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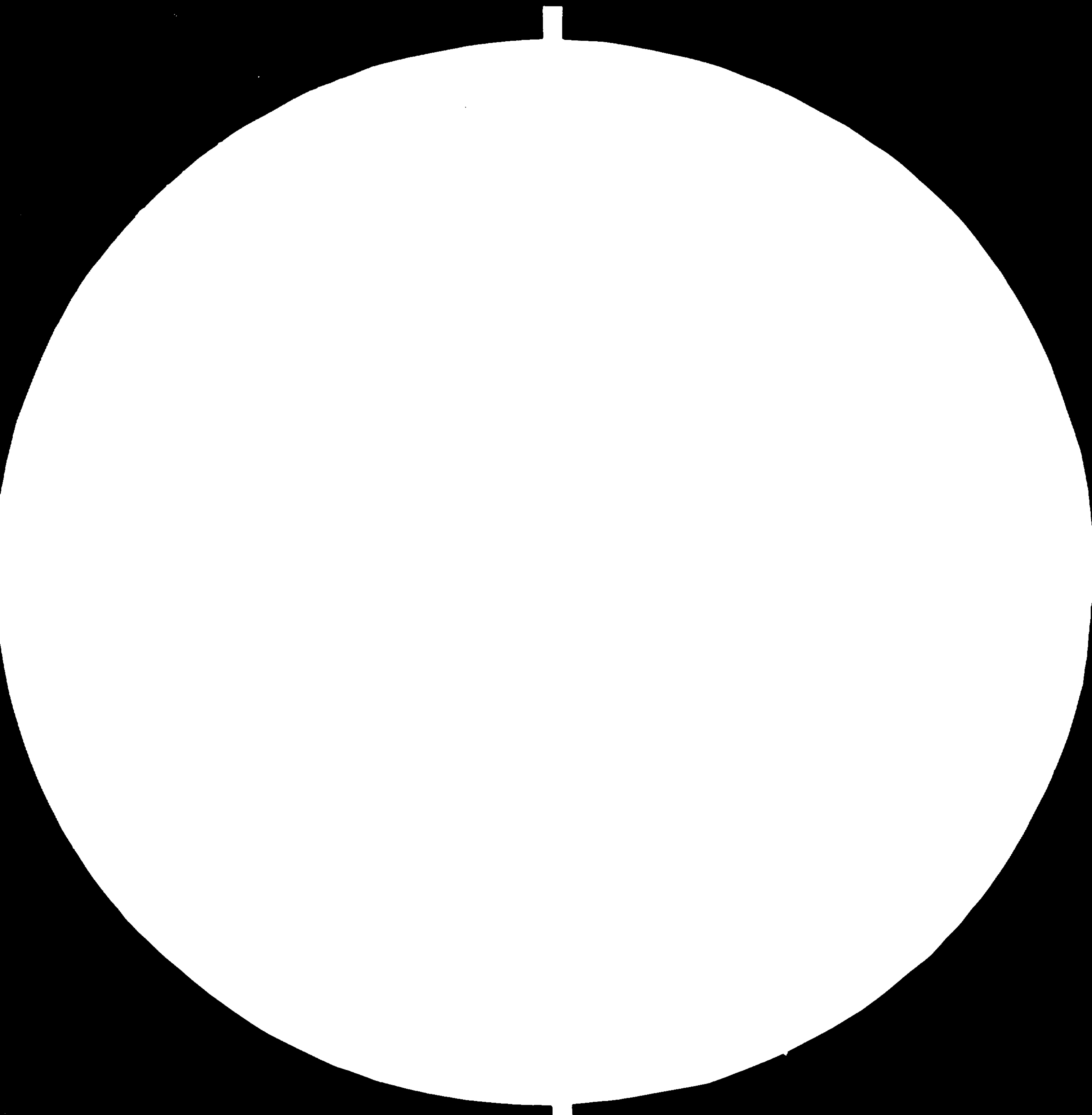

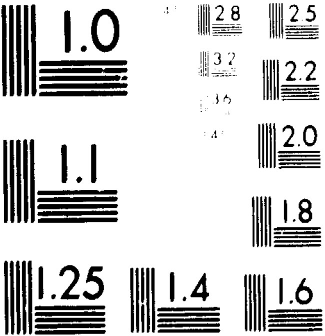
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FINAL REPORT

TO

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

EVALUATION OF TENDER FOR THE VALENTINE IRON ORE PROJECT IN URUGUAY,

DP/KEN/74/007

OCTOBER 1981

002134

DASTUR ENGINEERING INTERNATIONAL GMBH

Consulting Engineers

DUSSELDORF

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TO

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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OCTOBER 1981

DASTUR ENGINEERING INTERNATIONAL GMBH

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DÜSSELDORF

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Consulting Engineers

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23rd October 1981
0756-148A

Mr D.F. Mant, Chief
Purchase and Contractors Services
United Nations Industrial
Development Organisation
Vienna International Centre
P.O. Box 300
A-1400 Vienna
Austria

Re: UNIDO Project SI/URU/80-802
Contract No. 80/138/dg -

Evaluation of Tender for the
Valentine Iron Ore Project in Uruguay

Dear Sir,

In accordance with the terms of the above contract dated 25th November 1980, we have pleasure in submitting herewith 30 (thirty) copies of our Final Report (in English) on the Evaluation of Tender for the Valentine Iron Ore Project in Uruguay. The aim of the project and the substantive terms of reference, in accordance with which the enclosed study has been prepared, are given in Appendix 1-1.

The evaluation by DEI has been made covering all the major aspects of the project enumerated in the Brazilian study so that the findings could help the Project Authorities in further negotiating the project deal with the Consortium.

DEI would like to record their appreciation of the work of the Brazilian Consortium in compiling the techno-economic feasibility study-cum-offer within the time available. During the course of DEI's evaluation work, however, it was found that various clarifications and elaborations were necessary. These will have to be obtained to enable the Project Authorities to take binding investment decisions. The areas where such clarifications are called for have been pointed out under respective chapters.

We take this opportunity to express our gratitude to UNIDO, UNDP-Montevideo and the representatives of the project group at the Ministry of Industry and Energy, for the cooperation extended to us during the course of work on this assignment.

Respectfully submitted
DASTUR ENGINEERING INTERNATIONAL GmbH
by

M.N. Dastur

MND:sr

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S U M M A R Y

This study carried out by Dastur Engineering International GmbH (DEI), Consulting Engineers, Düsseldorf at the instance of United Nations Industrial Development Organisation (UNIDO), seeks to present an evaluation of the feasibility study presented to 'Republica Oriental del Uruguay, Ministerio de Industria y Energia' (Project Authority) by the Brazilian Consortium (comprising Tenenga, Coferraz, Cimetal and Interbrass) along with a project bid including financing possibilities. In accordance with the contract requirements, a draft final report was submitted by DEI in June 1981. The draft final report has been accepted by the UNIDO. Accordingly, DEI was authorised by UNIDO on 18th September 1981 to submit 30 copies of this final report based on our draft final report.

The Government of Uruguay (Project Authorities) is desirous of improving their national economy through exploitation of resources with which the nation is endowed. Studies so far conducted in Uruguay reveal that the Valentine iron ore deposits amount to about 30 million tons with an average Fe-content of 33%; an additional probable reserve of about 17 million tons is also expected. The Project Authorities have been examining the possibility of exploiting these iron ore reserves for the establishment of a viable iron and steel complex within the country.

Summary (cont'd)

Major Findings

The major findings of DEI which are discussed in detail in relevant chapters of this Final Report, based on the information available in the Brazilian study, are summarised below:

(1) The Valentine project, which is proposed to be implemented using the national raw materials, and which is expected to cater to the moderate local market, is viable. The investment cost of US $ 140.2 million as established by the Brazilian Consortium might probably increase by about US $ 3.0 million, if the various recommendations proposed by DEI are implemented. These recommendations have been elaborated under respective chapters in the report and are briefly summarised below:

   i) Installation of third Cowper stove in Blast Furnace

   ii) Gas cleaning facility in BOF-shop

   iii) Installation of lime kiln to produce calcined lime

   iv) Provision of two 2-strand billet casters

   v) Changing of last four horizontal bar finishing stands to vertical/horizontal configuration.

(2) It is DEI's recommendation that the plant production facilities should be so designed that it can alter its production programme if market conditions warrant such flexibility.

(3) It is further recommended that apart from the flexibility of changing over to a slightly different production programme, no major investment should now be incurred for eventual

Summary (cont'd)

future expansion of plant capacity. Such future expansion would not be required in the light of the country's limited raw materials reserve, and the long-term probable demand pattern in the country for long products.

(4) In the interest of satisfying the national market for billets, not only for the first three years of plant operation as suggested in the Brazilian study, but also to possess such a flexibility even for the future, it is DEI's suggestion that the continuous casting machines be designed to cast 90 mm square to 120 mm square sections of lengths 3 m to 6 m, though the Valentine project itself will only roll billets 4 m long. DEI's suggestion in regard to modified billet size capability would make it possible to meet the demands of most of the rerollers in the country.

The casting technology available today makes it possible to cast round sections in the same continuous casting machine. It is believed that retaining this capability would be of advantage and would be possible if a minimum 6 m radius continuous casting machine is chosen for the project.

(5) With the proposed adoption of conventional Blast Furnace-BOF route, the plant would be in a position to produce higher quality products than through adoption of the scrap melting process, which is being currently employed by a number of rerollers. Thus, the products of Valentine project would enjoy qualitative and economic advantages.

It is possible that in the future the plant will produce suitable quality bars for more sophisticated end-use like in automotive industry, cold heading quality etc and consequently it is suggested that the last four finishing stands should have vertical/horizontal configuration. This will enable last four no-twist passes for

Summary (cont'd)

the bar resulting in improved products, as well as provide possibility of rolling sections like angles, flats etc, if required.

(6) It is suggested that Project Authorities should obtain the Brazilian Consortium's firm indication that the project bid as submitted is complete in all respects and that for the investment cost proposed, the plant would be in a position to start commercial operation. Also, it should be ensured that their supply scope includes spares for two years of plant operation. Such an overall undertaking from the Brazilian Consortium would be essential as it is not clear from the documents now available if any limitations in scope of supply is inherent in the bid.

(7) It would appear logical that as a joint-venture partner, the Brazilian Consortium should be made to take part in the project's equity and/or in guranteeing the project loans. With a low equity proposed for the total project (about 11 per cent of the total investment visualised), this should not be a major bottleneck.

INTRODUCTION

An overall evaluation of the existing economic conditions in Uruguay reveals that the country is fully poised for taking off in its goal to industrialise. It is widely recognised that for this purpose the back-bone of all industrial development - steel industry - has to be expeditiously implemented. In this context, United Nations Industrial Development Organisation has commissioned Dastur Engineering International GmbH to provide services relating to the evaluation of the feasibility study presented to 'Republica Oriental del Uruguay, Ministerio de Industria y Energia' (Project Authority) by the Brazilian Consortium (comprising Tenenga, Coferraz, Cimetal and Interbras) along with a project bid including financing possibilities.

Authorisation

Dastur Engineering International GmbH commenced work in accordance with contract No. 80/B8 between UNIDO and DEI (Appendix 1 Scope of Work of Consulting Engineers) and a briefing meeting was attended by DEI in Vienna between 13th and 15th November 1980.

Following this, as per terms of the contract, a team of two experts from DEI was in Montevideo in November 1980 for a period of about two weeks. However, due to non-receipt of bids by the Project Authority by then, no effective work on the assignment could be commenced. The Project Authority desired that DEI's

Introduction (cont'd)

team should return to Montevideo at a later date after receipt of the bid documents. Nevertheless, DEI's initial field team made use of their period of stay in Montevideo in collecting background information relevant to the evaluation assignment, as well as in developing a suitable work plan in consultation with the Project Authority and UNDP. Also a note on probable approach to the evaluation assignment together with a suggested methodology was submitted to the Project Authority. As advised by UNIDO, a second 2-man field team of DEI reached the Project Area in early March 1981, and spent about four weeks conducting field investigations. Based upon intensive home-office work deploying the relevant engineering disciplines, the findings of DEI were documented in the form of a Draft Final Report and the same was submitted by DEI in June 1981. This Draft Final Report has been accpeted by UNIDO vide their telex dg 61911 (Project Si/Uru/80/802) dated 18th September 1981. Accordingly DEI have pleasure in submitting 30 copies of this Final Report. This Report is submitted in one volume containing 8 chapters along with tables, drawings, figures and appendices. Also for quick review of the findings a brief summary has been prepared highlighting the salient points of the project and is presented at the very beginning of this Report.

Acknowledgement

DEI gratefully acknowledges the cooperation and assistance extended by the various officials of UNDP, Montevideo and UNIDO, Vienna; Plan de Estudios

Introduction (cont'd)

Complementarios de la Zona Ferrifera de Valentines (Valentine Project), iron and steel producing and consuming companies and other agencies in Uruguay. DEI also wishes to record its thanks to the counterpart team associated with this study on behalf of the Government of Uruguay (particularly Madame Ing.María Ema Villemur and her colleagues) for their invaluable help in arranging visits and discussions.

1 - URUGUAY - COUNTRY BACKGROUND

Geographically one-third of Uruguay is exposed to Atlantic Ocean with Brazil and Argentina bordering on the inland side. With an estimated population of 2.9 million (mid-1979 estimate), and an area of 176.216 sq km the country registered a gross domestic product (GDP) of 6.95 billion US dollars in 1979 and a foreign exchange reserve of about 446.4 million US dollars in February 1981. Although economic growth is slowing, reflecting a downturn in tourism and related construction activity, progress continues to be made in reducing inflation.

Economy

The economic growth in 1979 at 8.4% was the highest for over two decades. However, the pace slackened last year, with an increase of 5.2% in the first nine months in relation to the same period of 1979.

Growth rates

Following is summary of percentage change over corresponding period of previous year:

	January/September 79	January/September 80
GDP	8.8	5.2
Agriculture	2.8	9.7
Industry	10.1	2.7
Construction	22.6	8.5
Trade	15.4	8.0

1 - Uruguay - Country Background (cont'd)

A strong exchange rate policy in combination with the import liberalisation programme - both part of the authorities' anti-inflationary stance - have placed local industry under growing pressure reflected in the sharp fall in the sector's growth last year. A further decline in overall economic growth is expected this year in view of the perseverance with the successful anti-inflationary policy. Last year's inflation rate at 42.8% in the 12-months to December was only a little over half the increased recorded in 1979 and lower than the target of 50% and inflation this year is expected to be in the 35% to 40% range. In order to protect purchasing power minimum wages are raised every four months - the most recent was in February 1981 of 11%. However, each advance is accompanied by a rise in tariffs for electricity, telephone, petrol and other items so that there are only, at most, minimal increase in real wages. In fact, at present real wages stand at around three-fifths of their 1968 level.

Agriculture

In the first nine months of 1980 agricultural production rose by nearly a tenth, mainly because of excellent crops in 1979/80 season. Livestock raising is responding well to government attempts to stimulate production. Livestock at the end of July 1980 totalled 11 million cattle and 20 million sheep. Meat production rose substantially last year providing a strong boost to exports, with some 137.000 tons of meat exported giving foreign exchange earning of US $ 203 million.

The fish catch in 1980 was estimated at 145.000 tons compared with 105.000 tons in 1979, with 60.000 tons

1 - Uruguay - Country Background (cont'd)

being exported with a foreign exchange earning of US $ 50 million. Following the completion of the second phase of the fishing port of La Paloma (Rocha) in 1985, the volume of exports is expected to increase four-fold.

Industry and Construction

Compared with the boom year of 1979, industrial growth slowed sharply last year, mainly because of the growing over-valuation of the exchange rate, low foreign demand and increasing competition from imports. A reduction of the employers' share in social security from 24% to 10% gross wages and salaries was not sufficient to prevent a decline in most industrial branches. Output expanded only in tanning (by 50%) and electrical goods industry (17%). All other sectors declined especially chemicals by 33% and metal-working by 20%. The boom in construction is easing although orders are still high mainly due to public sector investment in public-assistance dwellings.

Energy

Sharply rising expenditure on imported oil has led to increased attention being paid to domestic energy supplies in recent years. A number of hydro-electric facilities are under construction, the largest of which is the 1,980 MW Salto Grande project on the Rio Urugay, a bi-national venture with Argentina. Work at the Palmar hydro-electricity project on the Rio Negro is also progressing on schedule and in December 1981 the first turbine is scheduled for operation. Oil exploration is also continuing and the Ministry of

Industry and Energy is expecting financial assistance with seismic research. A search for uranium is also being undertaken with help from France whilst an agreement has been made with Argentina regarding the construction of experimental nuclear reactor. Argentina natural gas is to be supplied from 1983, which will also contribute to a reduction in the country's dependence on imported oil.

Foreign Trade

The trade deficit increased again in 1980, reaching according to preliminary estimates, around US $ 600 million compared with $ 418 million in the previous year. Increased expenditure on imported oil together with a rapid increase in import volume as a result of the tariff liberalisation programme were the main factors behind this trend.

Between January and October 1980, exports reached US $ 808 million, nearly a quarter higher than the corresponding period of the previous year. However, the 38% increase in imports over the same period involved foreign exchange expenditure of US $ 1.3 billion. Purchase of oil at US $ 429 million compared with US $ 224 million in January-October 1979 accounted for nearly a third of this total, although imports of machinery and electrical appliances and transport equipment also rose steeply.

As part of its programme of reducing and simplifying import charges the government has begun a gradual reduction of import duties imposed on items competing with domestically produced goods. By 1985, the basic duty will be 35% the same level as that on goods not produced in Uruguay. In order to protect local producers against unfair foreign competition an anti-dumping law was introduced in 1980. This could be all the more relevant to the implementation of the proposed iron and steel complex at Valentine, in that effective implementation of the anti-dumping measures in respect of steel products to be imported into the country could make the viability of the project a stable proposition rather than leaving it to defend itself against unfair steel export practices of various major steel producing countries. Steel supply scenario is somewhat cyclical and many exporting countries use dumping at a low price in black market to keep their plant operating at higher rate. This also hampers development of domestic steel capacity and provides a continued market for exporting countries.

General Outlook

A freer market is not proving easy to implement and it is requiring great economic flexibility. In particular th· industrial sector is exposed to severe competition from abroad as a result of the trade and exchange rate policies. However, the economy is basically sound and in general the economic policy is succeeding.

The standard of living is quite high; with an enviable degree of literacy the country has a large number of technically qualified population and commands a well-developed network of infrastructure facilities. Thus the country notionally grouped under 'developing world' could easily be categorised as a developed economy in many respects.

The Brazilian study has provided extensive information on the status of economy etc and these data could be suitably updated by the Project Authorities.

1 - Uruguay - Country Background (cont'd)

The basic raw material needed for the development of steel indstry, namely iron ore, is available in Uruguay, though for a relatively small operation. The present known iron ore reserves which can be economically exploited are expected to last at least for about 35 years for a production of about 100.000 tons per annum of finished steel product. Conventional energy for the steel production, such as metallurgical coal and natural gas are not available in the country. However, the country has sufficient land and a congenial climatic condition for planned growth of trees and development of forest resources for production of charcoal for ironmaking.

The technology for production of iron using charcoal as the reductant is a well-developed one and is being extensively made use of in the neighbouring Brazil and Argentina. Thus transfer of this technology to Uruguay would be relatively easy from the point of view of proximity.

The consumption of steel in the country is mostly related to construction and agriculture supporting activities. However, with the production and availability of steel within the country, industrial activity in sectors both serving the industry and those in the down-stream, metal-working industries would further accelerate. Therefore in the medium and long-term period, the demand for steel products would be multiplying.

Uruguay has close trade links with neighbouring Argentina and Brazil. Therefore, the excess production, if any, at the Valentine Project could be exported to consumers located in the border areas. In other words, the location of Valentine project would enjoy a favourable distribution cost than some of the major steel plants of Brazil. The major steel producing centres of Brazil are quite far from some of the consuming areas near Uruguayan border, and transportation cost alone could provide the adequate element of competitiveness for the Valentine products in these areas.

It is believed that it would be feasible for the Valentine project to supply to consuming centres in the border areas of Brazil because of the good trade relations already existing between these two economies, and the project proposal also is from a Brazilian Consortium.

It is recommended that Uruguay and Brazil could probably explore the possibility of entering into a bilateral agreement whereby any unfair restriction on the ability of Uruguay to eventually supply to these markets in Brazil bordering on Uruguay could be obviated. In any case the quantum of supplies which would be available for such trading between Brazil and Uruguay would be so insignificant in comparison with international trade volumes, that this matter could be easily resolved.

2 - THE VALENTINE PROJECT

The Valentine project symbolizes the aspirations of the Government of Republic of Uruguay. Since several years this project has been receiving careful attention of the agencies of the Government of Uruguay charged with the industrialisation of the economy. This is demonstrated by the various techno-economic studies so far compiled both by local and international agencies. Variously motivated, these studies have analysed aspects such as resources of raw materials, particularly iron ore, preliminary evaluation of agglomeration and beneficiation possibilities, overall project concept, investment requirements, cost of production etc. These exercises have also attempted to estimate the local market for products visualised including possible exports to neighbouring countries.

Techno-economic parameters for establishing steel industry change rapidly. Thus, unfortunately validity of feasibility studies on such complex projects as integrated steel plants become outdated in many respects within a relatively short time. This has also been the case in Uruguay. Also various other factors particularly investment cost, production cost etc have been undergoing steep changes in recent times. Though results of geological exploration, laboratory and production tests on Uruguayan raw materials etc may remain valid, the cost and the market aspect need updating or re-establishing shortly before the final investment decisions are made. In fact, this updating based on prevailing conditions makes the investment decision factual and practical.

2 - The Valentine Project (cont'd)

Due to the international phenomenon of spiralling prices, the investment capital and the cost of capital is continuously changing. Any investment decision involves certain amount of risk, but specially for iron and steel industry which is one of the most capital intensive sectors, due care should be exercised in order to arrive at appropriate techno-economic decisions. Apart from the rate of interest for long, medium and short term loans which are presently high and fluctuating, in comparison to the conditions of last decade, the cost of equipment and facilities are continuously going up with the effect of inflation and other factors.

The Brazilian offer for the Valentine project has been submitted together with a feasibility study. DEI would like to take the opportunity of recording that the Brazilian Consortium has done commendably well in compiling the feasibility report, which does full justice to the overall project concept. The Brazilians have, however, indicated that a detailed engineering study will be necessary before the implementation of the project. Such a detailed report would present definitive project parameters. They have offered to undertake this study jointly with the Project Authorities as a further step for the project implementation, once the Uruguayan Government agrees in principle for going ahead with the proposed project and enters into an arrangement with the Consortium.

It should however be pointed out that for purpose of taking a firm decision on implementing the project, a detailed project report with definitive parameters should be prepared. Such a study should also cover laboratory and industrial-scale tests of raw materials,

2 - The Valentine Project (cont'd)

surveys of plant site, soil investigations etc. It should be emphasised that project implementation should be effected within a reasonable time of preparing the detailed project report so that the findings do not become out-dated.

Generally speaking, development of indigenous steel industry gets added impetus with the availability of raw materials, energy source, infrastructure and above all local market, supplemented where necessary by export possibilities. In a recent analysis it has been concluded that in general the restraints for developing indigenous steel production, in the order of importance, are

- Finance and economics
- Raw materials and energy
- Markets, product-mix and scale of operation
- Infrastructure, transport and location
- Human resources development and manpower

influencing or acting as constraints which limit the size or the technology-route adopted. The Valentine project presents an excellent example for the above contention.

The possible use of indigenous raw material for the production of steel has been the singular incentive which has promoted the authorities to pursue the implementation of the Valentine project. It is therefore logical that the project concept is so evolved as would enable the use of the local low grade iron ore and charcoal which is again a product capable of being supplied from local resources.

2 - The Valentine Project (cont'd)

In fact, without the use of indigenous material and the local manpower to the maximum extent possible, there is very little justification for implementation of Valentine project.

The Brazilian concept of the project

One of the over-riding considerations of establishing indigenous steel capacity, specially in the third world, is the availability of major raw materials. In the Uruguayan context also, from the inception, the development of a suitable concept for the metallurgical industry has been based on the maximum use of local iron ore resources at Uria range and the use of the extensive forest resources of the country to produce charcoal for use in steelmaking.

The Brazilian study has presented a concept which would enable supply of 100% of plant's iron ore requirement from the deposits adjacent to the plant site. It is proposed to transport the ore mined to the beneficiation plant by road transport. Further, the ore is to be ground and magnetically separated to achieve a feed of higher Fe content which is to be sintered by using charcoal dust.

The blast furnace capacity proposed is 120.000 tons of hot metal. For this purpose, it is proposed to use about 185.000 tons of sinter and 300.000 cu m. of charcoal. The production of charcoal is not proposed as a captive function of the Valentine project. Half of the charcoal required is proposed to be purchased from private entrepreneurs and the rest from a subsidiary company of the Valentine project. The project will provide adequate incentives for the production of charcoal by Uruguayan entrepreneurs in that a ready market for their production will be assured.

In respect of one-half of the charcoal requirement to be supplied by the Valentine project's own subsidiary company, the Brazilian study has assumed that land for forestation at a rent of two per cent of land cost per year will be provided. However, the cost of acquiring land as well as rent received for the land has not been shown in the project's financial statements.

The hot metal will be produced in a charcoal blast furnace. The hot metal will go through an intermediate storage in a mixer to BOF shop for steelmaking. Some hot metal, about 5000 tpy, will go to pig casting machine and this pig iron will be sold in the market.

Two-vessel BOF shop will convert the hot metal to 115.000 tons of liquid steel which will be cast into billet of 120 mm sq and 4 m long in a 3-strand continuous casting machine. Billet production capacity will be 110.000 tpy.

The billets will be heated in a walking beam type heating furnace and rolled in a semi-continuous mill into coils of 6.5 mm to 12.7 mm dia of both plain and ribbed surface. A straightner is provided for straightening and cutting of coils to straight lengths to produce bars for the market. Provision for installation of a cooling bed has been visualised for the future.

2 - The Valentine Project (cont'd)

The project concept visualises getting supply of electricity from outside source by installing main sub-station about 12 km away from the plant. The source of water supply will be through a simplified dam to be constructed on Valentine river flowing beside the plant area. For steelmaking the oxygen will be procured on purchase basis. Oxygen plant will be installed by private entrepreneurs who will sell the product to the project. Also, for keeping the initial investment low, calcined lime for the BOF steelmaking has been assumed to be imported. Provision for gas cleaning of BOF vessel has also been indicated as optional for future installation. Therefore, the cost of pollution mitigation equipment has not been included.

The material balance and the major facilities as indicated in the Brazilian proposal is given in Fig. 2.1 and Table 2-1.

Expansion possibility

The Valentine project as it is conceived in the Brazilian study would produce 120.000 tons/year of hot metal. On this basis, the estimated iron ore reserves of the country would sustain the plant operation for about 35 years. From the view point of internal demand for long products this scenario also fits in. In fact, based on figures available for expected demand in Uruguay for a considerable period of plant operation it may become necessary for the project to look for export avenues for a major portion of its products.

FIG.2.1-MATERIAL BALANCE FLOW SHEET

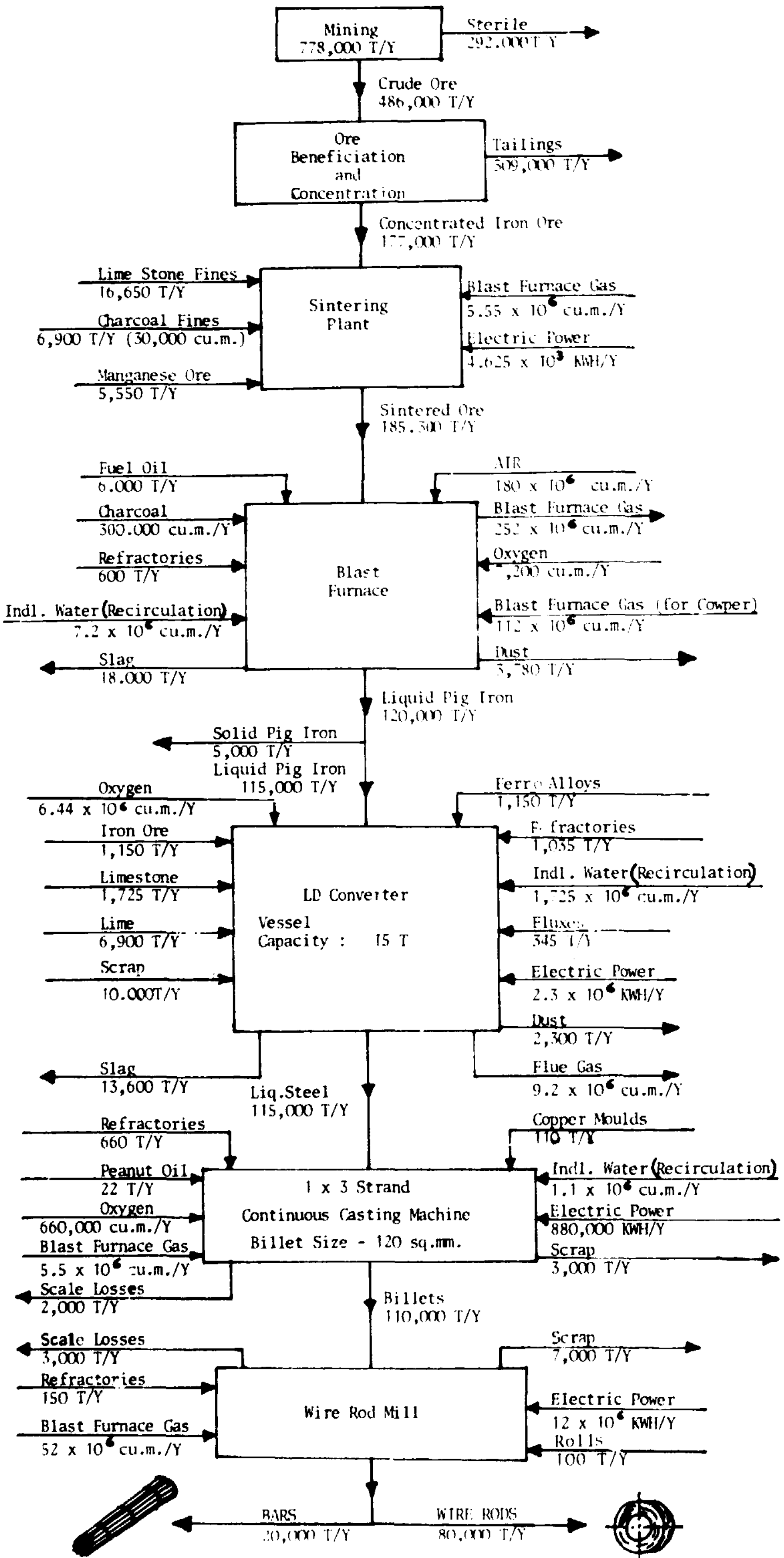


TABLE 2-1 - MAJOR FACILITIES

	Operation	Production	Facility
MINING	Open-cast iron-ore mining based on 2-shifts/ day and 300 days/year operation	Total annual mining 778.000 tons of which crude ore (34% Fe) is 486.000 tons and waste rock 292.000 tons	Drills/compressors/pneumatic hammer etc for mining Pay loaders/bull dozers/trucks etc for loading and transport
BENEFI-CIATION	Crude ore of about 750 mm reduced in size by jaw and cone crushers, rod milling in 3-stages, screening at 150 microns followed by 2-stage wet magnetic separation. Operation 3 shifts/day and 300 days/year	Annual production 177.000 tons concentrate of 65.5% Fe. Concentrate grade established on preliminary laboratory tests. Definitive large scale tests on representative ore samples still to be carried out	Jaw and gyratory crushers, vibratory feeder, conveyors etc for primary milling Rod mills, vibratory and micro screens etc for grinding circuit Low intensity wet magnetic separators, conveyors etc for concentration
SINTERING	One sinter machine of 20 sq.m. grate area for sintering and 14 sq.m. area for cooling. Operation 3-shifts/day and 300 days/year	Annual production 185.300 tons of fluxed sinter of average 62.5% Fe	Raw material silos, dozing and feeding equipment etc Mixer, belt conveyors etc Sintering machine with on-line cooling facility and dust extraction system
BLAST FURNACE	One charcoal blast furnace of 4,4 m hearth dia. and 262 cu.m. effective volume. Operation 3 shifts/ day and 350 days/year	Annual hot metal production 120.000 tons of which 115.000 tons going to steelmelt shop and the rest to pig casting machine	Furnace proper Two Cowper stoves each with 6.555 sq.m. heating surface Turboblower of 25.000 N cu.m./ hr capacity Charging system with skip hoists and 2-bell distribution system Stock-house, silos, conveyors etc Gas cleaning plant Carrousel type pig casting machine
STEEL-MAKING	Two 15-ton BOF vessels (one operating) 3-shifts/ day, 330 days/year	Annual production 115.000 tons liquid steel	One 400-ton hot-metal mixer Two BOF-vessels with lubrication/ oxygen lancing/ferro-alloy and flux addition system Handling and storage system for ferro-alloy, flux and scrap Instrumentation and electrics Cranes, ladles, steel and slag transfer cars Gas cleaning plant (optional)
CONTINUOUS CASTING	One 3-strand billet caster operating 3-shifts/day and 330 days/year	Annual production 110.000 tons of billets of 120 mm square section	One 3-strand curved-mould caster Fixed ladle stand Tundish car Cooling bed Mechanical shear Motors, electrics and instrumentation Handling and storage system for billets
ROLLING MILL	One semi-continuous bar and rod mill operating 3-shifts/day and 300 days/year	Annual production 100.000 tons rolled bars and rods	One 25/30 tons per hour walking-beam type billet heating furnace One semi-continuous bar and rod mill with 1 x 3-hi roughing stand, 4 x 2-hi continuous intermediate stands, 6 x 2-hi continuous bar finishing stands and 8 x 2-hi horizontal/vertical stand rod finishing block. Shears, wire rod cooling conveyor, coil compacting and handling system ard coil straightener Motor, electrics, instrumentation, hydraulic system, roll-turning and guide shop

2 - The Valentine Project (cont'd)

However, as the steel availability creates its own demand, and with increased economic activity in other sectors of the economy, it is expected that the project would very soon find local market for its entire production visualised.

As presently conceived the Valentine project would only cater to the country's demand for long products. Techno-economically, the production of flat products in the proposed Valentine project would not be feasible for quite some time to come. Under the conditions prevailing in Uruguay the demand for flat products is also too insignificant to think of indigenous production. The minimum scale of operation applicable in the rolling of flats plays a big role in any country's decision to go ahead with flat production. The huge investments involved in inclusion of flat production facilities at Valentine project would not be justifiable for some time to come.

Based on the above explanation, it is desirable that the Valentine project does not get unduly saddled with investments for future expansion possibilities. While every effort should be made to achieve higher production, through higher efficiency and effective and optimum utilisation of various equipment and facilities, it would be needless now to incur additional investment for expanding the plant capacity. However, the plant layout should be so conceived that location of initial facilities does not restrain eventual expansion of the plant. After all, if there is a need to produce more steel in the future and if the local raw materials would not be sufficient to sustain such

2 - The Valentine Project (cont'd)

expanded production, it is also possible to operate with imported raw materials as has been proven in the case of Japanese steel plants. Such an eventuality for the Valentine project might be kept in mind. However, it is recommended that at this stage no investment for future expansion should be included which would remain essentially idle.

3 - MARKET AND PRODUCTION PROGRAMME

The existing status of steel industry in Uruguay could be briefly described as follows:

There has been no primary steel production capacity till todate. There are however about half a dozen re-rolling mills in the country and their product-mix cover long products, mainly rebar and some smaller sections. By now it is estimated that these re-rolling mills account for a total of about 65.000 tons of various types of construction steel. Thus the country's requirements in excess of the above local production is being met by imports.

In the context of the implementation of the Valentine project, which would be the first integrated project in the country for the production of liquid steel and its subsequent rolling etc, the Brazilian study has estimated the market requirement of steel mainly based on direct apparent consumption in the last 6 years. This demand analysis also takes into account current production in Uruguay and direct import. However, the Brazilian Consortium exercise does not take into account the indirect import, that is steel being imported into the country as part of finished or semi-finished products. Per capita consumption as indicated in various international studies and forecasts has been made the basis for demand estimation.

3 - Market & Production Programme (cont'd)

It may be pointed out that generally steel demand forecast for a given economy is a specific exercise and needs to be compiled based on various national considerations and factors which are unique to that economy, such as the base sector of the economy, current level of industrialization, perspective planning for overall economic development and projected growth of industrial sector to manufacture consumable products, durable items etc. However, this is a time-consuming exercise and in most countries often tackled as a separate study. For purpose of conceiving the Valentine project however, the Brazilian Consortium has dealt with the demand aspect with brevity and simplicity which the current resources and time would permit. Also, the capability of the Valentine project to meet the country's requirements for non-flat products has been worked out using mainly what has been the international pattern. This however may not be fully transferable to countries with conditions similar to Uruguay.

Table 3.1 presents a very recent (May 1981) compilation by the Steel Industry Directorate of the Federal Statistical Bureau of German Government giving country-wise details of the world raw steel production. This table also presents the per capita production of liquid steel in these countries together with an indication of the share of these countries in total world raw steel output. The Uruguayan position is rather glaring from the point of view that several other developing countries which have a much lower per capita income and a lower standard of living enjoy a higher per capita steel production and thus a higher share in the world raw steel output. This comparative presentation would further imphasise the importance of steel in overall

TABLE 3-1 COUNTRY-WISE LIQUID STEEL PRODUCTION, PRODUCTION PER CAPITA AND SHARE IN WORLD STEEL PRODUCTION

Country	Annual production '000 tons			Production per capita kg#			Share in world production %	
	1978+	1979+	1980+	1978+	1979+	1980+	1970	1980
I. EUROPE								
West Germany	41 253	46 040	43 838	673	751	714	7,56	6,14
Belgium	12 601	13 442	12 319	1 281	1 362	1 244	2,11	1,73
France	22 841	23 360	23 137	429	437	431	3,99	3,25
Italy	24 283	24 250	26 477	428	426	463	2,90	3,71
Luxembourg	4 790	4 950	4 618	13 456	13 750	12 687	0,92	0,65
Netherlands	5 590	5 806	5 269	401	414	373	0,85	0,74
Denmark	863	804	734	168	156	142	0,08	0,10
Great Britain	20 311	21 464	11 391	364	386	205	4,75	1,60
Ireland	69	72	2	21	21	1	0,01	0,00
ECM	132 601	140 188	127 785	511	539	490	23,16	17,91
Finland	2 335	2 464	2 488	491	518	522	0,20	0,35
Greece	936	1 000	1 000	101	107	106	0,06	0,14
Norway	813	921	852	201	226	153	0,15	0,12
Austria	4 335	4 917	4 624	577	655	616	0,68	0,65
Portugal	614	649	659	621	66	67	0,06	0,09
Sweden	4 325	4 731	4 234	522	570	509	0,92	0,59
Switzerland	784	886	850	124	140	134	0,09	0,12
Spain	11 510	12 254	12 670	306	330	340	1,25	1,78
Turkey	2 172	2 396	2 403	50	54	54	0,22	0,34
OECD	160 425	170 406	157 565	411	435	401	26,79	22,08
Albania	..	..	..	..	..	..	..	..
East Germany & East Berlin	6 976	6 964	7 000	416	416	419	0,91	0,98
Bulgaria	2 469	2 483	2 450	280	282	277	0,30	0,34
Yugoslavia	3 451	3 534	3 630	157	159	162	0,37	0,51
Poland	19 251	19 218	18 000	539	546	518	1,98	2,52
Romania	11 779	12 909	13 450	541	585	602	1,09	1,88
Czechoslavakia	15 294	14 817	14 950	1 010	972	973	1,93	2,09
Hungary	3 877	3 909	3 925	363	365	366	0,52	0,55
EUROPE*	223 522	234 240	220 970	426	445	419	33,89	30,97
SOVIET UNION	151 436	149 087	150 500	577	565	566	19,44	21,09
II. AFRICA								
Egypt	700	800	800	28	20	19	0,04	0,11
Ethiopia	5	5	5	0	0	0	0,00	0,00
Algeria	380	417	500	21	22	25	0,01	0,07
Angola	40	40	40	6	6	6	0,01	0,01
Ivory Coast	..	..	10	..	..	1	-	0,00
Ghana	15	15	15	1	1	1	-	0,00
Cameroon	10	10	10	1	1	1	-	0,00
Kenya	10	10	10	1	1	1	-	0,00
Libya	20	20	20	7	7	7	-	0,00
Morocco	6	7	10	0	0	1	0,00	0,00
Mauritania	10	10	10	7	7	6	-	0,00
Mauritius	..	..	5	..	..	5	-	0,00
Mozambique	40	40	40	4	4	4	-	0,01
Nigeria	15	15	20	0	0	0	0,00	0,00
South Africa	7 905	8 875	9 050	285	314	314	0,80	1,27
Senegal	-	..	10	-	..	2	-	0,00
Zimbabwe §	500	500	650	74	74	96	0,06	0,09
Tanzania	..	..	5	..	..	0	-	0,00
Togo	-	-	5	-	-	2	-	0,00
Tunisia	195	200	200	31	32	31	0,02	0,03
Uganda	15	15	15	1	1	1	0,00	0,00
Zaire	30	30	30	1	1	1	-	0,00
AFRICA	9 896	11 009	11 460	22	24	24	0,94	1,61

Contd./-

Table 3-1 Country-wise Liquid Steel Production, Production Per Capita and Share in World Steel Production (cont'd)

Country	Annual production '000 tons 1978+	1979+	1980+	Production per capita kg# 1978+	1979+	1980+	Share in World production % 1970	1980
III. AMERICA								
Argentina	2 786	3 199	2 750	105	120	102	0,31	0,39
Brazil	12 107	13 893	15 300	105	117	125	0,90	2,14
Chile	597	657	740	55	60	67	0,10	0,10
Dominican Republic	3	4	5	0	0	0	-	0,00
Ecuador	4	8	10	0	1	1	-	0,00
El Salvador	30	38	35	7	9	8	-	0,00
Canada	14 898	16 078	15 880	635	679	663	1,88	2,23
Colombia	390	362	430	15	14	16	0,05	0,06
Cuba	331	350	350	31	36	35	0,02	0,05
Mexico	6 775	7 041	7 280	101	101	101	0,65	1,02
Peru	374	420	400	22	24	23	0,02	0,06
Puerto Rico	..	..	..	..	..	..	-	..
Uruguay	7	15	12	2	5	4	0,00	0,00
Venezuela	859	1 495	2 100	66	111	151	0,16	0,29
USA	127 170	126 530	103 160	579	573	464	20,49	14,46
Central America	27	48	45	2	3	3	0,00	0,01
AMERICA	166 358	170 138	148 497	282	284	244	24,58	20,81
IV. ASIA								
Bangla Desh	125	130	131	1	1	1	0,01	0,02
Burma	40	45	50	1	1	1	0,00	0,01
China, Taiwan	3 581	3 507	4 225	212	203	240	0,07	0,59
Communist China	31 780	34 430	34 000	37	35	34	2,63	4,76
Hong Kong	75	75	75	17	15	15	0,01	0,01
India	10 099	10 126	9 430	16	16	14	1,05	1,32
Indonesia	225	305	300	2	2	2	0,00	0,04
Iraq	100	59	100	8	5	7	-	0,01
Iran	570	500	300	16	14	8	-	0,04
Israel	94	107	110	25	28	28	0,01	0,02
Japan	102 105	111 748	111 410	889	964	954	15,66	15,61
Jordan	65	69	70	21	22	21	0,00	0,01
Oatar	127	396	400	632	1 932	1 905	-	0,06
North Korea	3 200	3 300	3 200	187	189	178	0,37	0,45
South Korea	4 969	7 610	8 605	126	202	225	0,08	1,21
Kuwait	..	116	150	..	91	118	-	0,02
Lebanon	60	60	30	20	20	10	0,00	0,00
Malaysia	203	207	200	16	16	15	0,02	0,03
Pakistan	..	..	10	..	..	0	-	0,00
Philippines	276	397	400	6	8	8	0,02	0,06
Saudi Arabia	..	45	100	..	6	12	-	0,01
Singapore	281	297	300	120	126	126	0,02	0,04
Syria	120	130	150	15	16	17	-	0,02
Thailand	346	440	450	8	10	10	0,03	0,06
Vietnam	6	6	10	0	0	0	0,00	0,00
Dubai, U.A.E.	46	113	150	55	134	176	-	0,02
ASIA	158 493	174 218	174 356	66	71	69	19,98	24,43
V. OCEANIA								
Australia	7 613	8 147	7 594	536	565	519	1,13	1,06
New Zealand	225	229	230	72	74	74	0,03	0,03
OCEANIA	7 838	8 376	7 824	353	377	350	1,16	1,09
TOTAL WORLD PRODUCTION	717 700	747 200	713 700	169	172	162	100,00	100,00

Note: # Per capita production computed taking into account total population
+ Partly estimated and preliminary figures as on 10.2.1981
* Excludes Soviet Union
§ Till recently 'Rhodesia'

Source: Statisches Bundesamt -- Außenstelle Düsseldorf economic development. Uruguay's overall objective of increasingly industrialising the economy would get a further fillip once the Valentine project is implemented.

Role of Steel

The iron and steel industry enjoys a high priority in the development plans of most countries, primarily because of the significant role of steel in their industrial development and economic growth.

The fact that a definite correlation exists between steel and economic growth is well known. Apart from this general correlation, the findings of a study conducted some years back in the USA, on the degree of interdependence of industries in Italy, Japan and the USA have shown that the iron and steel industry provided the maximum growth stimuli in relation to other industries which use its output as 2ell as to those industries from which it obtains its raw materials and services. The extent of this interlocking of iron and steel industry with other industries brings out the 'backward and forward linkage effects' of steel development on the rest of the economy.

Steel Consumption and G.N.P.

The correlation between steel and economic growth is well brought out by the ratio of per capia steel consumption to per capita GNP. This ratio or steel intensity as it is known, is derived by relating steel consumption to two macro-economic variables - CNP and population. It is, therefore, a fairly reliable indicator not only of the level of industrial development of a

3 - Market & Production Programme (cont'd)

country but also of the vital role played by steel in such development. The relationship between steel intensity and per capita income levels at various levels of income is shown in Fig. 3.1.

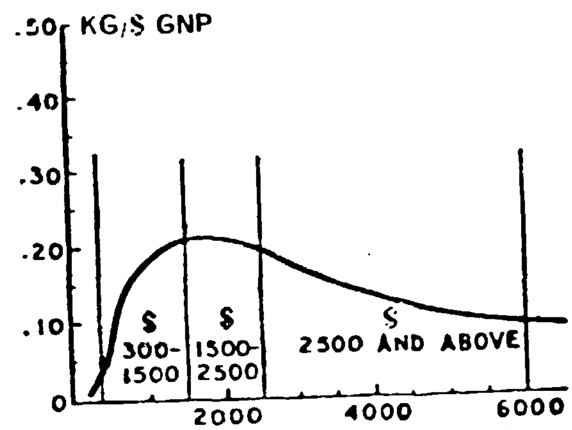


Fig.3.1

The steel intensity is high in advanced countries where steel and steel-based industries contribute in a large measure to the GNP. For example, in the USA, the steel intensity (expressed in terms of kilogrammes of steel consumed per $ 1.000 of GNP) reached a peak level of 300 in the 1920s. It declined in subsequent years to 215 in 1955 and was around 160 in 1970. In the highly industrialised European Community, the steel intensity reached its peak at 260 in 1969 and declined to 258 in 1970. In Japan, the steel intensity had gone up from 238 in 1955 to a peak level of 553 in 1967 and then started to taper off.

3 - Market & Production Programme (cont'd)

This only serves to emphasise the urgent need for rapid expansion of the steel capacity, which would in turn accelerate the growth of the various sectors of the economy. Fig. 3.2 also illustrates the comparative status of per capita consumption in some of the industrialised and developing countries.

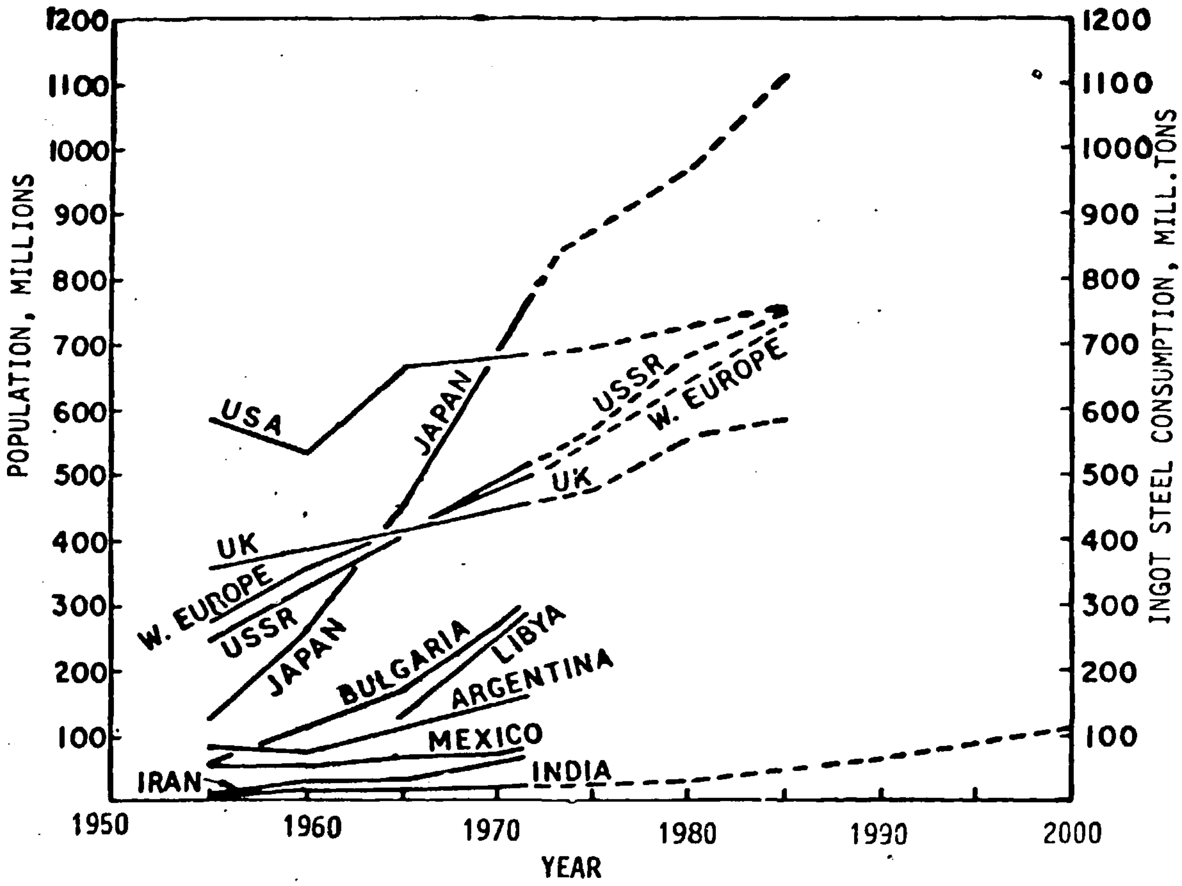


FIG.3.2 PER CAPITA STEEL CONSUMPTION, Kg.

3 - Market & Production Programme (cont'd)

Investment in Steel

The efforts of developing countries to establish steel industry are not motivated by prestige considerations alone, but the genuine conviction that assured supplies of steel constitute the surest base for rapid economic advance on all fronts including agriculture. Despite the grave doubts voiced in some quarters about the viability of steel plants for developing countries, both Latin American countries and India have successfully established their steel industries - even though some of them (such as Peru and Venezuela) lacked major raw material resources like coking coal.

In the economic circumstances prevailing today in most of the developing countries, the pace of development has necessarily to be accelerated. Therefore in determining investment priorities and allocation of resources, the choice should naturally fall on those industries which would not only generate income and create production capacity, but also set the pace for additional investment in future years. Obviously, investment in steel, heavy machinery and other basic industries (which are largely dependent on steel) provide a reliable foundation for rapid and sustained economic growth.

Steel - Pace Setter of Economic Growth

The dynamic aspects of steel industry as a pace-setter of economic growth need to be fully appreciated. Steel activity acts as a catalyst on the rest of the economy and a rapid growth rate in steel production brings about a faster increase in the growth rate of the gross domestic product than would otherwise normally

3 - Market & Production Programme (cont'd)

occur. Assured availability of steel sets in motion an entire chain of economic activities over a wide sector and provides the impetus for the establishment of processing and fabricating industries based on steel. This in turn widens the range of import substitution and export capability, leading to the generation of larger income and employment.

Unfortunately, the tendency in many developing countries is to instal new capacity only after shortages have developed. Moreoever, for economies eager to accelerate their growth by intensive planned effort, the tendency to wait for the demand to be created and shortages to be developed is not meaningful while planning their steel development. During the initial stages of rapid growth of steel industry, there may actually be short periods of excess capacity, as was the case in some of the advanced countries during the course of their industrial development. This is an inevitable phase in the growth process and should cause no alarm. It should not be [illegible]ed as set-back to the steel industry or the economy. As soon as indigenous steel capacity is created, the ready availability of steel stimulates the demand and therefore, additional steel capacity has to be created in anticipation of demand, as a basic strategy of economic development.

Employment Potential

The 'leverage' effect of steel development on the rest of the economy is also brought out by the employment potential generated by the entire chain of activities set in motion by the installation of steel plant. It is estimated that for every direct job in the steel plant, thirty or more jobs are created in other manufacturing industries based on steel as well as non-manufacturing industries like mining, transportation, construction etc.

Creation of Skills and Expertise

There is also a remarkable relationship between skill formation and economic growth. The iron and steel industry, which is essentially technology-oriented, promotes the creation of skills and expertise in the country.

The methodology which the Brazilian Consortium has attempted to extrapolate demand figures appears to be the right one considering the preliminary nature of the study. However, in DEI's view, considering the dynamic situation of Uruguayan economy, the forecasting has been done on a conservative basis for reasons which have been briefly explained in the foregoing paragraphs.

The Brazilian estimate of steel consumption from 1980 to 2000 AD both flats and non-flats corresponding to estimated population are given in Table 3.2.

3 - Market & Production Programme (cont'd)

TABLE 3-2 - PROJECTED CONSUMPTION OF STEEL IN URUGUAY BETWEEN 1980-2000

Year	Per Capita Consumption kg/year	Population	Consumption of steel t/yr Flat	Non-flat	Total
1980	50	2.912.000	58.240	87.360	145.600
1981	55	2.938.000	66.252	95.338	161.590
1982	60	2.965.000	74.780	103.182	177.900
1983	65	2.991.000	83.598	110.817	194.415
1984	70	3.018.000	92.954	118.306	211.260
1985	75	3.045.000	102.760	125.615	228.375
1986	80	3.073.000	113.086	132.754	245.840
1987	85	3.100.000	123.845	139.655	263.500
1988	90	3.128.000	135.130	146.390	281.520
1989	95	3.156.000	146.912	152.908	299.820
1990	100	3.185.000	159.250	159.250	318.500
1991	105	3.214.000	172.110	165.360	337.470
1992	110	3.243.000	185.500	171.230	356.730
1993	115	3.272.000	199.428	176.852	376.280
1994	120	3.301.000	213.905	182.215	396.120
1995	125	3.331.000	229.000	187.375	416.375
1996	130	3.361.000	244.681	192.249	436.930
1997	135	3.422.000	263.323	198.647	461.970
1998	140	3.452.000	280.302	202.978	483.280
1999	145	3.483.000	298.157	206.878	505.035
2000	150	3.515.000	316.350	210.900	527.250

It is believed that steel consumption will tend to increase much faster than visualised. However, in the interest of quick implementation of the project, a smaller capacity plant might be preferable which would also keep the risk factor to the minimum.

3 - Market & Production Programme (cont'd)

A more detailed analysis of the market requirements using suitable forecasting techniques, if desired by the Project Authorities, could be made. In this context, Appendix 3-1 gives an overall review of the various methodologies applicable for determination of steel demand.

PRODUCTION PROGRAMME

Based on the market estimation, the Brazilian study has established the production programme of the Valentine project. They have assumed starting of production in 1985 and the production build-up as follows:

1985 - 1st year of production - 60% of the plant capacity (66.000 T continuous cast billets)

1986 - 2nd year of production - 80% of the plant capacity (88.000 T continuous cast billets)

1987 - 3rd year of production - 100% of the plant capacity (110.000 T continuous cast billets)

For a plant to produce long products, it is normal and logical that it can achieve full production in three years from start-up. With good operating practices, the production in the first and second year could be higher than even the 60 and 80 per cent respectively visualised by the Brazilian Consortium. Any increased production that can be managed will improve the economics of the project.

The year-wise production programme of the Valentine Project as well as distribution of the rolled products are as follows:

3 - Market & Production Programme (cont'd)

a. First year production continuous cast billets - 66.000 T

Wire Rod size	Internal market tons	Export tons
6.5 mm	11.600	2.800
8.0 mm	8.700	2.100
10.0 mm	4.900	1.200
12.7 mm	3.800	900
Bars size		
6.5 mm	-	-
8.0 mm	-	-
10.0 mm	-	4.500
12.7 mm	-	4.500
Total:	29.000	16.000

Additionally 18.000 tons of continous cast billets will be supplied to internal market.

b. Second year production of continuous cast billets-88.000 T

Wire Rod size	Internal market tons	Export tons
6.5 mm	12.800	7.200
8.0 mm	9.000	5.400
10.0 mm	5.100	3.000
12.7 mm	3.900	2.400
Bars size		
6.5 mm	-	-
8.0 mm	-	-
10.0 mm	-	6.000
12.7 mm	-	6.000
Total:	30.000	30.000

Additionally 24.000 tons of continuous cast billets will be supplied to internal market.

3 - Market & Production Programme (cont'd)

c) Third year production of continuous cast billets-110.000 T

Wire Rod size	Internal market tons	Total tons
6.5 mm	12.800	11.200
8.0 mm	9.600	8.400
10.0 mm	5.400	4.800
12.7 mm	4.200	3.600
Bars size		
6.5 mm	-	-
8.0 mm	-	-
10.0 mm	-	7.500
12.7 mm	-	7.500
Total:	32.000	43.000

Additionally 30.000 tons of continuous cast billets will be supplied to internal market.

d) Fourth year production of continuous cast billets-110.000 T

Wire Rod size	Internal market tons	Total tons
6.5 mm	14.800	17.200
8.0 mm	11.100	12.900
10.0 mm	6.300	7.300
12.7 mm	4.800	5.600
Bars size		
6.5 mm	-	-
8.0 mm	-	-
10.0 mm	-	10.000
12.7 mm	-	10.000
Total:	37.000	63.000

3 - Market & Production Programme (cont'd)

With the implementation of the proposed Valentine project in such a way that the plant goes into operation in 1985, the expected demand and supply position in Uruguay for non-flat steel products during the periods 1980-1987 and 1988-2000 is summarised in Table 3.3 and Table 3.4 respectively.

TABLE 3-3
SUPPLY AND DEMAND
in '000 t

Between: 1980 and 1987

PRODUCT	1980			1[illegible] Year 1)			1986 (Year 2)			1987 (Year 3)		
	Demand	Supply		Demand	Supply		Demand	Supply		Demand	Supply	
		Existing Production	Valentine Project Production		Existing Production	Valentine Project Production		Existing Production	Valentine Project Production		Existing Production	Valentine Project Production
Billets	77	16	-	129	19	66	149	20	88	168	21	110
Wire Rods	20	-	-	29	-	36	30	-	48	32	-	60
Bars	45	45	-	65	[illegible]	9	68	50	12	72	52	15
Section	15	15	-	22	[illegible]	-	23	19	-	24	19	-
Others	7	7	-	10	8	-	11	8	-	12	9	-
Total Rolled Product	87	67	-	126	74	45	132	77	60	140	80	75

TABLE 3-4

SUPPLY AND DEMAND
in '000 t

Between: 1988 and 2000

PRODUCT	1988 (Year 4)			1989 (Year 5)			1990 (Year 6)			2000 (Year 16)		
	Demand	Supply		Demand	Supply		Demand	Supply		Demand	Supply	
		Existing Production	Valentine Project Production		Existing Production	Valentine Project Production		Existing Production	Valentine Project Production		Existing Production	Valentine Project Production
Billets	172	21	110	175	22	110	207	23	110	247	24	110
Wire Rods	34	-	80	35	-	80	37	-	80	49	-	80
Bars	75	54	20	79	56	20	82	58	20	109	82	20
Section	25	20	-	26	21	-	27	22	-	36	31	-
Others	12	9	-	13	9	-	13	10	-	17	14	-
Total # rolled product	146	83	100	153	86	100	159	90	100	211	127	100

Total figures relate to only rolled products and does not include intermediate products.

4 - EVALUATION OF PLANT FACILITIES

Valentine project is conceived for a production of 100.000 tons per year of rolled products. The facilities visualised are for

- Mining
- Concentration and Agglomeration of Iron Ore
- Charcoal Production
- Hot Metal Production in Charcoal Blast Furnace
- Steelmaking in Basic Oxygen Furnace
- Continuous Casting of Liquid Steel into Billets
- Rolling of Billets into Rods and Bars

DEI's evaluation is presented on each of the above facilities. Also, a write-up on proposed power system based on supply from outside source is included.

MINING

The Brazilian study together with supplementary clarification envisages an open-cast mining of the Valentine deposit with an annual production of 486.000 tons of run of mine ore on basis of 2 shifts/day and 300 days/year operation. Taking ore to waste ratio 1:0.6 the waste rock to be removed has been estimated at 292.000 tons/year making the total quantity to be mined 778.000 tons/year. The basis for estimating total mined ore is shown in Table 4.1.

TABLE 4-1 - ESTIMATION OF ANNUAL REQUIREMENT OF MINED ORE

		Tons/year
Hot metal requirement	..	120.000
Sinter requirement (grade 62.5% Fe)	..	185.300
Concentrate requirement (grade 65.5% Fe)	..	177.000
Ore requirement (grade 34% Fe)	..	486.000
Ore to waste ratio	..	1:0.6
Waste rock quantity	..	292.000
TOTAL MINING	::	778.000

4 - Evaluation of Plant Facilities (cont'd)

The above estimation of iron ore requirement and the needed mining tonnage is adequate based on the assumption of ore quality and degree of beneficiation etc as adopted in the Brazilian study. However, these assumed characteristics have to be further established both quantitatively and qualitatively by adequate tests which Brazilians have also recommended. However, the extent of mining requirement may not so vary that this would affect the project concept.

Considering the estimates of ore to waste ratio given by F. Huss in his report No. DP/UN/URU-74-014/2 for the three cerros for different levels, it is seen that the ratio of 1:0.6 assumed by the tenderer implies quarrying the iron ore to about 170 m. This indicates mineable reserves of more than 18 million tonnes lasting over 35 years at the rate of mining envisaged.

The mining equipment proposed in the Brazilian study for blasting, excavating, loading and transport is given below:

Proposed Mining Equipment

Equipment		Quantity
Drills, 100 mm dia, platform mounted	..	2
Compressors, 17 cu.m./min	..	2
Bulldozer, Cat. D8	..	2
Payloader, tyre-mounted, Cat.966	..	2
Dumper, 35 t	..	5
Motor grader, type E 14	..	1
Truck, 3 t	..	4
Pneumatic hammer, light duty	..	4
Grinder for drill bits	..	1

4 - Evaluation of Plant Facilities (cont'd)

In general, the proposed equipment and personnel requirement is considered adequate. Also, explosive consumption estimated at 110 g/ton of on ore appears in order. However, following modifications are suggested for excavation and loading equipment to improve performance.

The caterpillar 966 tyre-mounted front-end loader recommended for loading the primary blasted rock into 35 t dumpers has a dumping clearance of 3 meters which may hinder loading of dumpers on level ground. Consequently, slots would have to be dug in the ground in which dumper trucks can back-up for loading or small ramps should be constantly made from which the loader would get adequate working height. It is suggested that the two front-end loaders be replaced by two 1.9 cu.m. bucket-capacity hydraulic shovels.

Though all equipment proposed have not been mentioned it is presumed that an explosion van and water tanker-sprinkler needed for the mining operation are also included.

CONCENTRATION AND AGGLOMERATION OF IRON ORE

The iron ore quality for blast furnace use is improved by agglomeration, sizing and blending to achieve consistency and desired standards of physical and chemical characteristics. The average Fe content of ores used in blast furnaces is estimated to have moved up by 10 per cent during 1955-1976 period due to development of high quality ore mines and improved beneficiation and concentration technologies. On a global basis the role of lump ores in ironmaking by blast furnace has declined precipitously whereas that of sinters and pellets has increased steadily as may be seen from Table 4-2.

4 - Evaluation of Plant Facilities (cont'd)

TABLE 4-2 - CHANGING PATTERN OF IRON ORE CONSUMPTION IN THE WORLD - 1955-1976

Iron Ore	Unit	1955	1960	1965	1970	1976
Average Fe content	Per cent	47	49	52	56	57
Production	million tons	378	512	624	768	877
Use as:						
Lump ores	million tons (per cent)	309 (77)	319 (63)	298 (48)	273 (35)	237 (27)
Sinter fines	-do-	92 (23)	171 (34)	281 (45)	381 (50)	455 (53)
Pellet feed	-do-	2 (0)	16 (3)	47 (7)	118 (15)	167 (20)

Closer sizing of the ore and screening out the fines before charging into the furnace significantly improves the blast furnace productivity and reduces coke consumption. In Japan, for instance, the lump ore is sized to 8 to 25 mm for use in large blast furnaces to ensure best performance. The fines are screened out at the blast furnace plate itself so that the -5 mm fraction going into the furnace is less than 2 per cent.

Proportions of sinter and pellet in the feed are determined by various considerations such as optimisation of the furnace productivity, characteristics of available ore and utilisation of waste materials in the steel plant. The cold state strength of (acid) pellets is superior to that of sintered ore. Sintered ore has better high temperature strength (or better melting characteristics) and wider range of chemical composition adjustment. Development of self-fluxed and super-fluxed sinters has made the use of sinter quite attractive. Using sinter leads to improved productivity of blast furnaces, savings in coke consumption, reduction in the dust loss and smoother smelting operation. Sintering also enables use of lower grade iron ores after beneficiation, ores containing sulphur and arsenic as well as various plant wastes such as coke breeze, mill scale, limestone/dolomite fines, lime fines and flue dust which would otherwise have to be dumped and would add to the operating costs.

By virtue of their size uniformity, high strength and uniform micro-porosity which ensure good gas permeability and reducibility, use of pellets reduces coke consumption rate, increases output and improves operation of blast furnaces like sinter. However, considering Valentine project parameters and raw material characteristic and also from the consideration of investment and production cost, it is considered that use of sinter as suggested in Brazilian offer is preferable. Also, in case pellet is used in the blast furnace it will be necessary to charge about 15% of high grade lump ore which would need to be imported in case of Valentine project. Blast furnaces are also operated with mixed feed of pellet and sinter but the required low tonnage of agglomerates does not justify installation of both pelletising and sintering facilities. In view of the above considerations adoption of the pelletising route is considered unadvisable.

<u>Concentration</u>

<u>1. Sinter-grade concentrate</u>

The tenderer has envisaged a beneficiation plant to treat 486.000 tons/year iron ore of about 34% Fe to produce 177.000 tons/year concentrate of about 65.5% Fe. In the proposed flow-sheet about 750 mm run-of-mine ore would be reduced in size by jaw and cone crushers, rod milling in 3 stages and subsequent screening at 150 microns.

4 - Evaluation of Plant Facilities (cont'd)

Finally the two size fractions undergo separately a 2-stage wet magnetic separation on drums. As the final equipment is proposed to be specified after semi-industrial scale tests on actual representative samples, the present flow sheet is considered only conceptual and is commented upon accordingly.

Crushing: Equipment proposed for primary crushing is conventional and in order. As regards secondary crushing, the proposed cone crusher is adequate. However, the purpose of removing minus 50 mm material from 0-100 mm feed is not clear as this would introduce partly minus 50 mm material into the feed of first rod-mill which is undesirable. It is thus suggested that the vibrating screen prior to cone crusher should scalp out the undersize equal to the product size of cone crusher.

Grinding: This section consists of two 70 t/hr 60/75 HP rod mills discharging on to two 1200 x 2400 mm wet vibrating screens of 6 mm opening. Plus 6 mm fraction is further ground in one 2400 x 3600 mm 70 t/hr, 350 HP central peripheral discharge rod mill operating in closed circuit with above-mentioned screens. Minus 6 mm fraction is wet screened at 1 mm with undersize going directly to micro-screen of 150 microns. Plus 1 mm material is further milled in one 2400 x 3600 mm 70 t/hr, 350 HP central peripheral discharge rod mill and screened at 150 microns.

As the main objective in grinding is to have a coarse feed for magnetic separation and essentially limit the minus 150 microns fines to as low a figure as possible, rod mills are the obvious choice. It is however felt that grinding circuit could be simplified to a 2-stage rod milling without detrimental effects.

Magnetic separation: The plus and minus 150 micron fractions are proposed to be subjected separately to a two-stage low intensity wet magnetic separation to produce final concentrate of 65.5% Fe with 70% iron recovery.

This conclusion had been reached on the basis of earlier tests conducted by CVRD (May-September 1977), Lurgi and Vöest Alpine. The tenderer however does not consider results of a later test conducted by CVRD (end-1980) as relevant on grounds that the two samples, magnetite ore of 38.5% Fe and haematite ore of 24.03% Fe, were not truly representative. In this latter test, from magnetite sample, a concentrate of only 61.83% Fe was obtained whereas the Fe content of haematite ore concentrate was 59.83%. Since a complete report on this test work has not been made available to DEI, it appears that the tenderer considers the test work incomplete and hopes to improve the concentrate grade to 65.5% Fe with 70% iron recovery which constitutes the basis for estimating the quantities of ore, concentrate and sinter. DEI is of the opinion that it is imperative to confirm this basic fact through extensive bench-scale and industrial tests before finalisation of the project.

2. Alternative concept: Pelletising-grade Concentrate

As an alternative to sintering, the tenderer has also given consideration in a supplementary note to the eventual possibility of preparing a pellet feed. The bench-scale beneficiation tests by wet magnetic separation on fine grinds conducted by Lurgi and CVRD show the possibility of obtaining high grade concentrate of 67-68.9% Fe. The Fe recovery depends upon the proportions of magnetite and martite. With low martite, recoveries of 95-96% have been reported, whilst for more oxidised samples recoveries were 7 to 15% lower. Both Lurgi and Vöest Alpine have also established the feasibility of producing acceptable grade pellets from these concentrates. However, as discussed before use of pellets is not recommended.

Agglomeration

To economise on investment for agglomeration plant and to keep operating cost low, the Brazilian Consortium has chosen to concentrate the Valentine iron ore by wet magnetic separation at a coarse size so that sintering can be employed. Results of CVRD's recent tests, which may be considered indicative, reveal the following size analysis for the two concentrates:

	Weight per cent	
	+4 mm	-0.149 mm
Haematite concentrate ..	0.07	10.93
Magnetite concentrate ..	1.40	20.12

Results also show that by careful mixing and rolling to induce micro-pelletisation, good quality fluxed sinter (CaO/SiO_2 = 0.8) could be produced at specific productivities of 33 to 39 t/sq.m/24 hr with 14% to 16% limestone and 11% to 14% charcoal addition.

A sinter machine of 20 sq.m. grate area for sintering and 14 sq.m. area for cooling has been suggested on the basis of specific productivity of 30 t/sq.m/24 hr. As detailed information on the various items of sintering equipment has not been furnished in the offer and the final concentrate quality yet to be firmly established, DEI can comment only generally as follows:

4 - Evaluation of Plant Facilities (cont'd)

- CVRD tests indicate that in spite of finer-than-optimum granulometry of the concentrate, acceptable quality of sinter could be produced. Realistic projections for the raw material input to sintering and the final sintering parameters will need to be established through semi-industrial scale tests on representative concentrate samples.
- The grate and cooling area provided in the offer are adequate for the envisaged sinter production of 185.300 tons per year.

CHARCOAL PRODUCTION

This part of the study was prepared by Florestal Acesita S.A. of Brazil and submitted as Annex II of the feasibility study.

The study estimates annual charcoal requirement at 300.000 cu.m. per year at the rate of 3 cu.m. charcoal per ton of hot metal, assuming annual hot metal production of 100.000 tons. Taking conversion factor of 2 steres of wood per cu.m. of charcoal, 600.000 steres of wood is estimated to be annually required for 100.000 tons per year of hot metal. After due consideration of factors such as intensity of land exploitation, accelerating tree growth by using fertilisers, cycle time, distances of transport as well as the use of existing Eucalyptus trees spread in various areas of the country, it has been suggested that the Valentine project should aim at having their own plantation to satisfy 50 per cent of their needs and buy the balance 50 per cent from private entrepreneurs.

4 - Evaluation of Plant Facilities (cont'd)

Charcoal from private sources

After a survey of the Uruguayan forests, the Brazilian Consortium has found that there are thousands of massive Eucalyptus trees existing in various parts of the country which are more than 30 years old. These older trees could yield annually about 400 steres per hectare while stands of younger trees would yield 50 to 60 steres per hectare. Since these Eucalyptus trees are dispersed over a very large area the feasibility report recommends that the best solution would be to encourage charcoalmaking activity by giving special incentive to ranchers and the other local people - to teach them forestry technology and the art of charcoal-making and to buy the charcoal they produce for the Valentine project. This scenario suggests that once the local people realise the attractive business possibilities based on this activity, many more people could be persuaded to undertake this as their side profession, in addition to their usual vocation of agriculture or cattle-breeding. They would carry out re-forestation or planting of suitable Eucalyptus trees on that part of their land which is not particularly useful/wanted for agriculture or cattle-breeding purposes. The study estimates that around 4150 hectares of land would be needed for such activity so that the estimated 50 per cent of the project need could be met this way. The charcoal production is recommended to be carried out in small kilns of 3.2 m dia. - a capacity of 12 steres fire wood per charge.

4 - Evaluation of Plant Facilities (cont'd)

Charcoal from own plantation

Forestry

To realise optimum plantation growth, the study recommends appropriate choice of (a) seeds best suited to Uruguayan soil and climate and (b) plantation areas close to project site. Tree propogation by staking method is recommended as it is most suitable for mass production at low cost. As regards fertilisers, recent Brazilian experiments indicate that addition of lime to NPK fertiliser improves yield of Eucalyptus trees by 10% whilst use of natural phosphates improves yield by about 20%. The fertiliser requirement has been estimated at 334 kg/ha. With respect to tree spacing, placement in rectangles of 3 m x 1 m is recommended as against conventional spacing of 3 m x 2 m. The cycle time taken for design purposes is five years and the trees are assumed to have a 20-year life. Total area required for plantation has been estimated to be 10.000 hectares on the basis of 36 stere wood per hectare per year. This is proposed to be achieved by planting 2000 ha per year for five years. It has been recommended that trees suitable for low temperature should be selected for planting in nurseries as frost occurs 30 days in a year and the best time for planting is recommended to be end-August to mid-October.

Charcoal Production

Charcoal making is envisaged in a CENSUS surface type kiln of 5 m dia. and 36 cu.m. useful volume. The expected charcoal production from such a kiln is about 60 cu.m./month. Thus number of kilns for annual production of 150.000 cu.m. charcoal would be 209.

4 - Evaluation of Plant Facilities (cont'd)

Adding 10 per cent safety margin, 230 kilns or 23 batteries of 10 kilns each is recommended. For kiln-charging and unloading of charcoal two payloaders (capacity 50 cu.m. per hour each) are envisaged.

Cost Estimation

Investment cost: For kilns, substructures, payloaders, chemical laboratory etc an investment of US $ 563.625 has been foreseen.

Personnel: A total staff of 96 at US $ 25.373,76 per month has been estimated.

Cost of charcoal: The cost of charcoal has been calculated as detailed below:

Item	US $ per cu.m.
a) Direct cost	16,38
b) 100 km transport	1,61
c) Admin. plus others 15% of (a) and (b)	2,79
d) Profit 15%	3,11
	23,89

Break-down of Direct Cost is as follows:

Item	US $ per cu.m.
Firewood	2,84
Forest exploitation	10,84
Carbonisation	2,70
	16,38

Intermediate depot requirement has been calculated at 2500 cu.m. capacity for which investment will be US $ 5,125,-

4 - Evaluation of Plant Facilities (cont'd)

Transport: The cost estimated for 100 km is US $ 1,61. One truck can make two trips and the number of trucks will vary between 10 and 13 depending upon the capacity of vehicle used that is either 40 cu.m. or 55 cu.m. or 80 cu.m.

The central administration office will have 26 staff.

Sectoral offices: The Brazilian study suggested that there should be one for every 2000 hectare planted. That is, 5 in all and total staff in the third year of operation should be around 85. Also that there should be as many purchase sectoral offices as necessary with 5 staff in each.

Investment: Rent for land at 2% per year - total for 26 years (5 of plantation and 21 of exploitation) is US $ 2,2 million. The investment on plantation is estimated to be US $ 8,5 million in 26 years.

The total forestry and carbonisation activity proposed in the tender is reproduced in page 4-14.

Comments:

1. Charcoal requirement for the project has been estimated at the rate of 3 cu.m. per ton of hot metal. Considering that 10 per cent fines are produced during screening the above-mentioned rate is considered adequate. The conversion factors of 2 steres wood per cu.m. charcoal and an annual forest yield of 36 steres per hectare also appear satisfactory.

2. In order to reduce the investment for the project, the feasibility study has suggested the formation of a forestry subsidiary which

4 - Evaluation of Plant Facilities (cont'd)

		CHARCOAL				FIREWOOD		
Year	Pig iron tons	Consumption cu.m.	Own Production § cu.m.	Private Entrepreneur cu.m.	Stock Build-up cu.m.	Consumption cu.m.	Existing Woods Production cu.m.	New Woods Production cu.m.
-3	0	0	0	20.000	20.000	28.000	28.000	-
-2	0	0	0	90.000	110.000	126.000	126.000	-
-1	0	0	0	120.000	230.000	168.000	168.000	-
1	50.000	150.000	0	140.000	220.000	196.000	196.000	-
2	70.000	210.000	0	150.000	160.000	210.000	210.000	-
3	90.000	270.000	0	150.000	40.000	210.000	210.000	-
4	100.000	300.000	150.000	150.000	40.000	420.000	210.000	210.000

§ Considering a gross consumption of 3 cu.m. of coal per ton of pig iron

4 - Evaluation of Plant Facilities (cont'd)

will produce 150.000 cu.m. per year of charcoal from its own plantation and purchase the balance demand of 150.000 cu.m. charcoal per year from private sources. This scenario visualises popularising forestry and charcoal making activities among the rural population by making it financially attractive as a side-business. Sales profit which could accrue to private entrepreneur has been estimated at about 15 per cent.

As charcoal is an essential raw material for iron ore reduction and the success of the project depends upon its timely and regular availability, an early start of this activity is to be recommended.

3. The forestry subsidiary that is proposed to be formed will pay a rent of 2 per cent on the land to be used for plantations. Total land area required has been calculated as 10.000 hectares and the plantation scheme foresees 2.000 hectares being planted every year for a period of five years. At a land cost of US $ 500 per hectare, it will require an investment of US $ 5.000.000 over five years to purchase the land and this is not shown in the requirements of capital for the project.

4. Hot metal production for the project at full capacity has to be 120.000 tpy and not 100.000 tpy as assumed in the charcoal study. The production build-up is also assumed on the basis of 100.000 tpy of hot metal should be revised for a production of 120.000 tpy as visualised in the Brazilian study for the Valentine project.

4 - Evaluation of Plant Facilities (cont'd)

Also production build-up in the study is given as 60%, 80% and 100% respectively in the first, second and third year of operation. This is based on production of concast billet and hence corresponding hot metal production will be 69.000, 92.000 and 120.000 tons. In 120.000 tons of production there will be 5.000 tons of pig iron for sale. Hence requirement of forestation area as well as charcoal production together with storing of charcoal for three years prior to commencement of plant operation have to be re-established.

It is to be noted that actual charcoal consumption in Blast Furnace will be 2.5 cu.m. per ton of hot metal. Assumption of 3 cu.m. charcoal per ton of hot metal in determining the production capacity of charcoal is appropriate considering 10% fines and other losses.

Investment in purchase of land, forestry and charcoal making facilities will also increase in the same proportion.

The purchase price assumed has taken into account all expenses, including financing costs, return on investment etc for charcoal production. The Brazilian concept of charcoal s ,ply to Valentine project visualises this operation being carried on under a separate entity.

HOT METAL PRODUCTION IN CHARCOAL BLAST FURNACE

The Valentine project visualises maximum utilisation of indigenous raw mater:als to justify installation of steel capacity in the country. The proposed plant concept is based on 100 per cent use of local iron ore concentrated and agglomerated to a high Fe-content sinter and charcoal.

As there is no known reserve of coking coal in Uruguay, blast furnace operation using coke as a reductant is not a feasible proposition. The direct reduction - arc furnace route though attractive for a small scale operation is also not feasible in Uruguayan context in view of non-availability of suitable reductants such as gas or fossil coal and low cost electric power for subsequent steelmaking. For similar reasons, iron-making by electric smelting process is not advisable and practical as the power requirement for such a process is quite sizeable - about 2400 kWh/ton of hot metal. In view of the above-mentioned reasons, the hot metal production in charcoal blast furnace as advocated in the Brazilian study, appears to be the most suitable option.

Argentina, Brazil and Malaysia have operating blast furnaces based on charcoal derived from their extensive forest resources. Brazil, leading in this mode of hot metal production, has produced about 4.4 MT pig iron in 1979 from 134 blast furnaces. Production of hot metal through charcoal was considered uneconomical and cumbersome since recently in view of its requirement of huge forested area as well as manpower compared to the conventional coke-based blast furnaces. However, the rise of fossil fuel prices has changed the economics and Brazil alone is thinking of producing about 10 MT pig iron in 1990 by use of charcoal. Other parameters which have made charcoal-based production attractive are improved production methods of charcoal, improved forestation and better utilisation of by-product.

4 - Evaluation of Plant Facilities (cont'd)

However, hot metal production by use of charcoal could only be limited to those countries which have suitable climate for the growth of woods, availability of land in abundance and also shortage of or no supply of metallurgical coke. In countries, where metallurgical coke is available, there have been no or very limited growth of charcoal-based blast furnaces for production of pig iron. Recently Paraguay is also going for steel production through 2 charcoal blast furnaces, steelmaking in two 15-ton BOF vessels, continuous casting and rolling. This production process route is also similar to that proposed by the Brazilian Consortium.

The reduction process using charcoal in the blast furnace is similar to that of operation with coke from metallurgical coal. However, design of the blast furnace requires special consideration to suit the chemical and physical characteristics of the charcoal.

Suitability of offered equipment

The feasibility study envisages 120.000 tons per year of hot metal in a blast furnace of 4.4 m hearth diameter and a working volume of 262 cu.m. The major operating parameters considered in the study are shown below:

Hot metal production, annual	..	120.000 tons
Hot metal production, daily	..	350 tons nominal
Hot blast temperature	..	1100°C
Productivity index	..	1.3 tons/day/cu.m.
Raw material consumption:		
Sinter	..	1.54 tons/ton hot metal
Charcoal	..	2.50 cu.m./ton hot metal

4 - Evaluation of Plant Facilities (cont'd)

The study has considered, in accordance with modern blast furnace operating trends, use of a well prepared burden of hundred per cent fluxed sinter and a hot blast temperature of 1100°C. From this viewpoint the charcoal consumption rate and productivity index mentioned above are considered appropriate. In practice, improvement can be expected both in reduced consumption of charcoal and increase in specific productivity rate.

The main ancillary equipment mentioned along with the blast furnace supply are

- one turbo-blower of 25.000 N cu.m./hr capacity and one identical blower as standby
- two Cowper-stoves each with 6.555 sq.m. heating surface
- charging system with skip hoists and two-bell distribution system
- stock house
- gas cleaning plant
- pig casting machine

The above mentioned faciliteis are considered adequate for the proposed blast furnace. However, following observations are made:

a. Humidity of the blast plays a significant role towards stable blast furnace operation and fluctuations in humidity can adversely affect thermal stability of the furnace. It would, therefore, be necessary to check the level of humidity considered in the blast as design basis and the facilities envisaged for achieving a stable humidity.

4 - Evaluation of Plant Facilities (cont'd)

b. For achieving a straight line hot blast temperature of 1100°C, the Cowper-stove dome needs to be heated to about 1350°C. For this purpose, the blast furnace gas of calorific value 940 k.cal/N cu.m. for combustion is considered inadequate.

c. It would be desirable to screen the sinter prior to charging in the skip, to eliminate fines from the blast furnace feed. It is not clear whether the arrangement for screening the sinter is provided.

d. There is no mention as to the cooling system to be adopted.

e. As the Brazilian offer covers the supply of blast furnace with all auxiliary facilities, it is presumed that following items which are considered essential to maintain uninterrupted material flow as well as a trouble-free plant operation are also included:

- storage facility for granulated slag
- dry slag handling equipment
- facilities for dust removal at blast furnace stock house
- facilities for preparation of runner and tap hole mass
- facilities for repair of hot metal ladles
- facilities for pig-iron storage

4 - Evaluation of Plant Facilities (cont'd)

f. There are blast furnaces in operation with two Cowpers and similarly two Cowper-stoves have been included by the Brazilian Consortium. However, it is felt a third Cowper as standby should be included from the beginning.

g. Only 5.000 tons/yr of pig iron production has been considered for the Valentine project. Further, the proposed pig casting machine will have a capacity of 200 tons/day. It must be investigated whether hot metal can be cast on sand bed and broken into pieces after solidification for supply to local foundries. Thus, it is felt the pig casting machine could be eliminated with the resultant saving in investment requirement. If found necessary, the pig casting machine could be added at a later date.

The overall layout specifies location of the blast furances with respect to incoming materials, sinter as well as charcoal and also outgoing hot metal, slag etc. However, the layout needs to be finalised keeping in view the site location, roads, railway track connections and compatibility of existing terrain conditions. The layout presented in the feasibility study can, therefore, be considered as only indicative.

STEELMAKING IN BASIC OXYGEN FURNACE

The steelmelt shop facilities have been planned for a nominal production of 115.000 tons of liquid steel per year. The shop will be operated for 330 days in a year producing about 24 heats per day of 15 tons liquid steel per heat.

4 - Evaluation of Plant Facilities (cont'd)

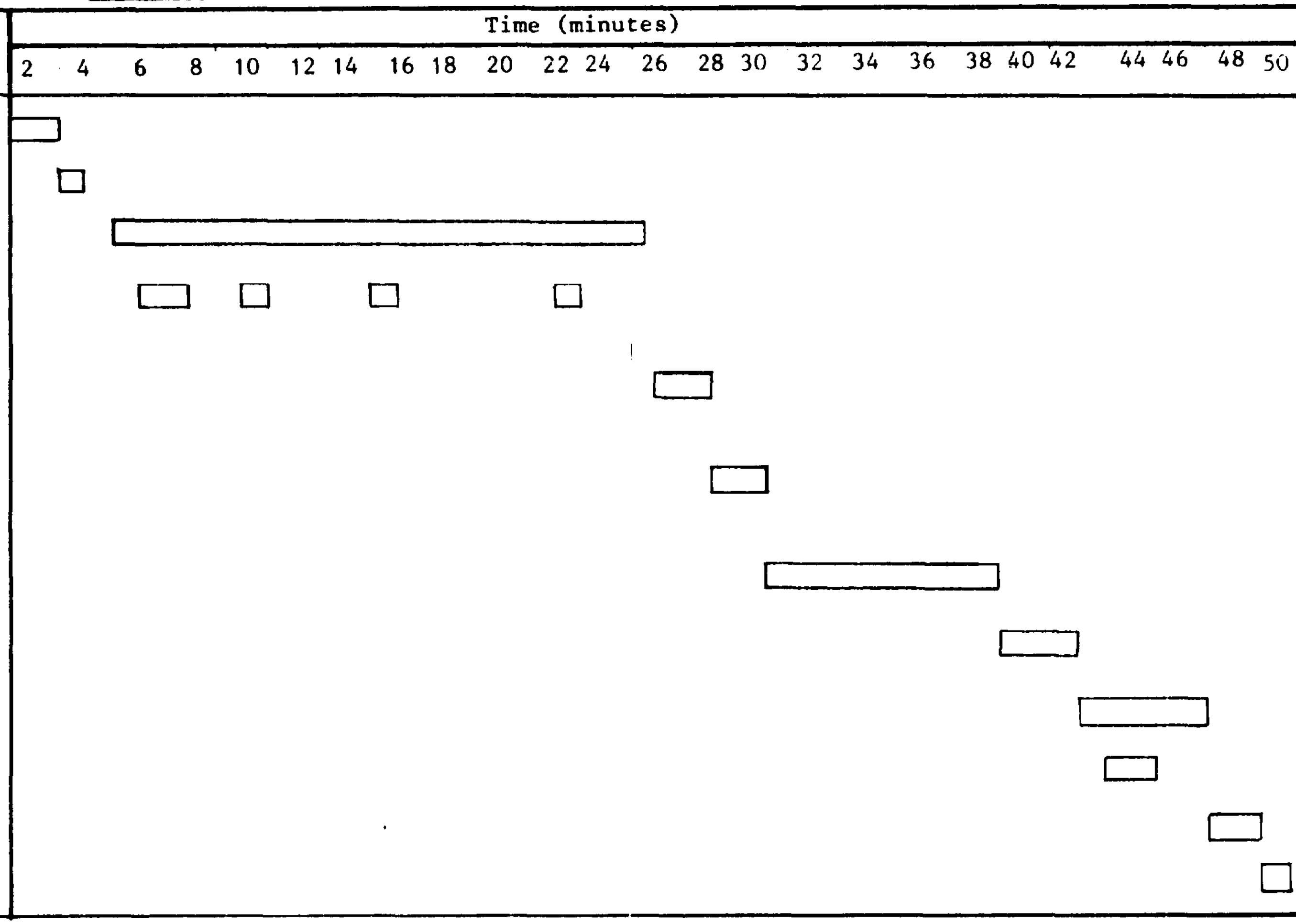
Considering the availability of 342 tons of hot metal per day from the blast furnace, that is an annual production of 120.000 tons based on 350 day operation per year it is likely that about 340 tons of liquid steel could be produced per day. This is equivalent to about 22.7 heats per day of 15 ton heat size. Therefore, for meeting the production programme of 115.000 tons of liquid steel per year, the converter shop may have to be operated for about 338 days in a year.

The design basis envisaged in the Brazilian study provides for operation of the converter shop for 330 days in a year. The steelmelt shop, however, could be operated for more than 330 days in view of the installation of two converters out of which one will be operating at a time. Therefore, the annual production programme of 115.000 ton liquid steel could be met with the 15-ton converter capacity. Moreover, the proposed production of 120.000 tons per year of hot metal and supply of hot metal to BOF through a 400-ton mixer will ensure necessary flexibility in planning and achieving the required production capacity.

Average heat cycle for a 15-ton BOF vessel i.e. tap-to-tap time is about 50 minutes as shown in Table 4.3. On this basis maximum capacity of the BOF shop with two vessels (one operating) will be about 28.8 heats per day or production of 432 tons of liquid steel per day. Considering at least 330 days of operation per year the shop will be able to produce 142.000 tons of liquid steel. This higher production will require adequate supply of oxygen,other additives etc.

TABLE 4.3-HEAT CYCLE FOR BOF OPERATION

S.No.	Operation
1	Scrap charging
2	Hot metal charging
3	Oxygen blow
4	Flux addition
5	Turndown vessel, temperature measurement, turn-up and limestone addition
6	Turn up vessel, add limestone, rock vessel for limestone mixing
7	Turndown, temperature, measurement, Analysis results
8	Alloy addition, turn up vessel and reblow
9	Tapping
10	Alloy addition to ladle
11	Vessel turnover and slag-off
12	Make ready for next charge



Notes: 1. Average heat cycle of 50 minutes based on standard operating practice

2. Time gap between operations 2 and 3 is for turning the vessel and lowering of oxygen lane

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Charge Pattern

Yield from metallic to liquid steel from converters may be based at about 90 per cent. The use of iron ore as coolant may be avoided as good quality iron ore is not available in the country and needs to be imported. The use of plant return scrap and limestone to some extent will be adequate for meeting the coolant requirement of the LD heats.

Layout

The steelmelt shop building comprises of three aisles. The charging aisle, converter aisle and casting aisle are parallel and extend to billet discharge/billet storage and the rolling mill aisles which are at right angles to the BOF-shop aisles. The comments on the layout are as follows:

Charging aisle: The location of the converters, hot metal mixer and other accessories is appropriate. The crane capacities indicated are adequate; however, the crane rail height needs to be finalised at the detailed engineering stage. The scrap storage area provided in the charging aisle appears to be insufficient. It is suggested that storage space for scrap of about 3 days consumption should be provided. The space available in the charging aisle is adequate and additional storage faciliteis could be provided by reorienting the facilities.

As regards slag handling, the pots will be handled by the mobile carrier from outside the charging aisle and this arrangement is suitable.

Converter aisle: It is noted that the converter aisle is about 72 m long and 10 m wide between the column centres. Two 15-ton BOF vessels, flux storage bunkers, BOF gas stack, oxygen lance system etc will be installed in this aisle. It is noted that fluxes in bottom discharge type containers will be lifted by under-slung crane from the ground level up to about 28 m level for filling up the overhead flux bunkers. Under-slung crane has to be selected keeping in view the duty requirement, height of the lift and the method of operation. The under-slung crane location and the location of buckets for fluxes will have to be checked. Each converter has been provided with an independent set of bunkers and flux charging system.

The location of maintenance room at the basement and the office room at the first floor is convenient. However, location of shop laboratory for bath sample and pit sample analysis is being suggested in the second floor by relocating the electrical room outside the building. One freight elevator for serving various platforms in the building will have to be provided. The overall dimensions of the converter aisle and the disposition of the equipment in general are acceptable.

Casting aisle: This aisle located between A and B row appears to be inadequate. Ladle and tundish relining facilities have not been properly placed and working in this area will be quite unsafe. Ladle nozzle setting stands are located beyond the reach of the crane. All these facilities need to be suitably located. For ingot casting, bottom pouring practice has to be adopted for casting small ingots. Area for ingot casting and the facilities considered will have to be re-examined keeping in view the process steps involved in bottom pouring. Otherwise adequate continuous casting capacity is to be provided for eliminating emergency ingot casting. This is also advisable from the consideration that the Valentine project will not have any facility to roll ingots.

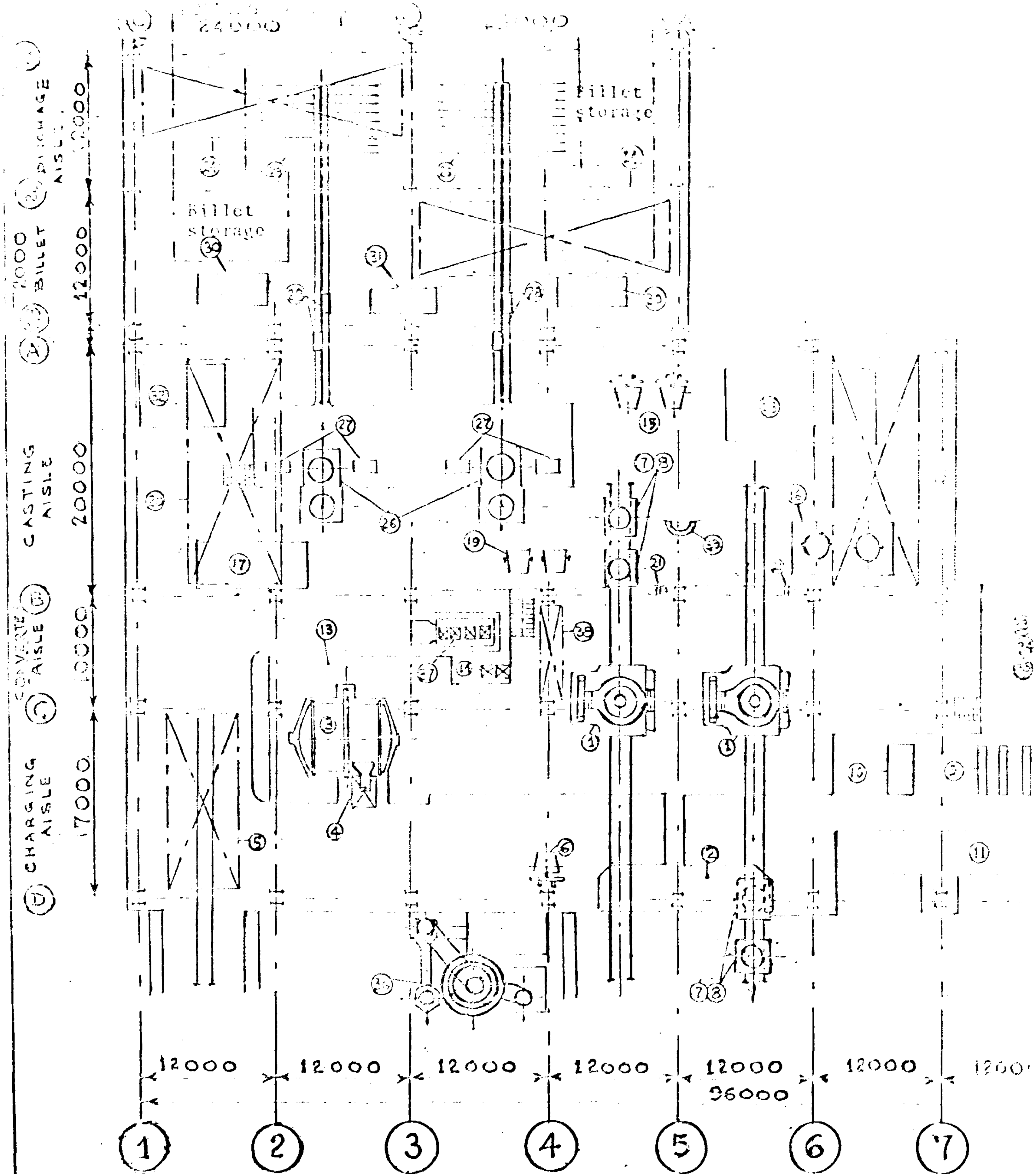
A proposed tentative layout is shown in Fig. 4-1 indicating rearranged major equipment and facilities of the steelmelt shop including two 2-strand billet casters.

Major Equipment

The equipment and facilities considered for installation have not been described in detail; as such meaningful comments on their completeness is not possible. However, some of the comments on major equipment are as follows:

Mixer: The type and size of hot metal mixer considered for installation is adequate and acceptable. Fuel oil shall be used for heating the mixer. Magnesite, alumina and heat insulating refractory bricks shall be used in the mixer lining. Mixer instrumentation and controls as per ISA standard is acceptable. Hot metal shall be weighed on a platform scale located adjacent to mixer or by weighing device mounted on charging crane.

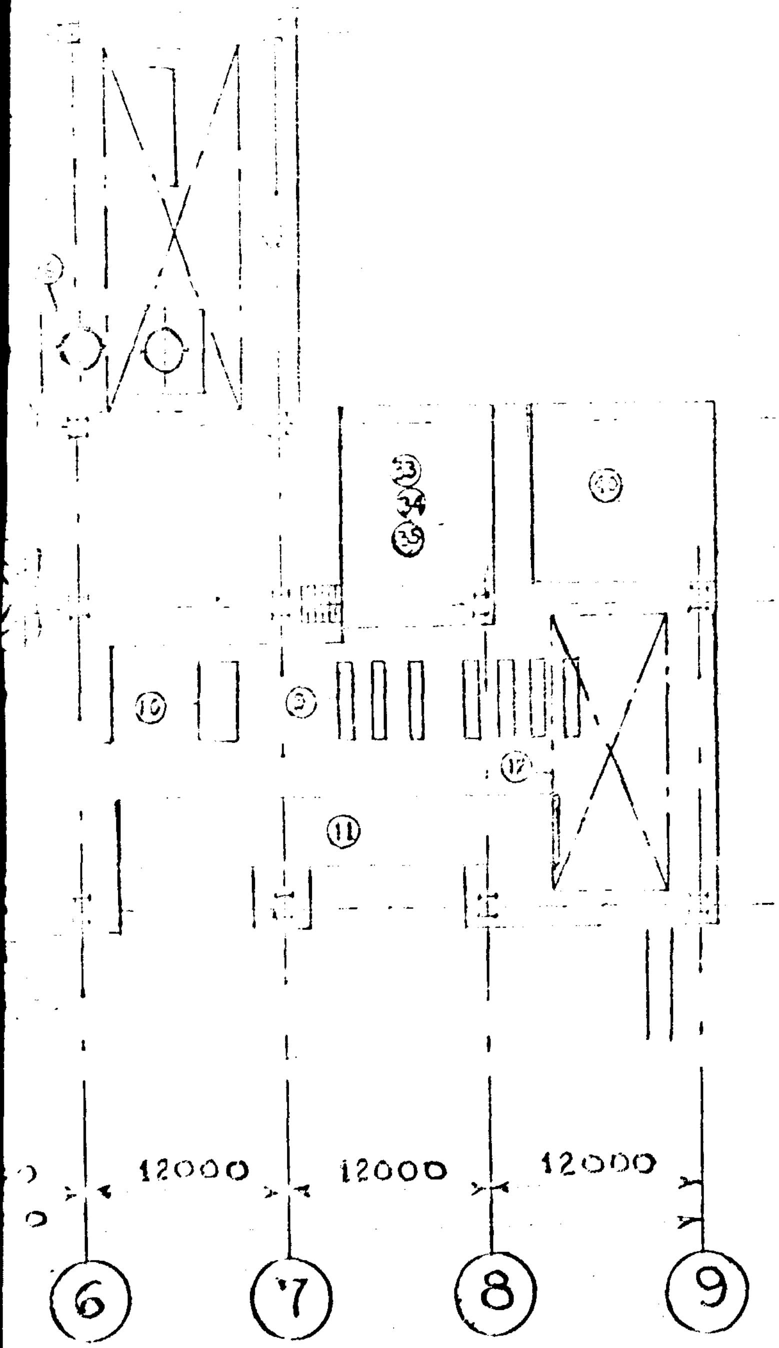
Converter: The specific volume of the newly relined converter shall be about 1 cu.m./ton of liquid steel. The converter shall be provided with separate trunnion ring and of welded construction for easy replacement of trunnion ring or converter shell as and when required. The converter shall be equipped with



24000
Billet storage
Billet storage
(D) CHARGING AISLE 17000
(C) CONVERTER AISLE 10000
(B) CASTING AISLE 20000
(A) BILLET 12000
DISCHARGE AISLE 12000
12000
12000
12000
12000
12000
12000
96000
1
2
3
4
5
6
7

SECTION 1

1. [illegible]
2. [illegible] ROOM (STEELMAKING)
3. HOT [illegible] MIXER
4. MIXER [illegible] BRIDGE
5. [illegible]
6. [illegible]
7. [illegible] CAR FOR STEEL LADLE
8. [illegible] CAR FOR SLAG POT
9. SCRAP BAY
10. SCRAP [illegible] BRIDGE
11. SCRAP [illegible] AREA
12. [illegible] SCRAP HANDLING
13. [illegible]
14. [illegible] BINS
15. [illegible]
16. [illegible] AREA
17. [illegible] STORAGE
18. AREA [illegible] TUNDISH PREPARATION
19. [illegible] NOZZLE SETTING
20. [illegible] FOR LIQUID STEEL HANDLING
21. [illegible] DESK FOR TRANSFER CARS
22. [illegible] CASTING PIT (ELIMINATED)
23. STORAGE FOR INGOTS AND [illegible] (ELIMINATED)
24. [illegible] BILLET TRANSFER
25. [illegible] FOR LADLE HANDLING
26. [illegible] CONTINUOUS BILLET CASTING MACHINE
27. [illegible] STATION
28. [illegible] SHEAR
29. [illegible] BED
30. SCALE PIT
31. [illegible] ROOM (CC)
32. [illegible] ROOM (CC)
33. [illegible] SHOP (BASEMENT)
34. [illegible] ROOM (FIRST FLOOR)
35. [illegible] LABORATORY ([illegible] FLOOR)
36. GAS CLEANING FACILITY
37. [illegible] BIN
38. [illegible] CRANE FOR HANDLING FLUX BINS
39. SLAG POT STAND
40. [illegible] ROOM (STEELMAKING)



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PROYECTO VALENTINES - URUGUAY

STEELMELT SHOP - PROPOSED TENTATIVE LAYOUT

SCALE - 1:400

FIGURE - 4-1

SECTION 2

tilt drive, instruments and controls etc as normally provided. Installation of two converters for operating one converter at a time is normal practice in a two-converter shop.

Converter relining facilities have not been discussed in the Brazilian study. The equipment for converter cooling, debricking, relining and the arrangement for supply of new lining as well as the disposal of worn-out lining have to be examined.

One centralised converter control room for installing all the instruments and controls for two converters as proposed is acceptable. However, each converter shall be provided with two control pulpits, one at the tapping side and the other on the charging side.

Oxygen lance system: Oxygen lance system as proposed for each converter is acceptable. However, though not mentioned, it is presumed that standby lance is included in the system.

Pig iron and steel ladles: The report does not indicate the numbers of pig iron and steel ladles included in the scope of supply. Hot metal ladle of 20-ton capacity will be adequate, however, ladle for liquid steel should have a capacity of 15-ton. Normally a density of liquid steel of 6.800 kg/cu.m. is considered for designing the ladle. It is not clear from the report whether slide gate system or the conventional stopper will be provided in the steel ladle for continuous casting. It is suggested sludge gates should be used for liquid steel ladles going to continuous casting.

4 - Evaluation of Plant Facilities (cont'd)

Transfer cars: Each converter will be provided with one steel transfer car and one slag transfer car. The transfer cars are self-propelled. The construction details as described in the report is acceptable. However, the travel distance of the steel transfer car and slag transfer car as shown in the drawing will be difficult to achieve and may be re-examined at the detailed engineering stage.

Gas cleaning system: For preventing atmospheric pollution each BOF vessel should be equipped with independent gas cleaning system. From operation and maintenance viewpoint one combined gas cleaning system for two converters is not preferable. Wet type gas cleaning system offered as optional item may be included from the very beginning.

Cranes: The crane capacity is considered adequate. However, crane rail height and maximum height of the lift need to be checked. Ladle cranes shall have approach below the ground level for lifting ladle from relining pits. Billet aisle cranes have not been indicated; however, it is assumed that the cranes will be about 10/5-ton capacity. Under-slung crane capacity is to be indicated. Crane repair hoists shall be provided for maintenance purposes. Details of cranes provided are given in Table 4-4.

Steelmaking Shop - List of Equipment

As the list of major equipment and facilities is not provided in the Study, it is presumed that items and quantities given below would be included:

TABLE 4-4 - DETAILS OF CRANES FOR VALENTINE PLANT

CRANE CHARACTERISTICS	LOCATION			
	STEELMAKING			
Crane Activity	Pig iron handling (charging aisle)	Scrap handling (charging aisle)	Liquid steel handling (casting aisle)	Billet transport an storage (Billet aisle/rolling aisle
No. of bridge cranes	One	One	Two	One
Capacity	55/15 T	7.5 T + 7.5 T	30/7.5 T	10 T
Bay width	17.0 M	17.0 M	17.0 M	21.0 M
Bay clearance	15.5 M	15.5 M	15.5 M	20.0 M
Electrics	a. Feeding tension 440 V-50 Hz-3 Phase b. Control tension 110 V	a. Feeding tension 440 V-50 Hz-3 Phase b. Control tension 110 V	a. Feeding tension 440 V - 50 Hz - 3 Phase b. Control tension 110 V	a. Feeding tension 440 V - 50 Hz - 3 Phase b. Control tension 110 V-50 Hz-1 Ph
Elevation height	14 M	14 M	14 M (Main) 15 M (Aux.)	8 M
Type of hook	Double	Double	Double	Simple
Structure	Welded monoblock	-	Welded monoblock	Welded monoblock
Braking system	-	Electro-magnetic	Electro-magnetic	Electro-magnetic
Type of crane	CMAA-70-E	CMAA-70-E	CMAA-70-E	CMAA-70-B
Speed:				
Main lifting	9 m/min	12 m/min	9 m/min	10 m/min
Auxiliary lifting	12 m/min	12 m/min	12 m/min	-
Carriage translation	30 m/min	50 m/min	30 m/min	40 m/min
Bridge translation	60 m/min	90 m/min	60 m/min	100 m/min
Suggestion/Comments on modification to Crane facilities	Crane rail height and max. lifting height need to be reviewed.	Crane rail height and max. lifting height need to be reviewed.	a. Crane rail height and max.lifting height need to be reviewed. b. Bay clearance should be 19.0 M against suggested bay width of 20.0M	a. Bay clearance should be 23.0 m against suggested bay width of 24.0 m.

NOTE: 1. One 5-ton under slunge crane be provided in Converter Aisle for lifting flux containers from ground level to fill up overhead flux bunkers at 28.0 M level in steelmelt shop.

2. Two 5-ton capacity monorail cranes for peel pit and roller shop are considered adequate.

SECTION 1

.F CRANES FOR VALENTINE PLANT

LOCATION					
	ROLLING MILL				MACHINE SHOP
ι handling ιisle)	Billet transport and storage (Billet aisle/rolling aisle)	Billet feeding to heating furnace (Rolling aisle)	Roll mounting and maintenance (Rolling aisle)	Coil and Bar transport (Rolling aisle)	Maintenance
	One	One	One	One	One
	10 T	10 T	10 T (main) 3 T (aux.)	10 T	10 T
	21.0 M	21.0 M	21.0 M	21.0 M	30.0 M
	20.0 M	20.0 M	20.0 M	20.0 M	28.838 M
: tension 50 Hz - : tension	a. Feeding tension 440 V - 50 Hz - 3 Phase b. Control tension 110 V-50 Hz-1 Ph	a. Feeding tension 440 V - 50 Hz- 3 Phase b. Control tension 110 V-50 Hz-1 Ph	a. Feeding tension 440 V -50 Hz- 3 Phase b. Control tension 110 V-50 Hz-1 Ph	a. Feeding tension 440 V-50 Hz -3 Phase b. Control tension 110 V-50 Hz-1 Ph	. Feeding tension 440 V-50 Hz- 3 Phase b. Control tension 110 V-50 Hz-1 Ph
(Main) (Aux.)	8 M	8 M	8 M	8 M	8 M
.	Simple	Simple	Simple (main & aux.)	Simple	
:oblock	Welded monoblock	Welded monoblock	Welded monoblock	Welded monoblock	Welded monoblock
:gnetic	Electro-magnetic	Electro-magnetic (4.5 T-Rect.)	Electro-magnetic (4.5 T-Rect.)	-	-
	CMAA-70-B	CMAA-70-D	CMAA-70-E	CMAA-70-E	CMAA-70-C
	10 m/min	10 m/min	10 m/min	10 m/min	5 m/min
	-	-	10 m/min	-	-
	40 m/min	40 m/min	40 m/min	40 m/min	36 m/min
	100 m/min	100 m/min	100 m/min	100 m/min	40 m/min
rail and ting need reviewed. earance be 19.0 ast ted bay of 20.0M	a. Bay clearance should be 23.0 m against suggested bay width of 24.0 m.	a. Bay clearance should be 23.0 m against suggested bay width of 24.0 m b. This crane will also be used for billet transport and storage if second continous caster is provided.	a. Bay clearance should be 23.0 m against suggested bay width of 24.0 m	a. Bay clearance should be 23.0 m against suggested bay width of 24.0 m	

4 - Evaluation of Plant Facilities (cont'd)

I. BOF CONVERTER AND ACCESSORIES

Two 15-ton BOF converters including linings, lance and lance handling equipment, electrical drives, instrumentation and control, etc.

Two sets of gas cleaning system complete with hood, venturi scrubber, ID fan, stack, water treatment facilities, electrics, instruments and controls, etc

One set of converter relining facilities including converter cooling fan, lining wrecking machine, relining rig, etc.

II. SCRAP HANDLING SYSTEM

Seven 2 cu.m. scrap charging boxes

One 10-ton weigh-bridge

One Lifting bail for scrap box

III. FLUX AND FERRO-ALLOY HANDLING SYSTEM

Two sets of high level storage bins with sliding gate

Two sets of vibratory feeders

Two sets of weigh hoppers

Two sets of water-cooled charging chutes

One set of stellor bins for transporting fluxes

One set of ferro-alloy storage bin with sliding gate

One set of vibratory feeder

Two sets of ferro-alloy addition chute with hopper

One set of stellor bins for handling ferro-alloys

One set of 500 kg portable weigh scale for ferro-alloys

IV. HOT METAL HANDLING SYSTEM

One 400-ton hot metal mixer complete with tilting mechanism, heating arrangement, electricals, instrumentation and control, etc

Three 20-ton hot metal pouring ladles

One 30-ton weigh-bridge

4 - Evaluation of Plant Facilities (cont'd)

V. LIQUID STEEL AND SLAG HANDLING

Ten 15-ton steel ladles
Two self-propelled steel transfer cars
Two ladle stands
Three Ladle driers
Six 2 cu.m. slag pots
Two self-propelled slag pot transfer car
Six stands for slag pots
Two mobile slag pot transporter
Two sets operating tools, oxygen lancing facilities, etc

VI. MISCELLANEOUS

One 2-ton fork lift
One 3-ton elevator
One 1 cu.m. pay-loader
One equipment for area repair post
One slurry mixer
Two oxy-fuel scrap cutting torches
Two brick cutting saws
Two sets of pneumatic chisel, hammer, etc
(EOT cranes not included)

CONTINUOUS CASTING

Brazilian Consortium has proposed one 3-strand billet caster to cast 115.000 tons of liquid steel into 120 mm square billets and 4 m long. The total production of billets going into the rolling mill will be 110.000 tons/year. The casting machine has been provided with accessories.

Though ingot casting facility has been shown in the meltshop drawing, nowhere in the Report details for inclusion of this facility have been given. It is presumed that use of ingot casting unit will be made only in an emergency i.e. in case of non-availability of casting machine, when the BOF will be producing the steel or during casting machine break-down and maintenance.

As has been indicated, 15-ton BOF will be producing steel at about 50 minutes tap-to-tap time cycle and all the heats would have to be processed through the casting machine. Casting of ingot is not preferable, as there will be no facility to roll even small ingots in Valentine Plant. In fact, there may not be any facility in the whole of Uruguay to roll these ingots. Hence ingots, if produced, might have to be exported or shipped to plants outside the country for making billets and bringing back to Uruguay.

It is essential that enough continuous casting capacity needs to be provided to handle the entire liquid steel of the BOF shop. In case of emergency, the liquid steel might have to be poured on the floor and used as chargeable scrap in subsequent BOF steelmaking. In this connection, the following aspects are to be considered:

a) Small heat capacity ladles (15 tons) need quick casting to avoid freezing of liquid steel. For a ladle of this capacity, depending upon the steel grade, maximum casting time is between 40 to 45 minutes. Superheating the steel for casting at a lower rate and thus extending the casting time is not preferable as the chances of breakout are more and increases consumption of refractories etc in ladle and tundish.

4 - Evaluation of Plant Facilities (cont'd)

As BOF vessel will be producing 15 tons of heat every 50 minutes on an average, continuous continuous-casting in one machine will not be possible.

b) For sections of 120 x 120 mm the casting speed is about 2.5 m/minute for common steel. For a casting machine of about 5 m radius assuming average casting speed during the entire casting of about 2 m/minute, a 3-strand casting machine will complete 15-ton heats in about 23 minutes. The casting speed could be reduced to some extent, but the casting time cannot be increased to suit even the 50 minute heat cycle from the BOF vessel for continuous continuous-casting mode. This would be still more difficult in case of heat cycles ranging more than 50 minutes due to hot metal quality, requirement of re-blowing etc.

c) After completion of a heat, that is, the last steel coming out from tundish nozzle, the next casting operation could start only after completion of the following activities:

- withdrawing of the tail-end of the cast billet
- repositioning of the starter bar
- sealing of the mould opening with starter bar head, and
- any other minor adjustments etc.

Thus the time gap between two casting operations, which is the machine turn-around time, is about 30 to 35 minutes. Casting time with the turn-

4 - Evaluation of Plant Facilities (cont'd)

around time gives the casting cycle time, which in case of a 3-strand machine will be about 58 minutes. Apart from this, there will be time necessary for mould changing after certain number of castings, as well as machine maintenance and repair and thus in no case one 3-strand machine will be able to cope with the production of BOF shop. For 115.000 tons of liquid steel to be cast in a year from 15-ton BOF, the number of castings per year comes to about 7666 heats, which is also beyond the capacity of a single-machine specially using batch-casting mode.

d) Instead of the proposed one 3-strand billet caster, two 2-strand casting machines will be able to handle the total number of heats even in batch casting mode of operation. In this case, emergency ingot casting facility can be eliminated. Also casting of a small heat size in more number of strands creates more number of front-end and tail-end cropping, resulting in lower yield. Hence two 2-strand billet caster is suggested. Average casting time of 15 tons heat in a 2-strand caster will be about 34 minutes.

Installation of two 2-strand casting machines will also require increasing the bay width from 21 m to 24 m. The revised bay arrangement and relocation of some of the main facilities of the steel making and the casting shop is shown in Fig. 4-1 for indicative purposes.

4 - Evaluation of Plant Facilities (cont'd)

The billet size selected for the continuous casting machine will to some extent, determine the final rolled product sizes of the plant. Moreover, Valentine project visualises supplying some billets to the internal market of Uruguay for the first three years of production. Hence the billet sizes need to be in line with what is required by the re-rollers of the country.

Also it is felt that as a national steel plant, Valentine project should endeavour to satisfy the local demand for billets as far as possible, which would help achieve greater import substitution. The capacity to supply billets to local re-rollers will greatly improve the operational flexibility of the plant in that the plant would not be solely dependent on supplying rolled products only to internal market. This gets added emphasis by the fact that the export market for finished rolled products may be cyclic. Therefore, recourse to sell billets to local re-rollers, when warranted, will ensure necessary stability of operation.

It is suggested that the casting machines be designed for casting 90 to 120 mm square billets of length 3 to 6 m and of maximum billet weight of 450 kg. This will give the possibility of meeting most of the requirements of local re-rollers. Shorter length of billet could be produced, if necessary, by subsequent gas cutting or by cold shearing.

Casting of round billet is also possible if selected continuous casting machine is of about 6 m radius. During round billet casting, manual torch cutting could be used which is quite convenient for 2-strand machines. This will also ensure better flexibility of the plant.

4 - Evaluation of Plant Facilities (cont'd)

The continuous casting machines should be complete with all accessories. For indicative purposes, the main facilities for two 2-strand billet casters are given below:

	CONTINUOUS CASTING MACHINES AND ACCESSORIES
Two	2-strand, curved mould type continuous casting machines, each complete with electrical equipment, instrumentation and control, structurals, dummy bars with handling device, tundish, tundish preheating units etc.
Four	Sets billet discharge roller tables
Four	Cooling beds
Two	Immersion pyrometer assemblies
One	Optical pyrometer
Two	Sets oxygen lancing equipment
Two	Sets operating tools, spoons etc.
Fifteen	Slide-gate equipment and accessories
Two	Traverse for billet handling

ROLLING MILLS

For heating of billets one 25/30 ton per hour walking beam type, end-charge, side-discharge furnace has been provided. The billets to be heated are 120 mm square cross section, 4 m long weighing 440 kgs.

The walking beam type furnace included is ideal and will provide uniformly heated billets for rolling. However, for simplification, end-charge front-discharge type furnace could be considered. In this case, there might be relatively higher heat loss at the discharge-end but elimination of an extra operator at the discharge-end will be possible in addition to simplified operation and elimination of billet ejector etc.

Brazilian study has shown provision for an additional billet heating furnace. In view of the plant's limited expansion possibility resulting out of factors such as lack of iron ore resources, capacity to produce and supply charcoal requirements, market limitations etc, it is suggested that this provision be eliminated. To ensure sufficient billet heating capacity to match rolling of bigger sizes at higher hourly rate of production etc, it is suggested that nominal heating capacity of the furnace be increased to 35 t/hr.

Semi-continuous rolling mill proposed in the Brazilian study consists of:

- One 480 mm 3-high roughing stand with tilting table at the delivery end
- Four 380 mm 2-high continuous second intermediate stands (which in future with cooling bed will work as bar finishing stands).
- One wire rod finishing block with eight (alternate horizontal/vertical) 2-high stands of 180 mm rolls.
- Auxiliaries like shears, wire rod looping system, collecting system etc (cooling bed for future not included).

The mill proposed is suitable for the proposed production programme i.e. rods in coil starting from 120 mm square billet to 6.5 mm minimum diameter. However, consideration to work distribution in various stands, final sections coming out of roughing stand etc have to be given in deciding spacing between roughing stand and the first intermediate stand. This consideration also holds good for the roller table length in front of the roughing stand etc.

Use of a 3-high stand as roughing for feeding a continuous intermediate and finishing block is not ideal as it creates limitations to the maximum length of billets that can be rolled and thus the coil weight. However, this is the most economical solution and roughing stand will be able to match with the maximum finishing speed of 40 m per second. Also, for the given production programme, the annual tonnage of 100.000 tons could be met. In fact, with minor modifications even some higher production could be achieved with the proposed mill, if necessary.

Alternatively, DEI's examination of the possibility of providing two or three 3-high stands with common drive as roughing and using last one or two passes with looping reveals possible improvement to rolling rate and higher coil weight, but at a substantial cost increase. Also use of a 3-high jumping stand (Morgadshammer design) has shown to be costlier than the proposed roughing.

Selection of rolling mill determines the possible production capability at the plant. It is preferred to have as much flexibility as possible with minimum additional cost. It is suggested that the following alterations are made:

4 - Evaluation of Plant Facilities (cont'd)

a) Increase the roll dia of the roughing stand to 530 mm instead of 480 mm. More reduction per pass could be taken reducing the number of passes and thus decreasing cooling of bar during rolling in the roughing stand. In case of using bigger roll stand, as suggested, it will also be necessary to ensure the crane capacity already provided would be adequate for roll changing purposes.

b) Last four stands of the second intermediate 320 mm 2-high stands (Stand Nos. 8, 9, 10 and 11) may be changed to alternate vertical/horizontal arrangement (No. 8-V, No. 9-H, No. 10-V, No. 11-H) instead of all horizontal arrangement as included in the Brazilian study. This arrangement will have no adverse effect on the proposed production programme; on the other hand, this will improve the quality by giving four twist-free passes before the bar enters the no-twist rod finishing block. However, the main advantage will be in the future when cooling bed is installed for production of straight product. Last four no-twist passes will ensure better bar product for various quality applications. Also, this arrangement will be desirable to roll angles, flats etc in future, if required.

c) Though it is proposed to roll 6.5 mm dia wire rod coil, it is desirable to be able to supply lowest size at 5.5 mm dia wire rod. It is suggested for rolling 5.5 mm dia rod continuous cast billet of 100 mm square and 4 m long is used without adding any extra rolling stands in the proposed arrangement. This smaller section billet will result in a coil weight of about 290 kg.

The layout shown in the drawings of the Brazilian study is of preliminary nature and needs to be finalised only after a more thorough examination of considerations such as smooth material flow, adequate storage capacity, location of roll and guide shop, scale pit etc. Mill bays proposed are 21 m wide. However, it is suggested that to accommodate two 2-strand continuous casting machines, the billet discharge bays which also accommodate rolling mill complex is widened to 24 m. This will require change of the crane i.e. distance between the crane rails etc, but will ensure more space for billet storage, rolling as well as finishing. The Brazilian layout of 21 m bays appears quite congested and may not be suitable for the smooth operation of the plant.

PLANT POWER SYSTEM

The Valentine plant does not visualise any generation of power from captive plant. Power will be supplied by the national grid to a sub-station located about 12 km away from the plant site and will be brought for use in the plant. The following aspects are not clear from Brazilian study and will require to be clarified by the suppliers:

Standby capacity: Total failure of electric power supply to the complex or any plant department will seriously affect plant operation. It is presumed that adequate standby capacity has been provided in the feeder lines as well as in the transformers at all sub-stations so as to ensure that when one of the feeder lines or one of the transformers at any of the sub-stations is down for maintenance or due to any other reason, electric power supply to the plant is maintained without affecting plant production. This has to be confirmed by the tenderer particularly with respect to the following:

i) Incoming 30 kV line from U.T.E. transforming station to receiving sub-station in the plant, referred to as "cut-down station" in the tender.

ii) 30/13.8 kV transformers at plant "cut-down station".

iii) All 13.8/2.4 kV and 13.8/0.48 kV transformer sub-stations in the further distribution system in the various plant areas, including the incoming feeders to these transformers.

Sectionalising of switchgear line-up at all sub-stations:

It is to be confirmed that for ensuring continuity of power supply, the switchgear line-up at each sub-station will be sectionalised over the bus-tie circuit-breaker so that when one section of the line-up is shut down due to fault or for maintenance, power supply can be maintained over the other section of the switchgear line-up. Under normal operation the two sections can be operated in parallel with the bus-tie circuit-breaker closed.

4 - Evaluation of Plant Facilities (cont'd)

Number of sub-stations: It is essential that requisite number of sub-stations or switching stations will be provided as required for efficient functioning of the power system as well as the plant. Confirmation on this aspect is required in general and in particular for the following cases:

i) In the area of the rolling mills, continuous casting and converter shop, it will be necessary to form a local 13.8 kV switchgear line-up for distribution of power in the area. This is particularly necessary as thyristor converters for rolling mill main drive should be connected to a local 13.8 kV switchgear line-up for operational convenience. From the same local 13.8 kV switchgear line-up, 13.8/0.48 kV load-centre transformers may be fed.

ii) The motors of ratings 200 kW and above will be mainly located in the blast furnace, sinter plant and oxygen plant areas. It is presumed that for feeding these motors a common 13.8/2.4 kV load-centre sub-station will be established. If so, the 13.8/2.4 kV sub-station will have to be judiciously located at the load-centre of these loads. The 13.8/0.48 kV sub-stations for catering to the low voltage power requirement in the above area will also have to be located at judiciously selected load-centres. For feeding all these load-centres sub-stations it may be convenient to provide a separate local 13.8 kV switchgear line-up in the area.

4 - Evaluation of Plant Facilities (cont'd)

iii) For distribution of power in the mining sector a 13.8/0.48 kV sub-station will have to be provided at a suitable load-centre of the low voltage loads in the mining sector.

Reserve feeders: At each sub-station and switching station, two (2) reserve circuit-breakers should be provided to take care of possible unforeseen requirements which may be found necessary during implementation of the project or during initial operation of the plant.

Controls and protection: It is presumed that at all sub-stations and switching stations as well as in the motor control centres and sub-distribution switch-boards necessary controls, protective relays, instruments and meters shall be provided as required. This aspect has to be confirmed.

Station battery banks: It has to be confirmed that the station batteries for supplying DC control power shall be of nickel-cadmium type and shall have adequate capacity to meet all the control power requirements in the respective areas as well as the requirement for meeting the emergency lighting loads for a reasonable period.

Power factor compensation, harmonic suppression and voltage fluctuation:

It is presumed that provision of power factor compensation has been included in the offer particularly as the demand of 10 MVA estimated in the tender is considered reasonable provided the plant overall power

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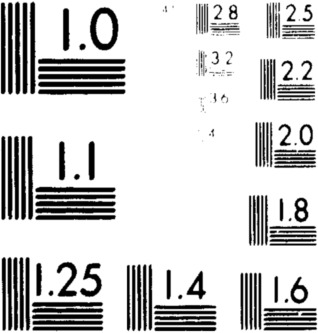

MICROCOPY RESOLUTION TEST CHART

4 - Evaluation of Plant Facilities (cont'd)

factor is maintained in the region of 0.9, which will require providing suitable power factor improvement equipment.

To suppress higher harmonics generated by the use of thyristor converters for the DC motors in the rolling mills, continuous casting and converter shop, it will be required to install suitable filter circuits. It has to be confirmed that such filter equipment has been included.

The compensation and harmonic suppression equipment should preferably be located in the main receiving sub-station i.e. "cut-down station" of the plant.

In order to avoid the problems of voltage fluctuation caused by thyristor converters, it would be advisable to connect the converters for rolling mill main drives to the 13.8 kV system and not to 480 V system as in the latter case the other equipment connected to the low voltage system will be affected by voltage disturbance problem. This aspect needs to be confirmed.

Motors and controls: It is presumed that the motor enclosures and types used in different plant units have been selected to suit the local environmental conditions including ambient temperature. Also different American Standards viz. NEMA for rolling mill main drive motors and AC motors, AISE for auxiliary DC motors and IEEE standard for thyristor power supply equipment have been adopted in their selection. The application of different types of motors have to be selected based on the duty as well as process requirement of the driven machines. Also it is presumed that the control and regulation equipment have been selected to suit the particular application and with a view to meet the process requirement. Necessary protection and metering equipment have been incorporated for proper protection of motors and their power supply equipment as well as for monitoring of the system against abnormal conditions. These aspects need to be confirmed.

Emergency power: For meeting the requirement of emergency power in the plant, it will be necessary to have some captive power generation. Such power generating plant may be located centrally to cater for the emergency power requirements of the entire complex or provided in different zones to meet the local emergency power requirements. It has to be confirmed that sufficient captive power generating capacity has been included in the offer for meeting the emergency power requirements of the entire complex.

Illumination: The plant external and internal illumination levels as well as the lighting fittings are presumed to be designed and selected in accordance with the guides provided by the Illuminating Engineering Society (IES) of America or any other standards published by the recognised National Standard Institutions or the Publications of International Electrotechnical Commission (IEC).

Equipment in general: It needs to be confirmed that all the electrical equipment adopted in the plant have in general been selected to suit the local environmental conditions, altitude of the plant, the

4 - Evaluation of Plant Facilities (cont'd)

average ambient temperature and other specific requirements of the area. The design of various equipment will conform to the relevant standards published in America or other National Standards or publications of IEC.

Regarding the cables used in the plant it is presumed that these are basically selected on the following considerations:

i) power required to flow through it and voltage drop;

ii) the laying method;

iii) the environmental conditions;

iv) the short-circuit current likely to be encountered by it.

5 - CAPITAL COST, PRODUCTION COST AND MANPOWER REQUIREMENT

This chapter presents the observations of DEI in respect of the capital cost, production cost, manpower estimates etc included in the Brazilian study. It is submitted that a more detailed evaluation of these costs has not been possible for the reason that the Brazilian study itself includes only a limited information/ explanation. DEI has proceeded with their evaluation on the basis of available information, in the hope that, apart from the following plant facilities which the Brazilian study specifically excludes, supply of the rest of plant and machinery are complete in all respects and that it would be possible to start the plant operations with the facilities already incorporated:

a. for blast furnace only two Cowper stoves - no standby third stove is provided

b. in BOF shop no gas cleaning equipment

c. Lime calcining plant

d. Rolling mill cooling bed

The capital cost elements indicated all over in the Brazilian study have been put together and presented in a composite fashion in Table 5-1. Diseconomy of scale of operation can be easily attributable to the proposed Valentine project which planned to have a capacity of 100.000 tons per year of finished products, adopting a simplified production programme i.e. wire rods and bars. As a result of the considerable role played by its size of operation, Valentine project's per ton investment cost

TABLE 5-1 - INVESTMENT COST
(Figures in US $)

S.No.	Item	Cost: Indigenous	Cost: Imported	Cost: Total
1.	Land ..	82.500	-	82.500
2.	Building:			
	a. Plants ..	9.513.464	14.270.196	23.783.660
	b. Offices ..	731.997	1.097.996	1.829.993
	c. Warehouses ..	496.526	744.791	1.241.317
	d. Others ..	4.774.356	7.161.534	11.935.890
	Sub-total (2a to 2d)	15.516.343	23.274.517	38.790.860
3.	Machinery and equipment:			
	a. Mining (Equipment & vehicles) ..	165.254	4.781.641	4.946.895
	b. Ore beneficiation:			
	- Fragmentation, milling and screening equipment	360.517	1.672.542	2.033.059
	- Concentration equipment ..	735.700	3.605.172	4.340.872
	Sub-total (3b).	1.096.217	5.277.714	6.373.931
	c. Sintering ..	735.700	7.357.000	8.092.700
	d. Ironmaking:			
	- Blast furnace ..	800.000	8.000.000	8.800.000
	- Cowpers and turbo-blowers ..	800.000	4.500.000	5.300.000
	- Complementary equipment of blast furnace ..	750.000	7.500.000	8.250.000
	Sub-total (3d).	2.350.000	20.000.000	22.350.000
	e. Steelmaking:			
	- BOF converter and pig iron mixer ..	259.085	12.000.000	12.259.085
	- Cranes ..	-	980.000	980.000
	Sub-total (3e).	259.085	12.980.000	13.239.085
	f. Continuous casting:			
	- Intermediate ladle heating system ..		187.500	187.500
	- Moults, oscillation system, extractor rollers and straighteners, primary and secondary cooling, dummy bar, cooling bed and collecting cradle ..	-	2.250.000	2.250.000
	- Electric system and instrumentation ..	-	1.312.500	1.312.500
	Sub-total (3f).	-	3.750.000	3.750.000
	g. Reheating furnace ..	-	2.000.000	2.000.000
	h. Rolling mill:			
	- Roughing ..	-	178.290	178.290
	- Intermediate I ..	-	1.129.170	1.129.170
	- Intermediate II ..	-	2.139.480	2.139.480
	- Wire rod finishing block ..	-	891.450	891.450
	- Cooling, loops forming, finishing and forwarding	-	2.496.060	2.496.060
	- Support equipment, spare parts, starting motors, cranes, instrumentation, lubricants, rollers, auxiliary services and equipment for quick change of rollers etc	-	4.754.400	4.754.400
	- Mounting, starting, training and supervision	-	297.150	297.150
	Sub-total (3h).	-	11.886.000	11.886.000
	i. Mechanical workshop ..	-	450.000	450.000
	j. Cranes for mechanical workshop ..	-	118.750	118.750
	k. Machines, gadgets and equipment for laboratories	-	450.000	450.000
	l. Vehicles, gadgets and tools for internal transport	50.000	300.000	350.000
	m. Machines and equipment for auxiliary services..	-	400.000	400.000
	n. Furniture and equipment for offices ..	100.000	-	100.000
	*Sub-total (3a to 3n)	3.672.556	69.778.549	73.451.105
		(4.756.256)	(69.751.105)	(74.507.361)
4.	Other investments:			
	a. Pre-investment expenses, cost of project, consultants' and engineering costs ..	1.188.065	10.283.865	11.471.930
	b. Start-up costs ..	1.000.000	-	1.000.000
	c. Interest on loans during the settlement of plant	-	8.837.989	8.837.989
	Sub-total (4a to 4c)	2.188.065	19.121.854	21.309.919
5.	Working capital:			
	a. Effective ..	509.580	-	509.580
	b. Inventories ..	4.459.676	1.886.219	6.345.895
	c. *Others:*			
	- Purchaser's credit ..	(-) 880.873	-	(-) 880.873
	- Advance payment for imports ..	-	648.842	648.842
	Sub-total (5a to 5n)	4.088.383	2.535.061	6.623.444
	TOTAL INVESTMENTS (1 to 5)*	25.547.847	114.709.981	140.257.828
		(26.631.547)	(114.682.537)	(141.314.084)

* Figures given in brackets are actual addition of total investments 1 to 5 and it seems there is an arithmetic mistake in the figures given in Brazilian study (difference is only in sub-total 3a to 3n).

5 - Capital Cost, Production Cost and Manpower Requirement (cont'd)

works out to US $ 1.347. In this connection, it should also be borne in mind that the proposed concept of the Valentine project does not encompass production of charcoal, production of oxygen for steelmaking, generation of the plant's power requirements, and the lime calcining plant and thus the project's total capital cost excludes these departments.

Based on present day international experience, the following can be said of per-ton investment costs: Depending upon the scale of operation, and the production programme - flat or non-flat products - the per-ton investment cost of plants of over a million ton capacity with integrated operation ranges between US $ 1.100 and US $ 2.200. With increasing production of more sophisticated items (which result in higher sales realisation), the annual per ton investment cost also increases. However, normally the facilities in large integrated steelworks today include coke making as well as generation of at least a part of its power requirements on captive basis.

According to DEI's analysis, based on international prices prevailing in early 1981, the overall plant cost estimates for the suggested plant facilities presented by the Brazilian Consortium in their study are considered reasonable, specially the plant's smaller capacity acting as a constraint.

A detailed techno-economic evaluation of individual plant facilities is presented under Chapter 4. A summarised version of the various comments/recommendations of DEI in respect of plant facilities is presented below, with the main objective of bringing out the possible effect these

5 - Capital Cost, Production Cost and Manpower Requirement (cont'd)

suggestions might have on the project's overall capital cost:

1. Two 1.9 cu.m. bucket-capacity hydraulic shovels in place of two front end-loaders provided.
2. One additional Cowper of 6.555 sq.m. heating surface for blast furnace - estimated additional cost: US $ 850.000,-
3. Elimination of the pig casting machine - estimated saving: US $ 200.000,-
4. Gas cleaning system for the BOF vessels - estimated additional cost: US $ 1.800.000,-
5. Elimination of emergency ingot casting with mould etc - estimated saving: US $ 220.000,-
6. Vertical kiln lime calcining plant - estimated additional cost: US $ 400.000,-
7. Two 2-strand billet caster instead of one 3-strand billet caster - estimated cost US $ 450.000,-
8. Changing of two 2-high horizontal stands to two 2-high vertical stands in the bar finishing trains, so that the last four stands alternate with each other - that is one vertical and one horizontal.
9. Increase of bay width for billet discharge and rolling mill from 21 m to 24 m. Additional cost for this alteration is not thought necessary as extra space recommended would have been required in any case for rolling mill operation

5 - Capital Cost, Production Cost and Manpower Requirement (cont'd)

10. Billet heating furnace capacity to be increased from 30 to 35 tons per hour. Further the furnace should be simplified by incorporation of a billet ejector, and elimination of roller table. Implementation of both these suggestions would have a balancing effect on the cost.

Manpower Requirement

The manpower estimates shown are in conformity with the general requirements of a plant having the production programme and scale of operation as visualised at the Valentine project.

The annual production of finished product per man per year average to about 135 tons. Again, on account of economies of scale, this average production at Valentine project is not truly comparable with the operating results obtainable in large integrated plants in other countries of the world. The manpower estimates indicated in the Brazilian study are summarised in Table 5-2.

Production Cost

The production cost at each stage of operation as well as conversion cost at each stage has been compiled and presented in Table 5-3 and 5-4 respectively. It is felt that the production and conversion cost per ton of product is high, when compared with cost of production of similar products in large integrated steelworks. As explained above due to diseconomy of scale of operation, it is doubtful if any major saving in production and

TABLE 5-2 - PRODUCTION COSTS

Item	Mining+ 778.000 t/yr	Concentration + 177.000 t/yr	Sintering+ 185.300 t/yr	Hot metal 120.000 t/yr	Liquid steel 115.000 t/yr	Billets 110.000 t/yr	Rolled products 100.000 t/yr
Raw materials ..	-	2.687.121	4.784.196	14.044.382	19.454.625	25.247.029	26.653.416
Auxiliary materials ..	603.235	327.450	-	192.000	3.923.800	603.000	398.000
Electric power ..	-	222.000	185.000	312.000	92.000	35.200	480.000
Fuels ..	431.102	-	27.750	562.000	-	27.500	260.000
Industrial water ..	-	29.970	-	1.375.200	329.475	210.100	-
Manpower ..	332.000	173.900	168.350	400.800	460.000	158.400	718.000
Repair & maintenance, stores and supply ..	286.898	316.662	441.420	800.000	519.200	150.000	555.440
Main plant's depreciation ..	1.033.886	357.097	517.666	1.311.091	967.929	222.187	929.833
Credit gas B.F ..				(-) 315.250			
Credit of scrap produced in rolling mills ..					(-) 500.000		(-)1.000.000
TOTAL PRODUCTION COST	2.687.121	4.114.200	6.124.382	18.682.223	25.247.029	26.653.416	28.994.689
PRODUCTION COST, ton	3.24	22.24	33.10	155.70	219.53	242.30	289.94

NOTE:
(+) Cost of all items indicated are based on mining of 830.000 t/yr, concentration of 185.000 t/yr and sintering of 185.000 t/yr as given in original study. The tonnages have changed slightly but production costs have been retained.

TABLE 5-3 - CONVERSION COST (ABOVE RAW MATERIALS, DEPRECIATION AND CREDIT)

(Figures in US $)

Item	Mining§ 778.000 t/yr	Concentration § 177.000 t/yr	Sintering§ 185.300 t/yr	Hot metal 120.000 t/yr	Liquid steel 115.000 t/yr	Billets 110.000 t/yr	Rolled products 100.000 t/yr
Electric power..	-	222.000	185.000	312.000	92.000	35.200	480.000
Fuel ..	431.102	-	27.750	562.000	-	27.500	260.000
Industrial water	-	29.970	-	1.375.200	329.475	210.100	-
Direct and indirect manpower ..	332.000	173.900	168.350	400.800	460.000	158.400	718.000
Preparation & maintenance stores and supplies ..	286.898	316.662	441.420	800.000	519.200	150.000	555.440
TOTAL CONVERSION COST (without raw materials, depreciation and credit	1.050.000	742.532	822.520	3.450.000	1.400.675	581.200	2.013.440
Conversion cost/ton	1.27	4.0	4.45	28.75	12.18	5.29	20.13
Av. International costs for above							

NOTE:

§ Cost of all items indicated are based on mining of 830.000 t/yr, concentration of 185.000 t/yr and sintering of 185.000 t/yr as given in original study. The tonnages have changed slightly but conversion costs have been retained.

TABLE 5-4 - MANPOWER ESTIMATES

Category	Mining+ 778.000 t/yr	Concen-tration+ 177.000 t/yr	Sinter-ing+ 185.300 t/yr	Blast furnace 120.000 t/yr	BOF shop 115.000 t/yr	Billets 110.000 t/yr	Rolled products 100.000 t/yr	Mainte-nance (#)	Administ-ration(*)	Auxiliary & complemen-tary (§)	Total
Direct manpower											
Supervisory ..	-	-	-	-	-	-	-	1	-	2	3
Administrative	-	-	-	-	-	-	-	4	120	-	124
Skilled ..	-	-	11	14	33	15	74	52	-	10	209
Semi-skilled ..	35	21	14	25	29	3	25	23	-	9	184
Unskilled ..	38	6	-	18	9	-	9	14	-	55	149
Sub-total ..	73	27	25	57	71	18	108	94	120	76	669
Indirect manpower											
Supervisory ..	2	7	5	9	5	4	8	-	-	-	40
Administrative	3	2	-	5	4	-	3	-	-	-	17
Skilled ..	1	-	-	-	-	-	4	-	-	-	5
Semi-skilled ..	5	-	-	-	-	-	-	-	-	-	5
Unskilled ..	3	-	-	-	-	-	-	-	-	-	3
Sub-total ..	14	9	5	14	9	4	15				70
TOTAL (DIRECT & INDIRECT) ..	87	36	30	71	80	22	123	94	120	76	739

NOTES:

(+) Manpower indicated is based on mining of 830.000 t/yr, concentration of 185.000 t/yr and sintering of 185.000 t/yr as given in original study. The tonnages have changed marginally but original manpower has been retained.

(#) Workshops, mining camp, civil construction administration.

(*) President's office, commercial dept, financing dept, administrative dept and industrial dept.

(§) Nurses, doctors, cooks, drivers, electricians etc.

5 - Capital Cost, Production Cost and Manpower Requirement (cont'd)

conversion costs could be achieved. It must be pointed out here however that the cost of production as compiled by the Brazilian Consortium does compare favourably with costs obtaining in plants of similar capacity in other countries.

Large modern integrated steel plants enjoy a considerable advantage (largely due to scale of operation) in respect of operating costs. This is a major constraint on smaller plants of the size proposed at Valentine project. However, there are many an instance where for considerations of overall financial viability, smaller steel producing capacities have been established. These plants are generally to cater to a limited market. Also the production programme of these mini to medium operations would be limited to a few selected items. Small size plants do enjoy certain other advantages in comparison to the large ones: for example, a smaller plant could start operation with a relatively small infrastructure base, which may already exist in the country. As against this, creation of large infrastructure base, most often as a captive facility of the operating plant, imposes a great burden on larger plants. This argument would hold good in respect of infrastructure facilities such as township, transport network, operating personnel, facility for creation, development and training of human resources etc. Apart from these benefits smaller plants are also less complicated in their operation practices. Considering all these factors, there is no doubt that the proposed Valentine Project, the first steel producing capacity in the country, would be a dynamic forerunner for overall industrialisation in the country.

5 - Capital Cost, Production Cost and Manpower Requirement (cont'd)

Construction Schedule

The construction schedule presented by the Brazilian Consortium envisages going to operation in 39 months from the date of go-ahead. This period is considered rather too short. If this tight construction schedule is to be successfully adhered to, a considerable amount of advance planning and programme would be called for. It needs hardly to be mentioned that a short implementation schedule would greatly help improve a project's financial viability. From this point of view it would be to the advantage of the Valentine project if the above construction schedule could be adopted. It is DEI's recommendation that every effort should be made to keep to this tight schedule, which would not be impossible if appropriate advance planning is done right from now onwards.

6 - PROJECT EVALUATION

This chapter presents the observations of DEI on the financing pattern proposed by the Brazilian Consortium and the financial aspects emerging as a result of the various cost and revenue data assumed by the Brazilian Consortium. In view of the very brief nature of this evaluation study, it has not been possible to make independent investigations regarding the various elements of capital cost, production cost, administrative cost, sales realisation etc, and hence DEI have assumed these figures as adopted by the Brazilian Consortium in the report to be valid.

As explained in the latter part of this chapter, DEI have made independent enquiries in respect of one of the vital aspects of the study, namely the selling prices of products visualised to be produced at the Valentine Project. DEI's findings in this regard are accordingly presented.

In the process of our evaluation however DEI have felt the need for several clarifications which we have not been able to obtain from the documents made available to us. For instance, detailed information on the practice adopted for calculation of interest charges on various loans and charging of depreciation and amortization are not available. As such the review presented in this chapter is of a limited nature.

6 - Project Evaluation (cont'd)

Salient features of financing pattern

The Brazilian study estimates the investment required for the project to be US $ 133.6 million, the major components of which are as follows:

a. Own capital	$	15.000.000
b. Brazilian long-term loan and other loans	$	112.316.753
c. Short-term loans	$	6.317.630

The working capital requirement which has been estimated to be of the order of US $ 6.6 million. Thus the total capital requirement will be of the order of US $ 140.2 million.

An analysis of the Table on Sources and Uses of Finance contained in the Brazilian study reveals that even for the purpose of raising the total initial investment requirement, the project would have to resort to short-term financing measures.

The financing assistance offered by the Brazilian Consortium is not only tied to supplies of corresponding magnitude from Brazilian sources, but also is conditional on appropriate guarantees from the Central Bank of Uruguay. Further, the rates of interest assumed for different types of loans have to be fully guaranteed from respective financing agencies as the liability of the project would be vitally influenced if, due to the current high interest trend, the credits/loans could not be obtained at the rates assumed. The external sources of financing generally available for industrial projects in developing country are elaborated in Appendix 6.1.

6 - Project Evaluation (cont'd)

The sale prices of products visualised at the Valentine project have been computed, taking an assumed FOT price in Argentina for various products. For instance, the price of wire rod is worked out as follows:

I - By Road Transport

	US $ per ton
Price FOT Argentina	348,-
Cost of transport by truck	45,-
C.i.f. Montevideo (A)	393,-
Plus 26% of (A) towards duties/imports	102,-
National price (B)	495,-
Plus 5% of (B) towards financing charges	25,-
Plus 4% of (B) towards administration charges	10,-
Landed cost Montevideo	530,-

II - By Sea Route

	US $ per ton
Price FOT Argentina	348,-
Plus Sea Freight	24,-
Plus Post charges	37,20
Plus Internal charges	4,50
C.i.f. Montevideo (A)	413,70
Plus 26% duties and imports	107,56
National price (B)	521,26
Plus 5% of (B) towards financing charges	26,06
Plus 2% of (B) towards administration charges	10,43
Landed price in Montevideo	557,75
Say	558,-

Average of I and II = 530 + 558 = $\frac{1088}{2}$ = 544,-

6 - Project Evaluation (cont'd)

In evolving the cost of the products produced at the Valentine Project at Montevideo the Brazilian study has provided for a freight equalising rebate on the price as calculated above. Such a rebate is assumed on the argument that for the products to reach Montevideo from the Valentine Project area there would be a certain transport cost involved, and this cost should be legitimately deducted from the cost per ton as worked above to establish selling prices of Valentine project.

Based on the above formula the selling prices for various products assumed are as follows:

		US $
Wire rod FOT Valentine	..	536,-
Billet FOT Valentine	..	412,75
Pig iron FOT Valentine	..	265,20

For that portion of Valentine Project's wire rod and bar production which is proposed to be exported, the Brazilian study has assumed export price based on "Metal Bulletin" information for future years which has been also adopted for DEI evaluation.

However, the actual ex-works prices in Montevideo in the first quarter of 1981 for wire rod was US $ 630,-.

Thus it appears that a more realistic approach to selling prices of the Valentine project products would be necessary in order to indicate the correct profitability of the project. Considering the present selling prices in the country, the profitability of the project could become even more attractive with the adoption of realistic selling prices. Further it is essential to justify the base FOT prices (supposed to be prevailing in Argentina) assumed by the Brazilian Consortium for computing the landed cost of products in Montevideo. This is warranted for the reason that the current selling prices of similar products in Argentina itself are much higher than the landed prices assumed in the Brazilian study. For instance as against a base FOT price of US $ 348 assumed by the Brazilian Consortium for wire rod the actual selling price in Argentina in the first quarter of 1981 is reported to be much higher.

It is to be pointed out however that for the purpose of DEI's exercise the same selling prices used by the Brazilian Consortium have been adopted.

Financial Analysis

Based on the estimated capital cost, annual production cost, other charges and income from sale of products, as indicated in the Brazilian study, the financial aspects of the project for 25 years of operation have been analysed by DEI. These cover profit and loss statement, cash flow statement, internal rate of return and pay-back period as discussed in this chapter.

Total fixed investment and mode of financing

The total fixed investment including working capital for the project has been estimated at US $ 140.2 million.

6 - Project Evaluation (cont'd)

The financing pattern of the project visualised in the Brazilian study is summarised below:

	Million US $
Equity ..	15.0
Long term and medium term loans ..	112.3
Short term loan ..	6.3
Sub-total	133.6
Short term loan for working capital ..	2.0
Internal generation of funds	4.6
Total	140.2

Annual sales realisation

The annual sales realisation has been estimated to be of the order of about US $ 50.71 million when the plant achieves its rated finished product capacity in the fourth year of operation. The annual sales realisation in the 1st, 2nd and 3rd years of operation will be about US $ 30.82 million, US $ 40.90 million and US $ 50.38 million respectively.

The selling prices assumed for the products are as follows:

	US $
Billet	412,75
Wire rod	536,00
Pig iron	265,20

6 - Project Evaluation (cont'd)

Annual manufacturing expenses and other charges

These include manufacturing expenses, administrative and sales expenses, interest charges, depreciation and amortisation of deferred charges.

Total manufacturing expenses and other charges for 4th year of operation when plant achieves its rated capacity are summarised below:

	Million US $
Manufacturing expenses ..	22.88
Administrative & Sales expenses	4.12
Total interest charges ..	9.22
Depreciation and amortisation..	6.28
Total manufacturing and other expenses ..	42.50

Interest charges for long term, medium term and short-term loans

DEI's financial analysis is based on the interest charges .. adopted in the Brazilian study. Due to limited scope of this evaluation, independent investigations regarding interest rates, practices adopted in Uruguay for treatment of interest charges on different types of loans, etc have not been carried out by DEI.

Depreciation and amortisation of deferred charges

It is submitted that the depreciation and amortisation as worked out in the feasibility report prepared by Brazilians for Valentine Project need to be reviewed. It appears that in the Profit and Loss

6 - Project Evaluation (cont'd)

statement prepared by Brazilians depreciation and amortisation of deferred charges have been shown to be of the order of US $ 6.28 million on straight line basis annually, whereas in the cash flow statement, in order to arrive at the actual cash generation, depreciation and amortisation figures which have been added back, differ from the 5th year of operation. It can be observed from the details in the financial report of Brazilian Consortium that some of the facilities are being retired after 5 years, some after 10 years and a few others after 20 years and 30 years of their useful life in project. In adjusting the depreciation figures, however, the Brazilian study appears to have gone on charging the same depreciation amount in the order of US $ 6.28 million throughout the period of 25 years whereas subsequent to retirement of some facilities after the first five years, the annual depreciation charges ought to have come down. Hence the difference from the 5th year of operation between the depreciation figures appearing in Profit and Loss statement and cash flow.

Another aspect that needs careful consideration is that, since the facilities are being retired after their useful life in the project, capital cost for the replacement of retired units ought to be provided for. No such provision is to be found in the Brazilian study.

6 - Project Evaluation (cont'd)

Profit and Loss Statement

Based on the estimates and assumptions stated in the chapter on financial analysis prepared by Brazilians, DEI have worked independently a fresh Profit and Loss Account, presented in Table 6-1. According to this exercise also the plant is expected to achieve its rated capacity in the fourth year of operation.

The net profit will increase progressively as the sales realisation increases and interest charges decline. When all the loans are paid off by the 12th year of operation, the net profit would amount to about US $ 18.54 million. The cumulative net profit over 25 years of operation amounts to about US $ 387.75 million, yielding an average of annual net profit of about US $ 15.51 million.

Cash flow statement

DEI have also worked out the estimated figures of cash generated by the project over 25 years of operation which are presented in Table 6-2. It will be seen that as and when the funds are available, repayment of loans has been provided for. After repayment of the loans, there is a cumulative net cash surplus of about US $ 378.61 million at the end of 25th year.

Internal rate of return

The cash flow figures of DEI's exercise have been adjusted to find out the real cash generated by the plant operation for working out the internal rate of

TABLE 6-1 – [illegible]
([illegible]

	1	2	3	4	5	6	7	8	9	1[illegible]	11	12
A. SALES REALISATION	30.82	40.90	50.38	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71
B. MANUFACTURING EXPENSES	14.90	19.08	22.68	22.88	22.88	22.88	22.88	22.88	22.88	[illegible]	22.88	22.88
C. [illegible] PROFIT (A - B)	15.92	21.82	27.70	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83
D. [illegible] EXPENSES/CHARGES												
Administrative and sales expenses	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12
Interest on [illegible] term and medium term loan	9.7[illegible]	9.35	8.33	7.06	5.76	4.47	3.22	2.16	1.22	0.43	0.05	-
Interest on short term loan	-	-	4.44	2.16	-	6.04	1.77	-	4.32	-	-	-
Depreciation and Amortisation	6.28	6.28	6.28	6.28	6.28	5.18	5.18	5.18	5.18	5.18	5.17	5.17
TOTAL (D)	20.19	19.76	23.17	19.62	16.16	19.81	14.29	11.46	15.03	9.73	9.34	9.29
E. [illegible] PROFIT/LOSS (C - D)												
Current	(-)4.35	2.06	4.53	5.21	11.67	8.02	13.54	16.37	12.80	18.10	18.49	18.5[illegible]
Cumulative	(-)4.35	(-)2.29	2.24	10.45	22.12	30.14	43.68	60.05	72.85	[illegible]	109.44	127.[illegible]

[illegible] Engineering International GmbH
[illegible]

SECTION 1

TABLE 6.1 – PROFIT AND LOSS STATEMENT

(Figures in Million US $)

Years

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	2.
50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	50.71	5[illegible]
22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	22.88	2[illegible]
27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	27.83	[illegible]
4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	4.12	[illegible]
1.23	0.43	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.18	5.18	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	1.42	1.42	1.42	1.42	1
15.03	9.73	9.34	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	5.54	5.54	5.54	5.54	5.
12.50	18.10	18.49	18.54	18.54	18.54	18.54	18.54	18.54	18.54	18.54	18.54	22.29	22.29	22.29	22.29	2[illegible]
72.55	90.[illegible]	1[illegible].44	127.98	146.52	165.06	183.60	202.14	220.68	[illegible]	257.76	276.30	[illegible]	[illegible]	343.17	[illegible]	[illegible]

SECTION 2

(... million $)

	Construction period 1	2	3	1	2	3	4	5	6	7	8	9	[illegible]	11	12	[illegible]
SOURCES OF CASH																
Equity (share capital)	1.22	7.66	6.12	-	-	-	-	-	-	-	-	-	-	-	-	-
Long and medium term loan	10.61	55.96	48.77	1.97	-	-	-	-	-	-	-	-	-	-	-	-
Short term loan	-	-	6.10	2.96	-	8.30	2.44	-	6.18	-	-	-	-	-	-	-
Net profit/loss	-	-	-	(-)4.35	2.06	4.53	8.21	11.67	8.02	13.54	16.37	12.50	[illegible]	15.49	15.7[illegible]	[illegible]
Depreciation and Amortisation	-	-	-	6.25	6.28	6.25	6.25	6.25	5.15	5.15	5.15	5.15	[illegible]	5.17	5.17	[illegible]
TOTAL (A)	11.53	58.62	60.99	6.56	8.34	10.11	16.93	17.95	19.35	18.72	21.55	17.25	[illegible]	23.[illegible]	23.71	[illegible]
APPLICATION OF CASH																
Capital expenditure	11.80	56.62	54.19	2.19	-	-	-	-	-	-	-	-		-	-	-
Interest during construction	0.03	2.00	6.80	-	-	-	-	-	-	-	-	-		-	-	-
Working capital requirement	-	-	-	3.97	1.32	1.32	-	-	-	-	-	-	-	-	-	-
Repayment of long and medium loan	-	-	-	0.70	6.08	12.63	13.97	13.97	13.96	13.60	12.35	11.78	[illegible]	3.80	0.12	-
Repayment of short term loan	-	-	-	-	-	6.10	2.96	-	8.30	2.44	-	6.18	-	-	-	-
TOTAL (B)	11.83	58.62	60.99	6.56	7.40	20.05	16.93	13.97	22.26	16.04	12.35	17.96	[illegible]	3.80	0.12	-
CASH SURPLUS (A - B)																
Current	-	-	-	-	0.94	(-)10.94	-	3.98	(-)2.88	2.68	9.17	0.02	13.[illegible]	13.[illegible]	23.[illegible]	23.71
Cumulative	-	-	-	-	0.94	-	-	3.98	1.10	3.78	12.95	12.97	[illegible]	[illegible]	[illegible]	[illegible]

... Engineering International GmbH

SECTION 1

[illegible]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	12.50	[illegible]	[illegible]	15.54	15.54	15.54	15.54	15.54	15.54	15.54	15.54	15.54	22.29	22.29	22.29	22.29	[illegible]
[illegible]	5.18	5.18	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	1.42	1.42	1.42	1.42	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	[illegible]
[illegible]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	11.78	[illegible]	3.50	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	6.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	17.96	9.32	3.50	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	0.02	[illegible]	[illegible]	23.59	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71	[illegible]
[illegible]	12.07	[illegible]	[illegible]	70.38	[illegible]	117.80	141.51	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	283.77	307.48	331.19	[illegible]	[illegible]

SECTION 2

6 - Project Evaluation (cont'd)

return. For this adjustment, apart from adding back depreciation and deferred charges the interest charges on loans have also been added back to work out internal rate of return on the total investment including loan capital.

For the Valentine project in the 25th year of operation, the residual value of the plant is estimated by Brazilians at US $ 17.55 million. The working capital of US $ 6.6 million is also assumed to be fully salvaged at the end of the 25th year. The beginning of the first year of operation is taken as zero point for working out the present value. All fixed investment outflows during construction period have been compounded.

In Table 6-3 present values of outflows and inflows have been arrived at by adopting two trial rates of 12% and 15%. On this basis the internal rate of return of the project work out to 13.27%.

Pay-back period

In Table 6-4 the pay-back period of the project is worked out using traditional method of actual net inflows. The pay-back period of the project is about 9.4 years.

6 - Project Evaluation (cont'd)

TABLE 6-3 - INTERNAL RATE OF RETURN
(Million US $)

	Fixed investment excluding capitalised interest	Working capital loan	Total fixed investment	Present value 12%	Present value 15%
A. CASH OUTFLOW					
Construction period					
1	11.80		11.80	16.57	17.94
2	56.62		56.62	71.00	74.85
3	54.19		54.19	60.69	62.32
Operation period (zero period)					
1	2.19	2.04	4.23	4.23	4.23
Total	124.80	2.04	126.84	152.09	159.34

B. CASH INFLOW

Year	Adjusted Cash surplus	Discounted at 12%	Discounted at 15%
1	11.71	10.45	10.18
2	17.70	14.11	13.38
3	23.58	16.79	15.49
4	23.71	15.05	13.56
5	23.71	13.44	11.78
6	23.71	12.00	10.25
7	23.71	10.71	8.92
8	23.71	9.57	7.75
9	23.71	8.54	6.74
10	23.71	7.63	5.86
11	23.71	6.81	5.10
12	23.71	6.08	4.43
13	23.71	5.43	3.85
14	23.71	4.85	3.35
15	23.71	4.32	2.91
16	23.71	3.86	2.53
17	23.71	3.45	2.20
18	23.71	3.08	1.92
19	23.71	2.75	1.67
20	23.71	2.45	1.45
21	23.71	2.19	1.26
22	23.71	1.96	1.09
23	23.71	1.75	0.95
24	23.71	1.56	0.83
25	47.87	2.78	1.44
		171.61	138.89
	Ratio A/B ..	0.89	1.15
	IRR ..	13.27%	

6 - Project Evaluation (cont'd)

TABLE 6-4 - PAY-BACK PERIOD
(Million US $)

A. CASH INFLOW

Year	CASH INFLOW Current	CASH INFLOW Cumulative
1	1.93	1.93
2	8.34	10.27
3	10.81	21.08
4	14.49	35.57
5	17.95	53.52
6	13.20	66.72
7	18.72	85.44
8	21.55	106.99
9	17.98	124.97
10	23.28	148.25

B. CASH OUTFLOW

	ESTIMATE FOR THE PERIOD
Construction period	
1	11.80
2	56.62
3	54.19
Operation period	
1	2.19
Interest during construction	8.83
TOTAL	133.63

C. PAY BACK PERIOD = 9.4 years

7 - APPROACH TO SOCIAL COST-BENEFIT ANALYSIS

Increasingly, project choice is being used by economies in the process of industrialisation as a tool in achieving the State objectives, in view of the constraints the State faces in using fiscal measures to achieve welfare goals. Social cost-benefit analysis has been evolved to examine how far the projects contribute to the achievement of such welfare goals.

Obviously, setting up of such a basic industry as steel goes a long way in realising the objective of generating not only changes in income but also in the economic structure i.e. increase in the combined share of the industry, mining, construction and the transport sectors in GDP. Apart from this, implementation of a basic industry does also fulfil the overall objective of attainment of a more equitable distribution, development and its gains leading to the welfare of the entire nation.

In the Uruguayan context, the country today is basically agriculture and tourism-oriented and at the same time, it enjoys a high standard of living and per capita income. By the installation of the proposed steel complex based on Valentine ores, an entire gamut of activities would be generated towards providing the various inputs required and later in utilsing the finished products for construction and other activities.

The prospects of increased inflow of foreign exchange by attracting tourist traffic to the country are bright and this could further stimulate construction activities in the hotel and related branches. The ready availability locally of a crucial engineering material

7 - Approach to Social Cost-Benefit Analysis (cont'd)

like steel would in turn result in considerable employment potential in the industrial sector.

The overall social and economic benefits arising out of the development of the steel industry are generally outlined below:

Development of Human Resources

In comparison to other heavy industries in which operations are continuous and automated, the steel industry provides greater opportunities for the formation of technical and organisational skills in a wide range of disciplines. Though the benefits of skill formation are largely intangible, a study of the development process of various countries establishes human skill as the single largest factor in promoting the economic prosperity of a country.

Realisation of social returns on the massive investment in general education will depend on the simultaneous creation of job opportunities in capital-intensive industries. It is well known that for every job in the steel plant, twenty or more new jobs are created in other steel based manufacturing industries as well as in non-manufacturing industries like mining, construction, transportation etc. Because of this multiplier effect, investment in steel is paid back many times over by its contribution to industrial development and economic growth.

In other words, the steel industry will generate a massive fund of human wealth in Uruguay in the form of skills, organisational capacity and management talents in one place, from where it will in due course be disseminated through the development programme to different parts of Uruguay.

Backward and Forward Linkages

The prospects and potential of any economy are through the establishment of heavy industries and the linkage of the industry to other industries. Due to its high backward and forward linkages, the establishment of steel industry stimulates the rapid growth of steel consuming industries using its outputs and of feeder industries supplying the inputs and services.

Backward linkage: The operations of the steel plant will draw a large number of local inputs such as iron ore, limestone, dolomite and steel scrap (to the extent it is locally available). They will also encourage in the expansion of the domestic shipping and trade by imports of equipment, ferro-alloys, fluxes etc in shiploads. It will also put into economic use a number of by-products from other industries such as residual fuel oil from the refineries, acids from the chemical complexes, automotive and industrial scrap etc. Viewed against this background, the backward linkage effect of the energy-intensive steel industry could be considered sizeable.

Forward linkage effect: International inter-industry economic comparison of selected developed countries has shown that the forward linkage effect of steel industry is higher than that of any other industry. In other words, the proportion of the products of the steel industry used as a material input by other industries is the highest among all industries. The products of the steel industry in Uruguay will find extensive use in other industries such as building and construction, galvanizing units, wire drawings units, engineering industry etc.

The largest consumer of steel in Uruguay is the engineering and construction industry, most of the requirements of which are met at present through imports; also substantial quantities of engineering goods are imported as such into Uruguay. Thus, with the growth of the domestic steel industry, in addition to the construction sector, the other biggest beneficiary will be the engineering industries which play a key role in the economic development and act as catalyst in the speedy economic and social development as outlined below:

(i) Engineering industries generally contribute one-third of the gross capital formation in the form of metal products, machinery and transport equipment.

(ii) Together with construction, they are the largest element in the new production capacity required for the national output.

(iii) In countries with high per capita income, their consumption accounts for about 10 per cent of the total consumption from all sectors of the economy and therefore, this consumption competes with the investment.

(iv) Engineering industries have a much lower capital-output ratio and hence, setting-up of such industries in the country tend to improve overall capital-output ratio of the metal based industry and the economy as a whole.

7 - Approach to Social Cost-Benefit Analysis (cont'd)

Indirect Benefits

Several benefits accrue to a country through the establishment of a heavy industry like steel. Firstly, the proportion of civil and structural steelwork in capital investment is more massive in the installation of a steel plant than in most of other industries. Construction of this magnitude can stimulate development of many construction industries like fabrication of steel structures on the basis of imported steel; develop the construction expertise in the execution of complicated civil engineering work; and can augment the employment opportunities during the construction phase.

As the component of labour cost in the steel industry is quite high in comparison to other heavy industries, its establishment generates high incomes and more equitable distribution of incomes.

Other Benefits

Besides the special social benefits described above, the steel industry will also yield additional benefits to the Uruguayan economy generated by the establishment of other industries. Some of the typical benefits are:

i) With the substitution of trade by manufacture, the transfer of income from the tertiary sector to the secondary sector will be effected and this will help abating the inflationary trends.

ii) Terms of trade with other countries will be improved.

7 - Approach to Social Cost-Benefit Analysis (cont'd)

iii) Significant scale economies of the non-tradable public utility services will be achieved in respect of inland transport, electricity, water, telephone and other communication systems

iv) More balanced manpower occupational pattern will be achieved by promoting the mobility of manpower from the agricultural and the trade/service sectors to the manufacturing sector

v) The synergetic effect of one industry advancing the rhythm of development of other industries will be achieved.

vi) The Government of Uruguay will get back a part of the salaries, wages and expenditure in the form of turnover tax, corporate taxes, indirect taxes in the form of import and customs duties etc.

Social Benefit of Steel Plant Infrastructure Facilities

Most of the investment in the development of infrastructure for the steel plant will, in due course, improve the social and the economic structure of the country. Thus, for instance, the construction of the captive harbour, roads and communication, township etc, will throw open new areas for development.

7 - Approach to Social Cost-Benefit Analysis (cont'd)

SOCIAL PROFITABILITY

Social Evaluation

There are atleast three aspects in which the appraisal of a project's worth to the community differs from the appraisal from commercial point of view. First, whereas the economic worth of a project is usually calculated utilising the market prices of production factors, the evaluation from the community's viewpoint needs to be based on the use of prices which reflect the scarcity of these production factors. As market prices may not measure the marginal productivity of production factors because of imperfections in the market, 'shadow' prices may have to be employed. Secondly, the 'community evaluation' should take into account such factors as the indirect or secondary benefits or costs attributable to the project. Thirdly, the social evaluation will measure the net return to the economy by relating total benefits to total costs, rather than to any particular factor. The evaluaötion is, therefore, made in terms of the social rate of return.

The government authorities and planners in various countries have approached the problem of reaching crucial decision on supporting investment in the highly capital-intensive steel industry and reconciling the conflicting stimulants and constraints depicted in Figure 7.1 in different ways. The ranking of importance by the planners in different economies to major considerations for this decision-making is illustrated in Table 7-1.

STEEL PLANT FACILITY PLANNERS
HAVE TO RECONCILE CONTRADICTORY
FORCES TO ACHIEVE GOALS

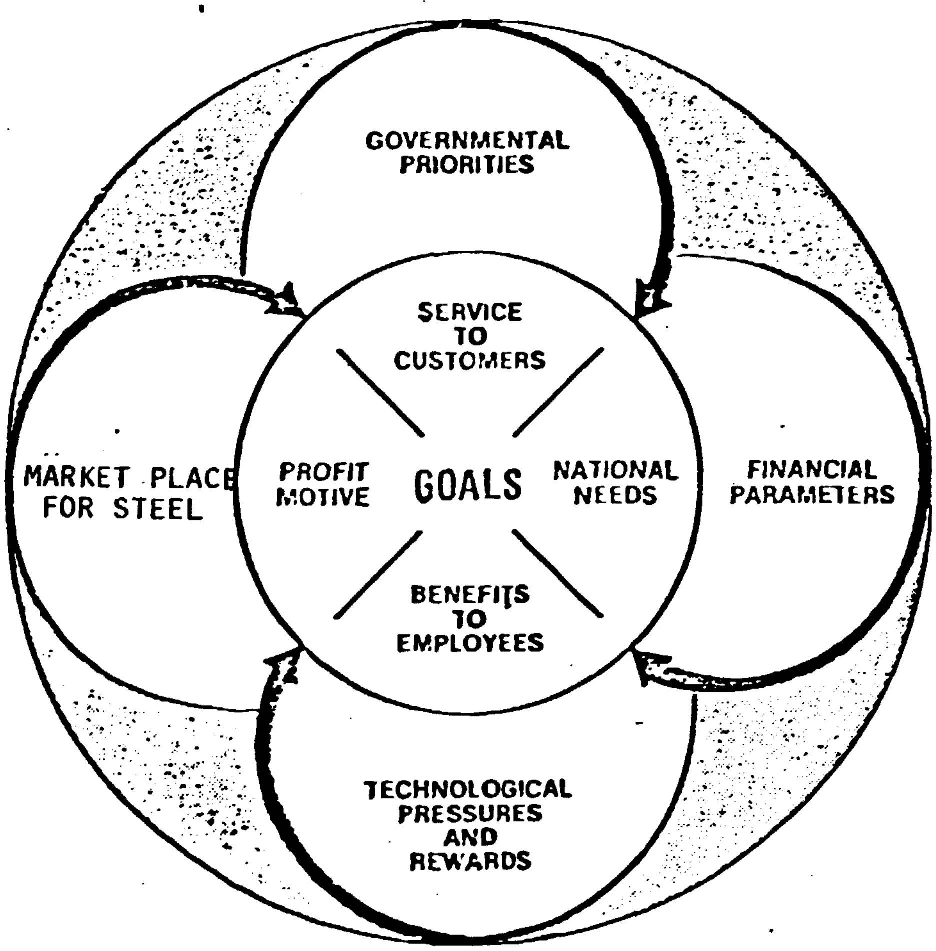

FIGURE 7.1 - STIMULANTS AND CONSTRAINTS FOR STEEL INDUSTRY

TABLE 7-1 - KEY TO RANKING

Decision making factor	Group
"Stature" of steel industry	A
Government/steel industry relationship	A
Existing large steel market	A
Availability of skilled workers	A
Energy availability and cost	A
Raw materials for steel:	
- ore	A
- coal	A
Extent of supporting infrastructure	A
Steel plant sites on deep water ports	A
Profit motive	B
Degree of government involvement in steelmaking decisions	B
Government protection of domestic steel markets	B
Expansion plans	B
Availability of funds	B
Ability to lay-off workers	B
Producers' pricing freedom	B
Pollution abatement requirements	C

NOTE:
(1) Rankings are classified as follows:

	1	2
A =	Excellent	Typical
B =	High	Moderate
C =	Least costly	Average

Source: 'Internationalization of Steel' - Hutchins Inc, in February 1974.

OF FACTORS FOR DEVELOPMENT OF STEEL INDUSTRY

Type of economy						
Free enterprise	Socialist		Mixed		Developing	
USA	USSR	China	ECSC	Japan	Brazil	Typical
3	1	NA	2	1	1	1
3	1	1	3	1	1	1
1	1	2	1	1	3	3
1	1	3	1	1	2	3
1	1	1	3	3	3	3
1	1	1	3	3	1	2-3
1	1	1	2	3	3	2-3
1	1	3	1	1	2-3	3
2	3	2	2	1	1	1-2
1	3	3	2	2-3	3	3
3	1	1	1-2	1	1	1
3	1	1	3	1	2	1
3	2	1	2	1	1	2
3	1	1	1	1	1	1-2
1	2	2	2	3	2	2
3	1	1	3	2-3	2	2
3	2	1	3	3+	1-2	1

3
Poor
Low
Most costly

published by Mitchell,

7 - Approach to Social Cost-Benefit Analysis (cont'd)

Objectives of Planning in Uruguay

Despite the present high per capita and the favourable balance in respect of the foreign exchange transactions of trade and services enjoyed by Uruguay, from the planning point of view, the urgency and the priority that needs to be accorded to a project has to be assessed in the context of the fulfilment of the major development objectives, namely:

(i) creation of assets with high appreciation potential

(ii) diversification of the economy into industry, to accelerate attainment of self-generation stage

(iii) harnessing limited manpower resources of the country into most productive uses; and

(iv) equitable distribution of the country's wealth.

Taking cognisance of the interaction of these socio-economic objectives, the authorities have rightly given attention to using the locally available iron ore and coal resources to the most extent possible, based on the following guidelines:

(i) To embark on projects for implementation having high potential for appreciation of assets notwithstanding their gestation duration, provided marketability of their products can be assured with a measure of confidence;

7 - Approach to Social Cost-Benefit Analysis (cont'd)

(ii) To channelise investment in these sectors which can stimulate growth of other economic activities by their backward and forward linkage effects;

(iii) To utilise investment as an instrument to accelerate the transfer of limited manpower into sectors which can be more productive due to their intrinsically high capital intensity;

(iv) To equip the limited work force with the necessary skills and disciplines to enable them to man in the long run on their own the job opportunities created by massive investments; and

(v) To create social amenities and services to distribute benefits of the country's wealth down to the common man and the underdeveloped regions.

Approach to Social Profitability

In preparing the social profitability analysis, the financial receipts (represented by the sales realisations) and expenditure (corresponding to the capital and operating costs) have to be so adjusted that the resulting difference will give a realistic indication of the net social gain. The social benefits can thus be assessed in terms of the net increase in the welfare of the society in consonance with the objectives of development in Uruguay. This would necessarily involve visualisation of the major changes in the various sectors of the economy which would take place by setting up the steel project.

7 - Approach to Social Cost-Benefit Analysis (cont'd)

Basic Assumptions and Procedures

The following paragraphs discuss the social implications of the Valentine project and seek to quantify the gross social costs and the gross social benefits. The estimation of social costs and social benefits is essentially a subjective econometric exercise and the social rate of return is calculated by discounting the net social benefits. The general procedures adopted in attempting a social cost benefit analysis are outlined below:

Computation of social costs

All financial costs of the project during the construction period and during the operational stage are to be converted to social costs. The foreign exchange component of the total financial costs has been segregated to estimate the costs to be incurred in local currency. Direct expenses in foreign exchange are treated as direct social costs, since these amounts have opportunity costs; that is, if they are not expended on this project, they would be available for the import of steel products or for other capital/consumer goods, as may be decided by the Government agencies.

Local currency costs are to be classified into three categories, namely, tradables, labour and residual.

Tradables

In the category of 'tradables' or materials are those items which involve expenditure on goods which can be traded on the international market. An item like power may not be a tradable item in practice in the international market, though the cost of extra generation required for the steel plant would be accounted for in terms of the costs incurred on the import of requisite power generating equipment. However, items which can be theoretically traded in the international market are to be treated as 'tradables'. In order to find out the value obtainable by their export, the local currency costs are to be converted to international prices through appropriate conversion factors. In respect of certain items, it is normally to be assumed that the local costs (Uruguayan) are of the same order as the prices prevailing in the international market and in such cases, no conversion factors are to be adopted.

Labour charges and shadow rates

To assess the social costs of payments to labour on the project, the manpower is generally divided into three categories, namely supervisory or skilled personnel, semi-skilled labour and unskilled workers. The shadow rates for these three categories are approximately assumed as a percentage of the monetary salaries and wages respectively.

The social costs are necessarily lower than monetary salary and wage payments for various reasons. Some of the salient ones are:

(i) as unskilled workers will be drawn mainly from new entrants to the work force, the industrialisation of Uruguay will enable diversion of manpower from subsidised and overemployed sectors of economy to more productive ones, therey reducing the concealed subsidies in other sectors of economy.

7 - Approach to Social Cost-Benefit Analysis (cont'd)

(ii) the consumption pattern that develops through such payments helps to accelerate the overall economic development, through greater use of services and consumer goods of Uruguayan origin;

(iii) intangible human wealth through the development of skills in new areas is stimulated, and

(iv) a part of these payments are returned to the society in the form of direct and indirect taxes.

The shadow rate adopted for the semi-skilled and unskilled labour is somewhat lower compared to the supervisory or skilled personnel, in view of the fact that the social costs are usually lower in the case of the lower category of workers for the following reasons:

(i) Employment generation in the lower category helps to funfil the social objective of providing a wider base for employment in new and more productive ventures

(ii) As employment of unskilled workers will be drawn mainly from new entrants to the Uruguayan workforce, it would help in attaining the social objective of adjusting income distribution

(iii) For lower categories of workers, the rate of skill formation is more rapid.

7 - Approach to Social Cost-Benefit Analysis (cont'd)

The pattern of shadow rates adopted is in keeping with the overall objective of the Uruguayan Government of providing better employment opportunities in the industrial sector.

Residuals

In the category of 'residuals' are those items of costs which are not included either under tradables or under labour charges such as payments for rent, administrative expenses and profits of local contractors employed for construction.

Shadow rate of investment

All the financial costs of investment (at market prices) in the steel plant and related infrastructure facilities, namely, the power generation and desalination plant, township, harbour, natural gas pipeline and construction facilities are to be reduced to the opportunity cost of investment (at market prices). The reasoning for the use of opportunity cost of investment is outlined below:

Conversion of capital cost to social cost:

Total capital costs for different units are to be broken down into foreign and local currency components. Local currency component is again to be broken down into materials (tradables),labour and residuals. The material cost is to be suitably adjusted by the standard conversion factor to arrive at the comparative international prices of the material. The residual items are excluded from social profitability calculations. Labour cost has to be further divided into three categories of supervisory/skilled, semi-skilled and unskilled labour.

In computing the yearly values of the social capital cost for the steel plant and the infrastructure facilities, the annual phasing of capital expenditure is to be adopted as the basis.

Conversion of operating cost into social cost:

Operating cost is to be converted similarly into social cost by first breaking down the estimated costs into foreign and local currency components. Likewise, the local currency component of the material cost is to be adjusted with suitable standard conversion factors. Labour cost is also to be adjusted by using appropriate shadow rates.

Payments of interest charges are conventionally excluded from the social operating costs, except where these payments are payable in foreign currency against the foreign currency borrowings.

Social benefits:

Social benefits of the steel complex comprise: (i) foreign exchange savings in steel imports, (ii) contribution of the steel plant atleast partially to the defence development effort of the country, (iii) savings in the national inventory of imported materials due to local availability of rolled steel products and (iv) the residual value of the complex at the end of accounting period.

The social cost-benefit ratios are worked out by discounting the social investment and the net social benefits at appropriate rates per annum.

8 - SUGGESTED ACTION POINTS

In the foregoing seven chapters several specific aspects of the Bid-cum-Feasibility Study submitted by the Brazilian Consortium have been dealt with. Based on DEI's international experience and designing and operating practices being adopted in other plants of similar capacity and production route, various suggestions have been incorporated in respective chapters for consideration by Project Authorities.

With a view to help implementation of the Valentine Project, DEI presents hereunder areas where action has to be initiated by the Project Authorities.

The viability of the Valentine Project, based on the estimated capital cost, cost of financing, sales realisation and production cost, is well established. The internal rate of return, as computed by DEI works out to 13.2% which by any international standard is quite attractive.

It should, however, be mentioned that DEI's calculation has been made using information provided in the Brazilian study. Though generally well prepared, the Brazilian study does not give sufficient details/ clarifications needed for a detailed analysis. In this respect, confirmation should be sought from the Brazilian Consortium on the following aspects:

a) The Brazilian Consortium should be asked to confirm that the investment cost estimated by them includes all expenses for starting up of the plant. Also cost of spares for initial two years operation is included as is the usual practice.

b) Also, Project Authorities should obtain firm financing cost. This is vital because, on this depends the project viability.

c) Expeditious arrangements should be made between the governments of Brazil and Uruguay, giving protection to the export of Valentine project's product to Brazil, considering that the plant is to be built and supplied by a Brazilian Consortium.

d) As this plant is visualised as a joint venture, some sort of risk participation from the Brazilian side will be logical and justifiable. It is seen there is no equity participation from the Brazilian side. This should be easily possible as the total equity capital represents only 11% of total investment. The risk participation could be in various forms like participation in equity capital or loan guarantee participation etc.

8 - Suggested Action Points (Cont'd)

The Brazilian Consortium estimates total construction time i.e. from go-ahead date to plant going into operation as 39 months. To adhere to this schedule, and if possible to improve upon the construction time, it would be essential to take immediate advance action on the following:

a) Detailed site survey and soil testing
b) Planning of the dam at Valentine for water supply to the plant
c) Arrangements to connect plant site with the railway line which is some kilometres away
d) Arrangement for bringing electrical power to the plant from the 12 km away sub-station. Also getting confirmation about the natural grid's capacity to meet plant's requirements
e) Assessment of the requirement of construction facilities and establishing the capability of national contractors to meet project requirements. In case of a shortfall in indigenous construction capacity, services of foreign companies might be negotiated
f) Establishment of forestration and charcoal making facilities as well as arrangements with private entrepreneurs for supply of charcoal

8 - Suggested Action Points (cont'd)

g) Identification of definite sources for the supply of limestone, dolomite etc for the plant's operation

h) Extensive bench-scale and industrial tests on representative iron ore samples to finalise parameters and equipment needed for ore beneficiation and to confirm the feasibility of producing assumed quality of concentrate and sinter

i) Establishment of indigenous human resources availability and training facilities to meet project needs

j) Formation of Valentine project-execution company or any other form of authority who will be responsible for the plant construction and eventually operation of the plant.

The points mentioned above are in the form of check-list for advance action necessary for the successful implementation of the project. Above all, consideration may be given to the commissioning of a detailed engineering study. Such a study would help in evolving definite plant parameters based on extensive testing of raw materials specially iron ore in laboratory and semi-industrial scale etc.

APPENDICES

APPENDIX - 1

SCOPE OF WORK OF CONSULTING ENGINEERS

Relevant extracts from the UNIDO contract no.80/138/dg between the United Nations Industrial Development Organisation and Dastur Engineering International GmbH are reproduced below:

1.00 AIMS OF THE PROJECT

The aims of the Project are:

a) The development objective is the utilisation of the country's natural resources by exploiting the iron ore deposits of Valentines, for iron and steel production.

b) The immediate objective is to evaluate the tenders for the execution of a project to undertake the industrial exploitation of the iron ore deposits in close co-operation and co-ordination with the Uruguayan authorities.

2.00 OUTPUTS

The subcontracting firm will prepare a report consisting of an evaluation of the technical, economic and financial aspects of the offers presented.

Appendix - 1 (cont'd)

3.00 ACTIVITIES

a) Definition of the methodology to be used in the evaluation of the offers.

b) Analysis of the investment capital including fixed and working capital.

c) Analysis of the cost of production at different states of ore concentration, pelletisation, reduction, refining, castings and rolling.

d) Analysis of the various financing proposals.

e) Evaluation of the technology offered for the different process states.

f) Specification of the equipment required.

g) Evaluation of the infrastructure and services proposed to be furnished by the bidders such as water, gas, electric energy, etc.

h) Evaluation of the amount and quality of labour inputs which will be needed at each stage.

i) Evaluation of the work plan and implementation schedule proposed.

4.00 REPORTS

The Contractor shall submit to UNIDO the reports which are listed below. Such reports shall be written in accordance with Annex D entitled

Appendix - 1 (cont'd)

"Basic Principles of Scientific Report Writing" and dispatched in accordance with Annex C entitled "Instructions to Contractors for the Dispatch of Reports" which are attached hereto and made parts hereof.

a) <u>Draft Final Report</u>

A Draft Final Report, in English, in six (6) copies, covering the work performed in accordance with paragraph 2.01 hereinbefore and Annex E hereof, which shall be submitted to UNIDO, Vienna, in time to ensure it is received not later than fourteen (14) calendar weeks following commencement of the work in the Project Area (19 November 1980 - revised 3 March 1981). In the preparation of the Final Report referred to in sub-paragraph b) hereinafter, the contractor shall give due consideration to the comments formulated by UNIDO and the Government in the course of the Draft Final Report Review meeting referred to in paragraph 2.04 hereinbefore which UNIDO shall confirm in writing to the Contractor within two (2) calendar weeks after completion of the said Review meeting.

b) <u>Final Report</u>

A Final Report, in English, in thirty (30) copies, covering the work performed in accordance with paragraph 2.01 hereinbefore and Annex E hereof, which shall be submitted to UNIDO, Vienna, in time to ensure it is received not later than five (5) calendar weeks after the Contractor's receipt of UNIDO's comments on, or approval of, the Draft Final Report referred to in sub-paragraph a) hereinbefore.

APPENDIX 3-1

TECHNIQUES OF DEMAND FORECASTING

For estimating future steel demand, there are various techniques ranging from historical analogy and other simple empirical methods to complicated statistical techniques, as well as other techniques such as Delphi Model, Scenario and PATTERN. Amongst the various techniques, the well established ones are time-trend analysis, regression analysis and the end-use method. The various techniques are briefly discussed below.

Historical analogy method

The historical analogy method consists of examining past trends of steel consumption in countries which have attained a fairly high level of steel consumption, when the economic development level was comparable to that of the country under study. While historical analogy gives some insight into the changing patterns of steel consumption in relation to economic development at different points in time, it does not take into consideration the effects of technological changes in production and of substitution on steel consumption. Moreover, the economic development attained by countries at different stages of growth may not be readily comparable, as the pattern of development could vary widely due to differing political and economic systems.

Trend method

The trend method is based on linear or non-linear time series relationship that can be established on the basis of past consumption. The use of this method for

Appendix 3-1 (cont'd)

forecasting, therefore, requires availability of long and reliable time series data on consumption of steel in order that forecasts made are also reliable. Nevertheless, the method may be used for cross-checking the demand projections obtained by other methods.

Regression method

Instead of relating the steel consumption on time intervals, the regression method correlates the consumption (a dependent variable) with an independent variable or variables, usually macro-economic factors such as national income, gross domestic product, index of industrial production etc. The correlation may be simple with only one independent variable, or may be multiple involving more than one independent variable. Here again, as in the trend method, a long reliable series of past data is required to establish the relationship.

End-use method

Past experience has shown that the end-use method is by far the most appropriate one for forecasting the demand for an industrial product in a developing country, especially when the results are required in category-wise breakdown and not aggregate levels.

The end-use method is basically a derivative approach which starts with an analysis of the current demand for steel by major consuming sectors in terms of steel types and product categories. On the basis of projections of the growth of major steel using industries and sectors, as well as the technical norms of consumption, the future pattern and volume of demand are assessed. For this purpose, it is necessary to have past data for at least 10 to 15 years on the category-wise steel consumption in the country for different steel consuming items, as well as indication of future anticipated growth rates of these items.

Delphi model

The Delphi model developed by RAND Corporation is based on intuitive thinking of the experts. This is essentially a refinement of the original 'brain-storming' technique. It seeks the advice of a number of experts who are asked to critically review the current thinking and indicate the possible break-through in the economy. In this method of analysis, the intuitions of the experts help a forecaster to indicate the possibility of break-throughs in the economy. The method is relevant to forecasting possible break-throughs in technology or economy rather than for forecasting demand, as the latter involves many end-uses, each of which is a technology in itself. Application of this technique calls for 'brain-storming' sessions of a multitude of experts which is practically impossible in a developing country.

Scenario writing

This technique, developed by Hudson Institute, attempts to set up a logical sequence of events in order to show how, starting from the present or any other given situation, a future state might evolve step by step. The primary purpose is not to predict the future but to explore systematically branching points depending upon critical choices.

Appendix 3-1 (cont'd)

PATTERN technique

PATTERN (project assessment through technical evaluation of relevance number) technique requires the goal to be fixed. This method was employed by NASA for their 'Apollo' programme. The PATTERN method is essentially a technique for pinpointing the deficiencies in the technology proposed for achieving a certain fixed goal and not one for studying the demand of iron and steel.

APPENDIX 6-1

EXTERNAL SOURCES OF FINANCING FOR INDUSTRIAL PROJECTS

The external sources of financing available for industrial projects in developing countries can be broadly classified under three categories as follows:

i) International sources of financing;
ii) Regional sources of financing; and
iii) Export credits from industrialised countries

International sources of financing

The main sources of international financing are IBRD, IDA and IFC.

The International Bank for Reconstruction and Development (IBRD) also known as World Bank provides loans for specific projects promoted by Governments, governmental agencies or private enterprises. Generally, funds cover foreign exchange expenditure and are repayable in the currency borrowed. The terms of loan are related to the characteristics of project; grace period is given and the interest rate is based on the cost to the bank raising money in capital markets. The Bank requires a guarantee from the member government, if the borrower is not a Government; and also the Bank requires that goods and services purchased with the proceeds of its loan be acquired on a basis of international competitive bidding by suppliers.

The International Development Association (IDA) makes credit available to less developed and low income countries whose balance of payment problems make it difficult or impossible to service sufficient imports of external capital at very concessional rates.

Appendix 6-1 (cont'd)

The International Finance Corporation (IFC) mainly operates as an International Investment Bank and makes loans, invests in equities, underwrites sales of securites and shares in new or expanding private enterprises. IFC invests in less developed member countries, when sufficient private capital is not available to them on reasonable terms.

Export credits from industrialised countries

Export credit is one of the attractive form of long-term financing available to today's market conditions. It is common practice for countries with large export markets to provide Government-supported credit to assist the financing of capital goods. The facilities available to finance individual projects can be further classified into:

- Buyers' credits
- Suppliers' credits

Under the buyers' credit scheme, the bank in the suppliers' country makes a loan to the importer which is used to finance the payments to the supplier as per an agreed contract. The finance can cover services as well as goods.

Normally such credits are available for an amount equal to roughly 85 per cent of the content of the supply contract. It is possible that a small proportion of the local supply (for large contracts) can also be covered by such credits. Repayment of the loan normally starts after the estimated commissioning of the project and the

Appendix 6-1 (cont'd)

period of repayment may vary from 5 to 10 years depending on the size of the project and contract. Normally such credits stipulate the payment of interest semi-annually, with the interest rate ranging from 7 to 8 per cent.

Suppliers' credit is made available direct by the supplier to the buyer in the form of deferred payments. The terms are much the same as for buyers' credits. Suppliers' credit is normally made available for small orders, while the buyers' credit is made available for big contracts. The normal currency of contract is either US Dollar or Deutsche Mark.

The terms of export credit vary depending on the country providing export credits. Export credit is made available by many countries such as Austria, Belgium, Canada, Czechoslovakia, Denmark, Federal Republic of Germany, Finland, France, Hungary, India, Italy, Japan, Netherlands, Norway, Poland, Romania, Sweden, Switzerland, USSR, UK and USA.

Other sources

Apart from the above mentioned categories, other sources can be the Development Assistance Committee of the Organisation for Economic Cooperation and Development.

At times, joint ventures between private enterprises and Governments are possible on production compensation basis, that is, the supplier will give the loan at a very concessional rate in return for an assured supply of finished output.

Appendix 6-1 (cont'd)

When the project is financially very attractive and when the importer is going in for the first time, it is possible that the supplier may indicate his willingness to invest in the project. The importer may agree to foreign equity participation if he perceives a greater than normal amount of risk in the investment.

Apart from the direct investment, portfolio investment, namely through a variety of flows such as purchase of bonds issued by the developing countries, the purchase of equity in existing companies etc has also been one of the sources. The availability of Euro-currency facilities, basically credit from the "on lending" of banks in one country from the deposits placed with them by residents abroad, has led to Euro-currency lending.

Review of financing arrangements[1/] carried out in the recent past

It may be worthwhile at this juncture to examine the financing arrangements in the recent past, for development schemes for integrated steelworks in developing countries. Following summary notes indicate the type of financial terms and conditions which have been established in this field of financing.

i) Deposit notes with a life of three years were issued by the National Bank of the developing country in cooperation with a

1/ Note on Aspects of Financing Steelworks and Ore Field Development in Developing Countries, UNIDO, 1979.

Proceedings from Second Consultation Meeting on the Iron and Steel Industry, January 1979.

Appendix 6-1 (cont'd)

bank in USA, covering 10 pe cent of the total cost of the project and redeemable at six-monthly intervals. The rates of interest were calculated at 1/2 per cent above the London Inter Bank offered rate for 6 month US Dollar deposits.

ii) Loans from the EXIM Bank in USA or with their guarantee covered 40 per cent of the estimated cost of a project and were repayable at six-monthly intervals over periods ranging from 7 to 14 years including a grace period of 4 years. Rates of interest were quoted at 7/8 per cent above the US prime lending rate, or 1 per cent above the LIBOR rate[2/].

iii) An unsecured loan for 20 per cent of the cost of a project was negotiated for repayment at six-monthly intervals over five years starting three years after the first advance. The rate of interest was 2 per cent above the LIBOR rate.

iv) European export credit organisations provided finance for 15 per cent of the cost of one project and 50 per cent of another, with repayment at six-monthly intervals over 12 years starting six months after commissioning of the plant. Interest rates ranged from 7.5 per cent to 8.5 per cent.

2/ LIBOR - London Inter-Bank Offering Rate

Appendix 6-1 (cont'd)

v) A Euro-currency loan was organised by a British merchant bank for 15 per cent of the cost of a project, the finance being advanced in three tranches with maturities of 5, 6 and 7 years. Rates of interest varied from 1-7/8 per cent to 2-1/8 per cent above the LIBOR rate.

vi) The World Bank made a direct advance amounting to 7 per cent of the cost of a project with a term of 15 years including a five-year grace period. The loan was guaranteed by the national finance institution and carried an interest rate totalling 9 per cent.

vii) A country importing iron ore provided the whole capital cost of exploiting a new ore field, taking repayment and interest in the form of regular deliveries of ore to be completed over a period of twenty years. The effective rate of interest could be calculated as 13 per cent.

viii) A Government-to-Government loan from USSR amounted to 50 per cent of the cost of a project and formed part of a package deal including the provision of plant and consultancy services. The repayment period was 12 years and the rate of interest 2-1/2 per cent (these terms date from 1965).

Appendix 6-1 (cont'd)

The UNIDO report makes the point that international arrangements for export credit guarantee terms categorise developing countries as poor, intermediate or rich, based on their per capita income. This categorisation determines the maximum length of credit from commissioning which will normally be available, and the interest rate which currently applies:

e.g. Per capita income less than $ 1 000 7-1/2 per cent interest .. 10 years credit

Per capita income $ 1 000 to 3 000 7-3/4 per cent interest.. 8 years credit

Per capita income over $ 3000 7-3/4 per cent interest. 5 years credit