

4. High priority is to be given to private industries of small and medium size, among them the machinery manufacturing sector.

5. During the period from 1969 - 1971 Thailand experienced an economic recession. Expectations for 1972 and for the next years of the Third National and Economic Development Plan are more promising.

6. The most important long term financing bank is the Industrial Finance Corporation of Thailand (IFCT).

7. Private investors in Thailand are still not used to the way of investing in industrial enterprises as found elsewhere.

8. However, entrepreneurs in Thailand are dynamic, flexible and are well able to take advantage of changing opportunities and circumstances.

9. Political, economic and social life is mainly concentrated in the Bangkok area.

10. There is no shortage of labor and labor is found to be very responsive to training. Compaired with wage levels in the surrounding countries wages are quite reasonable. However, experienced and skilled managers and technicians are not available in sufficient numbers.

11. The total market for small combustion engines will increase in the future. Up to 1976 an increase in the growthrate is expected. Then the growthrate will decrease and will stabilize at around 9 percent per year.

12. The demand for two-stroke engines will increase slightly in the next ten years. The average growth is estimated at 2 percent per year. A local producer of two stroke gasoline engines is expanding his production capacity of 3,000 units/year at the moment.

13. The projected market demand for four-stroke gasoline engines in Thailand will continue to show a larger growth than the demand for two-stroke engines and, in the years 1972 and 1973, larger also than for diesel engines.
After 1973 the demand growthrate is expected to decline in the favor of the diesel engine.
Estimated annual growth in 1973 and 1974 is of 10 percent, in the period 1977 - 1981 of 5 percent.
There are no distinct plans to produce four-stroke gasoline engines in Thailand.

14. We expect that the demand for diesel engines will be moderate in the near future, but will increase in the years 1973 - 1976 from 5 percent to 20 percent annually. After 1976 and until 1981 we projected an average annual growth of 10 percent.
The annual demand for the most popular type of diesel engines (5 HP) is higher than the annual demand for the most popular type of four-stroke gasoline engines (4 HP).
There exist no distinct plans to produce diesel engines in Thailand.

15. In India and Pakistan a ECAFE/AIDC/UNIDO factfinding mission estimated an impressive high annual demand for 3 - 15 HP diesel engines, with a tendency towards medium speed engines, as well as an attractive demand for 3 - 15 HP gasoline engines in the four partner countries of Thailand in the ASEAN group: Malaysia, Singapore, Indonesia and the Philippines.

16. For technical and production reasons and from the demands of the market it is considered advisable to start with a production of hopper cooled diesel engines of about 5 HP capacity with a maximum of 2000 rpm.

17. Out of the financial and economic analysis we estimate the results of the various analysed production capacities to be :

production capacity	5000	10,000	20,000	units per year
financial evaluation	insufficient	reasonable	good	
economic evaluation	excellent	excellent	excellent	

18. From financial and economic viewpoints and for reasons of marketing it is recommended to start in Thailand with an engine manufacturing plant with a production capacity of 10,000 engine units per year.

19. For a manufacturing plant with an annual production capacity of 10,000 combustion engines the capital requirements are estimated as follows :

Total capital to be invested	2,115,000 US $	44,000,000 Baht
Invested capital per employee	4,000 US $	95,000 Baht
Annual turnover per employee	5,800 US $	122,000 Baht
Number of employees	290	
Annual gross profit	29.2 percent	
Capital/output ratio	1 : 2.8	
Financial internal rate of return	16.8 percent	

20. Expansion to a production capacity of 20,000 units per year will be feasible five years after starting the production, together with a diversification of types of engines in production. This would involve the continuation of the production of the same type of engine and the introduction of a larger engine (8HP).

21. It is recommended that a review of tax and duty rates on the import of internal combustion engines for manufacturing purposes and on import of components be carried out.

22. We recommend assistance to be given to the Thai management of the engine manufacturing plant for their negotiations with the external suppliers and that training be provided to management in the use of modern techniques of business administratio., production planning and control and marketing.

23. The information available on Thai industries that could supply certain engine parts and on the plans for improvement or expansion of these industries is incomplete at the moment and not up to date. A system should be set up within the country to have these data readily available on the basis of individual companies and on the national level.

24. Thailand possesses iron casting industries and a high tensile bolts and nuts manufacturing plant. On this account and because other adequate subcontractors exist it is not advisable, for financial reasons, to provide facilities for these specialized products in the proposed engine production plant.

25. It is recommended to use universal production equipment in order to assure sufficient flexibility of the production system and to facilitate training of machine tool operators.

2. GENERAL INFORMATION

2.1. Political, Economic and Social Background

Tendencies

The Kingdom of Thailand is mainly agriculturally orientated. About 80% of the population finds a living in agriculture. Although rice is still the principal product, other products too are beginning to receive attention. Industry and mining are also becoming more important. Since 1932, Thailand has been a constitutional monarchy. On 17 November 1971 the new constitution of 1969 was suspended. At the same time parliament was dissolved and the government replaced by a National Executive Council headed by the former prime minister Thanon Kittikachorn.

The Government represents a close knit coalition between the military, aristocracy and private businessmen. The strongest element are the military commanders, who take the most active part in government administration as well as in business. At the same time, non military men hold some key positions as members of the N.E.C. and heads of government agencies.

Individualism and traditionalism has been one of the strongest traits of the Thai society. This has also been demonstrated in the Thai government and civil service.

A strong emphasis on financial stability has been one of the features of the Thai economy. The government has traditionally encouraged cautious fiscal and monetary policies, and attached considerable importance to price stability and to maintenance of a high level of exchange reserves.

The private sector has proven to be dynamic, flexible and quick to take advantages of changing opportunities. It has also demonstrated remarkable openness to minority groups as well as social and economic mobility.

Government attitude to the private sector is generally "laissez faire".

Another characteristic of the Thai political and social system is the extreme concentration and centralization in Bangkok. In this region most of the Thai manufacturing, administration and financing services are situated.

During the 1960's Thailand had very close ties with the U.S. in military, political and economic points of view. The last few years Japan has become the main trading partner. With the increasing role of Japan in the world economy and particularly in South East Asia, economic relations between Thailand and Japan are becoming more important.

Quite remarkable in Thailand is the exceptionally rapid growth of its economy during the years from 1966 to 1969. In this period Thailand experienced the favorable combination of a 9 percent G.D.P. growth a year, balance of payment surpluses and price stability. The principal growth stimuli were the attractive rice prices on the world market, the U.S. expenditures in Thailand and the income obtained from the spendings of American soldiers in Thailand. This caused high investments in the private sector as well as in the public sector and an increasing demand. The increase in demand was met by an expansion in real production and a steep increase in imports.

The turning point came in 1969 due to a combination of the decline in U.S. military expenditures and a decrease in prices of the main export products. In 1970 the demand growth slowed down considerably. G.D.P. increased by a 6 percent in 1970, and is expected to increase slightly less in 1971.

The import growth slowed down particularly after June 1970, when a considerable increase in duties and sales taxes had been introduced. Yet it appeared that the net capital inflow was not sufficient to cover the current account deficit. Hence foreign currency reserves in 1969 decreased by US$ 44 million and by US$ 128 million in 1970. A further but smaller reserve loss is expected in 1971.

Present Situation and Expectation

The developments in external economic relations in 1971 show good promise, a tendency which continues in 1972.

Exports in 1971 are estimated at 16.200 million Baht[A] which is an increase of 10 percent as compared with 1970. Export of rice, tapioca, maize, rubber, tin and sugar increased both in value and in quantity.

[A] 1 US $ = 20.8 Baht

Imports in 1971 have kept about the same level as in 1970. This stabilization is mainly due to the increase of duties and sales taxes.

Also the trade with Japan resulted in 1971in a smaller deficit in the foreign goods traffic on account of an import decrease from Japan and an export increase tc that country.

The decrease of the shortage on the goods balance of course favorably influenced the balance of payments.

The improving developments in commercial foreign traffic will bear favorably on the national economy.

As the rate of exchange of the Baht as regards the US $ was not modified a devaluation took place in 1972. Owing to this a further export increase is to be expected.

Further, in the forthcoming years an important increase in tourism may be expected on account of the growth of world tourism and the growing interest for Thailand with European and American travel agencies.

The Third National Economic and Social Development plan started in 1972. The two preceding programs have focused in the first place to extend and to increase the participation of the private sector in the economy and to establish and adequate infrastructure The third five year plan will aim to solve the economic problems that have arisen together with the associated social problems. The economic problems lie for the greater part in the fields of:

a. the fluctuation of demand and prices for Thai export products,

b. the decline of US expenditures in Thailand,

c. the decline of direct investments in Thailand.

In the social field the problems are caused by changes in the social values and behavior patterns of the younger generation and intellectuals. This has resulted in widening of the "generation gap". Also the big difference between incomes of people in urban areas and people in the rural areas is likely to result in unstable economic growth.

Together with the development of the rural areas an increase of production will have to take place. In addition, industrial expansion and urban development aspects must be studied in relation to one another.

The G.D.P. growthrate is planned at 7 percent for the duration of the Plan.
During the Second Plan period (1967-1971) the average growth rate was 7.2 percent.

The projected total annual growth rate for agriculture is 5.1 percent. For crops it is relatively low, i.e. 4.6 percent.

The development program was reviewed by a mission from the World Bank. The opinion of the mission was that the growth objectives of the Third Plan are acceptable. The strategy to achieve the aims was considered reasonable. However, a few shortcomings, e.g. in the collaboration between governmental organizations, might constitute an impediment for the proper execution of the Plan.

2.2. General Information on the Industrial Fields

General

For the term of the third 5 year plan the industrial growth is estimated at an average of 8 percent (this was for the second 5 year plan 9.2 percent). The slower rate of increase is explained by the expected smaller increase in demand of industrial products, especially during the first years of the Plan. For new industries is calculated with a growth of 9.2 percent. The Plan emphasizes the need for rationalization of the industry, with general orientation towards exports of manufactured products. This entails the introduction of extensive market research, sufficient financing facilities and the availability of a well trained and skilled management and technical potential.

The expansion of the industrial sector will for the greater part be left to the private sector. The policy followed so far to promote the establishment of small and middle-sized enterprises which in the future may grow into larger industries, will be continued.

The government will pay special attention to the removing of impediments, which in the past, have slowed down the industrial expansion. The main obstacles were: lack of capital, the duties and taxes-structures and the inadequate government support for the establishment of enterprises. Agreeable conditions will encourage foreign investors to take part in the industrialization process. Encouragement should be especially given to those countries which will broaden the capital investment structure of Thailand and thus avoid a monopoly position of any particular country.

Most Thai entrepreneurs are found in the group of tradespeople.

They are mainly businessmen on account of which a "short-term profit" way of thinking is prevalent. As already mentioned the Thai entrepreneurship is characterized as adaptable and flexible and quick to grasp a chance. The larger part of enterprises still works on a family basis and is of an inward-directed character.

The possibilities however of simple import substitution with a good chance of short term profit are becoming exhausted. The domestic markets often are too small for production at an economic rate.

Therefore, the necessity is being felt of a more industrial way of thinking of the Thai entrepreneurs. This means to take into account longer return on investment periods, proper market analysis, adequate project preparation and evaluation, introduction of modern management and business administration techniques and systems to make a rapid reaction possible to changing external factors. There are in this respect signs of a growing awareness. The following paragraph pays attention to some of the more important problems industrial development is facing in Thailand.

Government Support

In 1962 the Promotion of Industrial Investment Act was signed. This act gives certain facilities, guaranties and incentive benefits to local and foreign investors who have been qualified for "Promotion". This act is executed by the Board of Investment, an agency of the Royal Thai Government.

The special benefits for "promoted" new industries include a five year income tax exemption of import duties on production machinery and equipment, a reduction of one third on

import duties on raw materials and spare parts, freedom to bring in foreign technicians, rights to export profits and the right to own land.
During the Third Plan the Promotion of Industrial Investment Act will be improved by placing special emphasis on import substitution and export activities utilizing domestic raw materials and labor and established outside the metroplitan areas.
High priority is given to small and medium scale private industries in the machinery manufacturing sector which will provide a basis for future expansion.
As stated in the Third Plan chapter 9 the goverment is aware of the inadequacies in goverment services and infrastructure. During the next five years the coordination between various government agencies concerned with industrial development will be improved. An Industrial Information Centre will be created to provide up to date industrial data and information. At present the availability of information to investors is limited.

Because of the need for new industrial estates and industrial zones a new agency will be set up to carry out studies, to select the best locations for industrial estates, free trade zones and industrial export zones.

2.3. Tax and Duty Structures

Indirect Tax revenues are historically the major source of Government income. As a consequence of the less rapid expansion of the Thai economy the growth rate of the government income slowed down. To compensate these losses the Government will improve the tax structure not only to increase the revenues, but also to reduce social injustices. Industrial development also calls for adjustments of the tax structure as the Third Plan states.

The following taxes and duties mainly concern the small internal combustion engines industry:

a. Company Income Tax

b. Taxes on Remittances Abroad

c. Business Tax

d. Personal Income Tax

e. Import duties

Items a. b. c. d. are described in "the Act Promulgating the Revenue Code BE 2481".
Item e. is described in "the Emergecy Degree on Customs Tariff BE 2503".

sub a.

A Thai limited company is subject to income tax on all its income also on the part which is earned abroad. Foreign corporations are taxed only for the part of the net profit, earned in Thailand. If a company has a part of at least 50 percent owned by a natural person, then the company is subject to the personal income tax rates.
The rates of income tax schedules for companies or juristic partnerships vary from 15 percent on the net profit not exceeding 500,000 Baht, to 20 percent on a net profit between 500,000 and 1,000,000 Baht, to 25 percent on a net profit exceeding 1,000,000 Baht.

In this respect it is pointed out that, if in the case of a "promoted industry", exemption on income tax is granted for the first five years, this refers to the first five fiscal years and not the five years from the start of production.

sub b.

In general, dividends, interests and other forms of income are subject to a taxation at same rates as calculated for companies or partnerships. Companies or juristic partnerships remitting from Thailand profit or funds or any other category reserved from profits, shall pay income tax at a flat rate of 15 percent.

sub c.

This tax is a gross receipts tax to be payed monthly based on the proceeds from the sale of goods.
The tax is a fixed rate depending on the business category of the Business Tax Schedule to which the company belongs.
After studying this Tax Schedule the survey team cannot decide to which category a small combustion engines importer-producer-exporter belongs. In our opinion it could be one of the following:

- Business category 1 : sale of goods, type 2 (b) stoves or ovens or other equipment used with electricity, fuel oil or gas - importer of producer - rate of tax : 15 percent

- Business category 1 : sale of goods type 1 (a), goods and by-products other than those listed in (b) and (c) or types 2 to 8 or in other business categories - importer or producer - rate of tax : 7 percent

- The Emergency Decree on Custom Tariffs mentions as rate of Business Tax on internal combustion engines other than motor units for bicycles 3 percent
  (see item nr. 84.06 and Code for Business Category Type and Item nr. 2301)

Above the business tax a municipal tax is charged of 10 percent of the business tax.

If the tax is calculated according to the schedule of the first group, the tax rate seems to us high as compared with other tax rates. Only two groups are subject to higher taxes (30 %), i.e. importers- producers of motorcars/motorbuses, and of liquors/ alcoholic beverages.
We are of the opinion that on account to the agricultural related character of the product and of export prospects, the tax percentage for a small combustion engines producer should be set as low as possible. It may even be that an export bonus could be considered. Of course financial priorities set by the government will largely determine such measures.

sub d.

All persons who earn income frome employment or business in Thailand must pay personal income tax. The taxes are progressive and vary from 10 percent to 50 percent. Employers are required to withhold personal income tax on salaries paid to employees.

sub e.

Assuming that exemption of import duty can be obtained for imports of production equipment, we have considered only the import duties on the principal parts of the engines which must be permanently imported.

We have further assumed that these accessories come under Item no. 8406 - "spare parts' of the Emergy Degree on Customs Tariff , as no other item was found which could refer to components for internal combustion engines. Unless they should come under item no. 8465 - "machinery parts ..... not falling within any other heading in this chapter". However, then they are subject to the same import duties as the category "spare parts".

The total import duty is calculated as follows: the import duty ad valorem is calculated on the C.I.F. import value, this duty must be paid. To the C.I.F. value + import duty is added a standard rate of profit; on the sum of this total a rate of business tax be paid.

The import duty ad valorem for combustion engines other than for bicycles is of 15 percent, the standard profit rate of 13 percent, and the business tax of 3 percent. For spare parts the percentages are 15 percent, 26 percent and 7 percent respectively.

If we calculate the total import duty we obtain: 18.9 percent for combustion engines and 25.15 percent for spare parts.

In this way the situation in Thailand for the producer of combustion engines would be less favorable than for the importer of complete engines. We recommend therefore to make the import duties on components of internal combustion engines at least comparable to those on complete engines and if possible to set them even lower as a stimulating factor.

It must be noted that import duty on combustion engines with a horsepower rating not less than 400 HP has been reduced to 5 percent on June 8, 1970. We are of the opinion that a similar tariff would be justified for the small combustion engine in view of its increasing importance for Thailand.

Finally, it may be observed that for the purpose of export promotion, the Minister of Finance has recently issued a notification (no. C 5/2514) reducing the rate of import duty to one tenth of that specified in the Custom Tariff for the goods imported for the purpose of producing, or assembling into goods for export.

2.4. Financing

In general industrial financing possibilities in Thailand are limited and relatively expensive. For large investments usually foreign financial participation is indispensable, which may take the form of joint ventures.
This may easily be supplemented with transference of know-how, management assistance, etc., which certainly in the case of a more complicated production process as the production of small combustion engines is an outstanding advantage.

The main capital sources in Thailand are:

- commercial banks,
- suppliers credit,
- investment banks and finance companies,
- capital markets.

Commercial Banks are the main suppliers of long term loans.
The interest rates vary from 11 - 15% per annum depending on the credit status of the borrower.
In spite of the relatively high interest rates many borrowers use this possibility because the Commercial banks do not demand an extensive project analysis. For commercial banks the most important prerequisite is the availability of sufficient securities. As most Thai companies are family enterprises adverse to outside

interference, commercial banks constitute a relatively convenient and attractive source of capital.

Supliers Credits are becomming an important means of medium term industrial financing. The interest rates vary from 5.5% to 12.8 per annum and the maturity varies from 1 to 6 years.

Investment Banks and Finance Companies. In 1959 the Industrial Finance Corporation of Thailand was established under government sponsorship. Its objectives are to assist in the establishment and expansion of private industry by providing medium and long term credits. In the past few years 12 other banks and companies of this type have been established which are affiliated to commercial banks. They are engaged in the money market as well as the capital market.
The I.F.C.T., which is the most important bank in this branch, emits foreign currency loans at an interest rate of 9.5 percent per year and at 10.5 percent per year for local currency loans.
The minimum loan size is Baht 500,000 and the maximum is Baht 29 million. The maximum will increase as I.F.C.T.'s resources increase.
Although the share of the I.F.C.T. loans in total industrial financing in 1971 was about 11%, it is expected that this share will increase steadily in the near future. Well prepared industrial projects will probably enforce this tendency.

Capital Markets. The share of capital market financing in the total of industrial development financing is small.
This is due to the closed character of the majority of Thai enterprises and to the possibilities for potential investors to invest in projects with a high profitability rate and a rapid turnover.
The Government has recognized the important role of private investment and will encourage the expansion of the capital market during the Third Plan period.

2.5. Labor

In 1971 the aggregate Thai labor force was estimated at 19 million. It increases at a rate of about 500,000 persons annually.
About 80% are engaged in argriculture, 6% in commerce, 5% in administration, 3.5% in manufacturing and the remaining in other fields.
Thai labor, if properly trained and supervised has proved itself very fit for industrial employment.

There is no shortage of unskilled and semi-skilled labor, but experienced and skilled managerial and technical personnel is not sufficiently available. However more and more professional experienced people have gone into manufacturing. The various universities and trainings centers (for example Thailand Management and Development Productivity Center, National Institute for Skill Development, Industry Service Institute), train many persons. Thus the situation is gradually improving.

In comparison with other countries in Asia labor costs are quite reasonable. The various average wages used in our computations are for:

operators unskilled	7,200 Baht per year
operators skilled	16,800 Baht per year
foremen	21,000 Baht per year
overseers	30,000 Baht per year

The Thai in the production

In an engine factory (Tai Heng Long), in small metallurgical workshops, in a factory of high tension bolts and nuts, in smaller and larger foundries, in heat treatment workshops and in assembly plants, it was observed that the Thai man and woman may certainly be expected to adapt themselves to the labor conditions of an engine factory, although job training could be useful.

Consequently, no special problems need to be expected regarding the engagement in industrial activities. It may well be that in or around the factory certain religious facilities must be provided. It was observed that the Thai woman particularly, keeps her work place, her clothing and hands extremely clean.
The fact that laborers tend to stay away for one day if they feel that they have earned sufficient during the previous days, for one thing indicates that average productivity will be lower than in Western Europe. Lack of more precise information, productivity will be estimated at 90% of European averages.

In the recommendations for the plant setup this has been taken into account.

The Thai in the factory management

In the visited factories and workshops, the management generally proved itself well acquainted with technical matters and willing and able to give all information requested. Moreover interest was shown in the experience of others. Though the lack of knowledge of the Thai language on the part of the consultants sometimes

hindered the exchange of ideas, thanks to the co-operation on the part of our counterparts of the ASRCT, the program could be carried out well.

Technical feeling and innovating courage are certainly existing. A small factory of agricultural equipment built a small diesel engine for its own use and had cast the aluminium parts for ten more. In an engine factory, series of self-built grinding machines and one serie of machine-tools were found. The latter were built of largely uniform elements and performed one milling or drilling operation. Moreover, these machines were ingeniously adapted to the skills of their (female) operators. Product dimensions were guaranteed by fixed stops. Feed was done by hand, a labor-intensive solution, well justified by the relative abundancy of labor. For a large engine factory to be established this will require highly skilled managers. Management training will therefore require attention.

2.6. Small Combustion Engines Industries in Thailand

Thai Heng Long Padriew Ltd., Pt.

This company produces copies of Austrian Rotax engines under the name "Winner". Annual production amounts to about 3000 units of two-stroke air cooled gasoline engines of one and two-cylinder type and 3 to 30 HP at about 4500 r.p.m.
The full production gamma will consist of the following capacities:

hp	r.p.m.
3	4500
4	4500
6	4500
7	4500
8	4500
9	4000
10	4000
15	4000
30	4500

The factory has its own foundry, which produces carter halves, cylinders linings via the shell moulding process. The foundry is actually being relocated because of a strong expansion of production. The crank-shaft is built from grinded elements crimped together. Grinding machines were built by the factory itself for this purpose.

For the machining of carter halves, covers, cylinders, and cylinder-heads, the factory staff had designed very simple single-operation machinetools, which were operated by girls. The numbers of produced grinding and single-operation machine-tools are large. The factory made anorderly impression, the machines were placed in a logical order, though very close to each other. The assembled engine, which did not undergo a final test run in the factory, made a robust impression, although the survey team has some doubts about the quality of the engine. There was no unanimity about the numbers of engines to be produced after the expansion. In view of the machinery being installed, a production capacity of 30,000 two-stroke air cooled gasoline engines may be possible.

The engines are sold by a large number of dealers (200 according to our information), each possessing his own repair shop. The engines have a guarantee period of two years.

The following parts are imported:

- connecting rod
- electrical equipment
- carburator
- spark plugs
- piston rings
- ball bearings
- seals

The following parts are produced by suppliers in Thailand.

- gasoline tank
- nuts and bolts
- silencer
- gaskets

The company is a typical example of a family enterprise, with its typical characteristics as described before, particularly in the managerial aspects. However this enterprise, has given proof of technical understanding and perseverance. The expansion urgently calls for additional financial means.

Thai Machinery Industry Co. Ltd.

The sales program of this firm consists of a.o. the following products:

- Koehring (Isido) cranes
- Mitsui Seiki air compressors
- Steyr tractors
- Wisconsin and Scuthern Cross i.c. engines
- generators
- outboard engines

The company possesses a fully installed and equipped high quality machine factory. Also foundry equipment is available which is still unpacked. Total costs about 25 million Baht. About 200 Steyr 57 hp tractors have been assembled, whereby the complete engines were imported. Because Thai farmers are often unable to fulfill their payment obligations, many tractors were returned to the company. Now there is a tractor leasing program and repair facilities have been created. A total of about 1400 Wisconsin and Southern Cross small gasoline engines have been assembled at the plant. These engines undergo a final testrun in the factory. The assembling of small i.c. engines poses no special difficulties in the factory. However, production has now stopped. The machinery of this factory is, in our opinion, less fitted for the production of small combustion engines. To find a good use for the factory a committee has been nominated for studying the possibilities of the equipment. The company can be situated in the corporate sector. The government is involved in it even with a significant share, as well as private entrepreneurs. After the short visits, that the survey team paid to the factory, it was impossible to get an impression of the managerial aspects of the company. Regarding the troubles raised during the implementation phase, the team feels that the management systems could be improved.

Factory of Mr. Charrey Borriboom

This was reported to be a diesel engine factory. In fact, there has been produced only one diesel engine, as a sideline activity of a landowning farmer. The constructed engine did not yet have an optimal combustion. In the foundry engine castings for ten more engines were manufactured. The design of the parts was heavily influenced by the extremely primitive production means available. In view of the many other activities of this small enterprise and of the primitive production conditions, its output cannot be regarded as a substantial contribution to the satisfaction of demand.

Louis T. Leonowens Ltd. Assembly

This enterprise assembles Massey-Ferguson Tractors, but imports complete engines. Its production amounted to 100-150 pieces of each of three types. Assembling did not pose special problems. Due to payment difficulties of farmers, many tractors had to be returned.

2.7. Supporting Industries

Various Thai enterprises expressed their willingness and ability to act as subcontractors for an engine factory to be established. The most important of these are: an iron foundry operating forming cases on transport lines, a high tension bolts and nuts manufacturing firm, a firm producing profiled steel and cast iron, a Thai-Japanese company planning to start production of pistons in short time.

The management of a combustion engine factory will have to examine closely the expansioncapacities of possible sub-contractors and will have to be observant of the establishment of new enterprise that might serve as subcontractors.

The information available seems to be not 100% accurate. Several times specialized producers were encountered which officially were supposed to be non-existent. Furthermore it was sometimes apparent that information on existing industries was somewhat overdrawn. It may be safely assumed that the possibilities of finding specialized subcontractors in Thailand will constantly increase.
In the following we shall pay attention to several visited industries.

Sisco Siraburi

Sisco Saraburi is a concern, consisting of cement factories and a number of foundry and rolling mills. The latter are very modernly equipped and designed with Danish know-how. The foundries have, besides facilities for hand forms also some heavily mechanized forming casing systems on transport lines for larger series. The company already has some experience with smaller series of castings for combustion engines for repair purposes. The equipment for metal cutting is specialized for larger castings, and to a lesser extent for small combustion engine castings. The steel foundry of the rolling mill can produce blocks of qualities required for forgings. The rolling mill produces wire, besides the current smaller profiles. In principle it can produce the kind of wire of which high tension bolts and nuts can be produced. The company is able and particularly fitted to act as sub-contractor for more complicated high quality castings.

As may be expected that new high quality foundries will be established in the near future, (such as Thai Machinery Industry Company Ltd. and Somboon Spring Factory L.P.) a dependence upon a single sub-contractor need not be feared.

Small Foundries

Them are many small foundries, able to produce at competitive prices simple castings like brackets, fly-wheels, etc. In view of their equipment and know-how, no uniform quality of their products may be expected.

Mahajakyontr. Ltd. Part. Bolts and Nuts Manufacturer

This manufacturer of high tension bolts and nuts has constructed, in cooperation with a Japanese company, a particularly well equipped factory, now about one year in production.

The machines are of Japanese origin. The basic material was cold formed round wire, equally from Japan. The screw thread can be rolled or cut as required.

Eventually necessary heat treatment can be executed at own premises. The capacity of the factory is sufficient to suit ample needs. Delivery time is short.
Plans have been elaborated for other products, e.g. for spring washers.

3. THE MARKET

(for tables and diagrams mentioned in this Chapter, we refer to Appendix 3)

3.1 Determination of the Product

This survey focuses on the small internal combustion engines in a horsepower range of 1 to 20 HP. They can be kerosine-, gasoline-, or dieseloil-fueled. Motorcycle engines are not included in the survey.

3.2 Evaluation of Available Information

So far no thorough market research has been done in the demand for small internal combustion engines. Yet the extent and the importance of the market would justify such an investigation, but it is very difficult to obtain a clear picture of this market on account of the large variation in users, type of motors and fluctuations in the turnover of recent years. Neither have the consultants been able to do a detailed market research on account of the limited study period. The information obtained during the study is however, considered to be sufficient to serve as a basis for a feasibility study. The market demand forecast is based on:

a. evaluation of prior studies and reports concerning engine production in Thailand,

b. analysis of the import statistics,

c. interviews with engine importers and an engine manufacturer,

d. analysis of developments in agricultural mechanization

Most reports giving details of the demand for small combustion engines are based on the import statistics. This is the usual procedure for products which are not produced locally or produced locally to a smaller extent, as is the case for small combustion engines in Thailand.
Import statistics of small combustion engines however should be examined with caution. The import data in Thailand are classified according to usage purposes, e.g. tractor engine, outboard engine etc. and according to the kind of fuel but not according to H.P. ranges. In our investigation we have found that 0 - 5 percent of the imported gasoline engines and 10 - 20 percent of the diesel engines had a capacity greater than 20 H.P. Further it must be taken into account that the same type of engine may appear in different categories. In addition changes in the coding of import engines were made in 1970, which gives rise to difficulties as does the fact that engines can also be imported as components of other machinery and that no distinction is made between new and second hand engines. However it is the overall assumption that the latter problem will only arise with engines of a capacity greater than 10 H.P.

There appears to be no agreement between the import data of imports from USA and Japan supplied by the Department of Customs, and the numbers exported to Thailand, supplied respectively by the US Department of Commerce FT-410 reports and the Ministry of Finance of Japan - Japan Export Statistics -.
We refer in this instance to the diagrams C, D, F and to tables A,B,C.

For these reasons it is not possible to read the market demand for the different types of engines from the import statistics in their present form. They do however give a picture of the total demand and shiftings of demand (see paragraph 3.3.).
With the additional information obtained from interviews and from prior reports it is now possible to make a more detailed analysis.

For this purpose a description is given in par. 3.4, 3.5, 3.6, 3.7 principal factors bearing on the market demand of small combustion engines. In paragraph 3.5 an analysis is made of market demand in the past years in relation to the general trend of the Thai economy as described in chapter 2 and to the direct bearings on the small engines market as described in paragraph 3.4. Next in par. 3.8 market demand is forecasted on the basis of this analysis.

3.3 Total Imports in the Past

Based upon data presented by the import and export statistics from the Department of Customs the number of relevant engines imported in Thailand is shown in Table A and in diagram A (the connecting lines in diagram A between the points indicating imports per year were drawn to bring out the tendencies and have no meaning graphically).
The classification of combustion engines is given in table D.
Outboard engines and marine engines are included on account of the fact that these groups also comprise engines used as prime mover for the so called "long tail boats".
During the survey it was found that:

a. the group internal combustion engines, respectively gas and gasoline engines, comprises a negligible number of gas and kerosine engines.

b. the group diesel and semi diesel engines, respectively diesel and other heavy oil engines consists of engines which may all be classified as diesel engines;

c. export and re-export of combustion engines is less than one percent of the number of imported engines and therefore negligible. Therefore, these numbers are not taken up in this report.

The diagram A shows :

a. a large increase in imports of gasoline engines up to 1968 and a strong decrease after 1968;

b. a more gradual increase in imports of diesel engines up to 1969 and a slight decrease after 1969;

c. a more constant line in imports of diesel engines in comparison with imports of gasoline engines;

d. an increase of the part of diesel engines in the total imports after 1968, and that in 1971 this part is higher than that of gasoline engines.

It is notable that with the declining economy after 1968 imports of gasoline engines do indeed decrease but that the imports of diesel engines remain fairly constant. This in spite of the fact that the diesel engine is about three times as expensive as the gasoline engines.

3.4 Consumers

Introduction

The surveyed total group of engines can be divided in:

according to type : a. gasoline engines - 2 stroke
4 stroke

b. diesel engines

according to use : a. pump

b. boat

c. generator

d. agricultural machinery - small tractors
processing equipment

e. miscellaneous

From the here given utilization and also from the fact that about 80 percent of the Thai population works in the agriculture, it follows that the small combustion engines are used especially by farmers for their cultivations. Therefore, the development of agricultural mechanization is the main factor to influence the potential demand for small engines.

Agriculture

The farmer

Though of a conservative disposition the Thai farmer is not subject to cultural or religious prejudices. He is however sensitive to the influence and opinions of his neighbors. If his neigbor uses new machinery this will provoke him to try and obtain such a machine himself. We have also found that advertising is likely to influence sales considerably in Thailand. Another feature is the distinct liking for ornamented utility objects. This is clearly apparent from the elegantly forged ironwork on tractors, the chromium and the painted ornaments on vehicles, and so on. We think this aspect should not be neglected when determining the finishing quality of the engine to be produced.

Land use

In spite of the trends towards industrialization Thailand is still an agricultural country. In the third five-year plan the agricultural products (crops, livestocks, fishery and forestry) continue to take up the greater part of the G.D.P., i.e. 26,8 percent (the estimate for 1971 was 29,5 percent). For crops only is counted with a part of 18,2 percent (the estimate for 1971 was 20,5 percent) which is the largest part in the G.D.P. after the total part of agricultural products. According to the land classification survey held in 1965 about 24 percent of the total area of Thailand is farm land. Of the farm land about 82 percent is under cultivation.

In table E is shown that of the total production area the rice production area has the greatest share, i.e. about 70 percent. Of other principal crops rubber takes a share of about 6 percent and maize (corn) of 7.5 percent of the production area.

During recent years demand and price of major crops such as rice, maize, kenaf, rubber and tapioca have been subject to heavy fluctuations. Therefore the agricultural development strategy is directed to diversification of crops. Maize, tapioca, jute and cotton are much in demand now. Some farmers are starting to cultivate one of these crops after the rice season. The need for mechanization and irrigation becomes evident if double-cropping increases. In this respect is is worth mentioning that at present about 12,5 million rai ✱ land can be irrigated by the existing and to be completed reservoirs. However many of the secondary provisions such as ditches, dikes, village level irrigation and drainage systems are still to be completed. As a result agricultural production in Thailand is still far below its potential. The third five year plan emphasizes the importance of completion of these works

✱ 6.25 rai = 1 ha.

As reported the average size of farm holdings is 3 to 5 ha per family. Table F shows the average size of farm holdings. There is also a tendency of an increasing number of farmers forfeiting their land and the main cause for this is reported to be the fact that many farmers are financially dependent on other people. Mainly on the so-called "middle-man", who will grant credits at very high interest rates, and if the farmer cannot pay his debts he loses his land.

Market system

There is no well developed modern market system for agricultural products. The aforementioned "middle man" plays an important role as, apart from being the financier, he acts as intermediary at the sales of agricultural products, which enables him to offer more than marginal prices for these products. Once a farmer begins working with a middle man, it is difficult to free himself due to the fact that it will be hard to find credits elsewhere.

Credit system

Various sources report that the agricultural credit possibilities are distinctly inadequate. The government is aware of this problem and also the farmers have started to tackle the problem by the setting up of cooperatives; however we doubt that an adequate solution will be reached in the coming five years.

Though the matter is taken up in the third five year plan we are under the impression that the complexity of this problem is not fully realized. Yet for a reasonable development of the farm mechanization and thus stimulating the use of small engines it is essential that this "credit-problem" be solved.

Training

A second restricting factory is the relatively low standard of education and training of the Thai farmer.
This often prevents him from actively trying to improve his situation. Also he is often not aware of the importance of adapted mechanization and of the use of fertilizers and other inputs and he has no knowledge on how to use the agricultural machinery. The survey team has visited several agricultural training centres and is of the opinion that valuable and necessary work is being done in these centres. However, their number is too small to yield rapid results at a sufficiently large scale and mass training schemes on selected techniques would be likely to give quicker results.

Farm mechanization

In spite of the restrictive factors facing him the Thai farmer is gradually becoming more interested in farm mechanization emphasized no doubt by the shortage of power in peak-seasons. As in most countries in S.E. Asia mechanization has started with the introduction of basic machines such as tractors and low lift pumps. As about 70 percent of the cultivated land is used for rice production, this means that there is a great need for soil preparation machinery and for irrigation pumps.

For the mechanical soil preparation in Thailand the big tractor is mostly used due to the heavy soil. As this type of tractor has an engine with a capacity of about 60 HP or more, we have not included it in our consideration. Our attention is mainly focused on machinery driven by small engines.

The small tractor with an engine in the range of 10-20 HP is mostly used for upland crops and not very popular in Thailand. This is reported due to the heavy soil conditions, but the survey team believes that this is only one reason and another reason may be that the farm mechanization still finds itself in the early stages. When the farmer recognizes the advantages of this type of engine and when implements will be improved so that they will be suitable for use in the paddy areas, a considerable increase in demand for the small tractor can be expected.

The local production of simple two-wheel tractors is estimated at about 3.000 units a year. It is expected that the production will increase at 10 percent per year over the next few years.

The main use for the small engine is the waterpump. Waterpumps are widely used all over the country mainly for irrigation of the paddy fields. In order to be able to regulate independently the water level per field, most farmers like to have their own pump. Also in fields where irrigation is done by means of gravity, pumps are used to pump the water from the irrigation channel over the dike into the field.

Demand for pumps will be stimulated especially through expansion of irrigation works. Another influence is the introduction of double cropping, for which irrigation is also necessary in the dry season.

If more cropping is widely introduced, (which is not likely for the moment), there will be greater need for other engines such as small tractors and some processing machinery. The period between harvesting (and processing)of the first crop and planting of the second is short.

Small scale processing machinery is hardly used in Thailand and no great changes are expected in the near future.

Boats are used principally in the Central Plain as a means of transport. This region has an extensive network of waterways. There are plans to improve these waterways. It is not clear at this stage to what extent larger irrigation works could stimulate the use of waterways. It is to be expected however, that an improved water household will stimulate water traffic also in other regions.

Generators are mainly used in those areas where electricity is not or hardly available. We may assume however, that the use of generators will decrease once the third five year plan provides rural electrification programs.

A very important factor in the use of small engines is their easy transportability. Many farmers use the same engine for different purposes, therefore a light weight is very important.

Further, we have been told many times during our survey that on account of the limited technical knowledge of the Thai farmer, the after sales care is very important. At present it is sometimes hard to obtain the necessary maintenance service during the warranty period and spare supplies are sometimes inadequate. Good handbooks on correct usage of the engine and on repair of small technical trouble are often not available.

We want to emphasize that an extensive and good functioning dealer network will greatly benefit the sales of the engine and is even considered an absolute necessity for the success of the project. We also want to point out that in view of the rather close character of the present dealer network, it has to be examined carefully if, and how existing network can be used.

Summary

From the foregoing concise exposition of farm mechanization in Thailand, we may draw the following conclusions:

Requirements for the engine are:

- low purchasing price
- low operating costs
- light weight and easy transportability
- robust construction, long life span
- fit for continuous operation and over-load
- simple to operate
- low chance of technical trouble
- easy to repair
- attractive appearance

Requirements for the service system are :

- extensive, well equipped and well-trained
- able to give clear information
- credit possibilities
- good assortment of spare parts.

Stimuli on demand are :

- increase in size of holdings
- stabilized and guaranteed crop prices
- rationalization of agricultural practice
- introduction of double cropping
- far reaching measures for a better market structure for agricultural products
- more credit facilities
- increase of training facilities to farmers
- setting up of farmers cooperatives
- execution of irrigation works
- advertising

3.5 Domestic Market Demand for Gasoline Two-Stroke Engines

Description

Two-stroke engines are light weight and of simple construction. Their maintenance is therefore simple. In the PP range under consideration they are aircooled. Compared to other types of engine the price is low (a price and weight list is given in table C). However, the fuel consumption is highest as compared with other types of engines. Another disadvantage of the two-stroke engine is that the life span is relatively short. Also starting problems are greater than with four-cycle engines. Further it seems that mixing of fuel with lubrication oil of the right quality and in right quantities sometimes presents a problem in Thailand, which leads to serious pollution of the engine's exhaust system. The two-stroke engine is less suitable as a tractor prime mover e.g. the torque-speed curve is not optimal for tractors.

Utilization

These engines are mostly used as a prime mover

a. for the so-called "long tail boats".
   The popular engine capacity ranges from 5-10 HP and up from 20 HP. It is estimated that about 70 percent of the two-stroke engines are used for this purpose.

b. in agricultural equipment, mainly pumps.
   The engine capacity is in the range of 5-10 HP

As regular boat traffic is mostly found in the Central Plain, it is here that most two-stroke engines are sold.

Brands

Although since a few years engines are locally manufactured (Brand-name : Winner, production about 3.000 units per year) the greater part of engines are imported. It is estimated that more than half of the market is dominated by the Austrian brand Rotax. Other popular brands are the Western German J.L.O. and Sachs and the Japanese Kawasaki and Yanmar. The Japanese brands are rapidly gaining field.

Market demand in the past

The total number of engines in Thailand is estimated at about 200,000. In the year 1968 there have been top sales of 35,000 - 40,000 units. In the years after 1968 sales have decreased until an estimated number in 1971 of 12,000 to 15,000 units.

If we compare these figures to the data from import statistics the same trends appear. Diagram B shows imports of gasoline engines, divided in categories and main exporting countries

From diagram B-a, it can be seen that imports of outboard and marine engines have decreased after 1968. Diagram B-b shows that imports from Austria (Rotax) are distinctly on the decrease. It is also apparent that the Japanese part is constantly increasing the reason of which is for a part found in the two-stroke engine market.

The downward trend can be explained as follows :

a. the general economic recession in Thailand,

b. the replacement of small engines as long-tail-boat driver by second-hand more powerful automotive engines,

c. saturation of the market,

d. change in preference on the part of buyers.

Which of these causes have had the most influence on the decline could not be determined in this survey. We are of the opinion however that market saturation should be taken into account. This means that measures must be taken to increase purchasing-power of the farmer before expansion of the market is possible. Next, the fairly constant line in the sales of diesel engines, also in a period of economic inertia, indicates a change in preference on the part of buyers.

Demand expectations

Table H shows the annual engine demand as estimated and projected by the survey team. The estimated demand in the past has been discussed in the preceding paragraphs.
The projected future demand of two-stroke gasoline engines is based on the following considerations.

Though Thai economy does show promises, no justification of this will be found in the salesof two-stroke engines in the near future, because of:

a. The shifting from two-stroke gasoline engines prime movers to bigger second hand automotive engines in the Bangkok area for the "long tail boat".
In addition there is no chance of important extension of water-ways in rural areas where small engines are preferable.

b. The probability that the point of saturation of the existing market for this type of engine has been reached.

c. The growing interest for diesel engines, information we obtained from prominent agricultural sources.

d. The increasing training facilities to farmers. They are better able to judge the purchase of technical equipment. The advantages of the diesel engine become more outspoken and weight more heavily.

e. The application fields in Thailand for engines fit for heavy work are larger than for engines for light work.

f. Accordingly, as the inland regions are opened up and become easily reachable, the weight of the engine will become less important and the interest will shift to efficiency, reliability and running costs.

On the basis of these considerations, it is presumed that the market demand will not increase strongly anymore. For 1972 estimated sales figures are even slightly below the 1971 figures. The survey team expects that after 1972 there will be a slight growth, up to about 5 percent annually for the necessary replacements to be made. After this, the growth will fall to about 2 percent annually. In our opinion, up to 1981, there will be no great change in the growth percentage. In spite of a larger total market, the part of the two stroke engines in this market will decrease.

Local production

As mentioned in paragraph 2.6 there is one local manufacturer of this type of engine. The production amounts to about 3.000 units per year. This manufacturer is busy expanding his plant so that his production capacity will increase. For this purpose he has applied to the I.F.C.T. for an investment credit.

Conclusion

In view of the moderate market demand and the projected extension of the local production this type of engine will be left out of consideration when evaluating the establishment of a new small combustion engines production plant in Thailand.

3.6. Domestic Market Demand for Gasoline Four-stroke Engines

Description

The four-stroke engine weights a little more than the two-stroke engine but considerably less than the diesel-engine. Just as for the two-stroke engine the cooling can be done by means of air up to 20 HP, on account of the relatively low heat pressure on the cylinder head. The construction is a little more complicated because of the valves mechanism in the cylinder head. The life span however is longer than that of the two-stroke engine while it is better resistant to overloading. The price is slightly higher than the price of the two-stroke engine but considerably less than that of the diesel engine (see table C).

Utilization

Four-stroke engines are mainly used as prime movers for :

a. pumps

b. generators

c. small tractors

d. other agricultural machinery, such as threshers, rice mills etc.

e. building machinery.

It is estimated that about 60 percent of the engines is used as prime movers for pumps. It has not been able to estimate the parts of the other using purposes.

Brands

So far no four-stroke engines are manufactured in Thailand. A few years ago a production plant was set up for the manufacture of the Wisconsin engine. Due to a number of difficulties there has been no production yet. The plant has been used however for assembling some engines (see Par.2.6.)

Export of four-stroke engines to Thailand is for the greater part handled by Briggs and Stratton from USA. It is estimated that this brand takes up about 60 percent of this market. Other important competitors are the Japanese brand "Kawasaki", "Mitsubishi" and "Shibuara". In the last few years the American brand "Wisconsin" has practically been ousted by the Japanese brands.

Numbers and tendencies

Four-stroke engines in Thailand are estimated at about 300,000 units.
The sales of small four-stroke engines have also fallen after the peak year of 1968. Cautious estimates give sales figures of 60,000 - 70,000 units for 1968, while for 1971 these figures are 30,000 - 35,000 units.

It was found that 90 percent of these sales concern engines in the range of 3-10 HP. Especially the 3-4 HP and the 7-8 HP engines are popular types. Their shares in the sales of the group 3-10 HP are respectively 50 percent and 25 percent. Sales are fairly equally distributed over the whole country except for the South where sales are low.

Though figures taken from import statistics give no indication of imports of four-stroke and of two-stroke engines it can be seen from the diagram B that:

a. import of gasoline engines from USA slow down especially in 1970 as compared to the preceding year.
This is in agreement with the slump in sales of the brand Wisconsin found in the survey.

b. rise of the Japanese contribution in the gasoline engines market which for the greater part must be attributed to the four-stroke market.

Conclusions

The fall in sales of four-stroke engines must mainly be attributed to the general economic depression in Thailand.

From the fact that the decline in sales is less pronounced for the four-stroke than for the two-stroke engines and that sales of the diesel engine remain constant we may deduce that sales of a more expensive but distinctly better product is less sensible to conjuncture influences.

If we finally compare the estimated total sales of gasoline engines, figures resulting from our survey, with the total imports of gasoline engines the figures of which were obtained by the Customs Department, we find the following.

For the year 1968 total sales are estimated at 35,000 - 40,000 units + 60,000 - 70,000 units = 95,000 - 110,000 units, while imports in 1968 were : 115,000 units and in 1969 : 95,000 units.
Estimates for 1971 are :
total sales : 12,000 - 14,000 units + 30,000 - 35,000 units = about 42,000 - 50,000 units.
Imports in 1970 were : 70,000 units and in 1971 : 30,000 units.

If we consider that:

a. imports do not react at once to a sudden slump in sales and that thus a stock is formed,

b. import statistics also comprise engines of a capacity greater than 20 HP and second hand engines,

then we esteem that the differences are sufficiently explained.

Demand expectations

As the four-stroke engine use purposes are similar to those of the diesel engine, and the two types can be considered competitors, the market demand will be discussed in one paragraph with the diesel engine market demand.

3.7. Domestic Market Demand for Diesel Engines

Description

In the surveyed HP range the four-stroke diesel engine is predominant. Diesel engines are heavier than other engines and have a rather complicated injection system.

Fuel consumption is a little below that of gasoline engines. Price of diesel-oil in Thailand is about half the price of gasoline.

Selling price of the diesel engine is about three times the price of the gasoline engine (see table G).

It is thought in Thailand that aircooling is an extra risk in agriculture. This opinion is shared by the survey team. Engines with radiator cooling should be filled with clean water for cooling and constant care should be taken of radiator and the water connections. These vulnerable, lighter engines have a small advantage in that the fuel consumption is slightly lower.

Engines with hopper cooling are more recommendable in countries where repair facilities are still scarce. They are robust, shock proof, have a large over-capacity, demand less maintenance, can be filled with river water. The user can see at a glance of the eye if there is enough water in the engine and if the cooling system is working correctly.

In this report we distinguish between :

a. low speed engines - speed less than 1500 rpm

b. medium speed engines - speed between 1500 and 3000 rpm

c. high speed engines - speed above 3000 rpm.

According as the cycles increase, weight and working security decrease and the engine becomes more complex.
However, low speed and medium speed engines are far more solid and have a longer life span than gasoline engines.

Utilization

On account of its characteristics which we have described in the foregoing the diesel engine is used mainly for stationary applications and continued use, e.g. with : a. pumps

b. generators.

Low speed engines are used for this purpose only, while medium speed engines are used for this purpose principally. The high speed engine is practically not used at all in Thailand.

It seems that medium speed engines are gradually used also for other agricultural purposes. As initial costs are rather high and operating costs low it is of interest to use the engines as many hours a year as possible. This can be done by using the engine as a multi-purpose engine. To this end it is necessary to manufacture the engine as a transportable type.

It is estimated that 60-70 percent of the sold diesel engines are used as prime movers for irrigation pumps and about 10 percent for generators.

Brands

Diesel engines in Thailand are all imported. The principal brands are Japanese "Kubota", "Yanmar", next is "Mitsubishi". These brands practically supply the whole market of the medium speed engines. The speed of these engines is between 1800 and 2200 rpm. However, it has to be taken into account, if local production of engines is attractive, the above mentioned producers surely will consider the possibilities of production in Thailand.

The low speed engine market is all but completely dominated by engines from U.K. Popular brands are "Lister", "Petter" and "Ruston" with a speed varying between 600 - 1500 rpm. Noticeable is the rise of the sales of the types Lister and Petter from India, which are built under license, same as the rising influence of the Italian brand "Lombardini" and of some East European brands. Because of an export bonus of 20 percent given by the Indian government, the price of the manufactured engine can be kept low.

Numbers and tendencies

Diesel engines are estimated to number about 200,000 units in Thailand.

In contrast to the sales of gasoline engines, sales of diesel engines have not fallen so much after 1968. The total sales in the range up to 20 HP are estimated at 45,000 - 55,000 units for 1968. For 1971 these numbers are esteemed to be 35,000 - 40,000.

The category low speed engines takes up 10 - 15 percent of the total market. In this category especially the 16 HP engine is very popular. In the category medium speed the range of 3 - 5 HP appears to be attractive. This capacity group counts for 60 - 70 percent of the total category of medium speed engines with the pitch on the higher capacities. They are used mainly for pumps and generators. Another category with important sales is the 7 to 8 HP engine. This engine takes up about 20 - 30 percent of the total sales of medium speed engines. These engines are much used as prime movers for larger pumps and "small tractors".

Engines in the range of 10 - 15 HP are mostly used for locally made small tractors.
Sales of this type of engine amount to 1000 - 2000 units per year.

From the import statistics on diesel engines as shown in Diagram E it appears that import numbers are in agreement with sales numbers for those engines resulting from our study. We observed that only from 1970, a distinction is made between marine engines, motor vehicle engines and not elsewhere specified engines (n.e.s.) in the data provided by the Customs Department. Before 1970, only total import numbers were given. In order to make a good comparison possible we have also taken up the imports of motor vehicle engines in diagram E-a.

The diagram E-b clearly shows the growing superiority of the imported Japanese diesel engine. We have not been able to determine the causes of the considerable differences in data supplied by the Customs Department about imports from Japan and data on exports from Japan to Thailand supplied by the Ministry of Finance of Japan, (see diagram F).

The diagram E-b also shows that the contribution of engines from U.K. is the second largest. The remaining numbers are the contributions of the other aforementioned exporting countries.

Conclusion:

In our opinion, the fairly constant demand for diesel engines, in spite of the economic recession, can be explained by a growing interest for this type of engine.

3.8. Demand Expectation for Four-stroke Gasoline and Diesel Engines

Total Demand:

The projected demand as shown in table II is based on the following considerations:

The first assumption is based on the considerations given in paragraph 2.1., political, economic and social information. As expressed in this paragraph a reasonable economic growth is expected in the coming five years. This means that gradually more funds will be available for the purchase of small engines. This point of view and our considerations on the factors which influence the growth of the agricultural mechanization, positively and negatively, as described in paragraph 3.4, (Consumers) are the basis of our cautious estimate of a 9 percent for the average annual growth for the total demands up to 1981.

For the years 1975 and 1976, we foresee a larger grow which we can explain as follows:

a. by that time purchasing power will be generated to the extent that demands can increase,

b. in this period the engines bought in 1968 - 1969 will be due to be replaced.

c. less new purchases in 1970 - 1971, for reason of insufficient financial means, will be made up in this period.

However, even in the years 1975 and 1976 the total demand will be checked by the limited availability of financial means.

For the year 1972, it is expected that the consumer will take a "sit on the fence" attitude and that sales will not come far above the 1971 figures.

Demand per Type

When analyzing the demand for the different types of engines our basic thought has been that a shifting is taking place in the buyer's preference from cheaper engines with a lower life span and higher operating costs to more expensive engines with a longer life span and lower operating costs.

This view is supported by the development of agriculture in the past in other countries. It demonstrates a shifting from the use of two-stroke to four-stroke gasoline engines and then to diesel engines.

The latter two however will always be competitors as they can be used for overlapping specific purposes as explained in our description of the different types of engines in paragraphs 3.6. and 3.7. As these engines are mainly used as prime movers for transportable pumps in agriculture (continued heavy duty purposes) it seems that particularly the medium speed diesel engine will stand a good chance. Although heavier than the four-stroke gasoline and more expensive, the advantages seem to be gaining ground.

These advantages are mainly:

a. longer life span

b. less mechanical trouble

c. lower fuel consumption

d. cheaper fuel costs

The survey team therefore expects that the forthcoming years will result in a better development in the demand for four-stroke gasoline engines than for two-stroke engines, but in the long run will shift to diesel engines.

Only for the years 1972 and 1973 can a slight decline in the diesel market share be expected to the advantage of the four-stroke gasoline market, (see table H). Replacement of the extremely high number of engines bought in 1968 - 1969 will be due then. In 1972 - 1973 however, the purchasing power will not have increased to the extent that high expectations in favor of the diesel engine are justified. A stronger increase in the demand for diesel engines is expected only at the end of the coming five year period and this is for the following reasons:

a. improved economic situation in Thailand

b. necessary renewals

c. awareness of the advantages of the diesel engine by principal users in Thailand.

As the weight plays an important role in view of the necessity of easy transportability, it is expected that demand for medium speed diesel engines will increase more rapidly than that for low speed engines.

3.9. Selection of the Market

Evidently, from the foregoing it is not attractive from a marketing point of view to manufacture two-stroke engines in Thailand. The good prospects lay in the field of the four-stroke gasoline and diesel engine. It is recommendable for technical reasons, both sales and production to reduce the number of types as much as possible in the beginning.

The most attractive types as regards market demand are: four-stroke gasoline 3- 10 HP, medium speed diesel 3 - 5 HP and medium speed diesel 7-8 HP.

The market survey has pointed out that in the group diesel engines 3 - 5 HP, the emphasis lays on the engine 4 - 5 HP. This can be one same engine. By means of adjusting speed the power output can be adapted.

If we assume that the part of this type of engine takes up 80 percent of the group high speed diesel 3 - 5 HP then the expected market demand for the medium speed diesel engine 4 - 5 HP is as indicated in table 1 of this chapter.

The group medium speed diesel engines 7 - 8 HP is also one and the same engine. By changing the speed the power output can be adapted.

The group four-stroke gasoline engines 3 - 10 HP comprises many different engines of different capacities. From the market survey it has appeared that the 3 - 4 HP engine and the 7 - 8 HP engine are most popular. The projected market demand is shown in table 1 of this chapter.

For the engines under consideration there are no plans to have them locally produced. Only for the four stroke gasoline engine plans have been considered for local production by T.M.I. The possibilities for this still existing production plant will be evaluated, also regarding possible future production of gasoline four-stroke engines.

table 1: Projected annual demand in units

type \ year	1972	1973	1974	1975	1976	1981
4-stroke gasoline 3 - 10 HP	30,000	33,000	36,000	38,500	41,000	50,000
of which 3-4 HP	15,000	16,500	18,000	19,000	20,500	25,000
of which 7-8 HP	7,500	8,000	9,000	9,500	10,000	12,500
Total 3-4 HP & 7-8 HP	22,500	24,500	27,000	28,500	30,500	37,500
Medium speed diesel 3 - 5 HP	20,000	21,000	24,000	30,000	36,000	60,000
of which 4-5 HP	16,000	17,000	19,000	24,000	29,000	48,000
7-8 HP	8,000	8,000	9,500	11,000	13,500	23,000
Total 4-5 HP & 7-8 HP	24,000	25,000	28,500	35,000	42,500	71,000

From this table, it clearly shows that the medium speed diesel engines 4 - 5 HP appear the most promising market. The annual demand for this most popular diesel engine type is higher than that of the most popular four stroke gasoline type. If, after a starting period, it would be possible to also manufacture the 7 - 8 HP diesel engine then attention could be paid to the second promising market.

In connection with power output and as regards type, the demand for diesel engines develops better than for four-stroke gasoline engines.

If a level can be reached, of price, performance and quality, which is comparable to the present prominent brands such as Kubota and Yanmar, then we believe a market share of 1/3 to 1/2 parts can be reached.

Calculating with an average between 1/3 and 1/2, the estimates for the market share of the 4 - 5 HP engine becomes as follows:

1972 - 6700 units per year

1973 - 7000 units per year

1974 - 8000 units per year

1975 - 10,000 units per year

1976 - 12,000 units per year

1981 - 20,000 units per year

In order to meet the requirements expected from the engine, (see paragraph 3.4.) and on the basis of the demand projections, (see table 1 of chapter 3) the survey team recommends the manufacturing of the engine with the following technical specifications:

type: 4 cycle diesel engine

cylinder: horizontal, one

cooling: hopper

output: (HP/rpm): 5/2000 or 8/2000

weight: (kg): less than: 75 respectively 90.

appearance: attractive

price: ฿ 3500, resp. ฿ 6000 for subdealers, delivery from factory

3.10 Export Possibilities

Considering the extent and the complexity of this problem the study team has been able to give only limited attention to it. A good knowledge of export possibilities is, however, essential because of the proportionally limited market in Thailand, in relation to the economic production size and also the importance of enlarging annual foreign currency savings.
Export problems should,however, not be underestimated. Competition in the international market for small combustion engines do not allow disorganized approach: if one tries to penetrate in existing markets, excessive risks can only be avoided by careful preparation, if - on the other hand - one aims at opening new markets, one must be prepared to meet the terms of competitors.
In order to attack these problems in a modern marketing approach

a. an inventory of expectations concerning relevant developments should be made,

b. the results of this inventory should be translated into export forecasts.

South East Asia

An attractive market is constituted by the surrounding South East Asian countries. Although these countries are in different phases of development of agricultural mechanization, industry, economy and technical power, they all have to face - to certain extent - the problem mentioned para 3.4 (Consumers).
Nearly all countries in this region import small combustion engines. In an ECAFE/AIDC/UNIDO fact finding mission report on Industries Manufacturing Agricultural Machinery the quantity demand, sales and manufacturing schedule can be found in tables I through M. It is questionable whether these figures are still valid as such, also in view of the unexpected development of Thailand since the visit of the mission in 1968/1969.

Nevertheless, the report mentions an annual demand of an impressive number of units in the visited countries. Total demand in 1970 is estimated at 590,600 units in 1975 at 1,002,000 units.
The Indian market amounting to about 60 percent of the total, is conspicuous. Diesel engines in the power range of 3 to 15 HP appear particularly attractive for this country.
The second quantitatively attractive market is constituted by Pakistan, where also a comparable preference for 3 to 15 HP diesel engines appears to exist. Pakistan's share in the total demand of the region amounts to about 10 percent.

A further export possibility can be found in the partner countries of Thailand in the ASEAN group : Malaysia, Singapore, Indonesia and The Philippines. If political and economic cooperation is realized it is recommended to establish some production plants, each producing a particular type of engine to supply this market.
In the other ASEAN countries ECAFE demand projection amounts to 44,000 engines in 1970 and 90,000 in 1975 not included the demand in Singapore.
In these countries the main share of the market is expected to fall to the 3 - 5 HP gasoline engine.

India and Pakistan are the main producers of small engines in the countries visited. In 1968 they assured more than 90 percent of the production in these countries. About 50 percent of the local production consists of 3 - 5 HP diesel fueled engines.
The better part of these are of the low-speed type, while there is a tendency towards the use of medium speed engines. The only other ASEAN country planning the production of a 3 - 5 HP gasoline engines is Indonesia.

Other countries

In this respect, one could think of the markets served by an enterprise with which a Thai engine factory will cooperate. Such a manufacturer will already dispose of a dealer network, which could be made use of. A further possibility would be to study, with the help of the marketing department of the industries counterpart, the possibilities of opening up new markets.

Conclusion

According to the ECAFE-fact-finding-team good sales opportunites for the recommended engine for Thailand exist in India and Pakistan. In these countries a preference for diesel engines and a tendency towards lighter medium speed engines are observable. At the same time no plans exist to produce these engines locally. A smaller but nevertheless attractive demand is estimated in the other ASEAN countries for a four-stroke gasoline engine. The size of the market share for a Thai engine cannot be estimated on the basis of the available information.

4. TECHNICAL ASPECTS OF PRODUCTION

(For tables and figures mentioned in this chapter we refer to Appendix 4).

4.1. Construction of the Engine

The type chosen has clear advantages for production of engines in Thailand.

Especially in the case of hopper cooling the number of parts to be assembled is the smallest possible. In comparison with gasoline engines the product is relatively labor-intensive especially if, as recommended, universal operating machinery is chosen.

The fitness of the recommended engine type (for production in Thailand) is notably increased by the relatively low number of uncomplicated castings, each of which consists of cast iron of qualities obtainable in Thailand and can be produced on universal metal-working machinery. Air-cooled engines need highly complicated casting and production techniques for their aluminium components. The same holds to a lesser extent for radiator-cooled engines.

The recommended engine type was produced in various European countries, mainly for agricultural applications, in the years after the second world war when agricultural mechanization made rapid increase. It is still produced by some European and Japanese firms and has been successfully applied in Thailand. The present design is largely identical with that of the post-war period. Technical development resulted in a beautifully finished product of lower weight.
For a list of manufacturers of this type of engines see table A.

The European firms who used to manufacture this type of engine have now turned to air-cooled or radiator-cooled diesel engines. These engines, produced mainly for the European market, are supported by an extensive and well functioning service network. They are certainly more complicated and are built up with precision castings (aluminium of cast iron), which can only be manufactured with highly specialized production techniques. Moreover, they are more vulnerable.

4.2. The Production Plant

General

For the determination of an optimal annual production size in the financial and economic analysis in chapter 5, three production capacities are compared, namely 5,000, 10,000 and 20,000 units per year of the same type. We thereby presupposed a hypothetical 4 stroke, hopper cooled, 5HP, max 2000 r.p.m. diesel engine.

Definitive and detailed specifications should follow from contacts with an eventual license supplier. In view of the virtually identical design of hopper cooled diesel engines, little if any adaptations of way of production will be necessary for the definitive product specifications.

Calculated are an unmachined crank-shaft, to be finished in the plant itself but to be fabricated elsewhere in Thailand. For the piston we calculated it to be finished in the plant. In our definition of the plant outlay we presupposed that the following parts will be imported or subcontracted.

Part	Imported	Sub-Contracted	Machined in Plant
connecting rod		yes	yes
piston		yes	no
piston rings		yes	no
bearings	yes		no
crankshaft		yes	yes
crankshaft bearings	yes		no
valves	yes		no
valve springs		yes	no
bolts and nuts		yes	no
fuel pump	yes		no
fuel injector	yes		no
seals (some)	yes		no
castings		yes	yes

Foundry

For the production of 5,000, 10,000 or 20,000 engines/year a foundry capacity of 400, 750 or 15000 ton/year respectively is required. These capacities are too low to warrant an economic exploitation of a foundry department, in view of the required uniformity and quality of its products. It could be considered to start a larger foundry, of an economically sufficient size and fill in the excessive capacity by working for outsiders. However, the market for castings does not seem favorable. The reasons for this are:

- heavy competition, which actually forces many smaller foundries to close down
- over-capacity in the existing Sisco foundry
- according to expectations the foundry capacity of T.M.I. will start production
- existing companies have plans to start or expand foundries

On the other hand it may be expected that the demand for quality casting will increase as industrial development proceeds.

The start of foundry department as part of an engine factory implies a substantial expansion of the capital requirements of the factory, in an extra risk bearing venture. Besides, foundry activities have very little in common with these involved in further engine production. The start of a foundry department would negatively affect the factory's flexibility, because it would hinder an eventually necessary shift towards engines with alloy components.

Because supplying industries are at this moment capable of supplying castings of required qualities in sufficient quantities, in our computing model we have chosen for subcontracting the production of unfinished castings. This policy might raise problems of quality control, delivery time and price fluctations, but we assume that these can be kept within acceptable limits if an adequate purchasing department can be organized, which works with contractual guarantees.

Experience of existing engine factories shows that in a modern industrial set-up this is the only feasible solution. The number of engine manufacturers who successfully operate a foundry of their own decreases rapidly.

Machine Shop

The metal operating machines to be used will be almost without exception of the universal type. This implies a fairly labor intensive production method, which positively affects employment possibilities, at the same time it implies a greater flexibility of the factory and lower demands for specialization.

Machining times used in our calculations are inclusive of rejects and the usual additions for rest, personal care, etc. Productivity is estimated to be 10% lower than is usual in Europe. This will allow for the production of spare parts, an activity which is not included in the computations, but might be financially attractive.

In agreements and contracts with subcontractors it will have to be stated that the subcontracted parts be sold to the Thai-engine company exclusively.

Table B gives a calculation of the required number of machines, for productions of 5,000, 10,000 and 20,000 engines annually. Presuppositions include: a total of 2000 workable hours per year, different occupancy percentages for the various machine types.

Table C gives the machining time of an engine of the chosen type, based on a production of 5,000 engines per year. Change of the production capacity to 10,000 or 20,000 pieces respectively, will have a favorable effect upon labor productivity which is due to the larger series to be manufactured in these cases. Also the occupancy level of several machinetools will increase correspondingly.

Assembling and testing

The assembling time of one engine is 12 minutes, when 10,000 units/year are produced with laborers, all additions included. The testing and partly running in of an engine will take 2 hours per engine, one hour at the dynamometer brake included. This will take 1.2 manhours per engine.

Quality control

In order to achieve the desired market share and to assure future sales volumes it is imperative to offer an engine of good quality. Therefore quality control is essential. Quality control can be divided into quality control of:

a. raw materials and semi-finished products from subcontractors

b. finished components from subcontractors

c. components manufactured in the plant itself

d. assembled components

e. complete engines.

We therefor recommend the quality control to be executed by 5 men in case of an annual production of 10,000 units and by 7 men in case of a production of 20,000 units. Besides, in the testing department a partial quality control will be executed.

Factory layout

The proposed factory layouts for productions of 10,000 and 20,000 engines annually are given in figures C and D. No outlay for a production of 5000 units has been designed because as demonstrated in Chapter 5, this production size is not financially attractive. The 10,000 units outlay has been designed with the presumption that production size should be easily enlargeable to 20,000 engines/year.
For the production of 10,000 engines annually a floor space of 4500 square meters should be accounted. Here we suppose 3 halls of 15 meters wide and 100 meters long. (see figure C)
To produce 20,000 units per year the layout has been deduced from the previous one. The necessary additional space can be produced very easily; only two extra halls of 15 meters wide and 100 meters long will be necessary. (see figure D)

Personnel

For the proposed organization scheme we refer to figure E. In case of a production capacity of 10,000 units annually the laborforce will count 290 men. If the production capacity is 20,000 units annually in total 490 men will be required. For a more detailed survey we refer to tables E1 E2 and E3 of appendix 6. In addition we have reckoned with foreign technical and managerial assistance during the first 6 years of full production (See tables N1 N2 N3 of appendix 6).

Power consumption

In table D the electricity consumption has been calculated. The total consumption will be, at an annual production of:

5,000 engines ..... 500,000 KWH/year

10,000 engines ..... 900,000 KWH/year

20,000 engines .....1,500,000 KWH/year

4.3. Location of Combustion Engine Manufacturing Plant

The metropole of Bangkok is an existing center of all sorts of activities. To locate a plant in the metropolitan area would certainly have its advantages. On the other hand, there is a government thrive to locate industrial enterprises outside the metropole and there are advantages in developing certain rural regions.

Besides a rather limited site area, the plant would absolutely require good road, railroad and waterway connections.

In the limited time available only general information on location possibilities could be assembled. In the Saraburi area, where the Sisco plant is situated, castings transport lines to the factory would be short. Land, labor and electricity are available, as are good transport facilities.

In the Bankok area land prices differ widely. Prices up to 1,000,000 Baht per rai occur in West Thonburi. As the road building program proceeds, more and more areas become suited for industrial enterprises. The surroundiugs of Ching Mai would give rise to long transport lines for parts and raw materials and equally long average transport lines for the completed engine.

As a general conclusion, it may be said that from financial and production-technical points of view a location in the Bangkok area would be preferable. This would ensure easy contracts with buyers and suppliers and good transportation facilities. For the acquisition of qualified personnel the attractive social life of Bangkokmight be a positive factor.

If and insofar as the government does not offer definite and highly attractive facilities for industrial establishments in rual areas, it remains less attractive to decide for rural locations.

4.4. Production Preparation and Start-up

For this period we have set up operational plans to attain the optimum production for each alternative in the shortest possible time. The plans are shown in figures A and B.

In order to set up the plans the following assumptions have been made :

a. the Thai engines manufacturer has got a joint venture or a licency-agreement with an experienced manufacturer of the chosen type of engine and the manufacturing- and sales rights are obtained;
b. a complete new production plant has to be set up.

The reasons for these assumptions are described in chapter 7 "project implementation".

The operational plans show a basic difference with respect to the preliminary stage.
The smallest plant, (5,000 combustion-engines per year) will be in full production in the fifth year, whereas the two larger plants reach that phase in the sixth year.
We believe that due to modern training techniques it is possible to shorten the training and start-up times of the smallest plant in comparison with two larger ones.

The total period is divided into two phases:

a. the preparation phase
b. the start-up phase

The preparation phase

The duration of this phase will be the same for the three alternatives and will last two years. We assume that the different sizes of buildings and the different numbers of machinery will not cause striking differences in duration. At the start of this phase the building-ground has been bought and there are no further limitations for starting the construction of the factory buildings.
During this phase all necessary activities take place to be able to start with the production of engines.

The activities include drafting of specifications and tenders, evaluation of quotations selecting and contracting contractors, erecting buildings and machinery testing supplied engine parts selection and appointing of employees.

It is clear that during this period many activities concerning many different subjects have to be executed. A strong and well equiped temporary project organisation will be necessary to control all these activities to finish this phase in the planned time at the planned costs. Therefore we have counted that the general manager and the purchasing manager have been selected and appointed already at the beginning of the phase, to be members of the project management team.

An administrator and two secretaries will be appointed during the first year to form a secretariat (for a more detailed survey see table D1 D2 D3 of appendix 6).

However, managerial and technical assistance will be necessary or partner in a joint venture during this period. It is almost certain that the licency-giver will be required to help, particularly in the technical aspects. For the managerial and the training aspects, as well as for assistance in the temporary project organization, specialized consultants might be better equipped.

The assistance of at least some independent technical advisers can be advantageous in order to promote sufficient opponency to the licency giver. It has to be decided in which degree and form the assistance can be given by for example the ASRCT, ISI, UNIDO, experts and (foreign) consultancy firms. (For a detailed survey of the proposed foreign assistance see table N1, N2, N3 of appendix 6). During this period all the personal necessary for the start up phase will be selected and appointed. In particular we mention the sales-manager. He will start his activities as soon as possible to build up an adaquate service- and dealer network.

Also should be received from the licency giver all fully or partially machined engine components necessary for the start-up phase.

The start-up phase

Was in the foregoing phase emphasis given to the coordination of all kind of activities during the start-up phase emphasis will be given to the training of the employees. The start up will be executed in three steps A B and C. In each step the amount of work will be increased as well as the different kind of work to be done in the factory (for a detailed survey we refer to figure A and B).

During step A assembling of the engine components delivered by the licency giver starts in order to furnish completeengines as soon as possible. On the other hand a modest start will be made with real production in the form of machinery of simple castings, work in the fitting shop and testing.

The share of the imported parts will be gradually reduced, depending on the possibilities of the Thai engines factory and the Thai supporting industries.

It is possible that if in time a Thai foundry can be provided with necessary information and with casting models, the castings can be produced in Thailand already in an early phase. The castings could be machined in this foundry, before the engine factory itself can take over the finishing work.

Besides the temporary supply of totally or partially machined components by the foreign partner a permanent import of a number of specialized parts will have to be reckoned with. These parts include the fuel injection pump, and the fuel injector as most important items, besides valves, valvesprings, pistons, pistonrings, special bearings and special seals.

It has already been pointed out that some of the latter parts could also be produced in Thailand (Thai-Japanese factory to start piston manufacturing plant).

The number of employees and employer categories will increase also stepwise in accordance with the work (for a detailed survey see table D1 D2 D3 of appendix 6).

The major factor that influences the capacities of the Thai engines factory will be the skill of the Thai personnel. Therefore a contrived trainings program is of great importance as well as in the preparation phase, assistance will be necessary for job-training and assistance in managerial and general technical training (for a more detailed scheme of foreign assistance see table N1 N2 N3 of appendix 6).

We estimated the duration of step A and B for the production of 5000 units per year on 6 month each; for the both other alternatives we estimated each step on 12 month. This difference in duration is due to the difference in the number of employees to the trained and the machinery to be started up.

5. FEASIBILITY AND EXAMINATION OF THREE ALTERNATIVES

As a result of the analysis and study it is possible to examine the financial and economic aspects of three alternatives of an engine manufacturing plant in Thailand :

Alternative A : a plant with an annual capacity of 5,000 engines

Alternative B : a plant with an annual capacity of 10,000 engines

Alternative C : a plant with an annual capacity of 20,000 engines

From the examination of the data collected during the mission it is possible to draw conclusions regarding the plant that offers the best results from both the financial and economic viewpoints. Selection of the optimum size of production facility is based on the comparison of the results of our financial/economic study together with those of the technical and marketing studies as outlined in chapter 6.

The proposals are based on the following assumptions:

- the production-method used will be as described in chapter 4
- permission to manufacture combustion engines in Thailand can be obtained,
- there are no sales restraints,
- the operational plan as described in chapter 4 will be followed.

In all three cases projections have been worked out for a ten year operation period after the preliminary start-up stages. That means for the three projects of the manufacturing plant with an annual production of :

	Size of Manufacturing Units		
	5,000 engines	10,000 engines	20,000 engines
Length of time required for :			
Plant construction, selection of personnel, training, start-up and various preliminary activities	3 years	4 years	4 years
Operating period	10 years	10 years	10 years
Total duration of project	13 years	14 years	14 years

As shown in figures A and B of Appendix 4.

Development of Production Volume for the 3 Units:

year	Estimated annual production rates		
	5,000	10,000	20,000
1	-	-	-
2	2%	2.5%	2.5%
3	45%	30%	30%
4	A 90%	60%	60%
5	100%	A 90%	A 90%
6 and following years	100%	100%	100%

A The first year of full operations, earlier years "start-up"

5.1 Financial Evaluation

From the technical and market analyses discussed in the preceding chapter as well as from the above mentioned operational plans the computed and the various project costs and revenues are given in Appendix 6 - elements for the financial and economic analysis. The conversion rates used were : 1 US $ = 20.8 Baht and 1 US $ = 3.20 Nf.

Cash flows

From the computations in Appendix 6 the projected cash flows as shown in tables A through F of Appendix 5 were calculated. The cash flow analysis examines the self-liquidating character of the various alternatives, which examines the possibilities of obtaining a positive cash flow from the project to repay the original capital input and the interest on eventual loans or dividend-payments to the equity holders.
The following assumptions for the machinery and buildings were used:

a. the buildings and installations are estimated to have a life span of 20 years

b. the machines would have a life span of 10 years of operation

c. other various equipment would have a life span of 5 years of operation

d. motorcars and trucks would have a life span of 2 years of operation

e. the straight-line depreciation method will be followed which means that the theoretical bookvalue after 10 years of operating time will be for .
   a. 50 percent for the purchase costs (see tables B1, B2, B3 of Appendix 6 whereas, the items b. c. and d. have no residual value.

The costs and revenues are based on the estimated cost and price-levels during the last quarter of 1971.

Finally it is assumed that inflation or increase in wages and salaries will be matched by sales price increases.

Conclusions obtained from the cash flows

1. Manufacturing plant with an annual capacity of 5,000 combustion engines

   The cumulative cash flow only becomes positive in the 10th year of the project's life or in the 7th year of the operation period, whereas, the annual cash flow becomes positive in respectively the 4th and 1st year. The internal rate of return of the discounted cash flow is 8.15 percent which is not an attractive figure for an industrial project.

2. Manufacturing plant with an annual capacity of 10,000 combustion engines

   The cumulative cash flow begins to give positive results in the 8th year of the project life time or in the 4th year of the operating life, whereas the annual cash flow becomes positive in respectively the 5th and 1st year. The internal rate of return of the discounted cash flow is 16.8 percent, which is a more attractive figure than for the 5,000 engine unit plant.

   In this instance it would be possible to pay an annual interest of 10 percent on an eventual loan, or a dividend in the operating period to the equity holders, taking the present business tax tariffs and regulations into account.

3. Manufacturing plant with an annual capacity of 20,000 combustion engines

   The cumulative cash flow becomes positive in the 7th year of the project's lifetime or in the 3rd year of the operating period, whereas the annual cash flow becomes positive in respectively the 5th and 1st year. The internal rate of return of the discounted cash flow is 24.6 percent which is an attractive figure for such an enterprise.

Observations

a. There will be a necessity to contract foreign technical assistance as only in a case of such supporting management, engineering and training will it be possible to reach the production and efficiency targets associated with financial projections

b. Tables G through J of Appendix 5 show the summaries of the total investment costs compared with the gross profits to be expected.

The following table shows a comparison of the alternatives in capacity concerning investment and returns to the projects.

table : COMPARISON OF THE ALTERNATIVES CONCERNING INVESTMENTS AND RETURNS

Optimum production capacity / Description	Amounts of money in 1,000 Baht			Amounts of money in 1,000 US $		
	Annual production combustion-engines			Annual production combustion-engines		
	5,000	10,000	20,000	5,000	10,000	20,000
1	2	3	4	5	6	7
1. CAPITAL REQUIREMENTS						
1.1. Fixed capital	17,400	27,500	45,200	836	1,322	2,173
1.2. Working capital	9,200	16,500	30,000	442	793	1,442
1.3. Total capital	26,600	44,000	75,200	1,278	2,115	3,615
1.4. Foreign currency	11,890	19,830	32,635	571	953	1,568
1.5. Local currency	14,710	24,170	42,565	707	1,162	2,046
2. EMPLOYMENT (in number of persons)						
2.1. Direct	124	222	391	124	222	391
2.2. Indirect	51	68	99	51	68	99
2.3. Total number	175	290	490	175	290	490
3. FIXED INVESTMENT PER EMPLOYE	100	95	92	4	4	4
4. ANNUAL GROSS SALES	17,500	35,000	70,000	840	1,680	3,360
5.1. Annual gross sales costs	11,700	21,200	39,000	562	1,019	1,876
5.2. Annual costs excl. return on capital and taxes	13,440	23,950	43,520	645	1,145	2,100
6. GROSS ANNUAL PROFIT BEFORE TAXES						
6.1. Total	4,060	11,050	26,480	195	535	1,260
6.2. % of total capital	15.3	25.1	35	15.3	25.1	35
6.3. % of gross sales	23.2	31.5	37.8	23.2	31.5	37.8
7. FOREIGN CURRENCY						
7.1. Annual needs	4,500	8,600	16,300	216	413	783
7.2. Annual savings	7,000	15,750	34,000	336	75	1,634
8. VALUE ADDED						
8.1. Per annum	9,500	19,500	39,700	456	937	1,908
8.2. % of gross sales	54	55	56	54	55	56
9. CAPITAL OUTPUT RATIO	1 : 1.7	1 : 2.8	1 : 3.85	1 : 1.7	1 : 2.8	1 : 3.85
10. INTERNAL RATE OF RETURN: CASH FLOW	8.15%	16.8%	24.6%	8.15%	16.8%	24.6%

Notes on the table: "Comparison of the Alternatives Concerning Investment and Return"

Columns

1	Description of the several competitive items
2, 3 and 4	The 3 competitive alternatives. Amounts expressed in 1,000 Baht
5, 6 and 7	Idem. Amounts expressed in 1,000 US $
Item 1.1	Total of investments in land, building and machinery installation, as per items, 1,2,3,4,5, 6,7,8 of tables C1, C2, C3 of Appendix 6
1.2	As specified in items 5 and 6 of tables M1, M2 and M3 of Appendix 6. This working capital does not take into account eventual interests to be paid
1.3	Addition sum of items 1.1 and 1.2
1.4 and 1.5	Foreign and local currency quote-parts
2.1 and 2.2	Specified in tables E1, E2, E3 of Appendix 6.
3	Division of items 1.1 by 2.3
4	We refer to tables P1, P2 and P3 of Appendix 6. The sixth year has been taken, while we assume that in this year for the first time normal conditions prevail
5.1	We refer to tables K1, K2 and K3 of Appendix 6 The sixth year has been taken
5.2	We refer to table K4 of Appendix 6
6.1	Difference between items 4 and 5.2
7.1	Estimated from column 14 of tables 01, 02, 03 of Appendix 6
7.2	As calculated in tables L-M-N of Appendix 5, (see paragraph Balance of Payments)
8.1	Difference between the sales value and the purchase prices for raw materials, spareparts, various material, energy, license-rights etc.,
9.0	We refer to tables G through J of Appendix 5 The ratio between the investment costs and the gross profits during the life span of the project
10.0	Internal rates of return of the discounted cash flows computed as per tables A through F of Appendix 5

5.2 Economic Evaluation

The positive and negative effects on the economy of Thailand for a plant for manufacturing combustion engines will be as follows :

Positive effects

- The numbers in paid employment will increase

- The salaries and wages to be paid will increase the comsumption of food and services in the region where the plant will be established. The multiplier effect of relatively high income workers in high technology industry would soon become apparent in the area surrounding the factory and generate secondary effects.

- The manufacture of combustion engines in Thailand will reduce imports which means lower foreign currency requirements.

- The plant will require engine parts and materials which can be manufactured by other industries in Thailand. This will promote other industrial activities in Thailand (e.g. the foundry industry) some of which are already established.

- Income and profit taxes will increase state revenues.

The secondary positive effects as mentioned above are likely to be important but are difficult to determine with any exactness at this stage.

Negative effects

- Decrease State revenues because of loss of import duties on those combustion engines previously imported.

The positive and negative effects on the economy of Thailand due to the influence of establishing a plant for manufacturing combustion-engines are examined in :

Tables K through M of Appendix 5 : The Current Account of Thailand's Balance of Payments

Tables N through P of Appendix 5 : The Economic Effects.

In tables N - P the economic effects are summarized on the basis of the previous calculations.
Not taken into account are the non-quantified, but nevertheless important, secondary positive effects. The overall conclusion is that the economic benefits are likely to far exceed the economic costs during the life span of the project.

Comparison of the economic effects during the life-time of the project

Amounts in US $

	Number of engines to be manufactured annually		
	5,000	10,000	20,000
Duration of the projects	14 years	15 years	15 years
Positive effects:			
. Thailands balance of payments	4,600	9,600	19,800
. gain in added value	4,725	10,600	21,550
. increase of import-duties & handling	255	590	1,115
. social benefits	P.M.	P.M.	P.M.
Negative effects:			
. Thailands balance of payments	715	822	1,005
. decrease of importduties & import handling	1,670	3,760	7,280

Conclusion : in all three cases: positive influence

6. SELECTION OF FACTORY SIZE AND PRODUCT

6.1 Production Capacity

It has been demonstrated in chapter 5 that the production of 5 HP medium speed hopper cooled engines constitutes and attractive project if the production capacity is equal or greater than 10,000 units/year. Such a project is attractive as well from a financial point of view for investors as from an economic viewpoint for the Thai economy as a whole.

Both the financial and the economic benefits would increase as production capacity increases.

From the analysis of the domestic market in chapter 3, it appeared that the 5 HP hoppercooled medium-speed diesel engine will be the most popular type of engine in Thailand. The share of the market for this type of engine is estimated, to amount to 1/3 to 1/2 of the total demand. As said this leads to the following expectations of the possible sales-volume :

1972	7600 units/year
1973 -	7000 units/year
1974 -	8000 units/year
1975 -	10000 units/year
1976 -	12000 units/year
1977 -	20000 units/year

Taking into account an implementation period of 4 years between removal of the last obstacle for the realization of the engine factory and production at full capacity, the estimated sales volume suggests that there is ample space for 10,000 units/year production.

From the technical point of view, described in chapter 4, the production of hopper cooled diesel engines is attractive. In comparison with the manufacturing of aluminium castings for air cooled four-stroke engines, manufacturing iron castings for hopper-cooled diesel engines is atrractive and relatively simple. This is important for a country like Thailand, where large scale manufacturing of this type of product is still due to begin. Also the fact that the supporting industry is still developing quantitatively as well as qualitatively, necessitates a start with a not too sophisticated product.

It is our opinion that neither the necessary universal production machinery nor the availability or the quality of the personnel will raise insurmountable problems. It seems advisable to start production with a minimal product range, to guarantee efficiency and simplicity of purchasing, production, organization, control, training and sales systems. From the marketing point of view, on the other hand, a wide product range is preferable to ascertain a good market coverage and customers service.

We think that the start-up of an engine factory, although producing relatively simple engines, will unavoidably raise so many technical and organizational problems, that insofar as the sales-volume may be expected sufficient, the technically and organizationally most simple solution should be taken.

We therefore recommend as optimal solution a plant for the production of 5 HP medium speed diesel engines as specified in the summary of paragraph 3.4 with a capacity of 10,000 units/year. Production set-up should be so flexible as to allow simple adaptation of engine capacity and production capacity as an answer to a shift in market demand.

6.2 Expansion of Production Capacity

Taking into account

a. a projected demand of 48,000 units/year of this type in 1981,

b. a projected attractive demand for engines of the same type but with a capacity of 7 - 8 HP by the same year,

c. an expected good export market for this type of engine in other Asian countries such as India and Pakistan if import restrictions are not insurmountable,

an expension of production, both of absolute capacity (to 20,000 units/year) and of the range of types produced (by starting the production of 8 HP engines) might well be undertaken in a later phase.
As can be calculated from the data of table 1 of chapter 3, in 1977 the total market share of a Thai manufacturer of small engines with a power output of 5 HP and 8 HP will be greater than 20,000 units per year.
However we advise not to expand the production capacity before 5 years after the start of production, in order to be sufficiently experienced to execute this operation safely.

In this respect, the necessity of flexibility of production set-up should be emphasized, regarding both absolute capacity and product type. The latter aspect is very important. An imperative condition for the realization of the projected sales volume is that the Thai diesel engine should be competitive in performance and quality. Undoubtedly the technical development of the chosen diesel engine type will continue although at this moment it is impossible to foresee the direction of this development. Besides the price, the weight of the engine will undoubtedly be an important sales argument.

Modifications of the production process, aiming at improvements in the process itself (cheaper, better quality) and at improvements of the product (lower weight, better quality) should be possible without large expenses.

An expansion of production can also be realized in a basic setup for 10,000 pieces/year by working in 2 or 3 shifts. With two shifts, 24,000 units/year would be possible. At first sight this seems a cheap solution, but it will be possible only if the workers live in the vicinity of the plant, This implies a location outside the Bangkok area and a fairly large scale housing program around the plant itself.

In our computations, we assumed a total of 2,000 workable hours per year. At this moment the number of workable hours is about 2,300. When, as we observed in some factories, six 10-hour days per week would be worked, the workable hours per year would amount to 2,900.

This would entail a 20 percent production increase, at the expense of overtime salary rates and lower average productivity.

In our opinion, the above mentioned possibilities, and especially the last mentioned, should be regarded as possibilities to satisfy a temporarily increased demand but not as a sound basis for a feasibility study. It should be borne in mind that the nature of the process is less fitted to working in shifts, which will probably result in a lower standard of operation precision (higher percentage of rejects). This is why we recommend an outlay with a capacity of 10,000 units/year, with a possibility of expansion to 20,000 units production in one shift.

6.3 Location

We advise a spatial concentration of the production in the Bangkok area. Simultaneous inception of production of the same engine type in various locations does not seem to make sense. All start-up difficulties would treble.

If however, there are imperative reasons to disperse the production of one engine type, we strongly advise not to begin production at the various plants simultaneously, but to let each subsequently starting plant benefit from the experience of its predecessors. A time lag of 1½ year between plant startups seems sensible.

Also for financial reasons a division into two 5,000 units/year or three 3,000 units/year plants should be discouraged as is explained in chapter 5.

If two or three engine types would be involved at the same time, the start-up difficulties would increase enormously. In that case, negotiations with two or three different engine manufacturers would be necessary to secure licenses, temporary parts supply, etc.

7. PROJECT IMPLEMENTATION

The period between presenting this report and starting the production on full capacity, we call the implementation period.
The activities to be executed during this period are of that kind, that a close cooperation with ASRCT and/or ISI would be very valuable. In addition the survey team feels that UNIDO assistance will be necessary.

This period can be divided in the following phases:

a. the initial phase
b. the preparation phase
c. the start-up phase.

The preparation phase and the start-up phase have been taken into account in the financial and economic analysis of the project and are therefore described in chapter 4.

The activities that have to be undertaken during these phases have such a close relationship with the production itself that it is necessary to take into account the costs and proceeds of these activities. Moreover it is possible to make sufficient accurate calculations of these activities.

The activities of the initial phase do not have such direct relationship with the production itself and it is impossible at this stage to predict the length of time and the costs involved. For these reasons we did not take into account the costs of the initial phase in the financial and economic analysis.

During the initial phase the following activities have to be carried out:

1. Evaluation and decision on the basic conclusions of our report.
   It has to be decided, whether it is feasible indeed from governmental policy point of view as well as from marketing, technical, financial and economic point of view to start the production of the proposed type of engines in Thailand in the proposed quantities.

   This decision should be taken by governmental institutions in Thailand as there are:

   . the Board of Investment

   . the Ministry of Industry

   Assistance in taking this decisions could be derived from:

   . the Industrial Finance Corporation of Thailand

   . Applied Scientific Research Corporation of Thailand

   . Industrial Service Institute

In this matter UNIDO can give assistance in the form of an advisor.

It is very important in this first step that somebody or some institution is responsible for the progress of the evaluation and decision making.

2. To decide in which sector the company has to be situated.

If it has been decided that it is feasible to start the production of small combustion engines in Thailand, it has to be decided if the company will be set up in

a. the private sector
b. the public sector
c. the corporate sector (companies in which the government as well as a private entrepreneur is involved)

This question is very closely related to the question whether it is wishful to settle a new company or to adapt an existing one.
One could recommend between the following possibilities:

a. adapting the existing production plant and organization of Thai Heng Long (private sector).
This company has an existing engines production system. One of the conditions is the willingness of the owners of this company to cooporate in this matter.

b. adating the existing production capacity and organization of T.M.I.
The T.M.I. factory has been closed down. If the committee, that is studying the possibilities for using the facilities, wishes to transform this factory as to produce the proposed engines in the proposed capacities, UNIDO would be pleased to give assistance. This assistance could be given as well as during the "rehabilitation study" as during the implementation period.

c. establishment of a complete new plant in an existing organization not belonging to the engines-producers sector.
The information available to the survey-team is insufficient to evaluate possibilities. However it could be a realistic possibility to establish a new production plant as a part of an existing supporting industry. For example the use of a well equippedorganization could be an attractive reason.

d. establishment of a complete new plant by a complete new company.

The survey team, taking into consideration the available information about the above mentioned possibilities, and the government policy not to invest in this type of industries, has preliminary proposed the latter possibility in the private sector. The financial and economic consequences of this solution have been worked out.

3. Selection of the local entrepreneur and the foreign experienced manufacturer of the proposed type of combustion engines and eventually a foreign capital supplier.

In principle a totally new engine design would be possible. However, a new design takes much time, because one needs to develop a new conception, one needs to have trial runs in the factory and in the field, and one has to redesign the conception to eliminate the faults. This process might take years.
Therefore it does not seem to be a wise policy in case one wishes a rapid start-up of an engine factory in Thailand to consider a completely new design. We recommend strongly to take up contact with manufacturers who have available experience with this type of engines. It may be expected that a number of these will be willing to conclude an agreement with a Thai entrepreneur, who wants to start an engine factory. The latter should thereby receive the rights to produce engines of the manufacturer's design, should receive advice concerning plant outlay and production methods, and should receive during the start-up phase fully or partially machined engine parts.
The cooperation of a local entreprenour and a foreign manufacturer can be given form as a joint venture or a license-agreement.
The choice between these two possibilities is depending on the fact whether a foreign manufacturer can be found who is also willing to take the risks of investing in a production plant in Thailand.

We recommend the solution of a joint venture, because in that case the assistance given by the foreign manufacturer is supported by the financial risks of his investment. If only a license giver can be found, it will be necessary that also a foreign capital supplier will be found.
The task of selection and bringing together of the partners could be done by a consultancy firm or a special temporary project-team of experts.
The consultancy firm or the project team will have to assure that sufficient attention will be given to the following aspects:

- technical
- juridical
- financial
- organizational
- economic

and cover the following items:

- delivery of shopdrawings
- discussion of production methods
- agreement with potential suppliers and subcontractors
- negotiations concerning manufacturing and salesrights in Thailand
- employment of experts, jigs, gauges, "know-how", etc.
- structure of the enterprise
- approval of the concession and financial matters
- appointment of the board of directors.

Our suggestions for membership of the board of directors if the project is to be sponsored in the public sector, include

. a businessman (e.g. from the foundry industry)
. a public authority official
. a banking official
. a qualified engineer

Official institutions connected with agricultural machinery developments in Thailand should be informed and kept posted of progress of the project.

4. After the approval and signing of the contracts, discussion with the official institutions in Thailand and approval of the concessions and allowances have to be completed by the signing of the necessary papers and contracts.

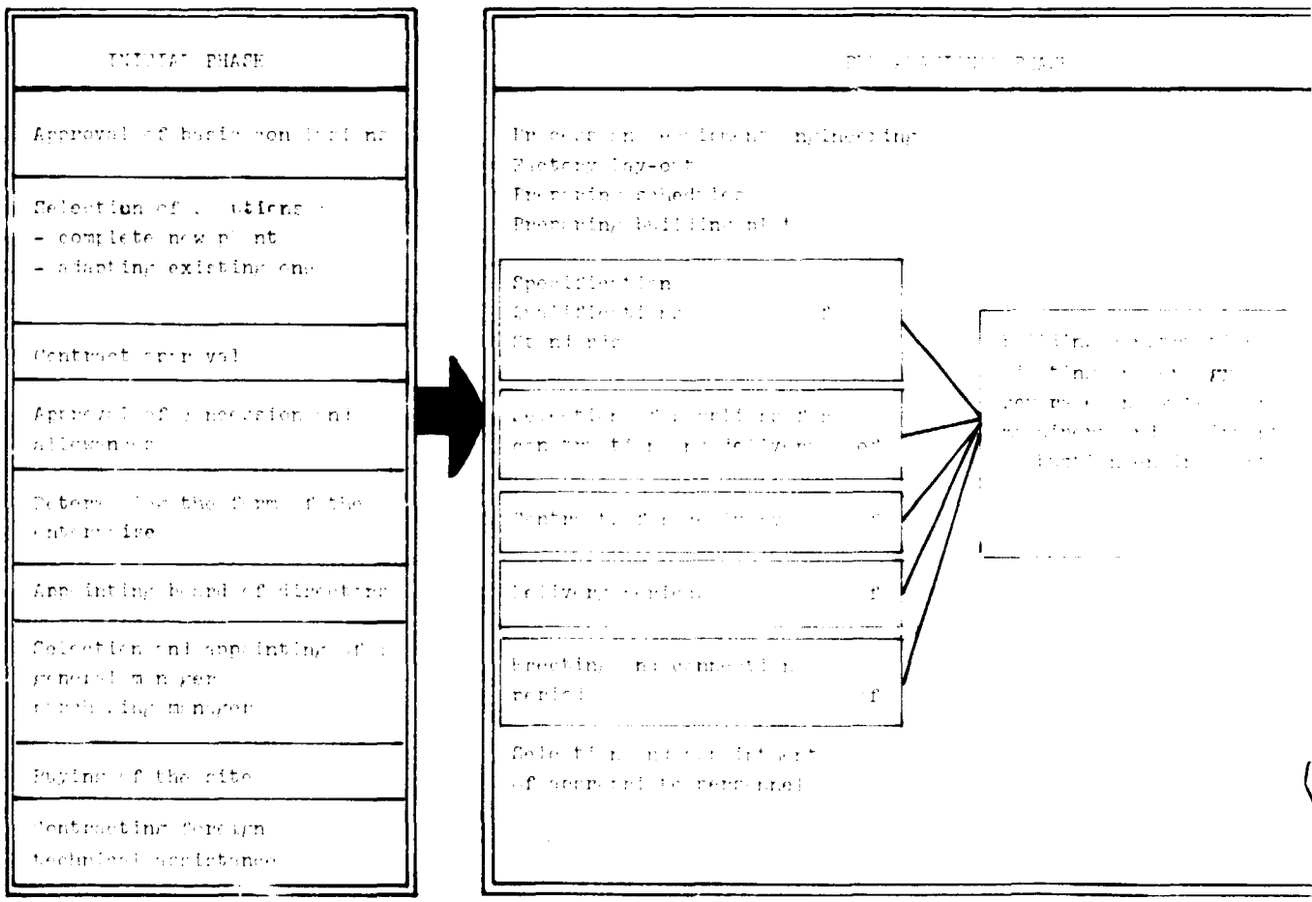
5. Selection of the site has to be made and the land has to be purchased.

6. Selection and appointing of the General Manager, Purchasing Manager, secretaries and administrative staff.

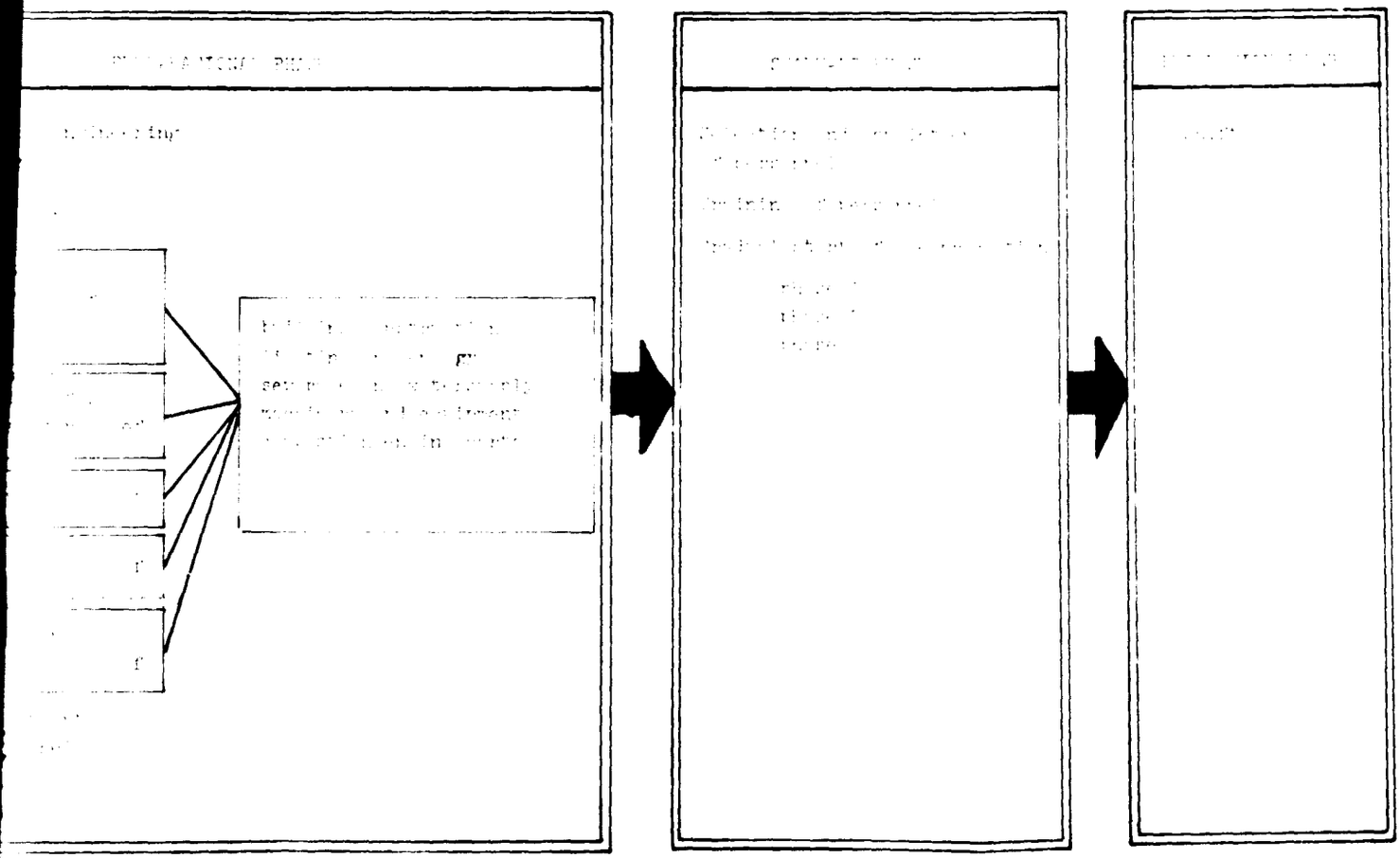
7. Foreign technical assistance has to be contracted for the preparation and start-up phase.

It is impossible at this stage to predict the lengths of time and the costs involved in these steps.

If an agency would be contracted for carrying out the important initial steps, we recommend a contract on the basis of actual expenditure against standard tariffs approved in advance covering man-months tariffs, lodging, travelling expenses, etc.


INITIAL PHASE
Approval of basic conception
Selection of solutions:
- complete new plant
- adapting existing one
Contract approval
Approval of concession and allowances
Decree for the form of the enterprise
Appointing board of directors
Selection and appointing of general manager
Buying of the site
Contracting foreign technical assistance

SECTION 1



SECTION 2

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

FINAL REPORT

—

THE MANUFACTURE OF SMALL INTERNAL COMBUSTION ENGINES IN THAILAND

—

APPENDICES

BERENSCHOT - BOSBOOM N.V.

517/1/127

September 1972

FINAL REPORT

THE MANUFACTURE OF SMALL INTERNAL COMBUSTION ENGINES IN THAILAND

APPENDICES

517/1/127

September 1972

CONTENTS

Appendix 1

List of International Organizations,

Governmental Institutions, Enterprises,

and Other Organizations Visited

INTERNATIONAL ORGANIZATIONS

UNIDO - Vienna

Mr. Mario Micillo
Mr. Swamy Rao
Mr. B. Jamilla
Mr. S. Nanjundan
Mr. Y. Phokhorov

UNDP - Bangkok

Mr. J. Power
Mr. N. Ramm Ericson

FAO - Bangkok

Dr. G. Schütz
Mr. D.Th. de Vries

Economic Commission for Asia and the Far East - Bangkok

Mr. V.M. Subrimanian
Mr. Keisaku Kobayashi

Asian Industrial Survey for Regional Cooperation

Mr. L.H. Randall

Mekong Committee

Mr. W.J. van Lier
Mr. I.S. Macaspac

Nedeco Foundation

Mr. J.B. Visser
Mr. G. Vriend

GOVERNMENTAL INSTITUTIONS

A.S.R.C.T.

Dr. Kasem Balajiva
Dr. Boon Indrambarya
Dr. C.L. Wrenshall
Mr. N.I. Wake
Dr. Narong Chomchalow
Mr. Nipon Panomkarn
Mrs.Suvanna Vibhatakarassa
Mr. Suwat Riebroicharoen

Board of Investment

Miss Wanee Lertdamrikarn

Ministry of Industry

Mr. Sivavong Jangkasiri
Mr. Chatchwed Musigchai
Mr. Vinit Tonavanik

National Economic Development Board

Mr. Krit Sembatsiri

Harbor Department

Lt. Cherd Roonguthai R.T.H.
Mr. Wirat Ratanapol

Ministry of Agriculture

Engineering Division of Rice Department

Mr. Paitoon Nagalakshana
Mr. Raphiphan Phasabutr
Mr. Metha Rajatapiti

Research and Experiment Division

Mr. Suthin Nopparat

Department of Prime Minister

Department of Technical and Economic Cooperation

Mr. Paitoon Saysevang

Industrial Service Institute

Mr. Sombat Boon Choo
Mr. Thammi Vasinont
Mr. T.W. Lomnicky
Mr. J.D. Lloyd

Customs Department

Mr. Suchit Chuavidual

ENTERPRISES

Thai Heng Long Padrieuw Ltd.

Mr. Praphat Thaisctahwhatkul

Thai Machinery Industry Co., Ltd

Mr. C.R. Snguan
Mr. Chalit Siripongse
Mr. Arnop Phornprapha

Mr. Charroy Borriboon (27 Intra-ASA-Road Panasuikom district, Chonburi)

Somboon Spring Manufacturing Ltd.

Samakkhi Padriew Ltd.

Siam Iron and Steel Co., Ltd.

Dr. Bhatpong
Mr. Sutham Ekahilanond - Chief Sales Department
Mr. Ganok Bhougbhibhat - Assistant Manager

Sripothong Foundry (250 Suksawat Road Dhonburi)

Mr. Tonglour - manager

Louis T. Leonowens Ltd.

Assembler of Mason Ferguson Tractors

Bangkok Sip-Yip LP (195/5-6 Sutiwongse Road, Bangkok 5)

Producer of nails

Mahajakyoutr, Ltd.

Manufacturer of high tensile bolts and nuts

Walking Tractor Manufacturing Industry "Sahayout" at Rangsit

Lindetevis

Mr. J.P.A. Linck
Mr. J.H. van de Geer
Mr. Surat Sirikul

United Motor Works (Siam) Co., Ltd.

Mr. Charoen Varnichkorn

Sahajoon Engineering Co., Ltd.

Mr. Tak Junchaya

Marubeni Corporation

Mr. M. Kimura

Ekman & Co., Ltd.

Mr. Tord Samuelson

Min Sen Machinery Co., Ltd.

Mr. R. Prakorb

Nichimen Co., Ltd.

Mr. Y. Inoué

Ford Company

Mr. J. Hadlow

Thai Seng Nguan Machinery Co., Ltd.

Miss Karnchana

Kawasaki Heavy Industries Ltd.

Mr. K. Nakazone
Mr. K. Nidaka

Mitsubishi Heavy Industry Co.

Mr. R. Yamamoto

OTHER ORGANIZATIONS

Industrial Finance Corporation of Thailand

Mr. Tos Phanthumasen

Royal Netherlands Embassy

Mr. V.J.J.M. Bruyns
Mr. G. Belgraver

Japan Trade Center

Mr. Mitsuo Kubota

American Trade Center

Mr. Gerardot

United States Operations Mission to Thailand

Mr. D.C. Marsden

Thai-German Agricultural Machinery Training Center

Dr. Banyat Vimokesant

Thai-Australian Project

(Central Region Agricultural Centre near Chainat)

Appendix 2

Literature References

LITERATURE REFERENCES

1. Thailand - Engineering Division of the Rice Department of the Ministry of Agriculture, Mr. M.R. Debriddhi Devakul. Memorandum

2. Present Status of Agricultural Machinery Industry in Thailand, Yoshikuni Kishida, Autumn 1971. Agricultural Mechanization in Asia

3. Agricultural Machinery and Implements Industry in South East Asia and Related Activities of UNIDO by A.A. Swamy - Rao Spring '71, Agricultural Mechanization in South East Asia

4. A Proposal for agricultural mechanization in the developing countries of South East Asia by Howard F. McColly, Spring 1971, Agricultural Mechanization in South East Asia
Some problems on policy for Agricultural Mechanization, Chiyiro Ozaki, Spring 1971, Agricultural Mechanization in S.E. Asia
Agricultural Mechanization and Rural Welfare in South and South East Asia, Robert D. Stevens - Bashir Ahmad, Spring 1971, Agricultural Mechanization in S.E. Asia

5. The present problems and future agricultural mechanization in Thailand, Anusorn Boon-it, Spring 1971, Agricultural Mechanization in South East Asia

6. Internal Combustion Engines
Japan Agricultural Machinery 1970-71

7. Establishment of the Plan to Promote Agricultural Mechanization in South East Asia and Problems of Growing Agricultural Machinery Industry, Yoshikuni Kishida, Spring 1971, Agricultural mechanization in S.E. Asia

8. Outline of the Government Policy for The Development of Agricultural Machinery Industry in Asian Developing Countries by Keisaku Kobayashi, Autumn 1971,Agricultural Mechanization in Asia

9. Thailand's "loosely structured social system" and Weberian Sociology
Arie Brand, South East Asian Journal of Sociology Vol II, May 1969

10. Thailand
Economische Voorlichtings Dienst, February 1968

11. Overseas Business Reports, October 1970
U.S. Department of Commerce

12. Firm Market for Steel, The Investor, November 1970

13. Thai Industry - Sink or Swim - The Investor, November 1970

14. Thailand needs more Machines, Components and Materials, T.E. Walton, Overseas Trading, May 1970

15. Thailand Water Pump Industry
Industrial Finance Corporation of Thailand
National Economic Development Board
Ministry of Industry
United State Operations Mission to Thailand

16. Manufacture and Indigenous Production
Report of the recent group meeting on Agricultural Machinery Industry in Developing Countries, August 18-22, 1969

17. Report of the United Nations ECAFE/AIDC - UNIDO
Fact Finding Team of Industries Manufacturing Agricultural Machinery 10 July 1969

18. Country Study Report on the Status of Agricultural Machinery Industry in Thailand. UNIDO, January 1969.

19. Status of Agricultural Machinery in Thailand, August 1969
Papers presented by Mr. Debriddhi Devakul at the Expert Group Meeting on Agricultural Machinery Industry in Developing Countries

20. Report of the ECAFE expert team on Small Engines for Agricultural Purposes, June 9, 1970

21. Industrial Finance Corporation of Thailand, Brochure

22. Thailand Farm Mechanization and Farm Machinery Market, Royal Thai Government, Ministry of Industry, Board of Investment, Ministry of National Development, Ministry of Agriculture, Kasetsart University, Industrial Finance Corporation of Thailand United States Operations Mission to Thailand

23. Investors Manual,December 1971
Board of Investment

24. Investing in the Dynamic Growth of Thailand, Board of Investment

25. Promotion of Industrial Investment Act., 1968, Board of Investment

26. Third National Economic and Social Development Plan, National Economic Development Board, Royal Thai Government October 1971

27. Projects with Promotion Certificates, Classified by Type of Activity, Board of Investment June 1972

28. Thailand: Investment Incentives for Business Enterprises, Board of Investment

29. Office of the Board of Investment activity report as of end February 1972

30. Statistics of Promoted Investment from October - December 1971 Board of Investment

31. Industrial Economics
A brief survey of selected industries
Ministry of Industry , Industrial Economics and Planning Division, 1970

32. Factory Act BE 2512, prepared by Ministry of Industry published by United States Operations Mission to Thailand 1972

33. The Development of Export Industries in Thailand, by L.H. Manderstam & Partners Ltd, Consulting Engineers under assignment by the Ministry of Overseas Development, October 1970

34. Current Agricultural Machinery Development in Thailand
Mr. Debriddhi Devakul
Presented to the International Rice Research Conference, April 19-23, '71

35. Farm Mechanization on Upland Areas in Thailand
Thai-German demonstration and Training Center, Self-help land-settlement Division, Dept. of Public Welfare, Ministry of Interior

36. Agricultural Machinery
Trade and Industry of Japan, No. 8 '71, Japan External Trade Organization

37. Problems of Industrial Financing,
Industrial Finance Corporation of Thailand

38. A study on combustion engines market in Thailand, by Thira Sivadist

39. Foreign Economic Trends, Sept. 2, 1971
Distributed by U.S. Department of Commerce

40. Agrotechniques, crops and implements for irrigated agriculture in the Lower Mekong Basin, Raanan Ben-Num. Nov. 1971

41. The Status Quo and Problems of Farm Mechanization in the Developing countries (Farm Machinery Industrial Research Corp) Agricultural Mechanization in South East Asia, Spring '71

42. Mechanization of small farms in Thailand and Malaysia by Tractor Hire Service, Transactions of the ASAE, 1971

43. Thailand Private Enterprise Investment Opportunities Board of Investment - Office of the Prime Minister - Ministry of Industry - Royal Thai Government - Agency for International Development - United States Operations Mission to Thailand, July 1968

44. Financing the Third Plan)
World Bank Report) The Investor, April 1972
Labor Protection - for whom?)

45. Hard Times for Thai Steel)
Thailand not growing enough) The Investor, May 1972
Japan's new Yen loan to Thailand)

46. Agri-Industrial Development in the Lower Mekong Basin: Summary of proposed programme, ECAFE, Agricultural Sub-Committee, Second Session, 15-27 March '72

47. The revenue code of Thailand as ammended up to April 1971, Translation Secretarial Office

48. Customs Tariff and Business Tax, Translation Secretarial Office.

49. Recommendations of the Expert Group Meeting on Agricultural Machinery Industry in Developing Countries, Vienna 18-22 August 1969

50. Summary of the Second Five-Year Plan The National Economic Development Board

Appendix 3

Tables, Diagrams, Belonging to the Market-Analysis

Described in Chapter 3

Table A : IMPORT STATISTICS OF INTERNAL COMBUSTION ENGINES

(source : Department of Customs, Thailand)

		1966		1967		1968		1969		1970		1971	
		number	value mill ฿	number	value mill ฿	number	value mill ฿	number	value mill ฿	number	value mill ฿	number	value mill ฿
Gasoline													
Outboard	149	951		4,140		2,070		0					
7110503	202	3,139		12,634		8,103		5,772					
	213	905		4,554		5,050		1,030					
	235	0		0		0		5					
	402	4,450		10,228		13,579		4,679					
	others	125		1,418		13		11					
Total		9,570	15,327	32,974	48,574	28,821	35,916	11,497	17,637				
Marine	149	1,742		1,959		2,098		2,124		4,752		19	
7110504	202	2,660		873		1,200		3,540		9,503		2,750	
840603	213	1,364		735		1,276		3,644		815		285	
	235	370		968		1,103		1,008		90		0	
	402	159		908		1 211		654		430		0	
	others	95		158		79		831		214		169	
Total		6,390	53,592	5,601	79.408	7,777	68.795	11,851	57.069	15,069	24.412	3,223	9.129
n.e.s.	149	11,468		17,096		26,225		34,881		35,073		16,273	
7110505	202	5,565		384		8,768		2,870		1,076		170	
840609	213	1,447		1,525		2,122		2,905		6,412		1,972	
	235	551		359		986		1,612		3,293		132	
	402	25,372		38,093		38,466		26,246		7,369		5,043	
	others	613		520		2,708		3,300		2,423		1,667	
Total		45,016	61.495	57,977	73.269	78,875	92.607	71,832	77.555	55,646	46.565	25,257	33.745
Gasoline total		60,976	128.414	96,552	201.251	115,873	197.318	95,182	152.261	73,450	70.977	28,480	42.874
Diesel													
Diesel and	149	21,563		28,385		37,640		41,495					
semidiesel	202	255		77		460		97					
7110508	213	1,437		608		825		2,013					
	235	3,446		11,996		3,751		6,321					
	402	1,934		587		409		6,930					
	others	1,332		6,236		1,748		3,259					
Total		29,967	169.526	47,889	167.169	44,829	183.707	60,115	176.000				
Marineeng.	149									1,503		2,440	
840612	202									2,493		551	
	235									685		444	
	402									784		24	
	others									268		267	
Total										5,733	69.612	3,726	31.732
Others	149									37,504		39,943	
840619	235									5,681		2,601	
	others									5,049		4,205	
Total										48,234	136.670	46,749	150.732
Diesel total		29,967	169.526	47,889	167.169	44,829	183.707	60,115	176.000	53,967	206.282	50,475	182.471
Engines total		90,943	297.940	144,441	368.420	160,702	381.025	155,277	328.261	124,417	277.259	78,955	225.345

149 Japan
202 Austria
213 W-Germany
235 U.K.

Note : n.e.s. = not elsewhere specified

Table B : US EXPORT OF SMALL ENGINES TO THAILAND

(no. of units)

Year	Gasoline engines			
	Total 0-50 BHP)	0-6 BHP	6-10 BHP	10-50 BHP
1966	33,348	20,833	12,293	222
1967	48,732	17,848	30,445	429
1968	59,171	33,948	25,088	135
1969	22,707	11,850	10,711	146
1970	9,416	5,710	3,706	26
t/m nov. 1971	7,572	4,352	3,220	127

Source : US Department of Commerce - FT 410 Reports

Table C : JAPAN EXPORT OF I.C.E., OTHER THAN AIRCRAFT TO THAILAND

Engines	1966		1967		1968		1969		1970	
	Units	US $	Units	US $	Units	US $	Units	1,000 yen	Units	1,000 yen
- I.C.E. for auto bicycles	50	1,617	7	879	102	7,020	452	5,945	157	1,092
- I.C.E. for three-wheeled motor vehicles	-	-	-	-	-	-	-	-	-	-
- I.C.E. for motorvehicles other than autobicycles							14,223	403,738	19,130	522,628
- I.C.E. (gasoline) for motor vehicles n.e.s.	142	21,204	10,864	1,004,037	12,191	1,194,978				
- I.C.E. for motor vehicles, n.e.s.	6,421	684,303	-	-	-	-	-	-	-	-
- I.C.E. for marines, not more than 300 Hp	714	1,255,422	866	1,457,883	682	1,145,271	574	355,838	649	521,040
- I.C.E. for marines, 300-3,000 Hp, not more than 10,000 kg	19	51,726	-	-	6	124,269	7	47,917	9	69,447
- I.C.E. for marines, more than 3,000 Hp	-	-	5	11,686	8	942	-	-	-	-
- Outboard motors	56	11,127	-	-	-	-	-	-	-	-
- I.C.E. (gasoline), not more than 30 Hp	14,272	700,647	15,572	872,598	17,631	955,881	19,296	301,194	17,813	284,920
- I.C.E. (diesel), not more than 30 Hp	17,040	2,242,218	25,237	3,193,412	38,134	5,011,926	35,483	1,133,423	20,019	924,110
- I.C.E., not more than 30 Hp, n.e.s.	1,952	137,475	242	15,105	320	29,661	603	16,949	806	27,802
- I.C.E., 30-100 Hp	235	83,172	257	103,722	576	170,649	386	46,160	2,186	62,347
- I.C.E., 100-500 Hp	20	109,935	60	66,069	20	25,098	4	5,586	2	3,666

Source : Japan Export Statistics
Ministry of Finance, Japan

Table D : CLASSIFICATION OF COMBUSTION ENGINES USED BY THE THAI CUSTOMS DEPARTMENT

Until 1970 :

- Internal combustion piston engines for tractor	serial number	7110501
- idem for motor vehicles		7110502
- idem for outboard-motor boats	serial number	7110503
- idem for marine	serial number	7110504
- idem, n.e.s.	serial number	7110505
- diesel and semidiesel engines	serial number	7110508

1970 until now :

- Gas and gasoline engines for motor vehicles	serial number	840602
- idem marine engines	serial number	840603
- idem other (land engines)	serial number	840609
- diesel and other heavy oil engines for motor vehicles	serial number	840611
- idem marine engines	serial number	840612
- idem other (land engines)	serial number	840619

As relevant classifications are considered :

a. for gasoline engines :

- internal combustion piston engines for outboard motor boats
- idem for marine
- idem n.e.s.
- gas and gasoline engines - marine engines
- idem other

b. for diesel engines :

- diesel and semidiesel engines
- diesel and other heavy-oil engines - marine engines
- idem other

Table . E : EXTIMATED CROP PRODUCTION, 1976

2,5 rai = 1 acre
6,25 rai = 1 hectare

Crop	1968			1976		
Principal crops	Production (ton)	Production area (rai)	Yield/rai (kg)	Production (ton)	Production area (rai)	Production (kg)
Paddy	11,858,298	46,750,000	235.65	14,500,000	48,000,000	302.08
Rubber	243,273	3,956,412	61.49	320,000	4,500,000	71.11
Corn	1,350,000	4,909,103	274.99	2,200,000	4,000,000	314.30
Tapioca	1,800,000	775,283	2,321.73	3,000,000	800,000	2,500.00
Kenaf	183,594	920,312	199.49	500,000	2,000,000	250.00
Total		57,311,110			59,300,000	

Other crops	1966			1976		
Sugar cane	3,827,000	778,000	5,000	6,000,000		
Mungbean	131,800	840,000	161	310,000		
Soya bean	37,900	285,000	137	150,000		
Ground nut	219,900	981,800	230	400,000		
Selame	19,900	187,000	109	30,000		
Caster bean	41,900	271,000	161	60,000		
Coconut	1,069,000	1,545,000	50	1,500,000		
Cotton	88,800	523,000	179	200,000		
Karok	273,000	330,000	910	300,000		
Tobacco	88,400	537,000	165	150,000		
Vegetables	914,900	1,160,000		2,500,000		
Fruits	1,904,500	1,710,000		3,000,000		
Total		9,147,800				

Remarks : The rubber production area includes only that area which yields rubber

Source : The Agricultural Economics Division, Ministry of Agriculture

Table F : AVERAGE SIZE OF FARM HOLDINGS

Approx. size of holding (ha)	No. of holdings	percent
Total	3,087,141	100.0
0.3 - 1	467,876	15.2
1 - 2.5	944,526	30.6
2.5 - 5	884,411	23.5
5 - 8	422,710	13.7
8 - 9.5	193,262	0.3
9.5 - 23	163,183	5.3
23 and over	11,173	0.4

Source : Status of agricultural machinery in Thailand
UNIDO country study report Vienna January 1969

Table G : PRICES AND WEIGHTS OF SOME POPULAR BRANDS IN THAILAND

Cash prices for sub dealers in ฿

HP	Gasoline engines										Diesel engines					
	two stroke				four stroke											
	Winner	Rotax	Kawasaki		Briggs and Stratton		Wisconsin	Mitsubishi	Kawasaki		Yanmar		Kubota	Southern Cross		Mitsu-bishi
	Price	Price	Price	weight in kg.	Price	weight in kg	Price	Price	Price	weight in kg	Price	weight in kg	Price	Price	weight in kg	Price
3	1,000			11	1,200-1,250	12			1,100-1,200	13	3,500	49		5,800	100	3,800
4	1,300			13				1,650	1,500-1,700	22	3,800	56	3,500			4,100
5		1,733			1,400	15			2,000-2,200		4,300	67	3,800			5,200
6	1,600			23			3,650	2,100			5,250	87	4,300	9,000	150	6,750
7	1,700	2,106			2,000-2,900	25	3,300-4,400				6,400	98	5,700			
8	1,900	2,380			2,100	40	3,600				7,550	115	6,500			
9	2,000	2,744					5,200			58			7,700-8,450			
10	2,100				3,700	50					9,500	128				
11															290	9,250
12							4,900-7,200			62			9.500	14,200		
14											13,600	155				11,850
15	2,200				4,700											13,000
16							10,500									
18		3,248														
20		4,565					13,000									
25				48										27,500		
30	3,900						15,750									
35		6,000														
40							16,700									

Note : for radiator cooling 600 - 1,200 ฿ to be added at the above mentioned price

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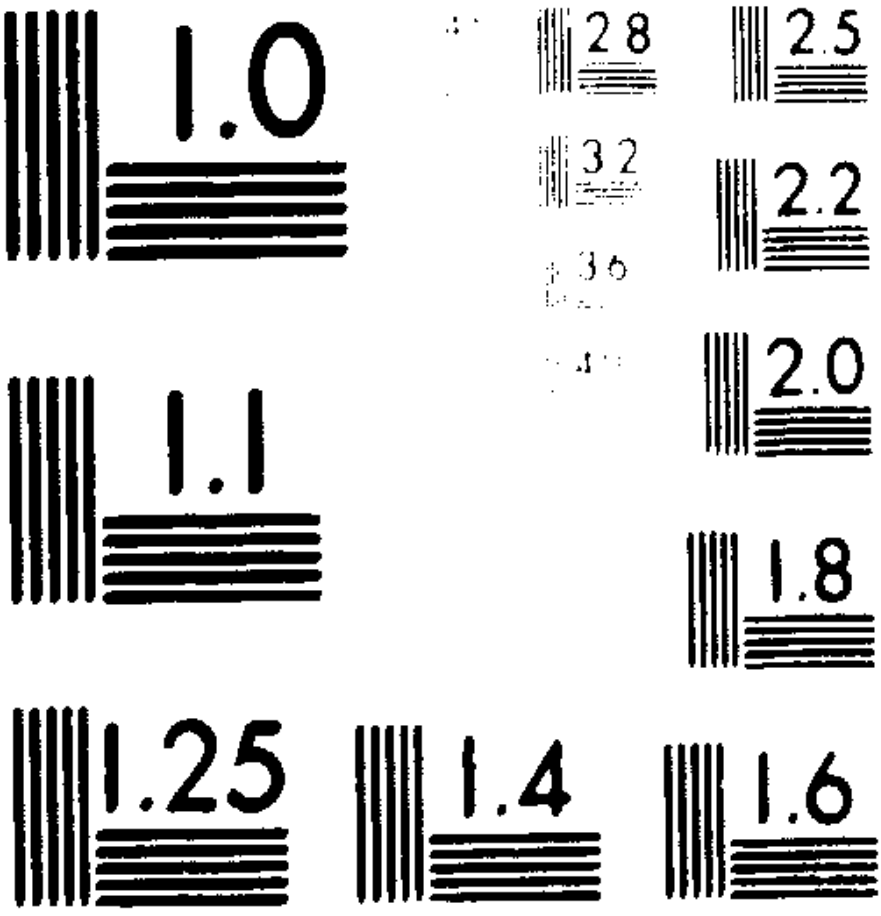


Table H : ANNUAL SMALL ENGINES DEMAND IN THAILAND

(number of units)

Year / Engine type	Estimated		Projected					
	1968	1971	1972	1973	1974	1975	1976	1981
2 Stroke gasoline								
Boats 5 - 10 HP	25,000 -28,000	8,500 - 10,000						
20 HP								
Agric 5 - 10 HP	7,000 - 8,000	2,500 - 3,000						
Others	3,000 - 4,000	1,000						
Total 2-stroke	35,000 -40,000	12,000 - 14,000	10,000	10,500	11,000	11,200	11,500	13,000
Growth rate per annum				5%	5%	+ 2%%	+ 2%	2%
Four stroke gasoline								
3 - 4 HP	25 -30,000	12,500 - 15,000	15,000	16,500	18,000	19,000	20,500	25,000
7 - 8 HP	12.5 -15,000	6,250 - 7,500	7,500	8,000	9,000	9,500	10,000	12,500
9 - 10 HP	50 -60,000	25,000 - 30,000	30,000	33,000	36,000	38,500	41,000	50,000
others 20 HP	10,000	5,000	5,000	5,500	6,000	6,500	7,000	10,000
Total 4-stroke	60 -70,000	30,000 - 35,000	35,000	38,500	42,000	45,000	48,000	60,000
Growth rate				10%	10%	7%	6%	5%
Total gasoline	95,000 -110,000	42,000 - 50,000	45,000	49,000	53,000	56,000	60,000	73,000
Growth rate per annum				9%	8%	5.5%	7%	4%
Diesel 20 HP								
low speed	4,500 - 8,000	3,000 - 6,000	4,000	4,200	4,500	5,000	5,500	90,000
high speed 3 - 5	25,000 -30,000	18,000 - 22,500	20,000	21,000	24,000	30,000	36,000	60,000
high speed 7 - 8	8,000 -13,000	6,000 - 9,000	8,000	8,000	9,500	11,000	13,500	23,000
high speed 10 - 20	1,000 - 2,000	1,000 - 2,000	2,000	2,000	2,500	2,500	3,000	5,000
high speed others	not available	not available	1,000	1,000	1,500	1,500	2,000	3,000
Total high speed	40,000 -47,000	30,000 - 32,000	31.000	32,000	37,500	45,000	54,500	91,000
Total diesel	45,000 -55,000	35,000 - 40,000	35,000	37,000	42,000	50,000	60,000	100,000
Growth rate per annum				5%	10%	20%	20%	10%
Total all types	140,000-165,000	77,000-90,000	80,000	86,000	95,000	105,000	120,000	173,000
Growth rate per annum				7.5%	9%	10.5%	14%	9%

Note : all numbers are round numbers and approximates

Source :investigations Berenschot-Bosboom

Table I : SMALL ENGINES (ALL TYPES): QUANTITY, SALES, DEMAND AND MANUFACTURING SCHEDULES

Estimated by ECAFE/AIDC - UNIDO fact-finding team
(Number of units)

Country	1968 Quantity	1968 Annual sales		Projected annual demand		Manufacturing capacity			
						1968		1970	1975
		Total	Imported	1970	1975	Production	Installed capacity		
Ceylon	(...)	(...)	(...)	11,600	26,000	-	-	-	-
China (Taiwan)	45,000	8,000	2,000	25,000	48,000	10,000	12,000	15,000	20,000
India	1,150,000	280,000	(...)	385,000	610,000	248,000	346,000	346,000	370,000
Indonesia	(...)	(...)	(...)	13,200	27,000	500	2,000	(...)	(...)
Iran	25,000	(...)	400	37,500	59,500	-	-	4,300	6,050
Korea, Republic of	85,000	(...)	(...)	70,700	92,600	7,800	10,500	15,000 [1]	15,000
Malaysia	30,000	(...)	2,700 [1]	6,500	15,000	-	-	-	-
Nepal	500	(...)	(...)	(...)	(...)	-	-	-	-
Pakistan	(...)	(...)	(...)	49,000	101,000	11,500	17,000	24,000	24,000
Philippines	22,500	(...)	(...)	23,000	47,500	-	-	-	-
Singapore	300	25	(...)	50	(...)	-	-	-	(...)
Thailand	(...)	(...)	(...)	17,000	31,500	-	-	-	6,000
Total	1,298,300	288,025	5,100	590,550	1,002,000	277,800	387,500	404,400	441,050

1 Including engines for tractors

Table J : 1-2 Hp GASOLINE-FED ENGINES [1]: QUANTITY, SALES, DEMAND AND MANUFACTURING SCHEDULES

Estimated by ECAFE/AIDC - UNIDO factfinding team
(Number of units)

Country	1968 Quantity	1968 Annual sales		Projected annual demand		Manufacturing capacity			
						1968		1970	1975
		1970	1975	1970	1975	Production	Installed capacity		
Ceylon	(...)	(...)	(...)	5,500	12,000	-	-	-	-
China (Taiwan)	(...)	(...)	(...)	5,000	10,000	-	-	-	-
India	75,000	20,000	-	30,000	75,000	18,000	36,000	36,000	40,000
Indonesia	(...)	(...)	(...)	5,500	10,000	-	-	-	-
Iran	(...)	(...)	(...)	15,000	22,500	-	-	-	-
Korea, Republic of	(...)	(...)	(...)	7,500	15,000	-	-	-	-
Malaysia	(...)	(...)	(...)	500	3,000	-	-	-	-
Nepal	(...)	(...)	(...)	150	300	-	-	-	-
Pakistan	500	(...)	(...)	11,000	20,000	-	-	-	-
Philippines	2,000	(...)	(...)	5,000	10,000	-	-	-	-
Singapore	50	-	(...)	(...)	(...)	-	-	-	(...)
Thailand	(...)	(...)	(...)	5,000	8,000	- ?	-	-	(...)
Total	77,250	20,000	-	90,150	185,800	18,000	36,000	36,000	40,000

1 Driving engine for knapsack-type of sprayers

Table K : 3-5Hp, GASOLINE-FED ENGINES[1]: QUANTITY, SALES, DEMAND AND MANUFACTURING SCHEDULES

Estimated by ECAFE/AIDC-UNIDO factfinding team

(Number of units)

Country	1968 Quantity	1968 Annual sales		Projected annual demand		Manufacturing capacity			
						1968		1970	1975
		1970	1975	1970	1975	Production	Installed capacity		
Ceylon	(...)	(...)	(...)	2,000	5,000	-	-	-	-
China (Taiwan)	(...)	(...)	(...)	5,000	8,000	3,000	(...)	(...)	-
India	75,000	20,000	(...)	50,000	100,000	20,000	30,000	30,000	30,000
Indonesia	(...)	(...)	(...)	5,000	10,000	500	2,000	2,000	4,000
Iran	(...)	(...)	(...)	4,500	6,000	(...)	(...)	(...)	(...)
Korea, Republic of	(...)	(...)	(...)	2,500	5,000	600	3,000	3,000	3,000
Malaysia	(...)	(...)	(...)	1,000	2,500	-	-	-	-
Nepal	(...)	(...)	(...)	100	400	-	-	-	-
Pakistan	(...)	(...)	(...)	4,000	10,000	-	-	-	-
Philippines	18,000	(...)	(...)	4,000	8,000	-	-	-	-
Singapore	50	-	(...)	(...)	(...)	-	-	-	(...)
Thailand	(...)	(...)	(...)	3,000	6,000	-	-	100	5,000
Total	93,050	20,000	-	81,100	160,900	24,100	35,000	35,100	42,000

1 Engines for driving power treshers, hullers, small milling equipment and small pumps

Table L : 3-15 Hp DIESEL-FED ENGINES [1], QUANTITY, SALES, DEMAND AND MANUFACTURING SCHEDULES

Estimated by ECAFE/AIDC-UNIDO factfinding team

(Number of units)

Country	1968 Quantity	1968 Annual sales		Project annual demand		Manufacturing capacity			
						1968		1970	1975
		Total	Imported	1970	1975	Production	Installed capacity		
Ceylon	(...)	(...)	(...)	4,000	8,000	-	(...)	(...)	(...)
China (Taiwan)	(...)	(...)	(...)	10,000	18,000	4,000	(...)	(...)	(...)
India	725,000	150,000	-	250,000	325,000	120,000 [3]	150,000	150,000	150,000
Indonesia	(...)	(...)	(...)	2,500	5,000	-	-	-	-
Iran	(...)	(...)	(...)	10,000	15,000	-	-	2,250	2,250
Korea, Republic of [2]	(...)	(...)	(...)	10,000	20,000	5,000	7,000	10,000	10,000
Malaysia	(...)	(...)	(...)	4,000	7,500	-	-	-	(...)
Nepal	(...)	(...)	(...)	250	1,000	-	-	-	-
Pakistan	(...)	(...)	(...)	24,000	50,000	9,500	13,000	18,000	18,000
Philippines	3,000	(...)	(...)	8,000	15,000	-	-	-	-
Singapore	150	-	(...)	(...)	(...)	-	(...)	-	(...)
Thailand	(...)	(...)	(...)	5,000	8,000	-	-	-	1,000
Total	728,150	150,000	-	327,750	472,500	138,500	170,000	180,250	181,250

1 Including engines for power tillers, pumps and threshers

2 Kerosine engines

3 About 60,000 manufactured by the small-scale sector

Table M : 12-30 Hp DIESEL ENGINES[1]: QUANTITY, DEMAND, SALES AND MANUFACTURING SCHEDULES

Estimated by ECAFE/AIDO-UNIDO factfinding team
(Number of units)

Country	1968 Quantity	1968 Annual sales		Projected annual demand		Manufacturing capacity			
		1970	1975	1970	1975	1968 Production	1968 Installed capacity	1970	1975
Ceylon	(...)	(...)	(...)	800	1,000	-	(...)	(...)	(...)
China (Taiwan)	(...)	(...)	(...)	5,000	8,000	-	-	-	(...)
India	200,000	75,000	(...)	15,000	30,000	75,000 [4]	100,000	100,000	100,000
Indonesia	(...)	(...)	(...)	1,000	2,000	-	-	-	-
Iran	(...)	(...)	400 [2]	4,000 [3]	6,000	-	-	2,050	6,050
Korea, Republic of	(...)	(...)	(...)	500	2,000	300	500	(...)	(...)
Malaysua	(...)	(...)	(...)	100	500	-	-	-	(...)
Nepal	(...)	(...)	(...)	50	250	-	-	-	-
Pakistan	(...)	(...)	(...)	5,000	11,000	2,000	4,000	6,000	6,000
Philippines	1,000	(...)	(...)	250	500	-	-	--	-
Singapore	50	-	(...)	(...)	(...)	-	-	-	(...)
Thailand	(...)	(...)	(...)	500	1,500	-	-	-	(...)
Total	201,050	75,000	400	31,600	62,750	77,200	104,500	108,050	112,050

1 For stationary use. The estimates do not include engines for tractors
2 Assumed to be imported for deepwell pumps
3 30 hp and above diesel-fed engines used for deepwell pumps
4 about 37,000 production from large scale sector

Diagram A

IMPORTED COMBUSTION ENGINES

Source : Department of Customs

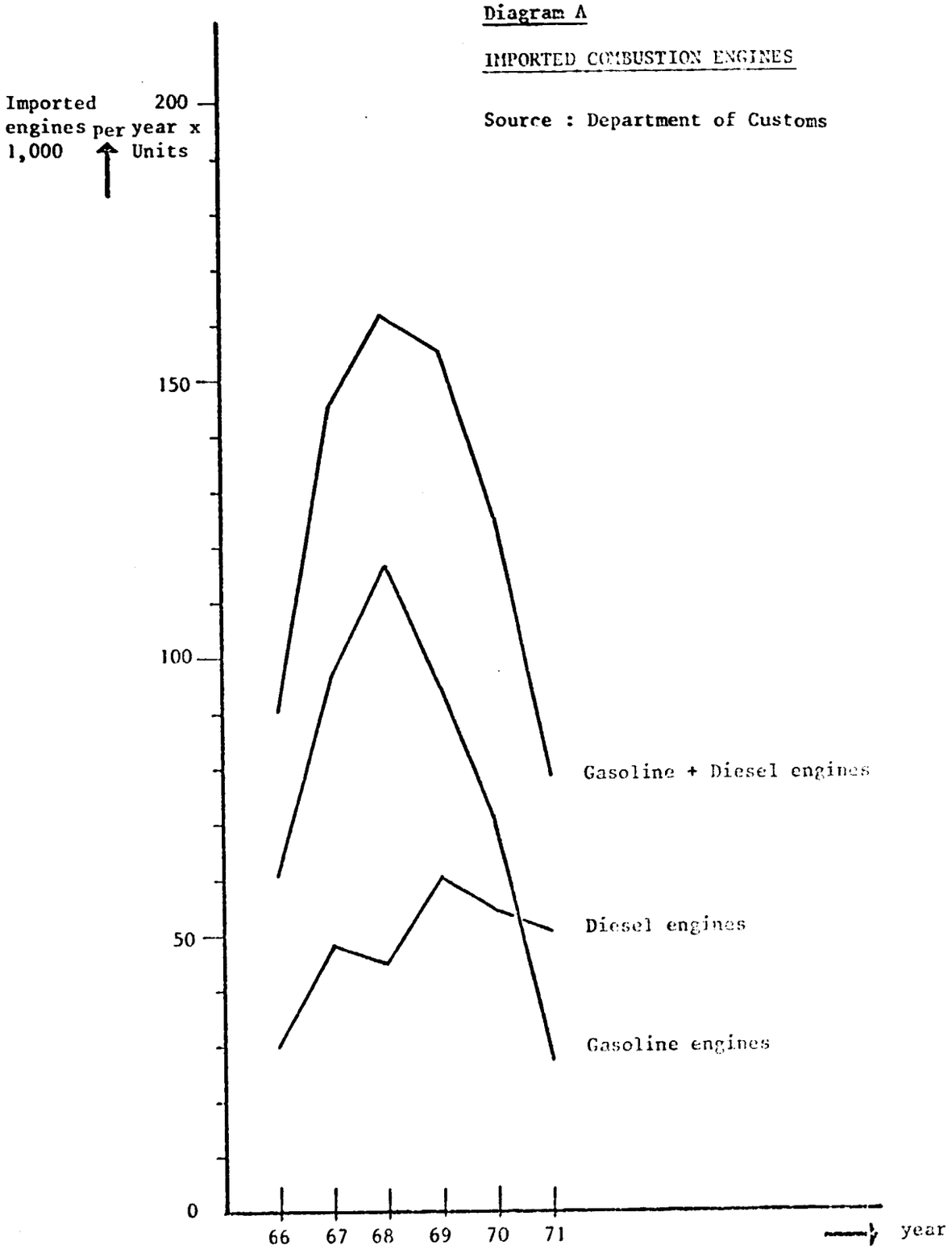


Diagram B: a - b IMPORTED GASOLINE ENGINES DIVIDED INTO CLASSIFICATION AND COUNTRY OF ORIGIN

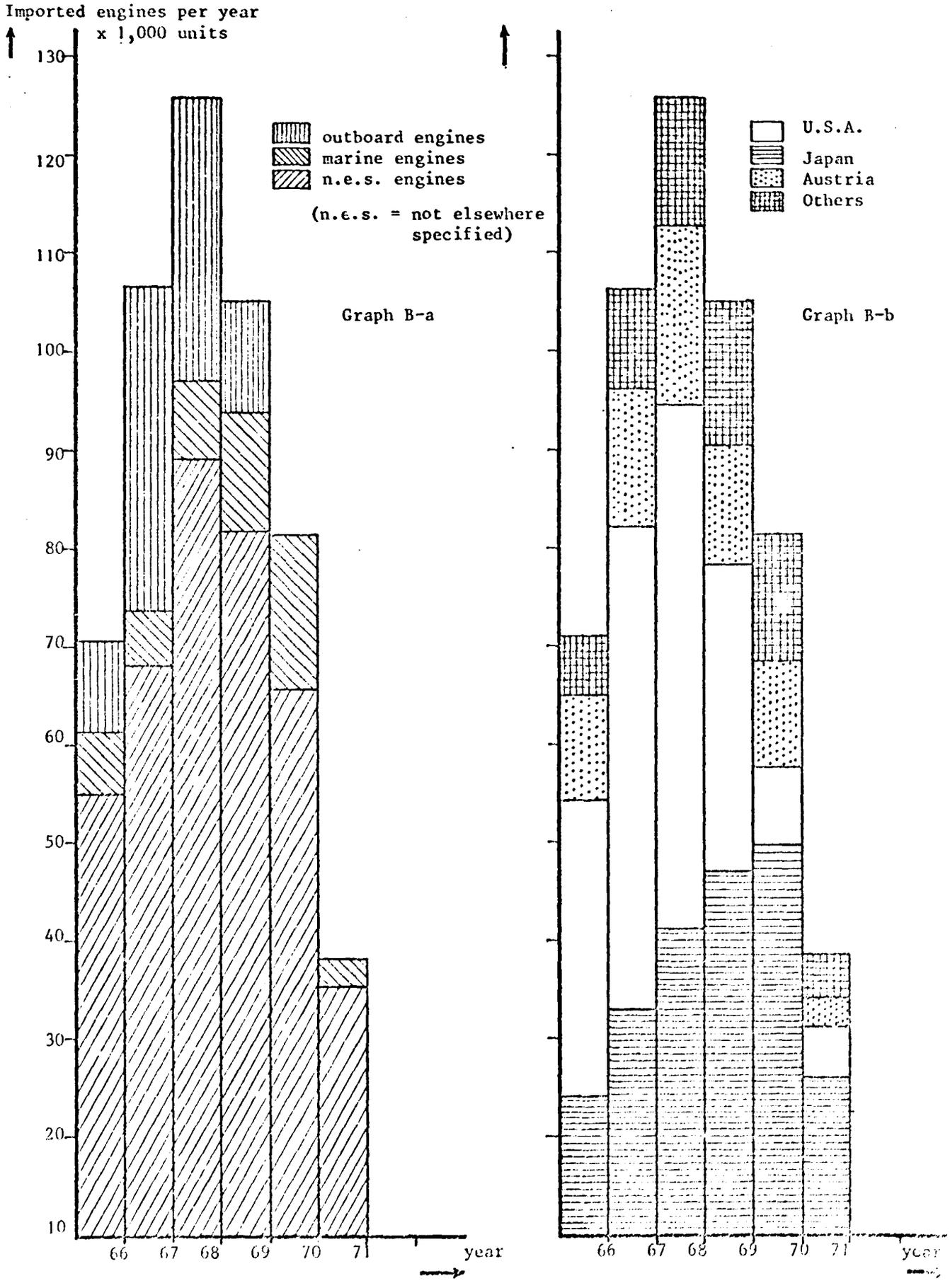


Diagram C : COMPARAISON OF DATA ABOUT IMPORTED GASOLINE ENGINES FROM JAPAN AND DATA ABOUT EXPORTS FROM JAPAN TO THAILAND

Sources : Department of customs of Thailand see A
Ministry of Finance of Japan see B

Note : In Thai data are included
- marine engines
- outboard engines
- n.e.s. engines

In Japanese data are included
- marine engines
- veh- gasoline engines for motorvehicles other than auto-bicycles
- 30 HP -land engines with a rating not more than 30 HP
- others

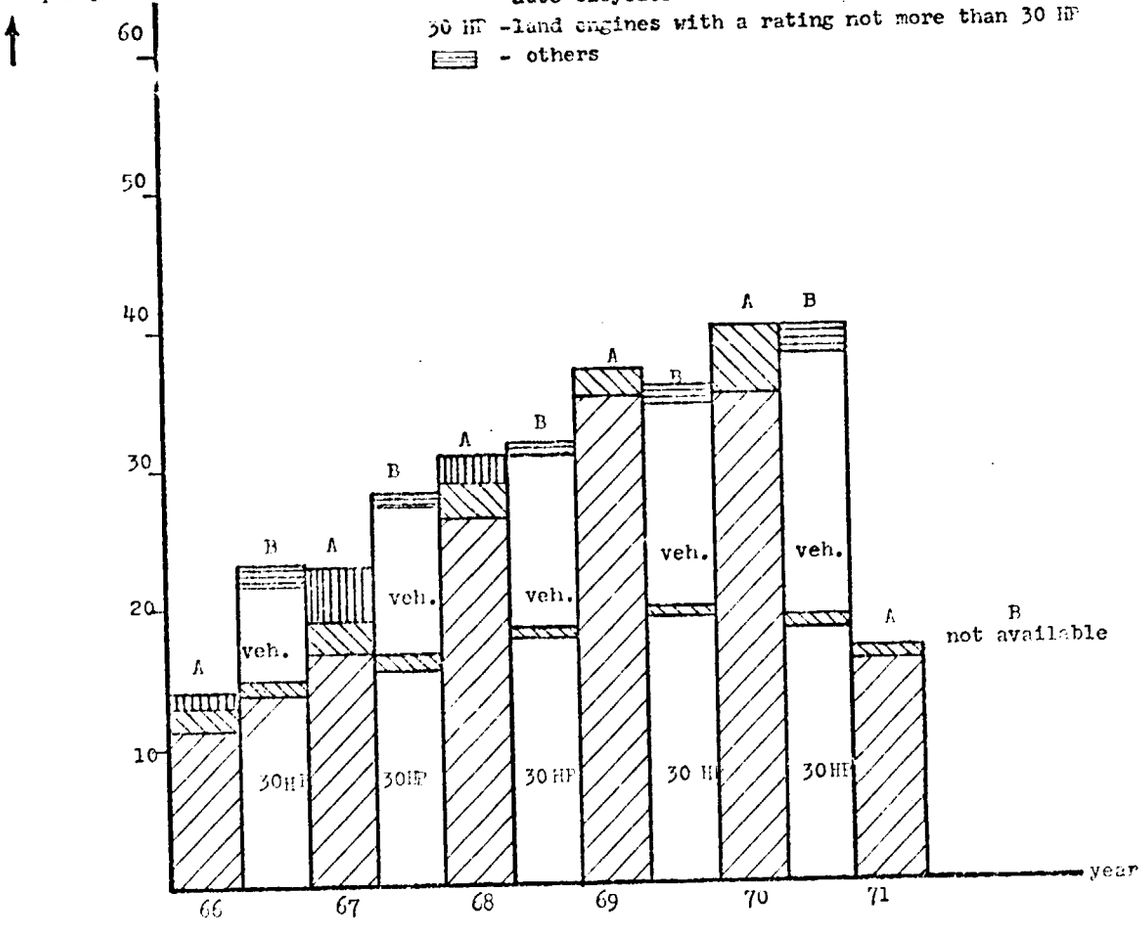


Diagram D: COMPARAISON OF DATA ABOUT IMPORTED GASOLINE ENGINES FROM USA AND DATA ABOUT EXPORTS FROM USA TO THAILAND

Sources : Department of Customs of Thailand see A
U.S. Department of Commerce see B

Note : In the Thai data are included
- marine engines
- outboard engines
- n.e.s. engines

In USA data are included
< 6 HP - 0-6 HP
6-10 HP - 6-10 HP

Remark : 10 - 50 HP engine exports to Thailand in period 1966 - 1971 are resp. : 222 - 429 - 135 - 146 - 26 - 127 units per year

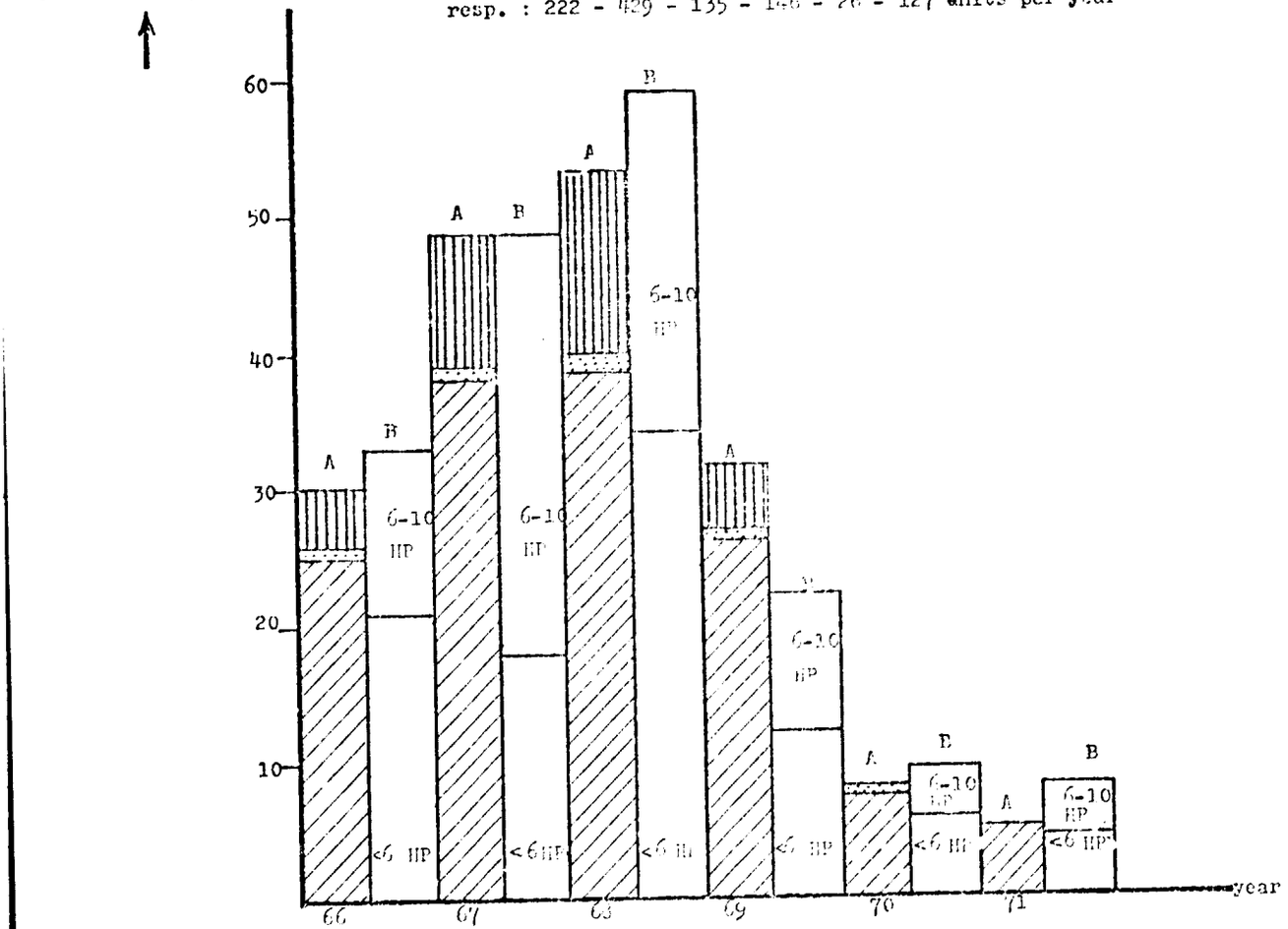


Diagram E a-b : IMPORTED DIESEL ENGINES DIVIDED INTO CLASSIFICATION AND COUNTRY OF ORIGIN

(Source : Department of Customs)

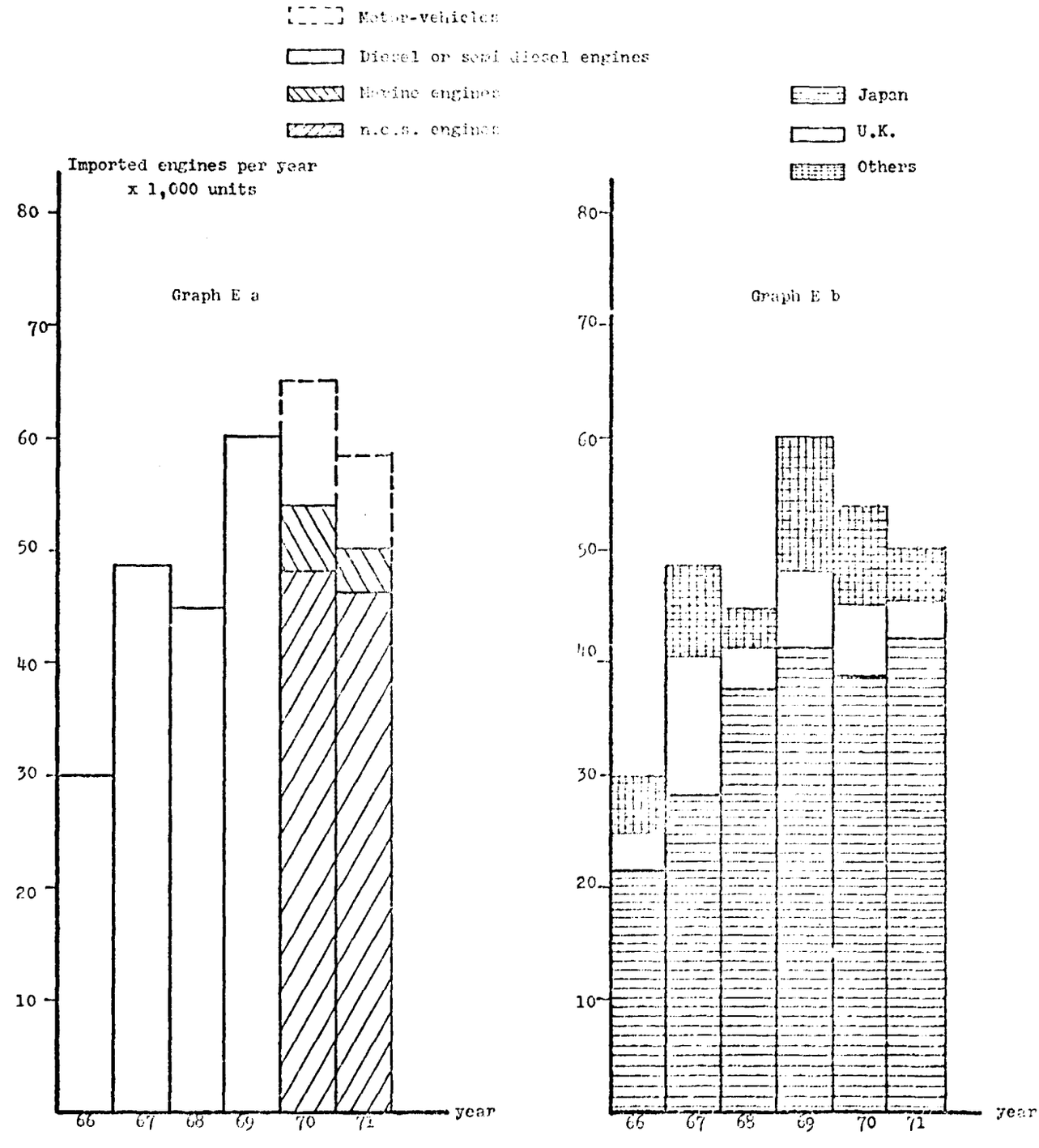
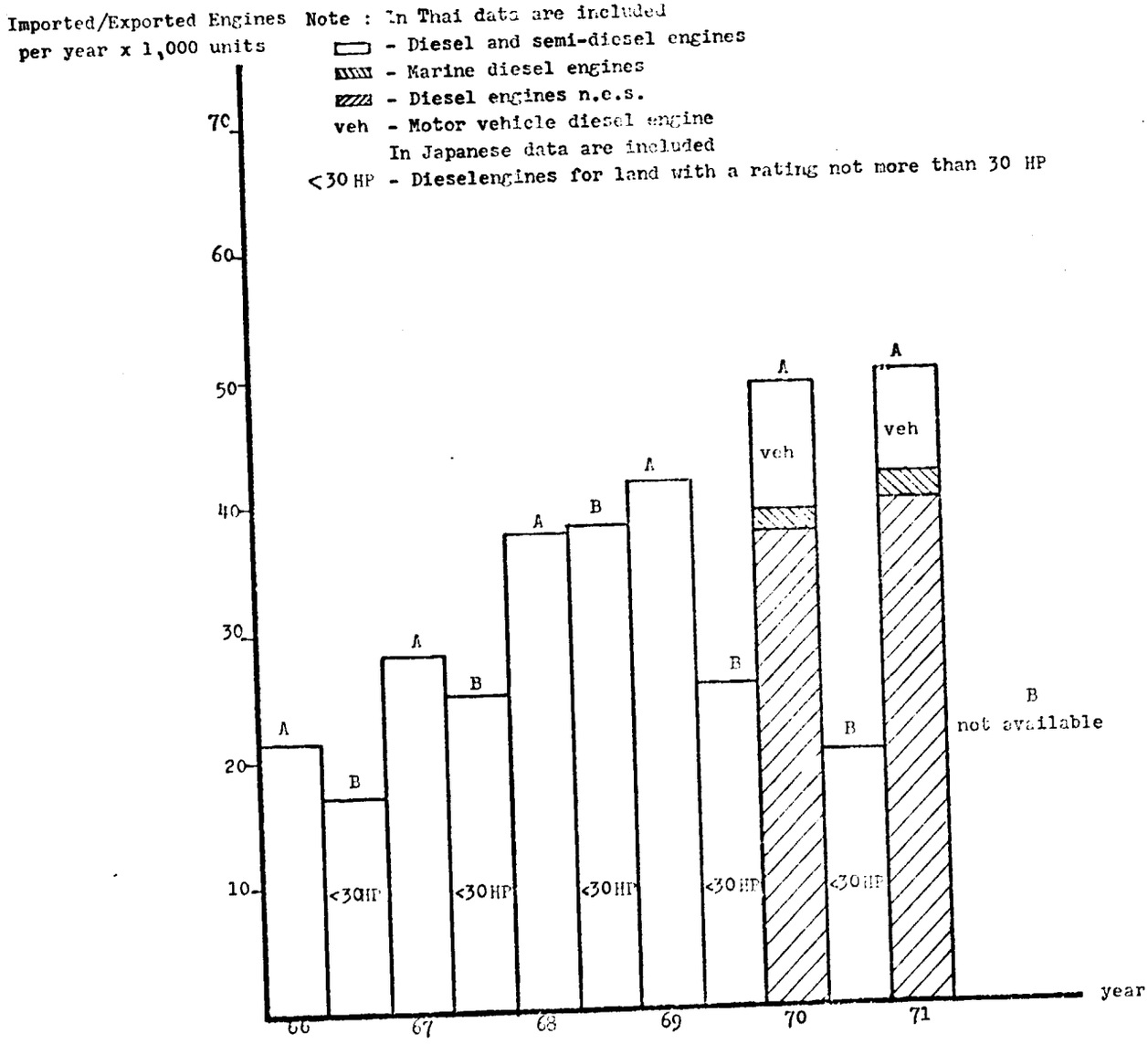


Diagram F : COMPARISON OF DATA ABOUT IMPORTED DIESEL ENGINES FROM JAPAN AND DATA ABOUT EXPORTS FROM JAPAN TO THAILAND

sources : Department of customs of Thailand see A
Ministry of Finance of Japan see B



Appendix 4

Production Details and Lay-out of the Factory

as Described in Chapter 4

Table A : LIST OF MANUFACTURERS PRODUCING OR HAVING PRODUCED FOUR-STROKE DIESEL ENGINES WITH HOPPER COOLING

Name and address	Types	Speed (rpm)	Power output (HP)
Deutz Motoren Fabriek Köln Germany	MAH 711, MAH 714, MAH 716	800 - 1500	4 - 10
Slanzi Novellara Italy	Do 5	1200 - 1600	5
Schlüter Freising bei München Germany	SDL 6, SDL 12	1000 - 1650	4 - 12
Sendling München Germany	D 6, D 7, D 10, D 20	750 - 1450	5 - 12
Normag Hattingen Ruhr Germany	W 6 L, W 10 L, W 14 L, W 15 L	1000 - 1500	4 - 15
Blackstone Stainford United Kingdom	JP	800	16
Lombardini Peggio Emilia Italy	LDO 85/1, LDO 105/1, LDO 120/1	1300 - 1500	6 - 13
Jenbacher Werke Jenbach Tirol Austria	JW 15	800 - 1500	8 - 15
Güldner Motorenwerke Aschaffenburg Germany	GK, GW 8, GW 15, GW 20	850 - 2000	4 - 19
Yanmar Diesel Engine Co 62 Cheyemachi, Kita-Ku Osaka 530, Japan	TH 3, TH 4, TH 5, F4Y, F5Y, F6Y, F7Y, F8Y, F9Y, F10Y	2200 2000 - 2200	4 - 5 4 - 12
Kubota 22 Funade-cho 2 chome Miniwa-ku Osaka, Japan	ES 30, ES 40 KND 3, KND 40, KND 5 B, KND 70 KND 90	2200 2000 - 2200	4 - 5 4 - 12
Mitsubishi 5-1, Marunouchi, 2-Chome, Chiyoda-ku, Tokyo-100 Japan	M4H, M5H, M7H, M85H, M95H, M11H, M14H	2200	3 - 10
Noda Industrial Co 532-1 Asahi-machi Takamatsu , Kagana 760 Japan	DE, D45H, D57H, D68H, D79H	2000 - 2200	4 - 9

Table B: SPECIFICATION OF NUMBER OF MACHINES IN MACHINE SHOP

A. To produce 5,000 engines in 2000 h per annum

	netto time (h) per engine		bruto time (h) per engine	nr. of machines or men
milling	6.1	+ 30 %	8	20
turning	8.0	+ 25 %	10	25
drilling	4.8	+ 20 %	6	15
guiding	1.6	+ 25 %	2	5
fitting	7.2	+ 10 %	8	20

B. To produce 10,000 engines per annum

milling	5.5	+ 27 %	7	35
turning	7.4	+ 22 %	9	45
drilling	4.4	+ 18 %	5	25
guiding	1.6	+ 23 %	2	10
fitting	6.4	+ 10 %	7	35

C. To produce 20,000 engines per annum

milling	4.8	+ 25 %	6	60
turning	6.8	+ 20 %	8	80
drilling	3.9	+ 16 %	4.5	45
guiding	1.5	+ 20 %	1.8	18
fitting	5.9	+ 10 %	6.5	65

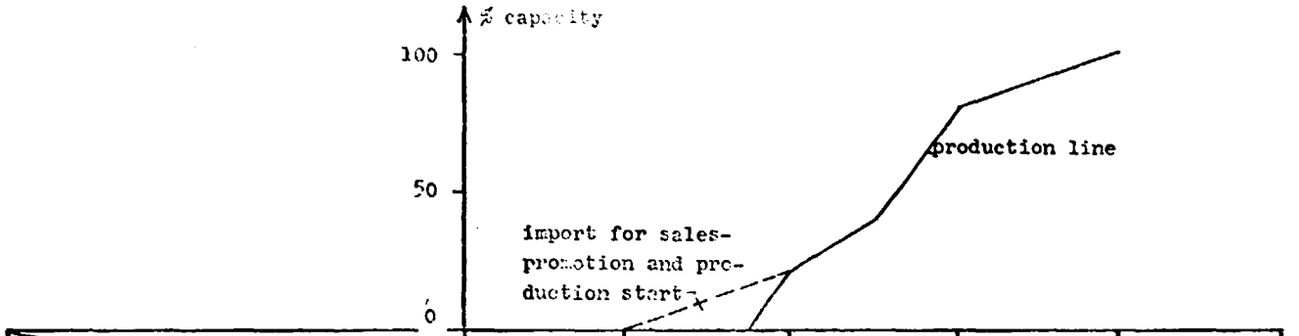
Table C : MACHINING TIME IN MINUTES BASED ON A PRODUCTION OF 5,000 ENGINES PER ANNUM

Part	Milling	Turning	Drilling	Guiding	Fitting
Cylinder block	50	25	15	-	-
Gear case cover	20	5	15	-	-
Cover	-	10	6	-	-
Flywheel arrow	-	-	3	-	15
Cover (2 x)	10	-	12	-	-
Dip stick	-	-	-	-	15
Cylinder liner	3	25	-	-	-
Camshaft bush (2 x)	-	12	5	-	-
Bracket (2 x)	25	-	15	-	24
Piston pin	-	6	-	15	-
Connection rod	5	12	6	15	-
Piston pin bush	-	6	3	-	-
Big end bolt (2 x)	-	7	-	15	-
Flywheel	-	24	10	-	-
Crankshaft	-	50	40	-	-
Gear wheel	25	6	3	-	-
Starting claw	3	10	5	-	-
Main bearing cover	-	18	20	-	-
Main bearing (2 x)	3	10	-	-	-
Housing oilpump	-	10	5	-	-
Valve	-	5	-	5	-
Nut	-	7	-	-	-
Set screw	-	5	-	-	-
Main bearing cover	-	25	20	-	-
Shaft	-	7	-	10	-
Gear wheel	40	11	-	-	-
Union	-	7	-	-	-
Set screw	-	5	-	-	-
Driven gear	12	6	-	-	-
Driven gear	12	3	-	-	-
Cover	-	3	6	-	-
Cyl. head cover	13	12	3	-	-
Shaft	6	8	6	-	-
Distance ring	-	4	-	-	-
Bush	3	7	-	-	-
Toothed quadrant	14	7	-	-	-
Camshaft	5	19	-	24	-
Tappet	-	12	6	10	-
Push rod (2 x)	-	6	-	-	-
Staring claw	9	12	-	-	-
Bush	-	6	-	-	-
Washer	-	3	-	-	-
Cover	-	6	5	-	-
Gear wheel	40	11	6	-	-
Starting crank	-	12	3	-	30
Starting claw	8	5	3	-	-
Cylinder head	40	-	30	-	-
Rocket (2 x)	-	9	12	-	5
Clamp	-	5	6	-	-
Bracket	5	7	6	-	-
Pin	-	7	5	-	-
Pawl	14	3	3	-	-
Fuel tank	-	-	-	-	180
Hose pipe	-	-	-	-	60
Bracket (2 x) fuel tank	-	-	-	-	42
Gaskets	--	-	-	-	60
	365	481	286	94	432

Table D: ELECTRIC POWER

Machines	KWH /machine	Nr. of engines produced		
		5,000	10,000	20,000
surface grinder	5	5	10	20
univ. internal grinder	3	6	12	21
univ. grinder	5	10	20	35
univ.milling machine	5	100	175	300
lathe universal	7	70	105	175
lathe small	3	45	87	141
sliding head automatics	10	-	10	30
drilling mach. 1 spindle	3	30	45	75
drilling mach. multi spindle	5	25	50	100
compressor	7	7	7	7
		298	521	904
factor of simultaneity	0.6	178	313	541
heat treatment installation	20	5	10	20
		183	323	561
divers		67	127	189
total KWH /h.		250	450	750
TOTAL KWH /year		500,000	900,000	1,500,000

Figure A : OPERATIONAL PLAN FOR A PLANT WITH 5,000 ENGINES PRODUCTION:

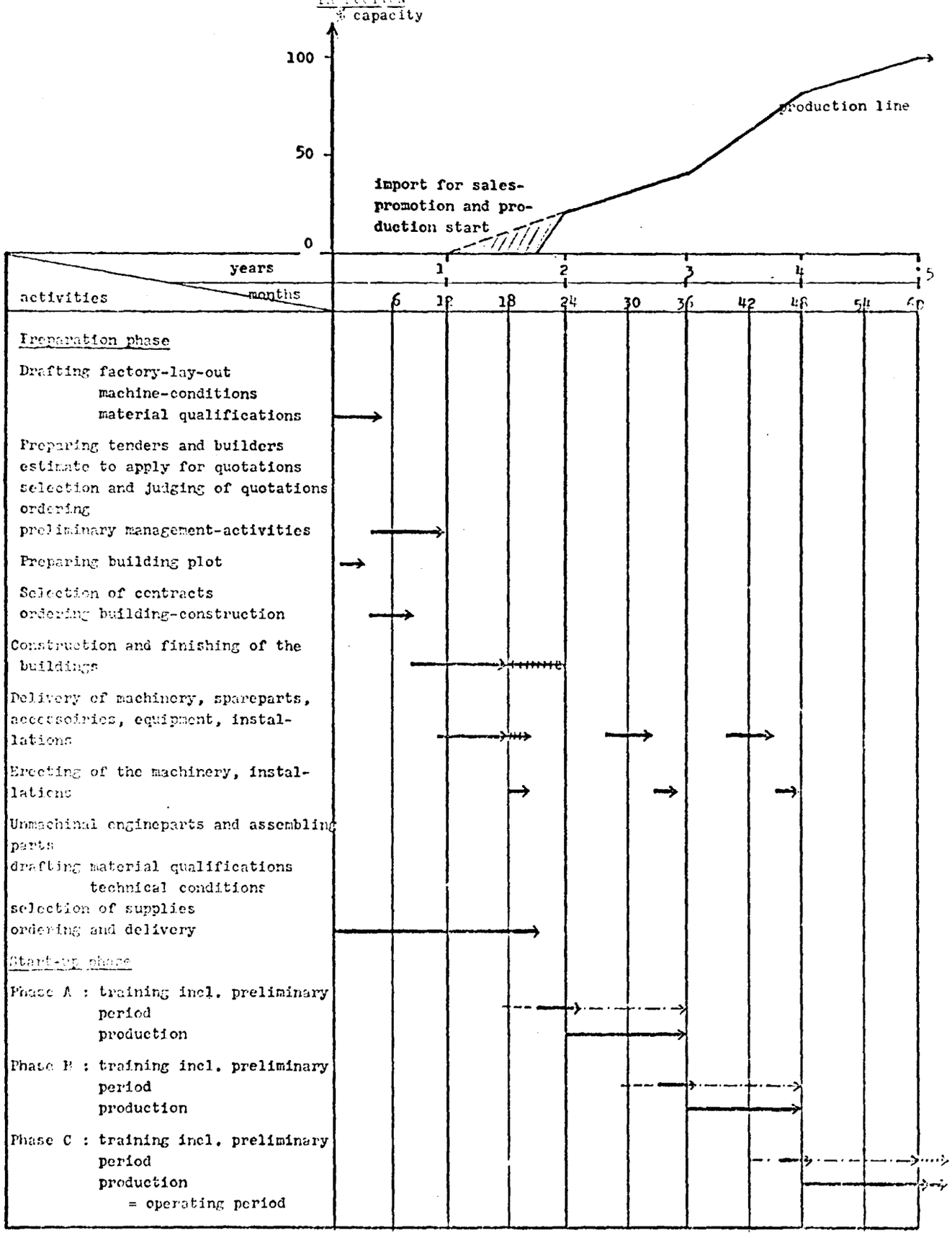


activities \ years / months	1	2	3	4	5
	6 12 18 24 30 36 42 48 54 60				
Preparation phase					
Drafting factory-lay-out machine-conditions material qualifications	→				
Preparing tenders and builders estimate to apply for quotations selection and judging of quotations ordering preliminary management-activities	→				
Preparing building plot	→				
Selection of contracts ordering building-construction	→				
Construction and finishing of the buildings	→	→			
Delivery of machinery, spareparts, accessoiries, equipment, installations	→	→	→	→	
Erecting of the machinery, installations		→	→	→	
Unmachinal engineparts and assembling parts drafting material qualifications technical conditions selection of supplies ordering and delivery	→	→			
Start-up phase					
Phase A : training incl. preliminary period production		→ - →	→		
Phase B : training incl. preliminary period production		→ - →	→	→	
Phase C : training incl. preliminary period production = operating period			→ - →	→ - → ····· →	→ →

Legenda:

- ——— = activity
- ++++ = remaining activity
- – – – = preparatory period
- –·–·– = covering period
- ····· = temporary assistance

Figure B : OPERATIONAL PLAN FOR PLANTS WITH 10,000 AND 20,000 SPINDLES IN COTTON



Legenda:

- ——— = activity
- ++++++ = remaining activity
- – – – = preparatory period
- –·–·– = covering period
- ····· = temporary assistance

EXPLANATION OF FIGURES A AND B

In the operational plans are included three consecutive phases named A, B and C. During these phases the production will be increased stepwise.
This concerns both the number of units to be produced and the various machinings to be executed.

Phase A : - start of assembly and increase to about 40 % of eventual capacity
- testing idem
- start of the fitting shop to produce all components needed by this department
- machining of simple castings and other simple parts

Phase B : - increase of assembly production to 80% of final level
- testing idem
- machining of more and more complicated parts
- increase of capacity of fitting shop

Phase C : - increase of assembling capacity to final level
- increase of production level and range of machine shop to final
- further increase of capacities of fitting shop and testing department

For the production of 10,000 or 20,000 units/year the duration of each phase is fixed at 12 months. For the production of 5,000 units/year, the duration of the phases A and B is fixed at six months, that of phase C at 12 months.

Figure C: PROPOSED FACTORY LAYOUT FOR PRODUCTION OF 10,000 ENGINES

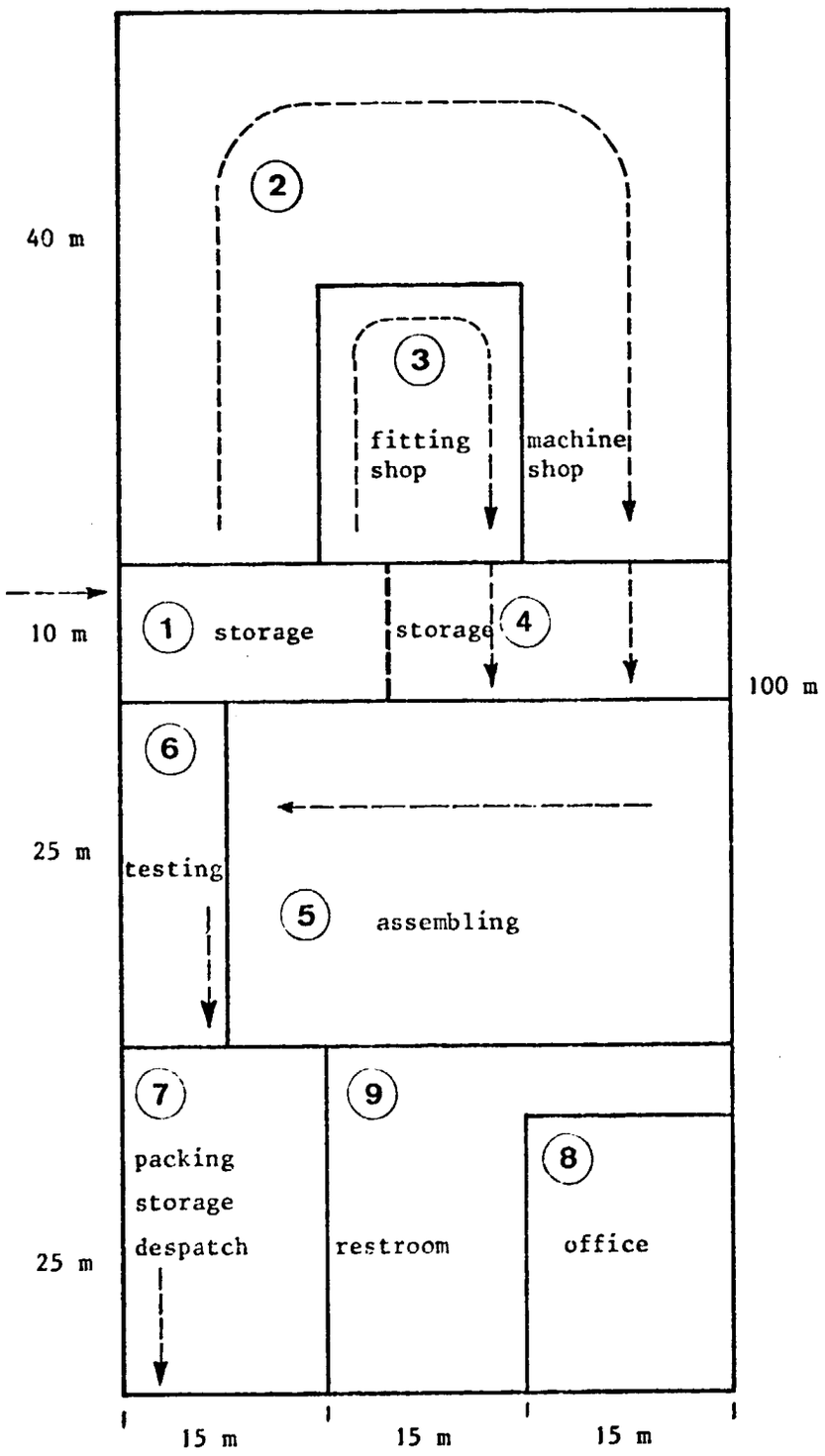
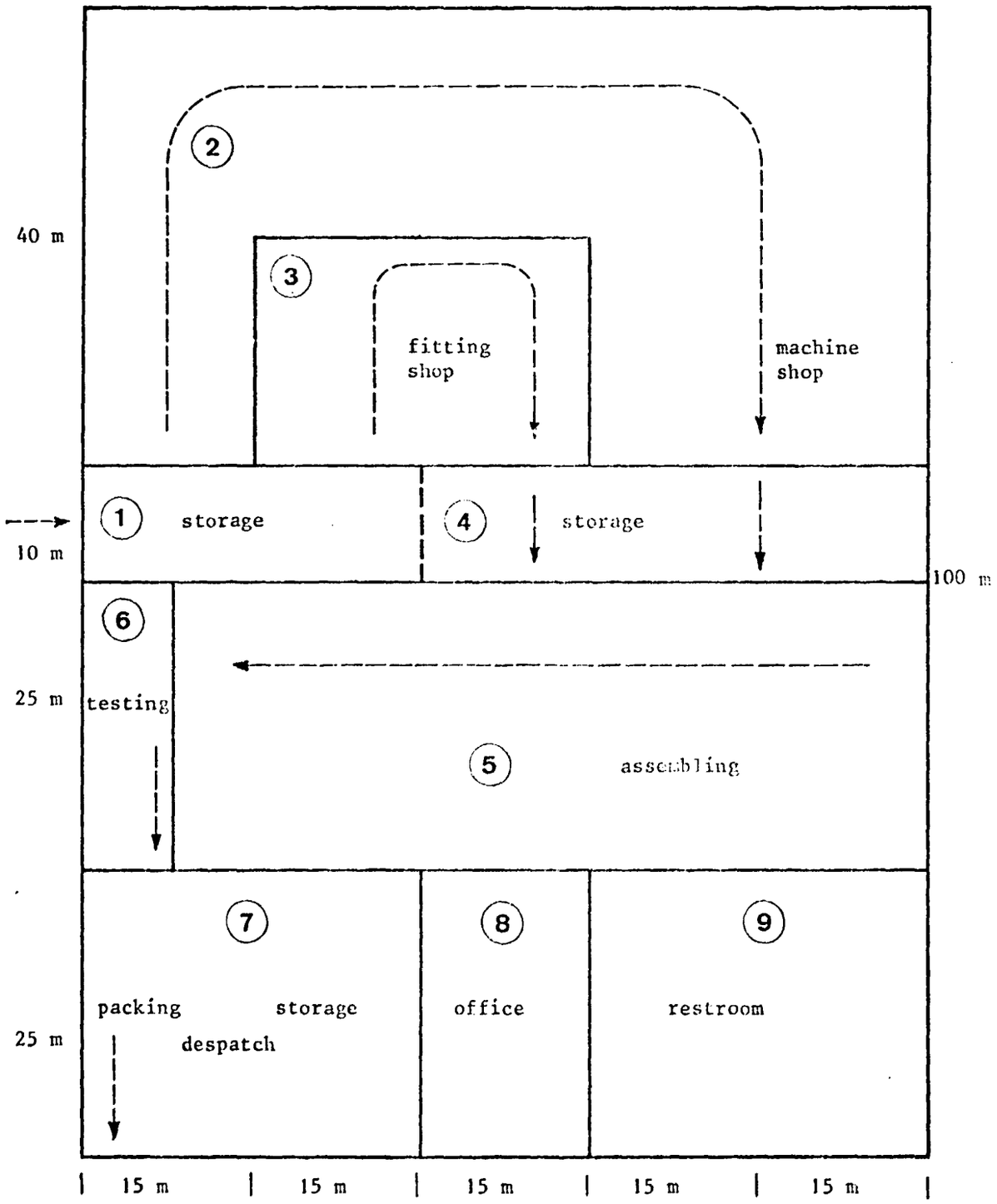


Figure D: PROPOSED FACTORY LAYOUT FOR PRODUCTION OF 20,000 ENGINES



EXPLANATION OF FIGURES C AND D

Indicated is the stream of parts throughout the factory

1. Storage of raw materials and half-finished products. Larger cast-iron parts are stored in open air.

2. Machine workhop where mechanical and heat treatments are executed. Once the engine type is precisely defined the outlay of the machine shop can be determined.

3. Fitting shop.

4. Storage of parts for the assembly of engines. These storage facilities are calculated to be sufficient for the assembly of 800 engines.

5. Assembly can be designed in the direction of the indicated main-stream with the following sidelines: crankshaft, connection rod + piston, cylinder head, fuel pump and injector.

6. Testing department has been designed in such a way that it disposes of relatively much of the outer factory wall, so that sufficient space for engines exhausts is available and other departments (such as offices) will suffer little hindrance from noise.

7. In this department the engines will be painted, wrapped, stored and delivered. At the same time space has been foreseen, for storage and deliverance of spareparts such as pistons, piston pins and piston rings, valves, valve guides, valve springs and tappets, push rods, parts of the fuel injection pump , filters gear sels, bearings, etc.

8/9. Office and rest rooms in this conception are lodged in the factory halls. It would be well possible to put these is a separate building at some distance of the factory. In that case the factory buildings would have to contain some facilities like dressing rooms, showers, restrooms, toilets, etc. now partially included in 8.

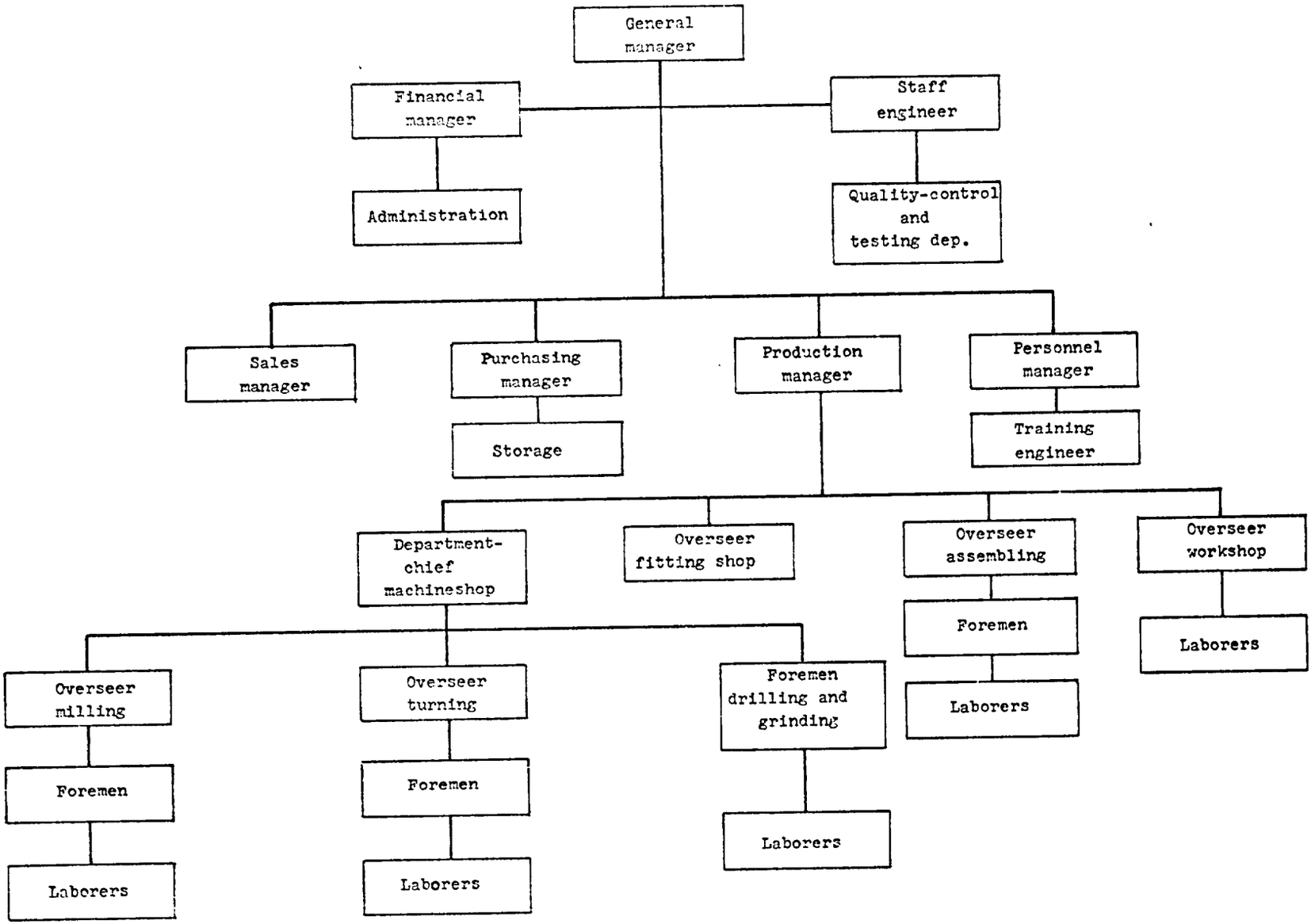


Figure E: ORGANIZATION SCHEME

Appendix 5

Tables Belonging to Chapter 5 :

. Computations of cash flows

. Summaries: total investments versus gross profits

. Effects Balance of Payments of Thailand

. Economic Effects

THE CASH FLOWS FOR THE THREE PROJECTS ARE SHOWN IN:

	Annual Production of Combustion Engines	Expressed in Currency
Table: 5.A	5000	Baht
Table: 5.B	5000	US$
Table: 5.C	10000	Baht
Table: 5.D	10000	US$
Table: 5.E	20000	Baht
Table: 5.F	20000	US$

The Cash Flows are composed of the elements of the tables A1,A2,A3, - P1,P2, and P3 of Appendix 6.

In this Appendix, the costs and revenues are examined in detail. The cash flows are calculated without taking into account interests, if any, or taxes to be paid.

Table 5.A: CASH FLOW FOR AN ANNUAL PRODUCTION OF 5,000 ENGINES

Amounts in 1,000 Baht

Years	Foreign technical assistance				Investment costs	Training start-up costs	Production costs	Working capital	Sub-total	Savings on production costs	Total costs	Income		Cash Flow (rounded of)	
	Preliminary costs	Training and supporting costs	Production supporting + efficiency improvement									Sales	Various	Annual	Cumul
			Before the 6th year	After the 5th year											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1,860				6,910	240	-	500	9 ,510	-	9,510	-		(9,500)	(9,500)
2	400	2,600			8,495	1,100	830	4,800	18,225	-	18,225	350		(17,875)	(27,375)
3		2,350			1,995	700	6,000	1,950	12,995	-	12,995	7,850		(5,150)	(32,525)
4			1,715		380		10,700	1,875	14,670	-	14,670	15,700		1,000	(31,525)
5			1,125		-		11,000	75	12,200	-	12,200	17,500		5,300	(26,225)
6				250	380		11,700		12,330	-	12,330	17,500		5,175	(21,050)
7				250	250		11,700		12,200	250	11,950	17,587		5,650	(15,400)
8				250	380		12,100		12,730	500	12,230	17,640		5,400	(10,000)
9				250	1,000		12,100		13,450	600	12,750	17,675		4,925	(5,075)
10					380		12,100		12,480	750	11,730	17,710		5,975	900
11					250		12,100		12,350	750	11,600	17,728		6,125	7,025
12					380		12,100		12,480	750	11,730	17,745		6,025	13,050
13							12,100		12,100	750	11,350	17,745		6,400	19,450
14													7,000	7,000	26,450
Tot.	2,260	4,950	2,840	1,000	20,800	2,040	124,530	9,200	167,620	4.350	163.270	182,740	7,000		

Table 5.B CASH FLOW FOR AN ANNUAL PRODUCTION OF 5,000 ENGINES

Amounts in 1,000 US $

Years	Foreign technical assistance				Investment costs	Training start-up costs	Production costs	Working capital	Sub-total	Savings on production costs	Total costs	Income		Cash Flow (rounded of)	
	Preliminary costs	Training and supporting costs	Production supporting + efficiency improvement									Sales	Various	Annual	Cumul
			4th year	5th year											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	90				330	12		24	456		456			(456)	(456)
2	20	125			410	53	40	230	878		878	17		(861)	(1,317)
3		115			96	34	290	95	630		630	380		(250)	(1,567)
4			83		18	-	515	90	706		706	760		54	(1,513)
5			54				530	4	588		588	840		252	(1,261)
6				12	18		560		590		590	840		250	(1,011)
7				12	12		560		584	12	572	850		278	(733)
8				12	18		580		610	24	586	850		264	(469)
9				12	48		580		640	29	611	850		239	(230)
10					18		580		598	36	562	850		288	58
11					12		580		592	36	556	850		294	352
12					18		580		598	36	562	850		288	640
13							580		580	36	544	850		306	946
14													330	330	1,276
Tot.	110	240	137	48	998	99	5975	443	8050	209	8259	8787	330		

Table 5.C: CASH FLOW FOR AN ANNUAL PRODUCTION OF 10,000 ENGINES

Amounts in 1,000 Bahts

Years	Foreign technical assistance				Investment costs	Training start-up costs	Production costs	Working capital	Sub-total	Savings on production costs	Total costs	Income		Cash Flow (rounded of)	
	Preliminary costs	Training and supporting costs	Production supporting + efficiency improvement before the 5th year	Production supporting + efficiency improvement after the 5th year								Sales	Various	Annual	Cumul.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	2,000				7,830	230	-	725	10,785	-	10,785	-		(10,800)	(10,800)
2	400	2,500			9,840	1,550	1,410	3,525	19,225	-	19,225	875		(18,350)	(29,150)
3		2,350			6,900	640	9,525	3,600	23,015	-	23,015	10,500		(12,500)	(41,650)
4			2,200		3,310	180	15,525	4,750	25,965	-	25,965	21,000		(5,000)	(46,650)
5			1,125		-		20,140	3,900	25,165	-	25,165	31,500		6,350	(40,300)
6				250	380		21,200		21,830	-	21,830	35,000		13,175	(27,125)
7				250			21,200		21,450	500	20,950	35,175		14,225	(12,900)
8				250	780		21,900		22,930	1,000	21,930	35,280		13,350	450
9				250	-		21,900		22,150	1,200	20,950	35,350		14,400	14,850
10				250	2,130		21,900		24,280	1,400	22,880	35,420		12,550	27,400
11					-		21,900		21,900	1,500	20,400	35,455		15,050	42,450
12					780		21,900		22,680	1,500	21,180	35,490		14,300	56,750
13							21,900		21,900	1,500	20,400	35,525		15,125	71,875
14							21,900		21,900	1,500	20,400	35,525		15,125	87,000
15													11,000	11,000	98,000
Tot.	2,400	4,850	3,325	1,250	31,950	2,600	242,300	16.500	305,175	10,100	295,075	382,095	11,000		

Table 3.D : CASH FLOW FOR AN ANNUAL PRODUCTION OF 10,000 ENGINES

Amounts in 1,000 US $

Years	Foreign technical assistance				Investment costs	Training start-up costs	Production costs	Working capital	Sub-total	Savings on production costs	Total costs	Income		Cash Flow (rounded of)	
	Preliminary costs	Training and supporting costs	Production supporting + efficiency improvement									Sales	Various	Annual	Cumul
			before the 6th year	after the 5th year											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	104				380	11	-	35	530		530	-		(530)	(530)
2	20	120			475	80	68	170	933		933	42		(891)	(1,421)
3		115			335	31	460	175	1,116		1,116	505		(611)	(2,032)
4			105		160	9	750	230	1,254		1,254	1,010		(244)	(2,276
5			54		-		970	190	1,214		1,214	1,515		301	(1,975)
6				12	19		1,020		1,051		1,051	1,680		629	(1,346)
7				12	-		1,020		1,032	24	1,008	1,680		672	(674)
8				12	38		1,055		1,105	48	1,057	1,700		643	(31)
9				12	-		1,055		1,067	58	1,009	1,700		691	660
10				12	105		1,055		1,172	68	1,104	1,700		596	1,287
11					-		1,055		1,055	72	983	1,700		717	2,004
12					38		1,055		1,093	72	1,021	1,705		684	2,688
13							1,055		1,055	72	983	1,710		717	3,405
14							1,055		1,055	72	983	1,710		727	4,132
15													530	530	4,662
Tot.	124	235	159	60	1,550	131	11,673	800		486	14,246	18,357	530		

Table 5.E: CASH FLOW FOR AN ANNUAL PRODUCTION OF 20,000 ENGINES

Amounts in 1,000 Baht

Years	Foreign technical assistance				Investment costs	Training start-up costs	Production costs	Working capital	Sub-total	Savings on production costs	Total costs	Income		Cash Flow (rounded of)	
	Preliminary costs	Training and supporting costs	Production supporting + efficiency improvement									Sales	Various	Annual	Cumul
			before the 6th year	after the 5th year											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	2,250				11,685	235	-	1,200	15,370	-	15,370	-		(15,375)	(15,375)
2	650	2,500			16,890	2,345	2,250	6,200	30,835	-	30,835	1,750		(29,150)	(44,525)
3		3,570			11,735	1,175	17,500	6,600	40,580	-	40,580	21,000		(19,580)	(64,105)
4			2,950		5,560	250	29,100	9,000	46,860	-	46,860	42,000		(4,860)	(68,965)
5			1,900		-		37,600	7,000	46,500	-	46,500	63,000		16,500	(52,365)
6				250	670		39,000		39,920	-	39,920	70,000		30,100	(22,265)
7				250			39,000		39,250	1,000	38,250	70,350		32,100	9,835
8				250	1,170		40,300		41,720	2,000	39,720	70,560		30,850	40,685
9				250	-		40,300		40,550	2,400	38,150	70,700		32,550	73,135
10				250	3,420		40,300		43,970	2,800	41,170	70,840		29,700	102,835
11					-		40,300		40,300	3,000	37,300	70,900		33,600	136,435
12					1,170		40,300		41,470	3,000	38,470	70,980		32,500	168,935
13							40,300		40,300	3,000	37,300	71,050		33,750	202,685
14							40,300		40,300	3,000	37,300	71,050	20,000	33,750 20,000	236,435 256,435
Tot.	2,900	6,070	4,850	1,250	52,300	4,005	446,550	30,000	547,925	20,200	527,725	764,180	20,000		

Table 3.F · CASH FLOW FOR AN ANNUAL PRODUCTION OF 20,000 ENGINES

Amounts in 1,000 US $

Years	Foreign technical assistance				Investment costs	Training start-up costs	Production costs	Working capital	Sub-total	Savings on production costs	Total costs	Income		Cash Flow (rounded of)	
	Preliminary costs	Training and supporting costs	Production supporting + efficiency improvement									Sales	Various	Annual	Cumul
			before the 4th year	after the 5th year											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	108				562	11	-	57	738	-	738	-	-	(738)	(738)
2	31	120			812	112	107	298	1,482	-	1,482	224	-	(1,258)	(2,140)
3		171			564	56	842	317	1,950	-	1,950	1008		(942)	(3,082)
4			142		267	12	1,399	432	2,252	-	2,252	2,019		(233)	(3,315)
5			91		-		1,806	236	2,235	-	2,235	3,028		793	(2,517)
6				12	32		1,875	-	1,919	-	1,919	3,365		1,447	(1,070)
7				12	-		1,875		1,887	48	1,838	3,382		1,543	472
8				12	56		1,937		2,005	96	1,909	3,392		1,492	1,964
9				12	-		1,937		1,949	115	1,834	3,399		1,564	3,528
10				12	164		1,937		2,113	134	1,979	3,405		1,427	4,955
11					-		1,937		1,937	144	1,793	3,408		1,615	6,571
12					56		1,937		1,993	144	1,849	3,412		1,562	8,133
13							1,937		1,937	144	1,931	3,415		1,622	9,756
14							1,937		1,937	144	1,931	3,415		1,622	11,379
15													961	961	12,340
Tot.	149	291	233	60	2,513	191	21,463	1,440		969	23,690	35,724	961		

EXPLANATION OF TABLES A through F

CASH FLOWS

Columns

1	Sequential years
2,3,4,5	Corresponds with the calculations of tables N1,N2,N3 of Appendix 6
6	Investment surveys summarized in tables C1,C2,C3 of Appendix 6
7	We refer to tables G1,G2,G3 of Appendix 6
8	Corresponds with the annual production costs as calculated in tables K1,K2,K3,L1,L2,L3 of Appendix 6, taking into account increased import duties after the first five years of production for goods to be imported
9	Working capital as calculated in tables M1,M2,M3 of Appendix 6
10	Addition sum of colums 2 through 9
11	Presents the favorable influence of continued foreign technical assistance on the yearly production costs
12	Subtraction of column 11 of subtotal (column 10)
13	We refer to tables P1,P2,P3 of Appendix 6
14	Mentions values as an income in the 14th and 15th year. If the plant after 10 years of full production continues the production, these values can be considered as input-value, which of course does not represent a real cash flow. The value is calculated as follows: . 50% of the investment costs for the building . small savage values of the machinery . receipts from working capital
15	Difference between column 12 and colums 13 and 14
16	Cumulative of column 15

Table 5.G Summary total investment costs versus gross profits for a plant with an annual production of 5000 engines

Amounts in 1000 Baht

Years	Investment costs	Exploitation			Income	Gross Profits	Cash-outlay Balance (rounded of) in	
		Reinvestment + training and start-up	Annual production costs	Sub-total			1000 Baht	1000 US $
1	2	3	4	5	6	7	8	9
1	9270	240	-	240	-	(240)	(9500)	(456)
2	16295	1100	830	1930	350	(1580)	(17875)	(861)
3	6295	700	6000	6700	7850	1150	(5150)	(250)
4	3590	380	10700	11080	15700	4620	1000	54
5	1200	-	11000	11000	17500	6500	5300	252
6		630	11700	12330	17500	5170	5175	250
7		500	11450	11950	17587	5637	5650	278
8		630	11600	12230	17640	5410	5400	264
9		1250	11500	12750	17675	4925	4925	239
10		380	11350	11730	17710	5980	5975	288
11		250	11350	11600	17728	6128	6125	294
12		380	11350	11730	17745	6015	6025	288
13			11350	11350	17745	6395	6400	306
14					7000	7000	7000	330
Total	36650			126620		63110		
	US $ 1762			6087		3034		

Table 5.H Summary total investment costs versus gross profits for a plant with an annual production of 10,000 engines

Amounts in 1000 Baht

Year	Investment costs	Exploitation			Income	Gross Profits	Cash-outlay Balance (rounded of) in	
		Reinvestment + training and start-up	Annual production costs	Sub-total			1000 Baht	1000 US $
1	2	3	4	5	6	7	8	9
1	10555	230	-	230		(230)	(10800)	(530)
2	16265	1550	1410	2960	875	(2085)	(18350)	(891)
3	12850	640	9525	10165	10500	235	(12500)	(611)
4	10260	180	15525	15705	21000	5295	(5000)	(244)
5	5025	-	20140	20140	31500	11360	6350	301
6		630	21200	21830	35000	13170	13175	629
7		250	20700	20950	35175	14225	14225	672
8		1030	20900	21930	35280	13350	13350	643
9		250	20700	20950	35350	14400	14400	691
10		2380	20500	22880	35420	12560	12560	596
11		-	20400	20400	35455	15055	15050	717
12		780	20400	21180	35490	14310	14300	684
13		-	20400	20400	35525	15125	15125	717
14		-	20400	20400	35525	15125	15125	727
15					11000	11000	11000	530
Total	54955			240120		152895		
	US $ 2642			11544		7350		

Table 5.I Summary total investment costs versus gross profits for a plant with an annual production of 20,000 engines

Amounts in 1000 Baht

Years	Investment costs	Exploitation			Income	Gross Profits	Cash-outlay Balance (rounded of) in	
		Reinvestment + training and start-up	Annual production costs	Sub-total			1000 Baht	1000 US $
1	2	3	4	5	6	7	8	9
1	15135	235	-	235	-	(235)	(15375)	(738)
2	26240	2345	2250	4595	1750	(2845)	(29100)	(1258)
3	21905	1175	17500	18675	21000	2325	(19580)	(942)
4	17510	250	29100	29350	42000	12650	(4860)	(233)
5	8900	-	37600	37600	63000	25400	16500	793
6		920	39000	39920	70000	30080	30100	1447
7		250	38000	38250	70350	32100	32100	1543
8		1420	38300	39720	70560	30840	30850	1492
9		250	37900	38150	70700	32550	32550	1564
10		3670	37550	41170	70840	29670	29700	1427
11		-	37300	37300	70900	33600	33600	1615
12		1170	37300	38470	70980	32510	32500	1562
13			37300	37300	71050	33750	33750	1622
14			37300	37300	71050	33750	33750	1622
15					20000	20000	20000	961
Total	89690			438035		346145		
	US $ 4312			21059		16641		

EXPLANATION OF TABLES G through I

SUMMARY TOTAL INVESTMENT COSTS VERSUS PROFITS

Columns

1 Sequential years

2 Addition sum of: investment costs (items 10 of tables C1,C2,C3 of Appendix 6)

foreign technical assistance (tables N1,N2,N3 of Appendix 6) up to the 5th year inclusive

working capital (tables M1,M2,M3 of Appendix 6)

3 Addition sum of: reinvestment costs as per items 9 of tables C1,C2,C3 of Appendix 6)

training and start-up costs (as per tables G1,G2,G3 of Appendix 6)

foreign technical assistance after the 5th year (tables N1,N2,N3 of Appendix 6)

4 Annual production costs as specified in tables K1,K2,K3,L1,L2,L3 of Appendix 6

5 Addition sum of colums 3 and 4

6 Annual sales income as estimated in tables P1,P2,P3 of Appendix 6

7 Subtraction of colums 6 and 5

8 Difference between colums 2 and 7

9 Idem in US$

Table 5.K : Positive and Negative Effects on the Current Account of Thai's Balance of payments for a plant with an annual production of 5000 engines

Year	Negative Effects			Positive Effects	Net balance of			
	Foreign payments			Earnings	in 1000 Baht		in 1000 US $	
	Technical foreign assistance	Investments	Parts and accessories for the production	imports of combustion engines	Positive Effects	Negative Effects	Positive Effects	Negative Effects
1	2	3	4	5	6	7	8	9
1	1860	4710	-	-		6570		315
2	3000	5495	150	275		8370		402
3	2350	285	1800	6300	1865		89	-
4	1715		2600	12000	7685		369	-
5	1125	-	3900	14000	8975		431	-
6	250	-	4200	14000	9550		459	-
7	250	200	4200	14000	9050		449	-
8	250	-	4200	14100	9650		463	-
9	250	600	4200	14100	9050		435	-
10			4200	14125	9925		477	-
11		200	4200	14150	9750		468	-
12			4200	14175	9975		479	-
13			4200	14200	10000		480	-
Total	11050	11490	42050	145425	95775	14940	4599	717

Table 5.L Positive and Negative Effects on the Current Account of Thai's Balance of payments for a plant with an annual production of 10000 engines

Years	Negative Effects			Positive Effects	Net balance of			
	Foreign payments			Earnings	in 1000 Baht		in 1000 US $	
	Technical foreign assistance	Investments	Parts and accessories for the production	no more imports of combustion engines	Positive Effects	Negative Effects	Positive Effects	Negative Effects
1	2	3	4	5	6	7	8	9
1	2000	4330	-	-		6330		304
2	2900	5840	250	700		8290		398
3	2350	5300	3400	8500		2550		122
4	2200	2430	5200	17000	7170		344	
5	1125	-	7700	25000	16175		777	
6	250	-	8350	28000	19400		932	
7	250	-	8350	28000	19400		932	
8	250	300	8350	28200	19300		930	
9	250	-	8350	28275	19675		945	
10	250	1130	8350	28350	18620		895	
11		-	8350	28400	20050		963	
12		300	8350	28450	19800		951	
13			8350	28500	20150		968	
14			8350	28500	20150		968	
Total	11825	19630	91700	305875	199800	17170	9605	824

Table 5.N Positive and Negative Effects on the Current Account of Thai's Balance of payments for a plant with an annual production of 20,000 engines

Years	Negative Effects			Positive Effects	Net balance of			
	Foreign payments			Earnings	in 1000 Baht		in 1000 US $	
	Technical foreign assistance	Investments	Parts and accessories for the production	no more imports of combustion engines	Positive Effects	Negative Effects	Positive Effects	Negative Effects
1	2	3	4	5	6	7	8	9
1	2250	5285	-	-		7535		362
2	3150	9990	375	1400		12115		582
3	3570	8770	6500	17500		1340		64
4	2950	4090	9000	34000	17960		863	
5	1900	-	14600	50000	33500		1610	
6	250	-	16100	56000	39650		1906	
7	250	-	16100	56000	39650		1906	
8	250	450	16100	56400	39600		1900	
9	250	-	16100	56550	40200		1932	
10	250	1600	16100	56700	39750		1862	
11		-	16100	56800	40700		1956	
12		450	16100	56900	40350		1939	
13			16100	57000	40900		1965	
14			16100	57000	40900		1965	
Total	15070	30635	175375	612250	412160	20990	19804	1008

EXPLANATION OF TABLES K through M

Positive and Negative Effects on the Current Account of Thailand's Balance of Payment

Columns

1 Sequential years

2

3

4 Foreign payments (negative effects)
see tables N1,N2,N3 of Appendix 6 for:

- investments as per tables C1,C2,C3 of Appendix 6
- parts and accessories for the production (estimates)

5 Owing to reduced imports of combustion engines, Thailand earns foreign currency (positive effect). The amounts are calculated from the annual sales minus 20% for import costs in Thailand

6

7

8 Net balance of positive and negative effects

9

Table 5.N : Economic effects of manufacturing in Thailand combustion-engines with an annual production of 5,000 engines

Amounts in 1,000 Baht/US $

	Negatif		Positif			
Years	Negative effects on the current account of Thailands balance of payments	Decrease of import-duties & import handling	Positive effects on the current account of Thailards balance of payments	Added value of the plant	Social benefits due to manufacturing in Thailand	Import-duties & handling on parts, accessories
1	2	3	4	5	6	7
1	6,570	-		-	P.M.	
2	8,370	125		-	P.M.	
3		1,000	1,865	2,100	P.M.	
4	-	2,000	7,685	5,200	P.M.	
5	-	3,200	9,000	9,000	P.M.	
6	-	3,500	9,600	10,000	P.M.	
7	-	3,600	9,400	10,000	P.M.	550
8	-	3,550	9,600	10,100	P.M.	600
9	-	3,550	9,000	10,200	P.M.	750
10	-	3,550	9,900	10,400	P.M.	850
11	-	3,550	9,900	10,400	P.M.	850
12	-	3,550	10,000	10,400	P.M.	850
13	-	3,550	10,000	10,400	P.M.	850
14	-					
Total Baht	14,940	34,725	95,950	98,200		5,300
US $	715	1,670	4,600	4,725		255

Table 5.0: ECONOMIC EFFECTS OF MANUFACTURING IN THAILAND COMBUSTION-ENGINES WITH AN ANNUAL PRODUCTION OF 10,000 ENGINES

Amounts in 1,000 Baht/US $

Years	Negatif		Positif			
	Negative effects on the current account of Thailands balance of payments	Decrease of import-duties & import handling	Positive effects on the current account of Thailands balance of payments	Added value of the plant	Social benefits due to manufacturing in Thailand	Import-duties & handling on parts, accessories
1	2	3	4	5	6	7
1	6,330	-		-	P.M.	
2	8,290	175		-	P.M.	
3	2,550	2,000		4,225	P.M.	
4	-	4,000	7,170	10,500	P.M.	
5	-	6,500	16,175	18,100	P.M.	
6	-	7,000	19,400	20,500	P.M.	
7	-	7,175	19,400	20,700	P.M.	1,000
8	-	7,080	19,300	20,800	P.M.	1,250
9	-	7,075	19,675	20,900	P.M.	1,500
10	-	7,070	18,620	21,000	P.M.	1,700
11	-	7,055	20,050	21,000	P.M.	1,700
12	-	7,040	19,800	21,000	P.M.	1,700
13	-	7,025	20,150	21,000	P.M.	1,700
14	-	7,025	20,150	21,000	P.M.	1,750
15						
Tot. Baht	17,170	76,220	199,490	220,725		12,300
US $	822	3,760	9,600	10,600		590

Table 5.P.: ECONOMIC EFFECTS OF MANUFACTRRING IN THAILAND COMBUSTION-ENGINES WITH AN ANNUAL PRODUCTION OF 20,000 ENGINES

Amounts in 1,000 Bahts/US $

	Negatif		Positif			
Years	Negative effects on the current account of Thailands balance of payments	Decrease of import-duties & import handling	Positive effects on the current account of Thailands balance of payments	Added value of the plant	Social benefits due to manufac-turing in Thailand	Import-duties & handling on parts, accessories
1	2	3	4	5	6	7
1	7,535	-		-	P.M.	
2	12,115	350		-	P.M.	
3	1,340	3,500		8,600	P.M.	
4	-	8,000	17,960	21,200	P.M.	
5	-	13,000	33,500	36,500	P.M.	
6	-	14,000	39,650	42,000	P.M.	
7	-	14,350	39,650	42,300	P.M.	2,000
8	-	14,160	39,600	42,600	P.M.	2,400
9	-	14,150	40,200	42,700	P.M.	2,800
10	-	14,140	38,750	42,800	P.M.	3,200
11	-	14,100	40,700	42,900	P.M.	3,200
12	-	14,080	40,350	43,000	P.M.	3,200
13	-	14,050	40,900	43,000	P.M.	3,200
14	-	14,050	40,900	43,000	P.M.	3,200
15						
Total Baht	20,990	151,930	412,160	450,600		23,200
US $	1,005	7,280	19,800	21,550		1,115

EXPLANATION OF TABLES N through P

Economic Effects of Manufacturing Combustion Engines in Thailand

Columns

1 Sequential years

2 + 4 We refer to table K through M on the Current Account of Thailand's Balance of Payments

3 If combustion engines are manufactured in Thailand, imports of engines will decrease and also import handlings. For our calculations we have assumed the decrease to be 20 percent of estimated sales as per tables P1, P2, P3 of Appendix 5

5 Sum of added value: annual difference between sales value and estimated purchase price for raw materials, spare parts, accessories, various materials, energy, license rights.

6 We have not taken into account the non-qualified secondary positive effects. These will however be considerable

7 During the first years of operation the plant will be free from import taxes on imported engine spare parts. After the sixth year however we expect that these duties will have to be paid. Hence this will mean extra income for the Government.

Appendix 6

Elements for the Financial and Economic Analysis

as Described in Chapter 3 and Computed in Appendix 5

APPENDIX: ELEMENTS FOR THE FINANCIAL AND ECONOMIC ANALYSIS

This appendix deals with the detailed calculations of the basic figures for the feasibility study described in chapter 5, namely:

- the cash flows,
- the summaries: total investment costs versus profits,
- investment and return ratios,
- economic effects.

For this purpose the different project costs and revenues will be examined for the 3 alternatives, as described in the text:
Plants annually manufacturing respectively - 5,000
10,000
20,000 combustion-engines.

Project costs and revenues

This appendix will deal with the following aspects:

Costs

a. the investment-costs,
b. the annual exploitation or operating costs,
c. the necessary funds for working-capital,
d. the costs of foreign technical assistance,
e. summary of the costs.

Revenues

The income from sales of the manufactured combustion-engines.

Costs

Ad a - the investment-costs

In the Appendix and preceding chapters a description is given of the plant lay-outs.

We recapitulated the different investment costs in the following tables:

Table A gives the purchasing prices and construction costs for the land and buildings.

We estimated for the two smaller plants the same land area, as we suppose that the plant with the smallest annual capacity will have to extend in the course of the years to an annual capacity of 10,000 combustion-engines.
Apart from that, we recommend: either to take the refusal of a larger piece of land or, if that should be impossible, to buy a larger land area.

Tables B1, B2 and B3 show the specification of the proposed investments during the first years specified for machinery, equipment, land and buildings excluding local erecting costs.

We estimate moreover a certain amount for buying the rights for manufacturing the combustion-engines, inclusive the preparation and negotiation costs.

Tables C1, C2 and C3 show the annual payments of the investments as per tables B1, B2 and B3 just as of the amounts for order-supervision, erecting costs and the reinvestments during the project's life. The order-supervision has been estimated at about 10% of item's 1,22 of tables B1, B2 and B3.

Ad b - the annual exploitation or operating costs

b1 The annual labor costs

Tables D1, D2 and D3 show a concise barchart of the personnel for the plants in question, whereas tables E1, E2 and E3 specify the personnel.
In tables F1, F2 and F3 are the annual labor costs calculated for the period that the plants are in full production.

b2 The local labor costs for training and the start-up of the project

The labor costs during

- the training and start-up period
- the preliminary stage of the production

have been calculated in the tables: G1, G2 and G3
H1, H2 and H3

The wages are based on initial salaries. The estimated man-months are based on modern training techniques.

b3 The annual production costs

The breakdown of these costs is as follows:

- material costs
- maintenance and reparation costs
- fuel, lubricants and energy
- office-expenses
- license-rights
- labor costs
- production losses

The material costs have been specified in Table I, whereas the other cost-elements have been specified in Tables K1, K2 and K3.

The license-rights can only be determined after future negotiations. As can be seen from tables B1, B2 and B3 and K1, K2 and K3 we propose an immediate payment at the moment the bargain is negotiated and next annual payments during the project life on base of the annually sold combustion-engines.
Table K4 shows the estimated annual exploitation costs including the estimated depreciation.

The annual production costs during the preliminary stages of the production (phases A, B and C) are shown in Tables L1, L2 and L3.

Ad c - the necessary funds for working capital

Tables M1, M2 and M3 are self explanatory. For sales promotion and production start, we strongly recommend to start at an earlier date. If the type to be built in Thailand is still available with the eventual present holder of the manufacturing rights, it is necessary to build up an operating stock for the first and second years.

Ad d. Foreign Technical Assistanve

For the : construction of the buildings
lay-out
start-up of the plant
erection of the machinery
training of the personnel
supporting of the production
organizational set-up
efficiency-improvement

we strongly advise to incorporate in the plant foreign technical assistance from the beginning and for several years to follow.

It is obvious, that the costs of this foreign technical assistance will differ dependent on the size of the plant.

The tables N1, N2 and N3 show our estimations.

We distinguish three sequences of activities:

Preparational phase, mainly in the first year

- making a network planning scheme for the whole project
- selection and appointments of personnel
- drafting factory-lay-out
  machine conditions
  material qualifications
- preparing the tender documents and builder's estimate
- selection of the quotations and ordering of the buildings, machinery, parts, equipment
- drafting material qualifications, technical conditions, selection of suppliers for the non-machine engineparts and assembling parts, their ordering and delivery
- starting with the training procedures.

Training and start-up phase during the 2nd and 3rd year

In conjunction with the above mentioned activities this phase consists mainly of the two major activities:

- finishing of the building construction
  erecting the machinery
- selection and training of the required personnel and starting the production (phase A and partly phase B).

Production phase

This phase concentrates on:

. reaching the production goals in the shortest possible periods regarding: capacity
efficiency
quality

The several phases characterised in the concise barchart as given in chapter 5.

Ad e. Summary of the project-costs

Tables 01, 02 and 03 show the different costs, recorded in the tables A - N and discussed in the preceding paragraphs.

In chapter 5 we discussed the difference between the smallest project with an annual production of 5,000 combustion-engines and the two larger ones with an annual production of 10,000 and 20,000 units regarding the periods of the preliminary stages and the total project periods.
Summarized:

	annual production of combustion engines:		
	5,000	10,000	20,000
building construction erecting the machines selection of personnel start with the training	during the 1st + 2nd year	idem	idem
Start with the production in the last quarter of the	second year	idem	idem
production phase A	third year	idem	idem
production phase B	third year	fourth year	fourth year
production phase C	fourth year	fifth year	fifth year
full production in the	fifth year	sixth year	sixth year
end of the project life	thirtheeth year	fourteenth year	fourteenth year

In tables 01, 02 and 03 the total expenses during the total project-period are divided in expenses in local and foreign currency.

Revenues

The income for the plants from the annual sales

The survey of the market and the technical possibilities resulted in a certain type of combustion engine, as was detailed in the preceding chapters.
The selling prices were concluded from the received information and investigations during the time the team visited Thailand.
Thence we can estimate the annual sales-income as shown in tables P1, P2 and P3.

Table A : Land and building costs for plants manufacturing combustion-engines

Plant with an annual production of combustion engines	5,000	10,000	20,000
Landarea in Rai	3.75	3.75	6.25
in m2	6000	6000	10000
Purchasing price A1 in Baht	1,125,000	1,125,000	1,875,000
in US $	55,000	55,000	92,000
Buildings comprising: workshop, storage, offices in m2	3000	4500	7500
construction price A2 in Baht	4,200,000	6,300,000	10,500,000
in US $	202,000	303,000	505,000

A1 based on a price of 300.000 Baht per Rai (1HA = 6.25 Rai)

A2 based on a price of 1400 Baht per m2 including floors, lighting, conduits for water and electricity

TABLE B 1 : SPECIFICATION OF THE PROPOSED INVESTMENTS DURING THE FIRST YEARS, EXCLUDING LOCAL ERECTING COSTS, FOR AN ANNUAL PRODUCTION OF 5,000 ENGINES

Description	Unit-prices in 1,000 Baht	Number of units	in 1,000 Bahts			in 1,000 US$		
			Total	Foreign currency	Local currency	Total	Foreign currency	Local currency
1	2	3	4	5	6	7	8	9
1. Machinery								
1.1. surface grinder	200	1	200					
1.2. universal internal grinder	200	2	400					
1.3. universal grinder	200	2	400					
1.4. universal milling mach.	120	20	2400					
1.5. universal lathe	65	10	650					
1.6. small lathe	30	15	450					
1.7. sliding head automatic	300	-	-					
1.8. drilling mach. 1 spindle	20	10	200					
1.9. drilling mach. multi "	50	5	250					
1.10. compressor	25	1	25					
1.11. heat-treatment apparatuses	50	1	50					
1.12. water-brakes	30	3	90					
1.13. control and test-apparatuses			100					
Various								
1.14. pallets, truck, tables, bins, etc.			175					
1.15. jigs and fixtures			600					
1.16. tools/equipment for the operator			70					
1.17. motortruck	200	1	200					
1.18. cars	90	2	180					
1.19. office equipment			150					
1.20. divers			300					
1.21. spareparts			110					
1.22. subtotal (1)			7000	6300	700	336	302	34
2.1. Land			1125	-	1125	55	-	55
2.1. Buildings			4200	500	3700	202	24	178
subtotal (2)			5325	500	4825	257	24	233
3. Purchase of licence			2080	2080		100	100	
4. Contingencies and price-increases			1595	1000	595	76	48	28
5. Total investment-costs (excluding local erecting costs)			16000	9380	6120	769	474	295

TABLE B. : SPECIFICATION OF THE PROPOSED INVESTMENTS DURING THE FIRST YEARS, EXCLUDING LOCAL ERECTING COSTS, FOR AN ANNUAL PRODUCTION OF 10,000 ENGINES

Description	Unit-prices in 1,000 Baht	Number of units	in 1,000 Bahts			in 1,000 US$		
			Total	Foreign currency	Local currency	Total	Foreign currency	Local currency
1	2	3	4	5	6	7	8	9
1. Machinery								
1.1. surface grinder	200	2	400					
1.2. universal internal grinder	200	4	800					
1.3. universal grinder	200	4	800					
1.4. universal milling mach.	120	35	4200					
1.5. universal lathe	65	15	975					
1.6. small lathe	30	29	870					
1.7. sliding head automatic	300	1	300					
1.8. drilling mach. 1 spindle	20	15	300					
1.9. drilling mach. multi "	50	10	500					
1.10. compressor	25	1	25					
1.11. heat-treatment apparatuses	50	1	50					
1.12. water-brakes	30	6	180					
1.13. control and test-apparatuses			150					
Various:								
1.14. pallets, truck, tables, bins, etc.			250					
1.15. jigs and fixtures			1150					
1.16. tools/equipment for the operator			130					
1.17. motortruck	200	1	200					
1.18. cars	90	2	180					
1.19. office equipment			175					
1.20. divers			490					
1.21. spareparts			200					
1.22. subtotal (1)			12325	11095	1230	592	533	59
2.1. Land			1125	-	1125	55	-	55
2.1. Buildings			6300	700	5600	303	33	270
subtotal (2)			7425	700	6725	358	33	325
3. Purchase of licence			2080	2080		100	100	
4. Contingencies and price-increases			3170	1970	1200	152	94	58
5. Total investment-costs (excluding local erecting costs)			25000	15845	9155	1202	76	441

TABLE 8a : SPECIFICATION OF THE PROPOSED INVESTMENTS DURING THE FIRST YEARS, EXCLUDING LOCAL ERECTING COSTS, FOR AN ANNUAL PRODUCTION OF 20,000 ENGINES

Description	Unit-prices in 1,000 Baht	Number of units	in 1,000 Bahts			in 1,000 US$		
			Total	Foreign currency	Local currency	Total	Foreign currency	Local currency
1	2	3	4	5	6	7	8	9
1. Machinery								
1.1. surface grinder	200	4	800					
1.2. universal internal grinder	200	7	1400					
1.3. universal grinder	200	7	1400					
1.4. universal milling mach.	120	60	7200					
1.5. universal lathe	65	30	1950					
1.6. small lathe	30	47	1410					
1.7. sliding head automatic	300	3	900					
1.8. drilling mach. 1 spindle	20	25	500					
1.9. drilling mach. multi "	50	50	1000					
1.10. compressor	25	1	25					
1.11. heat-treatment apparatuses	50	1	50					
1.12. water-brakes	30	12	360					
1.13. control and test-apparatuses			200					
Various								
1.14. pallets, truck, tables, bins, etc.			350					
1.15. jigs and fixtures			1900					
1.16. tools/equipment for the operator			200					
1.17. motortruck	200	2	400					
1.18. cars	90	3	270					
1.19. office equipment			200					
1.20. divers			710					
1.21. spareparts			400					
1.22. subtotal (1)			21625	19450	2175	1039	935	104
2.1. Land			1875	-	1875	92	-	92
2.1. Buildings			10500	1250	9250	505	60	445
subtotal (2)			12375	1250	11125	597	60	537
3. Purchase of licence			2080	2080		100	150	
4. Contingencies and price-increases			4920	3000	1920	236	144	92
5. Total investment-costs (excluding local erecting costs)			41000	25780	15220	1972	1239	733

Explanation of Tables B1 - B2 and B3

Specifications of the proposed investments during the first years excl. local erecting costs

Col 1: description of the several investment-items

Col 2: Unit-prices of the investment-items
These unit-prices are:
the factory prices plus:
seafreight, insurances, transportcosts from the supplier to the ship and from the harbour in Thailand to the plant, harbour-handlingcosts, including reduced importtaxes and duties as specified in the promotion of industrial investment act.

Col 3: The total number of proposed units

Col 4 and 7: The total purchase-prices local storage of the proposed plant

Col 5 and 8: Foreign currency - quote parts of col 4 and 7

Col 6 and 9: Local currency - quote parts of col. 4 and 7

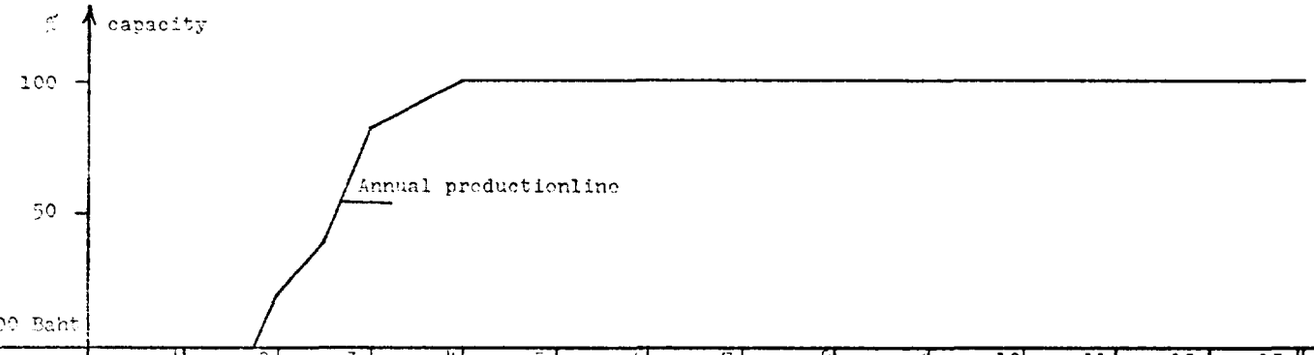
Item 1.21: About 2% of the total of the items 1.1 - 1.13

Items 2.1 and 2.2 We refer to table A

Item 3: This amount is an assumption

Item 4: About 15% of the total op the subtotales (1) plus (2)

TABLE C1: PAYMENT-SCHEME OF THE INVESTMENTS FOR AN ANNUAL PRODUCTION OF 5,000 ENGINES

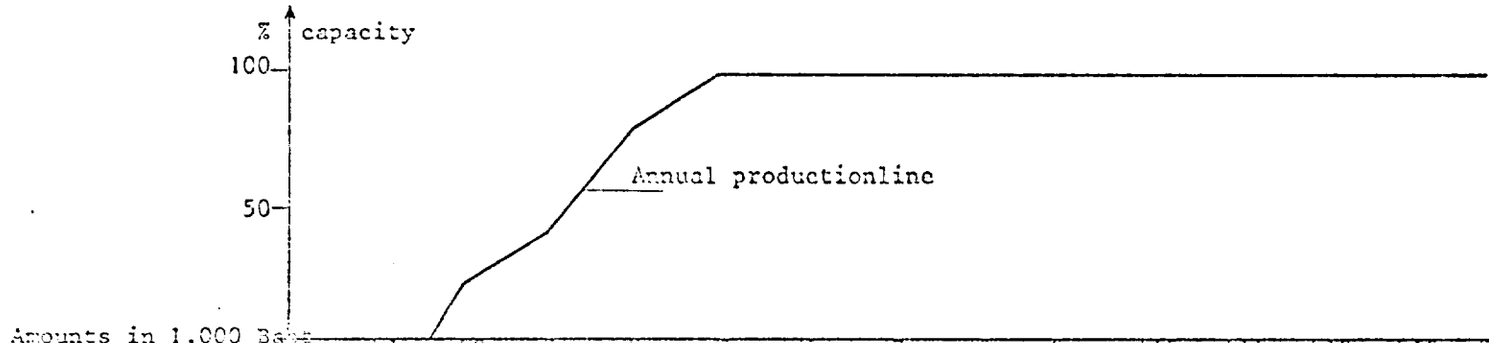


Amounts in 1,000 Baht

years

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total 1,000 Baht	Total 1,000 US $
1. Land	1,125													1,125	55
2. Buildingconstruction	1,400	2,800												4,200	202
3. Machinery															
phase A	900	1,900												2,800	134
" B	800	1,650												2,450	117
" C		600	1,150											1,750	85
4. Purchase of licence	2,080													2,080	100
5. Contingencies + price-increases	400	1,000	195											1,595	76
6. Sub-total	6,705	7,950	1,345											16,000	769
7. Orderssupervision	150	300	250											700	33
8. Erecting costs	55	245	400											700	33
9. Re-investments				380		380	250	380	1,000	380	250	380		3,400	163
10. Total-investments	6,910	8,495	1,995	380		380	250	380	1,000	380	250	380		20,800	998
11. Foreign currency quote-part	4,710	5,495	285				200		600		200			11,490	552

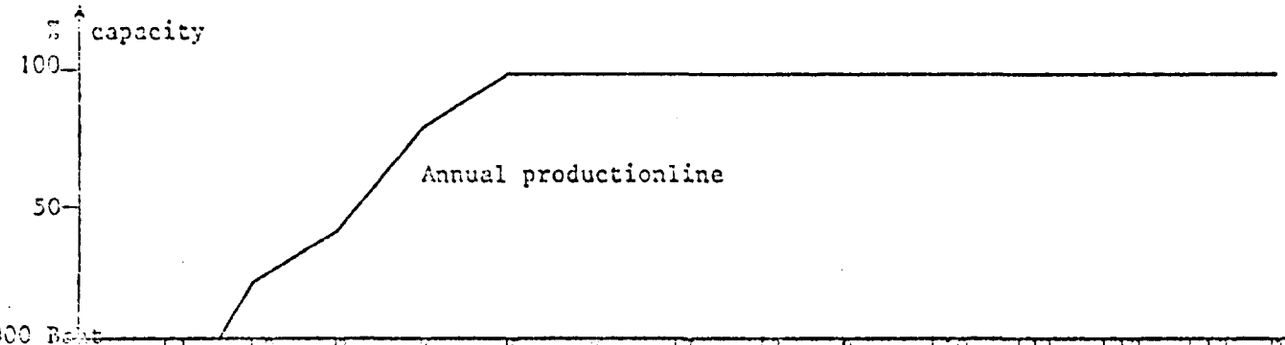
Table C 2: PAYMENT-SCHEME OF THE INVESTMENTS FOR AN ANNUAL PRODUCTION OF 10,000 ENGINES



Amounts in 1.000 Baht

	1	2	3	4	5	6	7	8	9	10	11	12	13	14 years Total 1,000 Baht	1,000 US $
1. Land	1125													1125	54
2. Buildingconstruction	2100	3000	1200											6300	303
3. Machinery															
phase A	1700	2300												5000	240
" B		1500	2800											4300	206
" C			1000	2025										3025	146
4. Purchase of licence	2080													2080	100
5. Contingencies + price-increases	730	1100	950	490										3170	152
6. Sub-total	7735	8900	5950	2445										25000	1202
7. Supervision	125	500	450	175										1250	60
8. Erecting costs	-	440	500	310										1250	60
9. Re-investments				380		380		780		2130		780		4450	213
10. Total investments	7930	9840	6900	3310		380		780		2130		780		31950	1535
11. Foreign currency quote-part	4330	5840	5300	2430				300		1100		300		19630	943

Table C 9 : PAYMENT-SCHEME OF THE INVESTMENTS FOR AN ANNUAL PRODUCTION OF 20,000 ENGINES



Amounts in 1,000 Baht

	1	2	3	4	5	6	7	8	9	10	11	12	13	14 years Total 1,000 Baht	14 years Total 1,000 US $
1. Land	1673													1673	82
2. Buildingconstruction	3500	3000	2000											10500	525
3. Machinery															
phase A	3000	6000												9000	450
" B		2500	5000											7500	380
" C			1700	3425										5125	246
4. Purchase of licence	2080													2080	100
5. Contingencies + Price-increases	1020	1800	1500	600										4920	236
6. Sub-total	11273	13300	10200	4025										40798	1973
7. Supervision	210	840	735	315										2100	100
8. Erecting costs	-	750	800	550										2100	100
9. Re-investments				670		670		1170		3420		1170		7100	341
10. Total investments	11483	14890	11735	5560		670		1170		3420		1170		52898	2514
11. Foreign currency quote-part	5283	9970	8775	4020				450		1600		450		30635	1472

Explanation of Tables C1 - C2 and C3

Payment-schemes of the Investments

Item 1:
2:
3:
4:
5:
} See Tables B1 - B2 and B3 Items 1 - 2 - 3 - 4

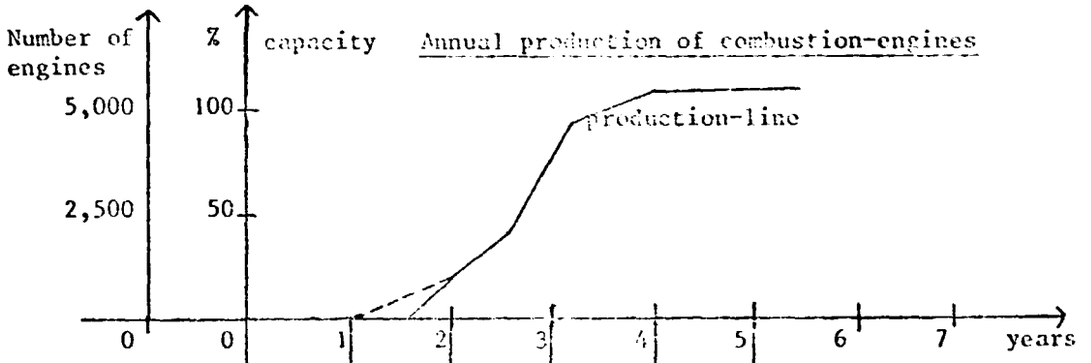
The total amounts of those items have been spread over those years, in which the payments may be expected.

7: This ordersupervision comprises:
check on the exact execution of the ordered machinery and spare-parts, dates of delivery, packing, arranging the shipping lines and shipping times.

8: The erecting and connection costs of the machinery, equipment, installations

9: Items 1.17 and 1.18 of the tables B1 - B2 and B3 will be replaced every two years, whereas items 1.14 - 1.15 - 1.16 and approx. 50% of 1.20 will be replaced every 5 years.

Table DI: Concise Barchart of personnel



Barchart personnel:

	Total number
General manager	1
Production manager	1
Accounting manager	1
Purchasing manager	1
Sales manager	1
Personnel manager	1
Receptioniste - Telefoniste	1
Administration ind.planning	5
Secretaries	6
Staff-engineer	1
Training-engineer	1
Milling	20
Turning	25
Drilling	15
Grinding	5
Fitting	20
Foremen	9
Overseen	1
Assembling	18
Contracting and testing	3
Quality-control	3
Spraying and packing	3
Warehousing	3
Workshop	4
Various - unskilled	10
- skilled	5
Reserve	4
Foremen	4
Overseer	2
Department-chief	1

Table D 2: CONCISE BARCHART OF PERSONNEL

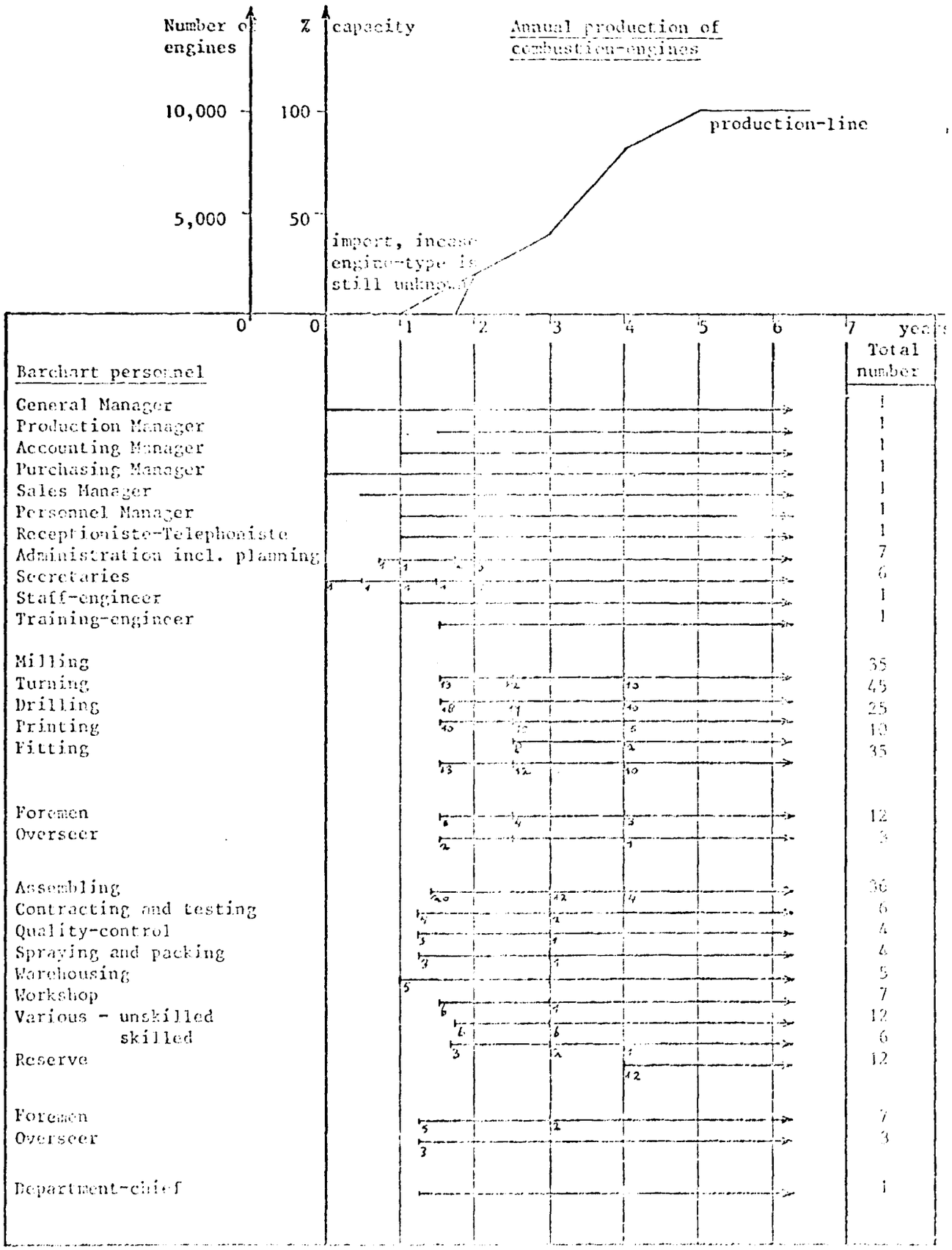


Table B3 : CONCISE BARCHART OF PERSONNEL

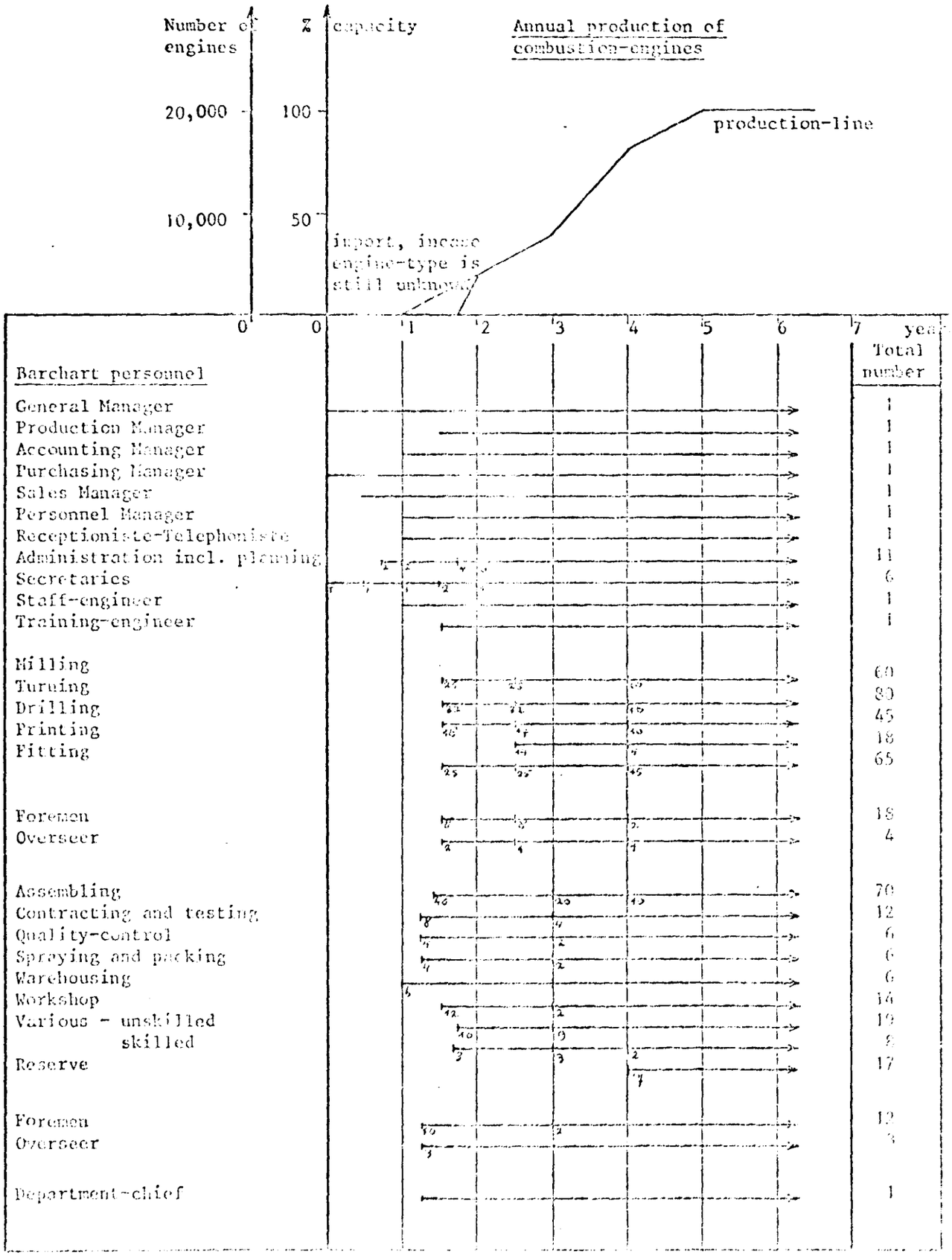


Table E1 Number of personnel required for an annual production of 5000 engines

Processes	FUNCTIONS							
	operators		foremen	overseer	depart-ment chief	Total	direct produc-tive	indirect produc-tive
	un-skilled	skilled						
1	2	3	4	5	6	7	8	9
Milling		20	2				22	
Turning		25	2				27	
Drilling		15	2				17	
Grinding		5	1				6	
Fitting		20	2	1			23	
Assembling		16	2	1			21	
Contracting/testing		3	1					4
Quality-control		3						3
Spraying and packing		3					3	
Warehousing		3						3
Workshop		4		1				5
Various	10	5			1			16
Reserve		4	1				5	
Sub-total (1)	10	125	13	3	1	155	124	31
OVERHEAD:								
General manager						1		1
Production manager						1		1
Accounting manager						1		1
Administration incl. planning						5		5
Purchasing manager						1		1
Sales manager						1		1
Personnel manager						1		1
Receptionist - telephonist						1		1
Staff-engineer						1		1
Secretaries						6		6
Training-engineer						1		1
Sub-total (2)						20		20
Total (1) + (2)	10	125	13	3	1	175	124	51

Table E2 Number of personnel required for an annual production of 10,000 engines

Processes	FUNCTIONS							
	operators		foremen	overseer	depart-ment chief	Total	direct produc-tive	indirect produc-tive
	un-skilled	skilled						
1	2	3	4	5	6	7	8	9
Milling		35	3	1		39	39	
Turning		45	3	1		49	49	
Drilling		25	2			27	27	
Grinding		10	1			11	11	
Fitting		35	3	1		39	39	
Assembling		36	3	1		40	40	
Contracting/testing		6	1			7		7
Quality-control		4	1			5		5
Spraying and packing		4	1			5	5	
Warehousing		5				5		5
Workshop		7		1		8		8
Various	12	6			1	19		19
Reserve		12	1	1		14	12	2
Sub-total (1)	12	230	19	6	1	268	222	46
OVERHEAD								
General manager						1		1
Production manager						1		1
Accountong manager						1		1
Administration incl. planning						7		7
Purchasing manager						1		1
Sales manager						1		1
Personnel manager						1		1
Receptionist - telphonist						1		1
Staff-engineer						1		1
Secretaries						6		6
Training engineer						1		1
Sub-total (2)								22
Total (1) + (2)	12	230	19	6	1	290	222	68

Table E3 Number of personnel required for an annual production of 20,000 engines

Processes	FUNCTIONS							
	operators		foremen	overseer	depart-ment chief	Total	direct produc-tive	indirect produc-tive
	un-skilled	skilled						
1	2	3	4	5	6	7	8	9
Milling		60	4	1			65	
Turning		80	4	1			85	
Drilling		45	3	1			49	
Grinding		18	1				19	
Fitting		65	6	1			72	
Assembling		70	6	1			77	
Contracting/testing		12	1					13
Quality-control		6	1					7
Spraying and packing		6	1				7	
Warehousing		6	1					7
Workshop		14		1				15
Various	19	8			1			28
Reserve		17	2	1			17	3
Sub-total (1)	19	407	30	7	1	464	391	73
OVERHEAD								
General Manager						1		1
Production manager						1		1
Accounting manager						1		1
Administration incl. planning						11		11
Purchasing manager						1		1
Sales manager						1		1
Personnel manager						1		1
Receptionist - telephonist						1		1
Staff-engineer						1		1
Secretaries						6		6
Training-engineer						1		1
Sub-total (2)						26		26
Total (1) + (2)	19	407	30	7	1	490	391	99

Table F1 : Annual labour costs of a plant for producing 5,000 engines per year, beginning in the 4th year

Costs in 1,000 Bahts

Function	number of personnel	Indirect costs		Direct costs		total costs
		wages and salaries per year	sub-total	wages and salaries per year	sub-total	
1	2	3	4	5	6	7
Overhead						
General manager	1	120	120			
Production manager	1	84	84			
Accounting manager	1	60	60			
Purchasing manager	1	36	36			
Sales manager	1	48	48			
Administration incl. planning	5	10	50			
Secretaries	6	18	108			
Receptionist-telefonist	1	12	12			
Staff engineer	1	72	72			
Training engineer	1	48	48			
Personnel manager	1	48	48			
Sub total (1)	20		686			686
Factory handworkers:						
Operators - unskilled	10			7.2	72	
skilled	128			16.8	2,150	
Foremen	13			21	273	
Overseer	3			30	90	
Department chiefs	1			36	36	
Sub total (2)	159				2,621	2,621
Total (1) + (2)	179					3,307
Supplementary provisions						
5,000 Baht per man per year			100		775	875
Total annual labour costs						
in 1,000 Baht			786		3,396	4,182
in 1,000 US $						201

Table F2 : Annual labour costs of a plant for producing 10,000 engines per year, beginning in the 5th year

Costs in 1,000 Bahts

Function	number of personnel	Indirect costs		Direct costs		total costs
		wages and salaries per year	sub-total	wages and salaries per year	sub-total	
1	2	3	4	5	6	7
Overhead						
General manager	1	120	120			
Production manager	1	84	84			
Accounting manager	1	60	60			
Purchasing manager	1	36	36			
Sales manager	1	48	48			
Administration incl. planning	7	10	70			
Secretaries	6	18	108			
Receptionist-telefonist	1	12	12			
Staff engineer	1	72	72			
Training engineer	1	48	48			
Personnel manager	1	48	[illegible]			
Sub total (1)	22		706			706
Factory handworkers:						
Operators - unskilled	12			7.2	86.4	
skilled	230			16.8	3,864	
Foremen	19			21	399	
Overseer	6			30	180	
Department chiefs	1			36	36	
Sub total (2)	268				4,565.4	4,565.4
Total (1) + (2)	290					5,271.4
Supplementary provisions						
5,000 Baht per man per year			110		1,340	1,450
Total annual labour costs						
in 1,000 Baht			816		5,905	6,722
in 1,000 US $						323

Table F 3 : Annual labour costs of a plant for producing 20,000 engines per year, beginning in the 5th year

Costs in 1,000 Bahts

Function	number of personnel	Indirect costs		Direct costs		total costs
		wages and salaries per year	sub-total	wages and salaries per year	sub-total	
1	2	3	4	5	6	7
Overhead						
General manager	1	120	120			
Production manager	1	84	84			
Accounting manager	1	60	60			
Purchasing manager	1	36	36			
Sales manager	1	48	48			
Administration incl. planning	11	10	110			
Secretaries	6	18	108			
Receptionist-telefonist	1	12	12			
Staff engineer	1	72	72			
Training engineer	1	48	48			
Personnel manager	1	60	60			
Sub total (1)	26		798			798
Factory handworkers:						
Operators - unskilled	19			7.2	136.8	
skilled	407			16.8	6,837.6	
Foremen	30			21	630	
Overseer	7			30	210	
Department chiefs	1			36	36	
Sub total (2)	464				7,850.4	7,850.4
Total (1) + (2)	490					8,649
Supplementary provisions						
5,000 Baht per man per year			130		2,320	2,450
Total annual labour costs						
in 1,000 Baht			888		10,171	11,099
in 1,000 US $						531

Explanation of Tables F1 - F2 and F3

Annual labour costs of the plants by optimum production

Col 1: The several functions to fill in the plants according the concise barcharts of Tables D1 - D2 and D3 and Tables E1 - E2 and E3, number of personnel.

2: The number of personnel

3/4: The indirect costs

5/6: The direct costs

3 and 5: The wages/salaries per year per man

7: The addition of col. 4 and 6

The supplementary provisions have to cover:

- medical care
- contributions to house rents
- lunches during the working-days

Table G1 : Training and start-up costs of local labour for an annual production of 5,000 engines

	man-months in the			in 1,000 Bahts					
				salary wage per year	total in the			total	total in 1,000 US $
	1st year	2nd year	3rd year		1st year	2nd year	3rd year		
1	2	3	4	5	6	7	8	9	10
General manager	12	12		120	120	120			
Production manager		6		84		42			
Accounting manager		12		60		60			
Purchasing manager	12			36	36				
Sales manager	6			48	24				
Personnel manager		12	6	48		48	24		
Receptionist-telephonist	-	-	-	-	-	-	-		
Administration incl. planning	3			8	2				
Secretaries	18			18	27				
Staff-engineer		12		72		72			
Training engineer		6	12	48		24	48		
Milling department		48	72	12		48	72		
Turning department		60	90	12		60	90		
Drilling department		36	54	12		36	54		
Grinding department		-	30	12			30		
Fitting department		60	60	12		60	60		
Foremen		30	24	21		52	42		
Overseer		6		30		15			
Assembling department		60	48	12		60	48		
Contracting and testing		12	6	12		12	6		
Quality control		12	6	12		12	6		
Spraying and packing		12	6	12		12	6		
Warehouses		-	-	-		-	-		
Workshops		18	6	12		18	6		
Various- unskilled		15	15	4,8		6	6		
skilled		6	6	12		6	6		
Reserve									
Foremen		27	6	21		40	11		
Overseer		12		30		30			
Department-chief		6		36		18			
	51	430	441		209	857	509		
Supplementary provisions									
5,000 Baht per man per year					25	200	190		
Total costs in 1,000 Baht					234	1,057	699	1,990	
Total costs in 1,000 US $					11	50	33	94	

TABLE G.1: TRAINING M. START-UP COSTS OF LOCAL LABOUR FOR AN ANNUAL PRODUCTION OF 10,000 ENGINES

	man - months in the				in 1,000 Baht						Total in 1,000 US $
					Salary wage per year	Total in the					
	1 st year	2 nd year	3 rd year	4 th year		1 st year	2 nd year	3 rd year	4 th year	Total	
1	2	3	4	5	6	7	8	9	10	11	12
General Manager	12	12			120	120	120				
Production Manager		6			84		42				
Accounting Manager		12			60		60				
Purchasing Manager	12				36	36					
Sales Manager	6				48	24					
Personnel Manager		12	6	3	48		48	24	12		
Receptionist-Telephonist											
Administration incl. planning	3				8	2					
Secretaries	18				18	27					
Staff-engineer		12			72		72				
Training-engineer		6	12	12	48		24	48	48		
Milling department		78	72		12		78	72			
Turning department		108	102		12		108	102			
Drilling department		60	60		12		60	60			
Grinding department			48		12			48			
Fitting department		78	72		12		78	72			
Foremen		30	24		21		50	45			
Overseer		12			30		30				
Assembling department		120		36	12		120		36		
Contracting and testing		36		6	12		36		6		
Quality-control		27		3	12		27		3		
Spraying and packing		27		3	12		27		3		
Warehousing		-		-							
Workshop		36		3	12		36		3		
Various - unskilled		36		18	4,8		15		8		
skilled		18		6	12		18		6		
Reserve											
Foremen		49		6	21		80		11		
Overseer		27			30		68				
Department-chief		6			36		18				
	51	804	396	96		209	1215	471	136		
Supplementary provisions											
5,000 Baht per month/year						21	339	165	40		
Total costs in 1,000 Baht						230	1554	636	176	2,592	
Total costs in 1,000 US$						11	78	32	8		129

TABLE 65: TRAINING AND START-UP COSTS OF LOCAL LABOUR FOR AN ANNUAL PRODUCTION OF 20,000 ENGINES

	man - months in the				in 1,000 Baht						Total in 1,000 US $
					Salary wage -per year	Total in the					
	1 st year	2 nd year	3 rd year	4 th year		1 st year	2 nd year	3 rd year	4 th year	Total	
1	2	3	4	5	6	7	8	9	10	11	12
General Manager	12	12			120	120	120				
Production Manager		6			84		42				
Accounting Manager		12			60		60				
Purchasing Manager	12				36	36					
Sales Manager	6				48	24					
Personnel Manager		12	6	3	60		60	30	15		
Receptionist-Telephonist					-						
Administration incl. planning	6				8	4					
Secretaries	18				18	27					
Staff-engineer		12			72		72				
Training-engineer		6	12	12	48		24	48	48		
Milling department		150	150		12		150	150			
Turning department		192	192		12		192	192			
Drilling department		108	102		12		108	102			
Grinding department			84		12			84			
Fitting department		150	150		12		150	150			
Foremen		48	48		21		85	85			
Overseer		12	6		30		30	15			
Assembling department		240		60	12		240		60		
Contracting and testing		48		12	12		48		12		
Quality-control		24		6	12		24		6		
Spraying and packing		24		6	12		24		6		
Warehousing		-			-						
Workshop		72		6	12		72		6		
Various - unskilled		60		27	4,8		24		11		
skilled		18		9	12		18		9		
Reserve											
Foremen		90		6	21		160		11		
Overseer		27			30		68				
Department-chief		6			36		18				
	94	1329	750	147		211	1789	856	184		
Supplementary provisions											
5,000 Baht per month/year						24	555	315	65		
Total costs in 1,000 Baht						235	2344	1171	249	3,999	
Total costs in 1,000 US$						11	112	56	11		190

Explanation of Tables G1 - G2 and G3

Training- and Start-up costs of local labour

Col 1: The functions in the plant

2:

3:

4:

event.5: The training and start-up times spent during the first three or four years for every function, expressed in man-months.

5 or 6: The annual salaries/wages per man

event.6:

7:

8:

event.9:

event.10: The training and start-up costs for the local labour estimated for the first three or four years for every function.

9 or 11: The total amount of the training and start-up costs for the local labour

10 or 12: idem in US $

The supplementary provisions have to cover:

- medical care
- contributions to house-rents and
- lunches during the working-days.

Table III : Labor Production Costs during the third year for a plant with a maximum annual production of 5,000 engines

	man-months in the			in 1,000 Bahts					
				salary wage per year	total in the			total	total in 1,000 US $
	1st year	2nd year	3rd year		1st year	2nd year	3rd year		
1	2	3	4	5	6	7	8	9	10
General manager			12	120			120		
Production manager			12	84			84		
Accounting manager			12	60			60		
Purchasing manager		12	12	36		36	36		
Sales manager		12	12	48		48	48		
Personnel manager			6	48			24		
Receptionist-telephonist		12	12	12		12	12		
Administration incl. planning		27	60	10		23	50		
Secretaries		30	72	18		45	108		
Staff-engineer			12	72			72		
Training engineer		-	-	-		-	-		
Milling department			144	15			180		
Turning department			180	15			225		
Drilling department			108	15			135		
Grinding department			24	15			30		
Fitting department			156	15			195		
Foremen			78	21			138		
Overseer			12	30			30		
Assembling department			156	15			195		
Contracting and testing			30	15			38		
Quality control			30	15			38		
Spraying and packing			30	15			38		
Warehouses		36	36	15		45	45		
Workshops			42	15			53		
Various- unskilled			75	7			45		
skilled			30	15			38		
Reserve		-	-	-		-	-		
Foremen			42	21			75		
Overseer			24	30			60		
Department-chief			12	36			36		
		129	1,431			209	2,196		
Supplementary provisions									
5,000 Baht per man per year						55	600		
Total costs in 1,000 Baht						264	2,196	3,060	
Total costs in 1,000 US $						12	134		146

Table H2 : LABOUR PRODUCTION COSTS DURING THE THIRD AND FOURTH YEAR FOR A PLANT WITH A MAXIMUM ANNUAL PRODUCTION OF 10,000 ENGINES

	man - months in the				in 1,000 Baht						Total in 1,000 US $
					Salary wage per year	Total in the					
	1 st year	2 nd year	3 rd year	4 th year		1 st year	2 nd year	3 rd year	4 th year	Total	
1	2	3	4	5	6	7	8	9	10	11	12
General Manager			12	12	120			120	120		
Production Manager			12	12	84			84	84		
Accounting Manager			12	12	60			60	60		
Purchasing Manager		12	12	12	36		36	36	36		
Sales Manager		12	12	12	48		48	48	48		
Personnel Manager			6	9	48			24	36		
		12	12	12	12		12	12	12		
Receptionist-Telephonist		27	84	84	10		23	70	70		
Administration incl. planning											
Secretaries		42	72	72	18		63	108	108		
Staff-engineer			12	12	72			72	72		
Training-engineer											
Milling department			156	300	15			195	375		
Turning department			216	420	15			270	525		
Drilling department			120	240	15			150	300		
Grinding department				96	15				120		
Fitting department			156	300	15			195	375		
Foremen			60	108	21			105	200		
Overseer			24	24	30			60	60		
Assembling department			240	348	15			300	480		
Contracting and testing			48	66	15			60	83		
Quality-control			36	45	15			45	43		
Spraying and packing			36	45	15			45	43		
Warehousing		60	60	60	15		75	75	75		
Workshop			72	81	15			90	100		
Various - unskilled			72	126	7			42	75		
skilled			36	54	15			45	68		
Reserve											
Foremen			60	78	21			105	136		
Overseer			36	36	30			90	90		
Department-chief		3	12	12	36		9	36	36		
		168	1,686	2,700			266	2,542	3,830		
Supplementary provisions											
5,000 Baht per month/year							70	705	1,125		
Total costs in 1,000 Baht							336	3,247	4,955	8,538	
Total costs in 1,000 US$							16	156	238	410	

Table H3 : LABOUR PRODUCTION COSTS DURING THE THIRD AND FOURTH YEAR FOR A PLANT WITH A MAXIMUM ANNUAL PRODUCTION OF 20,000 ENGINES

	man - months in the				in 1,000 Baht						Total in 1,000 US $
					Salary wage per year	Total in the					
	1 st year	2 nd year	3 rd year	4 th year		1 st year	2 nd year	3 rd year	4 th year	Total	
1	2	3	4	5	6	7	8	9	10	11	12
General Manager			12	12	120			120	120		
Production Manager			12	12	84			84	84		
Accounting Manager			12	12	60			60	60		
Purchasing Manager		12	12	12	36		36	36	36		
Sales Manager		12	12	12	48		48	48	48		
Personnel Manager			6	9	48			24	36		
Receptionist-Telephonist		12	12	12	12		12	12	12		
Administration incl. planning		54	132	132	10		46	110	110		
Secretaries		30	72	72	18		45	108	108		
Staff-engineer			12	12	72			72	72		
Training-engineer											
Milling department			300	600	15			375	750		
Turning department			384	768	15			480	960		
Drilling department			216	420	15			270	525		
Grinding department				168	15				210		
Fitting department			300	600	15			375	750		
Foremen			96	192	21			118	336		
Overseer			24	36	30			60	90		
Assembling department			480	660	15			600	825		
Contracting and testing			96	132	15			120	165		
Quality-control			48	66	15			60	90		
Spraying and packing			48	66	15			60	80		
Warehousing		72	72	72	15		90	90	90		
Workshop			144	168	15			180	210		
Various - unskilled			120	228	7			70	133		
skilled			36	72	15			45	90		
Reserve											
Foremen			120	144	21			210	252		
Overseer			36	36	30			90	90		
Department-chief		3	12	12	36		9	36	36		
		195	2,826	4,736			286	3,913	6,368		
Supplementary provisions											
5,000 Baht per month/year							81	1,165	1,975		
Total costs in 1,000 Baht							367	5,078	8,343	13,788	
Total costs in 1,000 US$							17	244	401	662	

Explanation of Tables H1 - H2 and H3

Labour production costs during the third and eventually fourth year (during the production phases A - B and C

Col 1: The functions to fill

2:

3:

4:

event.5: The production time during the production phases A - B and C per function, spent during the first 3 or 4 years, expressed in man-months

5 or 6: The annual salaries/wages per man

event.6:

7:

8:

event.9:

event.10: The local labour production costs, estimated for the first three or four years

9 or 11: The total amount of those costs for the local labour

10 or 12: idem, in US $

The supplementary provisions have to cover:

- medical care
- contributions to house rents and
- lunches during the working-days

Table J: Material costs of a combustion engine based on an annual production of 20,000 engines
Amounts in Bath per engine

	Phase A	Phase B	Phase C and optimum capacity
Cast Iron for e.g.: pistons covers bearinghouses			
- machined by others	375	325	
- machines by the own factory			285
Crankshaft and toothed wheel			
- machined by others	130	130	
- machined by the own factory			100
Supports			
- imported	100	65	30
- partly imported and partly machined by the own factory		10	20
Valves and valve-guides			
- import	100	100	100
Fuel pump incl. atomizer			
- import	600	600	600
Various	120	110	95
Sub-total	1425	1340	1230
Extra charge due to smaller production-quantities	100	50	-
Total costs:			
in case of optimum production of 20000 units	1525	1390	1230
10000 units	1570	1430	1265
5000 units	1600	1460	1290

TABLE K1 : ANNUAL PRODUCTION COSTS FROM THE 4TH YEAR FOR A PLANT MANUFACTURING 5,000 ENGINES PER YEAR

(excluding depreciation, interest payments)

	In Baht per year	in 1,000 Baht					in 1,000 US $				
		Direct costs	Indirect costs	Total	of which		Direct costs	Indirect costs	Total	of which	
					foreign curr.	local curr.				foreign curr.	local curr.
1	2	3	4	5	6	7	8	9	10	11	12
1. Engine-components	1290	6450		6450	3900	2550	310		310		
2. Chemicals, packing materials	5	25		25		25	1.2		1.2		
3. Fuel and lubricants	5	25		25		25	1.2		1.2		
4. Various materials	15	55	20	75	50	25	2.64	1	3.64		
5. Maintenance and reparation											
5.1. Machinery, installations		70		70	15	55	3.4		3.4		
5.2. Buildings			50	50	10	40		2.4	2.4		
5.3. Cars and truck incl.fuel			160	160		160		7.7	7.7		
6. Energy, abt. 500.000 kwh.		120	5	125		125	5.8	0.3	6.1		
7. Office-expenses, incl. advertising, folders, catalogues	40		200	200	20	180		9.7	9.7		
8. Labourcosts		3396	786	4182		4182	164	38	202		
9. Licence-rights	20	100		100	100		5		5		
10. Production losses		200		200	150	50	10		10		
11. Total production costs (rounded of)		10450	1250	11700	4245	7455	502	60	562	204	358
12. Production costs per combustion-engine				2340					113		

TABLE K2 : ANNUAL PRODUCTION COSTS FROM THE 5TH YEAR FOR A PLANT MANUFACTURING 10,000 ENGINES PER YEAR

(excluding depreciation, interest payments)

	In Baht per year	in 1,000 Baht					in 1,000 US $				
		Direct costs	Indirect costs	Total	of which		Direct costs	Indirect costs	Total	of which	
					foreign curr.	local curr.				foreign curr.	local curr.
1	2	3	4	5	6	7	8	9	10	11	12
1. Engine-components	1265	12650		12650	7700	4950	608		608		
2. Chemicals, packing materials	5	50		50		50	2.4		2.4		
3. Fuel and lubricants	5	50		50		50	2.4		2.4		
4. Various materials	15	110	40	150	100	50	5.3	1.9	7.2		
5. Maintenance and reparation											
5.1. Machinery, installations		120		120	25	95	5.8		5.8		
5.2. Buildings			60	60	10	50		2.9	2.9		
5.3. Cars and truck incl.fuel			180	180		180		8.7	8.7		
6. Energy, abt. 900000 kwh		215	10	225		225	10.3	0.5	10.8		
7. Office-expenses, incl. advertising, folders, catalogues	35		350	350	30	320		16.8	16.8		
8. Labourcosts		5906	816	6722		6722	284	39	323		
9. Licence-rights	20	200		200	200		10		10		
10. Production losses		375		375	285	90	18		18		
11. Total production costs (rounded of)		19700	1500	21200	8350	12850	947	72	1019	401	618
12. Production costs per combustion-engine				2120					102		

TABLE K3 : ANNUAL PRODUCTION COSTS FROM THE 5TH YEAR FOR A PLANT MANUFACTURING 20,000 ENGINES PER YEAR

(excluding depreciation, interest payments)

	In Baht per year	in 1,000 Baht					in 1,000 US $				
		Direct costs	Indirect costs	Total	of which		Direct costs	Indirect costs	Total	of which	
					foreign curr.	local curr.				foreign curr.	local curr.
1	2	3	4	5	6	7	8	9	10	11	12
1. Engine-components	1230	24600		24600	14800	9800	1183		1183		
2. Chemicals, packing materials	5	100		100		100	4.8		4.8		
3. Fuel and lubricants	5	100		100		100	4.8		4.8		
4. Various materials	15	220	80	300	200	100	10.6	3.8	14.4		
5. Maintenance and reparation											
5.1. Machinery, installations		220		220	45	175	10.6		10.6		
5.2. Buildings			75	75	10	65		3.6	3.6		
5.3. Cars and truck incl.fuel			300	300		300		14.4	14.4		
6. Energy, abt. 1.500.000 kwh		350	25	375		375	16.9	1.2	18.1		
7. Office-expenses, incl. advertising, folders, catalogues	30		600	600	50	550		29	29		
8. Labourcosts		10171	888	11059	-	11059	490	43	533		
9. Licence-rights	20	400		400	400		19.2		19.2		
10. Production losses		750		750	560	190	36		36		
11. Total production costs (round numbers)		37000	2000	39000	16100	22900	1780	96	1876	775	1101
12. Production costs per combustion-engine				1950					94		

Explanation of Tables K1 - K2 and K3

Annual production costs in case of optimum production

Col 1: Elements of the production costs

2: Costs of the elements per combustion engine

3/8: The direct costs

4/9: The indirect costs

5/10: The total costs

6/11: The foreign currency quote-parts

7/12: The local currency quote-parts

Item 1: We refer to Table J

2:

3:

4:

5: Our estimations

6:

7:

9:

10:

8: We refer to tables F1 - F2 and F3

Remark : a. We assume that the optimum production will be reached in the 6th year

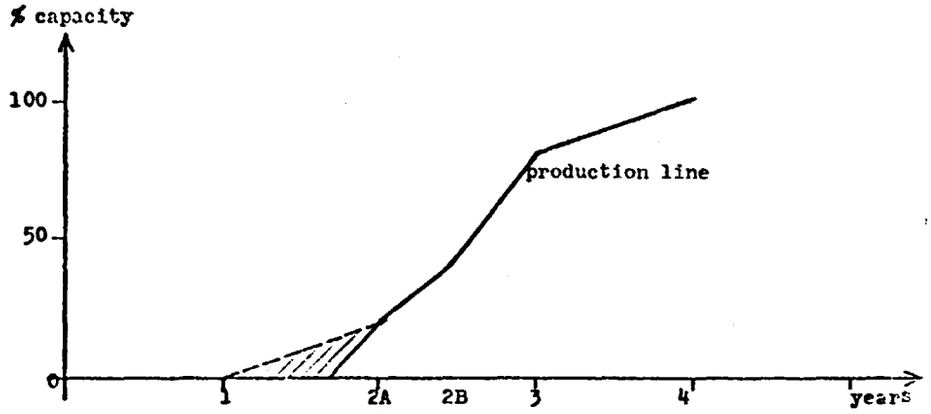
b. We assume that goods to be imported can be imported in this year against reduced import-duties

Table K.4.: ESTIMATION OF THE ANNUAL EXPLOITATION COSTS FOR THE 6th YEAR

	Amounts in 1,000 Baht/US $		
	Annual production combustion-engines		
	5,000	10,000	20,000
Annual production costs as per Tables K1, K2, K3	11,700	21,200	39,000
Estimated depreciation based on the investments, specified in Tables C1, C2, C3	1,570	2,525	4,220
Contingencies	170	225	300
Annual exploitation costs in Baht	13,440	23,950	43,520
in US $	645	1,145	2,100

Table L1 : ANNUAL PRODUCTION COSTS DURING THE START-UP PERIOD FOR A PLANT WITH A MAXIMUM ANNUAL PRODUCTION OF 5,000 ENGINES

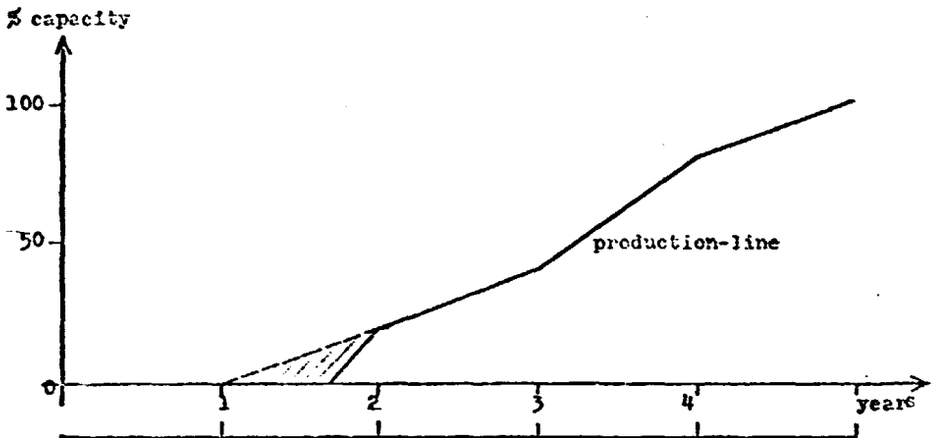
Amounts in 1,000 Bahts



		Total	Total	Total	Total
1	2	3	4	5	6
1. Engine components		200	3,400	5,800	
2. Chemicals, packing materials, fuel and lubricants and various materials		3	60	115	
3. Maintenance and reparations					
3.1. Machinery, installations, buildings		25	60	100	
3.2. Cars and trucks, incl. fuel		100	160	160	
4. Energy		10	70	120	
5. Office-expenses incl. advertising, folders, catalogues		200	200	200	
6. Labourcosts		234	1,315	3,500	
7. Licence-rights		7	50	90	
8. Production losses		50	600	600	
9. Total production costs (round numbers)		830	6,000	10,700	
10. Foreign currency quote-part		130	2,200	3,650	
11. Total prod. costs in US $		6	106	176	

Table L2 : ANNUAL PRODUCTION COSTS DURING THE START-UP PERIOD FOR A PLANT WITH A MAXIMUM ANNUAL PRODUCTION OF 10,000 ENGINES

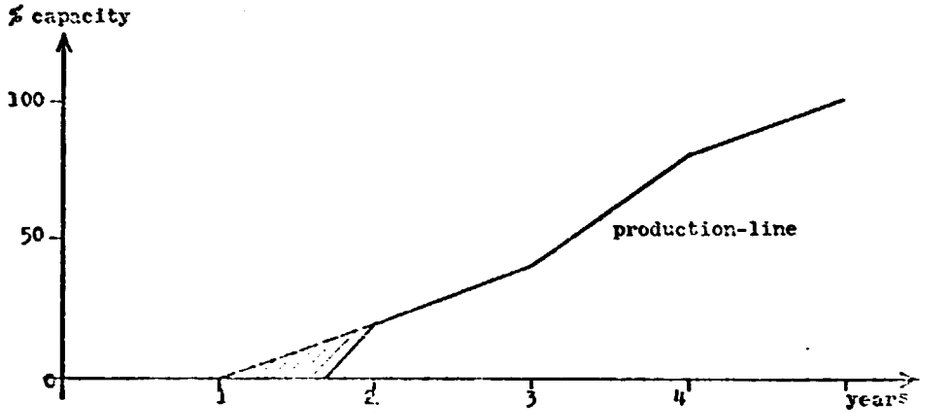
Amounts in 1,000 Bahts



		Total	Total	Total	Total
1	2	3	4	5	6
1. Engine components		400	4,710	8,580	11,305
2. Chemicals, packing materials, fuel and lubricants and various materials		7	75	150	225
3. Maintenance and reparations					
3.1. Machinery, installations, buildings		50	90	125	170
3.2. Cars and trucks, incl. fuel		120	160	160	180
4. Energy		25	80	140	210
5. Office-expenses incl. advertising, folders, catalogues		350	350	350	350
6. Labourcosts		340	3,250	5,000	6,275
7. Licence-rights		15	60	120	180
8. Production losses		100	750	900	800
9. Total production costs (round numbers)		1,410	9,525	15,525	20,140
10. Foreign currency quote-part		250	3,400	5,200	7,700
11. Total prod. costs in US $		12	164	250	370

Table 13 : ANNUAL PRODUCTION COSTS DURING THE START-UP PERIOD FOR A PLANT WITH A MAXIMUM ANNUAL PRODUCTION OF 40,000 ENGINES

Amounts in 1,000 Bahts



		Total	Total	Total	Total
1	2	3	4	5	6
1. Engine components		765	9,150	16,700	22,100
2. Chemicals, packing materials, fuel and lubricants and various materials		15	150	300	450
3. Maintenance and reparations					
3.1. Machinery, installations, buildings		80	140	180	290
3.2. Cars and trucks, incl. fuel		200	250	300	300
4. Energy		50	140	250	375
5. Office-expenses incl. advertising, folders, catalogues		500	600	600	600
6. Labourcosts		370	5,100	8,350	11,060
7. Licence-rights		25	300	600	900
8. Production losses		190	1,500	1,600	1,500
9. Total production costs (round numbers)		2,250	17,500	29,100	37,600
10. Foreign currency quote-part		375	6,500	9,000	14,600
11. Total prod. costs in US $		18	313	433	702

Explanation of Tables L1 - L2 and L3

Annual production-costs during the start-up period

Col 1: elements of the production costs
2: costs, applying to the first year
3: costs, applying to the second year
4: costs, applying to the third year
5: costs, applying to the fourth year
6: costs, applying to the fifth year

Item 1: We refer to Table J
2:
3:
4:
5: Our estimations
7:
8:

6: We refer to tables G1 -G2 - G3 - H1 - H2- and H3

TABLE M 1 : WORKING CAPITAL FOR A PLANT WITH AN ANNUAL PRODUCTION OF 5,000 ENGINES

Amounts in 1,000 Baht

	years										
	1	2	3	4	5	6	7	8	9	10	11
Manufacturing 5000 engines per year											
1. One month labor	230	2700	3500	4200	4200	4200	4200	4200	4200	4200	4200
2. Two months materials	-	600	800	1125	1125	1125	1125	1125	1125	1125	1125
3.1. One month finished goods (own production)	-	400	700	1000	1000	1000	1000	1000	1000	1000	1000
3.2. Three months finished goods (import)	240	480									
4. Two months receivables	-	1120	2240	2800	2800	2800	2800	2800	2800	2800	2800
5. Total in 1000 Baht (round numbers)	500	5300	7240	9125	9200	9200	9200	9200	9200	9200	9200
6. Total in 1000 US $	24	255	348	439	442	442	442	442	442	442	442

TABLE M2 : WORKING CAPITAL FOR A PLANT WITH AN ANNUAL PRODUCTION OF 10,000 ENGINES

Amounts in 1,000 Baht

	years										
	1	2	3	4	5	6	7	8	9	10	11
Manufacturing 10,000 engines per year											
1. One month labor	230	1900	3950	5200	6750	6750	6750	6750	6750	6750	6750
2. Two months materials	-	140	900	1600	2200	2200	2200	2200	2200	2200	2200
3.1. One month finished goods (own production)	-	110	750	1250	1800	1800	1800	1800	1800	1800	1800
3.2. Three months finished goods (import)	480	960									
4. Two months receivables	-	1120	2250	4500	5600	5600	5600	5600	5600	5600	5600
5. Total in 1000 Baht (round numbers)	725	4250	7850	12600	16500	16500	16500	16500	16500	16500	16500
6. Total in 1000 US $	35	205	377	606	793	793	793	793	793	793	793

TABLE M 3 : WORKING CAPITAL FOR A PLANT WITH AN ANNUAL PRODUCTION OF 20,000 ENGINES

Amounts in 1,000 Baht

	years										
	1	2	3	4	5	6	7	8	9	10	11
Manufacturing 20,000 engines per year											
1. One month labor	235	2750	6300	9600	11100	11100	11100	11100	11100	11100	11100
2. Two months materials	--	250	1700	3000	4250	4250	4250	4250	4250	4250	4250
3.1. One month finished goods (own production)	-	200	1400	2400	3250	3250	3250	3250	3250	3250	3250
3.2. Three months finished goods (import)	960	1920									
4. Two months receivables	-	2250	4500	9000	11200	11200	11200	11200	11200	11200	11200
5. Total in 1000 Baht (round numbers)	1200	7400	14000	24000	30000	30000	30000	30000	30000	30000	30000
6. Total in 1000 US $	58	356	673	1106	1442	1442	1442	1442	1442	1442	1442

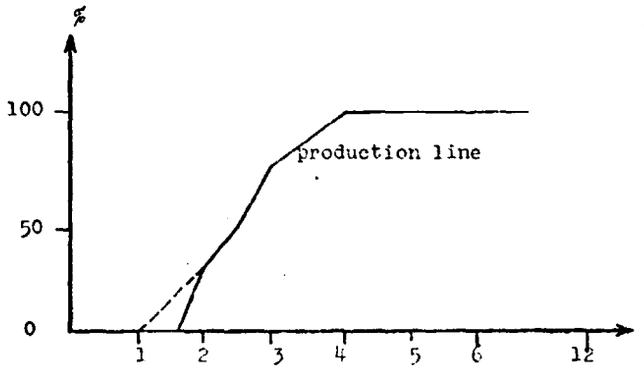
Explanation of Tables M1, M2 and M3

Working capital calculation

Item 1: based on tables F1, F2 and F3
Item 2: based on tables K1, K2 and K3
Item 3.1: based on tables K1, K2 and K3
Item 3.2: see the text.
Item 4: Although we recommend maximum terms of payment: 1 month after delivery, the praxis will show that one has to calculate with a longer period of payment, especially during the first years.
The amounts have been based on the sales-prices of the combustion-engines.

Table N1 : Foreign Technical Assistance Costs (field + home)
(excluding eventual reporting costs)
for a plant producing 5,000 engines

Amounts in 1,000 US $

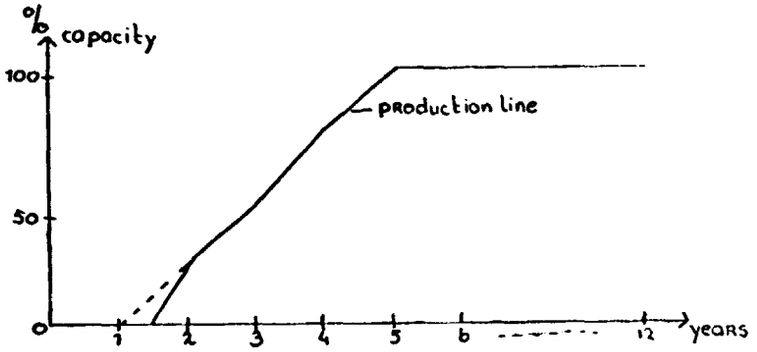


	man-months in the							total man-month	costs per month	total costs 1,000 US $	flights			total costs in US $
	1st year	2nd year	3rd year	4th year	5th year	6th year	after 6th year				times	cost per flight	total flight costs	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Preliminary costs for the start-up														
Management	7							7	6	42	4			
Building construction and technical equipment	3	3						6	5	30	6			
Training	1							1	5	5	1			
Various *	1							1	5	5	1			
Sub total	12	3						15		82	12	1.2	14.4	96,400
Monthly expenses								12	1					12,000
Total costs US $														108,400
Total costs Baht														2260000
Training and supporting costs														
Management		4	6					10	6	60	6			
Engineering		3	6					9	5	45	3			
Training		3	9					12	5	60	4			
Various *		2	2					4	5	20	4			
Sub-total		12	23					35		185	17	1.2	20.4	205,400
Monthly expenses								31	1					31,000
Total costs US $														236,400
Total costs Baht														4950000
Production-supporting and efficiency improvement														
Management				2	1			3	6	18	3			
Engineering				4	2			6	5	30	4			
Training				2	2	2	4x2	14	5	70	11			
Various *				2	1			3	5	15	3			
Sub-total				9	6	2	10	26	1	133	21	1.2	26	159,000
Monthly expenses								25	1					25,000
Total costs US $														184,000
Total costs Baht														3840000

* = financial-, accounting-, administrative-, technical consultancy

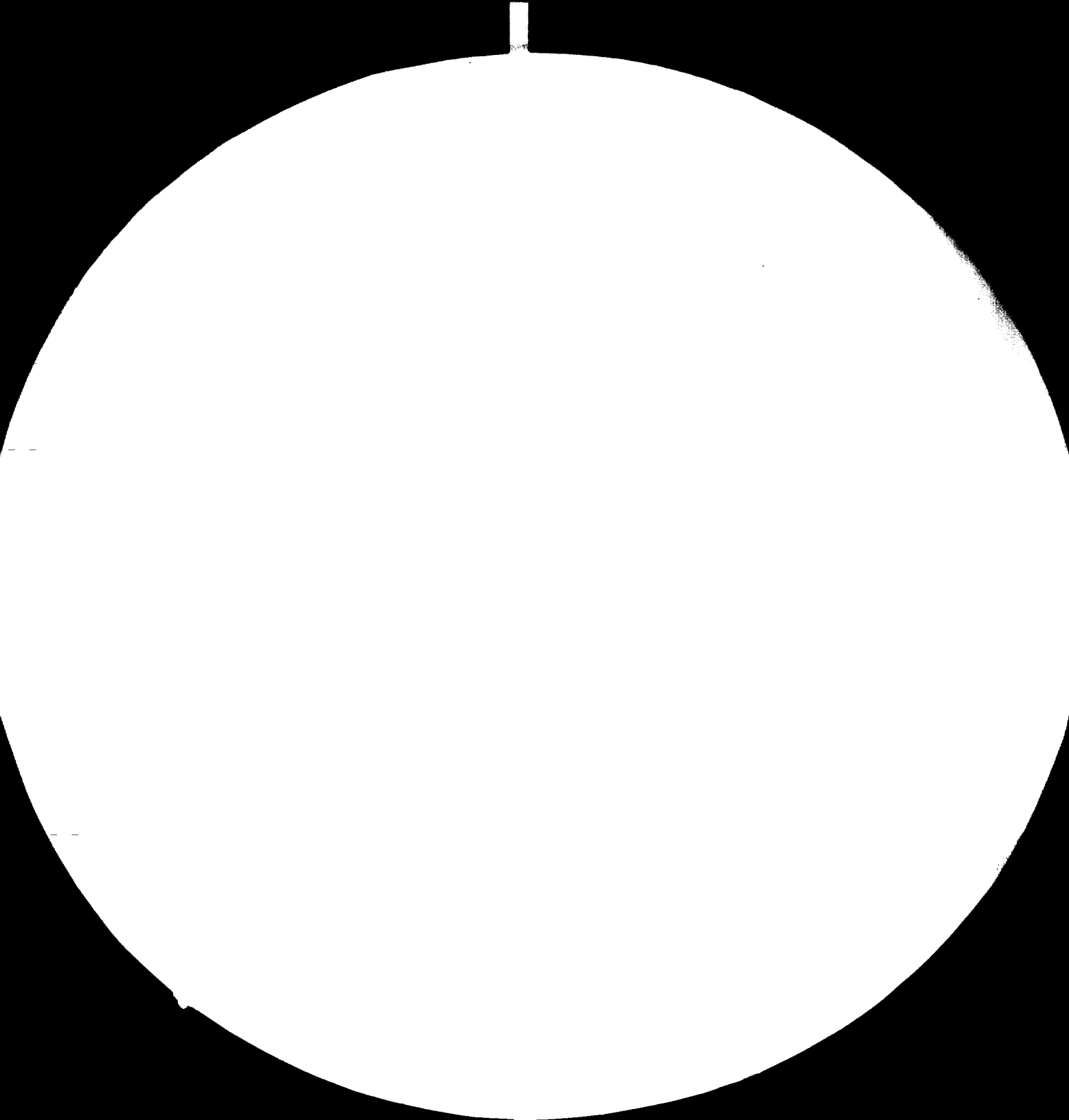
Table N2 : Foreign Technical Assistance Costs (field + home)
(excluding eventual reporting costs)
for a plant producing 10,000 engines

Amounts in 1,000 US $



	man-months in the							total man-month	costs per month	total costs 1000 US $	flights			total costs in US $
	1st year	2nd year	3rd year	4th year	5th year	6th year	after 6th year				times	cost per flight	total flight costs	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Preliminary costs for the start-up														
Management	7							7	6	42	4			
Building construction and technical equipment	4	3						7	5	35	6			
Training	1							1	5	5	1			
Various ★	1							1	5	5	1			
Sub-total	13	3						16		87	13	1.2	14.4	101,400
Monthly expenses								12	1					12,000
Total costs US $														113,400
Total costs Baht														2,400,000
Training and supporting costs														
Management		6	4					10	6	60	6			
Engineering		4	6					10	5	50	3			
Training		6	4					10	5	50	4			
Various ★		2	2					4	5	20	4			
Sub-total		18	16					34		180	17	1.2	20.4	200,400
Monthly expenses								31	1					31,000
Total costs US $														231,400
Total costs Baht														4,850,000
Production-supporting and efficiency improvement														
Management				3	1			4	6	24	3			
Engineering				4	2			6	5	30	4			
Training				4	2	2	5x2	18	5	90	15			
Various ★				2	1			3	5	15	3			
Sub-total				13	6	2	10	31		159	25	1.2	30	189,000
Monthly expenses								30	1					30,000
Total costs US $														219,000
Total costs Baht														4,575,000

★ = financial-, accounting-, administrative-, technical consultancy



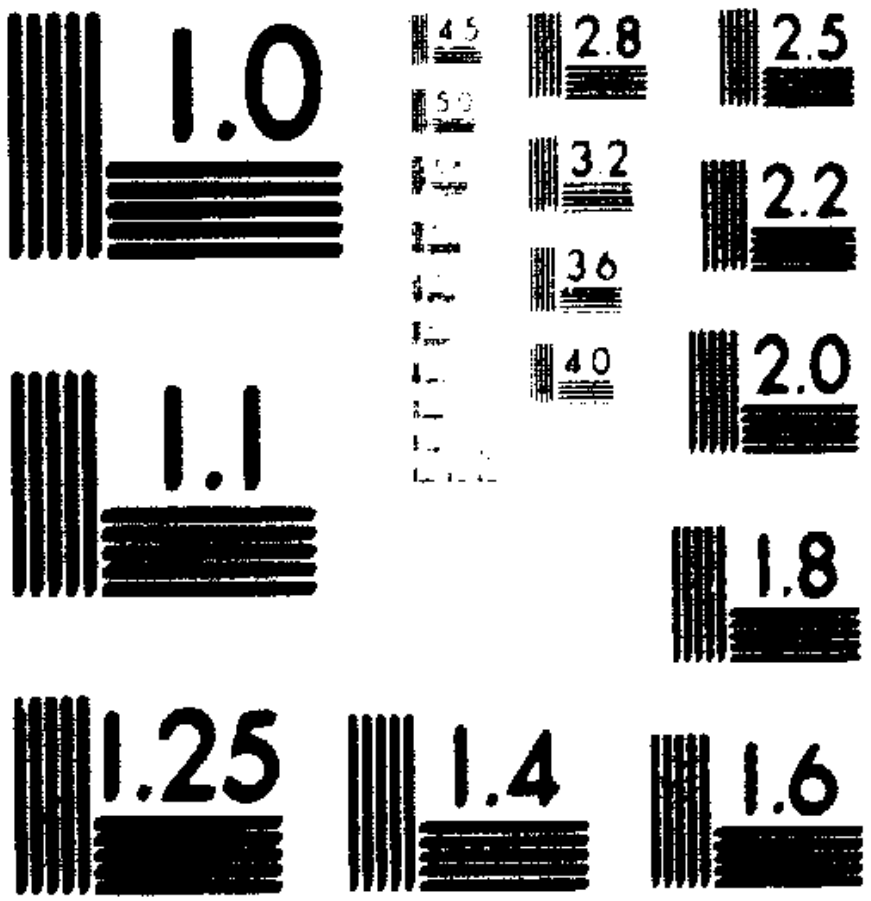
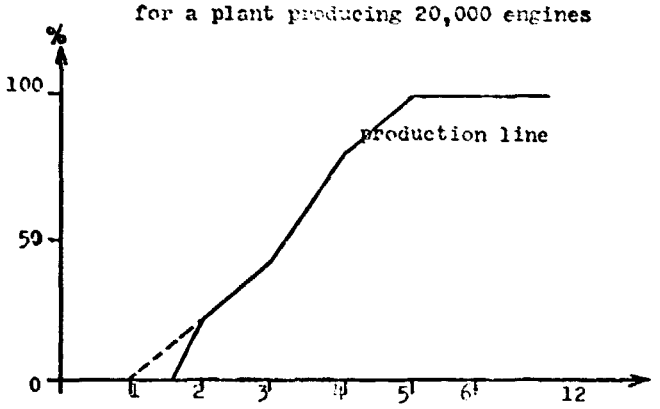


Table N3: Foreign Technical Assistance Costs (field + home)
(excluding eventual reporting costs)
for a plant producing 20,000 engines



Amounts in 1,000 US $

	man-months in the							total man-months	costs per month	total costs 1.000 US $	flights			Total costs in US $
	1st year	2nd year	3rd year	4th year	5th year	6th year	after 6th year				times	cost per flight	total flight costs	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Preliminary costs for the start-up														
Management	7							7	6	42	4			
Building construction and technical equipment	5	5						10	5	50	7			
Training	1							1	5	5	1			
Various *	2							2	5	10	2			
Sub-total	15	5						20		107	14	1.2	17	124,000
Monthly expenses								15	1					15,000
Total c sts US $														139,000
Total costs Baht														2900000
Training and supporting costs														
Management		6	4					10	6	60	6			
Engineering		4	10					14	5	70	3			
Training		6	8					14	5	70	4			
Various *		2	4					6	5	30	4			
Sub-total		18	26					44		230	17	1.2	20.4	250400
Monthly expenses								41	1					41,000
Total costs US $														291400
Total costs Baht														6870000
Production supporting and efficiency improvement														
Management				5	1			6	6	36	3			
Engineering				10	6			16	5	80	4			
Training				4	2	2	5x2	18	5	90	15			
Various *				2	1			3	5	15	3			
				23	10	2	10	43		221	25	1.2	30	251,000
Monthly expenses								42	1					42,000
Total costs US $														5,100,000
Total costs Baht														

* = financial-, accounting-, administrative-, technical consultancy

Table 01 : Summary of the costs for an annual production of 5,000 engines

Amounts in 1,000 Bahts

Years	Total costs							Costs in foreign currency							Costs in local currency						
	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	1,860	6,810	240	-	600	9,510	457	1,860	4,710		-	240	6,810	327		2,200	240	-	260	2,700	130
2	3,000	8,495	1,100	830	4,800	18,225	876	3,000	5,495		130	840	9,465	455		3,000	1,100	700	3,960	8,760	421
3	2,350	1,995	700	6,000	1,950	12,995	625	2,350	285		2,200	60	4,895	235		1,710	700	3,800	1,890	8,100	390
4	1,715	380		10,700	1,875	14,670	705	1,715	-		3,650	60	5,425	260		380		7,050	1,815	9,245	445
5	1,125	-		11,000	75	12,200	586	1,125	-		4,200		5,325	256		-		6,800	75	6,875	330
6	250	380		11,700		12,330	593	250	-		4,245		4,495	216		380		7,455		7,835	377
7	250	250		11,700		12,200	586	250	250		4,245		4,695	226		50		7,955		7,505	360
8	250	380		12,100		12,730	612	250	-		4,245		4,495	216		380		7,855		8,235	396
9	250	1,000		12,100		13,350	642	250	600		4,245		5,095	245		400		7,855		8,255	397
10		380		12,100		12,480	600		-		4,245		4,245	205		380		7,855		8,235	396
11		250		12,100		12,350	594		200		4,245		4,445	204		50		7,855		7,905	380
12		380		12,100		12,480	600		-		4,245		4,245	205		380		7,855		8,235	396
13				12,100		12,100	580				4,245		4,245	205				7,855		7,855	376
Tot.	11,050	20,800	2,040	124,530	9,200	167,620	8,057	11,050	11,490		44,140	1,200	67,880	3,262		9,310	2,040	80,390	8,000	99,740	4,794

Table 02 : SUMMARY OF THE COSTS FOR AN ANNUAL PRODUCTION OF 10,000 engines

Amounts in 1,000 Baht

	Total costs							Costs in foreign currency							Costs in local currency						
Years	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2,000	7,330	230	-	725	10,785	519	2,000	4,330		-	480	6,810	327		3,500	230	-	245	3,975	191
2	2,900	9,340	1,550	1,410	3,525	19,225	925	2,900	5,840		250	620	9,610	462		4,000	1,550	1,160	2.905	9,615	462
3	2,350	6,900	640	9,525	3,600	23,015	1,107	2,350	5,300		3,400	700	11,750	565		1,600	640	6,125	2.900	11,265	542
4	2,200	3,310	180	15,525	4,750	25,965	1,248	2,200	2,430		5,200	600	10,430	502		880	180	10,325	4.150	15,535	747
5	1,125	-		20,140	3,900	25,165	1,210	1,125	-		7,700		8,825	424		-		12,440	3.900	16,340	786
6	250	380		21,200		21,830	1,050	250	-		8,350		8,600	414		380		12,850		13,230	636
7	250	-		21,200		21,450	1,031	250	-		8,350		8,600	414		-		12,850		12,850	618
8	250	780		21,900		22,930	1,102	250	300		8,350		8,900	428		480		13,550		14,030	675
9	250	-		21,900		22,150	1,065	250	-		8,350		8,600	414		-		13,550		13,550	652
10	250	2,130		21,900		24,284	1,167	250	1,130		8,350		9,730	468		1,000		13,550		14,550	700
11	-	-		21,900		21,900	1,053		-		8,350		8,350	401		-		13,550		13,550	652
12		780		21,900		22,680	1,090		300		8,350		8,650	416		480		13,550		14,030	675
13				21,900		21,900	1,053				8,350		8,350	401				13,550		13,550	652
14				21,900		21,900	1,053				8,350		8,350	401				13,550		13,550	652
Tot.	11,800	32,950	2,600	242,300	16,500	306,175	14,675	11,325	19,630		91,700	2,400	125,555	6,035		12,320	2,600	150,600	14,100	179,620	8,640

Table 03 : Summary of the costs for an annual production of 20,000 engines

Amounts in 1,000 Bahts

Years	Total costs							Costs in foreign currency							Costs in local currency						
	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $	foreign technical assistance	investments	training and start-up	annual production	working capital	total	total in 1,000 US $
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2,250	11,685	235	-	1,200	15,370	740	2,250	5,285		-	960	8,495	410		6,400	235	-	240	6,875	330
2	3,150	16,890	2,345	2,250	6,200	30,835	1,480	3,150	9,990		375	1,240	14,755	710		6,900	2,345	1,875	4,960	16,080	770
3	3,570	11,735	1,175	17,500	6,600	40,580	1,950	3,570	8,770		6,500	-	18,840	905		2,965	1,175	11,000	6,600	21,740	1,045
4	2,970	5,360	250	29,100	9,000	46,680	2,250	2,970	4,090		9,000	1,000	17,060	820		1,470	250	20,100	8,000	29,820	1,430
5	1,900	-		37,600	7,000	46,500	2,235	1,900	-		14,600	1,300	17,800	855		-		23,000	5,700	28,700	1,380
6	250	670		39,000		39,920	1,920	250	-		16,100		16,350	785		670		22,900		23,570	1,135
7	250	-		39,000		39,250	1,890	250	-		16,100		16,350	785		-		22,900		22,900	1,105
8	250	1,170		40,300		41,720	2,005	250	450		16,100		16,800	810		720		24,200		24,920	1,195
9	250	-		40,300		40,550	1,950	250	-		16,100		16,350	785		-		24,200		24,200	1,165
10	250	3,420		40,300		43,970	2,115	250	1,600		16,100		17,950	865		1,820		24,200		26,020	1,250
11		-		40,300		40,300	1,940		-		16,100		16,100	775		-		24,200		24,200	1,165
12		1,170		40,300		41,370	1,990		450		16,100		16,550	795		720		24,200		24,920	1,195
13				40,300		40,300	1,940				16,100		16,100	775				24,200		24,200	1,165
14				40,300		40,300	1,940				16,100		16,100	775				24,200		24,200	1,165
Tot.	15,070	52,300	4,005	446,550	30,000	547,792	26,355	15,070	30,635		175,375	4,500	225,580	10,850		21,665	4,005	271,175	25,500	322,345	15,505

Explanation of the Tables 01, 02 and 03

Summary of the costs

Col. 1 : sequential years

Col. 2 : the costs for foreign technical assistance as specified in tables

Col. 3 : the investments as per tables

Col. 4 : the training and start-up costs as determined in tables

Col. 5 : the annual production-costs as calculated in tables, whereas we took into account increased importduties after the first five years of production

Col. 6 : the working-capital as estimated in tables

Col. 7 : the addition of col. 2+3+4+5+6

Col. 8 : idem, in US $

Col. 9 - 15: the foreign currency quote-parts of the foregoing columns 2 through 8

Col. 16-22 : the local currency quote-parts of the foregoing columns 2 through 8.

TABLE P1 : ANNUAL SALES-INCOME OF A PLANT WITH A MAXIMUM CAPACITY OF 5,000 ENGINES
AVERAGE SALES PRICE: 3,500 BAHT (US$ 170)

	Annual sales		Extra income owing to efficiency-improvem.		Total	
	sold number of engines	income in 1,000 B.	sold number of engines	income in 1,000 B.	in 1,000 Baht	US $
1	2	3	4	5	6	7
1st year	-	-	-	-	-	-
2nd year - import [1])	400	-			-	
production	100	350			350	16
3rd year - production	2250	7850			7850	380
4th year	4500	15750			15750	760
5th year	5000	17500			17500	840
6th year	5000	17500			17500	840
7th year	5000	17500	25	87,5	17587	845
8th year	5000	17500	40	140	17640	850
9th year	5000	17500	50	175	17675	850
10th year	5000	17500	60	210	17710	850
11th year	5000	17500	65	228	17728	850
12th year	5000	17500	70	245	17745	855
13th year	5000	17500	70	245	17745	855
Total					182740	8787

[1]) We suggest that the selling-price covers the costprice.
This costprice has not been included in all our previous calculations

Col. 4/5: Although the plant has been set-up for an optimum annual production of 5,000 combustion-engines, it will be possible to shorten the machine-times, waiting-times, processing-times, in the course of the years due to efficient improvement stimulated by thorough training, resulting in a higher productionvolume.

TABLE P 2 : ANNUAL SALES-INCOME OF A PLANT WITH A MAXIMUM CAPACITY OF 10,000 ENGINES
AVERAGE SALES PRICE: 3,500 BAHT (US$ 170)

	Annual sales		Extra income owing to efficiency-improvem.		Total	
	sold number of engines	income in 1,000 B.	sold number of engines	income in 1,000 B.	in 1,000 Baht	US $
1	2	3	4	5	6	7
1st year	-	-	-	-	-	-
2nd year - import [1]	700	-			-	
production	250	875			875	40
3rd year - production	3000	10500			10500	500
4th year	6000	21000			21000	1000
5th year	9000	31500			31500	1515
6th year	10000	35000			35000	1680
7th year	10000	35000	50	175	35175	1690
8th year	10000	35000	80	280	35280	1700
9th year	10000	35000	100	350	35350	1700
10th year	10000	35000	120	420	35420	1700
11th year	10000	35000	130	455	35455	1700
12th year	10000	35000	140	490	35490	1710
13th year	10000	35000	150	525	35525	1710
14th year	10000	35000	150	525	35525	1710
Total					382095	18357

[1]) We suggest that the selling-price covers the costprice.
This costprice has not been included in all our previous calculations.

Col. 4/5: Although the plant has been set-up for an optimum annual production of 10,000 combustion-engines, it will be possible to shorten the machine-times, waiting-times, processing-times, in the course of the years due to efficient improvement stimulated by thorough training, resulting in a higher production volume

TABLE P 3: ANNUAL SALES-INCOME OF A PLANT WITH A MAXIMUM CAPACITY OF 20,000 ENGINES
AVERAGE SALES PRICE: 3,500 BAHT (US$ 170)

	Annual sales		Extra income owing to efficiency-improvem.		Total	
	sold number of engines	income in 1,000 B.	sold number of engines	income in 1,000 B.	in 1,000 Baht	US $
1	2	3	4	5	6	7
1st year	-	-	-	-	-	-
2nd year - import [1]	1500	-			-	
production	500	1750			1750	80
3rd year - production	6000	21000			21000	1000
4th year	12000	42000			42000	2000
5th year	18000	63000			63000	3030
6th year	20000	70000			70000	3360
7th year	20000	70000	100	350	70350	3380
8th year	20000	70000	160	560	70560	3400
9th year	20000	70000	200	700	70700	3400
10th year	20000	70000	240	840	70840	3400
11th year	20000	70000	260	910	70910	3400
12th year	20000	70000	280	980	70980	3420
13th year	20000	70000	300	1050	71050	3420
14th year	20000	70000	300	1050	71050	3420
Total					764180	35724

[1]) We suggest that the selling-price covers the costprice
This costprice has not been included in all our previous calculations.

Col. 4/5: Although the plant has been set-up for an optimum annual production of 20,000 combustion-engines, it will be possible to shorten the machine-times, waiting-times, processing-times, in the course of the years due to efficient improvement stimulated by thorough training, resulting in a higher productionvolume.