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6 September 1978
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EXPERT ASSISTANCE IN ESTABLISHING A 2,4-D AND MCPA PLANT*.

SI/INS/77/801.

INDONESIA.

Terminal report

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

Based on the work of Gerald L. Baldit, pesticide chemist

United Nations Industrial Development Organization
Vienna

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EXPLANATORY NOTES

1 For ease of use, this report has been divided into Three Volumes :-

Volume 1	-	Findings and Recommendations
Volume 2	-	Feasibility Study on the Manufacture and Formulation of DDT in Indonesia
Volume 3	-	Technical Specifications for Invitation of Bids for the establishment of a DDT Insecticide Manufacturing Plant in Indonesia

2 Abbreviations

2.1 The "Recommended Common Names for Pesticides" - British Standard 1831:1969 with supplements - have been used throughout this report.

2.2 Metric and S.I units (Système International d'Unités) have been used.

2.3 BIMAS - Government sponsored rice intensification scheme involving credits and subsidies for pesticides and fertilisers.

3 Currency

The Indonesian unit of currency is the Rupiah (Rp). This has been converted into United States Dollars at the rate of :

1 US Dollar = Rps 415

4 Inflation

No attempt has been made to forecast inflation rates. All costs are given in terms of mid-1978 Rupiahs, Dollars etc.

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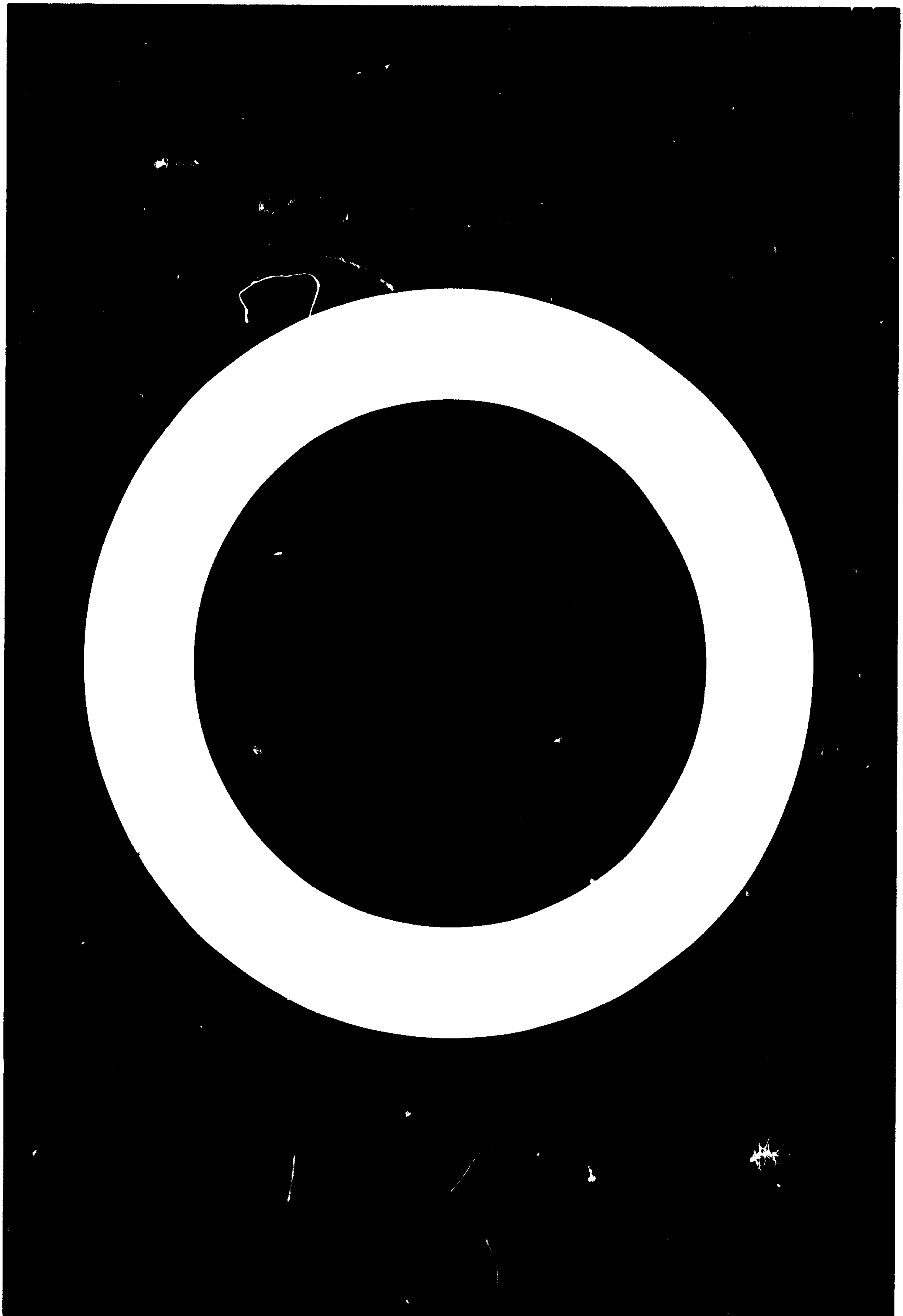
Volume 2. Feasibility study on the manufacture and formulation of DDT in Indonesia

APPENDICES

Volume 3. Technical specifications for invitation fo bids for the establishment of a DDT insecticide manufacturing plant in Indonesia



VOLUME 1

PROJECT FINDINGS

and

RECOMMENDATIONS

1 SUMMARY

1.1 The current and estimated future use of pesticides in Indonesia for agriculture and public health has been studied with a view to making recommendations for their manufacture, with particular reference to DDT, the organo-phosphorus insecticides and the herbicides 2,4-D and MCPA and to the long range objectives of Repelita III (the third 5-year Development Plan - 1979 / 1984) - "Expansion of industries converting raw materials into finished goods".

1.2 DDT

1.2.1 The requirement of 75% DDT Wettable Powder for mosquito control by the Ministry of Health during Repelita III is 32 000 tonnes equivalent to an average of 4 800 tonnes technical DDT per year. 50% of this will be financed by a US AID loan.

1.2.2 It is confidently expected that DDT will continue to be the major pesticide for mosquito control for the next 10 - 15 years.

1.2.3 In the Feasibility Study detailed in Volume 2 the fixed capital required to erect, on a green field site at Gresik, E Java, a plant to manufacture 5 000 tonnes a year technical DDT and formulate it into 6 500 tonnes 75% DDT Wettable Powder to WHO Specifications for mosquito control is estimated at US Dollars 9.815 million. Of this $ 6.15 million (62.7%) is for the basic hardware, and the balance for offices, workshops and other essentials as detailed in Volume 2 Appendix F I.

1.2.4 The working capital and direct expenses including loan financing interest for running such a plant (detailed in Volume 2 Appendix F VI) are estimated at $ 9.66 million per year equivalent to $ 1 486 per tonne 75% DDT WP (of which only $ 769 per tonne is in foreign currency) as compared with about $ 1 500 per tonne cif (all in foreign currency) currently being paid by the Ministry of Health. Thus there could be an annual foreign currency saving of $ 4.75 million once the plant is in operation.

1.2.5 Such a plant would utilise about 48% of Indonesia's chlorine capacity projected for 1980, eliminate any surplus and produce

annually, as by-products, 5 830 tonnes hydrochloric acid (35%) and 7 000 tonnes sodium hypochlorite (12% Cl). It would also use 1 600 tonnes per year indigenous ethyl alcohol. The processes involved are outlined in Volume 1 Appendices XI and XII. The raw materials and packages are estimated to cost $ 6.313 million annually or $ 971 per tonne 75% DDT Wettable Powder, of which 64.8% is for imported materials (Volume 2 Appendix F V).

1.2.6 The factory would employ 126 people, of whom 42 would be staff. A suggested organisation chart is given in Volume 1 Appendix XIII.

1.2.7 The technical specifications for bid invitations for a 5 000 tonnes per year DDT plant and formulation facilities for 6 500 tonnes per year 75% DDT Wettable Powder are given in Volume 3.

1.3 The annual usage of 2,4-D and MCPA in rice and plantation crops is not expected, at the most optimistic, to exceed 500 tonnes by the late 1980's.

1.4 21 million tonnes paddy yielding 16 million tonnes rice were grown in 1977 leaving 2.4 million tonnes rice to be imported. The main pests are rats, stem borer, brown plant hopper and gall midge. The potential for rice insecticides is put at about 4 000 tonnes active ingredient per annum but no-one is prepared to predict which pesticides are likely to be used in 5 - 10 years' time although there is a strong feeling that the use of the presently favoured fenitrothion and diazinon will rapidly decline.

1.5 The current system of subsidising and distributing rice pesticides (the BIMAS scheme) does not give the rice farmer sufficient inducement to grow more rice and is open to considerable abuse.

1.6 Crop losses of 10 - 20% due to rats have been measured but there is little evidence of any systematic control measures.

1.7 Extension services are under-staffed and unable to cope with schemes to intensify crop production.

2 INTRODUCTION

2.1 Project Background

2.1.1 Indonesia consists of 25 Provinces formed from a collection of over 4 000 islands (the largest being Java, Sumatra, Kalimantan and Sulawesi). There are over 37 different social groups each with their own language although the official language "Bahasa Indonesia" is in many respects similar to Malay and is now widely understood. Each Province is headed by a Governor and divided, for administrative purposes as follows :

Kabupaten - Headed by a Bupati

Kecamatan - Headed by a Camat (ca 4 to a Kabupaten)

Kelurahan (village) - Headed by a Lurah (ca 3-4 to a Kecamatan)

Kampong (hamlet)

A village can have about 1 000 houses and there is usually a "headman", who responds to the Lurah, in charge of a group of 10 houses.

The population of Indonesia is over 130 million of whom about 70 to 80 million live in Java and Bali. The population is stated to be increasing at 2.3% per annum.

2.1.2 Rice is the staple food crop, 16 million tonnes being produced in 1977. Nevertheless, a further 2.4 million tonnes had to be imported. Rice consumption is increasing at the rate of 1.7 kg per head per year. There is a considerable production of vegetables and fruits by small holders. Estates, essentially in Sumatra, produce oil palm, rubber, tea, cocoa, tobacco. 70% of the pesticides in agriculture are used in paddy fields where the price to the farmer is heavily subsidised under the BIMAS scheme. Pesticides for other agricultural uses are not subsidised.

2.1.3 Mosquitoes are a serious pest as vectors for malaria. The Ministry of Health, in collaboration with WHO and partly financed by US AID, carries out extensive spraying with DDT of houses in non-urban areas of Java and Bali in an attempt to control this pest. The other islands have so far received little attention.

2.1.4 A great potential increase of the use of pesticides in Indonesia was identified by the joint UNIDO / FAO survey carried out in 1973 / 74. The team identified DDT, HCH (now banned in agriculture except for wood preservation) organo phosphorus insecticides and 2,4-D / MCPA type herbicides as being potentially attractive for local production.

2.2 Outline of Official Arrangements

2.2.1 Since the Government of Indonesia attaches great importance to the development of the chemical industry and improved agricultural production, agreement was reached with UNIDO towards the end of 1977 to implement the recommendations of the 1973 / 4 survey that feasibility studies into the manufacture of the above mentioned pesticides (except HCH) should be carried out.

2.2.2 The expert was recruited in February, 1978 with the terms of reference given in the Job Description (Appendix I).

2.2.3 Because of the specialist nature of the project it was agreed that the expert should spend about 3 months in the field updating the information obtained by the 1973 / 4 team and collecting new data as required. The balance of the 6 months would be spent at the expert's home base analysing the data, writing the report, feasibility study and technical specifications for tender documents.

2.2.4 The expert took up his appointment on 3 March 1978 arriving in Jakarta on 8 March. He left Jakarta on 9 June and after debriefing by WHO in New Delhi and UNIDO in Vienna returned to the UK in 16 June.

2.2.5 The expert was given an office, with secretarial assistance, in the Directorate General of Chemical Industries in Jakarta. A chemical engineer, from the planning section of the Fertiliser and Petrochemicals Sub-directorate was assigned as counterpart, to arrange meetings and accompany the expert on visits etc.

2.2.6 The UNIDO Senior Industrial Development Field Adviser (SIDFA) in the UNDP office in Jakarta assisted with any administration problems.

2.2.7 The project was completed and reports written by 2 September 1978.

2.3.1 <u>Objectives of Project</u>

2.3.1.1 To determine whether the basic manufacture of pesticides in Indonesia would improve the social life and standard of living of the Indonesian people in general and the farming community in particular.

2.3.1.2 To determine which pesticides are likely to be used over the next 10 - 15 years in sufficient quantity to warrant basic manufacture.

2.3.1.3 To determine the extent to which such manufacture would use up indigenous raw materials.

2.3.1.4 To determine whether the capital investment involved would be justified.

3 FINDINGS

3.1 Use of Pesticides in Indonesian Agriculture

This section is not intended to be an exhaustive account of Indonesian agriculture but gives sufficient data to justify the recommendations made.

Because of the difficulty of obtaining and interpreting statistics, it is virtually impossible to obtain a meaningful figure for the total usage of pesticides (insecticides, fungicides, herbicides and rodenticides) in Indonesian agriculture. The problem is becoming more complicated by the increase in local formulation, statistics for which are treated in a completely different way from those of imported formulated pesticides. In 1977 the latter amounted to :

	Tonnes / kilolitres
Insecticides	390
Fungicides	781
Herbicides	258
Others	172
	1601 tonnes / kilolitres formulated product

3.1.1 Rice Cultivation

3.1.1.1 Rice is the most important (and often the only) source of nutrition for the majority of the Indonesian people and accounts for over 70% of the pesticide usage in the country. Efforts are being made by the Government to promote the consumption of maize, cassava, sorghum and other starch foods. The Asean Bureau of Science and Technology would like to intensify the production and consumption of the winged bean - Psophocarpus tetragonolobus - which is high in protein and is indigenous throughout S E Asia. The average consumption of rice is about 120 kilos per head of population increasing at about 1.7 kilos per head per annum. In some industrial areas it has already reached 160 kilos per head. In 1977 rice production amounted to about 16 million tonnes (about 31 million tonnes paddy) - some 1½ million tonnes short of plan - and a further 2.4 million tonnes was imported at over twice the cost of local production.

With the population increasing at 2.3% per annum and rice consumption increasing at 1.7 kg per head per annum it is obvious that every effort must be made to increase production which is at present in the hands of some 30 - 35 million farmers each farming about ¼ to 1 third hectare. The Second Five Year Development Plan (Repelita II) 1974/5 to 1978/9 gave great emphasis to this need for increased production and the present BIMAS ("intensification programme") scheme whereby rice farmers obtain credit for the purchase of fertilisers and pesticides (both heavily subsidised) and sprayers (not subsidised) was developed. The budgeted cost in Repelita II for the programme for increasing the production of paddy, secondary crops and horticulture was Rps 399 200 million ($ 960 million) - 40% of the total budget in the Agriculture and Irrigation Sector.

Repelita III will no doubt continue to give emphasis to this problem.

3.1.1.2 Pest Problems

The major pest problems in rice cultivation are :-

Rats - crop losses of 10 - 20% have been measured. A number of rodenticides are available but there is no evidence that any concerted effort to control this pest has been made.

Stem Borer (*Tryporyza incertulas*) which accounts for a yield loss equivalent to 40 000 to 50 000 hectares (0.7%) annually.

Brown Plant Hopper (*Nilaparvata lugens*) (known locally as Wareng) which in 1976 accounted for a yield loss equivalent to 200 000 hectares (2.8%).

Carbofuran is considered by the Plant Protection Department to be the best insecticide available to control this pest.

However, due to its mammalian toxicity, carbofuran must be formulated as a granule. Imported granules are very expensive and until a locally formulated non-dusty granule, acceptable to the Plant Protection Department, is made available it is unlikely that the use of carbofuran will increase. The value of diazinon and fenitrothion is now being questioned by research institutes who seem to be counting upon the development of rice varieties resistant to brown plant hopper attack. Acephate is reported as being highly effective against this pest in the Solomon Islands.

Gall Midge (*Pachydiplosis* spp) - no estimates of losses available.

3.1.1.3 Pesticide Usage

Concrete information on the actual usage of pesticides on rice is difficult to obtain. Published figures tend to be high and do not always agree from source to source. It is well known that farmers sell some of their allocation of pesticides to vegetable growers and estates. Furthermore, if all the pesticides claimed to be used were actually used, a further 500 000 sprayers would be required.

19 formulations (by Trade Name) of insecticides, 3 of fungicides and 4 of rodenticides are now approved by the Plant Protection Department for distribution under the BIMAS scheme. Herbicides are not featured as it is cheaper to use hand-labour which is plentiful in Java and Bali. Rice herbicides may however find a place in transmigration areas where farmers will not have enough labour to cope with their 5 hectares. Even here, however, the weeds are likely to be a mixture of broad leaved weeds, grasses and sedges requiring different herbicides for their control. The Plant Protection Department do not estimate the usage of the phenoxyherbicides 2,4-D and MCPA in rice to exceed 150 tonnes per annum by 1988 although certain estimates by commercial firms have come as high as 300 tonnes.

The distribution of formulated pesticides under the BIMAS scheme is given in Appendix II.

The 1975/6 insecticide figures have been analysed by active ingredients and compared with planned purchases for 77/78 and 78/79 with the results shown in Appendix III.

The potential for insecticides in rice is estimated by the Agricultural Research and Development Institute, Bogor at about 4 000 tonnes active per annum (ie 2 litres of 50% formulation x 2 applications per season x 2 seasons per annum x 10 million hectares). However, no-one is prepared to predict what the pest complex will be in 5 - 10 years' time although there is a strong feeling that the use of the present most favoured insecticides - diazinon and fenitrothion - will rapidly decline.

3.1.1.4 The BIMAS Scheme

A number of incentive schemes to try to increase rice production have been devised. The current BIMAS scheme works roughly as follows :

Farmers receive credit for the purchase of fertilisers, insecticides, fungicides and rodenticides (all heavily subsidised) and knapsack type sprayers (not subsidised).

Depending upon the recommendations of the Plant Protection Department of the Ministry of Agriculture and taking into account the anticipated requirements of farmers as collected by the Provincial offices from the villages, BIMAS invites offers for a list of products from local formulators / importers. Once the purchase negotiations have been completed and the products are available, the two distributing agencies, PT Pertani and PT Pusri collect the products from factories or warehouses and deliver them to stores in each Kabupaten from where they are collected by farmers or cooperatives. Farmers are charged a flat rate of Rps 1230 per litre for their insecticides which is only between 25% and 35% of the actual cost. In practice, farmers receive a substantial credit for the purchase of pesticides, fertilisers and sprayers so they do not have to pay for their insecticides until the harvest is in. Even then, farmers cannot always afford to pay and there are substantial debts. Under plague conditions the Ministry of

Agriculture sprays the area from the air at no cost to the farmer (The Ministry of Agriculture possesses a number of small single engined monoplanes which are flown and serviced by the Indonesian Air Force).

A better understanding of the finances of a typical rice farmer with 4 dependents, owning 1 third of a hectare, can be had from the following calculations :

Cost of insecticide	:	3 litres @ Rps 1 230 =	Rps 3 690 per hectare
Cost of fertiliser	:	300 kg @ Rps 100 =	Rps 30 000 per hectare
		Total (say)	Rps 33 700 per ha or Rps 11 200 per farm

Paddy yield, say, 4 000 kilos per hectare @ Rps 60 per kg = Rps 240 000 per hectare.

Average holding is only 1 third hectare.

Therefore Farmer's income	=	Rps	80 000
Less cost of insecticide and fertiliser	=	Rps	11 200
Net annual income		Rps	68 800 *

Government statistics indicate that a family of 5 need about Rps 100 000 a year to live adequately.

With this unsatisfactory state of affairs it is not surprising that :

i) children are leaving the land to try and get work in the cities

ii) farmers are selling their land to speculators who do not always re-employ them

iii) farmers do not take advantage of the BIMAS scheme

iv) farmers sell all or part of their subsidised fertilisers and insecticides at a higher price to vegetable growers and plantations who do not get subsidised goods

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* This may be compared with a car driver, employed by a Government Department, who earns Rps 12 000 per month plus a free issue of 10 kilos rice per head of family per month (say 50 kilos) at Rps 150 per kg = Rps 7 500 giving a total remuneration of Rps 234 000 per annum.

3.1.4.5 The Future

The production of rice will not catch up with increasing demand unless a number of urgent steps are taken :

These would include :

i) Use of high yielding varieties

ii) Increased use of fertilisers

iii) Improved crop management

iv) Improved pest management

v) Improved distribution of pesticides

There are at present a number of difficulties in achieving these objectives viz :

i) High yielding varieties seem to be more susceptible to accurate timing of application of fertilisers and pesticides

ii) Farmers are not sufficiently aware of the problems and of the need for forward thinking in their crop protection programmes

iii) This will demand greater efforts by the already stretched government extension services

iv) Farmers should be given a freer hand in choosing which pesticides they can buy. This can only be done effectively by allowing manufacturers to undertake the distribution to village level as recommended by Resource Planning Consultants Limited in their 1975 / 76 study

v Farmers must be given an economic incentive to grow more rice. The present subsidy scheme does not do this and some alternative scheme (eg paying the farmer a fair price for his effort and subsidising the consumer price for rice) should be considered

vi) The present tiny parcels of individually owned land are not conducive to improved crop and pest management.

Tied in with a better extension service, some form of village cooperatives should be considered whereby there is a pooling of labour and crop protection measures.

3.1.2 Plantation Crops

3.1.2.1 Next to rice, the plantation crops must be considered most important, as they bring in much foreign revenue.

Estimates may be divided into categories as follows :

Smallholders - very small, under 1 hectare

Private estates - 500 to 2 000 hectares

Foreign estates - ca 6 000 hectares

Government estates - 5 000 to 8 000 hectares (There are 30 of these)

A list of crops with estimated planted areas and production for 1976 is given in Appendix IV.

3.1.2.2 Pesticide Usage

Most pesticides are used by the private and foreign estates. The smallholders are so weak economically that their pesticide usage is minimal and unlikely to increase rapidly although some large scale demonstration trials were carried out in 1976 by the Directorate General of Estates to try and encourage pesticide usage.

The use of pesticides in Government owned estates accounts for only 2% of production costs and there is little sign of change. This is related to agricultural practice, the use of shade trees and shortage of cash. There is a very slight increase in fertiliser usage which, at present, accounts for about 15% of costs.

Little information could be obtained on pesticide usage by foreign estates.

Pesticide usage in the private estates was 1 100 tonnes formulated product in 1977. This is expected to increase to about 1 250 tonnes by 1983 viz.

Insecticides	-	275 t (mainly dichlorvos, methomyl, endosulfan, carbaryl)
Fungicides	-	270 t (mainly copper oxychloride, dithiocarbamates)
Herbicides	-	805 t (mainly dalapon, sodium chlorate, 2,4-D, paraquat, diuron)

The 2,4-D / MCPA usage is small and consumption estimates by 1988 vary from 50 to 200 tonnes active acid.

3.1.3 Other crops

Secondary crops with 1976 production figures are :

	'000 tonnes
Maize	2 512
Cassava	12 468
Sweet potatoes	332
Soya beans	482

A considerable quantity of vegetables is grown in small holdings. All the above are outlets for pesticides but the total usage is insignificant compared with that for rice and plantation crops.

3.2 Pesticides in Public Health

3.2.1 Mosquito Control

3.2.1.1 Current Practice

As the use of pesticides for mosquito control is entirely in the hands of the Ministry of Health and only one pesticide - DDT - has so far been used, data on current usage and prognostications for the future were easier to obtain than in the case of agricultural pesticides.

Some 4 000 tonnes 75% DDT WP are used annually, mainly in Java and Bali. Most of this has been supplied under loans from the US Agency for International Development (AID) who provided US $ 22 million for the purchase of DDT during Repelita II. The formulated 75% DDT WP was obtained from Montrose Chemical Corporation of California, the latest price being $ 1 430 per tonne cif. In addition to purchases under US AID, the Ministry of Health have purchased 75% DDT WP on their own account, the most recent being 700 tonnes from Rhône Poulenc at Rps 635 000 per tonne cif ($ 1 530 per tonne) packed in 35 kilo cartons with polyethylene liners (MB. Customs duty is waived on this).

All spraying of houses down to Kelurahan (village) level, but not to isolated Kampongs, is carried out by the Ministry of Health who distribute the DDT WP in its original containers to spray centres where it is repacked into 470 gramme polyethylene packages, the unit quantity for one sprayer load. The application rate to village houses is 2 gramme 75% DDT WP per m^2 wall area or approximately 600 g per house. Theoretically, spraying should be carried out twice a year but due to shortage of trained personnel, some areas only get sprayed once.

3.2.1.2 The Resistance Problems

In recent years it has been observed in Central Java that one species of mosquito, Anopheles aconitus, was no longer being controlled by the traditional application of DDT.

The WHO Vector and Rodent Control Research Units in Jakarta and Samarang has been investigating this problem with experts from the Ministry of Health and it is currently thought that the reason is that A aconitus has changed its behaviour pattern.

With the average mosquito, the male injects a quantity of sperm into the female who carefully stores it. The female then develops an egg inside her body, and fertilises it with a small quantity of the sperm. She now requires protein to feed the egg. This she obtains by biting an animal or a human being and drinking the blood. She then rests, usually on the inside wall of a house or cattle shed, while the food is digested. It is during this resting period that she picks up DDT from the sprayed wall and dies before having laid her egg. Aconitus, however, now appears to be resting only momentarily, and does not pick up the lethal dose of DDT, before laying her egg under some inaccessible stone at a nearby water course. Since 1976, the WHO unit at Samarang have been experimenting with fenitrothion, malathion, chlorphoxim (OMS 1197) pirimiphos methyl (OMS 1424) and an unidentified biodegradable analogue of DDT (OMS 1856) as wettable powders and fenitrothion as a ULV (ultra low volume) fog.

Malathion has failed completely as also has OMS 1856. Very good results have been obtained with fenitrothion WP at 2 g active per m^2 but results with the ULV fog were erratic. Control with chlorphoxim broke down after 6 weeks. Results with pirimiphos methyl seem very promising. As a result fenitrothion WP will be used for mosquito control in certain areas from 1979. This decision is causing some worry in certain circles who are afraid that the spray gangs will not adopt all the stringent safety precautions laid down by the WHO unit and illness to spray operators may result. However, the Ministry of Health are hoping that an organo phosphorus compound will only be needed for three years by which time A aconitus will have once more reverted to a totally endophyllic creature and be capable of control with DDT.

3.2.1.3 The Future

Although little is known about mosquito behaviour in the remoter parts of the "other islands" (ie outside Java and Bali) the Ministry of Health is convinced that the use of DDT will continue for at least 10 - 15 years. Intensification of control measures in the transmigration areas is essential as it has been found that the Javanese and Balinese are very susceptible to malaria after having been moved to Sumatra and Kalimantan.

Discussions have recently taken place between Ministry of Health and US AID officials and the requirement of pesticides for mosquito control for Repelita III (April 1979 to March 1984) has been put at :

16 000 tonnes 75% DDT WP for Java and Bali (ie 12 000 tonnes technical DDT)

16 000 tonnes 75% DDT WP for the other islands (ie 12 000 tonnes technical DDT)

1 000 tonnes 40% fenitrothion WP for Central Java (used over 3 years)(ie 400 tonnes technical fenitrothion)

The Ministry of Health have stated that in the first year of Repelita III, 3 800 tonnes of 75% DDT WP (2 850 t technical DDT) would be required for Java and Bali. This would reduce over the next two years but might increase again.

The following pattern of usage might be used for planning purposes :

	tonnes 75% DDT WP	tonnes technical DDT
1979/80	3 800	2 850
1980/81	3 500	2 625
1981/82	3 000	2 250
1982/83	2 700	2 025
1983/84	3 000	2 250
	16 000	12 000

It has been agreed that the Indonesian Government will purchase the DDT for Java and Bali.

US AID will make a loan of US $ 40 million to be used as follows :

US $ 25.5 million for DDT for the "other islands"
US $ 3.5 million for fenitrothion for C Java
US $ 11.0 million for equipment etc

US AID officials in Jakarta are unsure of the position should Indonesia produce part of its requirements of DDT. Under present regulations, AID loans must be used for purchasing USA-made materials if these are available. If not available ex USA, then purchase must be made from another country contributing funds. The officials in Jakarta are convinced that, whatever happens, AID loans would continue to be made available.

3.2.1.4 DDT Requirements in the Indian Sub-Continent, South East Asia and West Pacific

In order to put Indonesia's requirements for DDT in perspective, the WHO South East Asia Regional office in New Delhi and the Mediterranean Regional Office in Geneva provided the following figures :-

Country	Tonnes 75% DDT WP	
	1978	1982
Pakistan	1 000	100 (3)
Nepal	1 060	800
Thailand	1 750	2 000
Bangladesh	1 185	1 000
Burma	577	600
India	16 700 (1)	17 000
Sri Lanka	350	NIL (3)
Sabah	100	100 (2)
Philippines	250	250
Sarawak	250	250
Singapore	NIL	NIL
Peninsular Malaysia	500	50

(1) Plus large quantities of malathion and HCH

(2) May switch to emulsion concentrate

(3) Switching to malathion

The possible switch to emulsion concentrates by Sabah is interesting. If this could be fostered throughout, it would mean that a grade of DDT with less demanding physical characteristics would be required. This would be much cheaper to produce, particularly if an indigenous source of aromatic hydrocarbon solvent could be made available.

3.2.2 Household insecticides

Although large quantities of aerosols and dilute insecticidal liquids are sold in urban areas, the quantities of active pesticide involved are very small compared with other outlets. No accurate figures are available.

3.2.3 Rodenticides

The quantity of formulated rodenticides purchased by BIMAS is given in Appendix II. Rodenticides are, of course, also used in urban districts and in non-rice growing agricultural districts. There is no information on quantities but in terms of 100% active ingredients the usage is very small.

3.3 Pesticide Formulation in Indonesia

Nine firms have been licenced by the Directorate General of Chemical Industries to formulate pesticides. These are listed, with their nominal production capacities, in Appendix V. The plants of six of these firms were visited. There would appear to be ample capacity for the formulation of emulsion concentrates and granules. Wettable powder formulation capacity is small and the industry could be found wanting **if** there were a sudden demand for new wettable powder formulations.

The granule formulating capacity at PT Petrokimia Kayaku and PT Agrocarb Indonesia would appear to be grossly underused. This is probably due to the fact that, although rice farmers like to use insecticide granules their cost makes them unattractive, even with BIMAS subsidies.

This may be illustrated with reference to diazinon.

Diazinon 60% EC costs Rps 38 000 per litre from formulator

Farmer pays	Rps 1 230 per litre
Government subsidy	Rps 2 570 per litre

Diazinon 10% granules cost Rps 1 085 per kilo from formulator

Farmer pays	Rps 200 per kilo
Government subsidy	Rps 885 per kilo

The liquid is used at 2 - 3 litres per hectare and the granules at 20 - 30 kg per hectare.

Thus the products cost (per hectare)

	Liquid	Granules
To farmer	Rps 2 460 to 3 690	Rps 4 000 to 6 000
To Government	Rps 5 140 to 7 710	Rps 17 700 to 26 550
Total cost	Rps 7 600 to 11 400	Rps 21 700 to 32 550

Diazinon granules do not feature in the list of BIMAS requirements for 1978 / 79.

The Directorate General for Chemical Industries has stated that applications by new firms for formulation licences would be refused.

3.4 Manufacture of Fertilisers, Sulphuric acid, Chlorine and Alcohol

This part of the study was undertaken to find out how the Indonesian chemical industry worked, what raw materials might be available for pesticide manufacture with particular reference to DDT, what are the costs of labour, services etc and where could a pesticides plant be situated.

3.4.1 General

At the time of the UNIDO / FAO 1973 / 74 survey, it was confidently expected that the petroleum industry would diversify into aromatic chemicals, thus providing Indonesia with the basic raw materials for an organic chemical industry. These plans have now been shelved indefinitely.

The major industrial chemicals being produced are :

Urea - PT Pusri, Palembang, S Sumatra and PT Petrokimia, Gresik, E Java (plus a new plant being built near Jakarta)

Ammonium sulphate	-	PT Petrokimia, Gresik, E Java
Ammonia	-	PT Petrokimia, Gresik, E Java
Sulphuric acid	-	PT Petrokimia, Gresik, E Java
Caustic Soda	-	PN Soda, Waru, E Java
Chlorine	-	PN Soda, Waru, E Java
Ethyl alcohol	-	PT Asen Pabuaran, Mojokerto, E Java

Propylene and polypropylene - PT Pertamina, Plaju, S Sumatra

A triple superphosphate plant is being erected and a diammonium phosphate plant is proposed, both by PT Petrokimia at Gresik, who also have plans for the manufacture of acrylonitrile, caprolactam and phosphoric acid.

3.4.2 PT Pupuk Sriwidjaja (Pusri), Palembang, S Sumatra

This plant was visited to get a general picture of a large Indonesian complex in action. With the latest extensions opened in 1977, the plant produces 2 800 tonnes per day ammonia most of which is converted into 4 900 tonnes per day urea (over 1 million tonnes per annum) using piped natural gas. The ammonia process is by Kellogg and the urea process by Toyo. They also have a plant for producing woven polypropylene from polypropylene chips and lay-flat polyethylene tubing from polyethylene chips for making the outer and inner bags for urea.

Although most of Pusri's urea production is for internal use, they have a healthy export business to India, Philippines, Malaysia, Thailand, Pakistan, Sri Lanka, New Zealand, Australia and Zambia.

They own four 7 500 tonnes bulk ships and have direct loading facilities.

Under an agreement with the Technical University of Bandung, Pusri run their own training centre.

The plant has every appearance of being well-run with a high standard of housekeeping and safety consciousness.

3.4.3 PT Petrokimia Gresik, E Java

This plant was visited with particular reference to the siting of a DDT plant. Established in 1972 they are producing ammonia plus 45 000 tonnes per annum urea using an Italian process based on fuel oil. They also produce sulphuric acid (400 tonnes per day) from imported sulphur using a Monsanto process. Most of this is used to produce ammonium sulphate but they have excess capacity of 50 - 70 tonnes per day 98% acid. The plant could easily be modified to produce the 20% oleum (fuming sulphuric acid) required in a DDT process. A triple superphosphate plant and jetty for deep sea vessels is being constructed.

PT Petrokimia also have a plant for purifying river water and supply neighbouring factories.

As by-products from their urea and ammonia sulphate activities they sell liquid and solid carbon dioxide, ammonia and oxygen.

The general standard of housekeeping and safety was considered poor, but this could easily be rectified by management.

Even allowing for the proposed expansions into new products there is plenty of land available for a DDT plant although extensive piling would be necessary (in common with all flat land in Java).

3.4.4 PN Soda, Waru, E Java

This plant was visited with a view to ascertaining their production plans and excess chlorine capacity since it is only 25 kms from Gresik and the only chloralkali plant in Indonesia.

The plant was erected in 1953 with a capacity of 10 tonnes per day sodium hydroxide (100%) and 8.86 tonnes per day chlorine. With no development of the chemical industry, demand soon fell back until by 1969 they were working at only 17% capacity. Since 1971 demand has steadily picked up and a new extension is being built and a further one planned for 1980.

Production may be summarised as follows :

Product	Existing	1st Expansion due on stream end 1978	2nd Expansion due on stream 1980	Total by 1980
	t/day (t/y)	t/day (t/y)	t/day (t/y)	t/day (t/y)
Caustic soda liquor (as 100%)	10 (3 000)	20 (6 000)	10 (3 000)	40 (12 000)
Chlorine	8.9 (2 670)	17.8 (5 340)	8.9 (2 670)	35.6 (10 680)
Hydrochloric acid (35%)	20 (6 000)	30 (9 000)	20 (6 000)	70 (21 000)
Liquid chlorine (99%)	3 (900)	15 (4 500)	-	18 (5 400)
Bleach liquor (8%Cl)	20 (6 000)	20 (6 000)	10 (3 000)	50 (18 000)
Sodium hypochlorite (12%Cl)	3 (900)	10 (3 000)	15 (4 500)	28 (8 400)

Chlorine is at present only available in 1 tonne, 100 kilo and 50 kilo cylinders. At least one 14-tonne road tanker would be required to move chlorine to the proposed site for a DDT plant at Gresik. Sodium hydroxide is only available as 40% liquor.

At present mercury cells are used but the 1980 expansion will use diaphragm cells. As a long term project, they would like to replace all the existing plant with diaphragm cells and produce 50 tonnes per day caustic soda. This would then give them an extra 9 tonnes per day chlorine making a total of about 13 500 t/y chlorine.

It can be seen from the above table that, on present plans, PN Soda, Waru will only have available 15 - 18 tonnes excess chlorine per day which would be sufficient for making chloral for 3 000 tonnes per year DDT. However, since the chlorination of alcohol is not very efficient on chlorine and unreacted chlorine has to be scrubbed from the entraining gases after the reaction, this could be used for making sodium hypochlorite. Similarly the hydrochloric acid from the reaction can be trapped. It is thus considered that 5 800 tonnes per year of PN Soda, Waru's chlorine can be more efficiently utilised for chlorinating alcohol to give chloral sufficient to make 5 000 tonnes per year DDT, producing, at the same time 7 000 tonnes per year sodium hypochlorite liquor (12% Cl) and 5 830 tonnes per year hydrochloric acid (35%).

3.4.5 <u>PT Asen Pabuaran (Alcohol Factory Wates), Mojokerto, E Java</u>

This plant was visited since ethyl alcohol is required for DDT manufacture and the plant is only 75 kms from Gresik. Established in the late 19th Century, this plant produces, from molasses, 12 million litres per year (10 000 tonnes) ethyl alcohol - min 95% v/v - from a total of 22 million litres produced in Indonesia. Production could be increased if necessary. At present some 9.5 million litres / year are exported to Japan. The firm owns 6 x 5 000 litre tankers and can see no problem in delivering to Gresik. The current price for Super Grade is Rps 170 per litre ($ 520/t) ex works (tax not paid) but no doubt for an off-take of 1 600 tonnes per year (2 million litres) a special price could be negotiated.

Specifications of the grades of alcohol available are given in Appendix V.

The factory also has available fusel oil (amyl alcohol) as a by-product but there is no outlet in Indonesia.

3.4.6 Costs of labour, plant services, land etc

Considerable information was obtained when visiting these factories and these data have been incorporated in the feasibility study (Volume 2).

3.5 Site Selection

The parameters for selecting a site for the manufacture of pesticides in Indonesia are :

i) The land must be reasonably flat (but not subject to flooding) and of low earthquake potential

ii) It must be close to an international port to facilitate imports and exports

iii) It must be close to the indigenous raw material sources

iv) There must be good road and rail access

v) There must be a good water and electricity supply

vi) It must be close to a large river or the open sea for ease of discharge of detoxified liquid waste

vii) It should not be too close to a large urban area

viii) There should preferably be some form of chemically oriented infrastructure already available

Since it has already been decided to concentrate on the production of DDT, the major raw materials for which are chlorine, alcohol, monochlorobenzene and oleum, a site alongside PT Petrokimia's fertiliser works at Gresik, E Java, seems an obvious choice because :

i) chlorine is available from P N Soda, Waru, only 20 km away;

ii) alcohol is available from PT Asen Pabuaran, Mojokerto, 75 km away;

iii) oleum can be made available from PT Petrokimia who also have available the remaining facilities listed above

The main disadvantage of the site is that the land is soft clay but this is typical of the majority of coastal land in Java.

Other possible sites would be :

Alongside the chloralkali plant at Waru

On the industrial complex in Surabaya

Near the alcohol factory at Mojokerto

The Waru site is rejected because the area is already heavily congested, there is a shortage of water and disposal of treated effluent could be a problem. The last two points also apply to the industrial complex at Surabaya. The only point in favour of Mojokerto is that it would be close to the source of alcohol but this is greatly outweighed by its distance from other sources of raw materials and port facilities.

3.6 Contractors, Fabricators and Associated Skills

A number of international contractors have offices in Indonesia where they are engaged in petroleum / natural gas, fertilisers, irrigation, bridges, steelworks etc.

There is a strong Association of Indonesian Contractors who concentrate mainly on civil works (offices, hotels, department stores etc).

There are also capable Indonesian firms who act as supervisory contractors and quantity surveyors.

Building materials such as cement, bricks, asbestos sheet, steel plate and reinforcing rods are available from local manufacturers. Metal pipes and stainless steel sheet have to be imported but good fabrication facilities are available (eg the off-shoot of the Army central workshops in Bandung - IKABI-DME - which has designed and built palm oil processing factories, crumb rubber factories etc). All pumps, motors, electrical switchgear etc have to be imported.

Thus, for a DDT plant, although most of the equipment would have to be imported, and its erection supervised by representatives of the firm supplying the know-how, all civil works such as land clearance, piling, roads, drainage, factory and office buildings can be handled by companies operating permanently in Indonesia. Simple storage vessels of mild or stainless steel capable of withstanding 3 bars pressure can also be fabricated.

3.7 Cost of land, building, and services

3.7.1 Land

Cost of land in the Surabaya area is estimated at Rps 8 - 12 000 per m^2. With excavation and back-filling an average price for a prepared site may be taken as Rps 12 000 per m^2.

3.7.2 Building

The cost of building warehouses, factory shells and unpretentious offices with normal services including air conditioning is Rps 80 - 120 000 per m^2. Examples of material costs are given in Appendix VII. Materials for concrete would work out at about twice UK cost, steelwork about the same and timberwork about half. Examples of costs of labour and staff on building sites are given in Appendix VIII.

Piling varies according to type, eg

50 tonne pre-cast piles (made on site)	- Rps 15-18 000 per metre
100 tonne "Frankipiles"	- Rps 20-25 000 per metre
300 tonne bored piles, 900 mm diam	- Rps 75 000 per metre

(NB - The soft clay in the Gresik area would require piling to a depth of at least 20 metres)

Buildings and equipment are depreciated over 10 years.

3.7.3 Services

3.7.3.1 Electricity

The price structure issued by PLN (State Electrical Authority) is :

- installation cost : Rps 72 750 / KVA
- operating cost -

Fixed charges :	first	400 KVA - Rps 460/KVA/(month)
	then	600 KVA - Rps 420/KVA/(month)
		1 000 KVA - Rps 375/KVA/(month)
		2 000 KVA - Rps 275/KVA/(month)

- Supply charges : Rps 8.75/kWh
- Surcharges : Rps 8.50/kWh

PT Petrokimia Gresik would charge the same for any power they supplied.

3.7.3.2 Water

The price of water supplied by PAM (State Water Authority) is Rps 115 per m^3.

PT Petrokimia Gresik would charge the same for any water they supplied. A typical composition of their water is given in Appendix IX.

3.8 Salaries, Wages, Medical and Fringe Benefits

3.8.1 General

Salaries and wages vary considerably depending upon area and type of employer. Private firms pay more than the Government but Government employees receive certain fringe benefits which help to make up the difference. The figures given below are those provided by PT Petrokimia Gresik which is registered as a joint Government / Private concern.

3.8.2 Staff and Labour costs

Salaries are as follows :

a. Staff

Staff	Take home pay per month
Plant Manager	Rps 164 000 - Rps 210 000
Manager	141 000 - 172 000
Superintendent	124 000 - 153 000
Asst Superintendent	110 000 - 136 000
Supervisor	96 000 - 122 000
Foreman	85 000 - 108 000

b) Non Staff

Leadmen/Senior Operators	Rps 61 000 -	Rps 80 000
Craftsmen-I/Operators I	55 000 -	73 000
Craftsmen-II/Operators II	45 000 -	66 000
Craftsmen-III/Operators III	23 000 -	41 000

c) Casual Labour

Daily rate	- min.	Rps 350 per day
	- max.	Rps 850 per day

Rates of pay vary with length of service and with the number of dependants. Average figures have been used for the feasibility study.

Although PT Petrokimia Gresik only pay 12 months' salaries in a year, there seems to be a tendency for firms to give an extra 1 month's salary as a holiday bonus.

The normal working week is 40 hours. Overtime pay is usually twice the normal rate on weekdays and three times normal on Sundays.

Shift bonuses :	Staff	Rps	3,500 per month
	Non-Staff	Rps	2 250 per month

3.8.3 Social Security

A Government scheme is just being evolved and the following proposed premiums based on salaries have been published :

Accidents at work (chemical industry) : Employer 17.4 per thousand

Old age savings :	Employee	1%
	Employer	1½%
Life Insurance :	Employer	½%

PT Petrokimia Gresik at present have the following scale :

Old age pension :	Employer 16.1%
Accident Insurance :	Employer 17.4 per thousand
Life Insurance :	Employer 2%
	Employee 1%

Hospitalisation : Expenses paid by employer - allow Rps 125 000 per employee per annum

Thus a gross figure of 20% of salaries would appear reasonable for costing purposes.

3.8.4 Fringe Benefits

All directors and department heads / plant managers receive a free car worth Rps 3 million. All staff are given free furnished accommodation valued at about Rps 15 million per house. Water and electricity are free. However, as it is not UNIDO practice to include such charges in a feasibility study, they have been omitted.

Staff-employees who are not provided with cars are either transported to work or receive an allowance - (say) Rps 25 000 per month. Office staff receive 3 sets of uniforms a year. Factory staff receive 4 sets. All receive two pairs of shoes a year. (This is in addition to any special protective clothing).

3.9 Taxation, Insurance and Audit Fees

3.9.1 Taxation

The Government of Indonesia Act No 1/1967 regarding Foreign Capital Investment, as amended by Act No 11/1970 makes important concessions to foreign investors, granting relief from all or part of :

- Capital stamp duty
- Import duty and sales tax on machinery and equipment
- Transfer duty on deeds of ships registration
- Corporation tax
- Dividend tax

Provision is made for cooperation between foreign and national capital.

Outside these reliefs, however, corporate taxation can be up to 40% of pre tax profits.

Customs duty is levied on a variable scale, the Brussels tariff nomenclature applying. Duty on formulated pesticides is at present 6% ad valorem whereas on the unformulated active ingredient it is 5%. The Ministry of Health obtain a special waiver of duty on any DDT Wettable Powder imported for mosquito control and it is not unreasonable to assume that such a waiver would apply to any products used in the manufacture and formulation of DDT.

Income tax is levied on employees but is usually paid by the employer. There appears to be a considerable margin for negotiation but an average figure for a medium sized company would appear to be 6% of gross salaries.

Tax on land is Rps 25 per m^2 per year.

Tax on buildings is Rps 60 per m^2 per year - levied after completion.

3.9.2 Insurance

Insurance on plant and buildings is approximately 2.5% per year.

3.9.3 Audit fees

Audit fees tend to be high and a figure of 1% of turnover is normal. However, UNIDO advise that these should not be included in a costing for a Government owned factory.

3.10 Effluent Regulations

The awareness of the Government of the necessity for strict control of environmental pollution is manifested by a decree of the Ministry of Industry No 12/M/SK/1/78 dated 26 January 1978 which enables the Minister to curtail the activities of industrial firms which are causing a nuisance. No limits for effluent etc have yet been prescribed. In Regulation No 173/MEN,Kes/Per/VIII/77 dated 8 December 1977, the Ministry of Health has laid down limits for the quality of water from water bodies and the quality of effluent from industry, mining and household waste. The latter is given in Appendix X.

3.11 The Manufacture and Formulation of DDT

The basic processes involved with mass balances are shown in Appendices XI and XII. The final reaction involves the coupling of 0.55 tonnes chloral with 0.81 tonnes monochlorobenzene using 2.11 tonnes oleum 20% as dehydrating agent to produce 1 tonne DDT with a minimum p-p' isomer content of 76%. This gives an efficiency of 76.6% on chloral and 78.4% on MCB. Better efficiencies have been quoted in early publications on DDT manufacture but these omit to mention the p-p' isomer content of the resulting DDT - a most important factor since material with only 70% p-p' isomer (the minimum permitted by WHO Specifications) is completely ungrindable.

3.11.1 A more common route to chloral is from acetaldehyde but since this is not available in Indonesia, the alcohol route has been chosen. A large excess of chlorine is used but this can be recovered as hydrochloric acid and sodium hypochlorite. Chloral is produced as the alcoholate from which chloral is liberated with sulphuric acid prior to the final coupling reaction with monochlorobenzene.

3.11.2 The erection of a plant to produce monochlorobenzene (MCB) is not recommended because :

- i) No indigenous benzene is likely to be available in the foreseeable future
- ii) There is insufficient chlorine available
- iii) Further capital would have to be employed in a plant to extract and purify the ortho- and para-dichlorobenzenes produced in the reaction
- iv) There is considerable world over production of MCB and, even though some US plants are being closed down, prices are likely to remain depressed for a long time

3.11.3 Part of the sulphuric acid recovered after the final coupling reaction is used to liberate chloral. If the plant is erected alongside Petrokimia's ammonium sulphate plant at Gresik, it should be possible to recycle the balance of the sulphuric acid to that plant after removing para-chlorobenzene sulphonic acid (PCBSA) and other impurities.

3.11.4 Formulation of the technical DDT to a 75% wettable powder to WHO Specification for Public Health use involves mixing with inert carriers (kaolin and silicic acid) and surface active agents, coarse grinding in a mechanical mill followed by micronising in an air mill, remixing and filling into suitable containers. Although, for export purposes American and European producers use special cartons with polyethylene liners, for local use in Indonesia, packages could consist of a bunch tied inner polyethylene bag with a stitched kraft paper outer.

3.12 Organisation for a DDT Factory

Bearing in mind that senior management, major engineering and some plant services can be made available from the existing PT Petrokimia facilities, and that there is only one customer - the Ministry of Health, a simple organisation headed by a Works Director would adequately meet the needs of a DDT plant.

A proposed organisation chart is given in Appendix XIII.

The total number of people employed would be :

Staff	42 of whom 20 would be on shift
Non Staff	84 of whom 64 would be on shift
	126

3.13 Training

3.13.1 The manufacture of organic chemicals such as pesticides involves relatively complex industrial chemistry which is not yet being attempted on any scale in Indonesia. Thus Indonesia will have to acquire an extensive range of new knowledge both in technical operations and management. Too much emphasis cannot be placed on the need for adequate planned training programmes particularly for technologists and technicians since the facilities available in Indonesianhigh schools and universities are inadequate, being limited to theory with little or no practical work.

3.13.2 A management team can probably be recruited from among those already familiar with the chemical industry eg PT Pusri and PT Petrokimia.

3.13.3 The implementation of training programmes is an area in which UNIDO could be of further assistance.

3.13.4 A programme, which should be accomplished before the start-up phase of the unit would include :

Introductory Courses	Organisation and its objectives, Policies
Management and Supervisory Training	Management techniques such as accountancy, critical path analysis, man management, instruction techniques etc
Technologists and Technician	Process method, business appreciation, safety training and hygiene, analytical control, maintenance
Techno Commercial / Advisory Personnel	Technical product knowledge. Persuasion skills
Clerical support staff	Administrative systems and procedures

3.13.5 Specialist technologist and technician training would preferably be the responsibility of the contractor in charge of the overall erection and start-up of the complex. He would arrange courses for Indonesian technologists and technicians at the manufacturing plants of those foreign firms supplying process know-how and equipment. As part of his contract he might also be asked to arrange for foreign experts to "shadow" the Indonesian technical management, not only during start-up but also for a further period of one to two years until the plants are running smoothly.

3.13.6 The Indonesian personnel to be sent overseas for training would comprise :

Personnel	Place of Training	Type of Training	Time
Works Manager	Suppliers of know-how	General technical management, Processes	2 months
Supervisor manufacture	Suppliers of know-how	Detailed process operation	3 months
Supervisor formulation	Suppliers of know-how	Detailed process operation	3 months
Supervisor maintenance	Suppliers of know-how	Maintenance management	2 months
Maintenance Foreman	Suppliers of know-how	Routine maintenance and problem diagnosis	2 months
Safety Officer	Suppliers of know-how	Hazards in handling materials, General safety standards, Site Security	1 month
Chief Chemist	Suppliers of know-how	Organisation of a Quality Control Laboratory	1 month
Analyst	Suppliers of know-how	Practical analytical procedures	2 months
Supervisor maintenance	Equipment Manufacturers	Details of equipment design and maintenance	2 months
Maintenance Foreman	Equipment Manufacturers	Details of equipment design and maintenance	2 months

3.14 Manufacture of Other Pesticides

3.14.1 Although involvement by the Government of Indonesia in the manufacture of pesticides for agricultural use is not recommended, for the sake of completeness the processes involved are outlined in Appendices XIV and XV.

3.14.2 2,4-D and MCPA

As stated in Section 3.1 the total annual requirement by mid-1980's is, at the most optimistic, 500 tonnes. This quantity does not warrant the setting up of manufacture particularly since the raw materials (chlorinated phenol and cresol and monochloroacetic acid) will not be available in Indonesia. Even carrying out the final condensation stage (Appendix XIV Stages 3a and 3b) would involve the importation of about 1¼ tonnes raw materials to produce 1 tonne active acid which would not be economic particularly in view of the depressed world market for these herbicides. Furthermore, these reactions produce unpleasant by-products which can contaminate the atmosphere and waterways if expensive treatment mechanisms are not installed.

3.14.3 Organo phosphorus compounds

The arguments against the manufacture of these products are much the same as for 2,4-D and MCPA and have been further elaborated in Section 3.1.1.3.

Stages 1, 2 and 3 involve toxic and dangerous chemistry (the reaction between phosphorus pentasulphide and methanol is particularly hazardous) which, in the expert's opinion, should only be undertaken by organisations which have had long experience of this sort of chemical synthesis.

One possible interim measure would be for a private company or a consortium of private companies to erect a multi-purpose phosphorylation plant to carry out the Stage 4 reactions. Even though it is difficult to see how such a unit could be economically viable without increasing the cost of rice insecticides even further, any plans by private investors to carry out such an operation should not be turned down without more detailed examination.

To the expert's knowledge, no such multi-purpose organo-phosphorus plant is in operation.

4 RECOMMENDATIONS

4.1 The erection of a factory to manufacture and formulate DDT would appear to be economically viable as long as the equipment, etc is kept to the bare essentials. Manufacture of DDT in Indonesia would provide a stable outlet for excess production from its chlor-alkali, alcohol and sulphuric acid plants as well as forming the nucleus of an organic chemical industry and ensure continuity of supply of DDT if pressure from extremists among environmentalists in the USA and Europe should force the closure of some existing plants. It is therefore recommended that immediate and serious consideration be given by the Directorate General of Chemical Industries to the erection of a plant to manufacture 5 000 tonnes a year technical DDT and formulate it into 6 500 tonnes a year 75% DDT Wettable Powder for use by the Ministry of Health in their mosquito control programme.

4.2 Enquiry documents based upon the technical specifications given in Volume 3 should be sent out to suitably pre-qualified international contractors as soon as possible.

4.3 Contractors should be given six months to prepare their bids.

4.4 UNIDO should be invited to assist in the evaluation of bids.

4.5 UNIDO should be invited to assist in the basic training of personnel to be engaged in plant operations.

4.6 Even though monochlorobenzene represents 38.5% of the total raw material cost of the finished product, its manufacture in Indonesia is not recommended because :

a) there is insufficient chlorine available

b) there is no indigenous benzene available

c) chlorine and benzene are very expensive to ship

d) world consumption of monochlorobenzene is only about 50% of installed capacity and prices are depressed. Spot lots can be purchased at well below the figure given in the Feasibility Study

However, should the chlorine and benzene situation in Indonesia change in the future, the feasibility of manufacturing monochlorobenzene and the by-product dichlorobenzenes should be re-examined.

4.7 Phenoxy Herbicides

4.7.1 The manufacture of 2,4-D and MCPA herbicides is not recommended because :

a) the maximum requirement is only 500 tonnes a year whereas an economic plant size would be of the order of 3 000 tonnes per year

b) all raw materials would have to be imported

c) there is considerable over capacity in the World and prices are very depressed and likely to remain so in the foreseeable future

4.7.2 In the interests of ASEAN cooperation, consideration should be given to favouring imports of technical 2,4-D and MCPA from the under-utilised plant in the Philippines.

4.8 Organo Phosphorus Insecticides

The manufacture of organo phosphorus insecticides is not recommended because :

a) the uncertainty of the pest problems likely to be encountered in the next 10 - 15 years

b) the uncertainty as to which pesticides will be required

c) the basic raw materials for their manufacture would have to be imported

This decision shouldbe reviewed in 5 years' time.

However, should a private firm or a consortium of firms put up a convincing case for manufacture and be willing to underwrite the capital, the Directorate General of Chemical Industries should look favourably upon such a proposal.

4.9 Although there is plenty of capacity for formulating liquid and granular pesticides, the installation of more capacity for wettable powders should be encouraged. This might be considered in conjunction with the formulation of DDT Wettable Powder.

4.10 In view of the considerable crop losses caused by rats, the Ministry of Agriculture should instigate systematic control measures. UNIDO / FAO could assist in devising a suitable programme.

4.11 Great improvements could be effected in the distribution of pesticides to rice farmers. The recommendation of Resource Planning Consultants Limited that the distribution of agricultural pesticides be placed in the hands of the formulators is endorsed.

4.12 The BIMAS subsidy scheme for pesticides is often badly abused and neither gives the farmer any incentive to produce more rice nor the pesticide formulator any incentive to put technical service effort into farming areas. Alternative subsidy schemes should be investigated as a matter of urgency.

4.13 The Ministry of Agriculture extension services are grossly understaffed. Every effort should be made to improve this service since without adequate instruction in crop and pest management the planned increases in agricultural production will not be achieved. Here again, UNIDO and FAO can assist with training programmes.

4.14 One of the hindrances to increased rice production is the small land holding of individual farmers. Forms of collective or cooperative farming probably based on the Kelurahan (village) as a unit with a competent manager who can plan the use of available labour, machinery, fertilisers and pesticides should be investigated.

5 ACKNOWLEDGEMENTS

It would be impossible to name all the individuals who have given their advice and help to make this report possible, but special mention must be made of :

Ir Kousmono, the expert's Counterpart from the Directorate General Chemical Industries for organising visits and acting as interpreter

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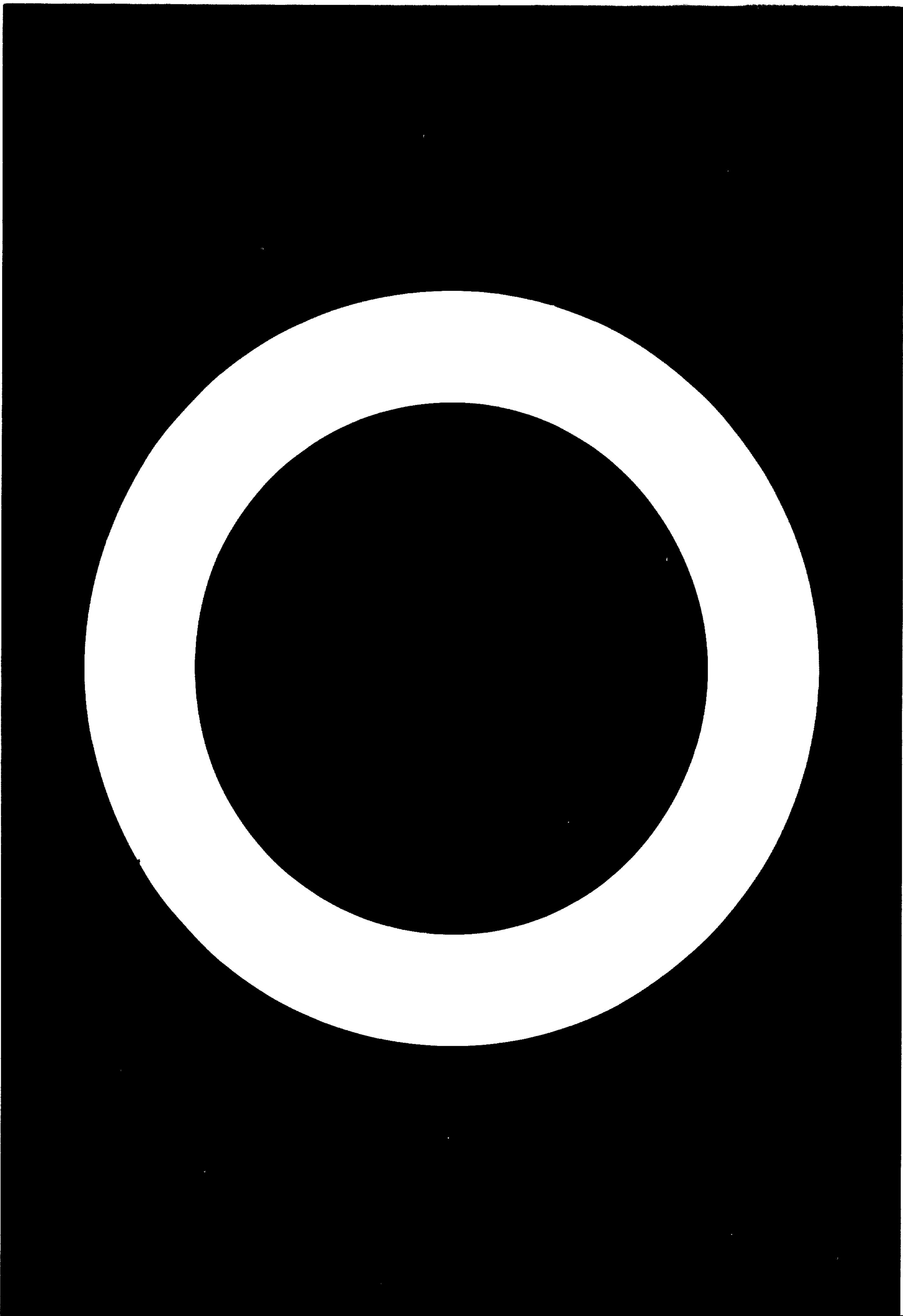
Imperial Chemical Industries Limited for advice on formulation equipment, general engineering and administration matters and costings

Hall Thermotank International Limited who advised on refrigeration requirements

International Crop Protection Consultants Limited for seconding the expert to UNIDO for this assignment and supplying secretarial facilities

A list of organisations consulted is given in Appendix XVI



APPENDIX I

Request from the Government of Indonesia for Special Industrial Services

JOB DESCRIPTION

Post Title	:	Consultant(s) in pesticide production
Duration	:	Six months
Date required	:	2 January 1978
Duty Station	:	Jakarta with possible domestic travel and Vienna (own base)
Purpose of the project	:	The consultant(s) will elaborate the feasibility of the local production of selected pesticides including 2,4-D and MCPA type of herbicides, DDT and organo-phosphorus insecticides
Duties	:	The consultant(s) will cooperate with the Directorate General for the Chemical Industry in the following areas :

i) Establish economic plant capacities in view of current and projected demand;

ii) Review the availability and specifications of raw materials required in the manufacture of the selected pesticides as specified above;

iii) Elaborate the feasibility of establishing local manufacturing units for selected pesticides including DDT, 2,4-D-MCPA type of herbicides and organo phosphorus insecticides;

iv) Suggest economic production technologies for the manufacture of pesticides considered suitable for local manufacture;

v) Draft flow diagrammes, material and energy balances for selected units;

vi) Draft tender specifications for product and equipment with necessary consideration for technical, commercial and contractual aspects;

vii) Prepare organisation chart including number of personnel for operation, maintenance and quality control and recommend appropriate advance training as required;

viii) Assist in plant site selection;

ix) Recommend follow-up UNDP/UNIDO technical assistance during contracting, erection and start-up of the plant(s)

Qualifications : Chemical engineer(s) with broad background in the production of pesticides

Language : English

Background information : There is a great potential for the increased use of a number of pesticides in Indonesia as indicated by the UNIDO/FAO joint survey carried out in 1973/4.

The products, the potential local production of which was considered realistic and attractive by the above team, were identified as follows: organo-phosphorus insecticides, DDT, 2,4-D-MCPA type of herbicides. Since the Government attaches great importance to the development of the chemical industry and improved agricultural production, the examination of the feasibility of locally manufacturing the above, and perhaps other, pesticides, deserves high priority

APPENDIX II

PESTICIDE DISTRIBUTION BY BIMAS

Period October/September	Formulated Product - Tonnes/Kilolitres		
	Insecticides	Fungicides	Rodenticides
70 / 71	664	-	39
71 / 72	573	-	32
72 / 73	1 443	-	77
73 / 74	1 371	-	47
74 / 75	2 362	7.5	84
75 / 76	3 398	20	159
76 / 77	3 774	37	102

APPENDIX III

INSECTICIDE USAGE IN RICE

	Tonnes Active Ingredient		
	Actual Sales	Planned Purchases ǂ	
	1976/77	1977/78	1978/79
A. Organo Phosphorus Compounds			
Diazinon	442	1320	810
Fenitrothion	188	275	375
Leptophos •	172	-	-
Phosphamidon	53	-	-
Cyanophos	47	-	-
Dichlorvos	42	178	150
Chlorpyrifos	39	90	85
Fenthion	31	150	100
Isoxathion	12	-	-
Triazophos	3	-	-
Phenthoate	-	-	50
TOTAL A	1029	2013	1570
B. Others			
Carbaryl	300	387	213
Endosulfan	35	105	18
Cartap	12	-	-
Aldrin +	4	-	-
Carbofuran	3	-	-
TOTAL B	404	492	231
TOTAL A + B	1433	2505	1801

The reduction in 1978/79 could be accounted for by over-purchase in 1977/78.

• No longer approved because of mammalian toxicity problems

ǂ Includesreserves for emergency application when pest explosion threatens large areas of crops

\+ The use of all organo chlorine compounds in agriculture, with the exception of HCH for timber preservation, is now banned

APPENDIX IV

PLANTATION CROPS - 1976

Crop	Planted Area (000 ha)				Production 000 tonne
	Smallholders	Private & Foreign	Government	Total	
Rubber	1850	260	210	2320	623
Oil Palm	-	75	150	225	439
Coconut	2200	20	10	2230	1527
Coffee	365	20	20	405	179
Tea	35	25	42	102	73
Tobacco	155	3	13	171	85 (?)
Pepper	60	-	-	60	25
Sugar Cane	90	15	92	197	1392
Nutmeg	50	-	2	52	16
Cloves	225	-	-	225	16
Cocoa	5	1	11	17	4
	5035	419	550	6004	

APPENDIX V

PESTICIDE FORMULATORS

	Firm	Nominal Production Capacity‡	Types of Products
1	PT Bayer Agrochemicals Jakarta	2 750 tonnes	Insecticide liquids and granules Herbicide wettable powders Rodenticide Granules Fungicide wettable powders
2	PT ICI Pestisida Jakarta	2 400 tonnes	Insecticide liquids Herbicide powder
3	PT Pasific Chemical (Dow) Medan, N Sumatra	3 600 tonnes	Insecticide liquid Herbicide powder
4	PT Inkita Makmur-Ciba Geigy Ltd Mojokerto E Java	4 600 tonnes	Insecticide liquids
5	PT Agrocarb Indonesia (Union Carbide) Surabaya, E Java	13 000 tonnes	Insecticide WP's dusts and granules Plant growth regulator liquid
6	PT Petrokimia Kayaku (Govt + Nippon Kayaku and Mitsubishi) Gresik, E Java	11 880 tonnes	Insecticide liquids and granules
7	PT Indagro Cimanggis W Java	9 500 tonnes	Insecticide liquids, powders Fungicide powders Herbicide liquids and powders
8	PT Alfa Pestisida Industri Cirebon W Java	1 500 tonnes	Insecticide liquids
9	PT Demhate Hamburg Corporation Jakarta	1 000 tonnes	Insecticide liquids

‡ NOTE : The actual manufacturing capacity of a multipurpose formulation unit can vary considerably and depends on the number of product changes and the sizes of containers being used

APPENDIX VI

SPECIFICATIONS FOR ETHYL ALCOHOL FROM PT ASEN PABUARAN

	Super	Grade I	Grade II	Method
Alcohol content % v/v at 25°C min	95	95.1	94.0	BS 507-1966
Non volatile matter (105°C) mg/l max	50	50	50	BS 507-1966
Acidity as acetic acid mg/l max	15	30	60	BS 507-1966
Barbet reaction max	20	8	8	BP 3G - Ps
Fuel oil mg/l max	4	15	15	AOAL 9.066-1975
Acetaldehyde mg/l max	4	150	150	BS 507-1966
Heavy metals (Pb, Cu, Zn, As, Hg)	Negative	Negative		BP 3G - Ps
Methanol % max	0.1	0.1	0.1	AOB 9.066-1975

APPENDIX VII

COST OF BUILDING MATERIALS

			UNIT	Rps
1	Materials for concrete			
	Cement		Tonne	28 750
	Aggregate		m3	5 800
	Sand		m3	3 500
	Water		1000 litres	1 250
	Additive eg Grace Duratard		Litre	400
2	Steel Reinforcement			
	Mild Steel (local)	ASTM Grade 40	Tonne	120 000
	High tensile	ASTM Grade 60	Tonne	125 000
	Stressing Stand		Tonne	296 000
3	Steel section		Tonne	170 000
4	Steel plate		Tonne	160 000
5	Fabricated light structural steel (subcontract)		Tonne	245 000
6	Light structural steel erection (subcontract)		Tonne	45 000
7	Timber for formwork (Terenteng)		m3	18 000
8	Timber for joinery (supply only)	(Jati	m3	(260 000
		(Kamper		(65 000
		(Borneo		(38 000
9	Doors		m2	9 000
10	GI Pipe			
	2 1/2 cm Ø		1m	500
	5 cm Ø		1m	500
11	Filling sand		m3	3 000
12	Petrol		Litre	70
13	Diesel fuel		Litre	25
14	Oil		Litre	400

APPENDIX VIII

COSTS OF LABOUR AND STAFF ON BUILDING SITES

- LABOUR

	UNIT	Rp
- Unskilled Labourer	man hour	120,-
- Skilled Labourer	" "	180,-
- Carpenter	" "	240,-
- Welder	" "	600,-
- Truck driver	" "	400,-
- Equipment Operator	" "	555,-

- STAFF

Foreman	MONTH	160 000,-
Superintendent	"	600 000,- ǂ
Surveyor	"	300 000,-
Draftsman	"	200 000,-
Storeman	"	150 000,-
Clark	"	175 000,-
Car Driver	"	100 000,-
Watchman	"	40 000,-
Mechanic	"	200 000,-

ǂ An expatriate superintendent would cost Rps 2 million per month

APPENDIX IX

TYPICAL ANALYSIS OF WATER SUPPLIED BY PT PETROKIMIA GRESIK

Raw Water

Origin	:	river
Temperature	:	29 ^{o}C
Pressure	:	negligible

The typical composition of the water after clarification is as follows :

temperature	20 ^{o}C
pH	9 - 10
total hardness as $CaCo_3$	45 - 80 ppm
ca - hardness	30 - 40 ppm
phosphate as PO_4	Nil
residual chlorine	0.5 ppm
chlorine	25 - 60 ppm
alkalinity P	30 ppm ($\frac{1}{2}$ carbonates + all hydroxides)
M	60 ppm (all bicarbonates + all carbonate + all hydroxides)
total solids	150 ppm
SO_4	25 - 100 ppm
Stability Index	6.5

APPENDIX X

REQUIREMENTS FOR THE QUALITY OF INDUSTRIAL, MINING AND HOUSEHOLD LIQUID EFFLUENT

No	PARAMETER	UNIT	Minimum which is permissible	Average in 24 hour period	Maximum which is permissible	NOTE
	I. PHYS.					
1	Temperature	°C			30	
2	Suspended matter	mg/1			nil	which is retained by filter with 3 mm aperture
3	Precipitated substances	mg/1			1.0	
	II. CHEMISTRY					
	A. Inorganic Chemistry					
1	Aluminium	mg/1			10	as Al
2	Arsenic	mg/1			1	as As
3	Barium	mg/1			1	as Ba
4	Iron	mg/1			1	as Fe
5	Chromium	mg/1			0.1	as Cr
6	Cadmium	mg/1			1	as Cd
7	Nickel	mg/1			2	as Ni
8	Silver	mg/1			0.1	as Ag
9	Quicksilver	mg/1			0.1	as Hg
10	Zinc	mg/1			1	as Zn
11	Copper	mg/1			1	as Cu
12	Lead	mg/1			1	as Pb
13	Free Ammonia	mg/1			0.1	as NH_3
14	Free Chlorine	mg/1			0.05	as Cl_2
15	Fluoride	mg/1			2	as F
16	Nitrite	mg/1			1	as NO_2
17	Phosphate	mg/1		2		as PO_4
18	Sulphide	mg/1			0.1	as S
19	Biological Oxygen Demand	mg/1		20	30	as O_2
20	Chemical Oxygen Demand	mg/1		50	80	as O_2
21	pH	mg/1	6.5		8.5	
22	Methyl blue test	mg/1				negative
23	Permanganate oxidation	mg/1		60	90	as O_2
24	Suspended solids	mg/1		20		
	B. Organic Chemistry					
1	Hydrocarbons				10	
2	Oil and fat				10	
3	Phenol				0.1	as phenol
4	Cyanides				0.1	as CN

APPENDIX XI

MANUFACTURE OF DDT - MAIN REACTIONS

1 chlorine + ethyl alcohol ⟶ chloral

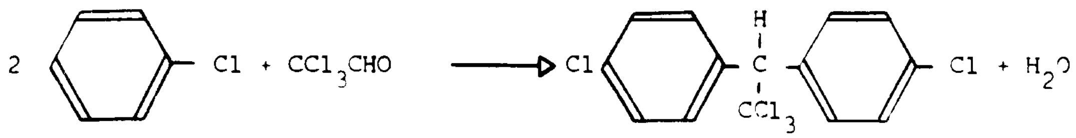
$3\ Cl_2 + C_2H_5OH \longrightarrow CCl_3CHO + 3\ HCl$

Sodium hypochlorite is also formed by the absorption of excess chlorine with caustic soda.

2 chlorine + benzene ⟶ monochloro benzene

a mixture of ortho and para dichloro benzene (10 - 70% depending on reaction conditions) is also produced during this reaction.

3 mono chlorobenzene + chloral —20% oleum⟶ DDT



p,p'-isomer of 1,1,1-trichloro-2,2-di (chlorophenyl) ethane

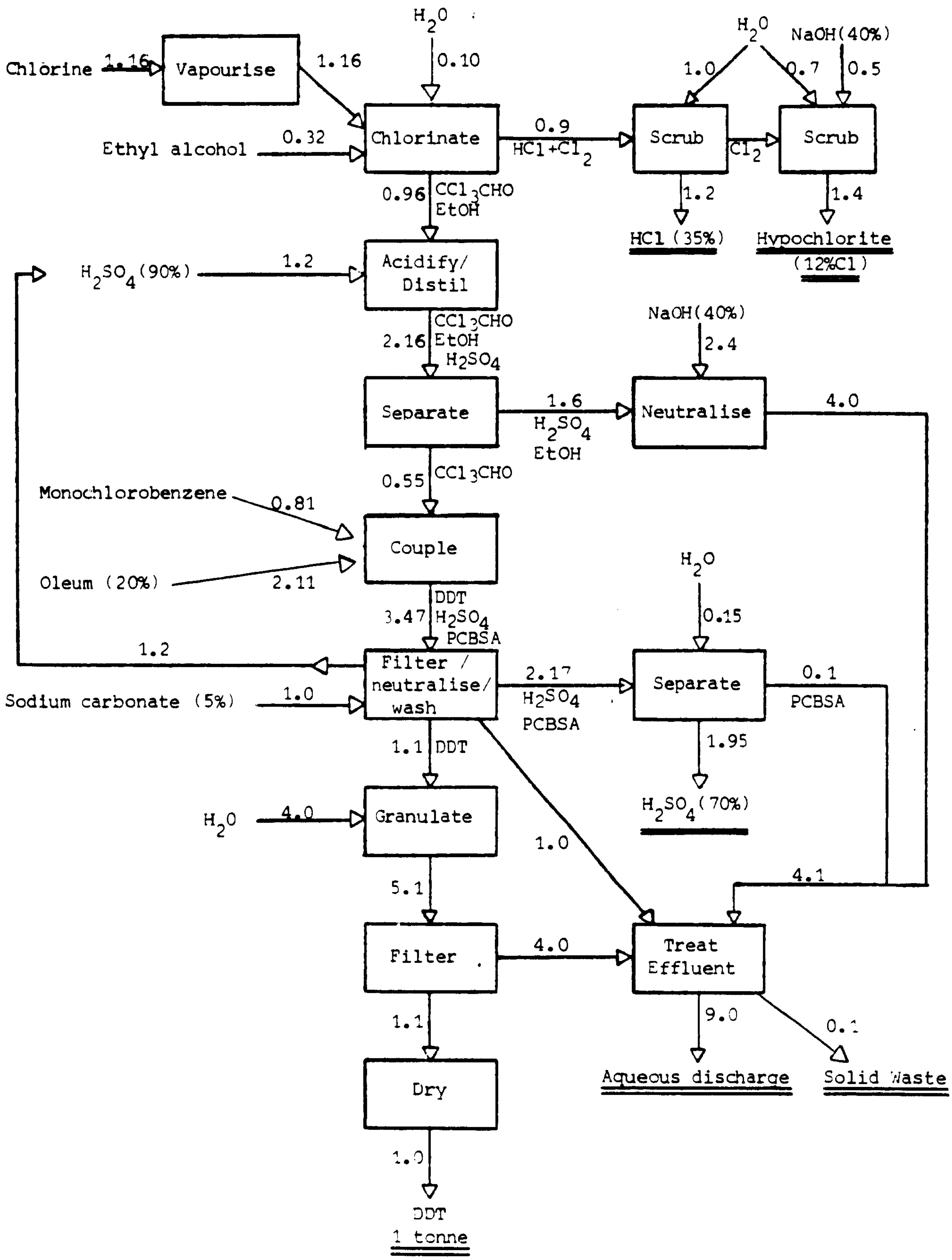
During this reaction other isomers, especially the ortho, para derivative are also formed. To produce a 75% DDT wettable powder to WHO specifications the technical DDT should contain a minimum of 76% p,p' isomer. This is achieved by varying process conditions and increasing the oleum usage. Oleum removes water as it is formed and diluted sulphuric acid can be recovered from the reaction.

4 A considerable amount of refrigeration (120 000 to 150 000 calories per hour per tonne DDT) is required during the reaction.

APPENDIX XII

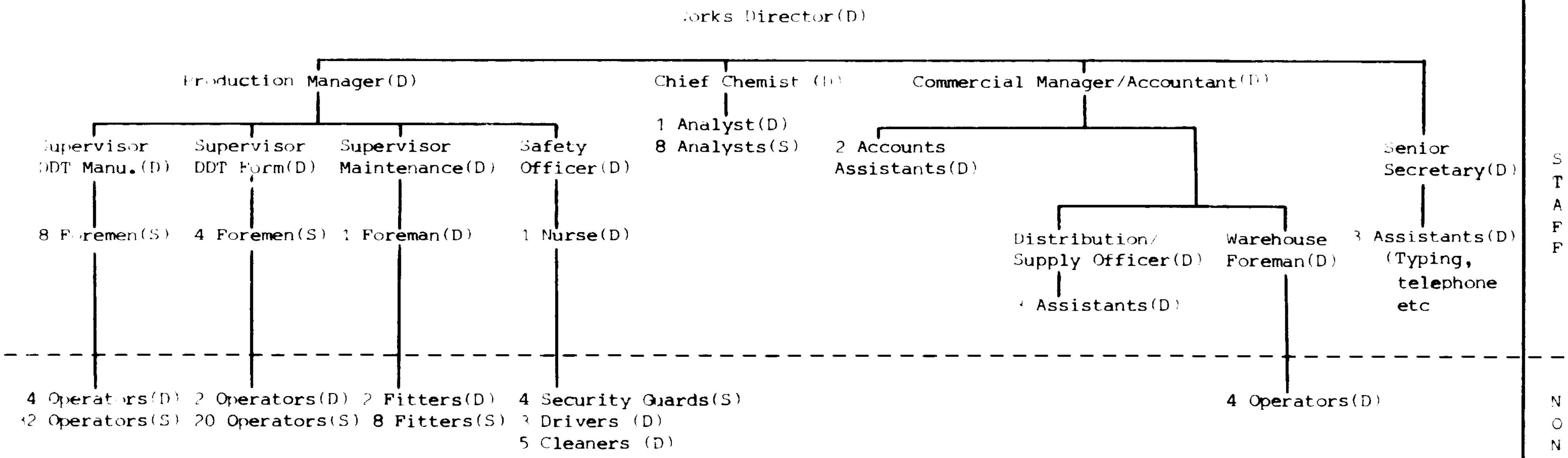
MANUFACTURE OF DDT

Flow Sheet and Mass Balances



APPENDIX XIII

PROPOSED ORGANISATION



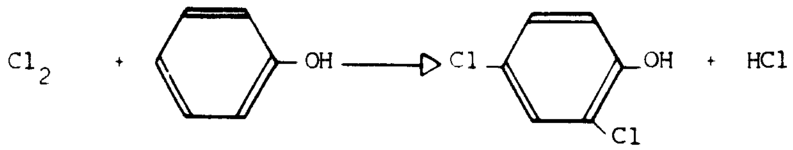
(D = Day work - S = Shift work)

Summary :	Day	Shift	Total
Staff	22	20	42
Non Staff	20	64	84
	42	84	126

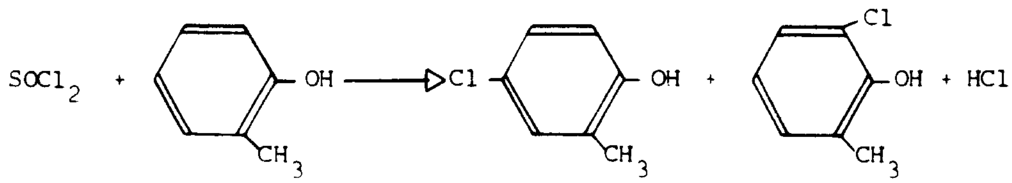
APPENDIX XIV

MANUFACTURE OF 2,4-D AND MCPA - MAIN REACTIONS

1a chlorine + phenol ⟶ 2,4-dichlorophenol (DCP)



1b sulphuryl chloride + ortho-cresol ⟶ para-chloro ortho-cresol (PCOC) 90 - 95% + 2-chloro-6-methylphenol 5 - 10%

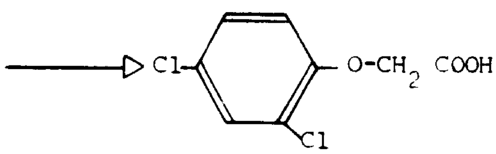


2 chlorine + acetic acid ⟶ monochloro acetic acid (MCA)

Cl_2 + CH_3COOH ⟶ CH_2Cl COOH + HCl

3a i) D C P + M C A $\xrightarrow{NaOH}$ 2,4-D sodium salt

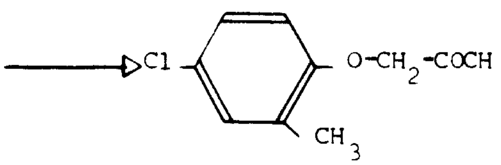
ii) 2,4-D Na + HCl



2,4-D

3b i) P C O C + M C A ⟶ M C P A sodium salt

ii) MCPA Na + HCl



+ 2-chloro-6 methyl impurity

MCPA

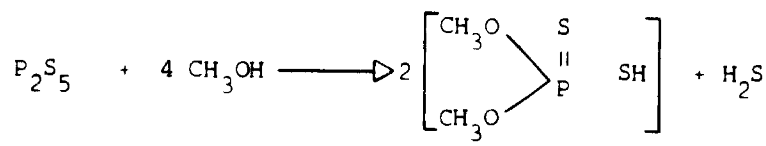
APPENDIX XV

MANUFACTURE OF ORGANO PHOSPHORUS INSECTICIDES - (MAIN REACTIONS)

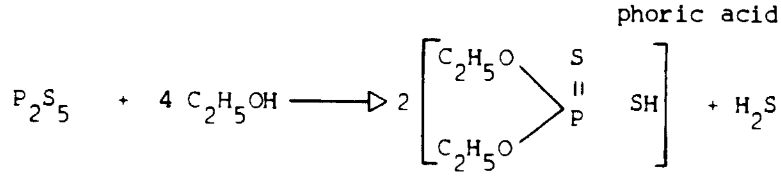
1 yellow phosphorus + sulphur ⟶ phosphorus penta-sulphide

$$2P + 5S \longrightarrow P_2S_5$$

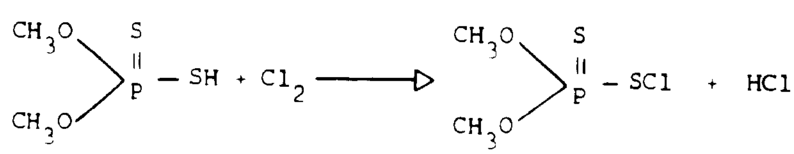
2a phosphorus penta-sulphide + methyl alcohol ⟶ dimethyl dithiophosphoric acid (MPI)



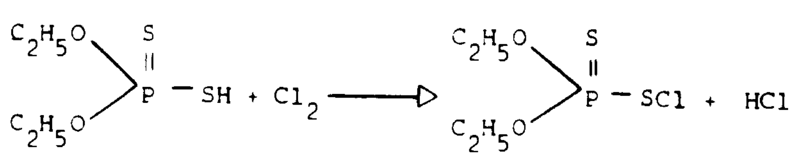
2b phosphorus penta-sulphide + ethyl alcohol ⟶ diethyl dithiophosphoric acid (EPI)



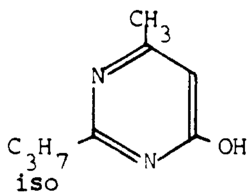
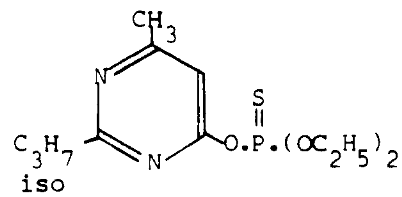
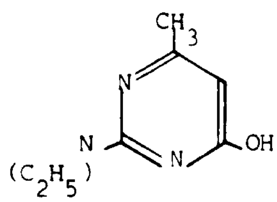
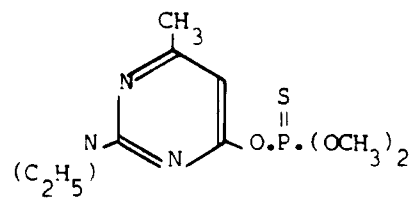
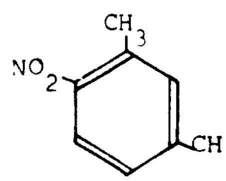
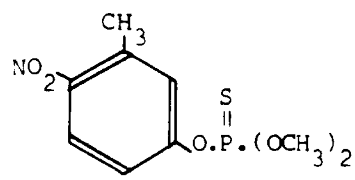
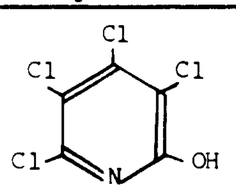
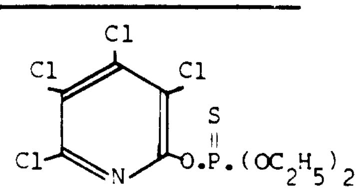
3a M P I + chlorine ⟶ dimethyl phosphoro chlorido thionate (DMPCT)



3b E P I + chlorine ⟶ diethyl phosphoro chlorido thionate (DEPCT)



4 The phosphate esters, MPI, EPI, DMPCT or DEPCT can then be condensed with an organic radical (R) to give the required organo phosphorus insecticide. Some typical reactions are as follows :

Type of phosphate esters	Type of radical R	Organo phosphorus insecticide
D E P C T	 a pyrimidine	 DIAZINON
D M P C T	 a pyrimidine	 PIRIMIPHOS METHYL
D M P C T	 p-nitro-m-cresol	 FENITROTHION
M P I	$CH_2.COOC_2H_5$ | $CH_2.COOC_2H_5$ diethyl maleate	S ‖ $(CH_3O)_2.P.S.CH.COOC_2H_5$ | $CH_2.COOC_2H_5$ MALATHION
D E P C T	 3,5,6-trichloro-2-pyridinol	 CHLORPYRIPHOS

APPENDIX XVI

ORGANISATION VISITED

The author is indebted to the many people who have given assistance with the project. It is impossible to name all the individuals concerned but the organisations visited are listed below :-

1 UNITED NATIONS

UNIDO	-	Senior Industrial Development Field Advisor	Jakarta
FAO			Jakarta
WHO	-	Permanent Representative	Jakarta
		Vector and Rodent Control Research Unit	Jakarta & Semarang (C Java)
		S E Asia Regional Office	New Delhi

2 GOVERNMENT OF INDONESIA

Ministry of Industry	-	Secretary General	Jakarta
		Dte General of Chemical Industries	Jakarta
		Dte General of Light Industries	Jakarta
Ministry of Health	-	Dte General of Communicable Diseases Control	Jakarta
		Drug Research Centre	Jakarta
		Public Health Department	Medan (N Sumatra), Semarang (C Java)
Ministry of Agriculture	-		Jakarta
		Dte General of Foodcrops Protection	Jakarta
		Dte General of Estates	Jakarta
		BIMAS	Jakarta
		Bureau of Planning	Jakarta
		Agricultural Extension Service	Medan(N Sumatra)
		Dept of State Estates	Medan(N Sumatra)
		Dept of Small Holder Estates	Medan(N Sumatra)
		Dept of Private Estates	Medan(N Sumatra)
		Regional Offices	Medan(N Sumatra), Denpasar (Bali)
		BAPPANAS (National Planning Agency)	Jakarta
		Army Industry Command (Kopindad)	Bandung (W Java)
		Army Vehicles Maintenance (Bengpusmat and IKABI-DME)	Bandung (W Java)

3 OTHER GOVERNMENT ORGANISATIONS

World Bank	-	Senior Industrial Advisor	Jakarta
British Embassy	-	Agricultural Attaché	Jakarta
American Embassy	-	Agency for International Development (AID)	Jakarta
ASEAN Secretariat	-	Bureau of Science & Technology	Jakarta

4 PESTICIDE FORMULATORS

• PT ICI Indonesia	Jakarta & Cimanggis (W Java)
• PT Pacific Chemicals Indonesia (Dow)	Jakarta & Medan (N Sumatra)
• PT Agrocarb Indonesia (Union Carbide)	Jakarta & Surabaya (E Java)
• PT Bayer Agrochemicals	Jakarta
PT Inkita Makmur-Ciba Geigy Ltd	Jakarta
• PT Petrokimia Kayaku	Gresik (E Java)
• PT Indagro inc	Jakarta & Cimanggis

• Formulation Plants Visited

5 OTHER INDUSTRIAL ORGANISATIONS

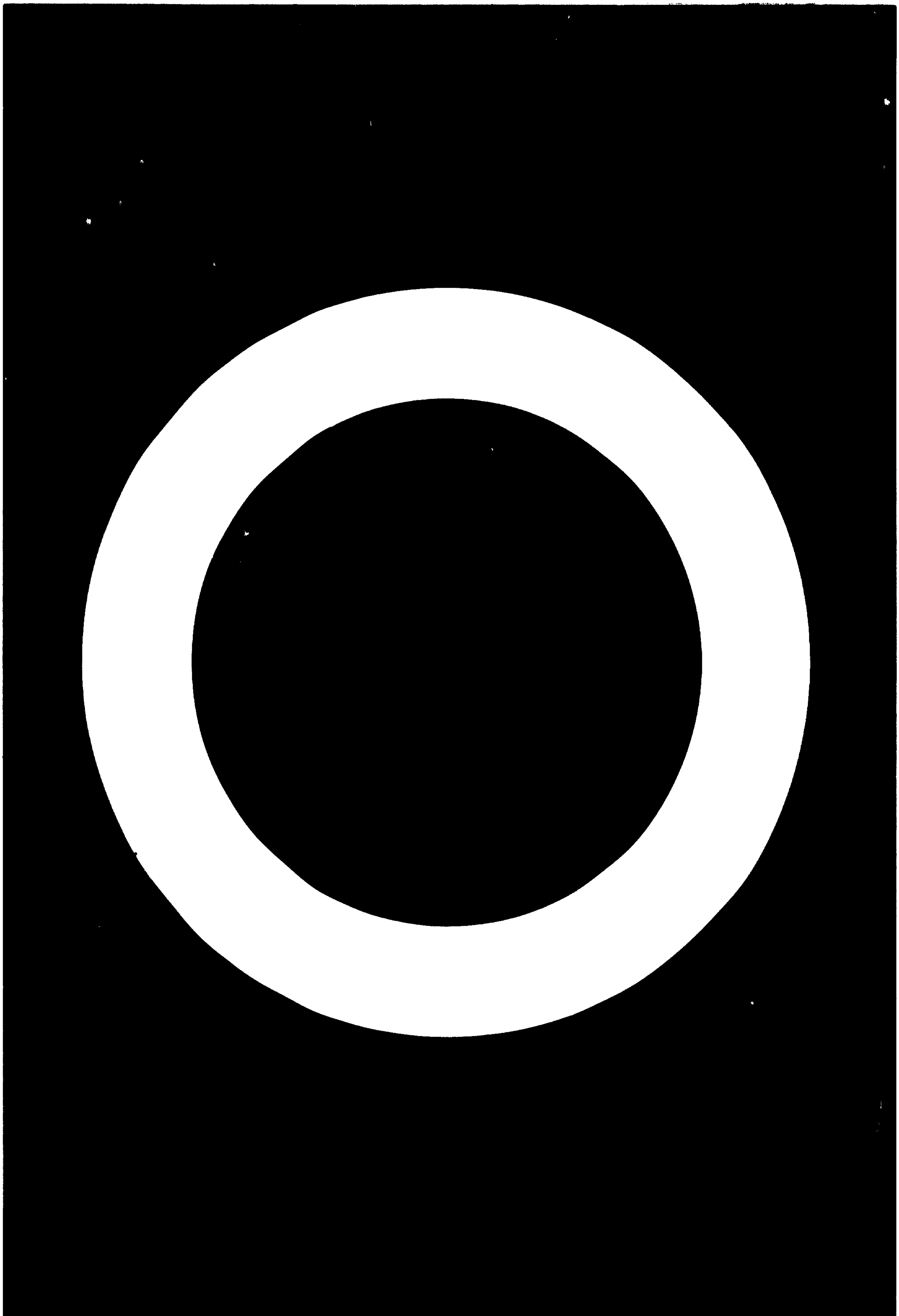
P.N. Soda	Waru (E Java)
PT Pupuk Sriwidjaja (Pusri)	Jakarta, Palembang (S Sumatra), Medan (N Sumatra)
PT ICI Paints	Cimanggis (W Java)
PT ICI Farmasi	Jakarta & Pandaan (E Java)
PT Pertani	Jakarta
PT Petrokimia Gresik	Gresik (E Java)
ICI Export	Jakarta
PT Asen Pabuaran	Mojokerto, (E Java)
Produits Chimiques Ugine Kulhmann	Paris, France
BTP-Cocker Chemicals Limited	Manchester, England
Imperial Chemical Industries Limited	England
Hall Thermotank International Limited	Dartford, England

6 CONTRACTORS, ARCHITECTS, ENGINEERS ETC

Fluor Eastern Inc	Jakarta
Bechtel	Jakarta
PT Citra Indonesia	Jakarta
PT Frankipile Indonesia	Jakarta
Resource Planning Consultants Limited	Jakarta
PT Korra Inconserve	Jakarta
PT Exakta	Jakarta
Spie-Batignolles	Paris, France

7 UNIVERSITIES AND RESEARCH INSTITUTES

Institute of Technology	
- Department of Chemical Technology	Bandung (W Java)
Institute for Agricultural Research and Development (CP[illegible]I)	Bogor (W Java)
Research Institute for Estate Crops	Bogor (W Java)
Agricultural University	
- Department of Social Economics	Bogor (W Java)



VOLUME 2

FEASIBILITY STUDY

on the

MANUFACTURE AND FORMULATION

of

DDT

in

INDONESIA

1 INTRODUCTION

1.1 General

The purpose of this study is to analyse the various costs involved in erecting and running a plant to manufacture 5 000 tonnes per year DDT and formulate 6 500 tonnes per year 75% wettable powder in order to obtain an ex works cost for the finished product.

1.2 Capital

The capital to be found is divided into

- fixed capital
- working capital and direct expenses

1.2.1 Fixed Capital

The following items must be considered :

Land
Site investigation and land preparation
Plant buildings, offices, canteen, etc
Roads and fencing
Main plant and equipment (for process)
Auxiliary plant and equipment (for services)
Miscellaneous equipment (office, laboratory, etc)
Effluent and sewerage treatment
Engineering
Know-how
Start up and commissioning
Consultants

Cars and houses for staff may have to be provided at some stage but it is not UNIDO practice to include their cost in a feasibility study.

For the purposes of this study it has been assumed that the fixed capital can be borrowed at $7\frac{5}{8}$% interest from an international development bank (ie the current World Bank rate).

1.2.2 Working Capital and Direct Expenses

Items under this heading include :

Salaries and wages

Insurance etc for all personnel

Transport and clothing allowances

Insurance on plant and buildings

Purchased services

Rates and taxes

Raw Materials and packages

Depreciation of plant and buildings

Maintenance materials

Cost of stock holding

Interest on capital

Working capital will have to be borrowed from commercial banks and the current borrowing rate in Indonesia is 14%.

1.2.3 Inflation

No allowance has been made for inflation. All costs are calculated in Rupiahs, Dollars and Pounds of mid-1978.

2 FIXED CAPITAL

2.1 Land

A site of approximately 3½ hectares will allow ample room for expansion. At Rps 10 000/m^2 this will cost Rps 350 million or $ 850 000.

2.2 Plant and Equipment

2.2.1 To manufacture 5 000 tonnes per year technical DDT

2.2.1.1 General considerations

As this is the most significant item in the fixed capital, it is necessary to make a judgement on the standard of technology, industrial safety and pollution control measures necessary and the level of amenities required by the workforce. A number of approaches have been considered.

i) To obtain a gross figure based on new plant as would have to be erected in Europe today, the "Process Step Scoring" method described by Taylor (1) which has been successfully applied to 45 recent projects covering a broad spectrum of plant sizes and technology was used. This gave a figure of $ 10.5 million for the plant erected in the UK plus off sites but excluding ancillary buildings such as offices, warehouses, workshops, canteen etc. To this figure should be added 5% for packing and delivery to fob, 10% for insurance and freight to cif and 5% for internal transport, expatriate supervision of erection etc bringing the total to $ 12.6 million.

ii) A European DDT manufacturer, without going into great detail, estimated the cost of the basic manufacturing equipment erected in Indonesia to be $ 10.8 million excluding all off-sites and amenities

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(1) Engineering and Process Economics 2 (1977) 259 - 267

iii) A more fundamental approach based upon estimation of the cost of individual basic items of equipment and keeping embellishments and amenities to the bare minimum is favoured by UNIDO. The main problem is to decide upon the efficiencies of the processes involved since the literature is vague on this and usually ignores the critical factor - the quality of the resulting DDT which must contain a minimum of 76% of the p-p' isomer is order to be able to grind it to a 75% Wettable Powder to meet WHO Specifications.

Quoted efficiencies on chloral vary from 65% to 95% and on monochlorobenzene from 60% to 85%. One experienced manufacturer has indicated efficiencies of 76.6% and 78.4% respectively and it is those figures which have been used for this study although it cannot be guaranteed that DDT of a quality suitable for grinding to a 75% Wettable Powder will always be manufactured.

2.2.1.2 <u>Outline of Process</u> (See also Volume 1, Appendices XI and XII)

i) Liquid chlorine is vapourised and passed into aqueous ethyl alcohol over a period of about 78 hours. The temperature is kept at $10^{\circ}C$ for the first 24 hours and then allowed to rise to $50^{\circ}C$. This produces chloral alcoholate / hydrate.

ii) The hydrogen chloride gas produced and excess of chlorine used are trapped in water and caustic soda solution respectively to produce hydrochloric acid and sodium hypochlorite.

iii) The chloral alcoholate / hydrate is distilled with sulphuric acid to produce chloral. This takes about 12 hours.

iv) The chloral is coupled with monochlorobenzene in the presence of oleum as dehydrating agent to produce DDT which comes out as a solid. This takes about 24 hours.

v) The acid layer, which also contains chlorobenzene-sulphonic acid and other impurities, is removed and some re-used to liberate the chloral from the alcoholate / hydrate.

vi) The crude DDT is neutralised, washed and granulated by melting in water and then cooling rapidly with a large volume of cold water and rapid stirring.

vii) The DDT is then filtered off, centrifuged and dried.

2.2.1.3 Raw Material Requirements

2 750 tonnes chloral and 4 050 tonnes monochlorobenzene are required to produce 5 000 tonnes DDT. The chloral is produced from 5 775 tonnes chlorine and 1 600 tonnes ethyl alcohol. 10 550 tonnes oleum 20% are also required plus quantities of caustic soda etc as detailed in Appendix F IV.

2.2.1.4 Equipment

i) General

Although the working year is nominally 300 working days, plant cannot be expected to run continuously and experience has shown that a 240 - 250 day occupancy is as much as can be expected.

Thus the plant would have to produce about 11 tonnes per day chloral and 21 tonnes per day DDT.

Since DDT is rapidly decomposed by traces of iron to give a product difficult to grind, great care must be taken in choosing equipment. Glass lined reaction vessels are considered essential.

It is estimated that the total plant and equipment, including buildings, effluent treatment and erection will amount to \$ 4.88 million as detailed in Appendix F II. \$ 0.68 million of this would be local currency.

The chloral manufacturing area would occupy 600 m^2 and the DDT area 800 m^2.

ii) Chloral

Three 13 500 litre glass-lined enamelled iron vessels complete with carbon condensers, stirrers, motors etc are required for the chlorination. Each vessel would be charged with 9 100 litres (7.1 t) ethyl alcohol, 2 000 litres water and fed with 25.6 tonnes of chlorine. The three vessels would produce 57 tonnes crude alcoholate / hydrate in 78 hours (17.5 tonnes or 11 800 litres per 24 hours).

As the decomposition of the alcoholate only takes 12 hours, one 13 500 litre vessel, identical to the chlorinating vessel is required. Into this would be charged 5 900 litres alcoholate and 5 900 litres spent sulphuric acid (from the DDT coupling). Two batches a day would give 11.25 tonnes per day chloral.

iii) Coupling to DDT

This would require 7 vessels, similar to those used for chloral but with simpler condensers. Each vessel would be charged with 1.65 tonnes (1 100 litres) chloral, and 2.42 tonnes (2 200 litres) monochlorobenzene. 6.34 tonnes (3 300 litres) oleum 20% is added over a period of about 12 hours keeping the temperature at about 15°C. The temperature is then allowed to rise to about 30°C over 4 hours when the reaction is complete. Neutralisation, washing and granulation are carried out in the same vessel and account for the balance of the 24 hour cycle. Each vessel would produce 3 tonnes DDT per day giving a total of 21 tonnes per day.

iv) By-products and effluent

By product hydrogen chloride and chlorine gases are trapped in glass equipment and collected in rubber lired tanks.

The portion of the spent oleum not required for liberating chloral (about 50%) is diluted to 70% sulphuric acid when the chlorobenzenesulphonic acid separates out. This stage can conveniently be carried out in one of the DDT coupling vessels where there is a little spare capacity, thus avoiding the extra capital costs.

2.2.2 To formulate 6 500 tonnes per year 75% DDT Wettable Powder

This plant will handle only dry powder products.

Based on a 300 day year and an effective 20 hour day, some 26 tonnes per day will have to be handled in and out of the plant. The basic equipment will cost $ 0.75 million installed and is detailed in Appendix F III.

The plant would occupy an area of 35 m x 20 m plus 15 m x 20 m for assembling raw materials and finished products.

2.2.3 The total cost of Plant and Equipment comes to $ 6.15 million of which about $ 0.91 million would be in local currency.

2.3 Electrical Installation

The installed horse power is 1 750 hp or (say) 1 550 KVA. At the very high cost of Rps 72 750 / KVA,(as confirmed by the State Electricity Board) the basic cost of installation (including transformer station) amounts to Rps 112.8 million or $ 272 000. By far the biggest load is for refrigeration - 1 100 hp.

2.4 Warehousing

With the exception of a little sodium carbonate, all raw materials for DDT manufacture are liquids which will be stored in bulk. The cost of bulk storage has been included in the basic plant cost. However, the formulation plant handles only powders which are bulky and must be stored under cover. The warehouse should be approximately 1.25 metres above ground level to facilitate loading and off-loading from trucks and, equally important to prevent ingress of water during periods of heavy rainfall. Experience has shown that at least 1 m^2 per tonne product must be allowed.

2.4.1 Formulation Raw Materials and Packages

These consist of DDT, silicic acid, kaolin and surface active agents totalling 6 500 tonnes per year. The packages could be kraft paper bags and polyethylene liners (both made in Indonesia). Although the DDT is made on site, it is necessary to 'age' it for 4 weeks to facilitate grinding. Thus it is recommended that provision be made to hold 1½ months' raw material in stock. This will occupy a covered area of about 1 000 m^2, allowing for handling space.

2.4.2 <u>75% DDT WP</u>

This is only purchased twice a year. However, since the Ministry of Health has stores all over Indonesia it is considered that it should be able to take delivery of product at regular intervals. Provision is, therefore, made to store 3 months' production which will require an area of 2 000 m^2, including space for handling on a first-in, first-out basis and a small office for the warehouse foreman.

2.4.3 <u>Cost</u>

The two warehouses, which can be regarded as one large building, will occupy a total area of 3 000 m^2. Apart from a little packaging material which can easily be segregated, there is nothing flammable to be stored, so a sprinkler device will not be necessary. Although a building cost of Rp 80 000 per m^2 including site preparation and foundations was indicated by contractors in Jakarta, a simple open-mesh type of wall albeit with a larger roof overhang would suffice bringing the cost down to Rps 50 000 per m^2. The total cost would be Rps 150 million = <u>$ 360 000</u>.

2.5 <u>Office Building</u>

The office building will accommodate :

Works Director
Production Manager
Safety Officer
Commercial Manager
2 Accounts Assistants
Distribution and Supply Officer + 3 Assistants
4 Secretaries
Analytical Laboratory with Chief Chemist + 2 Analysts (at any one time)
Surgery with 1 Nurse

A 2-storey block covering 350 m^2 with a total floor area of 700 m^2 would be required. It is estimated that this would cost, with land preparation, Rps 85 million = $ 205 000.

2.6 Ablutions Block

An ablutions block housing changing rooms, showers and toilets for the works personnel is estimated to cost $ 48 000.

2.7 Sewerage

There is no mains sewerage available at Gresik. Individual plants are expected to provide their own systems. It is estimated that the provision of septic tanks with 200 metres of pipe at $ 20 per metre laid would cost a total of $ 16 000.

2.8 Canteen

The canteen would have to cater for 42 day + 41 shift personnel. Including Kitchen, it would occupy an area of 120 m^2 and cost, with equipment $ 40 000.

(NB. Contractors would provide the food, so no kitchen/ serving personnel have been allowed for)

2.9 Maintenance Workshop

Bearing in mind that major repairs can be carried out in the main workshops of PT Petrokimia Gresik, a maintenance workshop occupying 500 m^2 would be ample. Equipped with basic tools, etc this would cost $ 200 000.

2.10 Roads, Fencing and Weighbridge

It is estimated that 400 metres of road with an average width of 10 m is the bare minimum required. At $ 40 per m^2 this would cost $ 160 000.

Chain link security fencing with concrete poles and barbed wire on the top costs $ 5 per metre installed. A site measuring 200 m x 180 m would require 760 m of fencing - say $ 4 000 plus $ 1 000 for a small gatehouse.

In order to cut costs, a weighbridge has been omitted since the facilities of PT Petrokimia Gresik can be called upon. The total cost for these items is $ 165 000.

2.11 Office, Surgery and Laboratory Equipment

2.11.1 Office and Surgery Equipment

As well as accommodating the people detailed in Section 2.5, desks etc will have to be provided in the plants, warehouses and workshops for supervisors, foremen, security guards etc. A telephone system would also have to be installed. A small amount of equipment would also be required in the surgery. It is estimated that this would cost Rps 11.5 million or $ 28 000.

2.11.2 Laboratory Equipment

Major items of equipment would include :

	$
1 gas chromatograph	7 500
1 liquid chromatograph	6 100
1 infra red spectrophotometer	11 000
1 ultra violet spectrophotometer	11 000
1 pH meter	600
2 analytical balances	2 000
1 top pan balance	800
1 centrifuge	2 000
Miscellaneous ovens, glassware, etc	6 000
	$ 47 000

2.11.3 Total Cost

The total cost of equipping offices, laboratory and surgery is estimated at $ 75 000.

2.12 Trucks

Two works vehicles costing Rps 4 million each would be required. Total cost - Rps 8 million = $ 19 000.

The Works Director, Works Manager, Chief Chemist and Commercial Manager would probably be supplied with cars at an average cost of Rps 3 million each = Rps 12 million, but this has been omitted from the cost estimates.

2.13 Housing

Houses might have to be provided for 42 staff. At Rp 15 million per house this represents an outlay of Rps 630 million = $ 1.52 million, but this sum has been omitted from the cost calculations.

2.14 Know-how, Start-up and Commissioning

Although the general processes involved in manufacturing and formulating DDT are well known there is still a lot of know-how involved in maximising raw material usages, getting DDT of the right quality and formulating it into a 75% DDT Wettable Powder which will meet WHO Specifications. It would be prudent to allow for a fee of $ 500 000 which would include provision of personnel for start-up and commissioning.

2.15 Training

The broad outline for a training programme is given in Volume 1 Section 3.13. The cost of sending the Indonesian personnel overseas (air fares and subsistance) is estimated at $ 60 000 made up as follows :

8 return economy class air fares to Europe @ $ 2 000	$ 16 000
Internal travel	4 000
20 months subsistance @ $ 2 000 per month	40 000
	$ 60 000

2.16 Consultants

A fee of $ 40 000 has been allowed for the services of a Consultant.

2.17 Contingencies

A sum of 10% should be added for contingencies, say $ 815 000.

2.18 Total Fixed Capital

This is estimated at $ 9.82 million as is summarised in Appendix F I.

3 WORKING CAPITAL AND DIRECT EXPENSES

3.1 Salaries and Wages

Monthly salaries and wages used in this study are detailed in Appendix F II.

Allowing for 13 months' salary a year, the annual bill comes to $ 317 200.

3.2 Foreign 'Shadow' Staff

If 'shadows' for the Works Manager and the three Supervisors are required to maintain the smooth running of the plant, they will cost $ 21 000 per month or $ 252 000 per year. This sum has not been included in the cost calculations.

3.3 Transport

42 staff will receive transport allowances of Rps 25 000 per m = Rps 1 050 000 per year or $ 2 500 per year.

3.4 Insurance and Medical Fees for Personnel

At 20% of 12 months' salary this comes to $ 58 600 per year.

3.5 Personal Taxation

It is now customary for firms to pay employees' income tax. A sum of $ 19 000 per year has been set aside for this (6% of gross).

3.6 Clothing for Personnel

At Rps 40 000 per person, this comes to Rps 5 million or $ 12 000 per year.

3.7 Depreciation

At 10% of the cost of buildings and equipment this comes to $ 711 400 per year.

3.8 Services

3.8.1 Electricity (purchased from Petrokimia)

Installed horse power = 1 750 Hp or (say) 1 550 KVA

Fixed Charges

		Rps 000/m
400 KVA @ Rps 460/KVA/month	=	184
600 KVA @ Rps 420/KVA/month	=	252
550 KVA @ Rps 375/KVA/month	=	206
		642

= Rps 7.7 m/y

= $ 18 600/y

Running Charges 7.8 million kWh @ Rps 17.25/kWh

= Rps 134 million/y

= $ 324 200/y

∴ Total electricity cost is $ 342 800/y.

3.8.2 Water (purchased from Petrokimia)

75 000 m^3 at Rps 115/m^3 = 8.63 million/y = $ 20 800/y

(NB. Cooling water recycled)

3.8.3 Steam (purchased from Petrokimia)

7 500 t/y at 8½ bars @ Rps 2 150/t =

Rps 16 125 m = $ 38 900/y

3.8.4 Total cost of services = $ 402 500/y

3.9 Taxes

35 000 m^2 land @ Rps 25/m^2 = Rps 875 000

7 500 m^2 buildings @ Rps 60/m^2 = Rps 450 000

Rps 1 325 000

= $ 3 200/y

3.10 Raw Materials and Packages

The estimated cost for 6 500 tonnes 75% DDT WP is $ 6.28 million or $ 966/t product of which 65% is for imported materials. This is detailed in Appendix F III.

The price of monochlorobenzene at $ 600 per tonne delivered might be considered high. There are lower quotations on the market but these are for spot lots originating from a US company which has recently ceased production.

Since 75% DDT WP is allowed into Indonesia duty free, it has been assumed that no customs duty will be levied on imported materials.

3.11 Maintenance Materials

The cost of ordinary maintenance labour has been included in the total salaries and wages cost. Spare parts etc are estimated on a sliding scale from nil in the first year to 10% in the tenth year (giving an average of 5% per year) in the DDT manufacturing plant and 5% in the formulation plant and other buildings (giving an average of 2.5% per year), giving an annual total of $ 320 000 of which one half would be in foreign currency.

3.12 Audit Fees

A private company would expect to pay about 1% of turnover for audit fees. As most Government organisations already have their own internal audit systems, this cost has been omitted for the purposes of this study.

3.13 Stock Holding

3.13.1 Raw Materials and Packages

The stock holding figure, in weeks, is given in the right hand column of Appendix F III. 4 weeks has also been allowed for the technical DDT to mature for ease of grinding.

With capital at 14% plus insurance at 2½%, the estimated annual cost of storing raw materials and packages is $ 199 600.

3.13.2 Finished Product

For the reasons given in Section 2.3.2, it is proposed to hold 3 months stock. The cost of this stock holding at 14% per annum plus insurance at 2½% is estimated at $ 349 800.

3.13.3 Total cost of stockholding is $ 549 400/y.

3.14 Protective Clothing

Great importance must be placed on the safety of personnel working on the plant and of visitors. An annual sum of Rps 5 million or $ 12 000 has been allowed.

3.15 Office Expenses

Expenses for stationery, telephones, etc have been estimated at $ 6 000/y.

3.16 Insurance of Equipment and Buildings

At 2.5% this amounts to $ 182 600/y.

3.17 Cost of Servicing Fixed Capital

The $ 9.82 million will be borrowed at 7 5/8% = $ 0.75 million/y.

3.18 Total Working Capital and Direct Expenses

This amounts to $ 9.66 million annually or $ 1 486 per tonne 75% DDT WP and is summarised in Appendix F IV. Only 52% of this is in foreign exchange.

4 DISCUSSION

It will be seen from the foregoing that the estimated cost of producing DDT and 75% DDT Wettable Powder in Indonesia is $ 1 486 per tonne finished product packed ex works, which is about the same as the present cif cost from Europe or USA. The direct cost of raw materials and packages accounts for $ 971 per tonne (65% of the total). However, there is a substantial local currency element in the cost build-up amounting to 48% of the total cost. Thus compared with importing the Wettable Powder for $ 1 500 per tonne, all in foreign currency, local manufacture will only involve foreign currency expenditure of $ 769 per tonne, an annual saving in foreign currency, based on 6 500 tonnes per year product of $ 4.75 million.

Considerable savings have been made by stripping the plant, ancillary equipment and amenities to the bare essentials.

It is generally considered, in the organic chemicals industry of Europe or USA, that the operating expenses for a new "grass roots" plant will be of the order of $ 3 000 to $ 5 000 per tonne plus raw materials depending upon plant capacity and process complexity.

Examination of Appendix F V immediately high-lights the cost of freight and insurance - about $ 200 per tonne or m^3, which ever is the higher, from Europe to Java. Although every effort has been made to obtain realistic quotations, it is possible that, were a buyer actively in the market today, he might be able to make some savings - possibly up to 10%, but no more. The quantity of the very bulky silicic acid used in the formulation (accounting for 21.6% of the raw material cost) might be reduced with experience of operating in Indonesia, but it is doubtful whether this is possible with the usage of monochlorobenzene (38.5% of materials). The unwanted para-chlorobenzene sulphonic acid (PCBSA) produced would require considerable purification to make it saleable, even if there were a local market.

The cost of the indigenous alcohol at $ 520 per tonne is high compared with current quotations of $ 415 per tonne in USA and $ 435 per tonne in UK, and this might be a pointer to the general high cost of operating chemical plant in Indonesia.

Turning to Fixed Capital - Appendix F I - one sees that the installed cost of the basic plant and buildings to manufacture and formulate the DDT is 62.7% of the total fixed capital.

Some capital savings might be made by fully integrating with PT Petrokimia Gresik, but it was the wish of the Directorate General of Chemical Industries that the plant should be considered as a separate venture in much the same way as PT Petrokimia Kayaku which was financed 60% by Pt Petrokimia Gresik and 40% by Japanese capital.

APPENDIX F.I

SUMMARY OF FIXED CAPITAL

		$,000
Plant and Equipment		
DDT Manufacture	5 400	
Formulation	750	
		6 150
Electrical installation		272
Warehouses		360
Offices		205
Ablutions block		48
Sewerage		16
Canteen		40
Workshops		200
Roads and fencing		165
Office, surgery and laboratory equipment		75
Trucks		19
Know-how, Start-up and Commissioning		500
Training		60
Consultants' fees		40
Contingencies		815
		8 965
Land		850
		9 815

APPENDIX F.II

PLANT AND EQUIPMENT TO MANUFACTURE 5 000 TONNES PER YEAR DDT

A **IMPORTED**

	$,000
Chlorine storage, metering and vapourising	300
3 x 13 500 litre chlorinators	280
1 x 13 500 litre decomposition still	70
7 x 13 500 litre coupling vessels	378
4 Nütche filters	72
7 x 120 cm centrifuges	420
Fluidised bed drier	120
Hydrogen chloride adiabatic adsorber	20
Chlorine adsorber for hypochlorite	26
Storage tanks for chloral and chloral alcoholate	150
Effluent treatment system	350
Refrigeration (will also serve grinding unit)	320
(say)	2 500
Pipework, electrics, staging etc @ 40% of above	1 000
	3 500
Add 5% to fob + 10% to cif + 5% erection supervision + 15% for design engineering	1 220
	4 720

B **LOCAL**

	$,000
Storage tanks for all other liquids	200
Water tower	150
Frame buildings 30 m x 20 m with piling for chloral	120
Frame buildings 40 m x 20 m with piling for DDT	160
Effluent settling tanks with drainage	50
	680 installed

Total cost of plant, equipment and ancilliaries = $ 5.40 million installed.

APPENDIX F.III

PLANT AND EQUIPMENT TO FORMULATE 6 500 TONNES PER YEAR 75% DDT WETTABLE POWDER

	$,000
2 Ribbon blenders	20.5
1 Pin mill	18.5
3 Air mills	45.2
3 Venturi feeds	2.1
3 Cyclones	19.2
2 Dust collectors	21.9
3 Feed hoppers	8.2
2 Bagging points	11.0
1 Bag stitcher	18.5
1 Air compressor	96.0
1 Fork lift truck	7.0
1 500 Pallets	6.9
20 Intermediate bulk containers	27.4
Dusting for compressed air, dust collection	8.6
Staging etc	9.0
Electrical panel, wiring, lighting, switching etc	62.0
	382.0
Add 5% to fob + 10% to cif + 5% erection supervision + 15% for design engineering	134.0
	516.0
Add site preparation, piling, building, local erection (local currency)	234.0
	$ 750.0

The cost of cooling water for the compressor and refrigerating the air has been included in the main refrigeration plant for DDT manufacture.

APPENDIX F-IV

Salaries & Wages

No.	Name	Monthly Salary Rps.,000	Remarks
1	Works Director	200	All receive transport allowance at Rps 25 000 / m
1	Production Manager	187	
1	Commercial Manager	187	
1	Chief Chemist	187	
1	Distribution/Supply Officer	156	All receive transport allowance at Rps 25 000/m.
3	Supervisors	417	
1	Safety Officer	139	
1	Senior Chemist	138	
4	Shift Chemists	568	
4	Asst. Shift Chemists	384	
2	Accounts Assistants	246	
3	Dist./Supply Assistants	288	
2	Day Foremen	192	
12	Shift Foremen	1194	
1	Nurse	96	
1	Senior Secretary	109	
3	Asst. Secretaries	240	
2	Asst. Day Fitters	112	
4	Shift Fitters	291	
4	Asst. Shift Fitters	233	
10	Day Operators	560	
16	Shift Operators	1164	
36	Asst. Shift Operators	2097	
4	Shift Security Men	363	
3	Drivers	120	
5	Cleaners	160	
126		10128	
		= $24 400	

Product	Quantity	Unit Cost ‡ $	Annual Cost $,000	Stock Holding weeks
Chlorine	5 775 t	161	930	1
Ethyl alcohol	1 600 t	520	832	1
• Monochlorobenzene	4 050 t	600	2 430	6
Oleum 20%	10 550 t	40	422	1
Caustic soda 40%	13 000 t	53	689	1
Sodium carbonate	250 t	130	33	1
			5 336	
Less Resale value of by-products				
Sulphuric acid (70%)	9 750 t	20	195	
Hydrochloric acid (35%)	5 830 t	38	222	
Sodium hypochlorite (12% Cl)	7 000 t	44	308	
			(725)	
DDT (net R M cost)	5 000 t		4 611	4
• Silicic acid	455 t	3 000	1 365	6
Kaolin	455 t	53	24	1
• Lignosulphonate	650 t	255	166	6
• Wetters	65 t	2 000	130	6
Kraft bags	275 000	36/1000	10	1
Polythene liners	275 000	24/1000	7	1
			1 702	

Total R.M cost for 6 500 t 75% DDT WP is $ 6.313 million ($ 971 per tonne finished product) of which $ 4.091 million ($ 629 per tonne) is for imported material.

• Imported materials

‡ Delivered works

RAW MATERIALS AND PACKAGES

APPENDIX F.V

APPENDIX F.VI

SUMMARY OF WORKING CAPITAL AND DIRECT EXPENSES

	Local Currency $,000	Foreign Currency $,000
Salaries & Wages	317.2	-
Transport	2.5	-
Personnel Insurance & Medical	58.6	-
Personal taxation	19.0	-
Clothing for Personnel	12.0	-
Depreciation	711.4	-
Services	402.5	-
Taxes	3.2	-
Raw Materials & Packages	2 222.0	4 091.0
Maintenance	160.0	160.0
Stock holding	594.4	-
Protective clothing	12.0	-
Office expenses	6.0	-
Insurance of buildings & equipment	182.6	-
Cost of servicing capital	-	750.0
	4 658.4	5 001.0

This gives a total for running costs of <u>$ 9.66 million</u> per year or <u>$ 1 486 per tonne</u> 75% DDT Wettable Powder. Only 52% of this has to be spent directly in foreign currency.

VOLUME 3

TECHNICAL SPECIFICATIONS

for

INVITATION OF BIDS

for the establishment of a

DDT INSECTICIDE MANUFACTURING PLANT

in

INDONESIA

1 INTRODUCTION

1.1 Plant Owners and the Executing Agency

The Directorate General of Chemical Industries (DGCI) of the Ministry of Industry, Government of Indonesia are the Owners as well as the Executing Agency for this project. DGCI may cause to be formed a separate Company, either wholly Government owned or with the participation of an Indonesian or foreign company, in which case such a Company would act as the Owner and the Executing Agency for this project.

1.2 Manufacturing Plant

DGCI proposes to establish a manufacturing plant for the manufacture of Technical DDT and 75% DDT Wettable Powder. Initially, the production capacity will be based on 5,000 tonnes per annum DDT but allowances for future expansion either in DDT or other pesticides should be made.

1.3 In addition to the manufacturing plant, offices, canteen, changing rooms and other amenities, warehouses, engineering maintenance and plant services are required.

1.4 Plant Location

It is proposed that the plant be located at Gresik, E Java some 20 km NW of Surabaya on the river Lamong, close to the sea, where PT Petrokimia Gresik have plants manufacturing ammonia, sulphuric acid, ammonium sulphate, urea and triple super phosphate.
A deep water jetty (12 metres low tide, 13.5 metres high tide) is available.

1.5 Project Time Schedule

The project is scheduled for completion 24 months from the date of the award of the contract. The plant shall be fully commissioned by the end of this period.

2 DEFINITION OF TERMS

The following words and expressions shall have the meanings hereby assinged to them except where the context otherwise requires.

2.1 The Owner

The 'Owner' means the Directorate General of Chemical Industries of the Government of Indonesia (DGCI) or a company formed and designated by DGCI for the ownership and management of the plant project, including legal successors in title to the Owners.

2.2 The Executing Agency

The 'Executing Agency' means the Directorate General of Chemical Industries or an agency designated by it as the Executing Agency for the plant project.

2.3 The Successful Contractor

The 'Successful Contractor' means the firm or company whose tender has been accepted by the Executing Agency and who has concluded a contract with the Owner / Executing Agency for the execution of the work. It includes the Successful Contractor's personal representatives, successors and permitted assignees.

2.4 The ntract

The 'Contract' means the legal document by virtue of which the work is awarded to the Successful Contractor and includes conditions of contract, specifications, drawings and all other such attachments to the Contract.

2.5 Contract Price

'Contract Price' means the sum named in the tender subject to such additions thereto or deductions therefrom as may be made under the provisions thereinafter contained in the Contract.

2.6 Works

'Works' means the works to be executed in accordance with the Contract.

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79.01.15

2 OF 2

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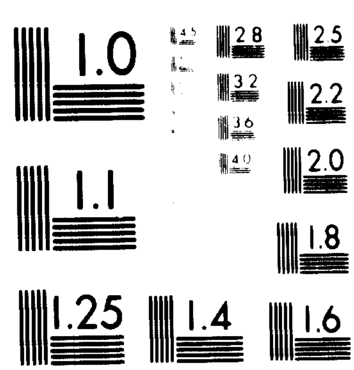

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B

2.7 Site

'Site' means the lands and other places on, under, in or through which the works are to be executed or carried out, and any other lands or places provided by the Owner / Executing Agency for the purposes of the Contract and specifically designated in the Contract as forming part of the site.

2.8 Plant Project

'Plant Project' means the project for the establishment of the following processing plants:

i) Unit for the chlorination of ethyl alcohol to chloral and recovery of by-product hydrochloric acid and sodium hypochlorite

ii) Unit for the manufacture of DDT from chloral and monochlorobenzene

iii) Unit for the formulation and packing of 75% DDT wettable powder

iv) Unit for the collection and treatment of all noxious gaseous, liquid and solid effluents to enable their safe disposal

v) All ancillary units for the provision of essential services, such as process steam, electric power, water, drainage, plant maintenance, quality control and warehouses required for the operation of the manufacturing units as well as disaster control and security services, administrative and plant personnel offices, changing rooms, canteen and welfare service establishments

The Plant Project shall include any other units or alterations in units which may result as a consequence of any changes in process technology which may be agreed upon hereinafter in the Contract.

2.9 **Battery Limits**

'Battery Limits' means the boundary line on the four sides of the plot of land on which the plant, offices etc are located.

2.10 Start-up and Test Runs

'Start-up' means the organisation and supervision of the operations of the plant initially and regular keeping up of its operation during the 'Test Run' period, during which it produces for a period of at least four weeks its rated output of products to the required specifications, thereby proving plant guarantees and proving raw materials and plant services consumptions, with due allowance made by the Successful Contractor for quality control by an independant laboratory.

3 CONDITIONS OF CONTRACT

The conditions stated below are generally indicative of the arrangement proposed for the management of the project and also the terms on which technology and engineering services are desired to be obtained by the Owner for the project. This however does not purport to be a complete list of the conditions of contract for this project.

3.1 Project Management and Co-ordination

The management and co-ordination of the project shall be handled by the Owner or an agency designated by the Owner for this purpose.

3.2 Technology, Design and Engineering

The supply of process technology and the design engineering and erection of the plant, and the related plant services shall be handled by the Successful Contractor, who shall provide an overall performance guarantee for the plant covering both technology and engineering to the Owner.

3.3 Buildings and Civil Works

Site investigation, design and construction of buildings and other civil works at the plant site shall be handled by the Successful Contractor.

3.4 Project Construction

Erection of the plant and other project construction works shall be handled by the Successful Contractor under the technical supervision of personnel supplied by the owners of the processes.

3.5 Training of plant personnel

Training of Owner's engineers and plant operating personnel in plant operations and maintenance and chemists in quality control shall be arranged by the Successful Contractor according to detailed arrangements made with the Owner.

3.6 Plant Start-Up and Test Runs

Starting-up of the plant and organising Test Runs for proving of plant performance guarantees shall be handled by the Successful Contractor with the help and supervision of his technical personnel.

3.7 Supply of Technology and Engineering

Although the technology for DDT manufacture is an open technology, the production of high quality DDT suitable for formulation to a 75% DDT Wettable Powder to WHO Specifications involves know-how which may not be freely available. If licensing formalities are involved, the technology shall be supplied to the Owner on a non-exclusive basis and without any restrictions as to its assignability.

3.8 Transfer of Patents

The technology transfer shall cover all patent rights relating to the concerned processes and a list of such patents shall be provided by the Successful Contractor to the Owner.

3.9 Contract Price

For the supply of technology design and engineering and other services the Successful Contractor shall charge a fixed lump sum fee which shall be the Contract Price for the package of services offered by the Successful Contractor to the Owner.

3.10 Visits to manufacturers' plants

In order to take a decision regarding the suitability of a technology, if the Owner desires to visit an operating plant of the manufacturers from which the technology is to be supplied, the Successful Contractor shall provide all necessary facilities to the Owner for such as inspection without any obligation.

3.11 Use of local equipment and materials

During the design and construction of the plant the Successful Contractor shall incorporate as much of equipment and materials of indigenous manufacture and origin as practicable and only such equipment which cannot be fabricated within Indonesia should be imported.

3.12 <u>Use of local manpower and sub-contractors</u>

During the design-engineering and construction of the project the Successful Contractor shall employ to the maximum extent possible local skilled and unskilled manpower and also local sub-contractors. The number of foreign experts employed on the project shall be kept to the minimum compatible with the efficient execution of the project.

4 SCOPE OF WORK

4.1 General

The purpose of this specification is to define the scope as well as depth and detail of the work which is required to be done on this project, so as to enable a contractor to prepare an offer including the process technology, design engineering, erection and other services required for the establishment of a DDT manufacturing and formulation plant. The scope of the work includes the following manufacturing and auxiliary establishments and technical services as listed in Sections 4.2 and 4.3. In the event of any minor changes in technology agreed upon at the time of acceptance of the proposal the scope of work would become modified to the extent of technology changes involved.

4.2 Manufacturing and Auxiliary Services Establishments

Design of all manufacturing and services facilities should be based on a 300 working day year and a three 8 hour shift / day operation.

4.2.1 Manufacturing Establishments

- Chemical manufacturing unit for the production of sufficient chloral from chlorine and ethyl alcohol to produce 5,000 tonnes per year technical DDT
- Absorption units for the recovery of by-product hydrochloric acid and sodium hypochlorite
- Chemical manufacturing unit for the production of 5,000 tonnes per year technical DDT from chloral and monochlorobenzene
- Unit for the recovery of spent sulphuric acid
- Formulation unit for mixing, grinding and packing 6,500 tonnes per year 75% DDT Wettable Powder
- Effluent treatment units for the treatment of all noxious gaseous, liquid and solid plant effluents for their safe disposal

4.2.2 Auxiliary Services Establishments

- Fume collection and scrubber system for the collection of dust and noxious fumes
- A package type steam boiler unit to provide the process steam requirement of the processing units including water treatment facilities
- A system for tapping and transferring the high voltage electric supply and distributing it to the points of use in the plant within Battery Limits including lighting design for the manufacturing / services departments, offices, warehouses and other user points
- An air conditioning plant to service offices, canteen, laboratory, amenities, plant control rooms and other plant areas where necessary to maintain efficient operation and satisfactory storage of products
- Stand-by emergency electrical generation facilities
- A workshop for plant maintenance
- A process control laboratory for the plant, including all laboratory equipment and apparatus
- Warehouse and other storage facilities for process raw materials, packages, finished products and engineering materials
- Packaging and loading systems for finished products
- Unloading systems for raw materials and engineering materials
- Fire fighting, safety and other disaster control systems for the entire complex within the Battery Limits
- Security systems within the Battery Limits

4.2.3 Civil Works

- Site investigation and development including underground sewage, rain water drainage systems and site lighting

- Design of buildings for manufacturing departments, auxiliary services departments as well as administrative departments
- Lighting system for the administration buildings
- Telephone communication system for the factory and administration buildings
- Public health facilities for the factory and administration staff including a surgery
- Employee welfare facilities for the plant and office personnel including a canteen

4.3 Technical Services

4.3.1 The scope of the work includes the provision of the following technical services by the Successful Contractor along with all related data, information and know-how for the establishments included in the scope as listed under 4.2.1, 4.2.2 and 4.2.3 above:

- Selection of sub-contractors for project erection and construction
- Selection of chemical process technology
- Process design to suit Indonesian conditions
- Design and engineering of plant facilities
- Equipment procurement including spare parts
- Supervision of erection and construction
- Training of Owner's plant operation, maintenance and quality control personnel
- Assistance during plant start-up and commissioning
- Engagement of 'Shadow' personnel for key production posts for 1 - 3 years after commissioning

NOTE

Details in respect of the different activities under the above services, the type of information, data and documentation required to be supplied by the Successful Contractor are described in Sections 7 to 16 inclusive of these Specifications.

4.4 Not included in the Scope of the Work

The following are not included:

- Selection of site
- Administrative control and monitoring of project activity
- Inspection of equipment before despatch from manufacturers (the cost of independent inspection will be charged to the Successful Contractor)

5 SPECIFICATIONS OF CHEMICAL AND PHYSICAL PROCESSES AND PRODUCTS

5.1 Chemical and Physical Process Specifications

The chemical process shall consist of the following unit processes and unit operations inherent therein:

- Chlorination of ethyl alcohol to produce chloral alcoholate using indigenous anhydrous liquid chlorine and commercial grade ethyl alcohol. A specification of the alcohol available is given in Appendix S.I.
- Recovery of by-product hydrochloric acid and sodium hypochlorite
- Liberation of free chloral from the chloral alcoholate using spent sulphuric acid
- Condensation of the chloral, indigenous oleum 20% and imported commercial monochlorobenzene to produce 5,000 tonnes per year technical DDT. A typical analysis of monochlorobenzene is given in Appendix S.II
- Recovery of spent sulphuric acid
- Formulation by mixing and grinding of the technical DDT with inert diluents and surface active agents to produce 6,500 tonnes per year 75% DDT Wettable Powder
- Efficient collection and treatment of all dusts, noxious gaseous, liquid and solid effluents and by-products in order to enable their safe disposal

NOTE

1. For the purposes of process design a 300 working day year and 3 x 8 hour shifts per day should be taken
2. While the process specifications outlined above delineate the general processes for the manufacture and formulation of DDT, it may be stated that

variations in the process technology offered by the bidders would be acceptable, as long as there is adequate and demonstrable justification for such variations, such as improved process yields, better efficiencies etc

3 The re-cycling of excess spent sulphuric acid to the neighbouring ammonium sulphate plant should be foreseen

5.2 Product Specifications

Specifications of the products to be manufactured shall conform to the following physical and chemical standards.

5.2.1 Chloral

The chloral liberated from the chloral alcoholate with sulphuric acid shall possess the following properties:

Distillation range	:	90% shall distil between 95°C and 100°C at 760 mm pressure
Density at 20°C	:	1.505 to 1.525 g / ml
Chloral assay	:	Not less than 97%

The chloral assay shall be carried out by the method given in Appendix S.III.

5.2.2 Technical DDT

This specification is based on WHO Specification WHO/SIT/1.R4.

5.2.2.1 Material

The material shall comprise essentially 1,1,1-trichloro-2,2-bis (p-chlorophenyl) ethane and shall be in the form of white or cream-coloured granules, flakes, or powder, free from extraneous impurities or added modifying agents.

5.2.2.2 Chemical and Physical Requirements

The material shall comply with the following requirements:

	Minimum	Maximum
Setting point	92°C	
Total organic chlorine content % by weight	49.0	51.0
Hydrolysable chlorine content % by weight	9.5	11.5
p,p-Isomer content % by weight	76.0	
Melting point of separated p,p-isomer	104°C	
Chloral hydrate content % by weight		0.025
Acidity % by weight, calculated as H_2SO_4		0.3
Solid material insoluble in acetone % by weight		1.0
Water content % by weight		1.0

5.2.2.3 Analytical Methods

The analytical methods to be used in determining the above chemical and physical characteristics are those described in 'Specifications for Pesticides Used in Public Health' issued by the World Health Organisation, Geneva.

5.2.3 75% DDT Wettable Powder

This specification is based on WHO Specification Number WHO/SIF/26.RI.

5.2.3.1 Description and Ingredients

The material shall consist of a homogeneous mixture of technical DDT and such inert diluents and other materials as are needed to meet the requirements of this specification. The product shall be in the form of a fine, free-flowing, white to cream-coloured powder, which wets out readily on stirring into water, and does not produce undue foaming under normal use conditions. The technical DDT used shall comply with the Specification given in Paragraph 5.2.2 above.

5.2.3.2 Chemical and Physical Requirements

The material, sampled from any part of the consignment, shall comply with the following requirements:

DDT content (w/w basis)

The content of DDT, shall be between 73.75% and 76.25%
The average content of all samples taken shall not be lower than 75.0%

Sieving after accelerated storage

Not less than 98% of the powder (dry weight) after accelerated storage treatment shall pass through a 74 µm sieve (BS 200 mesh; US Standard No. 200)

Suspensibility

a) In distilled water without pretreatment
A minimum of 70% of the DDT (1.75% w/v) shall be in suspension 30 minutes after agitating a suspension containing 2.5% w/v of DDT, prepared in distilled water from the powder as received

b) In standard hard water after accelerated storage treatment
A minimum of 65% of the DDT (1.625% w/v) shall be in suspension 30 minutes after agitating a suspension containing 2.5% w/v of DDT, prepared in standard hard water from the powder subjected to the accelerated storage treatment

Acidity or alkalinity

The acidity or alkalinity of the powder, shall not be greater than 0.2% calculated as H_2SO_4, nor greater than 0.2%, calculated as NaOH

Storage Life

The formulation ingredients chosen shall be such that any sample of the 75% DDT Wettable Powder stored in moisture-proof containers at an ambient temperature between 21°C and 38°C for a period of up to 12 months shall have a minimum of 50% (12.5 g/l) of the DDT in suspension 30 minutes after agitating a suspension containing 25 g/l of DDT prepared in Standard Hard Water

5.2.3.3 Analytical Methods

The analytical methods to be used in determining the above chemical and physical characteristics are those described in 'Specifications for Pesticides Used in Public Health' issued by the World Health Organisation, Geneva.

5.2.3.4 Packing and Marking

The product shall be packed in 25 kg nett kraft paper or woven polypropylene bags with an inner polyethylene bag. The inner bag shall be bunched tied with string or wire. The outer bag shall be stitched. As well as the name of the product and any other marks required by the Customer, the outer bag shall bear the nett weight of the contents, batch number and date of manufacture.

5.3 Effluent Treatment Unit

The effluent treatment unit may be based upon physical, chemical and bio-chemical methods of treating the gaseous, solid and liquid plant effluent, and may comprise of dust filters and of several stages of sedimentation and filtration of the liquid effluent prior to biological treatment, with incineration facilities for the sludge and carbon adsorbtion treatment of the aqueous effluent before its final disposal.

The bidder may propose alternative systems of effluent treatment.

The finally treated aqueous effluent before disposal shall meet the specifications laid down by the Indonesian Government as given in Appendix S.IV.

6 PLANT SERVICES

6.1 Electric Power

Electric power at the battery limits will be available from the State grid supply and will have to be stepped down to 380 volts, 3-phase 50-cycle for industrial use and 220 volts, 1-phase 50-cycle for lighting purposes.

6.2 Process, cooling and domestic water

Process, cooling and domestic water will be available from PT Petrokimia Gresik and will have to be pumped to the battery limits. A typical analysis of this water is given in Appendix S.V.

6.3 Refrigeration

Refrigeration for cooling water and compressed air used in processes will have to be provided within battery limits.

6.4 Steam

Steam for process use will have to be generated within battery limits in a package type boiler unit.

6.5 Compressed air

Compressed air at the required pressures will have to be provided from air compressors installed within battery limits for this purpose.

6.6 Sewers and drains

Sewers, drains and sewage treatment within battery limits will have to be designed and constructed and shall form part of the site development activity. Due cognisance of the need for separating used process and wash waters from normal surface drain water and domestic sewage must be taken, so as to maximise the efficency of the effluent treatment system.

6.7 Effluent disposal

After treatment, the aqueous effluent from the plant shall be discharged into a channel which leads to the Lamong River.

7 CHEMICAL PROCESS DESIGN CRITERIA

For the supply of process technology and provision of design and engineering services for the plant, the Successful Contractor shall provide and undertake services consisting of but not limited to the following:

7.1 Provide all basic information about the chemical process technology, including process flow sheets and material balances.

7.2 Provide all information and know-how relating to the temperatures, pressures and other operating conditions under which different reactions should be carried out to achieve optimum yields.

7.3 Prepare process time cycles for different reactions and processing operations in the plant.

7.4 Prepare process specifications.

7.5 Make all necessary process and plant services calculations required for the design.

7.6 Prepare mass balances and flow diagrams.

7.7 Prepare piping and instrument flow diagrams.

7.8 Prepare six (6) copies of operating and maintenance manuals describing start-up, operating, emergency and regular shut down procedures for processes and services of the plant, consisting of but not limited to :

1 Description of process and services systems
2 Process flow sheets
3 Piping and instrumentation diagrams including the services systems
4 Design basis and rating of all equipment and instrumentations
5 Procedure for plant start-up including all preparatory steps such as testing, running in of machinery, adjustment of instruments etc for bringing the plant to rated performance and maintained steady state conditions

6 Procedure of planned plant shut down and procedures for emergency shut down

7 Description of process hazards and safety procedures, including emergency first aid procedures for hazards specific to the processes

8 Procedures for process control and quality control of products through laboratory analytical techniques. Analysis procedures for raw materials, finished products and products at intermediate stages of manufacture

8 MECHANICAL DESIGN CRITERIA

The Successful Contractor will:

8.1 General

8.1.1 Prepare mechanical specifications including foundations for process vessels, heat exchangers, storage tanks, pumps and compressors, equipment drives, conveyors, piping, steel, instrumentation, insulation, electrical equipment and installations, special equipment and painting.

8.1.2 Establish corrosion protection requirements.

8.1.3 Prepare six (6) copies of Technical Data Books each containing:

1 Mechanical specifications
2 Manufacturers' equipment data books
3 Certified dimensioned drawings of all equipment
4 Equipment performance curves

8.1.4 Furnish an itemised list of recommended spare parts with prices for the Plant based on two (2) years normal operation.

8.1.5 Furnish an itemised list with technical specifications of any special equipment required for the maintenance of the Plant.

8.2 Specific

8.2.1 Vessels (including bulk storage of raw materials and intermediates)

1 Establish required dimensions, operating and design conditions for each vessel (Note 1)
2 Design vessels and furnish drawings showing materials of construction, wall thickness, heads, shells, nozzles, supports, internals, linings, platform clips and insulation angles
3 Prepare drawings showing arrangement of removable internals

NOTE 1

Bulk storage vessels for all liquids must be surrounded by a bund large enough to receive the entire contents of the largest vessel in the bund plus 10%. The vessels themselves must be adequatly earthed.

8.2.2 Heat Exchange and Cooling Equipment

1 Establish mechanical and material specifications

2 Prepare a list of heat exchange and cooling equipment items, and duty specifications for each

8.2.3 Pumps, compressors and their drives

1 Establish performance requirements and operating conditions for each pump and compressor and its drive

2 Establish mechanical and material specifications

3 Prepare a list of all pumps and compressor items and duty specification for each

8.2.4 Piping

1 Establish all piping and valve requirements with size and show on Piping Flow diagrams

2 Establish mechanical and material specifications for each section of Piping with suitable by-passes and shutoff valves

3 Prepare a line numbering schedule showing all lines required for the Plant

4 Design piping systems and prepare all necessary arrangement and detail drawings (underground piping except sewage should be included)

5 Prepare general piping arrangement drawings including necessary plans, elevations, and sections indicating all process and utility lines

6 Prepare details of all supports required for all pipe systems

7 Prepare drawings showing instrument air distribution systems

8.2.5 Structures

1 Prepare general arrangement drawings, plans, elevations and details for all steel or concrete structures, pipe racks, equipment support structure and platforms

2 Prepare detailed specifications covering all items established in item 1 above

8.2.6 Instrument

1 Set up instrumentation, control and safety systems, and show piping and instruments on drawings and flowsheets

2 Establish performance requirements and operating conditions for each item

3 Establish mechanical and material specifications for each item

4 Prepare schedule or specification sheets covering all instrument items

5 Prepare layout and details of all panel boards. (It should be borne in mind that the Indonesian people are some 20 - 25 cm shorter than Western people)

8.2.7 Insulation

1 Establish type, thickness and covering of insulation for each equipment item

2 Establish type, thickness and covering of insulation for each section of piping

3 Establish mechanical and material specifications for all insulation items

4 Prepare schedules covering 1 and 2 above

8.2.8 Electrical

1 Establish mechanical and material specifications for all electrical equipment, materials and services

2 Establish, design and prepare drawings as required for all switching, transformation, rectification and distribution systems

3 Prepare single-line wiring diagrams covering all electrical, instrument and lighting systems

4 Design and prepare drawings covering plant lighting systems showing panels and circuitry, including lighting requirements at ground level, platforms, structures, in buildings, and in other areas with specified detail as required

8.2.9 Painting

1 Prepare a schedule showing the requirements and methods of application of any special paints, or coatings that may be required

2 Make arrangements to have all materials and equipment including fabricated piping, where required to receive the following surface protection before shipment, unless specifically advised otherwise by Executing Agency

a) Adequate surface preparation using a commercial or near white sand blast

b) One (1) prime coat of zinc-rich prime coat with a dry thickness of about 0.1 mm

9 ELECTRICAL DESIGN CRITERIA

9.1 General

This section covers the requirements for electrical power, control and lighting systems.

9.2 Codes and standards

All equipment shall be designed and manufactured in accordance with the relevant Indonesian or equivalent standards. All installation work shall be carried out in accordance with the latest Indonesian or equivalent standards but where regulations of Local Authorities are at variance with these, the latter shall apply subject to modification at the discretion of the Executing Agency.

The Executing Agency or its representative reserves the right to approve the type and manufacture of all equipment and materials.

9.3 Work included

The Successful Contractor shall use the following in accordance with the specifications stated under 9.4.

1 All electric motors
2 Start/stop push button stations
3 Lighting fixtures with lamps and ballasts as required

9.4 Technical Specification

9.4.1 Motors shall be squirrel cage, induction type, with suitable enclosures, based on Indonesian or equivalent standards. All motors shall be suitable for operation on a 380 volt 3-phase, 50-cycle grounded neutral system. They shall be suitable for operation in a 50°C ambient temperature in accordance with Indonesian or equivalent standard. A 50°C rise in temperature should be desirable for motors.

All motors shall be Class A insulated and Indonesian or equivalent design, unless the starting requirements dictate that a different design is required.

All motors under 25 hp shall be suitable for across the line starting and continuously rated explosion proof wherever necessary. Motors of 25 hp and above, should have reduced voltage compensated starters.
All motors shall be supplied with a suitable terminal box for termination of conduits and wires.

All motors shall bear the same tag number as the driven equipment.

9.4.2 Start / Stop Push Button Stations

One local control station shall be supplied for each motor and all shall be suitable for operation on a 380 volt 3-phase, 50-cycle system, with start/stop push buttons and tell tale lamps. All enclosures shall conform to Indonesian or equivalent codes. Push button stations shall bear the same tag number as the driven equipment.

9.4.3 Lighting Fixtures, Lamps and Ballasts

The minimum 'maintained in service' level of illumination shall be 325 lux.

The lighting system will have single phase, 50-cycle, 220-V, 3-wire system.

The lighting system shall be designed to provide minimum maintenance.

Explosion hazard should be checked and all equipment shall be suitable for the hazard-rating.

9.4.4 Conduits

Each conduit shall be numbered with the driven equipment number.

The smallest conduit size used for exposed or embedded installations shall be 2.5 cm nominal outside diameter and shall be suitably sized for a purged air system, if required.

The Successful Contractor shall state whether a purged air system is required also state air requirements.

The Successful Contractor shall supply a conduit schedule showing all conduits.

9.5 Information to be Supplied by the Successful Contractor

After placement of order the Successful Contractor shall supply drawings, data and schedules including, but not limited to, the following:

1 Single line diagrams
2 Schematic diagrams
3 Wiring and interconnection diagrams
4 General arrangements
5 Lighting layouts
6 Conduit schedules
7 Wireway schedules
8 Motor manufacturer's outline drawings
9 Motor data sheets

10 INSTRUMENTATION DESIGN CRITERIA

10.1 Scope

This section describes technical requirements for instrumentation only.

10.2 Design Documents

10.2.1 Process and Instrument Diagram

The complete instrument / control system shall be depicted by means of a 'Process and Instrument' (P & I) Diagram. This P and I Diagram shall show all instruments, interconnections and interlocks.

10.2.2 Points and Lines Drawing

The location of all devices shall be indicated in plan view on a light tracing of the equipment layout drawing. This 'Points and Lines' Drawing shall show approximate instrument elevations. A material list covering pneumatic tubing, junction boxes etc shall be incorporated therein, as well as detail views pertaining to tubing installation. Wire and cable shall not be included on this 'Points and Lines' Drawing but will be shown on the appropriate electrical design documents.

10.2.3 Installation Detail Drawings

Instrument installation details shall be provided. Each drawing shall specifically refer to tag numbers covered by it and include a material list giving quantities and description of tubing, fittings etc. Electrical connection details and materials shall be covered under the appropriate electrical design documents.

10.2.4 Panel Drawings

Control panel layout drawings shall be subject to the Executing Agency's approval.

10.2.5 Instrument Description

A manual describing instrument system operation shall be supplied. The text shall state controller set points and mode adjustments, switch settings etc.

10.2.6 <u>Design Data and Calculations</u>

Instruments shall be specified on size A4 (210 x 297 mm) data sheets. Calculations for control valves, orifice plates, relief valves etc shall also be submitted on A4 sheets.

10.2.7 <u>Instrumentation Manual</u>

A separate binder (or binders) containing all the design documents and Manufacturers' prints, instruction manuals, priced recommended spare parts lists, complete part lists, performance curves etc shall be furnished.

10.3 <u>Design Information</u>

10.3.1 <u>Control Concept</u>

The plant shall be automatically controlled from local control panels, as far as it is necessary for normal running of the Plant. Automatic controls should be minimised to the extent possible. Local readouts shall be provided as are necessary for the proper execution of various manual adjustments and to provide measurements for maintenance purposes, process efficiency calculations etc.

10.3.2 <u>Electric Power Supply</u>

Single phase electric power supply for instruments will be available at 220v 50-cycles (or alternative desired voltage).

Instrumentation should be suitable for ± 10% voltage fluctuations and ± 1 cycle frequency variations.

10.3.3 <u>Instrument Air Supply</u>

Oil free, dried and filtered instrument air at 7 bar nominal (5.5 bar minimum) header pressures should be made available by the Successful Contractor.

10.3.4 <u>Ambient Conditions</u>

Site mounted instruments :

a) Ambient temperature daytime : $30^{\circ}C \pm 2^{\circ}C$

b) Relative humidity : 65% to 95%

10.3.5 Transmission Signals

Control and measurement signals to and from local control panels shall be 0.2 to 1 bar pneumatic, vacuum, draft and capillary tubes, or electric. Precautions shall be taken to prevent the possibility of process materials entering local panels due to equipment malfunction.

10.3.6 Instrument Spare Parts and Supplies

Instruments shall be supplied with a stock of consumable materials such as charts, ink, lubricants etc as well as spare parts which can reasonably be expected to fail or wear out quickly, to assure 12 months uninterrupted operation. Where applicable, complete spares may be provided (eg critical control valves).

10.3.7 Instrument Quality and Reliability

All instruments shall be of highest quality, industrial grade of continuous operation and minimum maintenance. Consistent with the above, standard instruments (recorders, controllers, transmitters etc) shall be supplied by the same manufacturer. Similarly, other groups of devices (control valves, pressure gauges etc) shall, where possible, be of the same manufacture within each group. Wherever possible, important instruments not critical to plant operation shall be installed in such a way as to permit removal for calibration and maintenance without requiring plant shutdown (block and bypass valves, shut-off valves etc). Sufficient spare parts for critical instruments or even a duplicate set should be supplied where considered essential.

Transmitters and transducers and like devices shall be of the force balance type wherever possible.

Temperature measurement for critical services shall be accomplished with thermocouples or resistance bulbs.

Filled systems may be used for back-up and non-critical services.

Instruments should be selected and installed in such a manner as to minimise the use of purging and flushing.

10.3.8 Charts, Scales, Measurements Units

Temperature units shall be in ^{o}C.

Flow units shall be :

a) Process liquid-litres (cu.m) per minute (additives, purges etc - litres (cu.m) per hour)

b) Air, gas and vapour - std litres (cu.m) per minute (bleeds, purges etc - std litres (cu.m) per hour)

c) Steam - tonnes or kilograms per hour

10.3.9 Pneumatic Tubing

Tubing shall be plastic or plastic coated and fittings sprayed with plastic.

The use of plastic tubing shall be limited to armoured Multi-tube bundles suitable for the prevailing high ambient temperature.

All pneumatic tubes shall be supported from inverted U-shaped channels throughout the entire run.

10.3.10 Instrumentation Wire and Cable

Thermocouple extension wires for individual pairs shall be H16 ANG (min) solid alloy, twisted, shielded, computer grade, with drain wire and overall jacket, installed in conduit. Wire shall connect sensor to instrument with no intermediate junction or splice of any kind.

10.3.11 Control Panels

Control panels shall be flat-faced, free standing, totally enclosed, gasketed cubicles with rear piano hinged access doors having automatic locking handle and two-point latching. The panel's paint finish shall be a multi-coat paint system applied in strict accordance with the manufacturer's instructions and selected for durability, resistance to local atmosphere and appearance.

11 CIVIL DESIGN CRITERIA

11.1 General

This scope covers the requirements for civil work for the Plant and Offices and other Buildings.

11.2 Plant

The work shall include, but not be limited to the following:

Establishment of requirements and design for all items of steel work as required for the Plant. This work shall include the laying out and design of all supporting steel access stairs, ladders, platforms, walkways etc all foundations both major and minor, trenches, sumps, basins, firewalls etc as required for the installation, operation and maintenance of the facilities. In regard to this work, the Successful Contractor shall prepare and submit design drawings, shop details and erection drawings and design calculations as required for the Executing Agency's approval.

11.3 Offices, amenity buildings etc

The work shall include, but not be limited to the following :

Establishment of requirements and design for all buildings to include layout, materials of construction, specification for foundations, concrete, timber, painting, drainage, air conditioning etc. All electrical work to be of the same standard as specified for the plant.

11.4 Air conditioning

The performance of the air conditioning plants shall be such as to maintain an ambient temperature of 20 to 23°C with a Relative Humidity of maximum 65% and minimum 30%.

12 STRUCTURAL DESIGN CRITERIA

12.1 General

This Structural Design Criteria covers the general requirements relative to the design of all steel structures, buildings and equipment supports.

12.2 Codes

The materials and design procedures shall comply in all respects with the provisions of the latest editions of the relevant Indonesian standards and codes or their equivalents.

12.3 Climatic Conditions

There is little variation in temperature of the Surabaya area throughout the year, the average of the highest of each month being about 32°C and the lowest about 22°C. The relative humidity varies between 95% and 65%. The maximum documented rainfall in any 24 hours is 70 mm, the wettest months being December to April.

12.4 Dead Loads

'Dead Load' shall be the weight of materials forming the structural unit, including insulation or fire-proofing.

Concrete	2,400 kg / m^3
Structural steel	7,850 kg / m^3

12.5 Live Loads

'Live Loads' refers to superimposed loads on roof, floor or platform area due to operation and maintenance only.

Roof

For roofing and supporting steel work	25 kg / m^2
Operating floors, unless otherwise specified	750 kg / m^2
Platforms, stairs and landings	500 kg / m^2
Walkways	350 kg / m^2
Laydown, storage and electrical equipment floors	1250 kg / m^2

12.6 Equipment Loads

1 'Equipment loads' shall be the weight of machinery and all process equipment, together with all dead load attachments and contents during testing or operation. This also shall include the dynamic effect of moving machinery or equipment. In general, equipment loads shall include their full capacity of process liquids or solids

2 Loads for pulling tube bundles shall be taken equal to one-half the weight of the tube bundle

3 Impact shall be determined for each equipment used.
Hand operated cranes,
crushers and mills 100% of operating weight

12.7 Pipe Loads

'Pipe Loads' shall be the weight of all pipelines, valves, fittings, insulation etc and shall include the weight of contents during test, or normal operation, whichever is greater.

Roof trusses and floor girders in the process areas shall have an allowance for suspended piping, equal to 25 kg / cm^2.

12.8 Thermal Expansion Loads

1 All equipment supports shall be designed to accommodate the loads or effects produced by thermal expansion

2 Pipeway support stanchions shall be designed to withstand a thermal force applied in either direction parallel to the piping run, equal to 7.5% of the operating weight, or 30% of any one or more lines known to act simultaneously in the same direction, whichever is larger

3 Pipe anchor loads shall be as calculated to resist anchorage loadings in piping systems

4 Thermal expansion loads shall be combined with the appropriate loading combinations, except that for pipeway stanchions they shall ordinarily not be combined with loads produced by hydrostatic test

12.9 **Loading Conditions**

All structures and their foundations, and all elements thereof shall be designed for the most severe of any of the following combination of loads and forces:

1 Shutdown dead load of equipment (empty, but with all permanent internals, piping, platforms, and insulation in place) combined with wind

2 Normal operating loads with all dead and live loads in place, but no wind

3 Normal operating loads with all dead loads in place combined with wind

4 Vessels and piping under hydrostatic test with all dead loads in place, but no wind acting

5 Main floor members shall be designed for a concentrated load of 1 tonne in addition to equipment and uniformly distributed live loads, but its effect shall not be included in columns

6 Roof trusses in the process area shall be designed for a concentrated load of 1 tonne at any one panel point in addition to uniformly distributed live loads

12.10 **Structural Data**

Materials and allowable stresses

Concrete	-	Structural - F'c 210 kg / cm^2
		Lean - F'c 140 kg / cm^2
		Pavements - F'c 280 kg / cm^2
Reinforcement	-	Plain Bars - Deformed structural grade Fs-1400 kg / cm^2
	-	Stirrups and Ties, Plain Bars Fs-1400 kg / cm^2 min diam 1 cm
	-	Steel Fabric Fs-2100 kg / cm^2
Structural and Miscellaneous Steel	-	fy - 2300 to 2500 kg / cm^2
Structural plates	-	fy - 1800 kg / cm^2
	-	fy - 2100 kg / cm^2

Steel Connections - Shop connections - welded
- Field connections:
major - 2¼ cm diam HT 'Friction grip'
minor, such as girts and purlins - 2cm diam 'black bolt'
Rigid frames - welded

12.11 Soil Bearing Pressures

The soil in the Gresik area consists of black and brown clay. Considerable piling will be necessary. The Successful Contractor shall carry out a survey and act accordingly.

13 PROCUREMENT

13.1 General

The Successful Contractor shall be responsible for the supply of all equipment, materials and supplies. In respect of equipment of imported origin it will be necessary for the Successful Contractor to obtain prior approval of the Executing Agency before taking procurement action. Equipment materials and supplies shall be furnished in the manner stated below for the specific commodities listed hereunder. This list is not intended to be all inclusive.

13.2 Vessels

a) Vessels shall be supplied completely fabricated and assembled if warranted

b) Vessel internals may be shipped separately properly marked for assembly at site

13.3 Heat Exchange Equipment

Tube and shell type exchangers shall be completely fabricated, and completely assembled prior to shipment. Three (3) spare sets of gaskets to be supplied for each exchanger. One (1) test ring for each size and type exchanger shall be supplied.

13.4 Pumps, Compressors and their Drives

a) All pumps, compressors, their drives, and guards are to be completely assembled on skid-type framework prior to shipment, unless shipping limitations prohibit

b) Assembly prior to shipment includes dowel pins when required

13.5 Piping and Piping Items - Alloy, Glass Lined, or Special Materials

a) All piping sections made of any type alloy, glass lined or other special materials, or linings shall be furnished completely fabricated into spools prior to shipment, with either flange, or other type special connectors, to reduce welding, cutting or fitting at site

b) All pieces, and connection materials, shall be tagged with the line number in which they are to be used

13.6 Hangers - Pipe and Piping Items Supports

To be fabricated at site.

13.7 Instrumentation

a) Panel Boards shall be shipped without mounting any instruments. All instruments shall be packed separately in polystyrene packs and shipped. All necessary piping, wiring junction boxes etc shall also be shipped separately

b) All instruments to be located on panel boards shall be mounted on the panels at site

c) All local instruments shall be supplied with local instrument piping, and valving, such as manifolding, bypasses etc connected to each component prior to shipment, with identification number marked thereon

d) Loose instrument materials, such as valves, tubing connectors etc shall be kept to a minimum

13.8 Inspection and Expediting

It shall be the Successful Contractor's responsibility to perform all expediting services necessary to ensure delivery of quality materials in strict conformance to specifications, within the scheduled time period.

Executing Agency reserves the right to arrange independent inspection of materials before shipment at the Successful Contractor's expense.

13.9 Shipping

The packing, shipping and dock clearance of all imported materials shall be the responsibility of the Successful Contractor.

14 TECHNICAL SUPERVISION OF ERECTION AND CONSTRUCTION

The Successful Contractor will be expected to provide technical supervision of the erection of machinery, piping and other installations and of construction activities of the plant, so as to ensure that they are in conformity to the design prepared by him.

This is to ensure that no problems arise during the start-up and operation of the plant and specially during the proving of the guarantees for which the Successful Contractor has the full responsibility.

15 TRAINING OF PLANT AND DESIGN ENGINEERING PERSONNEL

The Successful Contractor will be expected to provide in his own plant (or in the plants from which he is obtaining technology and equipment) training facilities for plant operating, maintenance and quality control personnel, while the plant project is under construction, so that these personnel are trained and equipped to man the new plant as soon as the construction phase is over.

Similarly during the design phase of this project the Successful Contractor will be expected to associate a specified number of the Owner's engineers with different aspects of the design activity of the project so as to impart to them necessary training in design work, which will be useful for any problems which might arise in the future operations of the plant.

The exact number of plant personnel and design engineers to be trained will be specified by the Owner, at the time of finalising the Contract for the project.

16 ASSISTANCE DURING PLANT START-UP AND COMMISSIONING

After the erection and installation of all plant facilities has been completed and the plant is ready for the start-up operations the Successful Contractor shall be required to provide for a specified period the services of suitably trained and experienced personnel under whose guidance and supervision the start-up operations of the plant can be commenced and the plant fully commissioned. The same personnel can undertake the proving of guarantee for the plant on behalf of the Successful Contractor in final fulfillment of the Successful Contractor's technical obligations in respect of the plant project. Provision should be made for these or similar personnel to remain on site for a period of 1 - 3 years, as may be agreed with the Owner until such time as the Owner's personnel can run the plant efficiently without recourse to outside help.

17 WEIGHTS, MEASURES AND LANGUAGE

17.1 All weights and dimensions shall be furnished in the metric system, viz:

A Weight or force
kilograms or tonnes (1,000 kilograms)

B Temperature
degrees Celsius (^{o}C)

C Pressure
kilograms per sq centimetre
kilograms per sq metre
millimetres of water
millimetres of mercury
bars

D Flow rates
litres per minute or cubic metres per hour
Standard cubic metres per hour at 15.5^{o}C and 760 mm of mercury or kilograms per hour
tonnes per hour

E Length or elevation
millimetres, centimetres, metres or kilometres

F Volume quantities
litres or cubic metres

G Viscosity
centistokes

17.2 Language

All drawings, data etc prepared for the plant shall be in English or with translation to English thereon.

Equipment Manufacturers' and Contractor's drawings shall be in English or bear English translations of all information pertinent to the erection, operation, and maintenance of the plant.

18 PROPOSAL

18.1 Proposal

The tenderbid shall be based on a package-type proposal covering the cost of technology, design, engineering, procurement and other services as defined in the scope of work for a fixed price. The Fixed Price shall be broken down according to the data requirements indicated in Section 18.4.

18.2 Exceptions

Proposals shall clearly state in a section entitled 'EXCEPTIONS' any and all exceptions to the Executing Agency's requirements contained in the enquiry documents. Failure by the Executing Agency to note that any of the bidder's specifications are not in accordance with the enquiry documents shall not relieve the Successful Contractor of the obligation to comply with the Executing Agency's specified requirements unless the differences are clearly stated in a section of the bidder's proposal explicitly devoted to 'EXCEPTIONS'.

18.3 Rejection of bids

The Executing Agency reserves the right to reject any or all of the proposals, to award part or all of the Contract to any contractor, and assumes no obligation to reimburse the cost incurred by the bidder in the preparation of the proposal.

18.4 Information required with bidder's proposal

The following listed data are the minimum required with the proposal.

18.4.1 Fixed Price - effective for 180 days - with breakdown as follows :

1 Supply of process technology

2 Design and engineering

3 License fees and / or patent rights (if any)

4 Procurement CIF Surabaya, Indonesia of equipment and materials for the plants as detailed under section 4.2 of the scope of work and delivery to site

5 Building and Erection, with estimated man-month costs, subsistence, travel etc

6 Starting-up and test runs of the units. The test runs should be for a period of four (4) weeks to prove the rated output of products to the required specifications proving raw materials and plant services consumptions

7 Training of design engineering, plant and quality control personnel

All costs as above shall be further broken down to indicate:

a) Off-shore costs, ie costs in overseas country of origin in US Dollars

b) Local costs in Indonesian Rupiahs

18.4.2 Schedule covering

1 Technology

2 Engineering

3 Procurement

4 Shipping, including delivery in Indonesia of all equipment by item numbers and materials by categories, predicated on a completion date of 2 years after award of Contract

5 Construction of all buildings, supervision erection and start-up of the Plants

6 Training of personnel

18.4.3 Contract guarantees

Bidders to list proposed guarantees covering:

1 Plant performance and process performance

a) Raw material and chemicals consumption

b) Power and other plant services consumption

c) Output

d) Product quality

2 Equipment design

3 Equipment mechanical warranties from equipment manufacturers

4 Indicate penalties for non compliance with product qualities and production capacities guaranteed for the plant

18.5 Process description

Furnish :

1 Process flow diagrams including piping and equipment sizes and materials of construction

2 Material balances

3 Utility requirements

18.6 Plot plan arrangement

The plot plan arrangement furnished shall show all major equipment and structures, and shall be dimensioned in such detail as to determine the size of the plot required to accommodate the Plant, including the storage areas, offices and amenity buildings.

18.7 Omissions

Notwithstanding any omissions in this enquiry specification it shall be clearly understood that equipment and supplies, shall be complete in all respects for the proper installation and functioning of all units

19 DESIGN CODES AND STANDARDS

In general, unless otherwise specified by the Executing Agency, all equipment and materials designed and furnished for the proposed plant shall conform to Indonesian Design Codes and standards which are generally comparable to British and American standards in their requirements. A list of the applicable Indonesian standards will be made available to the Successful Contractor, by the Executing Agency, before the commencement of design work for the project. Where no Indonesian standards are available, the Contractor shall propose Standards which, in no case, should be inferior to British and American Standards. The Executing Agency will be the final Arbiter on this matter.

APPENDIX S.I

SPECIFICATIONS FOR ETHYL ALCOHOL FROM PT ASEN PABUARAN

	Super	Grade I	Grade II	Method
Alcohol content % v/v at 25°C min	95	95.1	94.0	BS 507-1966
Non volatile matter (105°C) mg/l max	50	50	50	BS 507-1966
Acidity as acetic acid mg/l max	15	30	60	BS 507-1966
Barbet reaction max	20	8	8	BP 3G - Ps
Fuel Oil mg/l max	4	15	15	AOAL 9.066-1975
Acetaldehyde mg/l max	4	150	150	BS 507-1966
Heavy metals (Pb, Cu, Zn, As, Hg)	Negative		Negative	BP 3G - Ps
Methanol % max	0.1	1.0	0.1	AOB 9.066-1975

APPENDIX S.II

TYPICAL ANALYSIS OF MONOCHLOROBENZENE

(Conforming to British Standard Specification No 2533 (1954))

Appearance	:	A clear, almost colourless liquid with a penetrating characteristic odour, free from visible water and foreign matter
Boiling Point	:	131.7°C
Flash Point	:	23.5°C
Density at 20°C	:	1.106 g per ml
Acidity to bromophenol blue	:	none detected
Free chlorine	:	none detected
Water	:	0.03% max
Residue on evaporation	:	10 ppm max

APPENDIX S.III

CHLORAL ASSAY

1 Preparation of solution

Weigh accurately by means of a Lunge-Rey pipette about 10 grams (W g) of the sample into 50 ml distilled water contained in a 100 ml stoppered, graduated flask. Shake to dissolve, dilute to 100 ml with distilled water and filter if necessary.

2 Determination of acidity

Measure 25 ml of the solution from a safety pipette and titrate with 0.1N NaOH solution to methyl red indicator. Let this titre be "a" ml.

3 Original Chloride content

To a further 25 ml of the solution add 20 ml 2N HNO_3, add 30 ml 0.1N $AgNO_3$ from a safety pipette. Then add approximately 5 ml nitrobenzene and 5 ml ferric alum indicator solution. Shake vigorously and back titrate the excess $AgNO_3$ with 0.1N KCNS solution ("b" ml).

4 Hydrolysis

Measure 25 ml of the solution from a safety pipette into a stoppered conical flask and cool to below 5^oC. Measure 25 ml of N NaOH from a safety pipette into a flask and cool below 5^oC. Add the cold NaOH to the chloral solution (washing out the flask with water below 5^oC) and shake vigorously for five minutes.

Immediately back titrate the excess alkali with N H_2SO_4, using phenol phthalein indicator, from a 10 ml micro burette ("c" ml). RETAIN THE SOLUTION.

5 Chloride content after hydrolysis

Examine the solution from 4 in the same way as for 3 above.

Titre "d" ml 0.1N KCNS.

NOTE

In the case of a very acidic sample the quantities of $AgNO_3$ may have to be increased, and appropriate alterations made in the calculation.

6 Calculation

a) % Apparent Chloral by hydrolysis

Let C = ml N NaOH required for 0.25 W g of sample

ie = (25 x normality of N NaOH used) - (c x normality of N H_2SO_4 used)

Then $\frac{1475 \times 100 \times 4 \times C}{W}$ = % apparent chloral by hydrolysis

b) % Chloral corrected for acidity

Let A = a x normality of 0.1N NaOH used

Then $\frac{1475 \times 100 \times 4 \times (C - A)}{W}$ = % chloral corrected for acidity

c) % Chloral corrected for acidity and increase in chloride content during hydrolysis

Let E = correction to be applied due to increase in chloride content

Then E = (30 - d) - (30 - b) x normality of 0.1N KCNS used

Then $\frac{1475 \times 100 \times 4 \times (C - A - E)}{W}$ = % chloral corrected for acidity and increase in chloride during hydrolysis

APPENDIX S.IV

REQUIREMENTS FOR THE QUALITY OF INDUSTRIAL, MINING AND HOUSEHOLD LIQUID EFFLUENT

No	PARAMETER	UNIT	Minimum which is permissible	Average in 24 hour period	Maximum which is permissible	NOTE
	I. PHYSICS					
1	Temperature	°C			30	
2	Suspended matter	mg/l			nil	which is retained by filter with 3 mm aperture
3	Precipitated substances	mg/l			1.0	
	II. CHEMISTRY					
	A. Inorganic Chemistry					
1	Aluminium	mg/l			10	as Al
2	Arsenic	mg/l			1	as As
3	Barium	mg/l			1	as Ba
4	Iron	mg/l			1	as Fe
5	Chromium	mg/l			0.1	as Cr
6	Cadmium	mg/l			1	as Cd
7	Nickel	mg/l			2	as Ni
8	Silver	mg/l			0.1	as Ag
9	Quicksilver	mg/l			0.1	as Hg
10	Zinc	mg/l			1	as Zn
11	Copper	mg/l			1	as Cu
12	Lead	mg/l			1	as Pb
13	Free Ammonia	mg/l			0.1	as NH_3
14	Free Chlorine	mg/l			0.05	as Cl_2
15	Fluoride	mg/l			2	as F
16	Nitrite	mg/l			1	as NO_2
17	Phosphate	mg/l		2		as PO_4
18	Sulphide	mg/l			0.1	as S
19	Biological Oxygen Demand	mg/l		20	30	as O_2
20	Chemical Oxygen Demand	mg/l		50	80	as O_2
21	pH	mg/l	6.5		8.5	
22	Methyl blue test	mg/l				negative
23	Permanganate oxidation	mg/l		60	90	as O_2
24	Suspended solids	mg/l		20		
	B. Organic Chemistry					
1	Hydrocarbons				10	
2	Oil and fat				10	
3	Phenol				0.1	as phenol
4	Cyanides				0.1	as CN

APPENDIX S.V

TYPICAL ANALYSIS OF WATER SUPPLIED BY PT PETROKIMIA GRESIK

Raw Water

Origin	:	river
Temperature	:	29°C
Pressure	:	negligible

The typical composition of the water after clarification is as follows :

temperature	29°C
pH	9 - 10
total hardness as $CaCO_3$	45 - 80 ppm
Ca - hardness	30 - 40 ppm
phosphate as PO_4	Nil
residual chlorine	0.5 ppm
chlorine	25 - 60 ppm
alkalinity P	30 ppm ($\frac{1}{2}$ carbonates + all hydroxides)
M	60 ppm (all bicarbonates + all carbonate + all hydroxides)
total solids	150 ppm
SO_4	25 - 100 ppm
Stability Index	6.5

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