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SHORT-TERM TECHNICAL ASSISTANCE TO COIME
IN PROJECT IDENTIFICATION, PREPARATION AND PROMOTION

DP/RAS/85/010

Technical Report: Production of Ductile Cast Iron Pipe *

Prepared for the Committee for Industry, Mining and Energy, ASEAN Secretariat, by the United Nations Industrial Development Organization, acting as executing agency for the United Nations Development Programme

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* This document has not been edited.

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I. EXECUTIVE SUMMARY

1.1 Background and history (chapter II)

The idea of a local (ASEAN) manufacture of ductile iron pipe was identified by UNIDO during the first phase of DP/RAS/85/010. At the annual meeting of the Committee for Industry Mining and Energy (COIME) for ASEAN countries held in October 1987, the Committee endorsed the undertaking of an opportunity study to investigate the financial and technical viability of a ductile iron pipe manufacturing unit in the region.

Two member countries expressed particular interest, namely Malaysia and the Philippines, and they were later joined by Indonesia.

Ductile iron pipe has been imported into the ASEAN region since 1975 and before that time, grey spun-iron pipe. Since 1980 the overall level of imports has steadily increased although most of the recent imports have been associated with foreign loan agreements particularly with Japan and the United Kingdom.

1.2 Market and plant capacity (chapter III)

Market demand

It has been decided to initially cover the smaller-diameter pipe market. The selected products fall into the 100-450 mm range. Domestic demand for ductile iron pipe in Indonesia, Malaysia and the Philippines is forecasted as follows:

	1991	1992	1993	1994	1995
Philippines	7,910	7,910	7,910	7,910	...
Indonesia	68,774	68,774	68,774	68,774	...
Malaysia	34,636	41,184	49,277	57,368	...

In view of uncertainty envisaged in the demand forecast of DI pipe, e.g. procurement policy of water pipes for water supply projects, availability of foreign financial assistance funds, no specific growth rate has been taken into account for Indonesia and the Philippines. For Malaysia, the increasing penetration rate into asbestos cement and steel pipe market is the basis of demand growth.

In the fourth year (1994), the total demand in ASEAN including other ASEAN countries such as Singapore will amount to approximately 140-150,000 t.

Plant capacity

Two machines producing pipes ranging from 100-450 mm in diameter with 40 per cent of product A group (100-150 mm), 30 per cent of product B group (200-250 mm), 20 per cent of product C group (300-350 mm) and 10 per cent of product D group (400-450 mm) could reach the nominal maximum production of 82,800 t. This indicative full capacity is achieved through the following working arrangement: 8 hours/day, two shifts, 237 working days per year. This plant capacity would absorb approximately 60 per cent of the ASEAN demand in the selected groups of product. Installation of a third machine to produce 120-130,000 t. has not been recommended in light of uncertain demand and of the penetrating ratio to replace other material pipes.

Sales forecast

The following sales forecast has been made on the basis that (a) 50 per cent of the forecasted demand would be skimmed by the proposed products in the Philippines and Indonesia; b) replacing asbestos cement and steel pipes would be fully captured by the proposed products in Malaysia; (c) replacing imported DI pipe would only be half successful, i.e. 7,500 t. of DI pipes for product groups A, B, C, and D would be replaced by the proposed products in Malaysia.

Case I Philippines	1st	2nd	3rd	4th	...
Domestic	3,955	3,955	3,955	3,955	
Export	20,885	37,445	58,145	78,845	
Case II **Indonesia**					
Domestic	24,800	34,387	34,387	34,387	
Export	nil	7,013	27,713	48,413	
Case III **Malaysia**					
Domestic	24,800	33,684	41,777	49,868	
Export	nil	7,716	20,323	32,932	

Pricing

The selling price of products has been determined at a US$ 600/MT level. This does not include 15 per cent of sales commission, but distribution costs, mainly freight cost, are included in cases of products to be exported to foreign markets. The competitive price with other products would therefore be US$ 690/MT. The freight charge between Malaysia and Indonesia is set at US$ 36/MT and between the Philippines and Malaysia/Indonesia at US$ 72/MT. The set price for 300 mm pipe, i.e. US$ 219/piece, is competitive enough vis-a-vis spiral welded steel (US$ 220) and imported ductile iron pipe (US$ 290) and marginally competitive in asbestos Cement (US$ 198) in Malaysia. It is competitive only vis-a-vis imported ductile iron pipe (US$ 246) in Indonesia. It is not at all competitive vis-a-vis other materials in the Philippines. Despite of this price disadvantage in Indonesia and the Philippines, the relatively optimistic sales projection (50 per cent of projected demand), however, was made for the Philippines and Indonesia on the basis of expected changes in procurement policy of the water supply authorities who should promote a favourable ground for DI pipes.

1.3 Material inputs (chapter IV)

Basic feedstock for ductile iron is mild steel scrap or its equivalent in hot briquetted iron or direct reducing sponge iron. Steel scrap is recommended as basic feedstock on the grounds of availability, price, metallurgical suitability for electric induction melting, and a low net sulphur content. This decision does not necessarily preclude the future use of HBI or D.R. iron if circumstances change.

Alloys and recarburiser needed for ductile iron manufacturing are already imported and available locally. Local supplies of sand, cement and other materials for pipe finishing processes are also available.

The relative costs in US dollars per tonne of material consumables are the following:

	Malaysia	Indonesia	Philippines
Direct materials	190	211	215
Indirect and auxiliary materials	40	33	32

Energy costs (US$) vary with the countries as follows:

	Malaysia	Indonesia	Philippines
Unit cost	0.06	0.04	0.077
Full output costs	2,484,000	1,656,000	3,187,800

The price of cooling water (US$) is calculated at

	Malaysia	Indonesia	Philippines
Annual cost	165,000	116,530	140,250
Cost per 1000 m^3	160	113	136
Cost per tonne of pipe	1.993	1.410	1.694

The cost of fuel oil used in the heat treatment of pipe is estimated at US$ 3.5 per tonne, giving an annual cost of US$ 289,800 at full capacity.

Laboratory and quality control material costs have been estimated at US$ 1.5 per tonne, giving an annual cost of US$ 124,000 at full capacity.

1.4 Location and site (chapter V)

A specific site and location for the plant have not been established. A site of at least 25,000 square metres will be required for a ductile iron pipe plant. The study has assumed the purchase of the freehold, although suitable land may be rented or leased to financial advantage.

The typical costs of land and average costs of buildings and foundations are provided.

	Malaysia	Indonesia	Philippines
Land	1,000,000	1,400,000	1,200,000
Buildings and foundations	5,500,000	7,700,000	6,600,000

1.5 Project engineering (chapter VI)

A two-pipe spinning machine plant has been selected, supplied by molten treated ductile iron from a series of electric induction batch melters. This proposal incorporates a required degree of automation concomitant with the need for repetitive quality assurance production in a high volume environment and to precisely coordinate the various machine sequences at each operation by matching metal supply with pipe spinning and all subsequent finishing operations.

Whilst the so-called world best practice is said to be 5 man/hour per tonne, this study aims at producing pipes with a manpower ratio of approximately 10 hours per tonne. The study has limited the type of pipe produced to a size range of 100 - 450 mm diameter and a single type of push-in joint suitable for water applications.

The total cost estimate of plant and equipment is given at US$29,040,000.

The costs of technology transfer are estimated at US$ 1,620,000.

1.6 Organisational structure and overhead costs (chapter VII)

The management and organisational structure is shown in Table 7.1 on page 44.

Overhead costs

a. Factory overheads which relate to maintenance and spare parts, effluent disposal and insurance amount to US$ 871,500 per annum.

b. Administrative overheads reflect the costs of management and administrative labour, and the operating functions of the office involving computers.

Malaysia	Indonesia	Philippines
271,000	66,120	70,272

The large differences in costs between Malaysia and the other two countries is due to differences in wage and salary levels.

c. Administrative non-labour overhead. This provision covers the cost of communications, computerized production control, stationary etc. and provides a work medical service.

Cost provision = US$ 207,000 per annum.

d. Marketing non labour. Provision has been made to cover costs of customer liaison and travel at US$ 500,000 per annum.

1.7 Manpower

A. The cost of factory labour is calculated in US dollars at:

Malaysia	Indonesia	Philippines
808,124	393,752	321,559

Malaysian wage rates are more than double those of the other countries.

The total payroll including management and administration is 201 persons. Including overtime and night shift allowances, the total payroll costs (US$) at full output are:

Malaysia	Indonesia	Philippines
948,624	426,712	355,655

B. Expatriate labour

The use of foreign labour is seen as essential for the smooth and adequate transfer of technology and operational know-how. The costs include pre-production phases and two years of production.

	Pre-production		Production phase	
	Year 1	Year 2	Year 3	Year 4
Foreign expert costs	82,500	247,000	305,000	305,000

Costs of training for local engineers and management (US$ 120,000) are included in the pre-production cost allocation for technology transfer at US$ 1.62 m.

1.8 Project implementation (chapter IX)

Since this study was not required to select a location or site, the influence of site and location on costs and time are not known. The time of implementation will depend on whether appointed contractors for design, building and installation take longer than a contractor who is already in the pipe manufacturing business and intends to have an equity share in the new project. The study assumes a 24-month implementation phase.

Pre-production costs during the 2-year implementation phase

	Malaysia	Indonesia	Philippines
Management team	399,953	174,500	146,390
Expatriate team	330.000	330,000	330,000
Pre-marketing advertising	20,000	20,000	20,000
Inventory foreign	1,070,000	1,245,800	1,281,680
Inventory local	248,000	204,930	198,720
Pipe mould stocks	882,000	882,000	882,000

1.9 Financial analysis (chapter X)

A. Total investment cost (US$ 1,000)	Philippines	Indonesia	Malaysia
Building and land preparation	7,920	9,300	6,700
Plant equipment and engineering	30,660	30,660	30,660
Pre-production capital expenditure	2,859	2,859	2,950
Interest during pre-production	1,129	1,129	1,129
	42,568	43,947	41,439

B. Project financing (US$ 1,000)	Philippines	Indonesia	Malaysia
Equity	10,779	12,158	9,650
Foreign loan	30,660	30,660	30,660
Bank overdraft (or equity)	1,129	1,129	1,129
	42,568	43,947	41,439

C. Total production cost (US$ 1,000 - 4th year of production)

	Philippines		Indonesia		Malaysia	
	fixed	variable	fixed	variable	fixed	variable
Factory costs	1,270	24,531.8	1,087.8	22,980.7	1,506.9	22,672.2
Other costs						
Administration	242		240		342.5	
Sales and freight	500	5,676.8	500	1,742	500	1,185.5
Depreciation	2,452.9		2,488.6		2,488.2	
Financial charges	2,146.2		2,146.2		2,146.2	
Total	6,611.1	30,207.6	6,483	24,723	6,943.8	23,857.7

D. Financial evaluation

(i) The cumulated cash balance becomes positive in the sixth year of production for the Philippines and in the fifth year for Malaysia and Indonesia.

(ii) Net profit (loss) for the first five years (US$ 1,000):

	First	Second	Third	Fourth	Fifth
Philippines	-1,004	1,723	4,811	7,716	7,716
Indonesia	723	4,054	8,135	12,020	12,020
Malaysia	513	3,587	7,548	11,327	11,327

(iii) Net present value (US$ 1,000) and IRR

	IRR	Net present value at cut-off rate
Philippines	19.08	20% = -1,775
Indonesia	25.1	20% = 10,769
Malaysia	25.27	15% = 26,337

(iv) The break-even point

	Philippines	Indonesia	Malaysia
% of capacity	33.9	25.9	26.89
Production level	28,110 t.	21,442 t.	22,264 t.

(v) Debt service ratio for the first ten years

	Philippines	Indonesia	Malaysia
1st year	0.56	1.46	1.27
2nd year	2.36	3.52	3.27
3rd year	3.68	5.30	5.02
4th year	4.98	7.05	6.74
5th year	2.94	3.97	3.80
6th year	3.03	4.10	3.92
7th year	3.13	4.24	4.05
8th year	3.23	4.39	4.19
9th year	3.34	4.55	4.34
10th year	3.46	4.72	4.50

(vi) Sensitivity analysis

Assumption: Production level (sales volume) is reduced to 62,100 t. (75 per cent of full production level), 25 per cent of which is for export and 75 per cent for domestic market. This sensitivity analysis has been conducted only for Indonesia and Malaysia since the Philippines' IRR is already lower than the cut-off rate.

Result: In both cases the IRR still stays above the cut-off rate. Thus the plant can be commercially profitable even at 75 per cent of full capacity.

1.10 Conclusions

The financial indicators show that the plant to be established either in Malaysia or Indonesia would be commercially profitable. The project has to be strongly promoted for AIJV. The negative net present value for the Philippines case is attributable to the limited domestic market and to the fact that a larger portion of products (more than 90 per cent) would have to be sold on foreign markets, resulting in higher distribution costs (freight costs) than in the other two cases.

The decision on which country Malaysia or Indonesia presents more advantages for the establishment of production facilities could not be substantiated. It would be left to the private entrepreneurs' initiative to follow up this study with a more detailed, full fledged feasibility study.

The forthcoming feasibility study should focus inter alia on:

(1) Penetration possibility of DI pipes vis-a-vis AC, PVC, and spiral welded steel pipes;

(2) Water pipe procurement specifications in each ASEAN country;

(3) Substantiating sales forecast for each diameter in view of foreign aid availability as well as self-financing possibility;

(4) Possibility of expansion of plant to cover market for larger diameter pipes upon reaching the full-production year, if the potential project promoters so wish;

(5) Ascertaining the interest of potential technology suppliers and defining specific technical cooperation schemes in view of the fact that the technology would be made available by a very limited number of DI pipes manufacturers in industrialized countries.

II. BACKGROUND AND HISTORY OF THE PROJECT

2.1 General outlook of ductile iron pipe

Ductile iron spun pipe has been imported into ASEAN countries in substantial quantities since the mid 1970's although distribution of these imports is not evenly spread as seen from the statistics in Table 2.1. Before that time major spun pipe manufacturers had marketed grey iron spun pipe in the region.

The change from grey iron to ductile iron pipe in industrialized countries was the natural consequence of research and successful development of Magnesium and Cerium (plus rare earths) inoculated cast iron in which the free carbon in the iron was speroidised instead of precipitating as graphite flakes. This "new" material offered several advantages over the conventional grey iron including strength and ductility characteristics comparable to low alloy steel. In terms of spun iron pipe this meant a thinner walled pipe of higher strength which was not susceptible to crack during handling. A weight reduction of more than one third offset the higher costs of metal alloying and treatment.

By the year 1975 the major manufacturers in Japan, Europe and America had virtually phased out grey iron spun pipe and offered only ductile iron to the market. While most of the ASEAN countries have developed their own pipe making facilities using alternative materials to ductile iron ranging from asbestos cement, PVC/PE, spiral welded steel, re-inforced concrete and even grey iron spun metal, the growth of ductile iron pipe import has continued. Admittedly, the increasing levels of ductile iron imports into ASEAN countries are almost certainly connected with favourable loan agreements particularly from Japan and the United Kingdom where pipe imports are a "condition" of the loan. Nevertheless, there appears to be a growing awareness of the technical and "laid cost" advantages of ductile iron compared to asbestos cement and spiral welded steel pipe.

The development of potable water distribution systems has a high priority in Governmental development plans in line with perceptions of population growth, increasing population density in major cities, urban sprawl and satellite townships adjoining larger connerbations. Indeed, the need for fresh water often outstrips ability to fund water distribution projects.

2.2 Current usage of DI pipes in the ASEAN region

Table 2.1 below shows the level of imports of ductile iron pipe into the ASEAN region. Indonesia, Malaysia and Singapore appear to be the largest current markets for DI pipe. It is estimated that since 1983 the total value of ductile pipe imports, at present day values, exceeds US$ 265 million and the 1988 value will exceed US$ 70 million.

Table 2.1 Ductile iron pipe imports into ASEAN countries
(metric tonnes)

	1983	1984	1985	1986	1987	1988 (projected)
Malaysia	12,772	14,914	47,777	14,628	32,926	60,000*
Indonesia	9,801	2,522	9,694	15,198	15,353	15,000
Philippines	362	3	421	-	-	-
Singapore	15,014	20,208	11,899	18,479	9,396	10,000
Brunei	255	158	87	241	629	100
Thailand	86	28	-	9	1,211	500
Total	38,290	37,833	69,878	48,555	59,561	85,600

* Antah Biwater Project.

Note: The above figures are those combined from Japanese and United Kingdom export statistics and the Import Statistics of the Philippines, Indonesia and Malaysia and therefore can be considered as reasonably accurate. The figure given for the Antah Biwater Project in Malaysia may extend into 1989 in terms of pipes installed.

2.3 AIJV possibility of ductile iron plant

The idea for a local (ASEAN) manufacture of ductile iron pipe was identified during the first phase of DP/RAS/85/010 and at its annual meeting in October 1987, the Committee for Industry, Mining and Energy (COIME) endorsed the undertaking of an opportunity study to investigate the financial and technical viability of a ductile iron pipe manufacturing unit in the region. Two member countries, Malaysia and the Philippines, were initially identified as possible proponent of such a project and later on, Indonesia also expressed interest in having its own production facilities. This study is therefore confined to those three countries.

2.4 Modality of field survey and report compilation

A team consisting of a technologist and a financial analyst visited the Philippines and Indonesia, for one week each, to gather market, technical and financial data. The technologist proceeded alone to Malaysia to undertake a field survey. The report was compiled by both experts in Vienna incorporating all data gathered while on the field as well as those obtained from suppliers of machinery and DI pipe manufacturers. The financial analysis has been conducted by applying the UNIDO Computer Model for Feasibility Study Analysis and Reporting (COMFAR).

III. MARKET AND PLANT CAPACITY

3.1 Demand forecast

3.1.1 Uncertain demand

Water pipe installation projects are being actively implemented in all ASEAN countries. Major projects in capital and provincial municipalities in the three countries in question are mainly financed by external funding agencies such as the World Bank, Asian Development Bank (ADB), Japanese Financial Institution (OECF), and British Foreign Aide Agency. Future progress in implementing water supply projects depends heavily on loan commitments of the external funding agencies. The future water supply plan made by the local water supply agency and past implementation scheme funded by external resources thus cannot be fully granted as a sound basis for demand forecast. In addition, import statistics which show the imported volume of DI pipes largely cover those imported through foreign aid programmes. For the same above reason, these statistical figures do not fully constitute an analytical basis.

Secondly, water supply pipes presently being laid in the three countries are mainly of asbestos cement, spiral welding steel, PVC, and DI. Each type of pipes has its own technical characteristics. Their advantages and disadvantages in terms of applicability in certain diameters and soil conditions may have to be carefully investigated. The investigation should also cover prices, laying costs, and durability in order to set up specific replacement rate of DI pipes vis-a-vis other types. In each country, however, different specification requirements for water pipe installation and specification requirements are subject to change. For instance, asbestos cement pipes may be gradually replaced by some other type of pipes in light of recent debates concerning their impact on human health. Another disputable problem is corrosion caused by steel pipes which eventually lead to water leakage. The water authorities of each country determine specification requi.ements and open the bidding accordingly. The tendency shows favorable policy changes to DI pipes in the future, but no guarantee has been given to secure the procurement of DI pipes. Under these circumstances, it would be a difficult task to determine a concrete replacement ratio against asbestos and steel pipes.

Thus the demand for DI pipes depends on price and availability of foreign loans and procurement policy of water pipes. This constitutes an uncertain ground for demand forecast.

3.1.2 Market segmentation

Existing DI pipe manufacturers in the United Kingdom and Japan are continuously interested in supplying their products to ASEAN countries. The loan arrangements which OECF concluded with the Indonesian Government for instance cover wide range of DI pipe supply. However, the main coverage is with rather large-diameter pipes, e.g. 1,100-1,200 mm. The project presently being covered by OECF in Jakarta is for primary distribution system, not for secondary or tertiary. The project funded by the United Kingdom Government in Malaysia also heavily covers primary distribution. The question is whether or not to compete with these existing manufacturers of large diameter pipes.

In order to adequately provide a capacity to produce ductile iron pipe from 100 mm to 1,200 mm, the plant would probably need five spinning machines (certainly four) and three finishing lines. The melting shop would require a capacity of 45-50 tonnes per hour and the land required would be more than tripled.

As a rough unstructured calculation, it is estimated that such a plant would probably cost between US$ 85,000,000 and US$ 90,000,000. On this basis alone the plant would be too large to deal with none or little experience in spun pipe operating found in the region. A financial analysis exercise would show it to be profitable at full capacity but it would become very vulnerable if the market forecasts were not realized.

The major disturbing factor in this scenario is the difficulty of an ASEAN management team and work force to absorb technology and run such a large unit with its market so widely dispersed. In this study it would be wrong not to point out the obvious drawbacks of large-scale production in spun pipes or indeed in any other product where their markets are controlled by national economics, i.e. an ability to fund water pipeline systems.

With the above in mind, the proposed market segmentation has been defined as follows:

Product group	Diameter
A :	100-150 mm
B :	200-250 mm
C :	300-350 mm
D :	400-450 mm

3.1.3 Methodology applied for market demand forecast

In the case of the Philippines and Indonesia, the past and present water supply projects in Manilla and Jakarta have been reviewed and the annual installation of linear kilometers of pipes in each city for the above four different diameter pipes have been confirmed as base figures. It is assumed that the proportion of the four different groups of pipes will remain unchanged in other cities.

In order to assess the total demand in the above two countries, a multiplier of four and ten has been applied in the Philippines and Indonesia respectively. In other words, the ultimate demand forecast for DI pipe is derived from the notion of replacement of other materials by DI pipes with a 100 per cent ratio. In the case of Malaysia, actual asbestos pipe installations in 1986 and 1987 have been obtained by averaging the figures into per annum and using this figure as potential yearly demand for selected diameter water pipe in Malaysia. In addition, some replacements of imported DI pipes are also taken into account.

3.1.4 Demand forecast in the Philippines

The largest pipe users for water systems in the Philippines have been identified as Manilla Water System and Sewage Authority (MWSS) and the Local Water Utilities Administration (LWUA). Both are Government agencies through which all public services projects are planned and executed. Projects for which funds have been allocated are put out to tenders and the registered contractors make competitive bids against a specification of an installed pipe cost. All pipe materials, i.e. PVC/PE, asbestos cement, spiral welded steel and DI, are considered equally acceptable irrespective of soil conditions, loading, corrosion resistance, etc. and thus the contract price appears to be the paramount factor in awarding a contract.

Welded steel pipe thicknesses follow a USA Federal specification which allows a much thinner pipe wall than ISO standards would permit. For example, a 500-mm diameter pipe wall thickness is 4.76 mm for MWSS projects while for LWUA the thickness specified is 2.66 mm. A comparable ductile iron pipe wall thickness to ISO/DIN/BSS specification would be between 8 and 10 mm according to its class.

PVC/PE pipe specifications also follow United States federal standards which allow for lower (and cheaper) raw material components. PVC pipes have a maximum temperature requirement of 23°C whereas for a tropical climate the temperature standard should exceed 32°C, according to ISO specifications.

It is against this general background that DI pipe has to compete and it is the reason why locally manufactured grey iron spun pipe has made little or no impression on the market.

Most of the large-scale water supply projects in the Philippines are funded by foreign loans particularly by the Asian Development Bank. Project implementation is therefore a direct function of the availability of foreign loans.

Precise data on the use of pipe by diameter and length during the past five years and those pipeline projects planned for the next five years were not available to the opportunity study team. From the information that was provided during discussions with MWSS and LWUA managers and planners and the Asian Development Bank, the distribution and pipe installation during the next five years will approximate 2,000 km.

The figure obtained by the opportunity study team shows that approximately 93 km of steel pipe have been installed in Manilla in 1987/88 (two years). The range of pipe vary from 50 mm to 800 mm as follows:

Diameter	50-75	100-150	200	250	300	350	400	450	500	600	700	800
Linear km.	0.1	7.7	10.4	7.1	15.6	4	9	5.3	10.4	7.5	8.2	11.9

On the other hand, PVC pipes of 50-150 mm were installed on a length of 131 km. It is considered that a 150-mm range is a possible DI pipe market segment in the Philippines. Therefore, the following demand forecast has been made on the basis of the above-mentioned figures and applying a multiplier of 4 to estimate the nation-wide demand. These figures somehow endorse the estimation of a 2,000-km water distribution system to be installed in the next five years, excluding the main transmission.

Thus, the total forecasted demand for DI pipes, assuming that pipes with a 150-450 mm diameter will all be DI pipes, would reach 7,960 t/year.

Table 3.1 Estimated annual demand for DI pipes

	Linear (km)	(%)	Total estimated nation-wide demand (linear km)	Number of products	Tonnage
Below 100 mm	45.5	40.6	182	-	
Product A (100-150)	23.9	21.3	96	15,936	1,896
Product B (200-250)	8.75	7.8	34	5,644	1,247
Product C (300-350)	9.8	8.7	39	6,474	2,279
Product D (400-450)	7.15	6.4	29	4,814	2,489
Above 500 mm	16.75	15.1	68	-	-
	112.1	100	448		7,910

3.1.5 Demand forecast in Indonesia

The major pipe-making industries in Indonesia are:

a. Asbestos Cement: P.T. James Hardy (member of Bakrie Group) with technical tie-up with the Australian Hardie Group,

b. PVC: Wavin (with Dutch technology tie-up),

c. Steel: Krakatau Steel Company (a division of Pertamina, National Oil Monopoly).

The competition constraints and market forces are similar to those of the Philippines but the market is much larger. The imported DI pipes are mostly linked to loans from the Japanese Government. As a consequence of using ductile iron pipe, the technical advantages and long life over AC pipes are appreciated by Indonesian water project planners and engineers. This implies that penetration of DI pipes is potentially higher than in the Philippines.

The main consumers of water pipes are the Public Works Department in Jakarta and PDAM, and DKI Jaya. In 1985 a Master Plan of the City of Jakarta was completed by the Japanese Technical Assistance Agency (JICA) who proposed a long-term and phased development programme to extend the water distribution networks in Jakarta. This programme extends to the year 2005 and takes into account the growth of urban population and also the fact that at present the water distribution services barely cover 45 per cent of the Jakarta metropolitan area. In water supply terms, this means an increase of the present capacity by 3.5 times (10,600 litres/sec. to 36,300 litres/sec.).

The authorities are also aware of high water losses occurring in the existing pipe-work system, in some areas reaching 60 per cent. The Master Plan includes the replacement of degraded AC pipes and corroded steel pipes. The detailed pipe work plans and future procurement schedules under the Jakarta Master Plan were not fully available to the study team but it has been estimated that by 1995 some 4,500 km of pipe will have been laid representing some 630 additional kilometres per year.

This estimation is derived from the data on actual installation of half of the Pulgading area (one of the primary areas in Jakarta) given by PAM. Pulgading consists of several zones and there are about 220 different zones in Jakarta. Each zone will rehabilitate and expand approximately 20 km in the next seven years. Based on this data, the estimation of future demand for DI pipes in Jakarta has been derived as follows:

Table 3.2 Installation of secondary and tertiary pipe in half of the Pulgading area

Diameter	Linear km	Percentage	Linear km per year for entire Jakarta
50	22.5	29.5	
75	20.9	27.5	441.6
100	9.9	13.1	
150	9.8	13	82
200	4.9	6.5	41
250	3.04	1.4	25.2
300	2.8	3.7	23.3
400	2	2.7	17.3
	76		630 km.

The National Plan for Water Resources in Indonesia also includes projects for the West Java Province, Central Java, Surabaya and its surrounding towns, Bengkulu, Pontianak-West Kalimanton and Banjarmas-South Kalimanton with future implementation dates varying from four to twelve years. Although it is not possible to accurately assess the DI pipe requirements for these areas, demand for water pipe as a whole would have to be tremendous, considering the size of the country.

In order to roughly estimate total demand covering the entire country, however, the figure obtained for Jakarta projects has been used as a basis and the multiplier 5.45 was derived by comparing the population presently served by the Jakarta water supply authority with others. In other words, the existing Jakarta water supply system services 2.2 million people. Assuming that all other municipalities (Kotamadya) which are relatively highly populated areas also require rehabilitation and expansion as much as the Jakarta scheme, the sum of all the Kotamadya population is approximately 12 million.

Another possible yardstick to estimate nation-wide demand would be the revenue to the water authority. 1989 statistics show DKI Jakarta and Jawa Barat together earned 39 billion Rupiahs. According to the water supply capacity of Jakarta (10,600 litres/second vs 71,800 litres/second for the two together), the main income of Jakarta is estimated as 5.7 billion Rp. All other water supply establishments in other provinces supplied water and earn 111 billion Rp in 1986. Assuming that other provinces/municipalities require some rehabilitation and expansion, the multiplier would be 19.47. (111 divided by 5.7)

The following table shows different levels of demand forecast.

Table 3.3 Estimated nationwide annual demand for DI pipe

Product	Linear km of Jakarta per year	Multiplier (5.45)		Multiplier (10)		Multiplier (19.47)	
		km	t	km	t	km	t
A	82	447	9,275	820	19,738	1,597	33,637
B	66.2	360	13,543	662	23,470	1,289	48,358
C	23.2	127	8,559	232	12,246	454	30,558
D	17.3	94	8,192	173	13,320	337	29,369
Total	188.7	1,029	39,569	1,887	68,774	3,677	141,462

*/ Conversion rate of (166 pieces per km) X average weight of each diameter group.

It seems optimistic to apply the multiplier 19.47 in view of the external funds made available so far by foreign aid programmes. There would not be drastic increase in the available funds to implement 3,677 km/year water supply projects. Therefore, the indicator of multiplier 5.45 appears more realistic. It should be noted, however, that if the proposed plant is established in Indonesia, a good number of water supply projects are to be implemented without foreign aid programmes.

In view of expected increase in demand due to local production facilities of DI pipe, the multiplier 10 was chosen to estimate demand.

3.1.6 Demand forecast in Malaysia

Federal Malaysia is made up of thirteen separate States which operate with a high degree of autonomy under the Federal umbrella. Each State maintains its own water supply system. Development, renewal, and extension of water services are function of increasing water demand brought about by increasing population density (urban), urban sprawl, population growth rate and more importantly the State ability to budget for and fund new water projects with help of the Federal Government. All water supply schemes are submitted to the Federal Waterworks Department (JKR) in Kuala Lumpur which acts as planner and adviser to each State. The Federal Government operates on a five-year plan during which water projects are conceived, funded and implemented during the life of the Plan, thus within the time interval the consumption of pipe reaches a high peak amidst a more modest requirement overall.

Local pipe suppliers include welded steel pipe producers, asbestos cement pipe-makers, galvanised iron pipe manufacturers and grey iron spun pipe makers. PVC/PE pipe is not generally used in Malaysia - galvanised iron pipe being specified for smaller diameter requirements in connexion with housing.

The market for water pipe is currently being satisfied by imported ductile iron pipe tied to foreign loan agreements and from the local manufacture of AC and steel pipe. Imported pipe tonnages are quite substantial and it is estimated that the 1988 imported quantity of DI pipe will be around

60,000 tonnes, mainly from the United Kingdom under a loan agreement associated with the Antah Biwater JV project. See Table 3.4 which demonstrates the degree of DI pipe use in Malaysia and the growing confidence in its suitability as an alternative pipe material particularly in replacing asbestos cement and small diameter (100-250 mm) steel pipe. This fact is also substantiated by the progress of a local grey iron spun pipe manufacturer who has found an increasing market for DI pipe in this size range.

A further indication of the potential market for DI pipe in Malaysia is shown in Table 3.5. This assumes that the present rate of AC pipe consumption will continue. In the light of current DI pipe usage, it is reasonable to estimate that a penetration of the AC pipe market by a locally produced ductile iron pipe is certain to take place at a rate of at least 15 per cent in the first year of operation, rising to 40 per cent by the fourth year. Specific demand forecast to replace AC pipes in each product group is shown in Table 3.6.

Table 3.4 Total ductile iron pipe imports into Malaysia
(metric tonnes) a/

Exporting country	1983	1984	1985	1986	1987	1988 b/ (estimated)
Japan	7,663	9,694	43,350	6,032	1	1
Percentage share of the market	60	65	90	41	nil	nil
United Kingdom and other countries	5,109	5,220	4,427	8,596	32,926 c/	60,000 b/
Percentage share of the market	40	35	10	59	99.99	99.99
Total	12,772	14,914	47,777	14,628	32,926 c/	60,000 b/

a/ Statistics from Import Statistics of Government of Malaysia.
b/ 1988 estimated from Antah Biwater project data.
c/ Statistic from Overseas Export Statistics of United Kingdom.

Table 3.5 Current usage of asbestos cement pipe in Malaysia

Diameter (mm)		Federal Government contracts (1.1.86 to 31.12.87) Quantity (x 1000 metres) Tendered	Procured	'Private contracts' Housing developments etc. (x 1000 metres)	Annual average totals (x 1000 metres)
A	100	2,059	x 0.75 = 1,544	618	1,081
	150	1,978	x 0.75 = 1,484	594	1,039
B	200	1,208	x 0.70 = 846	211	529
	250	1,108	x 0.60 = 665	--	332
C	300	143	x 0.60 = 86	--	43
	350	67	x 0.60 = 40	--	20
D	400	133	x 0.50 = 67	--	34
	450	52	x 0.40 = 20	--	10

Table 3.6 Possible replacement of AC pipes by DI pipes

Product a/	Expected AC installation (km)	1st year (t)	2nd year (t)	3rd year (t)	4th year b/ (t)
A	2,120	6,281	8,376	12,564	16,751
B	861	4,737	6,317	9,476	12,635
C	63	552	736	1,104	1,472
D	44	566	755	1,133	1,510
	3,088	12,136	16,184	24,277	32,368

a/ Average weight for each group: 166 pieces per km x 0.119 (A); x 0.221 (B); x 0.352 (C); x 0.517 (D)

b/ The expected replacement ratio in the 1st, 2nd, 3rd, 4th are 15 per cent, 20 per cent, 30 per cent and 40 per cent, respectively.

In addition, replacement of steel pipes by DI pipes is foreseen to amount to 7,500 t. in the first year, 10,600 t. in the 2nd year onwards. DI pipes imported from outside the ASEAN region will also be replaced. The total DI pipes imported in the last six years (since 1983) is 183,017 t. varying from 15,000 t/year (in 1984) to 60,000 t/year (in 1988). Thus the annual consumption of DI pipe would average 30,000 t., half of which would fall into the proposed products groups A, B, C, D., i.e. approximately 15,000 t. imported DI pipes are potentially replaceable by the proposed plant products.

Assuming the replacement of steel pipes and imported DI pipes evenly distributed in the four different product groups, i.e. 5,625 t. for the first year for each product group, 6,250 t. in the 2nd year onwards and this level of demand continuing constantly throughout the project life of 15 years, the projected demand for Malaysia would be as follows:

Table 3.7 Projected demand (tonnage)

Product	1st	2nd	3rd	4th	5th
A	11,906	14,626	18,814	23,001	.. Ditto
B	10,362	12,567	15,726	18,885	.. Ditto
C	6,177	6,986	7,354	7,722	.. Ditto
D	6,192	7,005	7,383	7,760	.. Ditto
	34,636	41,184	49,277	57,368	....

3.1.7 Demand for DI pipe (150-450 mm) in ASEAN

The individual markets of Malaysia, Indonesia and the Philippines have been described and analysed separately primarily to establish the completeness of a home market.

In terms of an ASEAN joint-venture project, however, the ASEAN region including Singapore and Thailand should be viewed possibly as a single market.

An estimate of the individual country's demand in the fourth year of production:

Philippines: 8,000 tonnes per year
Indonesia : 70,000 tonnes per year
Malaysia : 55,000 tonnes per year

Total : 133,000 tonnes

If imports of ductile pipe in Singapore, Thailand and Brunei could be included (as seen in Table 2.1), then the maximum size of the ASEAN market would be 140,000-150,000 tonnes for the proposed product mix.

3.2 Plant capacity

3.2.1 Technical determinants

The data given in Table 3.8 and 3.9 show the capacity of a given pipe spinning machine to produce a casting from 100 to 450 mm diameter at normal casting rates. The following data, also shown in chapter VI, provide the basis for plant capacity.

a. A production shift is of 8-hour duration.
b. The production week is two shifts x 8 hours x 5 days.
c. A production year is 3,400 hours. This represents 237 working days with weekend and holidays shutdowns totalling 128 days per annum.
d. Shift working is deemed to be from 10 p.m. to 6 a.m. and from 6 a.m. to 2 p.m.

For instance, the design capacity for 100-150 mm pipe is 85 pipes per hour and this higher figure is achievable. However, for practical purposes the efficiency of production is set at 85 per cent. The outputs for larger diameters, being a function of metal pouring and solidification time is set somewhat lower than the 85 per cent rate since the machine is designed to operate in the 55-70 range, subject to metal temperature and efficiency of mould cooling, to be determined in the design.

Table 3.8 Production data to determine plant capacity

Spinning machine No. 1	100	150	200	250	300	/,,		
Spinning [illegible]			///	250	300	350	400	450
Nominal pipes per hour	72	72	64	55	47	43	34	30
Number of pipes /metric tonne	10.75	6.89	5.26	3.97	3.14	2.59	2.12	1.78
Production rates /hour in tonnes	6.7	10.4	12.16	13.9	14.95	16.56	16.0	16.83
Annual tonnes based on 3,400 production hours	22,772	36,076	41,369	47,103	50,830	56,287	54,530	57,303
Annual number of pipes	244,800	248,800	217,600	187,000	159,800	146,200	115,600	102,000
Kilometres per annum	1,475	1,475	1,310	1,126	963	881	696	614

Table 3.9 Plant capacity design data

	Pipe diameter in mm	Pipe weight in 6-metre lengths (kg)		Maximum design output per hour	Nominal production rates
A	100	93	Ave. 119	85	72
	150	145		85	72
B	200	190	Ave. 221	75	64
	250	252		70	55
C	300	318	Ave. 352	60	47
	350	385		55	43
D	400	472	Ave. 517	45	34
	450	561		38	30

N.B. Pipe weights vary marginally from one supplier to another due to differences in the socket profile. The weights given above are for a class K9 pipe push-in type joint.

3.2.2 Market determinants

The market forecast in Malaysia indicates a demand pattern predominantly in the small- to medium-diameter pipes, i.e. 100 to 300 mm diameters. On the other hand, the demand pattern in Indonesia and the Philippines shifts slightly to larger diameters due to strong competition with PVC pipes. Since it is not possible to precisely forecast what diameters will be required in the forthcoming project lifetime, it is estimated that the product mix will follow this trend, both on the domestic and export markets :

100 - 150 mm = 40 per cent
200 - 250 mm = 30 per cent
300 - 350 mm = 20 per cent
400 - 450 mm = 10 per cent.

This product mix is applied for all three cases irrespective of production facilities.

3.2.3 Suggested maximum plant capacity

The proposed two spinning machines would produce 82,800 tonnes with the suggested product mix of 40, 30, 20 and 10 per cent for product groups A, B, C, and D respectively. The proportioned tonnage for each product group would be 33,120 t., 24,840 t., 16,560 t., and 8,280 t. As indicated in Table 3.8, if 100 mm pipe production rate increases there will be a need to make three shifts to meet the production of 33,120 t. At this stage of the opportunity study, however, no particular provision for a third shift has been made since it appears more likely to produce greater portion of 150 mm pipe than 100 mm in view of the stronger competition with PVC in Indonesia.

This plant capacity enables the proposed plant to absorb approximately 60 per cent of the ASEAN demand. Although the total sales value depends on established marketing strategies (e.g. pricing and sales agent arrangements, etc.), this figure of 60 per cent is not unrealistic.

3.3 Sales forecast and production programme

3.3.1 Methodology applied and general outlook

The sales forecast has been made for three countries since the production facility is located in one of the countries but at this stage it is undecided. The basic notion behind this sales forecast is to skim the domestic market as much as possible and to distribute the remaining portion to the participating joint-venture partner countries. The total sales forecast at full production capacity will be 82,800 t/year.

The sales projection in the Philippines is based on the replacement of steel and PVC from the start-up of production by 50 per cent. It is hoped that the water supply authorities (MWSS and LUWA) will modify their specification requirements in the near future so as to facilitate a better competitive ground for DI pipes. If the situation remains unchanged, there will be no significant sales anticipated in the Philippines. All products will have to be sold in other ASEAN countries.

The Indonesian sales are to be achieved by penetrating the DI pipe market which is supported mainly by foreign aided water supply projects. The penetration ratio vis-a-vis estimated demand applied in this study is 50 per cent. This ratio could be brought up to an even higher percentage. It is mainly because the proposed plant will not produce large diameter pipes in the foreseeable future and will not compete with Japanese OECF financing projects which mainly cover primary transmission lines.

Since the demand analysis in Indonesia is finalized without ascertaining external funding possibilities, applying this 50 per cent instead of any higher penetration ratio would be more reasonable to be on the safe side. The remaining products will be sold in other neighbouring ASEAN countries such as Malaysia and Singapore.

The sales forecast in Malaysia is based on the penetration of AC pipes and DI pipes. Gradual penetration ratio such as 15 per cent, 20 per cent, 30 per cent and 40 per cent in the first, second, third and fourth year respectively, has already been given to AC pipes replacement and used as the base of demand forecast. This ratio was recommended by a potential project promoter in Malaysia. Since the demand forecast derived from replacement of AC and steel pipes represents the expected sales of the proposed DI pipes as substitute, the estimated volume of AC and steel pipe penetration remains unchanged for sales forecast. Replacement of imported DI pipes is uncertain. It might be realistic to estimate 50 per cent of the imported DI pipes will be replaced by the proposed locally made DI pipes, i.e. 7,500 t/year.

The entire sales volume for all three cases will coincide with 100 per cent production capacity, i.e. 82,800 t. in the fourth year. It will gradually increase with a capacity of 30 per cent, 50 per cent, 75 per cent and 100 per cent.

3.3.2 Projected sales value and production programme

The following table shows the sales forecast in tonnage and corresponding production programmes for the three countries. It becomes obvious that the Philippines' local market is too small and more than 90 per cent of its products are to be exported to other ASEAN countries. On the other hand, Malaysia's plant could distribute 60 per cent of its production to the domesc market and Indonesia's plant 42 per cent to the domestic market. The foreign markets have not been clearly identified other than for these three countries. However, other countries such as Singapore and Brunai could be other potential markets to absorb the export products.

Table 3.10 Philippines

Product Group	Mix	First year Export (MT)	First year Domestic (MT)	Second year Export (MT)	Second year Domestic (MT)	Third year Export (MT)	Third year Domestic (MT)	Fourth year Export (MT)	Fourth year Domestic (MT)
A	40	8,038	1,898	14,662	1,898	22,942	1,898	31,222	1,898
B	30	6,780	672	11,748	672	17,958	672	24,168	672
C	20	4,177	791	7,489	791	11,629	791	15,769	791
D	10	1,890	594	3,546	594	5,616	594	7,686	594
		20,885	3,955	37,445	3,955	58,145	3,955	78,845	3,955
Total		24,840		41,400		62,100		82,800	

Note: Exports will be targeted to Indonesia and/or Malaysia depending on distribution and joint-venture arrangements.

Table 3.11 Indonesia

Product Group	Mix	First year Export (MT)	First year Domestic (MT)	Second year Export (MT)	Second year Domestic (MT)	Third year Export (MT)	Third year Domestic (MT)	Fourth year Export (MT)	Fourth year Domestic (MT)
A	40	nil	6,955	(6,692)a/ 5,432	9,868	(14,972)c/ 14,522	9,868	23,252	9,868
B	30	nil	8,446	684	11,736	6,894	11,736	13,104	11,736
C	20	nil	4,471	(2,157)b/ 897	6,123	6 297	6,123	10,437	6,123
D	10	nil	4,968	nil	6,660	nil	6,660	1,620	6,660
			24,800	7,013	34,387	27,713	34,387	48,413	34,387
Total		24,800		41,400		62,100		82,800	

a/ b/ The figures in brackets add up to show 40 per cent of total production for product A and 20 per cent of total production for product C. Since product D in domestic market already exceeds the proportion of 10 per cent and for the intention of maintaining as much as possible the original production mix proportion, the figures are adjusted by reducing 1,260 t from 6,692 t and 2,157 t.

c/ For the same above reason, this figure has been adjusted by subtracting 450 t from 14,972 t.

Table 3.12 Malaysia

Product Group	Mix	First year Export (MT)	First year Domestic (MT)	Second year Export (MT)	Second year Domestic (MT)	Third year Export (MT)	Third year Domestic (MT)	Fourth year Export (MT)	Fourth year Domestic (MT)
A	40	nil	9,936	2,819 (3,809)a/	12,751	7,901	16,939	11,994	21,126
B	30	nil	7,452	1,728	10,692	4,779	13,851	7,830	17,010
C	20	nil	4,968	3,169	5,111	6,941	5.479	10,713	5,847
D	10	nil	2,484	nil	5,130	702	5,508	2,395	5,885
			24,840	7,716	33,684	20,323	41,777	32,932	49,868
Total		24,840		41,400		62,100		82,800	

a/ The figure in brackets added by 12,751 corresponds to 40 per cent of the total production. Since product D in domestic market already exceeds the proportion of 10 per cent and for the intention of maintaining as much as possible the original production mix, the figure has been adjusted by reducing 980 t from 3,809 t.

3.4 Marketing strategy

3.4.1 Distribution

Unlike European countries where pipe manufacturers have their own sales force it is common practice in Asia to employ agents to carry out the function of selling. Since this arrangement works very well it would be the accepted practice for locally produced DI pipe.

All products will be marketed by an appointed sales agent in each country participating to AIJV. The sales commission including handling charges is assumed approximately at 15 per cent of ex-factory price. This means that the proposed product will have to compete with other products in the same market with 15 per cent higher price.

3.4.2 Sales price

Selling prices for DI pipe will be determined by local costs of manufacture, selling prices of alternative pipe material and the CIF prices of imported DI pipe. Specific comparative prices are shown in the following table 3.13.

Table 3.13 Price comparisons between pipes of different materials (US dollars)

Market price per piece*/ of 300 mm diameter pipe	Malaysia	Indonesia	Philippines
PVC/PE (200 mm diameter)	-	-	114
Asbestos cement	193		63
Spiral welded steel	220	150	102
Imported ductile iron	290a/	241b/	
ASEAN - proposed DI pipe (300mm)c/	219	219	219
ASEAN - proposed DI pipe (200mm)d/	131	131	131

*/ Per piece means one 6-metre long pipe.
a/ CIF from the United Kingdom
b/ CIF from Japan, (approximately US$ 50 per piece for freight and insurance).
c/ For the case that the selling price of US$ 690/MT includes 15 per cent of the agent's commission and handling charges.
d/ 200 mm DI pipe for comparison with PVC pipe.

The strategy to be adopted must identify the benefits of using DI pipe, i.e. long life, less water loss, corrosion resistance etc. Since water losses in existing systems can be as high as 60 per cent, the savings to be made in terms of reduction in wasted water and the vast increase in revenue from the sale of water thus retained should prove to be a major factor in selling DI pipe against AC pipe and thin-wall unprotected steel pipe. Bearing this in mind, US$ 600/ton has been set up: for the domestic products, sales ex-factory price of US$ 600 plus US$ 90 commission; for the export products sales, US$ 600/t CIF plus US$ 90/t commission. Thus the selling price would be consistent for both domestic and export markets.

This price will enable the proposed products to compete with major Japanese competors for DI pipe products in Indonesia. Also this price may be competitive enough with AC pipes in Malaysia, taking into account the durability of DI pipe. Since the DI pipe installed in Malaysia are procured at much higher price, the sales price in Malaysia could be reasonably shifted upwards.

3.4.3 Freight cost

The local costs of transportation have not been considered in this study because the site and location are not determined (handling charges are included in the sales commission, i.e. 15 per cent of ex-factory price). On the other hand, a provision has been made for exporting pipe at the rate of US$ 36 per tonne as cost of freight, between Malaysia and Indonesia. US$ 72.00 are applied for the freight cost from Manilla to other ASEAN countries.

The following table gives approximate freight costs between countries, although specific rates for spun pipe have not been established. For financial analysis purposes, this freight cost is treated as non-labor marketing cost (variable cost). Therefore, more operational costs are incurred for the export products.

Table 3.14 Approximate costs of freight between ASEAN countries

Origin	and	destination	US$ m^3	US$ MT
Manilla, Philippines	to	Jakarta, Indonesia	98	113
Jakarta, Indonesia	to	Manilla, Philippines	102	102
Manilla, Philippines	to	Port Klang, Malaysia	35	40
Port Klang, Malaysia	to	Manilla, Philippines	55	55
Manilla, Philippines	to	Penang, Malaysia	70	77
Penang, Malaysia	to	Manilla, Philippines	53	68
Port Klang, Malaysia	to	Jakarta, Indonesia	n.a.	36
Jakarta, Indonesia	to	Port Klang, Malaysia	n.a.	36

IV. MATERIAL INPUTS

4.1 Basic feedstock materials

The basic feedstock for ductile iron production is mild steel scrap or its equivalent in hot briquetted iron or sponge iron by direct reduction processes. For the purpose of this study the choice of basic feedstock has been made on the following purchasing factors:

a. Pricing structure compared to alternative materials
b. Metallurgical suitability for electric induction melting, i.e. bulk density, freedom from entrained slag, etc.
c. Material low in sulphur and other tramp elements which inhibit nodularisation of graphite in the ductile iron melting and treatment process
d. A stable and consistent supply of feedstock.

Preliminary investigations within the scope of this study have revealed a current lack of availability for both hot briquetted iron (HBI) and direct reduction sponge iron DRI in the region. The Direct Reduction Process plant at Perjawa - Penang, Malaysia is not operational due to severe design implementation difficulties which are unlikely to be solved in the foreseeable future. In respect of the HBI plant at Labuan, Sabah, one hundred per cent of its capacity is being sold for export at prices consistently well above imported steel scrap prices. It is understood that this pricing policy is related to continuing financial losses incurred at full output.

Trials carried out by one company in Kuala Lumpur using HBI as feedstock for induction melting of ductile iron for sand castings revealed a substantial loss in melting efficiency (10 per cent more kWh/tonne), a lower melting rate for a given furnace and a build up of furnace slag coupled with furnace lining erosion. These trials also showed that the sulphur content of the HBI material used was higher than that of steel scrap resulting in higher inoculation costs.

It should be explained that when magnesium is added to molten feedstock suitably carburised and alloyed, the magnesium will preferentially combine with sulphur to form magnesium sulphide. Only when all the sulphur is combined will the remaining free magnesium influence the carbon content in the melt. If the sulphur is higher, then the amount of magnesium to be added is greater resulting in higher cost. The ideal feedstock should contain less than 0.05 per cent of sulphur.

The above factors, of doubtful supply, higher price compared to imported steel scrap, lower melt efficiency, combine to discard them from further consideration as feedstocks and therefore imported steel scrap is recommended. It should also be noted that all three countries expressing an interest in this project do not have an abundance of locally generated scrap and the additional consumption of 80-90,000 tonnes, for example in the Philippines if the plant was sited there, would de-stabilise scrap prices to the detriment of 150 foundries operating there. It is understood that the Philippines do not import large quantities of scrap.

The scrap problem is not so critical in Indonesia and Malaysia where large steel-making plants already import steel scrap and its effect on local scrap prices is already established.

4.2 Alloys

Additions of alloy to molten feedstock mainly include carbon and ferro silicon with magnesium and granular ferro silicon for graphite spheroidising treatment. Alternative nodular-forming alloys of cerium and rare earths may well be used in a production plant if supplies are readily available in the ASEAN region. The cerium addition does not have the violent reaction of magnesium with molten iron and differences in costs of treatment are likely to be marginal. For the purpose of this study, magnesium is chosen for the treatment methodology.

The list of material input for ductile iron pipe production and finishing is given below together with relative price comparisons between countries. The prices shown represent the best reliable information available at the time of the opportunity study.

4.3 Indirect materials

The materials used to produce a cement mortar-lined pipe are included in the list. Some of these materials have alternatives, for example bitumen used for external coating may be a proprietary tar oil or an epoxi resin tar mixture. Also the term acid lining is a silica quartz material using as a rammed furnace lining material but alumina or magnesite linings may be recommended by the furnace supplier.

The item calcium silicide is used in conjunction with powdered ferro-silicon and fine grade silica sand as a dry refractory mould coat in the pipe spinning process. Where appropriate all the items are included in the description of plant technology in chapter V (Project engineering).

4.4 Production consumables and comparative prices

Production consumables (in metric tonnes) except where stated	Cost in local currency and equivalent US$					
	Philippines		Indonesia		Malaysia	
	P	US$	RP	US$	M$	US$
Steel scrap	2,000	105	240,000	135	280	107
Ferro silicon 75%	22,000	1,056	1,750,000	1,000	3,500	1,315
Ferro manganese	16,500	790	960,000	542	2,000	751
Ferro magnesium	43,000	2,062	4,500,000	2,540	8,000	3,100
Calcium silicide	47,000	2,250	4,177,000	2,360	5,000	2,000
Carburiser	30,000	1,440	1,200,000	678	1,200	467
Clay	3,000	144	220,000	125	1,200	467
Coal dust	8,500	410	240,000	135	1,300	505
Silica sand	6,000	283	50,000	28	130	50
Core binder	25,000	1,200	2,112,000	1,200	3,000	1,200
Coagulant	12,550	602	1,130,000	639	1,600	622
Zinc	25,000	1,200	2,124,000	1,210	3,000	1,200
Bitumen	12,000	595	1,100,000	600	1,516	590
Cement	1,250	60	94,000	53	155	60
Acid lining	n.a.		950,000	536	1,200	466

The indirect consumables include safety clothing, gloves, laboratory expendables, cutting and grinding tools, stencils and marking paints, toilet and ablution requirements, machinery lubricants and hydraulic oil, etc.

Material costs per tonne in US$
Equivalent based on 82,800 tonnes per annum

	Philippines	Indonesia	Malaysia
Direct materials	215	211	190
Indirect and ancillary materials	32	33	40

4.5 Energy (electricity)

An electrical power input of 18 Megawatts is required to melt 34 tonnes of metal per hour and to provide the ancillary power for the finishing lines. The induction melters need a minimum of 15 Megawatts at 75 per cent furnace efficiency depending on the choice of furnace design and the number of melting units selected. The power consumption per tonne of metal melted is estimated at 360-400 KWh. For efficient operation the lower figure can be expected. This study does not consider the savings which might be made from high melting since this is a matter for negotiation when and where the plant is installed.

Most or all finishing processes may require a varying electrical demand depending on the choice of equipment. This study has looked at the use of hydraulics rather than electrical transmission and is impressed by the lack of noise and efficient use of this form of energy. The capital costs therefore make provision for a hydraulic ring main system and a series of pumps operating at 100 bar pressures. It is estimated that the power consumption for pipe making and finishing will be in the region of 100 KWh per tonne including normal lighting and office air-conditioning.

Energy costs

The annual costs (US$) for electrical power are:

	Philippines	Indonesia	Malaysia
	3,187,800	1,656,000	2,484,000
unit cost	0.077	0.04	0.06

4.6 Utility

4.6.1 Water

The requirement for both demineralized water and captive raw water is initially quite substantial. The electric furnace coils are water cooled using demineralized water which is pumped under pressure from an underground water tank through the furnace coil to a vertical cooling tower and returned by gravity to the tank. The spinning machines will use raw water for mould cooling and again the water will be pumped from a reservoir to feed the water spray mechanism finally to be collected and passed through a cooling tower and returned to the reservoir.

Raw water is also required for cement mortar lining and this will be supplied from an overhead tank. The water residue from the lining process will be discarded along with cement effluent into a settling and evaporation pond.

The price of water varies with the country and this is reflected in the annual costs as shown in US dollars.

	Philippines	Indonesia	Malaysia
Annual cost	140,250	116,530	165,000
Cost per 1,000m³	136	113	160
Cost per tonne of pipe	1.694	1.410	1.993

4.6.2 Fuel oil

The proposed heat treatment furnaces required to produce a ferritic matrix in the pipe wall can be either electric or oil-fired by design. It is recommended that for practical purposes oil should be the chosen energy source. Whether heavy oil or gas oil is used depends on availability wherever the plant is located. Gas oil is to be preferred since extra costs are offset by better handling, burner control and less effluent problem. It is estimated that the cost of finished pipe will be US$ 3.5 per tonne. For the purpose of financial analysis this figure is treated as entirely variable but in fact there is a fixed cost element because the furnaces are not completely shut off during production down time. The annual costs at full capacity will therefore be US$ 289,800.

4.6.3 Laboratory

The requisites for a computer controlled analytical laboratory include metallurgical sample standards, cutting and polishing consumables, stationary, bottled gases, etc. It is not possible to determine the actual costs at this stage but a provision of US$ 1.5 per tonne has been made.

The annual costs at full capacity are estimated at US$ 124,000.

4.7 Raw material sourcing

With the exception of silica sand, cement and fuel oil, all materials listed may be considered as direct or indirect foreign imports. In all three countries there are agents or foundry service suppliers of ferro alloys, core binders, refractories, etc. Pricing is almost certain to be a function of quantities regularly ordered.

Sourcing of suitable mild steel scrap would normally be through a scrap merchant or agent and no doubt an annual requirement of more than 50,000 t. would attract both quality and service against the specific needs of the plant. The balance of feedstock held at the plant will depend on the re-order levels, the time to deliver and the supplier's ability to stock and handle scrap. At the plant start-up it is estimated that at least three to four months consumption of steel scrap should be delivered, i.e. 10,000 t., but the stockyard would need to be large enough to handle at least 30,000 t. The difference between plant consumption and stocking capacity is because not all the scrap delivered will be usable despite stringent specifications. If scrap arrives by ship-loads it will be impossible to inspect every tonne delivered, hence there must be provision for sorting scrap, discarding and re-selling unsuitable material.

The supply of alloys and other expensive items will require secure and dry storage facilities. The supplying agency should be expected to keep stocks of such material against a call-off schedule to minimize plant inventory costs or offer sufficient price discount to cover such costs.

The study has not looked into sourcing of fuel oil for the heat treatment furnaces, since like petroleum it is likely to be obtained either through a government agency or oil company. Stocking fuel oil would have to meet local regulations and by-laws and the level of reserves at the plant should be at least one-month consumption.

4.8 Effluent disposal

In the manufacture of ductile iron pipe there are specific process operations which cause effluent gasses and liquids which have to be controlled.

a. Metallurgical fuel from the melting and magnesium treatment of ductile iron.
b. Products of combustion of fuel oil from the heat treatment furnaces.
c. Zinc particles and solvent vapours arising from hot spray coating of spun pipe.
d. Cement mortar residues from the pipe lining process.
e. Core sand residues containing resins and isocyanates.

Much of the effluent is controlled through the design equipment and therefore initial capital expenditure but provision has been made for a factory overhead cost of US$ 42,000 for disposal costs, i.e. US$ 0.50 per tonne. Further explanation is given where appropriate in chapter VI (Project engineering).

V. LOCATION AND SITE

5.1 Location of plant

The opportunity study has not considered the relevance of site location in terms of preference or profitability although from a JIV standpoint a preference may be obvious. However, in order to maximize the success of a ductile iron pipe plant, consideration must be given to:

a. A minimum home market demand for ductile iron pipe to sustain production levels above break-even point throughout the life of the project,

b. The relative distances from the market as a function of freight/transportation costs (reference in table 5.1),

c. Facilities and infrastructure for communications and transportation, both for pipe deliveries and for raw material procurement,

d. Ready availability of electrical power and raw water,

e. A suitable source of manpower which is capable of being trained to accept the required level of technology.

These factors are but a few of the many considerations to be taken into account in determining where the plant should be sited and, not the least, home demand and a stable, trained labour force.

5.2 Cost of land

The precise cost of land required for a ductile iron pipe plant cannot be determined without knowing the actual location and site. The conditions of the land, its surrounding environment, infrastructure and provision of services are all factors which determine the price to be paid. This study assumes the purchase of the freehold rather than renting or leasing land, although further investigations may show that it is economically justified to rent a particular site.

It has been estimated that a spun plant of the indicated capacity would require a minimum area of 25,000 m^2 and it would be safe to have access to adjoining land (which may be rented) in the event of overstock of finished pipes for a particular order.

5.3 Typical costs of land and factory-type buildings

The following table shows the relative costs in equivalent US dollars of land and buildings in Malaysia, Indonesia and the Philippines.

Table 5.1 Relative costs of land and buildings
(US$)

	Malaysia	Indonesia	Philippines
Basic cost of land in sq. metres	40	56	48
Average cost of factory type buildings	80	136	112
Relative cost of a site area of 25,000 m²	1,000,000	1,400,000	1,200,000
Relatively cost of factory buildings and offices*/	5,000,000	7,000,000	6,000,000

*/ An additional 10 per cent of building costs is to be added to account for foundations and civil engineering.

VI. PROJECT ENGINEERING

6.1 Introduction to technology

The manufacture of ductile iron spun pipe is generally acknowledged to be a specialized operation which is much more difficult than an uninformed spectator might suspect. The process is highly technical, demanding engineering, metallurgical and foundry skills that may not be readily available in ASEAN countries. These skills will have to be both taught and learnt and the cost of technology transfer will be considerable.

In this proposal the general level of automation is geared to the need for repetitive quality assurance in a high volume production environment, precisely coordinating the various cycles of machinery in each operation and matching metal supply with pipe spinning and all subsequent finishing processes.

The so-called world best practice for spun pipe production is calculated at about 5 man/hour per tonne. The plant concepts in this study aim at producing pipes with a manpower ratio of approximately 10 hours per tonne.

6.2 Pipe product range

In order to avoid unnecessary complications, this opportunity study assumes that all pipe production will be of the "push-in" type of socket joint. However, should the project be completed, customers will ask for and require a proportionate quantity of bolted gland and even double-flanged pipes. A spun pipe plant without adjoining sand foundry could not meet these requirements except in cooperation with a local foundry to produce gland rings and flanges. This also applies to pipe fittings in general unless it is always the the contractor's responsibility to procure them.

The push-in type joint requires a gasket made from ethylene propylene rubber. For simplicity it is assumed that the cost of the gasket is part of the laid cost of the pipe. The plant may have to stock glands for a given order but purchase price and handling costs would be passed directly to the contractor and not form part of spun pipe manufacturing cost.

6.3 Pipe size by diameter and length

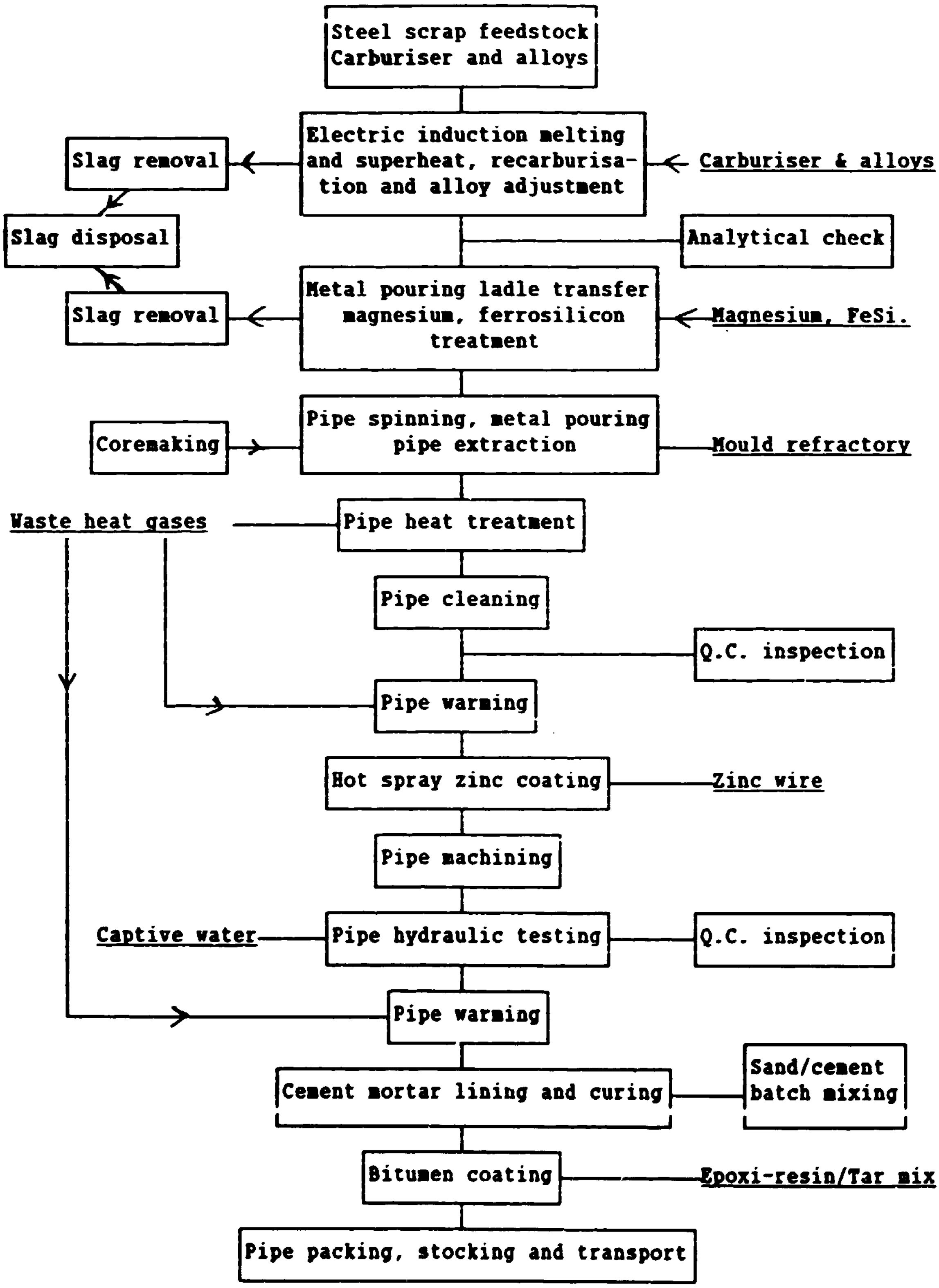
The market for spun iron pipe ranges from 80 to 1,500 mm in diameter and it would require a very large integrated manufacturing unit to meet every requirement. The market limitations in which a new DI plant could be successful and essentially profitable is determined by the market survey, at 100-450 mm diameter.

The length of pipes is determined by current international standards, between 5.6 metres (British 18 feet) and 6 metres. Japanese suppliers offer 4-metre, 5-metre and 6-metre pipes with up to 150-mm diameter, and 6-metre pipes for diameters above 200 mm.

The pipe length determines the mould length, the spinning machine dimensions and the speed of metal pouring by second.

It is proposed to standardize the length at 6 metres and to meet demand for shorter-lengths with cut-off pipes.

6.4 Process flow chart



6.5 Production data and process technology

The following data provides t asis for design capacity, manning levels outputs and unit costs.

1. A shift is understood to be of 8-hour duration.

2. The production week is two shifts x 5 days.

3. A production year is 3,400 hours. This represents 237 working days at 88 per cent utilisation. Holidays and weekend shut-downs total 128 days per year.

4. A continuous two-shift operation is deemed to be 10 pm - 6 am and 6 am - 2 pm. This allows for machine changes and maintenance at the end of the second shift during daylight hours. With a two-spinning machine plant it is desirable to programme a minimum 16-hour run on any particular pipe mould to avoid down time during production hours.

6.6 Plant limitations

(1) When the order book requires a particular pipe diameter pattern of production, i.e. where the largest orders are for the smallest diameter, the number of pipes produced per hour is at the highest but tonnage output is at its lowest. For this reason it is desirable to blend pipe diameters to maximize income from sales and to have stable cost standards for production purposes. If pipes are to be made for stock in order to meet production needs, executive decisions will have to be made to determine benefits of excess pipe production against costs of stocking unsold pipe. This is of particular importance where wages are geared to output and where the work force is seen to be 'held back' at one period and then expected to work overtime the next period.

(2) A two-machine plant has certain limitations particularly where the demand forecast is promoting small diameter range but still requires larger diameter pipes (as can be seen from the plant capacity chart in chapter III). A remedy is to provide a third spinning machine to be used as an auxiliary unit and feeding its output into the existing finishing lines at an additional capital cost of US$ 1.75 million. There is, however, a danger of using the machine all the time and causing metal starvation to the other machines. The effect would be a lowered plant utilisation and efficiency, so that a lower rate of pipe production becomes the norm.

It should perhaps be emphasized that the product mix A, B, C, and D given in the market forecast (Chapter III) actually includes eight different pipe diameters. If for example all pipes in product A were required to be 100 mm and not an average of 100 to 150 mm, the maximum output from one spinning machine would be 22,780 tonnes at 3,400 production hours and not 29,000 tonnes. If the pricing policy fixes the revenue in terms of price per tonne, then there will be a considerable shortfall if the average output in tonnes for each category is not realized. Alternatively, if the market favours larger diameter and therefore heavier pipes, within each category, then the tonnage output will be substantially higher and so will the revenue. In both examples, the number of pipes remains the same.

In the situation of under capacity it would perhaps be more economical to extend the working shift. For example, 2 x 10 shifts would provide an additional 866 machine-hours or 5,800 extra tonnes of 100 mm diameter pipe. Since the plant is designed to produce pipe in the 100-150 mm diameter range, at a rate of 85 pipes per hour, at any given point in time this rate may be reached and even sustained for noticeable periods. This additional output is a 'bonus' but if this represents only 5 per cent of total time, the annual output would be increased by 44,000 pipes. A two-machine spinning plant is therefore recommended in this study.

6.7 Process technology

Process quality control

The concept of repetitious quality control is embodied in the plant design. Metallurgical control of scrap input, melting, super-heating and alloy treatment of the base iron for ductile production is of utmost importance. This control calls for rapid analysis and automatic element adjustment to the metal being melted or treated. Quality control which starts at the scrap stockyard is a monitoring activity which covers every operation of the production process up to dispatch. Within the broad estimates of plant and equipment costs, provision has been made for equipment to control quality aspects and provide communications between process stations.

6.8 Metal melting

Steel scrap, of suitable quality and size, is fed into an automatic trickle charger by means of a manned overhead crane fitted with a magnet. The trickle charger equipment moves on rails to feed each of the furnaces as required.

Alternative methods of melting scrap and holding molten iron, have been considered in a relative fashion including Direct Arc furnace melting, and the use of a channel type induction holding furnace. After discussions with furnace suppliers, the noise and gaseous effluent from arc furnaces and a possibility of setting up electrical harmonics in the grid supply were seen as sufficient reason to select electric coreless induction melters for this study. Because molten metal requirements can vary between 21 tonnes per hour and 34 tonnes per hour, holding large quantities of iron in a channel type holding furnace for long periods is seen as unreasonable. What is needed is a flexible melting capacity and this can be accomplished by employing a series (4 or 6) of induction melters to meet the varying needs of production. Each melter also acts as a holding furnace during metal discharge and treatment. This option gives a variable metal supply from 6 tonnes per hour up to 34 tonnes per hour.

The melters will be equipped with back slagging arrangements, push-out linings, fume extraction and strain gauge weighing facilities. Provision is also made for automatic element adjustment controlled from the laboratory.

6.9 Metal treatment

The super heated iron from induction furnaces is poured into a treatment ladle held in a transporter cradle. The transporter then moves into a treatment station where magnesium is plunged into the metal. The effects of the violent reaction are controlled by a lid sealed to the ladle and fume extraction to remove the gaseous effluent. After inoculation of iron, ferro-silicon is then added to provide the nucleation for nodular graphite precipitation. The treated metal is then transported by crane to the spinning machines and poured into the machine quadrant hoppers.

6.10 Spinning machine cycle

The maximum pipe production cycle is to be designed at 85 pipes per machine/hour for 100 mm diameter pipe, i.e. one casting every 43 seconds. With an efficiency of 85 per cent this means one pipe every 50 seconds. This rate of production is to be accomplished by ensuring that the various functions, of tilting the quadrant hopper and delivering the metal stream to the rotating water cooled mould, loading the socket core and locking it into the mould, regulating the mould speed and extracting the pipe, must all be accomplished outside the time allocated to filling the mould and for pipe solidification - all within 43 seconds. The speed of mould filling, metal temperature and efficiency of mould cooling are therefore critical.

Unlike grey iron pipe which is thicker walled and remains in a semi-solid and low strength state for a longer period, thin walled ductile iron has considerable hot strength just below the solidus temperature (metal freezing point). Because its contraction rate is higher than that of grey iron, ductile iron pipe can be withdrawn from the mould almost immediately, provided that the pipe is supported along its entire length and simultaneously rotated to prevent collapse. This is carried out by means of a rotating pipe extractor which matches the reduced speed of the spinning machine (10 rpm).

When the pipe is withdrawn from the mould a new core is automatically loaded into the machine whilst it is rotating and the core backing plate is locked into position by pressure clamps. The mould then returns to its casting speed.

6.11 Core making

Every pipe produced requires a core to form the socket profile. The core must be able to withstand the exerted metal pressures and the method of handling and loading into the mould. It is proposed to have two core sections, one for each spinning machine. The core-making process is of hot box resin type and each section has a 100 cores/hour capacity. Cores are fed to a buffer stock area and then loaded onto a conveyor which in turn feeds the spinning machine core loader.

6.12 Mould filling

The magnesium treated metal is poured into the machine quadrant hopper which is mounted on a motorised chassis to which is attached a fall chute and a canti-levered double trough pouring device. The quadrant hopper is capable of pouring several pipes, depending on the diameter/weight ratio. Refilling the hopper is a matter of topping up from the treatment ladle at intervals coinciding with the times for metal treatment. This topping up operation minimizes the effect of magnesium fade by dilution in residual metal in the hopper.

Whilst the core is being placed in the socket end of the mould, the casting trough is moved through the spigot end so that the trough almost reaches the core. At this point, the metal is already being poured down the trough and the mould speed increased to accept the molten stream. The commencement of hopper tilting and metal entering the trough is accurately controlled and sequenced to present the metal at the socket end of the mould precisely and without time loss. Withdrawal of the casting trough is also controlled so that the socket is filled (almost) and then the trough is withdrawn up the length of the mould, delivering metal to the mould wall in a closed spiral fashion. The centrifugal forces generated by the mould rotation hold the molten metal to the mould wall until solidification takes place. The core profile at one end and a spigot end ring plate at the other contain the longitudinal flow of metal and with the volume of metal delivered, determines the wall thickness.

As soon as the metal is poured, solidification takes place due to heat extraction through the mould wall. This is a function of mould wall thickness and the efficiency of the water cooling method. The diameter of the cast pipe contracts (solid contraction) away from the mould wall which allows the pipe to be withdrawn by pipe extractor. To ensure that the metal does not stick to the mould wall a refractory powder mixture of FeSi and calcium silicide in a silica sand carrier is applied to the mould wall just ahead of the metal stream by means of a spiral tube applicator fitted under the casting trough.

6.13 Heat treatment

The rapid cooling rate of the cast pipe causes the metal matrix to contain pearlite and some skin cementite with dispersed graphite nodules. The matrix is brittle in character and the heat treatment process is necessary to produce a ferritic matrix with interspersed nodules of graphite throughout. The heat treatment at temperatures up to 1,320°C, the heat, soaking and cooling times can be readily determined but the furnace dimensions are function of the rate of pipe through-put and diameter range. Whilst the pipe is 'pushed' through the furnace by means of arms on the chain drive, it must also be rotated to maintain its concentricity and straightness. Banana shaped pipes can foul up the furnace.

While loading the furnace it is important to occupy every arm space to maximize through-put and prevent a back-log of pipes. The furnace arms are adjustable for varying pipe diameters. The method of pipe rotation within the furnace is achieved by means of metal plates acting as furnace floor upon which a thin layer of sand is sprinkled. The friction caused by sand forces the pipe to roll as it is pushed through the furnace, provided the pipe is reasonably straight.

This study proposes an oil-fired installation with ceramic tile insulation and a design rating of 85 pipes per hour through-put. Since pipe making and pipe finishing operations are different activities, it is necessary to have escape gantries between spinning machines and the heat treatment furnaces to avoid bottlenecks. This applies also to other finishing sections further along the line.

6.14 Pipe cleaning

After the pipe leaves the heat treatment furnace a rapid dry scrub cleaning operation takes place to prepare the metal for subsequent zinc coating. This operation also allows for pipe inspection and a check on the results of heat treatment by using eddie current probes to determine the matrix condition. If the pipe needs further heat treatment (as sometimes occurs) it is taken out of the line via the escape gantry and recycled through the furnace at an appropriate time.

6.15 Zinc coating

Applying metallic zinc to galvanize the outer surface of the pipe is a more recent development accepted and practised all over the world. Zinc coating resists the effects of corrosive soil conditions and overcomes the problems arising from localized damage to bitumen or epoxi-resin type coatings during pipe laying operations.

There are basically two methods of zinc application: by applying zinc powder as a polymer paint or by hot spraying of pure zinc onto the pipe wall. Both methods require a warm pipe to ensure complete coverage and to avoid moisture entrapment. Applying zinc is a potentially serious health hazard and therefore demands special fume extraction and control procedures. Zinc paint and solvent vapours can occur in explosive concentrations when mixed with extraction air. Similar conditions can arise with zinc particles in air. The hot spray method is to be recommended as easiest to control and as the most durable coating. It achieves a very intimate contact with the parent metal and cannot readily be removed even by reheating treatment.

6.16 Machining

The push-in type of pipe joint requires a machined spigot end and a machined socket lip. Both operations are carried out simultaneously as each pipe is presented to the machining station. Automatic tool control and tool change devices are to be employed together with NC dimensional checking. The iron turnings arising from the operation are magnetically removed and discharged into a container, to return to the melting shop. After machining, the spigot end is coated with zinc paint.

6.17 Hydraulic testing

Every pipe is to be hydraulically tested to ensure its soundness. The pipe is presented to the test machine which accurately simulates a laid pipe condition. The pipe is rapidly filled with water and pressurized to 40-50 bar. Visual inspection and scanning techniques are used to detect leaking pipes. After the test, water is drained from the pipe and the pipe is then warmed up in preparation for cement mortar lining.

6.18 Cement mortar lining

Applying mortar to a pipe can be carried out by several different methods. The study recommends the Tate Bridge method in view of the high through-put required. A 2:1 ratio sand cement mix is batch milled with water to form a slurry which is then fed by gravity into a positive displacement pump and forced through flexible hoses to the delivery head positioned inside the pipe. The rotating head delivers mortar through 360° as the mechanism is traversed through the entire pipe length. The cement surface can then be smoothed by a mechanical trowel or more simply by spinning the pipe. The pipe ends are then capped to maintain an atmosphere inside the pipe and speed curing. Rapid hardening additives may also be used advantageously.

6.19 Bitumen coating

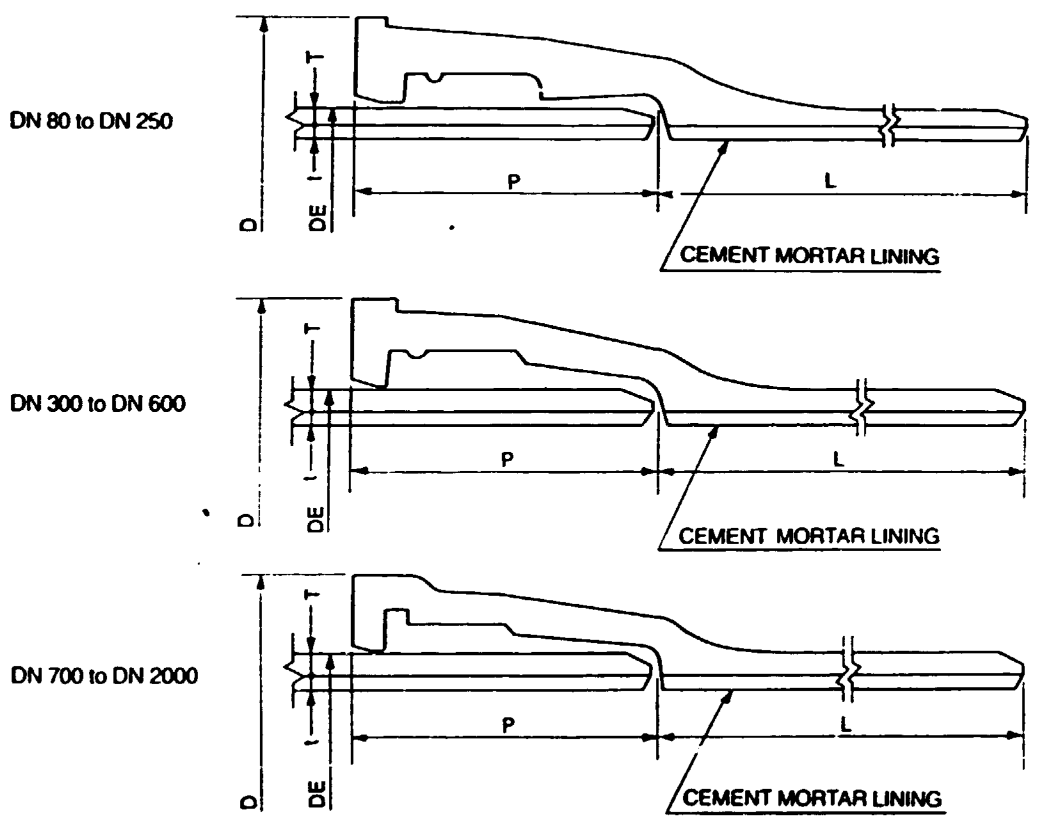
After a suitable cure period, the pipe can be handled and all its surfaces can be coated with a quick drying epoxi-butimen paint.

6.20 Pipe stacking and handling

At the end of each finishing line the pipes are loaded into stacking jigs, each layer of pipes being separated by wooden battens. Each parcel of pipe weighs a maximum of 3 tonnes and is taped to prevent pipe movement. The spaces between pipe layers allow the fork-lift truck to handle the load without damaging the pipe coating. Each parcel of pipes can be directly loaded onto transport vehicles or stocked to await despatch.

6.21 Centrifugally cast pipes

Push-on Joint T Type



K=9

Dimensions in millimeters

NOMINAL DIAMETER DN	THICKNESS		OUTSIDE DIAMETER DE	D	P	NOMINAL LAYING LENGTH L	MASS (kg)	
	T	t					IRON	CEMENT MORTAR LINING
80	6.0	4	98	149	77	4000	52.5	9.9
100	6.1	4	118	174	81	4000	65.5	12.3
100	6.1	4	118	174	81	6000	95.5	18.4
150	6.3	4	170	229	90	5000	122	23.0
150	6.3	4	170	229	90	6000	145	28.0
200	6.4	4	222	284	105	5000	165	31.0
200	6.4	4	222	284	105	6000	196	37.0
250	6.8	4	274	337	110	5000	217	38.5
250	6.8	4	274	337	110	6000	257	46.5
300	7.2	6	326	389	115	6000	322	83.0
350	7.7	6	378	454	130	6000	403	97.0
400	8.1	6	429	505	130	6000	480	110
450	8.6	6	480	558	130	6000	571	124
500	9.0	6	532	612	135	6000	663	138
600	9.9	6	635	717	140	6000	871	165
600	9.9	6	635	717	140	9000	1282	248
700	10.8	8	738	831	155	6000	1113	256
700	10.8	8	738	831	155	9000	1635	385
800	11.7	8	842	937	160	6000	1376	293
800	11.7	8	842	937	160	9000	2021	440
900	12.6	8	945	1042	175	6000	1665	330
900	12.6	8	945	1042	175	9000	2446	495
1000	13.5	10	1048	1155	185	6000	1988	457
1000	13.5	10	1048	1155	185	9000	2916	686
1100	14.4	10	1152	1261	200	6000	2340	504
1100	14.4	10	1152	1261	200	9000	3428	755
1200	15.3	10	1255	1366	215	6000	2715	549
1200	15.3	10	1255	1366	215	9000	3976	824
1400	17.1	12	1462	1585	245	6000	3569	769
1400	17.1	12	1462	1585	245	9000	5211	1153
1500	18.0	12	1565	1694	260	6000	4025	824
1500	18.0	12	1565	1694	260	9000	5875	1235
1600	18.9	15	1668	1801	275	6000	4532	1096
1600	18.9	15	1668	1801	275	9000	6603	1644
1800	20.7	15	1875	2016	305	6000	5615	1234
2000	22.5	15	2082	2231	335	5000	5791	1143

6.23 <u>Technology sourcing</u>

Manufacturing ductile iron spun pipe is generally acknowledged to be a highly specialized business involving large capital investment and strong engineering bias to the foundry casting process.

Most major manufacturers of spun pipe have been in business for many decades and have developed their own plant, equipment and production techniques based on the original Delavaud Process. Whilst there have been an apparent mutual cooperation and exchange of know-how between existing manufacturers, it is by no means certain that such understanding will be offered to a future competitor.

The ASEAN region is already identified as a major market for export of ductile spun pipe and rather than loose this market altogether, certain pipe manufacturers may wish to be involved in an ASEAN pipe project as a result of this or any other study. Such interested parties may be either Japanese, British or French.

Should the ASEAN joint-venture sponsors wish to do it alone, there are a few companies in the United Kingdom, Europe and the USA who have acquired expertise and possess capacity to design, build and install a spun pipe plant. Additional transfer of technology, if necessary, can be carried out by consultant engineers.

In anticipation of considerable cooperation between the future operating staff of the plant and the equipment supplier resulting in a transfer of technology at every stage of the project design and development, a pre-production cost of US$ 1.62 million has been estimated for training, drawing office fees and legal fees associated with drawing up the contract.

6.24 Technology transfer costs

The capital sum of US$ 1,620,000 has been set aside to cover technology transfer. This is divided in three parts:

		US$
a.	Training abroad of local team	120,000
b.	Costs incurred by contractor in supplying the initial process technology and design concepts, detailed plant layouts, manuals for plant operation and corticoil path planning. The sum allocated covers travel costs to and from the customers' factory	1,000,000
c.	Engineering and consultancy fees, contract fees and legal fees, registration fees and capital issue expenses, etc.	500,000

6.25 Estimated plant and equipment costs

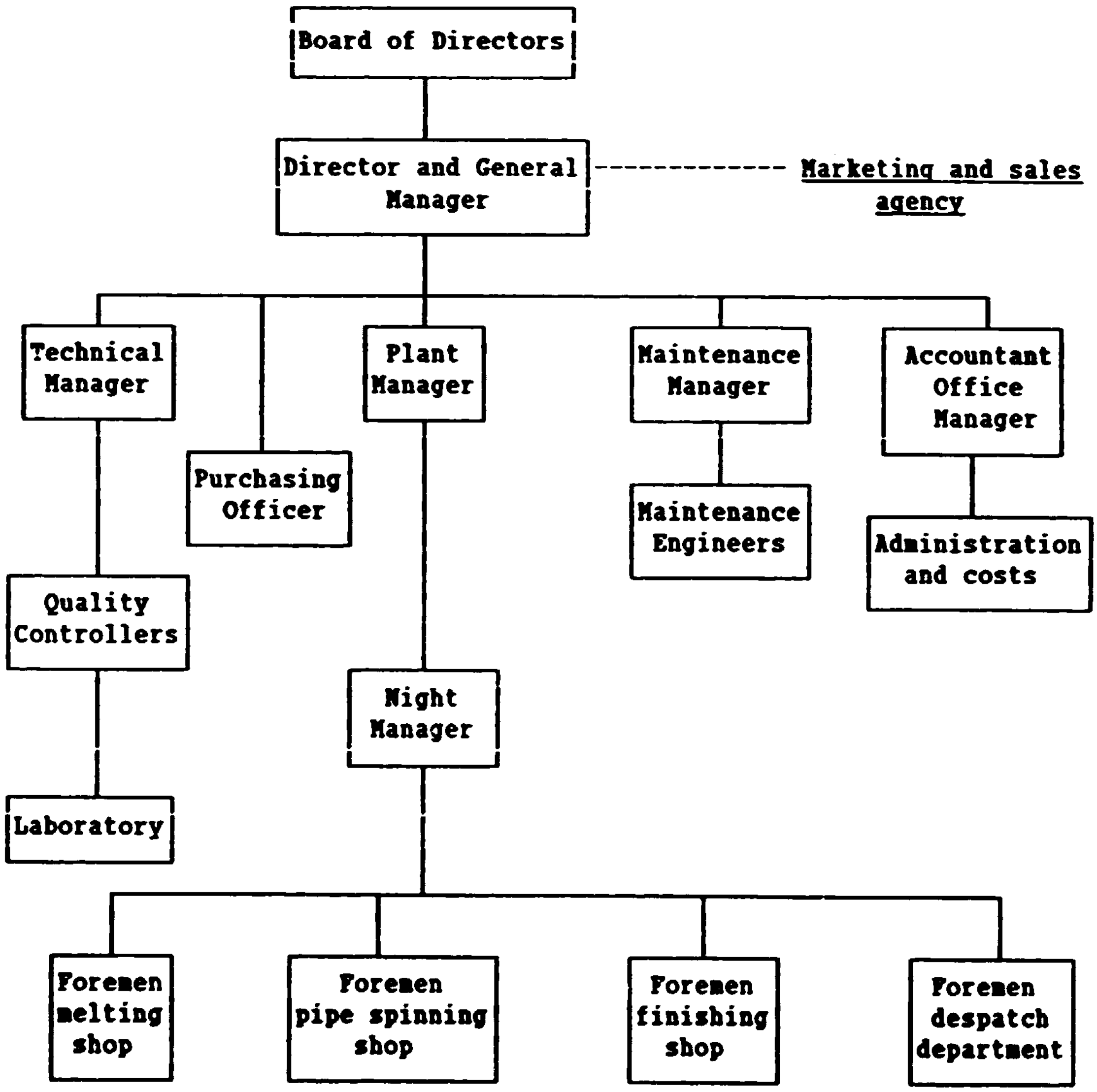
1.	Stockyard cranes and gantries, scrap chargers, electric induction furnaces plus 3 x 5 Megawatt power packs - 4 or 6 furnaces to give 34 tonnes/h at 75 per cent efficiency, water cooling tank and tower	4,600,000
2.	Two pipe spinning machines, extractors, machine hoppers, core loaders, core-making machines, gantries, monorail cranes, water cooling tanks and pumps	6,500,000
3.	Heat treatment furnaces (two) gantries, finishing lines and stockyard fork lifts and mobile cranes	9,500,000
4.	Water treatment and effluent control and disposal dust and fume extraction and noise control	1,100,000
5.	Laboratory and quality control equipment	800,000
6.	Office fittings, furniture, ablutions, changing room, showers, etc.	400,000

		US$
7.	Electrical sub-station, transformers, etc. Pumps compressors, distribution boards, wiring, etc.	3,500,000
	Sub-total	26,400,000
8.	Price escalation and contingency allowance	2,640,000
	TOTAL	29,040,000

VII. ORGANIZATIONAL STRUCTURE AND OVERHEAD COSTS

7.1 The management and organizational structure of a ductile iron spun plant is shown in Table 7.1. The structure differs from those of major pipe manufacturers in that technical and drawing office facilities are not provided and no provision is being made for technical services to customers except through the technical manager position.

Table 7.1 Organizational structure



The factory product sales function is entirely seated in a marketing agency. This agency is responsible for obtaining orders, offering technical service to customers, providing promotional and publicity brochures and for generally operating a sales office. The sales commission is sufficiently uprated to accommodate these functions.

The marketing agency operates at the General Manager's level but obviously both plant and technical management have liaison contacts with sales. The purpose of slim line organizational structure is to concentrate all activities on production.

7.2 Overhead costs

a. Factory overheads These costs relate to maintenance and spare parts, effluent disposal and factory insurances.

b. Administrative overheads These costs reflect expenditures on administrative labour, management and office operating functions involving computers.

7.2.1 Factory overheads

Maintenance and spare parts

The maintenance provision of US$ 500.000 is to take into account the degradation of plant and equipment in a molten metal casting environment.

The spare parts provision of US$ 250,000 is mainly to replace pipe moulds and maintain pipe mould stocks. In any given year when full capacity has been reached, this aim may not be sufficient to sustain a mould replacement programme and special additional expenditure may have to be made. This will be particularly relevant if the type of pipe joint is changed to bolted gland, for instance, and this decision involves expenditure for both moulds and core boxes.

7.2.2 Effluent disposal

The costs are incurred by disposing of metallic slags, rubbish, sand, cement, filtered dust, etc. An estimate of US$ 0.5 per tonne = US$ 41.400 has been included in the financial analysis.

7.2.3 Factory insurance

Provision has been made to cover plant and equipment insurance and also for building insurance. Annual insurance premiums have been calculated at US$ 72,600 and US$ 7,500 respectively.

7.2.4 Administrative overheads

Administrative labour

These labour costs relate specifically to providing the functions of clerical services, accounts, purchasing and medical staff.

Malaysia	Indonesia	Philippines
US$ 30,500	US$ 15,300	US$ 12,096

7.2.5 Management

The costs of six-line managers including general manager as set out in the manpower requirement chart is given below.

Malaysia	Indonesia	Philippines
US$ 105,000	US$ 17,760	US$ 23,040

Combined management and administrative labour total:

Malaysia	Indonesia	Philippines
US$ 135,500	US$ 33,060	US$ 35,136

7.2.6 Administrative non-labour overhead

This provision reflects costs involved in computer production control, stationary, communications, etc. and also in providing medical services to the factory.

US$ 207,000.

7.2.7 Marketing non-labour

To compute costs, some value for entertaining customers and travel costs relating to customer liaisons, not included in that element called "sales commission", must be estimated. In a consumer-oriented industry this cost is very high but for a pipe plant 1 per cent of sales or US$ 0.50 million is perhaps sufficient as a budget. The sales commission to be paid to an agent is not reflected in the plant manufacturing costs.

VIII. MANPOWER

8.1 Manpower planning

The lists of plant personnel, supervision, administration and management are tabled in this chapter. Out of a total of 199 persons, approximately 70 are in the skilled category including plant supervisers. It is to these people that special training programmes have to be directed. Their involvement during the installation and commissioning stages should be recognized and a pre-production cost has been included in the financial analysis.

8.2 Labour cost

A summary of labour costs is given below:

	Annual costs (US$)		
	Malaysia	Indonesia	Philippines
Factory labour including shift premiums and overtime	808,124	393,752	321,559
Office administrative labour and management	135,500	33,060	35,136
Total cost	948,624	426,712	355,655

It should be noted, where applicable, that no provision has been included in this study for employment liability insurance, health insurance, or pension and that these are not reflected in production costs. It should also be noted that wages and salaries are typical but do not necessarily reflect the actual costs of spun-pipe plant employees. The specialized nature of the work and in-depth training given to individuals may reflect higher incomes than local wage norms.

8.3 Typical manpower costs in local currency and US$ equivalent per man/month

	Philippines		Indonesia		Malaysia	
	Local	US$	Local	US$	Local	US$
Unskilled	1,500	70	100,000	60	450	175
Semi-skilled	2,000	96	200,000	114	650	250
Skilled	3,000	144	350,000	197	850	330
Piece-worker	3,000	144	350,000	197	850	330
Supervisory	2,500	120	250,000	150	1,200	466
Technical	6,000	288	400,000	228	3,500	1,360
Managerial	6,000	288	400,000	228	3,500	1,360
General Manager	10,000	480	600,000	340	5,000	1,950

Note: The above figures were obtained from local foundry-related business executives and are assumed to be currently prevailing and reasonably average manpower costs.

8.4 Manning levels at full production

Job description	Single shift	Second shift	Total
Scrap yard and materials handling	4	4	8
Furnace operation	6	6	12
Metal treatment	3	3	6
Metal distribution	2	2	4
Crane drivers	1	1	2
Pipe spinning	4	4	8
Core-making	6	6	12
Pipe transfer	2	2	4
Heat treatment	2	2	4
Pipe clean	2	2	4
Line inspectors	2	2	4
Zinc coating	2	2	4
Machining	4	4	8
Pipe transfer	2	2	4
Cement mortar lining	6	6	12
Bitumen coat	4	4	8
Stockyard and general labourers	10	10	20
Transport drivers	4	4	8
Electro-mechanical maintenance	9	9 plus 9	27
Laboratory	5	5	10
Effluent disposal	2	-	2
Plant supervision	6	6	12
Office administration	4	-	4
Cost department	2	-	2
Medical centre	1	1	2
Plant management and senior engineers	3	1	4
Senior managers	6	-	6
		Total	201

Note: Maintenance teams will be working in three shifts. General Manager included as Senior Manager. Other Directors not included.

8.5 Manpower requirement and relative labour costs (US$)

		Annual costs		
		Malaysia	Indonesia	Philippines
Factory labour				
Plant supervision	- 12	67,104	21,600	17,280
Skilled production workers	- 20	79,200	47,280	34,560
Semi-skilled prod. workers	- 60	180,000	82,080	69,120
Unskilled production workers	- 36	75,600	25,920	30,240
Skilled maintenance workers	- 27	106,920	63,828	46,656
Laboratory technicians	- 10	39.600	23,640	17,280
General labours	- 8	16,800	5,760	6,720
Crane drivers and transport	- 8	24.000	10,944	9.216
Office administration				
Clerks and typists	- 4	12,000	5,472	4,608
Cost clerks	- 2	6,000	2.736	2,304
Medical staff	- 2	8.000	4.728	3,456
Purchasing officer	- 1	4,500	2,364	1,728
Management				
General manager Plant manager Technical manager Maintenance manager Accountant and office mgr. Night manager	-	105,000	17,760	23,040
		724,724	314,012	265,208
Night shift premiums		160,000	84,700	67,967
Overtime allowance		58,900	28,000	22,480
Totals		948,624	426,712	355,655

8.6 Expatriate labour

Using foreign personnel during the pre-production phase and the first two years of plant operation is essential for a smooth and adequate transfer of technology and operational know-how. It is expected that the right calibre of personnel will be recruited by the plant supplier/contractor or by a specialized consultancy firm. These expatriates will in effect be responsible for operating the plant during the first two years with national counterpart staff progressively taking over those responsibilities. Consolidation of technology transfer also depends on the nature of contractual contractor's obligations, i.e. where the project is on a turn-key basis or whether an existing foreign pipe manufacturer is to be invited to financially participate in the project.

Expatriate management and supervision will effectively operate the plant for two years after the start-up date with national counterpart staff progressively assuming responsibilities and functions for efficient handover.

The estimated costs (US$) of expatriate labour are summarized below and given in more detail in chapter V.

	Pre-production phase		Production phase	
	Year 1	Year 2	Year 3	Year 4
Foreign experts	82,500	247,000	304,000	304,000

8.7 Training costs

Two elements of training have been included in this study:

a. Training abroad
b. In-plant training

Training abroad

The study proposes an expenditure of US$ 120.000 1/ to train twelve engineers/managers in a foreign spun plant environment and at the contracting engineers factory where specific trainers will be involved with machine building. For example, the electrical engineer will build the furnace wiring installations.

The Maintenance Manager will spend 12 months with the contractor to be fully acquainted with the design features of the plant and equipment. It has been mentioned that there is no maintenance cover by expatriates. This is purely to ensure a continuity in maintenance throughout. The Maintenance Manager will be supported by the Project Manager whose counterpart will be at the General Manager level.

In-plant training

This function will be carried out by the expatriate team both by "in-house" lectures and instruction and by on-the-job training. The exchange of technology and plant control features will be the responsibility of the contractor through the Project Manager.

1/ The costs of training are included in the US$ 1,620,000 funds allocated for technology transfer, drawing office and design manual compilation, implementation scheduling etc.

IX. IMPLEMENTATION SCHEDULING

9.1 The time to implement a spun-pipe plant in the ASEAN region will depend on several factors, but principally on:

a. where the factory is to be sited and
b. whether or not there will be an equity involvement with an existing pipe manufacturer.

It seems reasonable to assume that, should a foreign pipe manufacturer be involved in this venture, the engineering know-how, technical drawings etc. will already be available. Should the plant design be conceptually new, however, the initial stages of development will take appreciably longer.

The design time will be greater in those plant areas where specialized equipment is not readily available. For example, spinning machines, water cooling, core loading and pipe extraction. However, electric furnace design and layouts are more common place and can therefore be readily incorporated.

9.2 Implementation phase

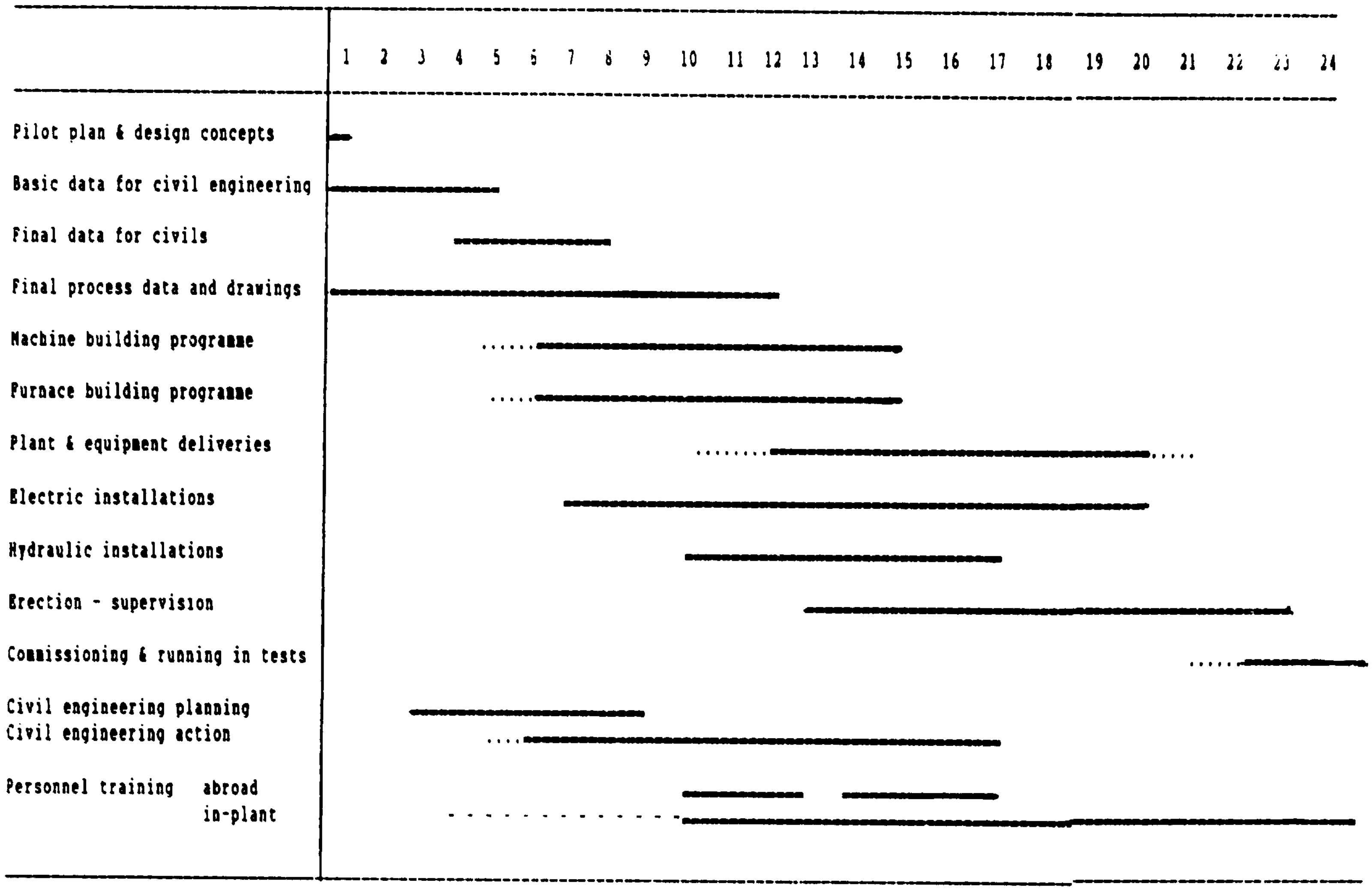
This study assumes a 24-month pre-production period for design, procurement, installation and commissioning and because of direct involvement of local management throughout, there will be no delays in plant approval etc.

The "effective date" of the contract, when detailed work commences, will follow that period as the design concepts have been agreed by all parties.

The consulting contractor will incur costs almost from the time of his initial involvement. An irrevocable letter of credit facility may be required by him at the outset. If the contractor is in fact an existing pipe manufacturer, then his costs may form part of foreign equity holdings in the company.

The study has not included a time scale for choosing the location and site and for arranging for finances and loans by project sponsors. This period could take many months and any costs involved are outside the scope of this report.

9.3 Ductile iron spun pipe plant - Implementation schedule



9.4 Cost estimates for project implementation

A. Pre-production costs (US$)

Plant management team	Malaysia	Indonesia	Philippines
a. National Project Manager to be General Manager b. Plant Managers c. Engineers (electro/mechanical) d. Maintenance Manager e Plant Supervisors f. Accountant Office Manager	399,952	174,500	146,390

This team will be progressively recruited at the commencement of year 1 to match the arrival of expatriate experts. The Project Manager supplied by the consultancy or contractor will participate in the selection process of a national team.

Expatriate expert team	Malaysia	Indonesia	Philippines
Project Manager Plant Manager Technical Manager Plant Supervisors	330,000	330,000	330,000

The expatriate team will arrive after the eight months of commencement of implementation. The above figure of US$ 330,000 includes salaries, local costs and travel.

9.5 Pre-marketing

Since this study assumes that marketing and sales functions are to be entirely the responsibility of a contracted agent (who may also be an equity shareholder), the initial costs of advertising have been split between the agent and the factory on a 60/40 basis of US$ 50,000.

The factory cost is therefore US$ 20,000.

9.6 Inventory Cost

The total inventory costs are given below. Inventory is made up of three elements:

a. Steel scrap as main feedstock totalling an initial stock of 8,280 t. This represents a 4-month stock for an output of 24,840 tonnes in the first year of production.

This initial stock is required at start-up so that the stockyard can be operated with efficiency and unsuitable scrap sorted out for re-sale.

	Foreign - US$		
	Malaysia	Indonesia	Philippines
Cost of main material: scrap etc.	1,070,000	1,245,800	1,281,680

b. Metallurgical alloys, core binders, sand, cement, bitumen, paints, stencils, packing materials, fuel oil and demineralized water.

	Local - US$	
Malaysia	Indonesia	Philippines
248,000	204,930	198,720

c. Pipe mould stocks. There are eight pipe sizes for the product mix presented in the chapter on marketing in this study, and two pipe spinning machines. It is estimated that an initial stock of 18 moulds is required at a cost of

	Foreign - US$	
Malaysia	Indonesia	Philippines
882,600	882,600	882,600

Replacement of moulds after production start-up is accounted for in the spare parts provision of US$ 250,000 per annum in production costs.

X. FINANCIAL ANALYSIS

10.1 Basic analysis

The financial analysis has been carried out using the UNIDO Computer Model for Feasibility Analysis and Reporting (COMFAR) and the results of this analysis are given in Annexes II to VI of this report.

10.1.1 Currency and exchange rate

Philippines	Indonesia	Malaysia
P 21 = US$ 1	Rp 1770 = US$ 1	M$ 2.58 = US$ 1

10.1.2 Project life time

The project is evaluated over a period of 17 years, the first 2 years being the pre-production period followed by 15 years of production.

10.1.3 Depreciation

The same depreciation method is applied to all three countries, i.e. straight line for all items: 40 years for building; 15 years for machinery and equipment with no salvage value; other incorporated fixed assets for 10 years.

10.1.4 Corporate tax

Forty per cent of corporate (income) tax is applied for Malaysia and the Philippines and 35 per cent for Indonesia.

10.1.5 Source of financing

Since no decision has been taken with regard to the capital budgeting, it is assumed that the foreign loan covers foreign equipment and technology transfer costs and that the rest is to be financed by equity. It is also assumed that 20 per cent of equity forms the foreign component. COMFAR automatically calculates its financial charges during pre-production, assuming the total loan will be employed in the middle of the second year of pre-production. This amount appears as bank overdraft in order to show how much interest charge will be required in the pre-production phase. This additionally required fund will most likely be financed by equity.

The equity/loan composite (US$ 1,000) is as follows:

	Philippines	Indonesia	Malaysia
Equity share	11,807[1/]	13,287[2/]	10,779[3/]
Loan composite	30,660	30,660	30,660
Total	42,567	43,947	41,439

1/, 2/, 3/ Including coverage of interest charges of US$ 1,128 during the pre-production phase.

10.1.6 Loan conditions

Seven per cent interest rate is charged to the foreign loan which will finance equipment and technology transfer costs. A fifteen-year amortization period and 5-year grace period are applied to ease the debt service burden. In fact the cash in-flow has turned out to be attractive with reasonably competitive selling price. Since this is an opportunity study which does not confirm the source of funds, however, further attempt to rectify the loan conditions has not been initiated.

10.2 Total initial investment

The breakdown of total initial investment without financial charges is shown in the following tables:

Table 10.1a Initial investment - Philippines

	Year 1	Year 2	Total	
1. Land and site preparation	1,320,000		1,320,000	L[a]
2. Buildings and foundations	2,600,000	4,000,000	6,600,000	L(50%)
3. Plant and equipment		29,040,000	29,040,000	F
4. Technology transfer	800,000	820,000	1,620,000	F
5. Expatriate labour	82,500	247,500	330,000	F
6. Local labour	32,200	114,190	146,390	L
7. Inventory - materials scrap, alloys, cement, sand, fuel oil, etc.		2,363,000	2,363,000	F(90%)
8. Advertising - proportional with agent costs which are separate		20,000	20,000	L
Total cost	4,834,700	36,604,690	41,439,390	

a/ L = local
F = foreign.

Table 10.1b Initial investment - Indonesia

	Year 1	Year 2	Total	
1. Land and site preparation	1,600,000		1,600,000	L
2. Buildings and foundations	3,200,000	4,500,000	7,700,000	L(50%)
3. Plant and equipment		29,040,000	29,040,000	F
4. Technology transfer	800,000	820,000	1,620,000	F
5. Expatriate labour	82,500	247,500	330,000	F
6. Local labour	38,380	136,120	174,500	L
7. Inventory - materials scrap, alloys, cement, sand, fuel oil, etc.		2,333,400	2,333,000	F(90%)
8. Advertising - proportional with agent costs which are separate		20,000	20,000	L
Total cost	5 720,880	37,097,020	42,817,900	

Table 10.1c Initial investment - Malaysia

	Year 1	Year 2	Total	
1. Land and site preparation	1,200,000		1,200,000	L
2. Buildings and foundations	2,500,000	3,000,000	5,500,000	L(50%)
3. Plant and equipment		29,040,000	29,040,000	F
4. Technology transfer	800,000	820,000	1,620,000	F
5. Expatriate labour	82,500	247,500	330,000	F
6. Local labour	88,600	311,352	399,952	L
7. Inventory - materials scrap, alloys, cement, sand, fuel oil, etc.		2,200,000	2,200,000	F(90%)
8. Advertising - proportional with agent costs which are separate		20,000	20,000	L
Total cost	4 671,100	35,638,352	40,309,952	

The major difference in total cost of the above three tables stems from "land and site preparation" and "building and foundation". The data related to estimation of these goods were provided by potential investor(s). The time did not allow the opportunity study team to cross-check the data. Besides, the specific site has not been determined at this stage and it was deemed to be less practical to ascertain the detailed cost data during the limited field survey period in each country.

10.3 Working capital requirement (see Annex II)

The required working capital is calculated on the basis of minimum days of coverage for current assets and liability. The following days of coverage are assumed:

Current assets

	Foreign	Local
Account receivable	20	30
Cash in hand	15	15
Feedstock and scrap(raw material a)	30	-
Materials for pipe finishing (raw material b)		30
Utilities (fuel, analytical consumables)		20
Spare parts	240	
Work in progress		1
Finished product	60	60

Current liability

	Foreign	Local
Account payable	15	30

Almost 2 million dollars worth of feedstock and scrap would be procured as inventory in a pre-production phase. This volume of inventory of raw material will be carried over to a production phase; therefore the days of coverage for foreign raw material have been reduced to 30 days only - otherwise it would require at least 70-80 days. Production should ideally run on an advanced order basis or special buying arrangements to be made with a sales agent. In this study, however, such an assumption has not been applied and 60-day coverage for finished goods has been provided. The working capital requirement for each country appears in Annex II. In summary, at full production capacity, the following are the total requirements:

Philippines	Indonesia	Malaysia
9,355	8,791	8,577

10.4 Total production costs

The cost components are identical in all three countries. The parameters are marginally different except for the Philippines. It is mainly attributable to distribution costs in which the freight costs are incorporated. The Philippines market is too small: more than 90 per cent of the products have to be exported. Freight cost at US$ 72/t is to be borne by the Philippines plant to export products to Malaysia and Indonesia, whilst US$ 36 freight costs are charged to the Indonesia and/or Malaysia possible plant and the foreign market share for these two countries is 58 per cent and 39 per cent respectively. The breakdown of production costs with fixed and variable cost components at full production capacity of 82,800 t/year is shown in the following table.

Annex III (COMFAR print-out) shows the first five-year production costs for close reference.

Table 10.2 Total production costs (US$ 1,000): fixed vs. variable

	Philippines fixed	Philippines variable	Indonesia fixed	Indonesia variable	Malaysia fixed	Malaysia variable
Raw material (a)		18,216		17,884.8		16,125.3
Raw material (b)		2,649		2,732.4		3,312
Utilities	55.4	499	53	477	57.8	520.2
Energy	478.3	2,710	248.4	1,407.6	372.6	2,111.4
Direct labour	225	96	275.6	118.1	565.7	242.5
Maintenance	250	250	250	250	250	250
Spare parts	200	50	200	50	200	50
Factory overhead	60.8	60.8	60.8	60.8	60.8	60.8
Factory costs	1,270	24,530.8	1,087.8	22,980.7	1,506.7	22,672.2
Administration overhead	242		240		342.5	
Sales promotion	500		500		500	
Freight (distribution cost)		5,676.8		1,742		1,185.5
Operating costs	2,012	30,206.6	1,827.8	24,722.7	2,349.4	23,857.7
Financial charges	2,146.2		2,146.2		2,146.2	
Depreciation	2,452.9		2,488.6		2,448.2	
Production costs	6,611.1 +	30,206.6	6,463 +	24,723	6,943.8 +	23,857.7
TOTAL	36,818		31,186		30,802	
Unit cost for production of 82,800 t/y	US$ 445		US$ 377		US$ 372	

10.5 Financial evaluation

10.5.1 Cash-flow (ref. Annex IV)

The cumulated cash balance becomes positive in the sixth year of production for the Philippines and in the 5th year for Malaysia and Indonesia.

The Philippines plant requires bank overdraft in the first year of operation to finance the loss from the first year operation, but will be able to pay off the short-term loan in the second year. Even in the third year, it could start repaying the loan principal instead of having a 5-year grace period, if it so wishes.

For Indonesia and Malaysia, the cumulated cash balance will be positive throughout, if the interest charge during the pre-production stage is financed from equity. If not, it becomes positive in the second year after paying off the bank overdraft in the first year. For these two cases, the only two-year grace period will be enough. It would be more realistic to shorten the amortisation and grace periods to reduce financial charges to the earlier year of production.

10.5.2 Net income

The operational margin of the Philippines plant is not sufficient to cover the financial charges in the first year. With the second year of production, the plant will yield net profit throughout.

The Malaysia and Indonesia plants enjoy net profit from the first year onwards. The summary of the net income statement in the fourth year (full production) is shown below:

Table 10.3 Net income statement
(at full production, fourth year)

	Philippines	Indonesia	Malaysia
Total sales	49,680	49,680	49,680
Variable cost	30,208	24,723.84	23,858
Non-variable cost, incl. depreciation	4,464	4,316.53	4,798
Operating margin	15,008	20,640	21,024
Financial charges	2,146	2,146	2,146
Gross profit	12,861	18,494	18,878
Corporate tax	5,145	6,474	7,551
Net profit	7,716	12,020	11,327

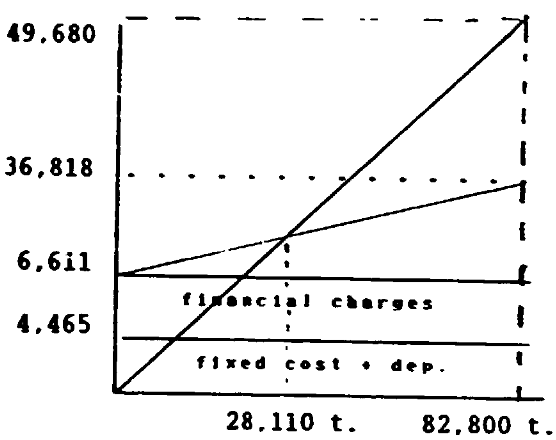
10.5.3 Break-even analysis

The fixed cost of Malaysia is almost US$ 500,000 higher than in Indonesia mainly due to high labour and fixed cost portion of energy cost. This element brings up the BEP of Malaysia higher than that of Indonesia, 26.89 per cent vs 25.9 per cent. The reason of the Philippines' higher BEP over the other two is because the distribution cost is about 4 million dollars higher than the others.

In general this BEP of 25-33 per cent for the three countries is relatively favourable. Even a drop in sales would not jeopardize the sound operational profitability to a great extent. Specific impact of sales drop on IRR will be investigated in the sensitivity analysis.

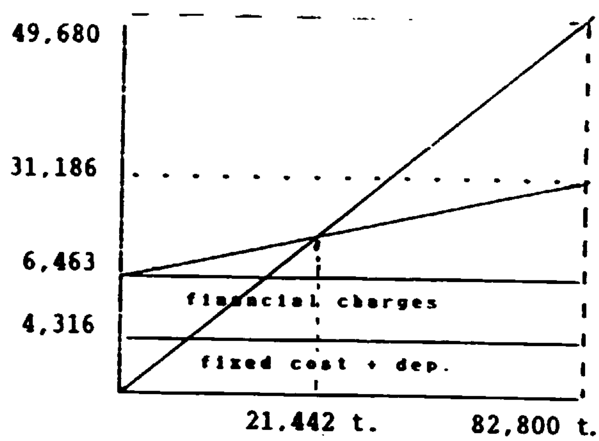
The following charts show each break-even point by tonnage and percentage of full production:

Philippines



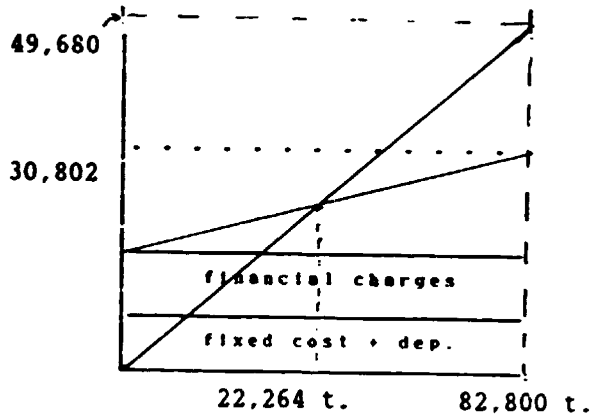
Break-even point: 28,110 t.
of full capacity: 33.9 per cent

Indonesia



Break-even point: 21,442 t.
of full capacity: 25.9 per cent

Malaysia



Break-even point: 22,264 t.
of full capacity: 26.89 per cent

10.5.4 Net present value and IRR

The IRR and net present value are as follows:

	Philippines	Indonesia	Malaysia
IRR	19.08%	25.1%	25.27
Net present value US$ 1,000	-1,774.86 (20% handle rate)	1,0769 (20% handle rate)	26,337.29 (15% handle rate)

Despite Malaysia's lower net profit, its high IRR against that of Indonesia is attributable to lower initial costs in Malaysia. As mentioned earlier, however, the higher initial investment in Indonesia is derived from higher cost of building and construction and these figures need further close investigation when the site is finally determined. Therefore, the difference of IRR between Malaysia and Indonesia should not be substantiated for specific decision-making on which of the two countries has more advantage for the establishment of production facilities.

The sensitivity of IRR is shown in the chart (Annex V). The sales price is the most sensitive one followed by operating cost and initial investment in that order. In the case of Malaysia, even if the sales price is lowered by 10 per cent, i.e. US$ 60 reduction and the selling price is US$ 540 (ex-factory price) plus 15 per cent sales commission, the IRR will still be higher than the handle rate of 15 per cent.

For the Philippines and Indonesia, the cut down in sales price of even 10 per cent would bring the IRR lower than the handle rate of 20 per cent.

The increase of initial investment would not make significant impact in the three cases. Even an increase of 20 per cent for initial investment would still keep the IRR for Malaysia and Indonesia above the handle rate. This means that the initial investment of US$ 48-50 million could still ensure a commercial profitability.

10.5.5 Debt-service ratio

The ratio showing in the tables below indicates all figures to be positive and favourable. The project can generate sufficient cash to pay interest and make repayment of loans without any difficulty. This implies that the proposed project could employ more loans if so wished. Covering some local portion of initial investment by local loans is also possible. Furthermore, the project sponsor could accept a foreign loan with higher interest rate if only the loan with higher interest rate is available.

In the case of Malaysia, for instance, the loan at 12 per cent commercial interest rate could be employed without hindering the preferable debt service ratio, whilst Indonesia and the Philippines may need further investigation before applying a 17 to 18 per cent commercial rate. It would not make significant impact on the cash-flow situation, particularly for the first two years of production.

Table 10.4 Debt-service ratio for the first ten years

	Philippines	Indonesia	Malaysia
1st year	0.56	1.46	1.27
2nd year	2.36	3.52	3.27
3rd year	3.68	5.30	5.02
4th year	4.98	7.05	6.74
5th year	2.94	3.97	3.80
6th year	3.03	4.10	3.92
7th year	3.13	4.24	4.05
8th year	3.23	4.39	4.19
9th year	3.34	4.55	4.34
10th year	3.46	4.72	4.50

10.5.6 Sensitivity analysis

The sales volume of 82,800 t/year would be approximately 60 per cent of forecasted demand in the ASEAN region. As stated earlier, however, the demand forecast was not based on a sound analytical ground due to the uncertainty of DI pipe procurement in the three countries under study. There exists likelihood that the proposed plant will not reach the sales volume of 82,800 tonnes.

The break-even point of this proposed project is rather low, i.e. 25 to 33 per cent variation between the three countries. This implies that the plant would most likely be financially sound even at the rate of 75 per cent of full production capacity. The manner in which this reduced production capacity would influence the IRR has been investigated to provide a yardstick for commercial profitability of this proposed plant. Since the Philippines' IRR is already lower than the handle rate, this sensitivity analysis has only been conducted for Indonesia and Malaysia.

Assumption

Only a production of 62,100 t/y can be obtained in the third year of operation and the production volume will remain for the rest of the project life time. The first year of production is 40 per cent of 62,100 t, the second year 60 per cent, the third year 100 per cent.

The production cost is adjusted applying the same variable cost/fixed cost portion of the base case and recalculated. The ratio of export and domestic sales is assumed to be 25 per cent and 75 per cent respectively.

Results	Indonesia	Malaysia
IRR	21.62%	21.49%
(base run)	(25.10%)	(25.27%)
Net present value US$1,000	3,134 at 20% handle rate	15,050 at 15% handle rate
(base run)	(10,769)	(26,337.29)

The result is also shown in the COMFAR Summary (Annex VI). The net income in the third year of full production decreases from 12,020 to 8,422 in Indonesia and from 11,326 to 7,651 in Malaysia. In the Malaysia case, since the handle rate of IRR is 15 per cent, the project will be recommended even if the total sales volume is much lower than the 62,100 t/year.

Conclusions

Financial indicators for the base assumption are all positive for Malaysia and Indonesia. This implies that the ductile cast iron pipe plant in the ASEAN region would make profitable operations in either of these two countries. It is obvious that among the three the Philippines show the least feasible financial indicators. It is mainly because of the limited domestic market and the higher freight cost charged to export products to either Malaysia and/or Indonesia. This freight cost disadvantage will make the proposal of DI pipe production in the Philippines less attractive.

This opportunity study does not make a clear suggestion as to where the plant should be located: either in Malaysia or Indonesia. The decision will have to be left to the private entrepreneurs' initiative for active follow-up of this report in a further detailed feasibility study. In other words, no significant advantages or disadvantages on site determination between the two countries can be identified or confirmed by this study.

Secondly, the market assessment is the most critical element in ascertaining in detail the future commercial profitability of the project. The plant, even if it can sell only 62,100 t/year, would be commercially profitable either in Malaysia or Indonesia. The IRR cut-off rate (handle rate) in Malaysia is lower than in Indonesia, in light of the prevailing bank interest rate. Even if the sales volume decreased down to 50,000 tonnes/year, the Malaysian plant would enjoy positive net present value at 15 per cent cut-off rate, whilst the Indonesian one would not, at this production level.

In order to secure the projected sales volume, intensive marketing efforts during pre-production and initial stage of production are of significant importance. Penetrating existing alternative pipe material markets such as asbestos cement, spiral welded steel and PVC is seen as a crucial factor in securing successful operation of a ductile iron spun plant in the ASEAN region. There will be strong opposition to promoting ductile iron pipe which, by reason of its similarity, i.e. "a pipe is a pipe" is also more expensive per meter than its competitive products. The fact that "laid cost" of a ductile iron pipe may be highly competitive and by reason of its corrosion resistance and stability and long life, once laid, ductile iron should be perhaps a preferred material is not a sufficient reason to overcome the existing marketing obstacles. This study has assumed that the barriers of competition can be overcome if the end users of ductile iron pipes (the water authority planners and engineers) appreciate the need for long-life pipes in poor soil conditions. The opportunity study team is convinced that the advantages of ductile iron pipe will be widely recognized by authorities and its future market in ASEAN is promising. At least the level of 62,600 t per year for the selected product groups could be obtainable through enlarging the market covering the AIJV participating countries at least and hopefully other countries such as Singapore.

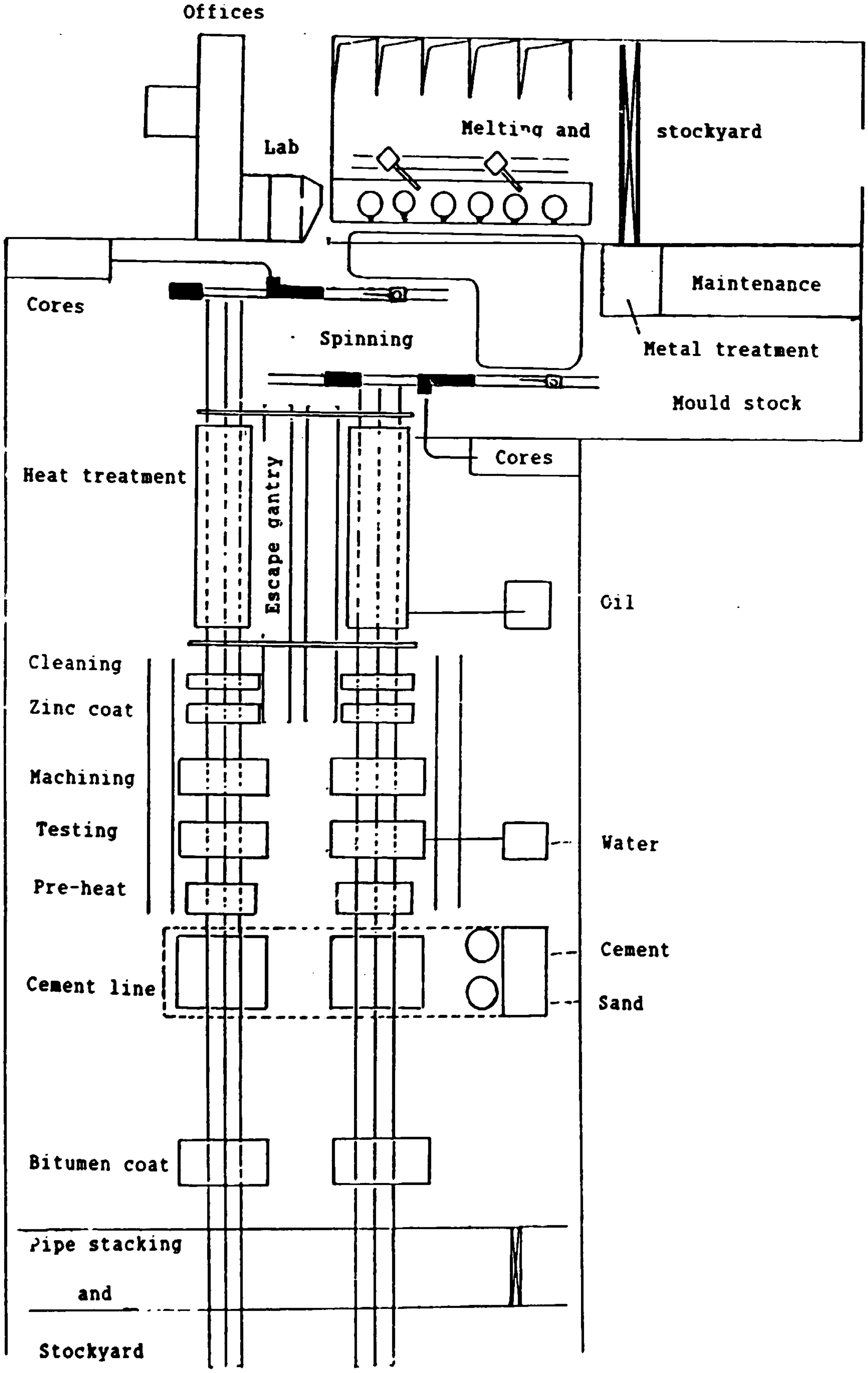
It is suggested, however, that the above sales forecast be once more substantiated by in-depth market investigation in the feasibility study. Particularly the specific product mix should be determined on each pipe diameter and not as a group.

As far as the market segmentation is concerned, the opportunity study team recommends the product mix 100-150 mm, 200-250 mm, 300-350 mm and 400-450 mm to start the operation. Later on, upon achievement of full production capacity, technical and financial implications of expansion of the plant to produce larger diameter pipes should be carefully investigated. It is anticipated that sound operation ground supported by technical and financial competence will be established by that time. Thus, it is recommended that the feasibility study covers possible plant expansion in the fourth or fifth year of operation, in order to produce pipes of 600 to 1,200 mm in diameter.

Over and above, the idea of establishing a ductile spun-iron pipe production facility in the ASEAN region should be firmly pursued. It would enable the AIJV participating countries to enjoy more rational social economic development through utilization of <u>locally produced</u> DI pipes for water supply development schemes. Without having the production facility, ASEAN water supply development projects will have to continue relying on imported products.

ANNEX I

Schematic plant layout (not to scale)



Net Working Capital in 000 US$

Year	mdc	coto	1991	1992	1993	1994	1995-2005
Coverage	mdc	coto					
Current assets &							
Accounts receivable	22	16.0	719.049	1091.969	1541.229	2007.378	2007.378
Inventory and materials	30	12.1	2895.429	3249.729	3690.355	4131.980	4131.980
Energy	0	---	0.000	0.000	0.000	0.000	0.000
Spares	240	1.5	143.333	150.000	158.333	166.667	166.667
Work in progress	1	360.0	7.740	11.151	15.415	19.679	19.679
Finished products	60	6.0	1529.147	2746.850	3318.312	4340.441	4340.441
Cash in hand	15	24.0	59.131	62.741	55.037	59.800	59.800
Total current assets			5353.829	6911.641	8778.682	10725.950	10725.950
Current liabilities and							
Accounts payable	19	18.8	475.633	731.226	1050.718	1370.209	1370.209
Net working capital			4878.196	6180.414	7727.965	9355.737	9355.737
Increase in working capital			2515.796	1302.218	1547.550	1627.772	0.000
Net working capital, local			919.012	1179.145	1504.312	1829.479	1829.479
Net working capital, foreign			3959.185	5001.269	6223.652	7526.258	7526.258

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

Net Working Capital in 000 US$

Year	adc	coto	1991	1992	1993	1994	1995-2005
Coverage	adc	coto					
Current assets &							
Accounts receivable	22	16.0	584.209	380.919	1258.690	1653.541	1653.541
Inventory and materials	30	12.1	2859.731	3708.655	3644.704	4080.963	4080.963
Energy	0	---	0.000	0.000	0.000	0.000	0.000
Spares	240	1.5	143.333	150.000	158.331	166.667	166.667
Work in progress	1	360.0	6.220	8.954	12.371	15.789	15.789
Finished products	60	6.0	1421.027	2187.059	3093.702	4051.474	4051.474
Cash in hand	15	24.0	61.421	65.411	57.732	62.721	62.721
Total current assets			5075.941	6500.998	8225.529	10031.150	10031.150
Current liabilities and							
Accounts payable	19	19.4	425.986	658.404	948.981	1239.695	1239.698
Net working capital			4650.056	5842.595	7276.549	8791.455	8791.455
Increase in working capital			2316.656	1192.539	1433.954	1514.907	0.000
Net working capital, local			826.671	1046.820	1321.939	1597.191	1597.191
Net working capital, foreign			3823.385	4795.775	5954.609	7194.265	7194.265

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

ANNEX II-C

Net working capital - Malaysia

Net Working Capital in 000 US$

	ndc	coto	1991	1992	1993	1994	1995-2005
Year			1991	1992	1993	1994	1995-2005
Coverage	ndc	coto					
Current assets &							
Accounts receivable . . .	23	15.5	634.63	[illegible]	1704.87	1689.24	1689.24
Inventory and materials .	30	12.1	2697.83	2027.57	3439.75	3851.97	3851.97
Energy	0	---	0.00	0.00	0.00	0.00	0.00
Spares	240	1.5	141.33	150.00	158.33	166.67	166.67
Work in progress	1	360.0	8.59	12.13	16.56	20.98	20.98
Finished products . . .	60	6.0	1492.55	2249.31	3142.74	4037.04	4037.04
Cash in hand	15	24.0	79.33	84.26	77.97	84.26	84.26
Total current assets			5056.26	6459.75	8139.92	9900.11	9900.11
Current liabilities and							
Accounts payable	20	18.2	475.10	717.15	1019.70	1322.26	1322.26
Net working capital			4581.16	5742.61	7120.12	8577.86	8577.86
Increase in working capital			2381.16	1161.45	1377.51	1457.74	0.00
Net working capital, local			1017.13	1297.44	1649.29	1998.97	1998.97
Net working capital, foreign			3564.03	4445.17	5471.83	6578.97	6578.97

Note: ndc = minimum days of coverage ; coto = coefficient of turnover .

ASEAN DUCTILE IRON PIPE -- ++++++++++

Total Production Costs in 000 US$

Year	1991	1992	1993	1994-95	1996	1997	1998
% of nom. capacity (single product).	30.000	50.000	75.000	100.000	100.000	100.000	100.000
Raw material 1	5464.800	9108.000	13662.000	18216.000	18216.000	18216.000	18216.000
Other raw materials	794.880	1324.800	1987.200	2649.600	2649.600	2649.600	2649.600
Utilities	204.999	[illegible]	429.389	554.050	554.050	554.050	554.050
Energy	1291.059	[illegible]	2510.393	3187.800	3187.800	3187.800	3187.800
Labour, direct	254.032	[illegible]	297.442	321.559	321.559	321.559	321.559
Repair, maintenance	325.000	375.000	437.500	500.000	500.000	500.000	500.000
Spares	215.000	225.000	237.500	250.000	250.000	250.000	250.000
Factory overheads	78.975	[illegible]	106.317	121.500	121.500	121.500	121.500
Factory costs	8828.744	[illegible]	19667.740	25800.510	25800.510	25800.510	25800.510
Administrative overheads	546.136	546.136	242.136	242.136	242.136	242.136	242.136
Indir. costs, sales and distribution	500.000	500.000	500.000	500.000	500.000	500.000	500.000
Direct costs, sales and distribution	1503.720	2695.039	4185.441	5676.840	5676.840	5676.840	5676.840
Depreciation	2452.855	2452.855	2452.855	2452.855	2452.855	2452.855	2452.855
Financial costs	2146.200	2146.200	2146.200	2146.200	2003.120	1860.040	1716.960
Total production costs	15777.660	21376.190	29195.370	36818.540	36675.460	36532.380	36389.300
Costs per unit (single product)	0.635	0.528	0.470	0.445	0.443	0.441	0.439
Of it foreign, %	76.833	77.673	78.016	78.399	73.314	78.229	78.144
Of it variable,%	56.175	68.792	77.357	82.045	82.366	82.689	83.013
Total labour	593.160	612.461	332.578	356.695	356.695	356.695	356.695

Total production costs - Philippines

Total Production Costs in 000 US$

Year	1999	2000	2001	2002	2003	2004	2005
% of nom. capacity (single product).	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Raw material 1	18216.000	18216.000	18216.000	18216.000	18216.000	18216.000	18216.000
Other raw materials	2649.600	2649.600	2649.600	2649.600	2649.600	2649.600	2649.600
Utilities	554.050	554.050	554.050	554.050	554.050	554.050	554.050
Energy	3187.800	3187.800	3187.800	3187.800	3187.800	3187.800	3187.800
Labour, direct	321.559	321.559	321.559	321.559	321.559	321.559	321.559
Repair, maintenance	500.000	500.000	500.000	500.000	500.000	500.000	500.000
Spares	250.000	250.000	250.000	250.000	250.000	250.000	250.000
Factory overheads	121.500	121.500	121.500	121.500	121.500	121.500	121.500
Factory costs	25800.510	25800.510	25800.510	25800.510	25800.510	25800.510	25800.510
Administrative overheads	242.136	242.136	242.136	242.136	242.136	242.136	242.136
Indir. costs, sales and distribution	500.000	500.000	500.000	500.000	500.000	500.000	500.000
Direct costs, sales and distribution	5676.840	5676.840	5676.840	5676.840	5676.840	5676.840	5676.840
Depreciation	2452.855	2452.855	2128.306	2128.306	2128.306	2128.306	2128.306
Financial costs	1573.880	1430.800	1287.720	1144.640	1001.560	858.480	715.400
Total production costs	36246.220	36103.140	35635.510	35492.430	35349.350	35206.270	35063.200
Costs per unit (single product)	0.433	0.436	0.430	0.429	0.427	0.425	0.423
Of it foreign, %	76.058	77.971	77.728	77.638	77.548	77.457	77.365
Of it variable,%	83.341	83.671	84.769	85.111	85.455	85.803	86.153
Total labour	356.695	356.695	356.695	356.695	356.695	356.695	356.695

Total Production Costs in 000 US$

Year	1991	1992	1993	1994-95	1996	1997
% of nom. capacity (single product).	30.000	50.000	74.994	100.000	100.000	100.000
Raw material 1	5365.440	8942.400	13412.520	17884.800	17834.800	17834.800
Other raw materials	819.720	1366.200	2049.135	2732.400	2732.400	2732.400
Utilities	196.722	281.682	410.977	530.370	530.330	530.330
Energy	670.680	952.200	1304.015	1656.000	1656.000	1656.000
Labour, direct	311.063	334.628	364.212	393.750	393.750	393.750
Repair, maintenance	325.000	375.000	437.435	500.000	500.000	500.000
Spares	215.000	225.000	237.497	250.000	250.000	250.000
Factory overheads	78.975	91.125	106.309	121.500	121.500	121.500
	-------------	-------------	-------------	-------------	-------------	-------------
Factory costs	7982.100	12578.290	18322.150	24068.780	24068.780	24068.780
Administrative overheads	544.060	544.060	240.060	240.060	240.060	240.060
Indir. costs, sales and distribution	500.000	500.000	500.000	500.000	500.000	500.000
Direct costs, sales and distribution	0.000	252.469	997.488	1742.367	1742.867	1742.867
Depreciation	2488.666	2488.666	2488.666	2488.665	2489.666	2488.666
Financial costs	2146.200	2146.200	2146.200	2146.200	2007.120	1360.040
	-------------	-------------	-------------	-------------	-------------	-------------
Total production costs	13661.070	19509.690	24694.560	31186.570	31043.490	30900.410
	=============	=============	=============	=============	=============	=============
Costs per unit (single product) .	0.550	0.447	0.398	0.377	0.375	0.373
Of it foreign, %	77.103	77.784	78.767	78.924	78.827	78.729
Of it variable,%	50.467	63.442	73.829	79.277	79.643	80.011
Total labour	548.122	671.747	397.272	426.810	426.810	426.810

Total Production Costs in 000 US$

Year	1998	1999	2000	2001	2002	2003	2004	2005
% of nom. capacity (single product).	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Raw material 1	17884.800	17884.800	17384.800	17884.800	17084.800	17884.800	17884.800	17884.800
Other raw materials	2732.400	2732.400	2732.400	2732.400	2732.400	2732.400	2732.400	2732.400
Utilities	530.330	530.330	530.330	530.330	530.330	530.330	530.330	530.330
Energy	1656.000	1656.000	1656.000	1656.000	1656.000	1656.000	1656.000	1656.000
Labour, direct	393.750	393.750	393.750	393.750	393.750	393.750	393.750	393.750
Repair, maintenance	500.000	500.000	500.000	500.000	500.000	500.000	500.000	500.000
Spares	250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000
Factory overheads	121.500	121.500	121.500	121.500	121.500	121.500	121.500	121.500
Factory costs	24068.780	24068.780	24068.780	24068.780	24068.780	24068.780	24068.780	24068.780
Administrative overheads	240.060	240.060	240.060	240.050	240.060	240.060	240.060	240.060
Indir. costs, sales and distribution	500.000	500.000	500.000	500.000	500.000	500.000	500.000	500.000
Direct costs, sales and distribution	1742.867	1742.367	1742.867	1742.867	1742.867	1742.867	1742.867	1742.867
Depreciation	2488.666	2488.666	2488.666	2161.706	2161.306	2161.306	2161.306	2161.309
Financial costs	1716.960	1573.880	1430.800	1287.720	1144.640	1001.560	858.480	715.400
Total production costs	30757.340	30614.260	30471.180	30000.740	29857.660	29714.580	29571.500	29428.420
Costs per unit (single product) .	0.371	0.370	0.368	0.362	0.361	0.359	0.357	0.355
Of it foreign, %	78.630	78.530	78.430	78.156	78.052	77.946	77.839	77.731
Of it variable,%	80.384	80.759	81.138	82.411	82.806	83.204	83.607	84.013
Total labour	426.810	426.910	426.810	426.910	426.810	426.810	426.810	426.810

ASEAN DUCTILE IRON PIPE --- ++++++

Total Production Costs in 000 US$

Year	1991	1992	1993	1994-95	1996	1997
% of nom. capacity (single product).	0.00	0.00	0.00	0.00	0.00	0.00
Raw material 1	4837.59	3062.65	12093.97	16125.30	16125.30	16125.30
Other raw materials	993.60	1656.00	2484.00	3312.00	3312.00	3312.00
Utilities	214.16	318.34	448.57	578.80	578.80	578.80
Energy	1006.02	1428.30	1956.15	2484.00	2484.00	2484.00
Labour, direct	638.43	686.93	747.53	808.14	808.14	808.14
Repair, maintenance	325.00	375.00	437.50	500.00	500.00	500.00
Spares	215.00	225.00	237.50	250.00	250.00	250.00
Factory overheads	78.97	91.13	105.31	121.50	121.50	121.50
Factory costs	8308.77	12843.74	18511.54	24179.74	24179.74	24179.74
Administrative overheads	646.50	646.50	342.50	342.50	342.50	342.50
Indir. costs, sales and distribution	500.00	500.00	500.00	500.00	500.00	500.00
Direct costs, sales and distribution	0.00	277.77	731.63	1185.55	1185.55	1185.55
Depreciation	2448.21	2448.21	2448.21	2448.21	2448.21	2448.21
Financial costs	2146.20	2146.20	2146.20	2146.20	2003.12	1860.04
Total production costs	14049.68	18862.02	24680.07	30802.20	30659.12	30516.04
Costs per unit (single product)	0.00	0.00	0.00	0.00	0.00	0.00
Of it foreign, %	71.92	71.36	71.88	72.30	72.17	72.04
Of it variable,%	48.41	61.57	71.86	77.45	77.32	78.18
Total labour	1077.93	1126.42	883.03	943.64	943.64	943.64

ASEAN DUCTILE IRON PIPE --- +++++++++

Total production costs - Malaysia

Total Production Costs in 000 US$

Year	1998	1999	2000	2001	2002	2003	2004	2005
% of nom. capacity (single product).	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Raw material 1	16125.30	16125.30	16125.30	16125.30	16125.30	16125.30	16125.30	16125.30
Other raw materials	3312.00	3312.00	3312.00	3312.00	3312.00	3312.00	3312.00	3312.00
Utilities	578.80	578.80	578.80	578.80	578.80	578.80	578.80	578.80
Energy	2484.00	2484.00	2484.00	2484.00	2484.00	2484.00	2484.00	2484.00
Labour, direct	808.14	808.14	808.14	808.14	808.14	808.14	808.14	808.14
Repair, maintenance	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00
Spares	250.00	250.00	250.00	250.00	250.00	250.00	250.00	250.00
Factory overheads	121.50	121.50	121.50	121.50	121.50	121.50	121.50	121.50
Factory costs	24179.74	24179.74	24179.74	24179.74	24179.74	24179.74	24179.74	24179.74
Administrative overheads	342.50	342.50	342.50	342.50	342.50	342.50	342.50	342.50
Indir. costs, sales and distribution	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00
Direct costs, sales and distribution	1185.55	1185.55	1185.55	1185.55	1185.55	1185.55	1185.55	1185.55
Depreciation	2448.21	2448.21	2448.21	2098.31	2098.31	2098.31	2098.31	2098.31
Financial costs	1716.95	1573.88	1430.80	1287.72	1144.64	1001.56	358.48	715.40
Total production costs	30372.96	30229.88	30086.80	29593.82	29450.74	29307.66	29164.58	29021.50
Costs per unit (single product)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Of it foreign, %	71.91	71.77	71.64	71.31	71.17	71.03	70.89	70.74
Of it variable,%	78.55	78.32	79.30	80.62	81.01	81.41	81.81	82.21
Total labour	943.64	943.64	943.64	943.64	943.64	943.64	943.64	943.64

Cashflow Tables, in 000 US$

Year	1989	1990	1991	1992	1993	1994	1995	1996
Total cash inflow . .	4834.71	36604.08	15379.63	25095.59	37579.49	49999.49	49680.00	49680.00
Financial resources .	4834.71	36604.08	475.63	255.59	319.49	319.49	0.00	0.00
Sales, net of tax . .	0.00	0.00	14904.00	24840.00	37260.00	49680.00	49680.00	49680.00
Total cash outflow . .	4862.70	37705.19	16316.23	22166.67	31835.40	41457.53	41554.27	41468.42
Total assets	4834.70	36604.09	2991.43	1537.81	1847.04	1947.26	0.00	0.00
Operating costs . . .	0.00	0.00	11178.60	17277.14	24555.31	32219.48	32219.48	32219.48
Cost of finance . . .	28.00	1101.10	2146.20	2146.20	2146.20	2146.20	2146.20	2003.12
Repayment	0.00	0.00	0.00	0.00	0.00	0.00	2044.00	2044.00
Corporate tax . . .	0.00	0.00	0.00	1185.53	3285.85	3144.58	3144.58	3201.83
Dividends paid . . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Surplus (deficit) .	-27.99	-1101.11	-936.60	2928.92	5744.09	8541.96	8125.73	8211.58
Cumulated cash balance	-27.99	-1129.10	-2065.70	863.23	6607.32	15149.29	23275.01	31486.59
Inflow, local	3227.76	5395.20	2605.20	2475.33	2500.92	2500.92	2373.00	2373.00
Outflow, local	2652.20	2370.49	4447.50	6704.59	9970.56	13424.71	12971.23	13028.46
Surplus (deficit) .	575.56	3024.71	-1838.33	-3829.25	-7469.64	-10923.79	-10598.23	-10655.46
Inflow, foreign . . .	1606.95	31208.88	12774.43	22620.26	35078.57	47498.57	47307.00	47307.00
Outflow, foreign . . .	2210.50	35334.70	11872.73	15862.08	21864.85	28033.22	28583.04	28439.96
Surplus (deficit) .	-603.55	-4125.82	901.69	6758.18	13213.73	19465.36	18723.96	18867.04
Net cashflow	-4834.70	-36604.09	1205.60	5075.12	7890.29	10688.36	12315.93	12258.70
Cumulated net cashflow	-4834.70	-41438.79	-40229.19	-35154.07	-27263.78	-16575.62	-4259.69	7999.01

ASSAN DUCTILE IRON PIPE --- *********

Cashflow tables, in 000 US$

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total cash inflow . .	49680.00	49680.00	49680.00	49680.00	49680.00	49680.00	49680.00	49680.00	49680.00
Financial resources .	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sales, net of tax . .	49680.00	49680.00	49680.00	49680.00	49680.00	49680.00	49680.00	49680.00	49680.00
Total cash outflow . .	41392.57	41296.73	41210.88	41125.03	41169.00	41083.15	40997.30	40911.46	40825.61
Total assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operating costs . . .	32219.48	32219.48	32219.48	32219.48	32219.48	32219.48	32219.48	32219.48	32219.48
Cost of finance . . .	1860.04	1716.96	1573.89	1430.80	1287.72	1144.64	1001.56	858.48	715.40
Repayment	2044.00	2044.00	2044.00	2044.00	2044.00	2044.00	2044.00	2044.00	2044.00
Corporate tax . . .	5259.05	5316.28	5373.51	5430.74	5617.79	5675.03	5732.26	5789.49	5846.72
Dividends paid . . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Surplus (deficit) .	8297.43	8383.27	8469.12	8554.97	8511.00	8596.85	8682.70	8768.54	8854.39
Cumulated cash balance	39784.02	48167.29	56636.41	65191.38	73702.38	82299.23	90981.94	99750.48	108604.87
Inflow, local	2373.00	2373.00	2373.00	2373.00	2373.00	2373.00	2373.00	2373.00	2373.00
Outflow, local	13085.69	13142.92	13200.16	13257.39	13444.44	13501.67	13558.90	13616.14	13673.37
Surplus (deficit) .	-10712.69	-10769.92	-10827.16	-10884.39	-11071.44	-11128.67	-11185.90	-11243.14	-11300.37
Inflow, foreign . . .	47307.00	47307.00	47307.00	47307.00	47307.00	47307.00	47307.00	47307.00	47307.00
Outflow, foreign . . .	28296.88	28153.80	28010.72	27867.64	27724.56	27581.48	27438.40	27295.32	27152.24
Surplus (deficit) .	19010.12	19153.20	19296.28	19439.36	19582.44	19725.52	19868.60	20011.68	20154.76
Net cashflow	12201.47	12144.24	12087.01	12029.77	11842.72	11785.49	11728.26	11671.03	11613.79
Cumulated net cashflow	20200.48	32344.72	44431.73	56461.49	68304.21	80089.70	91817.96	103488.99	115102.78

Cashflow Tables, in 000 US$

Year	1989	1990	1991	1992	1993	1994	1995	1996
Total cash inflow . .	5721.200	37097.500	15329.880	25072.520	37547.580	49970.720	49680.000	49680.000
Financial resources .	5721.200	37097.500	425.886	232.518	290.577	290.718	0.000	0.000
Sales, net of tax . .	0.000	0.000	14904.000	24840.000	37257.000	49680.000	49680.000	49680.000
Total cash outflow . .	5748.890	38198.120	14349.940	19661.690	28327.280	36976.230	37214.610	37121.600
Total assets	5720.880	37097.020	2742.542	1425.057	1724.530	1805.625	0.000	0.000
Operating costs . . .	0.000	0.000	9026.160	13874.820	20059.700	26551.710	26551.710	26551.710
Cost of finance . . .	28.000	1101.100	2146.200	2146.200	2146.200	2146.200	2146.200	2003.120
Repayment	0.000	0.000	0.000	0.000	0.000	0.000	2044.000	2044.000
Corporate tax . . .	0.000	0.000	435.040	2215.608	4396.853	6472.699	6472.699	6522.777
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	-27.680	-1100.621	979.943	5410.830	9220.301	12994.490	12465.390	12558.400
Cumulated cash balance	-27.680	-1128.301	-148.357	5262.473	14482.770	27477.260	39942.660	52501.050
Inflow, local	3937.000	5790.000	15090.600	20714.220	20734.700	20734.750	20632.200	20632.200
Outflow, local	3238.380	2639.460	4194.188	6481.231	9967.919	13274.540	12896.740	12946.820
Surplus (deficit) .	698.620	3150.540	10896.410	14232.990	10766.780	7460.209	7735.461	7685.383
Inflow, foreign . . .	1784.200	31307.500	239.289	4358.299	16812.880	29235.970	29047.800	29047.800
Outflow, foreign . . .	2510.500	35558.660	10155.750	13180.460	18359.360	23701.690	24317.870	24174.790
Surplus (deficit) .	-726.300	-4251.160	-9916.465	-8822.159	-1546.480	5534.277	4729.934	4873.014
Net cashflow	-5720.880	-37097.020	3126.142	7557.029	11366.500	15140.690	16655.590	16605.520
Cumulated net cashflow	-5720.880	-42817.900	-39691.760	-32134.730	-20768.230	-5627.545	11028.050	27633.560

Cashflow tables, in 000 US$

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total cash inflow	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000
Total cash outflow	37028.600	36935.600	36842.600	36749.600	36771.170	36678.170	36585.170	36492.160	36399.160
Total assets	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	26551.710	26551.710	26551.710	26551.710	26551.710	26551.710	26551.710	26551.710	26551.710
Cost of finance	1860.040	1716.960	1573.880	1430.900	1287.720	1144.640	1001.560	858.480	715.400
Repayment	2044.000	2044.000	2044.000	2044.000	2044.000	2044.000	2044.000	2044.000	2044.000
Corporate tax	6572.854	6622.933	6673.011	6723.089	6887.743	6937.820	6987.899	7037.976	7088.054
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	12651.400	12744.400	12837.400	12930.400	12908.830	13001.830	13094.830	13187.840	13280.840
Cumulated cash balance	65152.450	77896.850	90734.250	103664.700	116573.500	129575.300	142670.100	155858.000	169138.800
Inflow, local	20632.200	20632.200	20632.200	20632.200	20632.200	20632.200	20632.200	20632.200	20632.200
Outflow, local	12996.890	13046.970	13097.050	13147.130	13311.780	13361.860	13411.940	13462.020	13512.090
Surplus (deficit)	7635.306	7585.227	7535.149	7485.071	7320.417	7270.340	7220.262	7170.184	7120.106
Inflow, foreign	29047.800	29047.800	29047.800	29047.800	29047.800	29047.800	29047.800	29047.800	29047.800
Outflow, foreign	24031.710	23888.630	23745.550	23602.470	23459.390	23316.310	23173.230	23030.150	22887.070
Surplus (deficit)	5016.094	5159.172	5302.252	5445.332	5588.412	5731.492	5874.572	6017.652	6160.732
Net cashflow	16555.440	16505.360	16455.280	16405.200	16240.350	16190.470	16140.390	16090.320	16040.240
Cumulated net cashflow	44189.000	60694.360	77149.640	93554.840	109795.400	125985.900	142126.300	158216.600	174256.800

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ASEAN DUCTILE IRON PIPE --- +++++++++

Cashflow Tables, in 000 US$

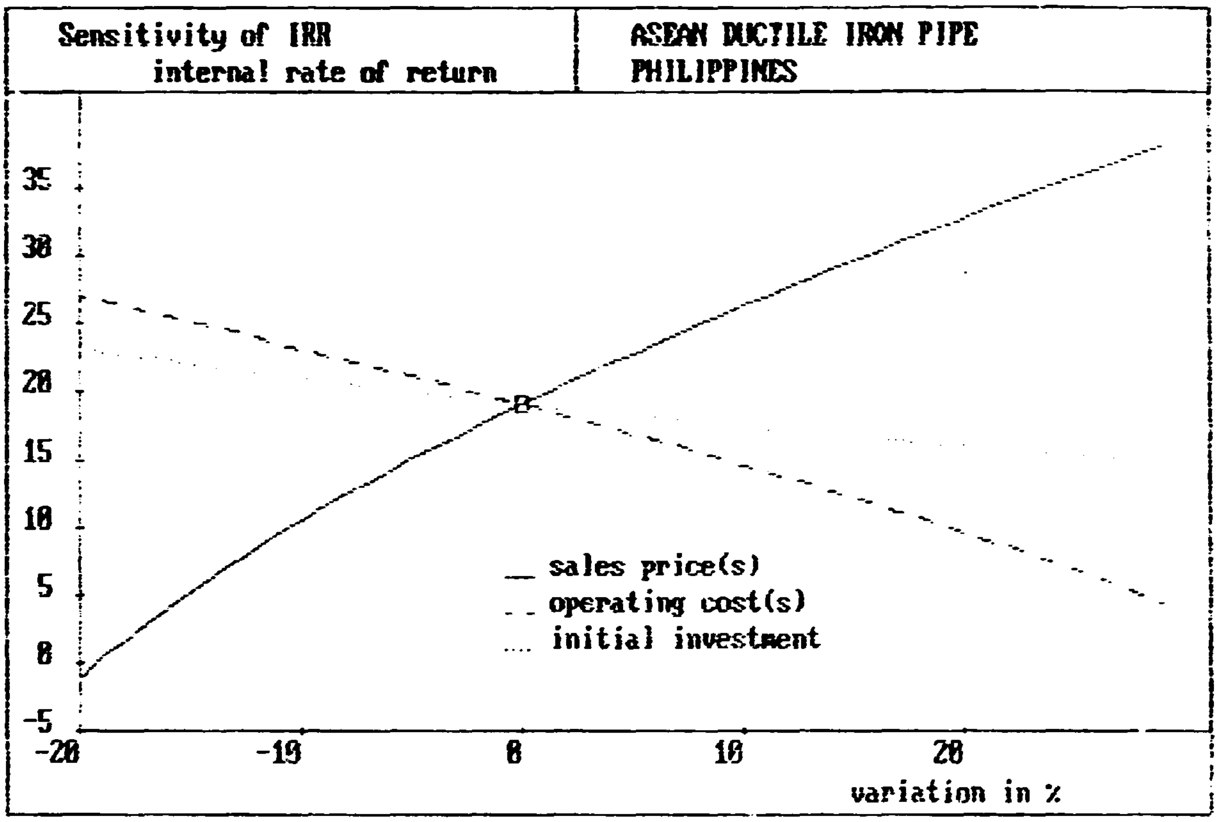
Year	1989	1990	1991	1992	1993	1994	1995	1996
Total cash inflow	4671.300	35639.000	15379.100	25082.040	37562.550	49982.550	49680.000	49680.000
Financial resources	4671.300	35639.000	475.102	242.044	302.555	302.555	0.000	0.000
Sales, net of tax	0.000	0.000	14904.000	24840.000	37260.000	49680.000	49680.000	49680.000
Total cash outflow	4699.100	36739.950	14799.460	20208.490	28943.900	37665.400	37949.110	37863.260
Total assets	4671.100	35638.850	2856.263	1403.492	1680.067	1760.293	0.000	0.000
Operating costs	0.000	0.000	9455.272	14267.610	20085.670	26207.790	26207.790	26207.790
Cost of finance	28.000	1101.100	2146.200	2146.200	2146.200	2146.200	2146.200	2003.120
Repayment	0.000	0.000	0.000	0.000	0.000	0.000	2044.000	2044.000
Corporate tax	0.000	0.000	341.727	2391.193	5031.970	7551.119	7551.119	7608.351
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	-27.800	-1100.953	579.642	4873.555	8618.650	12317.150	11730.890	11816.740
Cumulated cash balance	-27.800	-1128.753	-549.112	4324.443	12943.090	25260.250	36991.140	48807.880
Inflow, local	3097.000	4623.000	15161.810	20316.610	25198.960	30053.560	29920.800	29920.800
Outflow, local	2538.600	2051.352	5332.846	7988.598	12319.190	16431.460	15948.060	16005.290
Surplus (deficit)	558.400	2571.648	9828.962	12328.010	12879.770	13622.100	13972.740	13915.510
Inflow, foreign	1574.300	31016.000	217.295	4765.436	12363.590	19929.000	19759.200	19759.200
Outflow, foreign	2160.500	34688.600	9466.616	12219.890	16624.710	21233.940	22001.050	21857.970
Surplus (deficit)	-586.200	-3672.602	-9249.320	-7454.456	-4261.120	-1304.945	-2241.850	-2098.770
Net cashflow	-4671.100	-35638.850	2725.842	7019.754	10764.850	14463.350	15921.090	15863.860
Cumulated net cashflow	-4671.100	-40309.950	-37584.110	-30564.360	-19799.510	-5336.157	10584.930	26448.790

Cashflow tables, in 000 US$

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total cash inflow . .	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000	49680.000
Total cash outflow . .	37777.410	37691.570	37605.720	37519.870	37573.980	37488.140	37402.290	37316.440	37230.590
Total assets	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs . . .	26207.790	26207.790	26207.790	26207.790	26207.790	26207.790	26207.790	26207.790	26207.790
Cost of finance . . .	1860.040	1716.960	1573.880	1430.800	1287.720	1144.640	1001.560	858.480	715.400
Repayment	2044.000	2044.000	2044.000	2044.000	2044.000	2044.000	2044.000	2044.000	2044.000
Corporate tax . . .	7665.583	7722.814	7780.046	7837.277	8034.472	8091.705	8148.936	8206.169	8263.400
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	11902.590	11988.430	12074.280	12160.130	12106.020	12191.860	12277.710	12363.560	12449.410
Cumulated cash balance	60710.460	72698.890	84773.170	96933.300	109039.300	121231.200	133508.900	145872.400	158321.800
Inflow, local	29920.800	29920.800	29920.800	29920.800	29920.800	29920.800	29920.800	29920.800	29920.800
Outflow, local	16062.520	16119.760	16176.990	16234.220	16431.410	16488.650	16545.880	16603.110	16660.340
Surplus (deficit) .	13858.280	13801.040	13743.810	13686.580	13489.390	13432.160	13374.920	13317.690	13260.460
Inflow, foreign . . .	19759.200	19759.200	19759.200	19759.200	19759.200	19759.200	19759.200	19759.200	19759.200
Outflow, foreign . . .	21714.890	21571.810	21428.730	21285.650	21142.570	20999.490	20856.410	20713.330	20570.250
Surplus (deficit) .	-1955.689	-1812.611	-1669.531	-1526.451	-1383.371	-1240.291	-1097.211	-954.131	-811.051
Net cashflow	15806.630	15749.390	15692.160	15634.930	15437.740	15380.500	15323.270	15266.040	15208.810
Cumulated net cashflow	42255.410	58004.800	73696.970	89331.900	104769.600	120150.100	135473.400	150739.400	165948.300

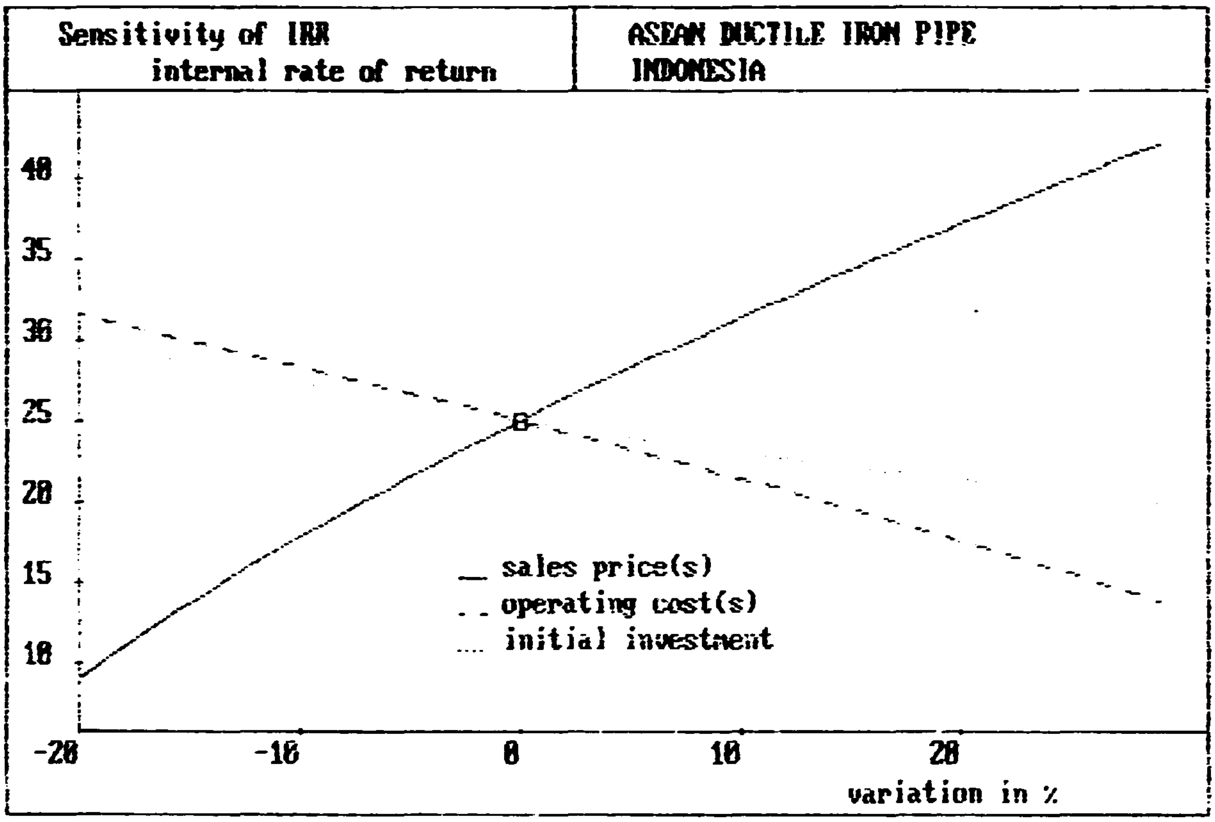
ANNEX V-A

Sensitivity of IRR - Philippines



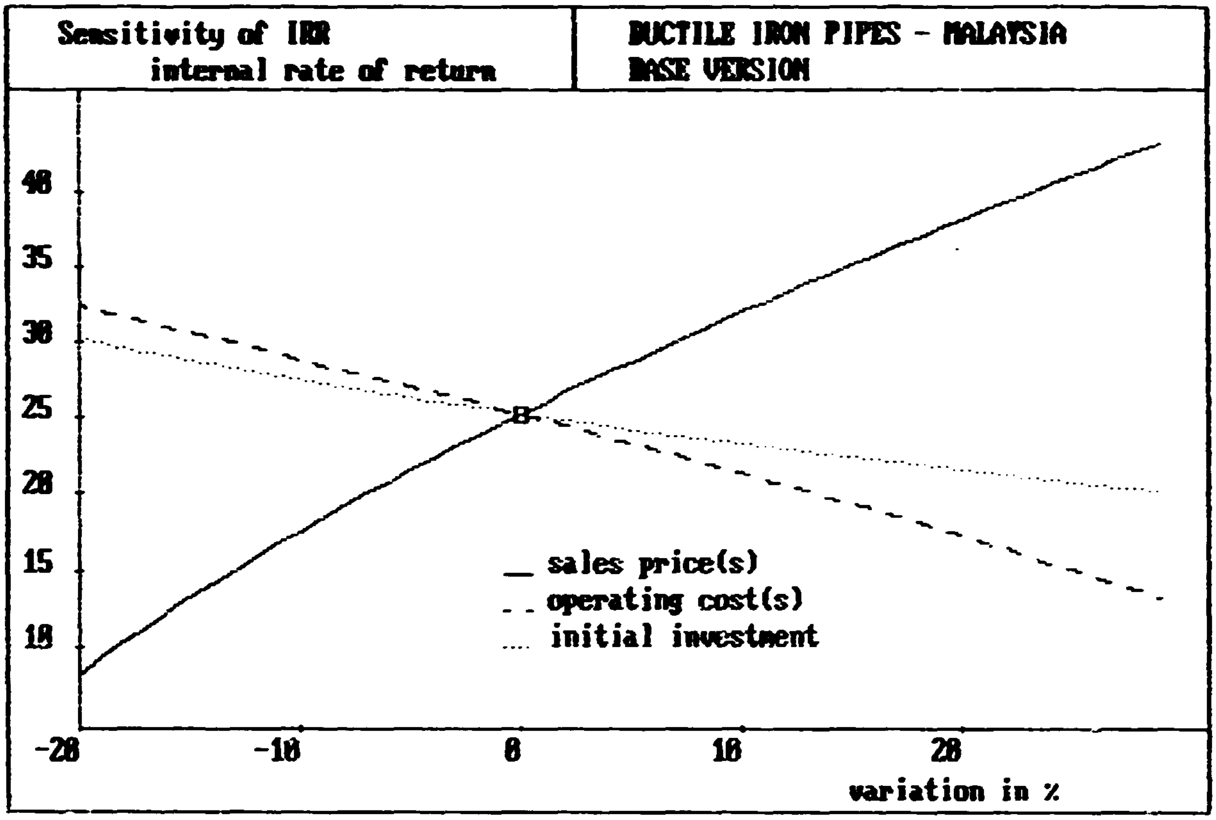
ANNEX V-B

Sensitivity of IRR - Indonesia



ANNEX V-C

Sensitivity of IRR - Malaysia



ANNEX VI-A

Indonesia

ASEAN DUCTILE IRON PIPE

Production Indonesia US$ 6M

3 years of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: 000 US$

Total initial investment during construction phase

fixed assets:	40617.60	[illegible] % foreign
current assets:	2222.49	[illegible] % foreign
total assets:	42847.00	[illegible] % foreign

Source of funds during construction phase

equity & grants:	12153.70	[illegible] % foreign
foreign loans :	30660.00	
local loans :	0.00	
total funds :	42818.70	77.283 % foreign

Cashflow from operations

Year:	4	5	11
operating costs:	9010.96	[illegible]	19108.80
depreciation :	2488.67	2488.67	2488.67
interest :	2145.20	2145.20	1430.80
production costs	13645.82	[illegible]	23027.59
thereof foreign	75.93 %	76.25 %	75.65 %
total sales :	14904.00	22356.00	37260.00
gross income :	1931.62	4905.65	13673.11
net income :	670.55	3188.67	8887.52
cash balance :	837.40	4780.49	9332.19
net cashflow :	2983.60	6928.69	12906.99

Net Present Value at: 20.00 % = 3134.12
Internal Rate of Return: 21.62 %
Return on equity1: 37.56 %
Return on equity2: 41.62 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

ANNEX VI-B

Malaysia

ASEAN DUCTILE IRON PIPE

sales price US$ 6[illegible] - MAL

2 year s of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: [illegible]

Total initial investment during construction phase

fixed assets:	[illegible]	[illegible] % foreign
current assets:	[illegible]	[illegible] % foreign
total assets:	[illegible]	[illegible] % foreign

Source of funds during construction phase

equity & grants:	[illegible]	[illegible] % foreign
foreign loans :	[illegible]	
local loans :	[illegible]	
total funds :	[illegible]	[illegible] % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	[illegible]	[illegible]	[illegible]
depreciation :	[illegible]	[illegible]	[illegible]
interest :	[illegible]	[illegible]	[illegible]
production costs	[illegible]	[illegible]	[illegible]
thereof foreign	[illegible] %	[illegible] %	[illegible] %
total sales :	[illegible]	[illegible]	[illegible]
gross income :	[illegible]	4643.45	[illegible]
net income :	444.51	2766.07	7651.60
cash balance :	526.38	4360.29	8432.05
net cashflow :	2672.58	6506.49	10578.25

Net Present Value at: 15.00 % = [illegible]
Internal Rate of Return: [illegible] %
Return on equity1: 40.73 %
Return on equity2: 45.37 %

Index of Schedules produced by COMFAR

Total initial investment
Total investment during production
Total production costs
Working Capital requirements
Cashflow Tables
Projected Balance
Net income statement
Source of finance