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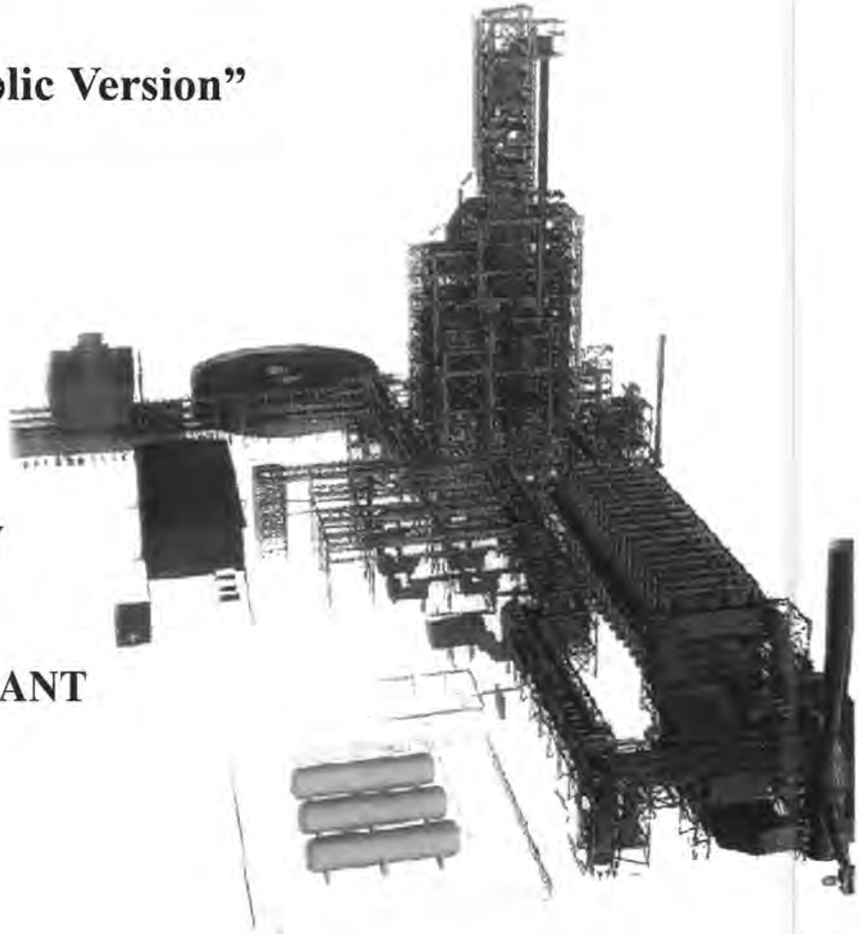

FINAL REPORT
ON
FEASIBILITY STUDY
FOR
DIRECT REDUCTION PLANT
IN
VIETNAM

PREPARED BY
UNITED ENGINEERS INTERNATIONAL, INC.
A SUBSIDIARY OF RAYTHEON ENGINEERS & CONSTRUCTORS, INC.
UNDER
A GRANT AGREEMENT BETWEEN
UNITED STATES TRADE AND DEVELOPMENT AGENCY
AND
VIETNAM STEEL CORPORATION

JULY, 2000

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FEASIBILITY STUDY
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ACRONYMS/UNITS/CHEMICAL COMPOSITIONS

- **ACRONYMS**

AA	=	Ambient Air
AASHTO	=	American Association of State Highway and Transportation Officials
AC	=	Alternating Current
ACI	=	American Concrete Institute
AF	=	Ampere Frame
AGMA	=	American Gear Manufacturers Association
AISI	=	American Iron and Steel Institute
AISC	=	American Institute of Steel Construction
AN	=	Alternation Notice
ANSI	=	American National Standards Institute, Inc.
approx.	=	approximately
AREA	=	American Railway Engineering Association
AS	=	Australian Standards
ASC	=	American Steel Corporation Private Limited, Singapore
ASEAN	=	Association of Southeast Asian Nation
ASME	=	American Society of Mechanical Engineers
ASTM	=	American Society for Testing and Materials
AWS	=	American Welding Society
BHP	=	Broken Hill Proprietary Co. Ltd., Australia
BOF	=	Basis Oxygen Furnace
BOP	=	Balance Of Plant
BS	=	British Standards
CADD	=	Computer Aided Design and Drafting
CEMA	=	Conveyor Equipment Manufacturers Association
CMP	=	Compania Minera del Pacifico S.A., Chile

ACRONYMS/UNITS/CHEMICAL COMPOSITIONS

- **ACRONYMS (continued)**

CPM	=	Critical Path Method
Craft	=	Craft Corporation, Hanoi, Vietnam
CVG	=	Ciudd Venezuelano del Guayana, Venezuela
CVRD	=	Compania Vale do Rio Doce, Brazil
CWR	=	Cooling Water Return
CWS	=	Cooling Water Supply
Dastur	=	Dastur International, Inc., USA/ M.N. Dastur & Company Limited, India
DC	=	Direct Current
DCN	=	Design Change Notice
DCS	=	Distributed Control System
DR	=	Direct Reduced
DRI	=	Direct Reduced Iron
DSCR	=	Debt Servie Coverage Ratio
DWT	=	Displacement Weight
E&IC	=	Employment & Industrial Services Centre, Vietnam
EIU	=	Economic Investment Unit
EA	=	Environmental Assessment
EAF	=	Electric Arc Furnace
EC	=	Electrical Conductivity
ECA	=	Expand Credit Agency
EMI	=	Equipment Modification Instruction
ENTEC	=	Environmental Technology Centre, Vietnam
EPC	=	Engineer/Procure/Construct
EU	=	European Union
FA	=	Forced Air
FC	=	Foreign Currency Equivalent to US $

ACRONYMS/UNITS/CHEMICAL COMPOSITIONS

- **ACRONYMS** (continued)

FIE	=	Foreign Invested Enterprise
FM	=	Factory Mutual
FOB	=	Free-On-Board
g	=	gravity
GDP	=	Gross Domestic Product
GIIC	=	Gulf Industrial Investment Company, Bahrain
H	=	Height
HBI	=	Hot Briquetted Iron
HMS	=	Heavy Melting Scrap
HYL	=	Hylsa, S.A. de C.V., Mexico
I/O	=	Input/Output
ID	=	Internal Diameter
IFC	=	International Finance Corporation
IMF	=	International Monetary Fund
IOC	=	Iron Ore Company of Canada
IRR	=	Internal Rate of Return
ISA	=	Instrument Society of America
ISCOR	=	Iron and Steel Corporation, South Africa
JICA	=	Japan International Cooperation Agency
JV	=	Joint Venture
JVC	=	Joint Venture Company
KIOCL	=	Kudremukh ron Ore Company Ltd., India
L	=	Long
LC	=	Local Currency Equivalent to US $
LKAB	=	Luossavaara - Kiirunavaara AB, Sweden
LLWL	=	Low Low Water Level
max.	=	maximum

ACRONYMS/UNITS/CHEMICAL COMPOSITIONS

- **ACRONYMS** (continued)

MCR	=	Mineracao Corumbaense Reunida, Brazil
Midrex	=	Midrex Direct Reduction Corporation
min.	=	minimum
MPN	=	Mean Probable Number
MOI	=	Ministry of Industry, Vietnam
MPI	=	Ministry of Planning and Investment, Vietnam
MSCO	=	Mobarakeh Steel Company, Iran
MSHA	=	Mining Safety Hazards Act
N/A	=	Not Applicable
NEC	=	National Electrical Code
NEMA	=	National Electrical Manufacturer's Association
NMDC	=	National Mineral Development Cooperation, India
NPV	=	Net Present Value
NTR	=	Normal Trade Relations
NTU	=	Nephelometric Turbidity Unit
OECD	=	Organization for Economic Cooperation and Development
OEMK	=	Oskol Electro-Metallurgical Korporation, Russia
OPCO	=	Operations al Sur del Orinoco, Venezuela
OPIC	=	Overseas Private Investment Corporation
OS&D	=	Over, Short or Damage
OSHA	=	Occupational Safety and Health Administration
P&ID	=	Piping and Instrumentation Diagram
PDC	=	Product Discharge Chamber
PEM	=	Project Engineering Manager
PLC	=	Programmable Logic Control
QCM	=	Qubec Cartier Mining Company, Canada
R&D	=	Research and Development

ACRONYMS/UNITS/CHEMICAL COMPOSITIONS

- **ACRONYMS (continued)**

RE&C	=	Raytheon Engineers and Constructors, Inc.
revs	=	revolutions
RFI	=	Request for Information
RHF	=	Rotary Health Furnace
SIDOR	=	Siderugica del Orinoco C.A., Venezuela
SOE	=	State-Owned Enterprise
SPT	=	Standard Penetration Test
TCN/TCVN	=	Vietnamese Design Standards and Codes
TDA	=	Trade Development Agency
TEDI South	=	Transport Engineering Design Incorporated South, Vietnam
UEI	=	United Engineers International, Inc.
UNDP	=	United Nations Development Program
UPS	=	Uninterruptible Power Supply
US/USA	=	United States of America
USSR	=	Union of Soviet Socialist Republics
UTM	=	Universal Traverse Method
VAT	=	Value Added Tax
VFD	=	Variable Frequency Drive
VSC	=	Vietnam Steel Corporation
W	=	Wide
wt.	=	weight
WTO	=	World Trade Organization

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- **UNITS**

A	=	Ampere
BTU	=	British Thermal Unit
cm	=	centimeter
cm/s	=	centimeter per second
cm^2	=	centimeter square
cm^3	=	cubic centimeter
o	=	degree
^{o}C	=	degree Celsius
$	=	Dollar
ft^3	=	cubic feet
g/cm3	=	gram/cubic centimeter
Gcal/h	=	Giga calorie per hour
hZ	=	hertz
ha	=	hectare
HP	=	Horse Power
hr	=	hour
"	-	inch
JIS	=	Japanese Industry Standard
kg	=	kilogram
kg/cm^2	=	kilogram per square centimeter
kg/h	=	kilogram per hour
kg/m	=	kilogram per meter
kg/m^2	=	kilogram per square meter
kg/m^3	=	kilogram/cubic meter

ACRONYMS/UNITS/CHEMICAL COMPOSITIONS

- **UNITS (continued)**

km	=	kilo meter
kPa	=	kilo Pascal
kV	=	kilo Volt
kVA	=	kilo Volt Ampre
kW	=	kilo Watt
kWh	=	kilo Watt hour
lb	=	pound
lux	=	Illuminace in metric system
m	=	meter
m/min	=	meter per minute
m/s	=	meter per second
m^2	=	square meter
m^3 or cu.m	=	cubic meter
m^3/h	=	cubic meter per hour
mA	=	milli Ampere
mb	=	milli bulb
mg/L	=	milligram per Litre
mg/m^3	=	milligram/cubic meter
MJ	=	Mega Joule
mm	=	millimeter
MPa	=	Mega Pascal
mtpa	=	million metric ton per annum
MVA	=	Mega Volt Ampre
Nm^3	=	Normal cubic meter
Nm^3/h	=	Normal cubic meter per hour
ppm	=	parts per million

ACRONYMS/UNITS/CHEMICAL COMPOSITIONS

- **UNITS (continued)**

ppmv	=	parts per million volume
%	=	percent
s	=	second
S/m	=	Siemens per meter
t or T or ton	=	metric ton
t/h	=	metric ton per hour
t/m^3	=	ton per cubic meter
V	=	Volt
VAC	=	Volt Alternating Current
VDC	=	Volt Direct Current

- **CHEMICAL COMPOSITIONS**

Al_20_3	=	Aluminum Oxide
BOD5	=	Biological Oxygen Demand
CaCO3	=	Calcium Carbonate
CH4	=	Methane
C2H6	=	Ethane
C3H8	=	Propane
C5+	=	Pentanes
CO	=	Carbon Monoxide
CO2	=	Carbon Dioxide
COD	=	Chemical Oxygen Demand
Cn	=	Copper
DO2	=	Dissolved Oxygen
Fe	=	Ferric (metallic iron)

ACRONYMS/UNITS/CHEMICAL COMPOSITIONS

- **CHEMICAL COMPOSITIONS (continued)**

Fe_2O_3	=	Ferric Oxide
H_2	=	Hydrogen
H_2O	=	Hydrogen Oxide (water vapor)
H_2S	=	Hydrogen Sulfide
H_2S04	=	Sulfuric Acid
i-C4H10	=	Iso-Butane
N2	=	Nitrogen
NaCl	=	Sodium Chloride
n-C4H10	=	Normal - Butane
NH4+	=	Ammonium
NO2 -	=	Nitrite
NO3 -	=	Nitrate
P	=	Phosphorus
pH	=	Hydrogen – ion Activity
PO4---	=	Phosphate
S	=	Sulfur
SiO_2	=	Silicon Dioxide
SO4---	=	Sulphate
TiO_2	=	Titanium Dioxide

SECTION 1.0

EXECUTIVE SUMMARY

1.1 Introduction

Vietnam's domestic steel demand has been growing steadily in recent years to keep pace with overall economic growth of the country. The demand for steel products in Vietnam has been projected to grow to 2.3 million tons this year and 5.7 million tons by 2010 compared to the current demand of 1.15 million tons.

Currently, about 70 percent of the Vietnam Steel Corporation's finished steels are made from imported billets. The price of domestic steel products is higher than those imported due to VSC's heavy dependence on imported steel scraps for the quality steel production, and reliance on the purchase of uneconomical semis to meet the demand of downstream rolling mills.

As a result, and as part of the Steel Industry Development Master Plan, VSC has contemplated the installation of a Direct Reduced Iron Plant to meet its own demand of steel making metallics for substituting quality scraps for steel production via Electric Arc Furnace as well as to serve as an export facility to meet demand of Hot Briquetted Iron in regional foreign markets.

Based on an encouraging Pre-Feasibility Study in early 1997, VSC requested Prime Minister, Ministry of Planning and Investment, and Ministry of Industry of the Vietnam Government for due considerations for a Detailed Feasibility Study of a DR Plant using a gas-based Midrex Megamod™ DR Technology. An agreement was entered into on May 12, 1997 by and between VSC and American Steel Corporation, solely represented by Craft Corporation of Hanoi, Vietnam, to perform the F/S.

Craft Corporation, in cooperation with Raytheon Engineers & Constructors Inc., submitted an application to the United States Trade Development Agency for financial assistance. A Grant Agreement assistance was entered into between the Trade Development Agency and VSC to partially fund the F/S on September, 1997 with the stipulation that RE&C will be the Contractor for performing the Study. Due to VSC's long negotiations with the Vietnam Government in establishing the gas price, which is critical for Project success, and other political and economic considerations, the Study did not start until September, 1998. A Contract was signed between VSC and United Engineers International, a

1.1 Introduction (continued)

subsidiary of RE&C to conduct the F/S on September 24, 1998 at which time actual work activities under the Grant Agreement were started.

1.2 Objectives and Scope of the F/S

The objectives and scope of the F/S as stipulated in the Grant Agreement are to address market potential, project definition, site selection and data, process technology, feed materials sourcing, utility services, environmental issues, design basis, project execution plan and schedule, operation plan and costs, capital cost estimate, financial analysis and financing arrangements, and political considerations.

1.3 Findings of Market Study

1.3.1 The Market Study part of F/S was prepared by Dastur International, Inc., Pittsburgh in July 1999.

1.3.2 <u>Major Objectives</u>

- Projecting future crude steel production, and consequent demand-supply situation of steel-making metallics on a global basis.
- Forecasting potential demand for DR products to bridge the shortfall in metallics supply.
- Identifying probable target markets for the Vietnam HBI plant on the basis of its competitiveness and geographic proximity, and estimating the likely extent of market penetration by the Vietnam HBI project.
- Determining appropriate plant capacity for the Vietnam HBI project.
- Future Projection of HBI price.

1.3.3 <u>Major Findings</u>

- **DRI/HBI demand**

Global demand of DRI/HBI has been estimated as follows:

Items	Actual		Projection		
	1996	1997	2002	2005	2010
1. Apparent consumption of finished steel, million tons	654	699	707	753	776
2. Crude steel production, million tons	733	774	808	858	877
3. Solid metallics requirement, million tons	381	406	427	460	487
4. Consumption of steel-making grade pig iron as scrap substitute, million tons	7	7	9	10	12

1.3 Findings of Market Study (continued)

Items	Actual		Projection		
	1996	1997	2002	2005	2010
5. Scrap consumption, million tons	341	362	361	383	393
6. Demand of DRI/HBI (3-4-5), mill. tons	33	37	57	67	83

Lion's share of this demand will be in Asia, where it is expected to rise from the 1997 level of about 8 million tons to about 19-27 million tons within the next decade.

- **DRI/HBI shortfall**

Total shortfall of DRI/HBI in 2002 will be about 2 million tons. This shortfall is likely to vary between 5 and 7 million tons in 2005 and 10 to 15 million tons in 2010, depending on the realization of additional capacity from announced DR projects.

- **DRI/HBI shortfall/surplus regions**

Europe, former USSR countries, the USA, and countries in Asia will need to import DR products from different sources to meet their steelmaking targets.

Other North America, South America, Middle East and Africa, and Oceania will have surplus DRI/HBI capacity, and hence these regions will be net exporters of DRI/HBI.

- **Target market regions for Vietnam HBI**

China, Japan and Other Asia, which will collectively experience shortfalls in the neighborhood of 7 million tons and 13 million tons by 2002 and 2010 respectively, will be major target market regions for the Vietnam HBI plant. Europe and former USSR countries can be considered as additional target markets beyond 2005.

- **Main competitors**

DR plants in South America, Middle East and Africa, and Oceania will be the main competitors to the Vietnam HBI plant. Existing merchant DR plants in Southeast Asia and India would also continue to be exporters of DRI/HBI, mainly to the Asian region.

1.3 Findings of Market Study (continued)

- **Market Potential**

It is expected that, depending on the realization of additional announced DR capacity, the potential market volume for the Vietnam HBI plant will be as follows:

Year	Potential Market Volume million tons
2002	2
2005	5 to 7
2010	7 to 10

After importing DRI/HBI from surplus supplier regions, Europe and former USSR countries will still have shortfall in DR products of about 0.3 million tons in 2005 and about 2 to 5 million tons in 2010. This market in Europe and former USSR countries will also be available to the Vietnam HBI plant in addition to the potential market in Asia.

Based on the present implementation schedule of the proposed plant, the market potential in 2005 and beyond would be relevant.

Of the total potential market volume, domestic market of HBI in Vietnam will be about 0.3 million to 0.5 million tons by 2010. Actual domestic demand in Vietnam would depend on the extent of use of HBI in EAF steelmaking, which could be in the range of about 50 to 70 per cent.

- **HBI price projection**

Projection of HBI price is based on scrap prices for the following two basic reasons:

Both are complimentary in use
Both follow similar price trends

Analysis of past data on prices of scrap and HBI indicates that HBI enjoys a price advantage of US $ 10 to 15 per ton over HMS#1.

Scrap price has been projected based on the following methods:

- Trend analysis considering (i) current (nominal) prices, and (ii)
- current prices converted to constant 1973 (real) prices
- Correlation with EAF crude steel production
- Correlation of obsolete scrap requirement.

1.3 Findings of Market Study (continued)

The projected price range of HBI in the terminal years given below indicates that the HBI price is expected to rebound to 1997 levels, in the years beyond 2000:

Year	Likely scrap price US $ per ton fob	Corresponding HBI Price US $ per ton fob
2002	120 - 130	130 - 145
2005	125 - 140	135 - 155
2010	135 - 155	145 - 170

1.3.4 Conclusion of Market Study

The market scenario discussed above justifies setting up a 1 million to 1.5 million tons per year HBI plant in Vietnam. The plant capacity may be expanded in the future by adding a second module of similar capacity, once the market for Vietnam fuel is established.

1.4 Project Description

The overall project can be defined by the following main features:

- Port Facility
- Material Handling System
- Core Plant
- Balance of Plant

The facility to be built is a 1.43 million tons per year DR Plant producing HBI utilizing the MIDREX MEGAMOD™ process technology. The annualized production rate guarantee is based on iron oxide feed mix of 90 percent DR-grade pellets and 10 percent DR-grade lump ores. The HBI product will have 93 percent metallization and 1.2 ~ 1.8 percent carbon. A brief description of main features is as follows:

1.4.1 Port Facility

The Port Facility will have a 310m long wharf connected by a 780m long approach bridge to the plant facilities. Approximately 2.1 million tons per year of iron oxides will be unloaded and 1.43 million tons per year HBI products will be loaded for shipment via the Port Facility. The Port will be designed to handle 70,000 DWT Panamax class vessels on the western side of the wharf for iron oxides unloading, and 30,000 DWT Handymax ships on the eastern side of the wharf to load HBI. A combination ship unloader/loader equipment and all necessary infrastructure necessary for operation will be provided. Loading and unloading will not occur simultaneously.

An alternate concept of having a longer berth to accommodate both loading and unloading ships at the same time on the western side of the wharf has also been considered; however, the concept was not adopted due to high capital cost.

1.4.2 Material Handling System

The material handling system for iron oxide and HBI products will include all conveyors, single wing, pivoting stacker for iron oxide, front-end loaders, oxide screens, storage bins & bunkers, scales, all necessary hoppers and feeders, travelling stacker for HBI, dust collection system and necessary operation controls. Two iron oxide storage piles, each having a working capacity of 170,000 tons and a HBI storage pile, capacity of 100,000 tons, will be provided.

An alternate system using two stacker/reclaimers in lieu of front-end loaders and reclaim hoppers for iron oxide handling and a bucket wheel reclaimer for HBI shipment, replacing HBI feed hoppers and some front-end loaders, has also been considered.

1.4.3 Core Plant

The key features of the proposed MIDREX MEGAMOD™ Core Plant will include:

- MIDREX Shaft Furnace, with double bustle ports.
- MIDREX Reformer – 19 Bays.
- 580°C Reformer Feed Gas preheat.
- Centrifugal Process Gas Compressors with variable frequency drives.
- Briquetting Machines with high capacity and hot DRI fines recycle system.
- Closed loop process cooling water and machinery cooling water systems, using circulating cooling water from a mechanical draft Cooling Tower for heat removal.

1.4 Project Description (continued)

The components are supported by ancillary systems for handling iron ore, cold and hot gases, water and HBI product.

1.4.4 Balance of Plant

The facilities and systems in the Balance of Plant will include:

- Facility Structures
- Main Substation/Power Distribution System
- Natural Gas Supply System
- Industrial Water Supply and Metering Station
- Diesel Fuel Station
- Cooling Water System
- Fire Protection System
- Plant Communication System
- Sewage Treatment System
- Storm Water Management System
- Roads/Parking Areas
- Track Work (Optional)
- Site Security
- Site Finishing and Landscaping

1.5 Site Selection and Data

1.5.1 Site Selection

Two important criteria in the selection process of the site, in addition to the general requirements of favorable conditions for the construction of Plant facilities, are:

- Supply of reliable large quantities of natural gas economically.

- Allow the construction of a captive Port Facility for sea-going vessels up-to 70,000 DWT.

To meet these main criteria, 8 potential sites in 6 provinces in the Southern and Southern-Middle Vietnam were investigated (see Map 1-1). Based on this investigative study conducted by THIKECO, a Vietnamese Corporation for Investment Consultancy for Development and Construction, the site has been selected in the Cai-Mep Industrial Zone, Ba Ria-Vung Tau Province, near the Cai- Mep river estuary.

The selected site is 80 km from Ho Chi Minh city in Hoi Boi Commune, Tan Thanh District of the Province. The land area of the site is 50 ha. The site is close to the National Highway No. 51 and 45 km from Vung Tau City by road and 18 km by waterway. The existing natural gas line from the Bach Ho gas field runs along the National Highway No. 51 and gas line from the Nam Con Son gas field has been planned also to run along the same corridor of the existing pipeline. The navigation channel in this area can receive large vessels without much dredging.

Disadvantages for this site, which are typical for all sites considered in the selection process, are:

- No existing infrastructure available at the present time.
- Most of the site is under water during high-tide. Substantial filling work and soil improvements will be needed to attain the designed elevation and to satisfy bearing capacity requirement of soils.

1.5.2 <u>Site Data</u>

- On Shore Topography – General terrain of the site is complex and is divided into plots by ditches. Average elevations vary from (+) 0.10 m to (+) 0.15m with respect to Hon Dau Datum. There are large number of mangroves and date-palms on the site.
- Off Shore Topography – The river bed near the site area is fairly deep, however, the terrain of the bed near the river bank is gradually sloping and shallow. The location (-25.0m) where the port wharf will be built is about 900m from the river bank and has about 1 in 7 slope, and it continues at a steeper slope towards the river navigational channel.
- Geological Features – Based on soils investigations conducted by THIKECO/TEDI South, the underlaying strata have generally the following 6 layers:

1.5 Site Selection and Data (continued)

Layer 1 – Fat Clay/Elastic Silt, light grey to dark grey, very soft to soft. The thickness varies from 33.5m to 43.3m with the elevation of the layer bottom from (-) 33.1m to (-)45.2m. Soils standard Penetration Test blows vary from 0 to 4. This layer has no bearing capacity for foundations.

Layer 2 - Clayey/Silty sand mixed gravel and sand stone, yellow grey, dark grey to green grey, very hard. The thickness varies 0.4m to 6.0m with the elevation of the layer bottom from (-) 34.1m to (-) 51.2m. Soils SPT blows vary from 25 to 50.

Layer 3 – Clay/sandy clay, dark grey to grey, grey motley yellow, firm to stiff. The thickness varies from 0.6m to 11.6m with the elevation of the layer bottom varies from (-) 35.7m to (-) 57.4m. Soils SPT blows vary from 12 to 50+.

Layer 4 – Silty clayey sand, grey, yellow, medium dense to dense. The drilled thickness is 34.6m. Soils SPT blows vary from 17 to 50+.

Layer 5 – Clay, green, grey motley white, hard to very hard. The drilled thickness varies between 2.1m and 6.8m. Soils SPT blows vary from 45 to 50+. Lenses of soft clay and medium dense silty sand are also encountered.

Layer 6 – Granite, weathering degree varies from highly to slightly, brown, yellow, green, grey motley white. The drilled thickness varies from 10.5m to 1.4m.

- Meteoro – Hydrological Feature

Wind and Storm Regime – Two main wind directions – Northwest and Southwest - with average speed of 5 to 10 m/s. According to the data of Ho Chi Minh city Hydrological Station, there were 6 storms passing by the areas of Vung-Tau and the Ho Chi Minh city with a maximum recorded wind speed less than 30 m/s.

Rain – Rainy season runs from May to October. The maximum rainfall in a year is 3272mm (1952). January, February and March are the months with the lowest average rainfall (less than 10mm).

Visibility - Annual average number of foggy days is 12, however, due to heavy ran, the visibility can be restricted for additional 142 hours per year.

Air Temperature and Humidity - Annual average temperature is 26.8°C (max. 33°C, min. 20.1°C). Air humidity varies according to seasons –

1.5 Site Selection and Data (continued)

in rainy season the average humidity is 86.6 percent, and in dry season 76 percent.

Hydrological Regime – The change of water level and current depends on the semidiurual tidal regime. The highest water level is (+) 177 cm and the lowest is (-) 290 cm (Hon Dau Datum). The maximum current speed is 180 cm/s.

Sediment Level – Average sediment level during periods of observation is 480mg/L, and fluctuates from 100mg/L to 2260 mg/L.

Navigational Channel – There are two shallow sections (10.6m deep) – the first section is at Ganh Rai Gulf, about 5 km long and the second at Cai Mep estuary, about 4 km long. A Feasibility Study on the navigation channel from East Sea to the Cai Mep Port complex for vessels of 70,000 DWT has been completed and submitted to the authorities for approval.

1.6 Process Technology

1.6.1 DR Processes Overview

The evolution of DR technology to its present status has included more than a hundred different DR process concepts, many of which have been operated experimentally. Most were found to be economically or technically unfavorable and abandoned. However, several were successful and subsequently improved into full-scale commercial operations. In some instances, the best features from different processes were combined to develop improved processes to eventually supplant the older ones.

Some processes were designed to use particular raw materials or fuels that are no long available, and were discontinued despite being technically sound. Others were viable under specific circumstances, and continue to operate as they are best suited for indigenous raw materials and fuels.

Because of the diversity of raw materials and fuels throughout the world, it is anticipated that a number of DR processes, both coal-based and gas-based, will remain in commercial operation. At present, these include:

Type	Process
• Gas-based Processes	
Shaft Processes	MIDREX HYL Process Purofer
Fluidized Bed Processes	FIOR/FINMET Iron Carbide Circored

1.6 Process Technology (continued)

- Coal-Based Processes

Rotary Kiln Processes	SL/RN Krupp-CODIR DRC ACCAR-OSIL Jindal
Retort Process	Kinglor Metor
Rotary Hearth Processes	Inmetco FASTMET Redsmelt Iron Dynamics

1.6.2 DR Process Selection

Most of the proven gas reserves in Vietnam are in the South in the Ba Ria-Vung Tau area close to Ho Chi Minh City. In addition to gas and oil, Vietnam is also rich in coal and has developed a coal industry, which is centered north of Hai Phong Harbor. Between these two energy rich sectors lies Vietnam's largest iron ore reserve.

The DR technologies that are currently the most proven to accomplish the production of DRI in the form of HBI is the MIDREX DR process and HYL III process, both employ natural gas as its reductant. A brief comparison of these processes are summarized in the following table:

COMPARISON OF MIDREX & HYL III	
MIDREX	**HYL III**
General Reformer and reduction sections are linked. There is recycle of reactor top gases through the reformer. Less total equipment	Reformer and reduction sections are independent. There is no recycle of reactor top gases through the reformer. Advantages in 2 reactors, 1 reformer system.
Reformer Special reformer of exclusive design. Special catalyst Low sulfur natural gas required.	Conventional steam reformer Desulfurization is required.
Reducing Gas Reduction based on CO rich gases (exothermic reactions): H_2 / CO: 1.55	Reduction based on H_2 – rich gases (endothermic reactions): H2/CO: 5.73

1.6 Process Technology (continued)

COMPARISON OF MIDREX & HYL III	
MIDREX	**HYL III**
Low reducing potential $(H_2 + CO) / (CO_2 + H_2O)$: 11.70 Low Pressure: 2.3 kg/cm^2 Dynamic sealing	High reducing potential $(H_2 + CO) / (CO_2 + H_2O)$: 20.53 High pressure: 5.5 kg/cm^2 Pressure valves for gas seal More equipment and energy for Quenching and heating the reformed gases.
Iron Ore Limited lump or friable ore; limit on sulfur-containing ore	More lump or friable ore tolerated

The gas based MIDREX MEGAMOD™ DR technology has such a proven record of performance that there is virtually no technical or operating risk. The coal-based FASTMET technology, by comparison, would require further confirmation of the operating parameters and the assumptions based on the use of Vietnam coal. In 1998, about 67 percent of world DRI production was by the MIDREX gas-based process.

Based on the MIDREX experience history and other factors, Vietnam Steel Corporation has selected the MIDREX gas-based DR technology for the Study.

The MIDREX DR Process converts iron oxide lump ore, pellets, or pellet/lump ore mixtures into highly metallized iron, either in the form of direct reduced iron or hot briquetted iron which are ideal feed materials for high quality steel making. The Core Plant to be supplied will use the MIDREX MEGAMOD ™ Module concept. The process flow sheets are included in the Midrex Technical Specifications (Appendix VIII). The simplified process details are shown on Table 1-2.

1.7 Feed Materials Supply

The major raw material required for the operation of a DR plant is iron oxide in the form of either lump ore or pellets. DR plants in different parts of the world have tried various combinations of iron oxide feed, ranging from 100 per cent pellets to 100 per cent lump ore, as well as a mixture of the two. However, for the production of HBI, a minimum of 20 per cent lump iron ore (preferably 30 per cent) should be used in the feed mix to ensure a desirable briquette quality. Different sources of oxide feed have been tried in DR plants in order to arrive at the most optimum combination of oxide pellets and lump iron ore for a particular plant, depending upon its operating parameters and economic considerations. For the purpose of the financial analysis, a feed mix of 50 per cent pellets and 50 per cent lump iron ore have been considered as base case and other mixes as alternates.

The Pre-Feasibility Study identified the Thach Khe deposit in the Ha Tinh Province, which is located on the sea coast, to be the main source of feed materials after the mine is put into production in year 2003. Prior to this, all feed materials will be imported. However, after 2 years of detailed exploration and study by a consortium consisting of Krupp of Germany, Genecor of South Africa, Mitsubishi of Japan and VSC, the deposit was found to be unacceptable due to high zinc content (not acceptable in current steel-making processes) and it increased geological and chemical variability, structural complexity and decrease in mineral resources.

In the absence of in-country sources of feed materials, 100 percent DR grade pellet and lump iron ores will be imported for the Plant production. The sources considered for the Project are:

- Pellets — Brazil – CVRD; Bahrain – GIIC; India - Kudremukh – Essar
- Lump ores — India - Bailadia; Brazil – Mutuca

Several discussions have been held with the potential feed materials suppliers from various countries for consideration of a long term supply contract and in establishing delivered prices of feed materials in Vietnam for the Project Financial Analysis.

1.8 Utilities

A Report (Appendix VI) addressing all utilities sources at the site has been prepared by THIKECO. The Report has confirmed that all utilities will be available as part of the development of the Cai Mep Industrial Zone where the Plant will be located. A brief background of all utilities' sources is discussed below.

- Gas Supply

  The Lan Do and the Lan Tay gas fields in the Nam Con Son Basin area, which were discovered in 1992 – 1993, will provide the gas source for the Cai Mep Industrial Zone. The estimated reserve of their two gas fields, which are separated by 25 km, is 58 billion cubic meters. Good quality of gas with high methane content and low condensate levels is expected from these fields. The planned capacity of the pipeline system is 5-6 billion cubic meters per year (average). The pipeline system will include: 1) 650 mm diameter, 372 km long, pipeline from gas field to the existing Gas Processing Plant; 2) 750 mm diameter, 28 km long, pipeline from the Gas Processing Plant to a new Nam Con Son Gas Distribution Plant located near the existing Bach Ho Distribution Plant.

  First gas production is scheduled in year 2001. Gas price for the Plant as established by the Vietnam Government is US$ 1.75 per million BTU.

- Electricity Supply

  Power in the vicinity of the site is supplied by Electricity Department of BaRia – Vung Tau Province. Power source for the Cai Mep Industrial Zone will be from Phu My Power Plant by 110 kV Line (planned) running along National Road 51. In the interim, power supply to the site will be from Go Dan – Phu My 22 kV line which will be ready in 1999. There will be a diesel generator plant to supply power to industrial zone's facilities when National electricity network failures occur. The electricity tariff for production activities in industrial zones varies with usage. Normal energy usage rate, including capacity charges is US$ 0.068 per kWh for 110kV and above and US $ 0.073 per kWh 22 kV power.

- Water Supply

  Water supply to the site will be provided by the Water Supply Company of BaRia – Vung Tau Province. The existing network and the planned network of water supply of the province through year 2010 are outlined in THIKECO's Report. Water to the Cai Mep Industrial Zone will be supplied from the 300 mm pipeline from Phu My new city located next to National Road 51. Water usage supply to the plant fence line will be taken from the main distribution pipeline (150-200 mm diameter) next to the main road of the industrial development. Water rate for industrial production activities is US $ 0.32 per cubic meter.

1.8 Utilities (continued)

All utilities will be brought to the northeast corner of the property as part of the Industrial Zone development.

1.9 Environmental Assessment

A preliminary EA has been undertaken a part of the F/S which has identified the regulatory policies and guidelines applicable to the design and review of the Project. The EA has identified the following:

- For the emission sources identified,. air quality impacts will be less than ambient guidelines.
- Up to 500,000 m^2 of undeveloped mangrove will be filled with the loss of associated habitat.
- Additional unidentified lands will be disturbed to provide soil borrow for site fill operations and land for an engineered landfill will be needed for the disposal of process waste products.
- A number of infrastructure and utility improvements will be needed, including electric supply, (fresh) industrial water, sanitary sewage treatment, natural gas supply, access roads, and port facility.
- No displacement of residences has been identified.
- A construction workers' housing village may not be needed due to close proximity of the selected site to established localities and national highway.
- Wastewater discharges will have minor impacts with adequate treatment.
- There is no anticipated impact of noise on residences due to the isolation of the site.

No assessment has been made of the cumulative impacts of this Project and other development planned for the Cai Mep Industrial Zone.

1.10 Design Basis

All systems, components and structures will be designed and constructed to comply with all applicable standards, codes and regulations initiated and issued by national engineering societies, associations, institutes and agencies. In addition, the work shall comply with all applicable local (Vietnam) codes, standards and regulations, having jurisdiction in the area where the Plant will be built. In case of differences between local building codes (including standards) and any other referenced specifications, standards, and manuals, the requirements of local code shall prevail, unless indicated otherwise

1.10 Design Basis (continued)

The Core Plant will be designed in accordance with MIDREX's standard practices based on MIDREX's specialized experience.

1.11 Project Execution Plan and Schedule

1.11.1 General

The plant will be owned and operated by a Joint Venture Company which will be established under the Foreign Investment Law of Vietnam. The Vietnamese entity of the JVC will be the Vietnam Steel Corporation. The foreign parties to the JVC will be the American Steel Corporation Pte Ltd., a Singaporean entity (currently represented by Craft Corporation, a subsidiary of the USA-Based Harwell Group), strategic investors and others who are directly involved in the implementation of the Plant construction including material suppliers and offtakers. The Project Structure is shown on Table 1-3.

1.11.2 Project Organization

The Project will be executed by the engineer/procure/construct contractors of the Core Plant and the Balance of Plant (including Port Facility and Material Handling System). Each contractor will be responsible to the JVC for quality, cost and the schedule of completion of its scope of work. The JVC will nominate a consultant as owner's representative during the project implementation. Each EPC Contractor will assign a Project Manager, an Engineering Manager and a Site Construction Manager with a full complement of all other required technical and administration support personnel.

1.11.3 Implementation Schedule

A Project Schedule has been established to complete the Project in the earliest feasible time to produce HBI for export and in-country use.

The schedule consists of a 10-month Project Development Phase concluding with financial closing. Upon financial closing, a 18 month site improvement work will be required. In parallel, design and construction of the Port Facility will be on-going. Within 3 months of financial closing, EPC contractors for the Core Plant and BOP will be selected and engineering and procurement phase of the project will start. Foundation piling work for facilities will start in month 16 from financial closing, followed by 23 months of construction, start-up and commissioning activities. A summary – level implementation schedule is shown on Table 1-4. Major milestone activities of the project implementation schedule of 35 months as given below has been envisaged:

1.11 Project Execution Plan and Schedule (continued)

Go-ahead	Implementation schedule (months from go-ahead							
	Delivery			Construction			Erection	
	P.O.	Start	Finish	P.O.	Start	Finish	Start	Com.
Mat'l. Handling System	10	16	20	-	16	18	23	32
Core Area Plant	3	18	29	12	14	22	19	35
Water Dist. Sys.	9-13	20	23	-	16	19	22	26
Pwr. Dist. Sys.	8-14	15	25	-	16	19	21	29
Natural Gas Dist. Sys.	14	20	22	-	16	19	23	31
Repair Shop	-	-	-	-	20	25	-	-
Mobile Equip.	12	22	27	-	-	-	-	-
Captive Port	6	8	17	3-5	8	23	8	23
BOP	4	12	19	-	6	19	14	21
Site Survey	-	-	-	2	3	4	-	-
Soil Investigation	-	-	-	2	3	4	-	-
Site Development	-	-	-	3	4	15	-	-

It is expected that after submission of F/S, about 13-15 months will be required to tie-up all formalities before the formal 'Go-ahead' of the project. Such formalities include basically the following major activities:

- Finalization of JV partners
- Tie-up raw materials sourcing
- Selection of EPC Contractor
- Finalization of product off-takers
- Obtain investment license from the Ministry of Industry, Vietnam
- Obtain financial/loan approvals

Accordingly, it is expected that the 'Go-ahead' for the HBI project will be around early fourth quarter of 2001 and the plant will be commissioned by the third quarter of 2004.

1.12 Capital Cost Estimate

1.12.1 General

The Capital cost estimate has been developed for the Project in accordance with the design basis and facility drawings included in this Report. The development of the cost estimate has been a joint effort of MIDREX, UEI and VSC/Craft. Total Project Capital costs can be divided into the following two categories.

- Plant capital costs which comprises of:

  Core Plant complete with Material Handling and Civil Works within its Boundary Limits - US $215 million.

  Balance of Plant including Port Facility, Site Improvements and Remaining Material Handling System - US $128.5 million.

- Other Capital costs which includes costs of Financing, Pre-operation Expenses, Taxes and Duties, Development, and Contingencies---US $54.9 million.

Escallation of the plant capital costs is not included.

1.12.2 Breakdown of Cost Estimate

- Plant Capital Costs (all in US dollars).

Core Plant Equipment	$97,310,000
Non-Core Equipment (excluding Port Facility)	$41,545,000
Site Filling & Compaction - Complete	$8,425,000
Facility Structures – Complete	$5,360,000
Port Facility – Complete	$24,930,000
Construction Materials[(a)]	$47,625,000
Construction Labor[(a)] (including Construction Management & Start-up)	$81,165,000
Professional Services (Engineering and Project Management)	$27,490,000

1.12 Capital Cost Estimate (continued)

Process Technology Fee	$	9,653,000
Sub Total	**$**	**343,500,000**

(a) Exclude: Site Filling & Compaction, Port Facility and Facility Structures.

- Other Capital Costs (all in US dollars)

Interest During Construction	$	28,300,000
Insurances	$	1,700,000
VAT/Local Taxes and Duties(a)	$	0
Development(b)	$	10,700,000
Pre-operation(c)	$	11,800,000
Contingencies	$	2,400,000
Subtotal	**$**	**54,900,000**

(a) Project is exempt of all Vietnamese Taxes and Duties

(b) Include: JV Formation Costs, Investment License & Legal Expenses, Permit Fees, Developer's Fee.

(c) Includes: Operations, Maintenance and Administrative Personnel Salaries and Expenses during plant construction and Start-up, Host Plant Training Costs, Raw Materials/Utilities Costs during Start-Up.

- **TOTAL CAPITAL COST ESTIMATE $398,400,000**

1.12.3 The US export potential towards suppliers and services is estimated to be US $238 million. Total capital cost estimate of US $398.4 million divided into local cost and foreign cost as US $98.4 million and US 300 million respectively.

1.13 Plant Operations Plan

The Plant business program organizational structure will include the Production Plant, the Sales Department and the Management and Administration Department who will report to the Company General Director. The General

1.13 Plant Operations Plan (continued)

Director will be assisted by two Deputy Directors. The net annual operating time for the Plant will be 325 days per year (7,800 hours/year) in a continuous operating mode everyday. The scheduled maintenance downtime for the Plant is 20 days per year. Total company personnel, excluding transportation and security personnel, will be 140. A detailed breakdown of personnel by departments is as follows:

• Board of Directors	3
• Management and Administration Department	12
• Sales Department	5
• Production Plant – Operators	77
• Production Plant – Maintenance	43

1.14 Operations Cost Estimate

1.14.1 Operating Parameters

- Core Plant (per ton of HBI)

Iron Oxide	1.45 t
Natural Gas	2.5 net Gcal
Electricity	120 kWh
Make-up Water	0.5 m^3
Oxide Coating	1kg
Chemicals for Water Treatment	US $0.35
Maintenance Supplies	US $5.00
Briquette Segments	US $1.0
Personnel	0.16 hours

- Port Facility and Balance of Plant (per year of operations)

Electricity	23,700,000 kWh
Natural Gas	36,000 Nm^3

1.14 Operations Cost Estimate (continued)

Industrial Water	50,000 m^3
Personnel	80,000 hours
Maintenance Supplies	US $2,500,000

1.14.2 Operation Costs (per ton of HBI) - First Year of Full Production

• Materials	
Iron Oxides (Pellets and Lump-50/50)	$ 63.69
Natural Gas	$ 17.36
Electricity	$ 9.51
Water	$ 0.17
Other (Consumables)	$ 1.90
• Repairs and Maintenance Supplies	$ 6.92
• Labor Costs	
Operating & Maintenance	$ 0.53
Management, Administration & Sales	$ 0.10
• Lease/Others	$ 2.57
• **Total**	**$102.75**

1.15 Financial Analysis

1.15.1 General

The capital cost of the Project has been estimated at US $398.4 million and this Project is proposed to be financed at a 70:30 debt-equity ratio. An amount of US $32 million is required as working capital of which US $27 million will be available as short-term loan from commercial banks. The working capital is estimated at US $24 million in the first year of operation.

Based on the project schedule, annual fund requirements for the Project, assuming that equity will be utilized initially and then followed by loan withdrawal, are as tabulated below.

1.15 Financial Analysis (continued)

ANNUAL FUND REQUIREMENTS (MILLION US $)			
Construction Year	Equity	Loan	Total
1st	69.64	7.07	76.71
2nd	49.88	102.69	152.57
3rd	-	101.73	101.73
4th	-	67.39	67.39
Total	119.52	278.88	398.04

Based on the Market Study, the sales prices of HBI for the Study are adopted as follows:

Year	HBI Sales Price (US $/ton)
2003 - 2004	135
2005 - 2009	145
2010 - 2014	155
2015 - 2019	165

It is assumed that the cash available in every year will be treated as follows:

- Retain 10 percent profit in each year up to a cummulative of 50% of equity.
- Retain cash in hand to the amount of US $2 million every year to meet operational contingencies.
- Balance cash will be reinvested on annual basis at an average interest rate of 5% per annum.

On this basis, it is estimated, in the first years of full production (2nd year of plant operation) total income from sales revenue and interest on bank deposit will amount to about US $208 million.

The basis for estimating of the working capital is as follows:

Item	Minimum Days of Coverage	
	Foreign Components	Local Components
Accounts Receivable	30	30
Raw Materials	30	15
Plant Supplies	-	15

1.15 Financial Analysis (continued)

Item	Minimum Days of Coverage	
	Foreign Components	Local Components
Spare Parts	30	15
Finished Products	-	15
Accounts Payable	15	15

Interest rate for this long-term loan for the Project is assumed as 8.5 percent per annum; whereas, the short-term financing for working capital is based on 10 percent per annum. It is assumed that long-term loan from financial institutions will be repaid in sixteen half-yearly installments commencing from second year of Plant operation. Working capital loan is expected to continue throughout plant operation.

Depreciation has been estimated by the straight-line method based on following norms prevalent in Vietnam:

Buildings - 4%

All Others - 10%

Based on information provided by VSC, the Project, being in the "Preferred Category Project" classification, the preferred tax will be as follows:

Item	Corporate Tax
First 2 Years Profit	0%
Following 3 Years Operation	7.5% (50% of Preferred Tax)
Balance of 12 Years Operation	15%
After 12 Years Operation	25%

1.15.2 Table

The Table 1-5 covers results of financial analysis and are listed as:

Chart - 1	Flow of Financial Resources
Chart - 2	Total Working Capital Requirement
Chart - 3	Total Debt Services
Chart - 4	Annual Cost of Product Sold
Chart - 5	Net Income Statement
Chart - 6	Cash Flow for Financial Planning
Chart - 7	Breakeven Analysis
Chart - 8	IRR and NPV on Total Capital Investment
Chart - 9	IRR and NPV on Equity Capital Investment
Chart - 10	Debt Service Coverage Ratio (DSCR)
Chart - 11	Projected Balance Sheet

1.15 Financial Analysis (continued)

1.15.3 Financial Highlights

The financial highlights of the Project in the first year of production at 100 percent capacity utilization level (second year of plant operation) and the financial performance after 15-year operating period are summarized below:

Financial Highlights in the 1st Year of Operation at Rated Capacity	
Net Sales Realization	US $208 Million
Annual Operating Cost (1)	US $147 Million
Gross Margin	US $ 61 Million
Interest Charges	US $ 24 Million
Depreciation	US $ 33 Million
Profit Before Tax	US $ 4 Million
Corporate Tax	US $ 0 Million
Profit After Tax	US $ 4 Million
Breakeven Capacity	95%
(1) Includes Administration and Sales Overhead	

Financial Performance After 15-Year Operating Period	
Cumulative Profit	US $ 552 million
Cumulative Cash	US $ 609 million
IRR on Total Investment	12.2%
IRR on Equity	15.8%
NPV (1) on Total Investment	US $ 87 million
NPV (1) on Equity	US $ 107 million
Pay-Back Period	7 years
Average DSCR	1.47
(1) Net Present Value (NPV) Discounted @ 9%	

1.15.4 Sensitivity Analyses

A series of sensitivity analyses have been conducted to assess the influence of variation in the capital requirement, raw material assembly cost, capacity utilization and sales realization on the financial viability of the project. The effect of these variables on the IRR has been determined and the results of the sensitivity analyses are presented below:

1.15 Financial Analysis (continued)

SENSITIVITY ANALYSES								
	Variables							
Capital Cost (million US $)	**Feed-mix (1)**	**Raw material price %**	**Natural gas price** (US $/mil. BTU)	**Power cost** (US $/kWh)	**Capacity utiliza-tion %**	**Sales realiza-tion %**	**Capital cost %**	**IRR %**
398 (Base)	Alt. 1	-	-	-	-	-	-	12.2
	Alt. 1	(+)5	-	-	-	-	-	11.1
	Alt. 1	-	1.50[(2)]	-	-	-	-	12.9
	Alt. 1	-	1.50[(2)]	0.065	-	-	-	13.0
	Alt. 1	-	1.50[(2)]	0.060	-	-	-	13.3
	Alt. 1	-	1.50	-	-	-	-	13.1
	Alt. 1	-	1.75	0.060	-	-	-	12.6
	Alt. 1	-	-	-	90	-	-	10.5
	Alt. 1	-	-	-	110[(3)]	-	-	13.6
	Alt. 1	-	-	-	-	(-)5	-	9.7
	Alt. 1	-	-	-	-	(+)5	-	14.7
	Alt. 1	-	-	-	-	-	(+)5	11.5
	Alt. 1	-	-	-	-	-	(+)10	10.8
	Alt. 2	-	-	-	-	-	-	10.6
	Alt. 2	-	-	-	-	(-)5	(+)10	9.3
	Alt. 3	-	-	-	-	-	-	9.6
	Alt. 4	-	-	-	-	-	-	9.9
	Alt. 5	-	-	-	-	-	-	9.4
	Alt. 6	-	-	-	-	-	-	9.2
395 (case 1)	Alt. 1	-	-	-	-	-	-	12.4
383 (case 2)	Alt. 1	-	-	-	-	-	-	12.8
362 (case 3)	Alt. 1	-	-	-	-	-	-	13.7
357 (case 4)	Alt. 1	-	-	-	-	-	-	13.9
407 (4)	Alt. 1	-	-	-	-	-	-	12.7

Notes:

(1) Capital cost cases and raw material mix alternatives are defined in Section 16.0 and Section 15.0 respectively.

(2) With cost escalation of 2.5 per cent every 5 years.

(3) From third year onwards.

(4) With gas turbine.

From the results of the sensitivity analyses presented above, the following could be concluded:

- Capital cost estimate for the Project needs to be reduced.
- Proper sourcing of iron oxide pellets and lump ore and their proportions in the feed mix are essential.
- Any possible reduction in the price of natural gas will improve the project viability.

1.16 Project Finance

The Project will be executed by a Joint Venture Company to be established under the Foreign Investment Law of Vietnam. The total investment capital of JVC will be $398.4 million. The legal capital of the JVC will be 30 percent of the total investment capital – approximately $119.5 million. The JVC expects to obtain long-term project-financed debt equal to about 70 percent of the total investment capital – approximately $278.9.

The VSC, who will be the Vietnamese party to the JVC, will hold a 30 percent share of the JVC – approximately $35.9 million. VSC will contribute land use rights and cash as part of its obligations of the project finance. VSC may elect to solicit other Vietnamese investors to join the JVC to meet its cash obligations.

The foreign party to the JVC will be the American Steel Corporation Private Ltd., a Singapore legal entity, who will hold the remaining 70 percent share of the JVC – approximately $83.6 million.

Currently, the ASC, the sole developer of the Project, is represented by Craft Corporation, Vietnam, a subsidiary of the Harwell Group – a privately held U.S. Company. ASC will contribute cash and pre-operational costs as its capital contribution to the JVC legal capital. ASC/Craft may also solicit a co-developer for the Project. It is envisioned that the shareholders of the foreign entity of the JVC will also include several partners who will be directly involved in the Project implementation, such as, EPC Contractors, Off-Takers, Feed Materials Suppliers, and Process Technology Vendor. Preliminary discussions about the project finance have been held with the other potential participants.

Several sources of debt financing have been considered by JVC for the project. These are briefly described below:

- Commercial Bank

  A commercial bank loan generally involves a small number of institutions which would typically commit to the full term of the loans. Such banks will, in certain circumstances, take construction risks, can provide locked-in pricing and funding amounts and generally do not require a rating from a rating agency, preferring instead to perform their own project evaluation. The commercial bank debt generally tends to be of shorter term and can contain more covenants.

- Capital Markets

  This type of debt financing involves the resale of securities by an accredited investor (such as a bank) to an unlimited number of qualified institutional buyers. Normally these private placements are large blocks of bonds placed with a limited number of investors, often insurance companies or pension funds. Bond offerings are rated by one of more of the prominent rating agencies, and the rating directly affects the cost of the financing. It is also possible to sell bonds in project finance transactions, which are less than investment grade. It is uncertain whether the Project can achieve an investment grade rating. Failure to achieve an investment grade rating would result in increased financing costs. The capital markets are preferred to bank loans because, in general, they often offer: (1) more competitive rates, (2) longer tenor, (3) longer grace periods before start of principal payments, (4) less restrictive covenants, and (5) access to an expanded investor base.

- Export Credit Agencies

The amount of debt that can be supported by an ECA is determined in accordance with certain guidelines. These guidelines limit the loan amount to a certain percentage of eligible equipment which can consist of (1) the cost of equipment and services that are supplied from the ECAs country of origin, (2) equipment and services sourced from countries other than that of the supplier, (3) the local installation costs associated with the imported equipment, plus capitalized interest expense on the above items. These guidelines also dictate that general terms under which ECA supported debt can be issued. Typically, the maximum term under the guidelines is ten years following completion of construction, with no grace period on interest (full principle and interest payments to begin six months after the start of operation); therefore, significantly less attractive economically to commercial debt. In addition, such lenders often require some recourse debt or greater future equity injections from the Project Sponsors, beyond the original levels.

Given the structure of the JVC, the two most likely prospects for this type of financing would be from the likely suppliers of the majority of the project's equipment and services. These would be the United States Export-Import Bank and Japan Export-Import Bank. Direct meetings have not yet been held with these agencies to determine whether they are currently open for involvement in Vietnam and their current terms and conditions.

- Multilateral Agencies

The leading multilateral lending agencies that could be considered for financing for the Project are the World Bank, their private sector arm, the International Finance Corporation, and the Overseas Private Investment Corporation. Their lending programs are briefly described below. Generally, it should be noted that the multilateral banks can require longer periods for closure of financing packages and then can also require more restrictive covenants.

1.16 Project Finance (continued)

World Bank – In 1994, the World Bank resumed issuing guarantees to private projects. The guarantees can be for specified risks for the length of the financing term (partial risk guarantee), or for all risks during a specified period of the financing term (partial credit guarantee). The partial risk guarantee covers debt service defaults that result from the non-performance of government obligations. For external debt and balance of payment reporting purposes, partial risk guarantees are not considered as government debt or government-guaranteed debt and only appear as a memorandum item (along with any other contingent liabilities) in the monetary statistics compiled by the International Monetary Fund (IMF). The partial credit guarantee is used when there is a need to extend loan maturities, but not necessarily to over sovereign contractual obligations. Partial credit guarantees are typically used when either the lenders or sponsors are willing to accept the risk of the government defaulting on its obligations. By guaranteeing later maturities, the World Bank helps the lender maximize the loan term.

IFC – The IFC is the world's largest multi-lateral lending institution dedicated to supporting private-sector projects. The IFC provides financing support on a case by case basis depending upon the Project's needs. IFC support can take multiple forms; a direct loan ("A" loan), being the lender of record in a syndicate with one or more banks which take a portion of the project risk ("B" loan); a direct equity investment; or quasi-equity investment.

OPIC – OPIC finances US business expansion overseas by providing long-term project financing to projects involving significant equity participation by US businesses (typically 25% minimum US equity). OPIC's mandate is to support projects that are responsive to the development needs of the host country. OPIC's terms vary on a project basis, but can run up to 15 years repayment following a suitable grace period during which only interest is payable. The interest rate is based on OPIC's assessment of the financial and political risks involved. OPIC has expressed support for this Project and wanted it to be one of the first OPIC financing made in Vietnam. OPIC has indicated a willingness to consider up to their project limit in loan support and is also willing to consider providing political risk coverage to US sponsor equity investment.

1.17 Political Considerations

Several commitments, consideration and concessions from the Government of Vietnam, and its agencies will be needed to make the Project economically viable and to assist the JVC to secure financing for the Project. These are:

- Priority allocation of credit capacity available under the limitations which the government has agreed with the IMF to observe (as part of the Fund's Extended Structural Adjustment Facility) to the debt required to finance the Project.
- Guarantee regarding foreign exchange availability, convertibility and rate fluctuations.
- Authorization for the JVC to export a portion of the HBI or to make sales to foreign invested enterprises in foreign currencies.
- Issuance of guarantees under bilateral export financing programs to be used to purchase equipment for the Project.
- Right of foreign investors timely repatriation of fund.
- Endorsement of the Project as a priority Project and confirmation of such status to multilateral financing agencies.
- Adequate positive measures to protect the competitiveness of the Project, including necessary restriction on the grant of further licenses to any entity that would compete with this Project.
- Assistance of the Government with infrastructure and the construction of port facility through the use of multilateral or bilateral concessionary financing facilities or assistance programs available to the Government or relevant ministries agencies.
- Timely issuance of all licenses, permits and approvals from governmental agencies.
- Considerations for natural gas price at less than US $ 1.75 per million BTU and electrical power tariff less than of US $0.68 per KWH to enhance competitiveness in the international market of DR products, as determined by the market study.

1.18 Conclusions

A detailed Feasibility Study to construct a Direct Reduced Iron Plant in compliance with the Master Plan of the Steel Industry to meet the increasing demand of steel products in Vietnam and to serve as an export facility of HBI for the regional demand has been conducted under a Grant Agreement between US TDA and VSC. The primary conclusions, based on this study, are as follows:

- Demand of steel products in Vietnam has been estimated to rise to about 2 million tons by year 2000 and 6 million tons by 2010 compared to the current annual rolled steel production of about 1.15 million tons.

- Demand of DRI/HBI, which is critical ingredients of steel making via EAF, in Asia is expected to rise from 1997 level of about 8 million tons to about 19 to 27 million tons within the next decade. Market potential of Vietnam HBI plant will be 5 to 7 million tons in year 2005 and 7 to 10 million tons in 2010.

- Considering market potential of the region and in-country demand, Vietnam can consider building a 1.5 million tons per year HBI plant. The Plant capacity may be expended in future by adding a second module of similar capacity.

- From a technical perspective, it is believed that a plant can be designed and constructed to produce the required output and quality of HBI product desired by the JVC. Additionally, there appears to be sufficient natural resources in the form of natural gas and electricity to support the Project. However, feed materials for the Plant (iron pellets and lump ore) need to be imported due to quality problems in the in-country iron ore reserves. Further work will be required to confirm suitability of in-country iron ore reserves.

- Following technical reports prepared for the Study are included as appendices:

  - Market Study
  - Selection of the Plant Location
  - Topographic and Hydrological Surveys
  - Geotechnical Investigations
  - Utilities Sources of the Site
  - Environmental Assessment
  - MIDREX MEGAMOD™ DRI Plant
  - Financial Analysis

- Initial discussions with primary suppliers for the Project suggest that suitable contracts can be achieved that will have sufficient pricing and terms to proceed with development. There are, however, some key issues that still need to be resolved with several of the contracts. In particular, substantial work will be required on the EPC contracts to reduce the Plant capital costs.

1.18 Conclusions (continued)

- There do not appear to be any significant problems with securing environmental permits for the facility.

- The Project is expected to be able to raise financing with about 30 percent equity and 70 percent debt. The current debt markets, however, are quite challenging for both the Vietnam and steel markets, in general. Allowing some time for the markets to return to better conditions would improve the Project economics. Currently, the steel market is still unsettled as a result of poor economic conditions in various critical regions of the world and a resulting drop in prices and over capacity.

- Financial analysis for the Base Case of the study yields a 12.2% IRR on total capital investment which may not meet the desired return threshold level of the JVC. In order to proceed with development of the Project, the economic return needs to be improved. The most likely area that can improve the economics is a reduction in the capital cost of the facility. This would need to come through either a substantial reduction in the EPC cost, or a reconfiguration of the Project on a different site. Various scenarios have been considered in the financial models. A 10% reduction in the plant capital cost will improve IRR to about 14%. An added factor could be in reducing the cost of material imports (e.g. iron ore, natural gas, electricity). Finally, favorable considerations from the Government of Vietnam are needed in establishing favorable utility tariffs for operation and to minimize risks of foreign investments in Vietnam.

- The Project would have several important benefits for Vietnam in the form of providing numerous jobs for construction and operation of the plant, tax revenues, and substantial revenues in the form of natural gas, electricity and HBI sales in regional foreign markets.

- In summary, the Study indicates the Project is viable, however, before proceeding actively with development of the Project as currently envisioned, the following 3 items need to happen: (1) steel market conditions and HBI price must show signs of improvement to confirm the Market Study assumption, (2) Project financing markets must show signs of improvement and (3) the project economics must get better by reducing total capital investments and/or operating costs with favorable utility tariffs. In addition, firm commitments of all potential JVC Partners need to be confirmed and the following critical project specific agreements should be developed:

  - Feed Materials Supply
  - Gas Supply
  - Electricity Supply
  - Water Supply
  - Land Lease
  - Product Off-Take

1.18 Conclusions (continued)

- Operations & Technical Assistance
- Maintenance
- Waste Disposal

It is envisioned that, based on a 3-month review period of the Report by VSC and other interested parties including final confirmation of all JV partners, followed by a 10-month project development phase as outlined in Section 12.0, the anticipated start date of the Project will be September 1, 2001, and the plant will be ready for operation by August, 2004.

REPORT ON

FEASIBILITY STUDY

FOR

DIRECT REDUCTION PLANT

IN

VIETNAM

POTENTIAL SITE LOCATION MAP

MAP NO. 1-1

LOCATION MAP OF PROVINCES IN THE RESEARCHED AREA

DRW. 1/8

REPORT ON

FEASIBILITY STUDY

FOR

DIRECT REDUCTION PLANT

IN

VIETNAM

SIMPLIFIED PROCESS DETAILS

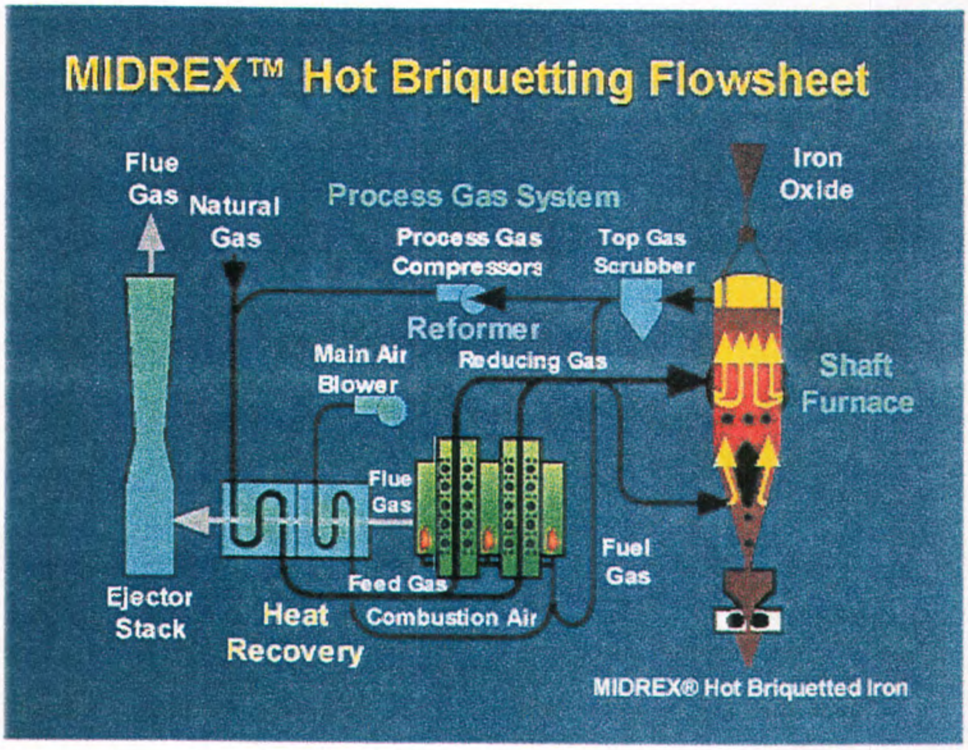
TABLE NO. 1-2

Process Details

THE MIDREX® DIRECT REDUCTION PROCESS

Reduction

Direct reduction is carried out continously in a vertical shaft furnace. Iron oxide is fed to the top of the shaft, where it flows downward by gravity and is discharged from the bottom in the form of DRI.



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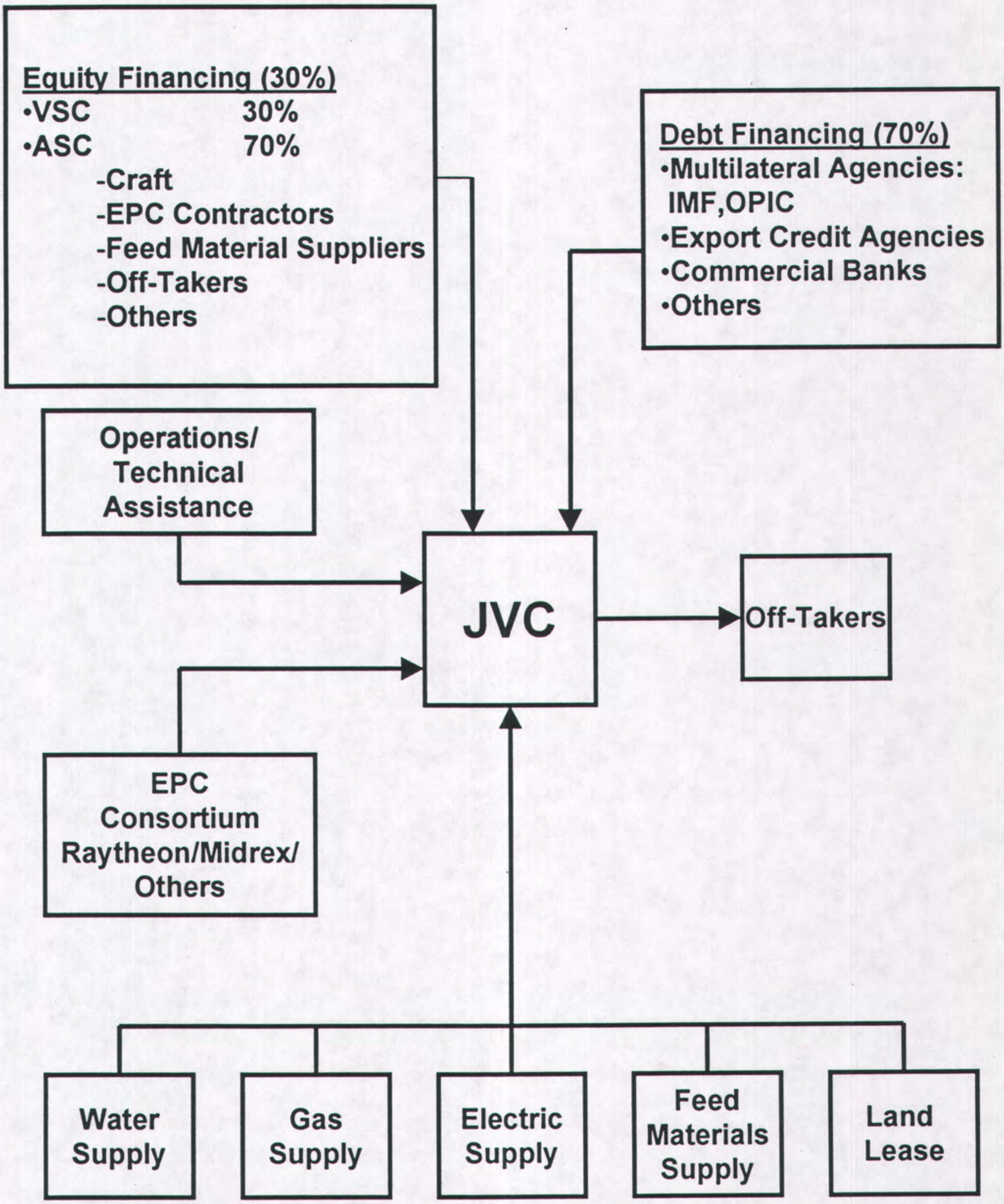
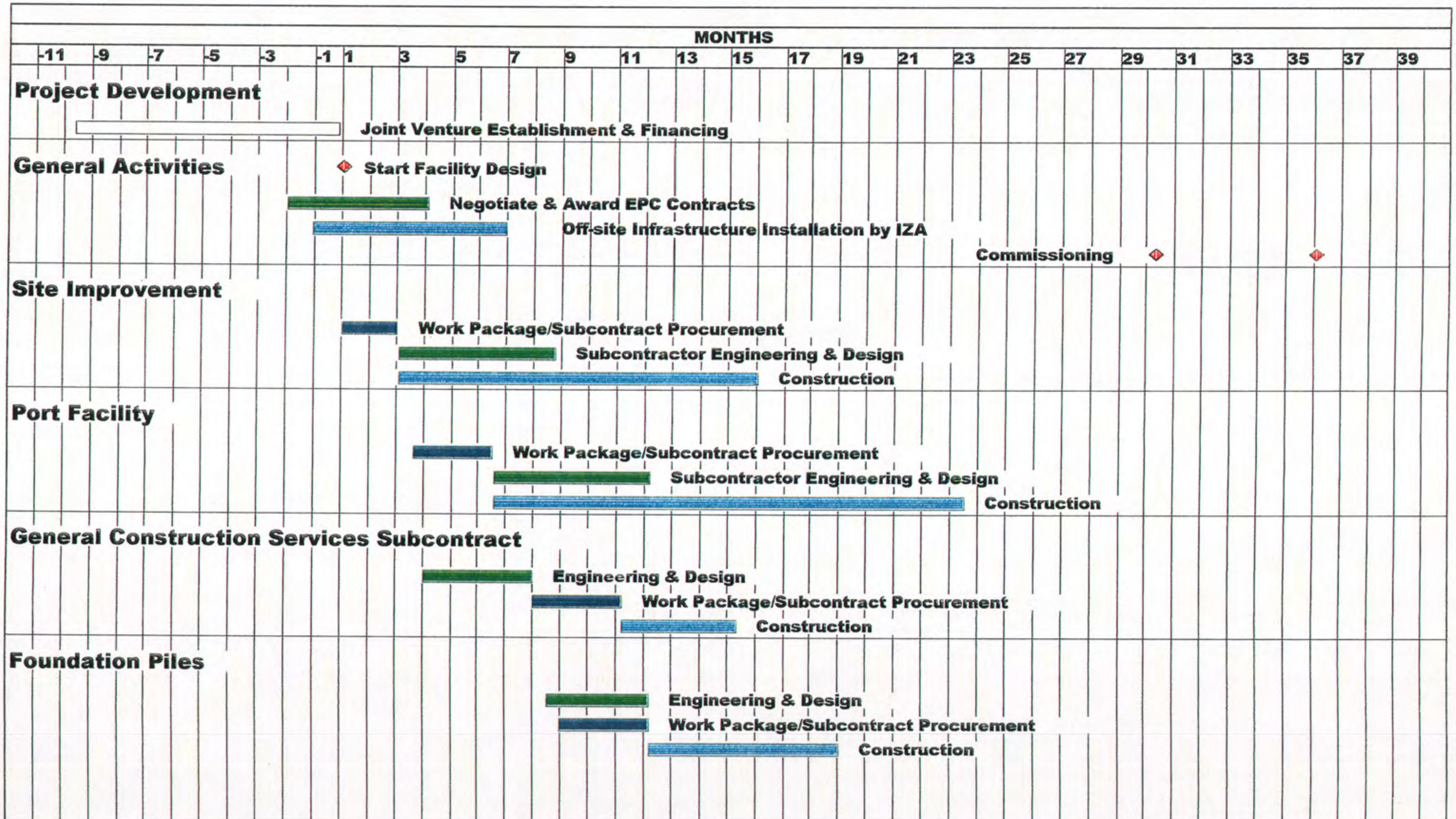
PROCESS CHEMISTRY		
Reduction:	**Carburization:**	**Reforming:**
$FE_2O_3 + 3 H_2 => 2 Fe + 3 H_2O$	$3 Fe + 2 CO => Fe_3C + CO_2$	$CH_4 + CO_2 => 2 CO + 2 H_2$
$FE_2O_3 + 3 CO => 2 Fe + 3 CO_2$	$3 Fe + CH_4 => Fe_3C + 2 H_2$	$CH_4 + H_20 => CO + 3 H_2$

Project Structure

Table 1-3





Plot Date 9DEC99

Legend:
Engineering & Design
Eqpt/Material/Subcontract Procurement
Construction
Commissioning

(c) Primavera Systems, Inc.

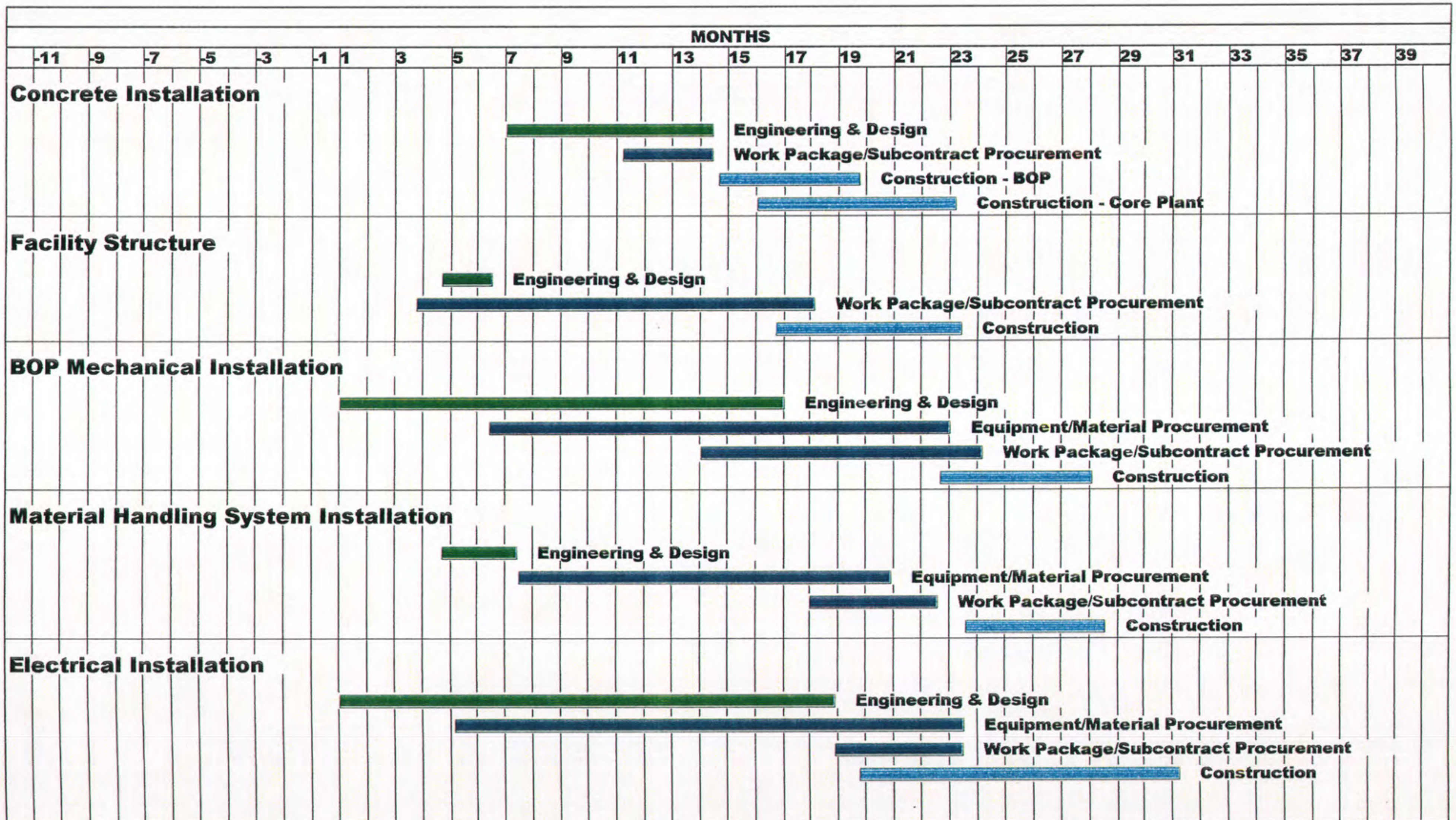
VDK2

Sheet 1 of 3

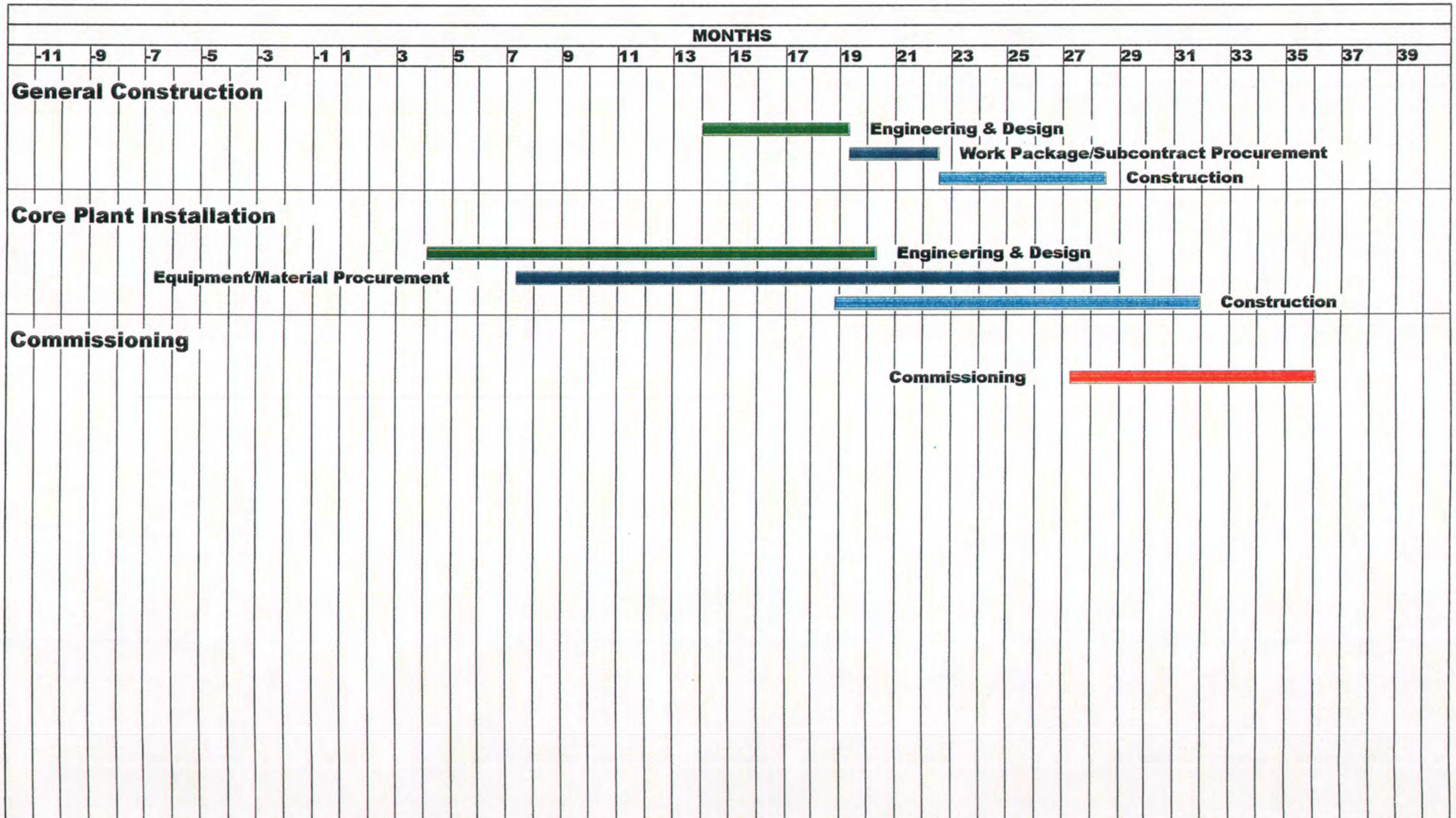
Vietnam Steel Company
DRI Facility
Summary Schedule

Table 1-4

Date	Revision	Checked	Approved



Plot Date 9DEC99	VDR2	Sheet 2 of 3	Table 1-4
(c) Primavera Systems, Inc.	Vietnam Steel Company DRI Facility Summary Schedule		Date / Revision / Checked / Approved



Plot Date 9DEC99

(c) Primavera Systems, Inc.

Legend:
Engineering & Design
Eqpt/Material/Subcontract Procurement
Construction
Commissioning

VDR2

Sheet 3 of 3

Vietnam Steel Company
DRI Facility
Summary Schedule

Table 1-4

Date	Revision	Checked	Approved

REPORT ON

FEASIBILITY STUDY

FOR

DIRECT REDUCTION PLANT

IN

VIETNAM

RESULTS OF FINANCIAL ANALYSIS
(11 CHARTS)

TABLE NO 1-5

Financial Analysis

Chart 1
FLOW OF FINANCIAL RESOURCES
(million US $)

Source of finance		Total value	Constrn. period, yrs 1st	2nd	3rd	Operating period, years 1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Equity capital																				
1. Foreign	FC	83.92	51.68	32.24																
2. Local	LC	35.60	17.96	17.64																
Sub-total (A)		**119.52**	**69.64**	**49.88**																
B. Long term loan																				
1. Foreign	FC	215.98	6.42	83.92	75.38	50.26														
2. Local	LC	62.90	0.65	18.77	26.35	17.12														
Sub-total (B)		**278.88**	**7.07**	**102.69**	**101.73**	**67.39**														
C. Internal generation of working capital	LC	4.96				3.58	0.81	(0.01)			0.29					0.29				
D. Short term finance																				
1. Bank loan for working capita	LC	27.15				20.06	4.79	(0.01)			1.15					1.16				
2. Short term borrowing	LC																			
Sub-total (D)		**27.15**				**20.06**	**4.79**	**(0.01)**			**1.15**					**1.16**				
E. Total financial flow (A to D)																				
1. Foreign	FC	299.90	58.09	116.16	75.38	50.26														
2. Local	LC	130.61	18.62	36.41	26.35	40.77	5.60	(0.02)			1.44					1.44				
Total (E)		**430.51**	**76.71**	**152.57**	**101.73**	**91.03**	**5.60**	**(0.02)**			**1.44**					**1.44**				

Chart 2
TOTAL WORKING CAPITAL REQUIREMENT
(million US $)

Items	Co-efficient of turnover [1]	Bank finance %	1st year operation			2nd year operation		
			Amount	Bank finance	Margin money	Amount	Bank finance	Margin money
A. Current assets								
1. Total inventory								
- Raw materials								
(i) Pellets	12	75	3.39	2.54	0.85	4.24	3.18	1.06
(ii) Sized iron ore	12	75	2.68	2.01	0.67	3.35	2.51	0.84
Sub-total (i)			**6.07**	**4.55**	**1.52**	**7.59**	**5.69**	**1.90**
- Wage and salaries	24		0.03		0.03	0.03		0.03
- Repair and maintenance	24	75	0.37	0.28	0.09	0.41	0.31	0.10
- Consumables	24	75	0.10	0.07	0.02	0.12	0.09	0.03
- Power and natural gas	24	75	1.35	1.01	0.34	1.60	1.20	0.40
- Work in progress [2]		75						
- Stock of finished goods	24	75	5.04	3.78	1.26	6.12	4.59	1.53
Sub-total (A.1)			**12.95**	**9.69**	**3.26**	**15.88**	**11.89**	**3.99**
2. Accounts receivable	12	75	13.82	10.37	3.46	17.28	12.96	4.32
Sub-total (A)			**26.78**	**20.06**	**6.72**	**33.16**	**24.85**	**8.31**
B. Current liabilities								
1. Raw materials								
- Pellets	24		1.70		1.70	2.12		2.12
- Sized iron ore	24		1.34		1.34	1.67		1.67
Sub-total (B.1)			**3.04**		**3.04**	**3.79**		**3.79**
2. Consumables	24		0.10		0.10	0.12		0.12
3. Power and natural gas								
Sub-total (B)			**3.13**		**3.13**	**3.92**		**3.92**
C. Total working capital requirement (A - B)			**23.64**	**20.06**	**3.58**	**29.24**	**24.85**	**4.40**

NOTE:
(1) Co-efficient of turn over = 360/minimum days of coverage
(2) Total residence time of material inside the shaft furnace is about 8 - 10 hours; hence ignored

Report on Feasibility Study
For
Direct Reduction Plant in Vietnam
Financial Analysis

Chart 3
TOTAL DEBT SERVICES
(million US $)

Source	Total value	Constrn. period, yrs			Operating period, years														
		1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Total long term loan																			
1. Disbursement	278.88	7.07	102.69	101.73	67.39														
2. Repayment	278.88					34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86						
3. Debt balance end of year		7.07	109.76	211.49	278.88	244.02	209.16	174.30	139.44	104.58	69.72	34.86							
4. Capitalized interest																			
5. Interest payable	112.60				23.70	21.48	18.52	15.56	12.59	9.63	6.67	3.70	0.74						
6. Other financial costs																			
B. Total short term loan																			
1. Disbursement	27.15				20.06	4.79	(0.01)			1.15					1.16				
2. Repayment																			
3. Debt balance end of year					20.06	24.85	24.84	24.84	24.84	25.99	25.99	25.99	25.99	25.99	27.15	27.15	27.15	27.15	27.15
4. Capitalized interest																			
5. Interest payable	38.51				2.01	2.48	2.48	2.48	2.48	2.60	2.60	2.60	2.60	2.60	2.71	2.71	2.71	2.71	2.71
6. Other financial costs																			
C. Total debt service																			
1. Disbursement	306.03	7.07	102.69	101.73	87.45	4.79	(0.01)			1.15					1.16				
2. Repayment	278.88					34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86						
3. Debt balance end of year		7.07	109.76	211.49	298.94	268.86	234.00	199.14	164.28	130.57	95.71	60.85	25.99	25.99	27.15	27.15	27.15	27.15	27.15
4. Capitalized interest																			
5. Interest payable	151.11				25.71	23.97	21.00	18.04	15.08	12.23	9.27	6.30	3.34	2.60	2.71	2.71	2.71	2.71	2.71
6. Other financial costs																			

Report on Feasibility Study
For
Direct Reduction Plant in Vietnam
Financial Analysis

Chart 4
ANNUAL COST OF PRODUCT SOLD
(million US $)

Item	Operating period, years														
	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**	**13th**	**14th**	**15th**
Capacity utilisation, %	80%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
A. Factory cost															
1. Variable cost															
(i) Raw materials															
- Sized iron ore: Bailadila, India	32.14	40.17	40.17	40.17	40.17	41.17	41.17	41.17	41.17	41.17	42.20	42.20	42.20	42.20	42.20
- Pellet : CVRD,Brazil	22.06	27.58	27.58	27.58	27.58	28.27	28.27	28.27	28.27	28.27	28.98	28.98	28.98	28.98	28.98
GIIC,Bahrain	18.66	23.32	23.32	23.32	23.32	23.90	23.90	23.90	23.90	23.90	24.50	24.50	24.50	24.50	24.50
Sub-total (A.1.i)	**72.85**	**91.07**	**91.07**	**91.07**	**91.07**	**93.34**	**93.34**	**93.34**	**93.34**	**93.34**	**95.68**	**95.68**	**95.68**	**95.68**	**95.68**
(ii) Others															
- Consumables	2.17	2.71	2.71	2.71	2.71	2.78	2.78	2.78	2.78	2.78	2.85	2.85	2.85	2.85	2.85
- Power	8.71	10.89	10.89	10.89	10.89	11.16	11.16	11.16	11.16	11.16	11.44	11.44	11.44	11.44	11.44
- Water	0.16	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
- Natural gas	15.89	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86
- Repair and maintenance	3.96	4.95	4.95	4.95	4.95	5.07	5.07	5.07	5.07	5.07	5.20	5.20	5.20	5.20	5.20
Sub-total (A.1.ii)	**30.89**	**38.61**	**38.61**	**38.61**	**38.61**	**39.08**	**39.08**	**39.08**	**39.08**	**39.08**	**39.56**	**39.56**	**39.56**	**39.56**	**39.56**
Sub-total (A.1)	**103.74**	**129.68**	**129.68**	**129.68**	**129.68**	**132.42**	**132.42**	**132.42**	**132.42**	**132.42**	**135.24**	**135.24**	**135.24**	**135.24**	**135.24**
2. Fixed cost															
(i) Labour and supervision	0.75	0.76	0.53	0.54	0.55	0.56	0.57	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.67
(ii) Power	2.72	2.72	2.72	2.72	2.72	2.79	2.79	2.79	2.79	2.79	2.86	2.86	2.86	2.86	2.86
(iii) Water	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
(iv) Natural gas	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97
(v) Repair and maintenance	4.95	4.95	4.95	4.95	4.95	5.07	5.07	5.07	5.07	5.07	5.20	5.20	5.20	5.20	5.20
Sub-total (A.2)	**13.44**	**13.45**	**13.21**	**13.23**	**13.24**	**13.44**	**13.45**	**13.46**	**13.47**	**13.49**	**13.70**	**13.71**	**13.72**	**13.73**	**13.75**
Sub-total (A)	**117.18**	**143.12**	**142.89**	**142.90**	**142.91**	**145.86**	**145.87**	**145.89**	**145.90**	**145.91**	**148.93**	**148.95**	**148.96**	**148.97**	**148.98**
B. Administrative overheads															
1. Salary and wages	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.14
2. Material and services	0.21	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
3. Rent/leasing costs	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
4. Insurance	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72
Sub-total (B)	**3.25**	**3.25**	**3.26**	**3.26**	**3.26**	**3.27**	**3.27**	**3.27**	**3.27**	**3.28**	**3.28**	**3.28**	**3.29**	**3.29**	**3.29**
C. Sales overheads															
1. Salaries	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
2. Other direct cost	0.41	0.52	0.52	0.52	0.52	0.55	0.55	0.55	0.55	0.55	0.59	0.59	0.59	0.59	0.59
Sub-total (C)	**0.44**	**0.54**	**0.54**	**0.54**	**0.55**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.62**	**0.62**	**0.62**	**0.62**	**0.62**
D. Manufacturing expenses (A to C)	**120.87**	**146.92**	**146.69**	**146.71**	**146.72**	**149.71**	**149.73**	**149.74**	**149.75**	**149.77**	**152.83**	**152.85**	**152.87**	**152.89**	**152.90**
E. Fixed charges															
1. Depreciation	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	2.46	2.46	2.46	2.46	2.46
2. Interest on long term loan	23.70	21.48	18.52	15.56	12.59	9.63	6.67	3.70	0.74						
3. Interest on short term loan	2.01	2.48	2.48	2.48	2.48	2.60	2.60	2.60	2.60	2.60	2.71	2.71	2.71	2.71	2.71
Sub-total (E)	**58.62**	**56.88**	**53.91**	**50.95**	**47.99**	**45.14**	**42.18**	**39.21**	**36.25**	**35.51**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**
F. Cost of product sold (D+E)	**179.49**	**203.80**	**200.61**	**197.66**	**194.71**	**194.85**	**191.91**	**188.95**	**186.01**	**185.28**	**158.01**	**158.02**	**158.04**	**158.06**	**158.08**

Chart 5
NET INCOME STATEMENT
(million US $)

Item	Operating period, years														
	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**	**13th**	**14th**	**15th**
Capacity utilisation (%)	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100
A. Total income	165.88	208.00	208.03	208.27	208.62	223.40	224.48	225.63	226.94	228.41	246.01	249.50	253.12	256.45	259.90
B. Less : variable costs															
1. Raw materials	72.85	91.07	91.07	91.07	91.07	93.34	93.34	93.34	93.34	93.34	95.68	95.68	95.68	95.68	95.68
2. Other variable cost	30.89	38.61	38.61	38.61	38.61	39.08	39.08	39.08	39.08	39.08	39.56	39.56	39.56	39.56	39.56
Sub-total (B)	**103.74**	**129.68**	**129.68**	**129.68**	**129.68**	**132.42**	**132.42**	**132.42**	**132.42**	**132.42**	**135.24**	**135.24**	**135.24**	**135.24**	**135.24**
C. Variable margin (A-B)	62.14	78.32	78.36	78.60	78.94	90.98	92.06	93.21	94.52	95.99	110.77	114.26	117.89	121.22	124.66
D. Less : fixed costs															
1. Labour and supervision	0.75	0.76	0.53	0.54	0.55	0.56	0.57	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.67
2. Marketing	0.44	0.54	0.54	0.54	0.55	0.58	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62	0.62
3. Other fixed cost	15.94	15.94	15.94	15.94	15.95	16.15	16.15	16.15	16.15	16.15	16.35	16.36	16.36	16.37	16.37
4. Depreciation	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	2.46	2.46	2.46	2.46	2.46
Sub-total (D)	**50.04**	**50.16**	**49.93**	**49.94**	**49.95**	**50.20**	**50.22**	**50.23**	**50.24**	**50.26**	**20.06**	**20.07**	**20.09**	**20.11**	**20.12**
E. Operational margin (C-D	12.10	28.17	28.43	28.66	28.99	40.78	41.84	42.98	44.27	45.73	90.71	94.19	97.79	101.11	104.54
F. Less : costs of finance	25.71	23.97	21.00	18.04	15.08	12.23	9.27	6.30	3.34	2.60	2.71	2.71	2.71	2.71	2.71
G. Gross profit / (loss) (E-F	(13.61)	4.20	7.43	10.62	13.91	28.55	32.58	36.68	40.93	43.13	88.00	91.48	95.08	98.39	101.82
H. Less : corporate tax				0.80	1.04	2.14	4.89	5.50	6.14	6.47	13.20	13.72	23.77	24.60	25.46
I. Net profit / (loss)															
1. Current (G-H)	**(13.61)**	**4.20**	**7.43**	**9.82**	**12.87**	**26.41**	**27.69**	**31.18**	**34.79**	**36.66**	**74.80**	**77.76**	**71.31**	**73.80**	**76.37**
2. Cumulative	**(13.61)**	**(9.41)**	**(1.99)**	**7.83**	**20.70**	**47.11**	**74.80**	**105.98**	**140.77**	**177.43**	**252.23**	**329.98**	**401.29**	**475.09**	**551.45**

Chart 6
CASH FLOW STATEMENT
(million US $)

Item	Constrn. period, yrs			Operating period, years														
	1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Cash inflow																		
1. Inflow funds																		
- Total equity	69.64	49.88																
- Total long-term loans	7.07	102.69	101.73	67.39														
- Total short-term finance				20.06	4.79	(0.01)			1.15					1.16				
Sub-total (A.1)	**76.71**	**152.57**	**101.73**	**87.45**	**4.79**	**(0.01)**			**1.15**					**1.16**				
2. Inflow operation																		
- Sales revenue				165.88	207.35	207.35	207.35	207.35	221.65	221.65	221.65	221.65	221.65	235.95	235.95	235.95	235.95	235.95
- Interest on bank deposit					0.65	0.68	0.92	1.27	1.75	2.83	3.98	5.29	6.76	10.06	13.55	17.17	20.50	23.95
Sub-total (A.2)				165.88	208.00	208.03	208.27	208.62	223.40	224.48	225.63	226.94	228.41	246.01	249.50	253.12	256.45	259.90
Sub-total (A)	**76.71**	**152.57**	**101.73**	**253.33**	**212.79**	**208.03**	**208.27**	**208.62**	**224.55**	**224.48**	**225.63**	**226.94**	**228.41**	**247.16**	**249.50**	**253.12**	**256.45**	**259.90**
B. Cash outflow																		
1. Increase in fixed assets																		
- Total fixed investments	69.64	147.03	86.36	67.05														
- Interest paid	7.07	5.54	15.37	0.34														
Sub-total (B.1)	**76.71**	**152.57**	**101.73**	**67.39**														
2. Increase in working capital				23.64	5.60	(0.02)			1.44					1.44				
3. Operating costs				120.43	146.38	146.15	146.16	146.18	149.13	149.15	149.16	149.17	149.19	152.21	152.23	152.25	152.26	152.28
4. Marketing costs				0.44	0.54	0.54	0.54	0.55	0.58	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62	0.62
5. Costs of finance				25.71	23.97	21.00	18.04	15.08	12.23	9.27	6.30	3.34	2.60	2.71	2.71	2.71	2.71	2.71
6. Corporate tax							0.80	1.04	2.14	4.89	5.50	6.14	6.47	13.20	13.72	23.77	24.60	25.46
7. Loan repayments					34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86						
Sub-total (B)	**76.71**	**152.57**	**101.73**	**237.61**	**211.35**	**202.54**	**200.40**	**197.70**	**200.38**	**198.74**	**196.40**	**194.10**	**158.84**	**170.19**	**169.29**	**179.36**	**180.20**	**181.07**
C. Cash surplus/(deficit)																		
1. Current (A - B)				**15.72**	**1.44**	**5.49**	**7.87**	**10.92**	**24.17**	**25.74**	**29.23**	**32.84**	**69.57**	**76.97**	**80.22**	**73.77**	**76.25**	**78.83**
2. Cumulative				**15.72**	**17.16**	**22.65**	**30.52**	**41.44**	**65.61**	**91.35**	**120.58**	**153.42**	**222.99**	**299.97**	**380.18**	**453.95**	**530.20**	**609.03**

Chart 7
BREAK EVEN ANALYSIS
(million US $)

Item	Operating period, years														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Variable cost															
1. Raw materials															
- Sized iron ore : Bailadila, India	32.14	40.17	40.17	40.17	40.17	41.17	41.17	41.17	41.17	41.17	42.20	42.20	42.20	42.20	42.20
- Pellet : CVRD,Brazil	22.06	27.58	27.58	27.58	27.58	28.27	28.27	28.27	28.27	28.27	28.98	28.98	28.98	28.98	28.98
GIIC,Bahrain	18.66	23.32	23.32	23.32	23.32	23.90	23.90	23.90	23.90	23.90	24.50	24.50	24.50	24.50	24.50
Sub-total (A.1)	**72.85**	**91.07**	**91.07**	**91.07**	**91.07**	**93.34**	**93.34**	**93.34**	**93.34**	**93.34**	**95.68**	**95.68**	**95.68**	**95.68**	**95.68**
2. Consumables	2.17	2.71	2.71	2.71	2.71	2.78	2.78	2.78	2.78	2.78	2.85	2.85	2.85	2.85	2.85
3. Power	8.71	10.89	10.89	10.89	10.89	11.16	11.16	11.16	11.16	11.16	11.44	11.44	11.44	11.44	11.44
4. Water	0.16	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
5. Natural gas	15.89	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86
6. Repair and maintenance	3.96	4.95	4.95	4.95	4.95	5.07	5.07	5.07	5.07	5.07	5.20	5.20	5.20	5.20	5.20
Sub-total (A)	**103.74**	**129.68**	**129.68**	**129.68**	**129.68**	**132.42**	**132.42**	**132.42**	**132.42**	**132.42**	**135.24**	**135.24**	**135.24**	**135.24**	**135.24**
B. Fixed cost															
1. Labor and supervision	0.75	0.76	0.53	0.54	0.55	0.56	0.57	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.67
2. Power	2.72	2.72	2.72	2.72	2.72	2.79	2.79	2.79	2.79	2.79	2.86	2.86	2.86	2.86	2.86
3. Water	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
4. Natural gas	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97
5. Repair and maintenance	4.95	4.95	4.95	4.95	4.95	5.07	5.07	5.07	5.07	5.07	5.20	5.20	5.20	5.20	5.20
6. Administrative overhead costs	3.25	3.25	3.26	3.26	3.26	3.27	3.27	3.27	3.27	3.28	3.28	3.28	3.29	3.29	3.29
7. Marketing costs	0.44	0.54	0.54	0.54	0.55	0.58	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62	0.62
8. Depreciation	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	2.46	2.46	2.46	2.46	2.46
9. Financial costs	25.71	23.97	21.00	18.04	15.08	12.23	9.27	6.30	3.34	2.60	2.71	2.71	2.71	2.71	2.71
Sub-total (B)	**75.75**	**74.12**	**70.93**	**67.98**	**65.03**	**62.43**	**59.48**	**56.53**	**53.58**	**52.86**	**22.77**	**22.79**	**22.81**	**22.82**	**22.84**
C. Net income	165.88	208.00	208.03	208.27	208.62	223.40	224.48	225.63	226.94	228.41	246.01	249.50	253.12	256.45	259.90
D. Contribution (C - A)	62.14	78.32	78.36	78.60	78.94	90.98	92.06	93.21	94.52	95.99	110.77	114.26	117.89	121.22	124.66
E. Break even capacity (B/D) , %	**122**	**95**	**91**	**86**	**82**	**69**	**65**	**61**	**57**	**55**	**21**	**20**	**19**	**19**	**18**

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Chart 8
IRR AND NPV ON TOTAL CAPITAL INVESTED
(million US $)

Item		Constrn. period, yrs			Operating period, years														
		1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Cash inflow																			
1. Inflow operation																			
- Sales revenue					165.88	207.35	207.35	207.35	207.35	221.65	221.65	221.65	221.65	221.65	235.95	235.95	235.95	235.95	235.95
- Interest on bank deposit						0.65	0.68	0.92	1.27	1.75	2.83	3.98	5.29	6.76	10.06	13.55	17.17	20.50	23.95
Sub-total (A)					**165.88**	**208.00**	**208.03**	**208.27**	**208.62**	**223.40**	**224.48**	**225.63**	**226.94**	**228.41**	**246.01**	**249.50**	**253.12**	**256.45**	**259.90**
B. Cash outflow																			
1. Increase in fixed assets																			
- Total fixed investments		76.71	152.57	101.73	67.39														
2. Increase in net working capital					23.64	5.60	(0.02)	0.00	0.00	1.44	0.00	0.00	0.00	0.00	1.44	0.00	0.00	0.00	0.00
3. Operating costs					120.43	146.38	146.15	146.16	146.18	149.13	149.15	149.16	149.17	149.19	152.21	152.23	152.25	152.26	152.28
4. Marketing costs					0.44	0.54	0.54	0.54	0.55	0.58	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62	0.62
5. Corporate tax								0.80	1.04	2.14	4.89	5.50	6.14	6.47	13.20	13.72	23.77	24.60	25.46
Sub-total (B)		**76.71**	**152.57**	**101.73**	**211.90**	**152.52**	**146.67**	**147.50**	**147.76**	**153.29**	**154.62**	**155.24**	**155.90**	**156.24**	**167.47**	**166.57**	**176.64**	**177.49**	**178.36**
C. Plant residual value																			102.45
D. Net cash flow																			
1. Current (A-B+C)		(76.71)	(152.57)	(101.73)	(46.02)	55.48	61.36	60.77	60.86	70.11	69.87	70.39	71.04	72.17	78.53	82.93	76.48	78.97	183.99
2. Cumulative			(152.57)	(254.30)	(300.32)	(244.84)	(183.48)	(122.71)	(61.86)	8.26	78.12	148.51	219.56	291.73	370.26	453.19	529.67	608.64	792.63
E. NPV (discounted @ 9 % / year)	**87.14**	**(70.38)**	**(128.41)**	**(78.55)**	**(32.60)**	**36.06**	**36.59**	**33.24**	**30.54**	**32.28**	**29.51**	**27.28**	**25.26**	**23.54**	**23.50**	**22.77**	**19.26**	**18.25**	**39.01**
F. IRR (on total capital invested), %	**12.22**																		

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Chart 9
IRR AND NPV ON EQUITY CAPITAL INVESTED
(million US $)

Item		Constrn. period, yrs			Operating period, years														
		1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Cash inflow																			
1. Cash surplus / (deficit)					15.72	1.44	5.49	7.87	10.92	24.17	25.74	29.23	32.84	69.57	76.97	80.22	73.77	76.25	78.83
B. Cash outflow																			
1. Equity capital paid (net of subsidies)		69.64	49.88																
C. Plant residual value																			102.45
D. Net cash return																			
1. Current (A-B+C)		(69.64)	(49.88)		15.72	1.44	5.49	7.87	10.92	24.17	25.74	29.23	32.84	69.57	76.97	80.22	73.77	76.25	181.28
2. Cumulative		(69.64)	(119.52)	(119.52)	(103.81)	(102.36)	(96.88)	(89.00)	(78.09)	(53.91)	(28.17)	1.06	33.90	103.47	180.45	260.66	334.43	410.68	591.96
E. NPV (discounted @ 9 % / year)	**106.64**	**(63.89)**	**(41.98)**		**11.13**	**0.94**	**3.27**	**4.31**	**5.48**	**11.13**	**10.87**	**11.33**	**11.68**	**22.69**	**23.03**	**22.02**	**18.58**	**17.62**	**38.43**
F. IRR (on equity), %	**15.78**																		

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Chart 10
DEBT SERVICE COVERAGE RATIO

(million US $)

Item	Operating period, years														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Debt coverage															
1. Net profit after tax	(13.61)	4.20	7.43	9.82	12.87	26.41	27.69	31.18	34.79	36.66	74.80	77.76	71.31	73.80	76.37
2. Depreciation	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	2.46	2.46	2.46	2.46	2.46
3. Cost of finance	23.70	21.48	18.52	15.56	12.59	9.63	6.67	3.70	0.74						
Sub-total (A)	**43.00**	**58.59**	**58.86**	**58.29**	**58.37**	**68.95**	**67.27**	**67.79**	**68.45**	**69.57**	**77.26**	**80.22**	**73.77**	**76.26**	**78.83**
B. Debt liability															
1. Loan repayments		34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86						
2. Cost of finance	23.70	21.48	18.52	15.56	12.59	9.63	6.67	3.70	0.74						
Sub-total (B)	**23.70**	**56.34**	**53.38**	**50.42**	**47.45**	**44.49**	**41.53**	**38.56**	**35.60**						
C. DSCR (A/B)	**1.81**	**1.04**	**1.10**	**1.16**	**1.23**	**1.55**	**1.62**	**1.76**	**1.92**						
D. Average DSCR [1] **1.47**															

NOTE :

(1) Average during the loan repayment period.

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Chart 11
PROJECTED BALANCE SHEET
(million US $)

Item	Constrn. period, yrs			Operating period, years														
	1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Total assets																		
1. Total current assets																		
- Inventory on materials and supplies				7.92	9.76	9.75	9.75	9.75	9.97	9.97	9.97	9.97	9.97	10.19	10.19	10.19	10.19	10.19
- Work in progress																		
- Finished product in stock				5.04	6.12	6.11	6.11	6.11	6.24	6.24	6.24	6.24	6.24	6.37	6.37	6.37	6.37	6.37
- Accounts receivable				13.82	17.28	17.28	17.28	17.28	18.47	18.47	18.47	18.47	18.47	19.66	19.66	19.66	19.66	19.66
- Cash surplus, finance available				15.72	17.16	22.65	30.52	41.44	65.61	91.35	120.58	153.42	222.99	299.97	380.18	453.95	530.20	609.03
- Securities																		
Sub-total (A.1)				**42.49**	**50.31**	**55.79**	**63.66**	**74.58**	**100.29**	**126.03**	**155.26**	**188.10**	**257.67**	**336.19**	**416.41**	**490.18**	**566.43**	**645.26**
2. Total fixed assets net of depreciation																		
- Fixed investment		76.71	229.28	331.01	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40
- Construction in progress	76.71	152.57	101.73	67.39														
- Less : accumulated depreciation				32.91	65.82	98.73	131.65	164.56	197.47	230.38	263.29	296.20	329.11	331.57	334.03	336.49	338.95	341.41
Sub-total (A.2)	**76.71**	**229.28**	**331.01**	**365.49**	**332.58**	**299.66**	**266.75**	**233.84**	**200.93**	**168.02**	**135.11**	**102.20**	**69.28**	**66.82**	**64.36**	**61.90**	**59.44**	**56.98**
3. Accumulated loss brought forward					13.61	9.41	1.99											
4. Loss in current year				13.61														
Total assets (A)	**76.71**	**229.28**	**331.01**	**421.59**	**396.50**	**364.86**	**332.39**	**308.42**	**301.22**	**294.05**	**290.36**	**290.30**	**326.96**	**403.01**	**480.77**	**552.08**	**625.87**	**702.24**
B. Total liabilities																		
1. Total current liabilities																		
- Accounts payable				3.13	3.92	3.92	3.92	3.92	4.02	4.02	4.02	4.02	4.02	4.12	4.12	4.12	4.12	4.12
- Bank overdraft				20.06	24.85	24.84	24.84	24.84	25.99	25.99	25.99	25.99	25.99	27.15	27.15	27.15	27.15	27.15
Sub-total (B.1)				**23.19**	**28.76**	**28.76**	**28.76**	**28.76**	**30.01**	**30.01**	**30.01**	**30.01**	**30.01**	**31.26**	**31.26**	**31.26**	**31.27**	**31.27**
2. Total long term debt	7.07	109.76	211.49	278.88	244.02	209.16	174.30	139.44	104.58	69.72	34.86							
3. Total equity capital	69.64	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52
4. Reserve, retained profit brought forward								7.83	20.70	47.11	74.80	105.98	140.77	177.43	252.23	329.98	401.29	475.09
5. Net profit after tax					4.20	7.43	9.82	12.87	26.41	27.69	31.18	34.79	36.66	74.80	77.76	71.31	73.80	76.37
Total liabilities (B)	**76.71**	**229.28**	**331.01**	**421.59**	**396.50**	**364.86**	**332.39**	**308.42**	**301.22**	**294.05**	**290.36**	**290.30**	**326.96**	**403.01**	**480.77**	**552.08**	**625.87**	**702.24**

SECTION 2.0

INTRODUCTION TO THE STUDY

2.1 General

Vietnam Steel Corporation is Vietnam's nodal agency responsible for spearheading the development of the metals industry in the country. VSC presently has 14 subsidiaries and 14 joint ventures with foreign countries.

Vietnam's first steel complex was built in 1959. Thai Nguyen Iron and Steel Company was established with the assistance of the Chinese Government and produced its first iron in 1963 with a design capacity 100,000 tons per year. From 1973 to 1975 Gia Sang Steel-Making and Rolling Mill was built with assistance from Eastern Germany with a capacity 50,000 tons per year to complement the Thai Nguyen Steel Complex.

In 1976 the government reorganized small size steel facilities in the south and established Southern Steel Company. Its total capacity was approximately 80,000 tons per year.

From 1976 to 1989, the steel industry faced many difficulties. Total capacity during that period ranged from 40,000 to 80,000 of rolling products.

After the introduction of Doi Moi (Reform) policy in 1986, the steel industry increased its production by 1990 to over 100,000 tons per year. Vietnam Metal Corporation was established, based on uniting all steel enterprises in the country. From 1990 to 1995 the industry blossomed, adopting new technology and equipment, and formed relationships with foreign partners. By 1995 steel production and output had increased 400% from that of 1990.

In 1995, Vietnam Metal Corporation and Vietnam Metal-Hardware Corporation was merged into the Vietnam Steel Corporation, a state owned enterprise under the Ministry of Industry of the Government of Vietnam.

Vietnam's domestic steel demand has been growing steadily in recent years to keep pace with overall economic growth of the country. At present, domestic output is 1.2 million tons per year of billet related products, namely bar, bar shapes and rods. The demand for steel products, driven by infrastructure, manufacturing projects and associated

2.1 General (continued)

construction, is projected to grow to 2.3 million tons by this year and to 5.7 million tons by 2010.

The current crude steel production in Vietnam is around 500,000 tons per year as against the annual production of rolled steel of 1.2 million tons per year, which indicates the great dependence of VSC on imported billets. About 70 percent of the rolled products by VSC steel companies in Vietnam are made from imported billets.

The domestic steel industry in Vietnam now faces stiff competition from imported steels. The price of domestic products used in construction industry is higher than those imported. The pricing disadvantage is mainly due to VSC's heavy dependence on imported steel scrap for quality crude steel production and reliance on the purchase of uneconomical billets to supply the demand of downstream rolling mills. Vietnam's domestic steel scrap is limited in supply and of inferior quality.

As part of Master Plan development of the Steel Industry to meet demands, VSC has been contemplating the installation of a Direct Reduced Plant employing a new technology to convert iron ores into materials that can be charged to electrical arc furnaces, substituting or in addition to scrap, for crude steel production. Vietnam has available natural resources to build such facility. It is envisioned that the contemplated DR Plant for production of hot briquetted iron will meet the country's own steel-making metallics demand as well as serve as an export facility to meet demand of HBI in the foreign markets in the region.

2.2 Background For the Study

In July 1996, the VSC issued a letter mandating the Craft Corporation of Hanoi, Vietnam with exclusive rights to establish the first DR Plant in Vietnam, pending the results of a Pre-Feasibility Study.

Heffernan International, an international consulting firm with considerable experience in the steel industry, was nominated by Craft to conduct a Pre-Feasibility Study on behalf of VSC. Heffernan International issued the study report in October, 1996 (Appendix I-1). The result of this study was very encouraging and called for full considerations of a detailed study.

In March 17, 1997, VSC submitted a summary of the Pre-Feasibility Study (Appendix 1-2) to Prime Minister, Ministry of Planning and Investment, and Ministry of Industry of the Vietnam Government for due considerations to initiate, using the natural gas-based MIDREX MAGAMOD™ DR Technology, a Detailed Feasibility Study, and in making a subsequent

2.2 Background For the Study (continued)

application for an investment license by a Joint Venture Company involving foreign parties.

The F/S Agreement (1-3) was entered into on May 12, 1997 by and between VSC and American Steel Corporation, Pte. Ltd., a Singaporean Company, solely represented by Craft Corporation of Hanoi, for the F/S.

On July 14, 1997 Craft and Raytheon Engineers and Constructors, Inc. submitted an application (1-4) to the United States Trade Development Agency for financial assistance to carry out the F/S of a DR Plant in Vietnam for VSC.

A grant agreement was entered into between the TDA and VSC to partially fund the cost of the F/S on September 16, 1997 (Appendix 1-5). TDA approves the selection of RE&C to perform the Study. A supplementary grant agreement was also approved by the TDA in March, 2000.

On September 24, 1998, a contract was signed between VSC and United Engineers International, Inc., a subsidiary of RE&C to conduct the F/S of the DR Plant (Appendix 1-6) at which time work activities under the Grant Agreement were started.

2.3 Study Participants

VSC = Vietnam Steel Corporation, named as "Guarantee" under the TDA Grant Agreement. Designated as a Vietnamese Party for the Joint Venture Company.

Craft = Craft Corporation, an American Company with a Representative Office in Hanoi, Vietnam, an exclusive developer for the DR Plant in Vietnam. Functions as an overall coordinator in Vietnam for the Study. Also, responsible for the market study, feed materials supply, operating cost estimate, financial analysis and political considerations of the Study.

ASC = American Steel Corporation Pte. Ltd., a Singaporean Company, designated as the foreign party to the Joint Venture Company, Represented by Craft Corporation for the Study.

UEI = United Engineers International, a subsidiary of Raytheon Engineers and Constructors, Inc., designated contractor

2.3 Study Participants (continued)

	for the Study under the TDA Grant. Responsible for overall coordination of the Study report.
TDA =	United States Trade and Development Agency, a partial financier for the Study.
Dastur =	Dastur International, Inc., an international consultant nominated by Craft to conduct market study, operating cost estimate and financial analysis for the Study.
Midrex =	Midrex Direct Reduction Corporation, a USA Corporation, selected by VSC for the Process Technology, Design and Supply of the Core Plant.
Thikeco =	Vietnamese Corporation for Investment Consultancy for Development and Construction, nominated by UEI for Site Investigations and Consultancy Services for the Study.
ENTEC =	Environment Technology Centre, a Vietnamese organization selected by Thikeco to prepare a Report on the Existing Environmental Data at the Site.
E&I SC =	Employment & Industrial Services Centre, a Vietnamese organization selected by Thikeco to prepare a Report on Utilities Sources of the Site.
TEDI South =	Transport Engineering Design Incorporated South, a Vietnamese organization selected by Thikeco to perform Topographic and Hydrological Surveys, Geo-technical Investigations of the Site and to prepare the Report on Selection of the Plant Location.

2.4 Steel Consumption Forecast

Steel Consumption forecast is based on:

- Vietnam GDP and GDP per capita growth rate as projected by Ministry of Planning and Investment.
- National steel consumption from 1975, and current steel consumption per capita.
- Steel production growth from 1990 to date.

2.4 Steel Consumption Forecast (continued)

- International and ASEAN economic analysis and forecast.
- JICA study.
  - Average growth rate of GDP

    1991-1997 period: 8.5%
    1998: 5.83%
    1999: projected to increase by 5-6%
    2001-2005: projected rate is 7.5% per annum
    2006-2010: projected rate is 6.5% per annum
    Projected average rate is 7% per annum

  - GDP per capita
    1997: approx. $300 per capita
    2010: projection is $700-800 per capita

  - Steel consumption rate
    1991-1997 average growth rate: 30% per annum
    1998: growth rate approx. 9% compared with 1997
    1999: projected increase to 8% compared with 1998
    2000: projected increase to 10% compared with 1999
    2001-2005: projected average rate is 10% per annum
    2006-2010: projected average rate is 9-10% per annum

  - Average steel consumption per capita: 23kg in 1998; 40kg in 2005; 60kg in 2010.

Based on investment forecast and implementation pace, combined with the possibility of new investment projects, steel production growth rates are anticipated as follows:

1998-2000:	Average growth rate of 11% per annum
2001-2005:	10% per annum
2006-2010:	Approx. 10% per annum

Besides traditional products (construction rod and section, welding stick, galvanized sheet, etc.), from 2000 onwards, Vietnam's steel industry will also manufacture hot roll and cold roll sheet, tin sheet, special steel and HBI, and increase billet-making to substitute import of billets.

2.5 Steel-Making Development Plans

In addition to the proposed HBI Plant, the following projects are being studied for implementation during the next 10 years:

2.5 Steel-Making Development Plans (continued)

- Cold Roll Mill: Capacity 200,000-250,000 tons per year; Investment capital-US $100 million; Project owner-Vietnam Steel Corporation; Location - Dong Nai province, Production date-2002.
- Billet Center 1: Capacity-500,000 tons per year; Investment capital-US$ 100 million; Project owner-VSC; Production date-2003; Location - Cai Lan port, Quang Ninh province; Supply to rolling facilities in northern area.
- Billet Center 2 and Port: Capacity 250,000 tons per year; Investment capital-US$ 100 million; Second stage to extend capacity to 500,000 tons per year by 2005; Project owner-Southern Steel Company; Location Baria-Vung Tau province.
- Hot Roll Mill: Capacity-600,000 tons per year; Investment capital - US $190 million; Project owner-VSC; Production date-2004; Location-Baria-Vung Tau province.
- Special Steel plant: Capacity-50,000-100,000 tons per year; Investment capital-US $150 million; Location in the South; Production date-around 2005.
- VSC/Kyoei billet center: Capacity-500,000 tons per year; Investment capital-US $100 million; Location in the South, Production date after 2006.
- Steel section and wire rod plant: Capacity-300,000 tons per year; Investment Capital-US $50 million; Location in the South; Production date-2006.
- Expansion of Thai Nguyen Steel & Iron Company to add new billet-making capacity of 300,000 tpa. Investment capital-US $150 million; Location-Thai Nguyen Province; Completion date-2007.
- Expansion of Cold Roll Mill to double capacity (400-500,000) tons per year with a new line for finished products. Investment capital-US $80 million; Location in the south; Completion date-2007.
- Coil box plant, as part of the first stage of the integrated steel mill. Location in Central Vietnam; Production date-2010.
- Formation of a Metallurgical Zone in Baria-Vung Tau province is under study. The zone will contain the HBI plant, Billet Center II, Port, and the Hot Roll Mill.
- Continuing study to determine the possibility to exploit iron ore mines, principally Thach Khe and Qui Xa mines for feed materials for the HBI Plant.

2.5 Steel-Making Development Plans (continued)

- Mobilize capital for investment in ferrous and refractory brick facilities.

SECTION 3.0

OBJECTIVES AND SCOPE OF THE STUDY

3.1 General

Most all of steel products by VSC is through EAF's which require quality scrap as feed materials for quality output. The availability of quality scrap in Vietnam is scarce. The availability of premium grade scrap in the international market is often unreliable and costly. The direct reduced iron is the product of the DR process, that converts iron oxide into metallic iron without melting the material. This metallic iron when processed through briquetting machines is called Hot Briquetted Iron. The metallic iron is used as a high quality feed material in steel making, as much as 100 percent, in the charge-mix of EAF. The HBI is very suitable for EAF steel making due to its consistency, very low trace elements and sulphur content, ease of handling and transportation, and benefits of continuous charging.

Consistent with VSC's future growth plan in steel production to meet Vietnam's demand and to avoid heavy reliance on uneconomical import of quality scraps from the global market for steel production, a reliable source of feed material for EAF – based steel making is envisioned by VSC by building an in-country HBI plant using a reliable DR process technology. Moreover, the objective of the Study is also to identify the probable target regions for exporting the plant output, on the basis of its geographic proximity and competitiveness of the delivered product.

To meet these objectives, a detailed feasibility study has been developed which addresses market potential, process design, site selection and development, feed material sourcing environmental issues, cost estimates, financial analysis and financing arrangements, political considerations and organization plan - both for construction and operations phases of the Plant.

3.2 Market Study

The scope of the Market Study is to:

- Establish the current DRI market size and project market growth to 2010 for both the Vietnamese and for reachable export markets.
- Project tonnage sales by each proposed consuming steel mill to the year 2010.

3.2 Market Study (continued)

- Project delivered DRI market prices, freight and any other distribution related expenses, and calculate plant-net selling prices in each market segment to 2010.
- Project total annual tonnage to be sold and total annual plant-net sales income to 2010.

3.3 Process Design

The scope of the Process Design is to:

- Make the requisite process technology selections.
- Implement the preliminary process design of the DRI plant battery limits and any other facilities which may be necessary.
- Calculate material flows.
- Calculate energy flows.
- Prepare material and energy balance, process flowsheets, including conceptual instrumentation and control systems.
- Prepare specification details for major equipment for the process systems, the utility systems and the material handling systems.

3.4 Feed Materials Sourcing

The scope of the Feed Materials Sourcing is to:

- Investigate potential of the supply of iron ores from the in-country mines.
- Establish supply sources from the international markets of DR-grade iron pellets and lump ores and the cost of delivered products.

3.5 Site Selection and Development

The Site Selection process to include:

- Survey of the proposed region to nominate one or more specific sites for the Plant location by using transportation, natural gas availability and topography as the main criteria. Ship/barge, rail and truck access are important considerations, and the Plant should be within conveyor distances of ship/barge loading and unloading facilities.

3.5 Site Selection and Development (continued)

The Scope of Site Development is to:

- Layout the plant site, including off-site materials handling facilities. Arrange major items of process equipment, and locate process buildings/structures, utilities, warehousing and storage, maintenance facilities and offices.

- Prepare preliminary layout drawings, including access to rail and public highway.

3.6 Environmental

The scope of Environmental is to:

- Conduct and report an environmental assessment of the Plant and related transportation systems.

- Prepare preliminary process design and equipment specifications of environmental control systems.

3.7 Cost Estimate

The scope of Cost Estimate is to:

- Prepare a detailed estimate of Capital Costs to address:

  - Plant Capital Costs

    Major equipment
    Minor equipment
    Facility structures
    Construction materials
    Construction labor
    Engineering costs
    Project management
    Capitalized license costs (if any)

  - Other Capital Costs

    Interest during construction
    Working capital
    Land lease
    Development, legal & financing fees

3.7 Cost Estimate (continued)

- Project annual Operating Costs to 2010
  - Direct plant operating costs
  - Annual fixed costs
  - Administrative and selling expenses
  - Estimated total annual business expenses

3.8 Financial Analysis and Project Finance

The scope of Financial Analysis and Project Finance is to:

- Develop the detailed Financial Plan for the project.
  - Solicit the interests of equity shareholders
  - Participate in political discussions concerning equity ownership.
  - Determine the optimum subdivision of capital into debt and equity.
  - Negotiate with potential holders of equity and providers of debt concerning participation in the venture.
  - Determine the capital draw-down schedule.
  - Prepare an annualized cash flow chart beginning with capitalization and extending to 2010. Show revenue and cost projections, and profits and internal cash generation. Show debt principal pay-down until complete and the net build-up of cash reserves. If recapitalization is contemplated during the subject period, show the details.
  - Show the relationship between net cash flow accumulation and the original equity capital requirement.

3.9 Political Considerations

The scope of Political Considerations is to:

- Negotiate with the Vietnamese government and the Vietnam Steel Corporation concerning program timing, iron ore mine development, equity capital conditions, and sources and conditions for debt capital procurement.

- Negotiate with the Vietnamese government tax concessions and depreciation allowances, for natural gas and iron ore prices, and for labor rates.

- Insure compliance with Vietnamese laws and local codes.

3.10 Organizational Plan

The scope of the Organization Plan is to:

- Prepare a critical path schedule for the design and construction project.
- Prepare an organization chart for the design and construction project.
- Prepare an organizational and manning chart for routine operation of the Plant business program, insuring that the organization plan is in compliance with local requirements.

SECTION 4.0

FINDINGS OF MARKET STUDY

4.1 General

Appendix II contains a detailed report titled "Market Study on Direct Reduced Products" conducted by Dastur in July, 1999 as part of the Feasibility Study. A summary of findings of the study is as follows:

- Global demand of DRI/HBI is expected to rise from about 37 million metric tons in 1997, to about 57 million metric tons by 2002, 67 million metric tons by 2005 and 83 million metric tons by 2010. The lion's share of this demand will be in Asia, where it is expected to rise from the 1997 level of about 8 million metric tons to about 19 to 27 million metric tons within the next decade.
- Total global shortfall of DRI/HBI in 2002 will be about 2 million metric tons.
- This shortfall is likely vary between 5 million and 7 million metric tons in 2005 and between 10 million and 15 million metric tons in 2010, depending on realisation of additional capacity from announced projects.
- Europe, former USSR countries, USA and countries in Asia will have to import DR products from different sources to meet their steelmaking targets.
- Other North America, South America, Middle East and Africa, and Oceania will have surplus DRI/HBI capacity; and hence these regions will be net exporters of DRI/HBI.
- Target market regions for Vietnam HBI are:
  - China, Japan and Other Asia, which will experience shortfalls in the neighborhood of 7 million metric tons and 13 million metric tons by 2002 and 2010 respectively, will be major target market regions for the Vietnam HBI plant.
  - Europe and former USSR countries can be considered as additional target markets beyond 2005.
- Main competitors for the Vietnam HBI plant are DR plants in South America, Middle East and Africa, and Oceania. Existing merchant DR plants in South East Asia and India would also continue to be exporters of DRI/HBI mainly to the Asian region.

4.1 General (continued)

- It is expected that, depending on realisation of additional announced DR capacity, potential market volume for Vietnam HBI Plant in the Asia region will be as follows:

Year	Potential market Volume Million metric tons
2002	2
2005	5 to 7
2010	7 to 10

- Even after importing DRI/HBI from surplus suppliers regions, Europe, and the former USSR will still have a shortfall in DRI products of about 0.3 million metric tons in 2005 and about 2 to 5 million metric tons in 2010. This market volume in Europe and the former USSR will also be additionally available to Vietnam HBI plant.

- Since the proposed plant is scheduled to commence operation in the year 2004 and may take a couple years to stabilize operation, the market potential in 2005 and beyond would be relevant for the potential market. Of this potential market volume, domestic market of HBI in Vietnam will be about 0.3 million to 0.5 million metric ton by 2005 and 0.8 million to 1.1 million metric tons by 2010.

- It is suggested to initiate negotiations with concerned authority/authorities in Vietnam for obtaining preferential natural gas and power tariffs for the proposed HBI plant, so as to enhance competitiveness. This will also enable the plant to earn valuable foreign exchange through export.

- In conclusion, Vietnam may consider building a 1.0 to 1.5 million metric tons per year HBI plant. The plant capacity may be expanded in the future by adding a second module of similar capacity, once the market for Vietnam HBI is established.

These findings are based on detailed studies of the following:

- DRI/HBI Demand
- DRI/HBI Shortfall
- Market Potential for Vietnam HBI Plant

4.1 General (continued)

The study is based on projections of data in the terminal years of 2002, 2005 and 2010.

4.2 DRI/HBI Demand

4.2.1 Projection of Apparent Consumption of Finished Steel

A recent prediction of steel demand indicates that world apparent consumption of finished steel will drop to 673 million metric tons in 1999 from 1998 level of 692 million metric tons. However, based on the past trend cycles, finished steel demand has been projected to recover from the current depressed level to about 707 million metric tons by the year 2002 and increase to about 753 million metric tons by 2005 and 776 million metric tons by the end of the next decade.

4.2.2 Likely Future Crude Steel Production

World crude steel production has been projected to increase from 808 million metric tons by 2002 to 858 million metric tons by 2005 and 877 million metric tons by 2010, compared to the level of production of about 778 million metric tons in 1998.

Based on part trend and probable future developments, the likely future global shares of different process routes in crude steel production are as follows:

- Share of EAF route is expected to gradually increase to about 36 per cent by 2002; 37 per cent by 2005; and 39 per cent by 2010; from 1996 level of about 34 per cent.

- Share of BOF route is expected to marginally decrease from about 60 per cent in 1997 to about 58 per cent by 2010.

- Expected increase in EAF share for crude steel production can be attributed primarily to the following factors:

  - Lower investment
  - More environmental friendly
  - Market oriented location
  - Development of EAF-thin slab casting route for medium sized steel plants
  - Flexibility of metallics input

4.2 DRI/HBI Demand (continued)

4.2.3 Projection of Solid Metallics Requirement

Requirement of solid metallics for projected crude steel production based on past trends and plant practices is estimated to be 427 million metric tons in 2002, 460 million metric tons in 2005 and 487 million metric tons in 2010.

4.2.4 Consumption of Steel-Making Grade Pig Iron

Likely future consumption of steel-making grade pig iron has been estimated based on past consumption trends. It is expected that global consumption of steel-making grade pig iron will rise from current level of about 7 million metric tons to about 9 million metric tons by 2002, 10 million metric tons by 2005 and 12 million metric tons by 2010.

4.2.5 Project of Scrap Availability

Estimates of different categories of scrap availability for steel-making, after providing for foundry usage, are indicated by terminal years as follows:

	Terminal Year		
Categories	**2002**	**2005**	**2010**
Return Scrap	110	115	112
Prompt Scrap	93	97	97
Obsolete/Capital Scrap	158	171	184
Total (million metric tons)	361	383	393

4.2 DRI/HBI Demand (continued)

4.2.6 Demand Of DRI/HBI

Global demand of DRI/HBI (million metric tons) has been estimated as follows:

	Terminal Year		
Particulars	**2002**	**2005**	**2010**
1. Apparent Consumption of Finished Steel	707	753	776
2. Crude Steel Production	808	858	877
3. Solid Metallics Requirement,	427	460	487
4. Consumption of Steel-making Grade Pig Iron as scrap substitute	9	10	12
5. Scrap Consumption	361	383	393
6. Demand of DRI/HBI (3 - 4 - 5)	57	67	82

4.3 DRI/HBI Shortfall

4.3.1 Availability of DRI/HBI

Production of DRI/HBI was about 37 million metric tons in 1998. Present worldwide installed capacity of DRI/HBI plants is about 50 million metric tons. Additionally, about 10 million metric tons of DRI/HBI capacity is under installation/active consideration, which is expected to be implemented by 2002, raising the total installed capacity to about 60 million metric tons. It is reported that due to recent global price recession in DRI/HBI, a few DRI/HBI plants are forced to either cut down present level of production or partly shut down their respective units. It is expected that once this recession is over, most of these DR plants will again be put into operation, however, a few DR plants are likely to permanently cease operation on account of various reasons, such as inefficient technology, high input costs etc.

Keeping in view the above, it is assumed that worldwide capacity utilization of presently installed DRI/HBI plants would be 90 percent in 2002, 2005 and 2010.

4.3 DRI/HBI Shortfall (continued)

Although an additional DRI/HBI capacity of about 57 million metric tons has been announced, it is difficult at this stage to predict with reasonable accuracy how much of this capacity will actually materialize. However, for the purpose of this Study, based on the mortality rates for announced projects in the recent past, probable implementation of announced capacity will be about 10 percent in 2005 and 25 percent in 2010. The following two possibilities have been considered:

- **Base Case** - About 10 percent of announced capacity will be implemented by 2005; and another 25 percent by 2010.

- **Alternative Case** - About 15 per cent of announced capacity will be implemented by 2005; and another 35 per cent by 2010.

On the above basis, likely availability of DRI/HBI in million metric tons in the terminal years will be as follows:

Year	Base Case	Alternative Case
2002	54	54
2005	60	62
2010	67	72

4.3.2 Anticipated Shortfall of DRI/HBI

- Anticipated global shortfall of DRI/HBI in million metric tons calculated by the difference between projections of availability and demand, is as follows:

Year	Demand	Base Case		Alternative Case	
		Availability	Shortfall	Availability	Shortfall
2002	57	54	3	54	3
2005	67	60	7	62	5
2010	82	67	15	72	10

- Anticipated regional shortfalls in million metric tons of DRI/HBI for Base Case and Alternative Case respectively are tabulated as follows:

4.3 DRI/HBI Shortfall (continued)

Region	Base Case			Alternative Case		
	2002	2005	2010	2002	2005	2010
Europe	4.0	4.8	9.1	4.0	4.8	9.1
Former USSR	0.3	0.4	2.7	0.3	0.4	2.7
USA	1.7	4.4	4.4	1.7	4.4	4.4
Other North America	(1.4)	(2.6)	(1.4)	(1.4)	(2.6)	(1.4)
South America	(2.3)	(1.9)	(3.4)	(2.3)	(2.8)	(4.7)
Middle East and Africa	(4.4)	(4.8)	(6.2)	(4.4)	(5.7)	(8.5)
China	1.0	3.4	7.1	1.0	3.4	7.1
Japan	0.7	1.0	1.2	0.7	1.0	1.2
Other Asia	5.1	5.0	5.0	5.1	5.0	4.1
Oceania	(2.3)	(2.4)	(3.3)	(2.3)	(3.3)	(4.2)
World	2.4	7.3	15.2	2.4	4.6	9.8

Note: **Figures in parenthesis indicate surplus of DRI/HBI.**

4.3.3 Probable Target Regions and Competitors

Based on the previous analysis and geographic contiguity, probable target market regions for export of Vietnam HBI will be as follows:

- China, Japan & Other Asia – in all the terminal years.
- USA, Europe and former USSR – beyond 2005.

Major supplier regions and merchant DR plants in these supplier regions which are likely to compete with Vietnam HBI plant are:

- South America - Venprecar, OPCO, COMSIGUA, POSVEN, FIOR and Orincco Iron in Venezuela
- Middle East and Africa - LISCO-III in Libya
- Oceania - BHP in Australia

In addition, existing merchant DR plants in South East Asia (Amsteel Mills and PSSB, Malaysia) and India, (Vikram Ispat) would continue to be exporters of HBI mainly to the Asian region.

4.4 Market Potential for Vietnam HBI Plant

Market potential for Vietnam HBI plant has been assessed from the view points of:

- Competitiveness of Vietnam HBI with respect to other competing supplier countries.

- Market volume available to Vietnam HBI plant.

4.4.1 Competitiveness and Market Penetration

a) *Competitiveness of Vietnam HBI with respect to other competing supply regions has been determined by:*

- Identification of target markets and competitors:

Target Countries	Competing Supplier Countries
China	Asian Region
Japan	– Malaysia
Other Asia	– India
– South Korea	Oceania
– Taiwan	– Australia
– Philippines	Middle East and Africa
– Thailand	– Libya
– Malaysia	South America
– Indonesia	– Venezuela

- Comparison of effects of following locational factors on Vietnam HBI plant vis-à-vis competing supplier countries in target market countries:

  - Impact of freight element on landed cost of product.

  - Impact of production cost elements like: cost of ore feeds, cost of natural gas and power and labor cost.

4.4 Market Potential for Vietnam HBI Plant (continued)

b) *Effect of Location Factors and Market Penetration*

- **Vietnam with respect to Malaysia and India** - As indicated previously, Other Asia is a DRI/HBI shortfall region. Accordingly, DR plants in Malaysia and India need not be considered as competing supplier countries. However, since merchant HBI plants in Malaysia (Amsteel Mills) and India (Vikram Ispat) are in operation for a number of years, these plants have already established their export markets in neighboring Asian regions.

  Hence it may be worthwhile to examine the competitiveness of Vietnam HBI plant with respect to Malaysia and India in target export countries in Asia, although Malaysia and India, in any case, will not affect the market potential of Vietnam HBI plant in target export countries. Overall effect of location factors (US $ per metric ton) as discussed above is given in the following table.

	Export Destinations							
HBI Source	**China**	**Japan**	**South Korea**	**Thai-land**	**Philip-pines**	**Taiwan**	**Malaysia**	**Indo-nesia**
Malaysia	70	71	71	68	69	70	49	68
India	66	67	66	64	65	65	63	64
Vietnam								
- Case A(1)	66	67	67	64	65	66	64	65
- Case B(2)	49	50	50	47	48	48	47	48
- Case C(3)	49	50	50	47	48	48	47	48

Notes: (1) Natural gas and electric power prices as per current tariff.
(2) Natural gas and electric power prices as in Middle East.
(3) Natural gas and electric power prices as in Venezuela.

From the above table, the following observations can be made:

- Compared to Malaysia, Vietnam is generally in a better position for all export destinations, except Malaysia itself, even under Case A.

- Vietnam, under Case A, is generally at par with India for all export destinations.

4.4 Market Potential for Vietnam HBI Plant (continued)

- Vietnam, under Case B and Case C, is better placed compared to India for all the target export destinations.

- **Vietnam with respect to Australia** - So far as Australian DRI/HBI is concerned, the entire South East Asian region may be considered as its natural target market, due to freight and other advantages offered by proximity of the markets and existing commercial relations. Accordingly, possible inflow of DR products in million metric tons from Australia in target export countries may be considered as follows:

Year	Base Case	Alternative Case
2002	2.3	2.3
2005	2.4	3.3
2010	3.3	4.2

Overall effect of locational factors (US $ per metric ton), taking into account both freight elements for HBI shipments and production cost elements, for Australia and Vietnam is compared in the following table.

	Export Destinations							
HBI Source	China	Japan	South Korea	Thai-land	Philip-pines	Taiwan	Malaysia	Indo-nesia
Australia	51	51	51	53	51	51	46	45
Vietnam								
- Case A(1)	66	67	67	64	65	66	64	65
- Case B(2)	49	50	50	47	48	48	47	48
- Case C(3)	49	50	50	47	48	48	47	48

Notes: (1) Natural gas and electric power prices as per current tariff.
(2) Natural gas and electric power prices as in Middle East.
(3) Natural gas and electric power prices as in Venezuela.

From the table it can be observed that if there is reduction in the unit prices of natural gas and electric power in Vietnam, as in under Case B and Case C, Vietnam can be more competitive than Australia in target export countries. However, with regard to Australian DR projects, the following aspects need to be looked into:

- Until recently, no DR unit is in operation in the Oceania region. First DR plant, with a capacity 2.5 metric tons per year based on FINMET process is under implementation in Australia, of which one module of 1.25 metric tons per year capacity has been commissioned in early 1999.

- The FINMET process is yet to be commercially established. Australian DR project is the first commercial unit based on this process. Accordingly, competitiveness of Australian DRI/HBI over Vietnam will greatly depend on the success of the FINMET process.

- It is reported that the FINMET plant in Australia has undergone a huge overrun of capital expenditure. This, in turn, may affect the viability of the project and international competitiveness of the product.

- The economics of all DR projects in Australia have been based on use of local oxide feed. Use of 100 percent of Australian ores in gas-based DR processes is yet to be commercially established. In case these plants (including announced projects) have to resort to import of raw materials, advantage of zero raw material freight component over Vietnam will not be there any more.

In view of the above, Australian DR products may lose their competitive edge over Vietnam in target export countries in Asia.

- **Vietnam with respect to Libya** - It is assumed that due to geographical proximity, DRI/HBI producers in the Middle East and Africa will mainly target Europe and the former USSR for exports. Remaining quantity, if any, will be available for sale in the South East Asian market. Accordingly, it is estimated that following quantities of DRI/HBI in million metric tons will be available for sale from the Middle East and Africa in target export countries in Asia:

Year	Base Case	Alternative Case
2002	1.1	1.1
2005	-	1.0
2010	-	-

4.4 Market Potential for Vietnam HBI Plant (continued)

Overall effect of locational factors (US $ per metric ton), taking into account both freight elements for HBI shipments and production cost elements, for Libya and Vietnam is compared in the following Table.

	Export Destinations							
HBI Source	**China**	**Japan**	**South Korea**	**Thai-land**	**Philip-pines**	**Taiwan**	**Malaysia**	**Indo-nesia**
Libya	56	57	57	55	55	56	54	54
Vietnam								
- Case A(1)	66	67	67	64	65	66	64	65
- Case B(2)	49	50	50	47	48	48	47	48
- Case C(3)	49	50	50	47	48	48	47	48

Notes: (1) Natural gas and electric power prices as per current tariff.
(2) Natural gas and electric power prices as in Middle East.
(3) Natural gas and electric power prices as in Venezuela.

From the preceding table, it is noted that competitiveness of Vietnam will be better in comparison to Libya only under Case B and Case C. In other words, possible market penetration by Vietnam in target export countries need to be assessed only after allowing imports from the Middle East and Africa.

- **Vietnam with respect to Venezuela** - In order to project likely market penetration of South American HBI in the South East Asian region, the following assumptions have been made:

  - The Primary export target for South American DRI/HBI will be the USA, which constitutes natural export market due to geographical proximity as well as trade relationship.

  - After meeting shortfall of DRI/HBI in the USA, South American producers will target Europe as well as South East Asian countries which are more or less equidistant from South American countries. Accordingly, it is assumed that only about 50 percent of the remaining quantity, after meeting the requirements of the USA, will move to South East Asian destinations.

4.4 Market Potential for Vietnam HBI Plant (continued)

Based on the above, availability of DR products from South America for market penetration in target export countries of Asia is estimated in million metric tons as follows:

Year	Base Case	Alternative Case
2002	1.0	1.0
2005	-	0.5
2010	0.2	0.8

Venezuela, by virtue of availability of local raw materials as well as natural gas and power at substantially lower costs than Vietnam, will always enjoy an edge over Vietnam. However, how long or to what extent Venezuela will continue to enjoy this advantage will depend, to a certain extent, on the following two factors:

- Availability of surplus DRI/HBI for sale in the Asian market is expected to fluctuate considerably over the next decade. In the steel industry, this is an undesirable scenario from the buyer's point of view, who prefer to source their imports from suppliers who can assure steady supply over a reasonable time frame. Therefore, Venezuela is likely to be considered more as a source for "spot" purchases by the Asian market.

- The entire South American region is passing through an economic upheaval and state economics are undergoing radical restructuring. For Venezuela, the long term policy with regard to energy will have significant impact on the competitiveness of the national DR industry in the international market.

In view of the above, while Venezuela will have the possibility of penetrating the target region in Asia to the extent indicated above, there could be some downward adjustments in the quantities actually traded.

4.4 Market Potential for Vietnam HBI Plant (continued)

4.3.1 Market Volume

Taking into consideration possible inflow of DRI/HBI to target export countries in Asia from various competing producing countries, as discussed above, it is estimated that there will still be a substantial shortfall of DR products in target export countries in Asia as can be seen from data shown below:

DRI/HBI	Base Case			Alternative Case		
	2002	**2005**	**2010**	**2002**	**2005**	**2010**
1. Estimated shortfall in Asian countries, million metric tons	**6.8**	**9.4**	**13.3**	**6.8**	**9.4**	**12.4**
2. Possible exports by competitors to Asian countries, million metric tons						
- South America	1.0	-	0.2	1.0	0.5	0.8
- Middle East and Africa	1.1	-	-	1.1	1.0	-
- Oceania	2.3	2.4	3.3	2.3	3.3	4.2
Subtotal (2)	**4.4**	**2.4**	**3.5**	**4.4**	**4.8**	**5.0**
3. Potential Market Volume for Vietnam HBI in Asia, million metric tons (1-2)	2.4.	7.0	9.8	2.4	4.6	7.4

4.4 Market Potential for Vietnam HBI Plant (continued)

It will be observed from the above that potential market volume for the Vietnam HBI plant in Asia is expected to be about 2 million metric tons by 2002, about 5 million to 7 million metric tons by 2005 and about 7 million to 10 million metric tons by 2010, depending on the extent of realization of the announced DRI/HBI capacity world-wide.

In addition to the above potential market volume for the Vietnam HBI plant in Asia, there will also be a net shortfall of DR products in Europe and the former USSR as indicated below, after importing from surplus supplier regions:

Year	Net shortfall in USA, Europe and Former USSR, Million Metric Tons	
	Base Case	Alternative Case
2002	-	-
2005	0.3	-
2010	5.4	2.4

Accordingly, the above market volume in Europe and the former USSR in 2005 and 2010 will also be available to Vietnam.

Since the proposed plant in Vietnam is scheduled to commence operation in 2004 and may take a couple of years to stabilize operation, market potential in 2005 and beyond would be relevant.

Of the above potential market volume, domestic demand of HBI in Vietnam, estimated based on the Master Plan developed for the growth of the steel industry in Vietnam, is indicated as follows:

Year	Million Metric tons
2005	0.3 to 0.5
2010	0.8 to 1.1

Domestic demand of HBI in Vietnam, as indicated above, will depend on the extent of use of HBI in EAF steel-making, which could be in the range of about 50 to 70 percent.

Based on the above analysis, Vietnam may consider installing a 1 million to 1.5 million metric tons per year HBI plant. The plant capacity may be expanded by adding a second module of similar capacity in the future after the market is established.

4.5 DRI/HBI Price Projection

- Projection of HBI price is based on scrap prices for the following two basic reasons:

  - Both are complementary is use.
  - Both follow similar price trends.

- Analysis of past data on prices of scrap and HBI indicates that HBI enjoys a price advantage of US $ 10 to 15 per ton over HMS #1.

- Projection of scrap price

  Scrap price has been projected based on the following methods:

  - Trend analysis considering (i) current (nominal) prices and (ii) current prices converted to constant 1973 (real) prices.
  - Co-relation with EAF crude steel production.
  - Co-relation of obsolete scrap requirement.

  Scrap price projections arrived at through above alternative projection techniques are compared in the following table

Year	Projected Scrap Price (US $ / t FOB)				
	Trend Analysis		Correlation With EAF Crude Steel Production	Correlation With Obsolete Scrap Requirement	Likely Price Range
	Considering Nominal Prices	Considering Real Prices			
2002	132	121	131	135	120 to 130
2005	142	126	143	145	125 to 140
2010	159	137	155	154	135 to 155

- Future HBI price

  Projected average international price range of HBI in the terminal years is given in the following Table.

Year	Likely Scrap price	Corresponding HBI price
	US $ per ton fob	US $ per ton fob
2002	120 – 130	130 – 145
2005	125 – 140	135 – 155
2010	135 – 155	145 - 170

SECTION 5.0

PROJECT DESCRIPTION

5.1 General

The facility to be built is a 1.43 million metric tons per year direct reduced plant (Plant), producing HBI product utilizing the MIDREX MEGAMOD^{TM} process technology. The Plant will be located in the Cai Mep Industrial Zone situated at the Cai Mep Estuary in Baria – Vung Tau Province, Southern Vietnam. The overall project can be defined by the following main features:

- **Port Facility** - for feed materials receiving and the shipment of finished product.
- **Material Handling System** - for receiving, storage, transporting and delivery of all materials.
- **Core Plant** - a MIDREX MEGAMOD HBI process Plant.
- **Balance of Plant** - includes support facilities and ancillary systems to the Core Plant including all required infrastructures for the Plant operation.

The guaranteed annualized production rate of 1.43 million metric tons per year (nominal production – 183.3 metric tons per hour) is based on iron oxide feed mix of 90 percent DR-grade pellets and 10 percent DR-grade lump ores and natural gas composition as described in the Section 11.0 – Design Basis. The HBI product will have 93 percent metallization and 1.2 – 1.8 percent carbon. A feed materials mix of 50/50 of DR-grade pellets and lump ores has been considered as the base case of the financial analysis. In addition, a gas-turbine option replacing two large electric motors for the process gas compressors has also been evaluated.

5.2 Port Facility

The Port Facility will be designed to serve the Plant operations to import 100 percent of the iron ore lump and pellets as feed materials, and to export HBI products to overseas markets and/or to deliver it to VSC's Steel-Making facilities. Additionally, other materials needed for Plant operation such as lime and oxide fines will also be handled by the Port, as needed.

5.2 Port Facility (continued)

Approximately 2,100,000 metric tons per year of iron oxides will be unloaded and 1,430,000 metric tons per year of HBI products will be loaded for shipment via the Port Facility. The Port Facility will have a 310m long wharf to accommodate one ship for unloading of material and one ship for loading of product simultaneously. The larger, deeper draft iron ore ships will berth on the western side of the wharf for easier maneuvering during arrival and departure. The smaller, shallower draft export ships will berth on the eastern side of the wharf. The berthing area will be connected by a 16 m wide and 780 m long approach bridge to the Plant. The Port Facility will have all infrastructure necessary for operation. A cooling water intake structure will be located on one corner of the wharf. The approach bridge will be divided into a vehicular aisle and a conveyor system/utility corridor aisle.

An alternate scheme of 510m long wharf for accommodating both unloading and loading ships on the western side has also been studied.

5.3 Material Handling System

Iron oxide will be received in two forms: DRI grade pellets and DRI grade lump ore. Iron oxide will be received in 70,000 DWT Panamax class vessels. Iron oxide will be removed from the shipping vessels at a nominal rate of 2,000 metric tons per hour, using a combined ship unloader/loader. The ship unloader portion of the unit will use of continuous excavator. The gantry of the loader/unloader will travel on runway rails on the wharf. Ship unloading will be done on the western side of the wharf. The ship-unloading execavator will discharge to a transfer conveyor system within the gantry. The ship loader portion of the unit will use a belt conveyor to load ships. Loading and unloading will not occur simultaneously.

A scale system will be provided on one of the transfer conveyors on the unloader to record the weight of all unloaded materials. A hopper located on the ship unloader will travel with the unloader along the wharf. The rate of discharge from the unloader hopper will be controlled to provide a steady flow of material to the ship unloading wharf conveyor and downstream equipment.

The ship unloading wharf conveyor will receive iron oxide from the continuous unloader. The wharf conveyor will have a gravity take-up located at its rear in order to allow maximum space below the head end assembly for access by front end loader.

The wharf conveyor will transfer iron oxide to the jetty conveyor. Water spray headers will be provided in the transfer chute for dust suppression. The jetty conveyor will have a full length cover. The jetty conveyor will be capable of

5.3 Material Handling System (continued)

conveying in either direction to operate in conjunction with the ship unloader/loader.

Iron oxide will be conveyed by the transfer belt conveyor to a single wing, pivoting stacker. The stacker will be used to form two parallel storage piles, each having a working capacity of 170,000 metric tons (79,000 m^3).

Iron oxide will be reclaimed from the storage piles by front-end loaders. Four reclaim hoppers with vibratory feeders will be provided along the length of each storage pile. Each feeder will have a capacity of 250 metric tons per hour. Oxide reclaim belt conveyors will collect iron oxide from the feeders and transfer it at a combined rate of 1,000 metric tons per hour to two oxide screens. A diverter valve above the screens will split the flow into two 500 metric ton per hour streams. Belt conveyors located below the screens will transfer fines and undersize material to temporary storage bunkers. A dust take-off will be provided above the screens to collect fugitive dust.

Sized iron oxide will be transferred to three day bins by the day bin feed conveyor. A diverter at the head end of the conveyor will allow iron oxide to be discharged directly into day bin number 2 or to the day bin transfer conveyor. The day bin transfer conveyor will be a reversing conveyor to allow filling day bins one and three. Each of the oxide day bins will have a working capacity of 2,500 metric tons. A building on top of the day bins will enclose the conveyors and diverter chute. Dust collection will be provided.

The extraction of iron oxide from the day bins will be ratioed with oxide undersize material, remet, and oxide coating. The ratioing control for this portion of the system will be provided as part of the reduction furnace feed system. A weigh belt feeder will be provided under each day bin for the measured withdrawal of iron oxide. The weigh controllers for the scales will be provided.

Two refeed hoppers will be provided to work in conjunction with bucket loaders. The hoppers will be 3.5 m^2 in cross-section. Weigh belt feeders will be located beneath these hoppers.

The weigh belt-feeders will meter iron oxide onto the day bin discharge conveyor for transport to the furnace feed conveyor. The two refeed hoppers bin will feed oxide undersized material (+3mm to –6mm) and remet (or other feed materials) onto the day bin discharge conveyor. A belt scale which records the total feed to the shaft furnace will be located downstream of the last feed point. After the scale an oxide coating will be applied to the furnace feed material. A cross belt magnetic separator will be provided to remove trapped magnetic material.

5.3 Material Handling System (continued)

The furnace feed conveyor will be a pocket type conveyor with flexible sidewalls that will deliver material to the top of the furnace structure by transporting the iron oxide vertically up through the furnace structure. The furnace feed conveyor will discharge onto the charge hopper feed conveyor which will extend over the charge hopper and discharge through a riffler to the charge hopper.

The charge hopper will be located at the top of the shaft furnace and use load cells which allow the operator to know the quantity of feed in the charge hopper. Through controllers, the day bin discharge feeders, the oxide undersize feeder, and the remet feeder, will be stopped and started automatically to control the level in the charge hopper.

After the oxide descends through the reduction shaft furnace, it will be hot and uniformly metallized DRI. It will flow through the dynamic lower seal leg and be discharged from the seal leg into the Product Discharge Chamber. From the surge hopper section of the PDC, the hot DRI will flow through individually isolated feed legs to either the briquette machine screw feeders or the by-pass screw feeder (used during periods when the briquetting machines are not operating).

Iron briquettes and remet material will exit the furnace on HBI conveyors and remet diverters. Product scales will be located on the HBI conveyors. Material will be at temperatures up to 140°C. During upset conditions, the diverters will bypass material to the remet conveyor. The remet conveyor will deliver remet to a bunker.

During normal operation, material will discharge onto the product collection conveyor. This conveyor can also be fed by the front end loader through a refeed station.

A product screen diverter will split the flow of material from the furnace to the two product screens. The screens will be of a multi-deck design that separates +20 mm and – 20 mm product from – 6 mm fines. Unders and fines will discharge onto belt conveyors and delivered to temporary storage bunkers.

HBI will discharge onto the product transfer belt conveyor system. A travelling stacker will form a linear storage pile with a capacity of 100,000 metric tons.

Material will be extracted from the pile with front end loaders. Eight HBI product reclaim hoppers and feeders will be provided along the length of the HBI storage/reclaim pile to allow loading HBI onto the product loadout conveyor system for ship loading.

5.3 Material Handling System (continued)

The product transfer conveyor will transfer the material to the jetty conveyor for transport to the wharf area. An auxiliary feed station at the tail end of the transfer conveyor will allow HBI fines material to be fed to the ship/barge loading system. Two fines feed stations will allow the shipment of fines via ship. A water spray system at the discharge of the vibratory feeders will be used for dust suppression.

A traveling shuttle with two chutes will be installed at the end of the product transfer conveyor to allow feeding either HBI or metal fines to ships. This is necessary because the chute required for HBI transfer are declined at a shallow angle to minimize wear at transfer points. Conversely, fines transfer chutes must decline at six degrees to prevent plugging. The shuttle will contain two chutes and will travel on a rail so that the correct chute is located at the conveyor discharge. The primary chute will be used for loading HBI. The HBI chute will be curved and declined to place HBI onto the wharf conveyor. The fines chute will be straight and have a decline angle of sixty degrees. At the base of the fines, chute will be a declined vibratory feeder to transfer the material to the wharf conveyor.

A ship loading wharf conveyor will feed the ship unloader/loader when it is being used to fill ships. The ship loader will be fed by a traveling tripper on the wharf conveyor during ship loading. The tripper will be pulled by the ship loader gantry during ship loading operations. The tripper will feed a hopper on the boom conveyor. During ship unloading, the tripper will detach from the gantry and remain stationary. The ship loader will use a cantilevered boom conveyor to load HBI into Handymax class ships up to a maximum size of 30,000 DWT. The loader will also be used to load metal fines into ocean going barges. The rated capacity of the unit will be 1000 metric tons per hour. The cantilevered loading boom will be capable of lowering to the ship's hold to minimize attrition of the HBI briquettes as well as to minimize dusting when loading barges. A scale system will be provided on one of the transfer conveyors on the unloader to record the weight of all outgoing materials.

5.3.1. Alternate Material Handling System

An alternate system may also be considered. This system would use 2 stacker/reclaimers in lieu of front-end loaders and reclaim hoppers to remove iron ore from storage and feed it to a conveyor system. During ship unloading one unit would be used to convey iron ore to a storage pile, while the other unit would convey iron ore from the storage piles to the day bins.

5.3 Material Handling System (continued)

In this system the primary screen would be located adjacent to the iron ore day bins. A steeply inclined flexible wall conveyor would elevate sized iron ore to the silo loading conveyor.

After the furnace, HBI would be conveyed to a storage area. There, a stacking belt conveyor would discharge it onto a storage pile. HBI would be reclaimed from the pile by a bucket wheel reclaim. A secondary screening system would remove fines from the briquettes as they are conveyed to the ship loading system. This system would replace the HBI feed hoppers and some additional front-end loaders.

5.4 Core Plant

The major components of the Core Plant include the Reduction Shaft Furnace, Reformer, Process Gas System, Heat Recovery System and Hot Briquetting Systems. The components are supported by ancillary systems for handling iron ore, cold and hot gases, water and HBI product.

The key features of the Core Plant include:

- MIDREX Shaft Furnace, with double bustle ports.
- MIDREX Reformer – 19 Bays.
- 580°C Reformer Feed Gas Preheat.
- Centrifugal Process Gas Compressors with variable frequency drives.
- Briquetting Machines with high capacity and hot DRI fines recycle system.
- Closed loop process cooling water and machinery cooling water systems, using circulating cooling water from a mechanical draft Cooling Tower for heat removal.

Various components of the Core Plant are described in the following sub-sections:

5.4.1 Midrex Shaft Furnace

The reduction furnace will be a patented MIDREX Shaft Furnace with a nominal 6.65 m I.D. refractory diameter.

5.4 Core Plant (continued)

Iron ore enters the MIDREX Shaft Furnace through a dynamic upper seal leg and is then uniformly distributed on the stockline by means of a plurality of symmetrical feed pipes.

A dynamic seal is created by a small flow of inert seal gas into the upper seal leg of the furnace. This flow of inert seal gas through the oxide material creates a backpressure and hence, by design, a higher pressure in the seal leg. This prevents the escape of furnace gases to the atmosphere, while still allowing the free flow of feed material by gravity into the furnace, without the use of lock-hoppers or valves.

The iron ore is reduced to metallic iron in the reduction zone (the upper portion of the furnace) by contact with hot reducing gas (hydrogen and carbon monoxide containing gas), which flows counter-current to the descending iron oxide. Uniform reducing gas flow is assured by special designed inlet ports (tuyeres).

Below the reduction zone, the furnace contains burden feeders and a flow device which ensure a uniform material flow through the reduction zone of the furnace. The hot direct reduced iron leaves the shaft furnace through the dynamic lower seal leg, that operates in the same manner as the upper seal leg. The material then enters the PDC, and finally the briquette machines before cooling.

5.4.2 <u>Midrex Reformer</u>

The MIDREX Reformer is a refractory-lined, gas-tight, steel structure which contains vertically suspended, heat resistant, alloy tubes filed with catalyst and arranged in the fired box in six parallel rows. For ease of installation, the reformer is constructed of modules called "bays" (5 tubes x 6 rows = 30 tubes/bay).

The reformer tubes are supported at the roof and expand downward through the shell of the reformer. The bottom of each tube is sealed with a flexible expansion seal to prevent air infiltration into the combustion zone of the reformer.

Thirty (250 mm ID) tubes constitute a so-called reformer "bay" which includes the tubes, required burners, ducting and support steel structure. An arrangement of identical bays along the longitudinal axis of the reformer is the general design for the reformer. 19 bays will be required

5.4 Core Plant (continued)

(570 tubes) to achieve the production of 183.3 metric tons per hour of HBI with the specified natural gas.

Preheated feed gas (a mixture of scrubbed and compressed process gas, low pressure steam, and natural gas) enters the bottom of each reformer tube and flows upward through the static catalyst bed. The natural gas is stoichiometrically reformed with carbon dioxide and water contained in the feed gas stream to produce a hot hydrogen and carbon monoxide containing gas.

The reformed gas exiting from three headers (each tied into two rows of reformer tubes) is collected into a single refractory lined duct that supplies the reducing gas directly to the bustles of the reduction shaft furnace.

Heat for the reformer is supplied by the main burners, which are located on the bottom of the reformer box between tube rows and between the outside tube rows and the reformer wall. The fuel for the main burners is a mixture of natural gas and excess spent reducing gas which has been cleaned and cooled in the top gas scrubber to produce top gas fuel.

The required air for combustion of the main burner fuel mixture is supplied by the main air blower. This air is first preheated in the heat recovery system before being sent to the burners.

Natural gas fired auxiliary burners serve to maintain the reformer box temperature when the Plant is in an idle mode of operation so as to minimize both restart time and thermal cycling of the reformer tubes.

The auxiliary burners are arranged in four rows. They are installed in rows between the outer tube rows (1st and 6th) and the longitudinal walls, and between tube rows 2 and 3, as well as 4 and 5. These burners are also used to bring the reformer from cold to idling temperature and to ignite the main burners.

Flue gas is withdrawn from the reformer box in two flue gas headers arranged along the upper parts of both longitudinal walls of the reformer. To ensure uniform heat distribution along the reformer length, each reformer bay has a separate sized flue gas port to each of the flue gas headers.

These flue gas ports are located in the sidewall sections of every bay directly below the reformer roof. The flue gas headers are refractory lined and expansion joints are provided between the single section of the headers to compensate for thermal expansion. Also, to permit thermal expansion, the reformer structure is anchored at its center and allowed to expand freely in either direction.

Finally, the flue gas exiting the reformer box via the flue gas headers flows to the heat recovery system where the waste heat is recovered.

5.4.3 Process Gas System

The process gas system consists of a direct contact water scrubber, mist eliminators, and compressors, that clean, cool, de-mist, and compress the spend reducing gas exiting the shaft furnace.

The spent reducing gas (called top gas) exits the shaft furnace and first enters the top gas scrubber. Inside the scrubber, the gas passes through two distinct processing zones:

- The gas first flows through the venturi portion of the scrubber where the hot gas is rapidly cooled and particulate matter is wetted and removed;

- The warm gas passes through a packed bed and spin vane (for water droplet removal) within the scrubber. Additional gas cooling takes place within the packed bed and excess water vapor condenses.

After scrubbing and cooling, approximately two-thirds of the clean top gas (now called process gas) flows through a second set of mist eliminators and then to the inlet of the first stage of the process gas compressor.

The compressors used in the process gas system are centrifugal type machines specifically selected for the Midrex DR process. The process gas compressors are arranged with 2 machines operating in series. These machines are designated the first stage and second stage process gas compressors.

After compression, the process gas is mixed with the required amounts of natural gas and low pressure steam to form the reformer feed gas.

The feed gas subsequently enters the feed gas preheater. After passing through the preheater, the preheated feed gas flows through the reformer tubes filled with catalyst where the reforming reactions take place. Sufficient energy is supplied by the reformer's main burners to heat the gases to the temperature required for reforming and to supply the energy consumed by the reforming reactions.

Reformed feed gas exiting the reformer (now called reformed gas) may need adjustment to the temperature required for direct injection into the reduction shaft furnace as bustle gas. If desired, cooling of the hot reformed gas can be accomplished with the addition of a small stream of process gas from the process gas compressors and/or natural gas. Alternatively, further heating of the hot reformed gas can be accomplished in the future with the addition of high purity oxygen to increase the temperature as required.

The other one-third of the cleaned top gas (now called top as fuel) is mixed with a small amount of natural gas to become the fuel mixture for the reformer main burners and the process humidifiers.

5.4.4 Heat Recovery System

The flue gas from the reformer is used to preheat the reformer main burner combustion air and the feed gas in two parallel streams. The total benefit of the parallel heat recovery system is an increase in reformer capacity and a reduction in the net Plant energy consumption by approximately 25-30 percent from the first generation Midrex Plant designed in 1969. The parallel systems each consist of combustion air preheaters and feed gas preheaters. The flue gas exits the parallel system through a common ejector stack that generates the required draft with a single ejector stack fan.

The ejector stack is an induced draft (venturi type) flue gas stack that withdraws the hot flue gas from the reformer through preheaters. A fan is used to generate the required suction to withdraw the flow by creating a venturi effect within the stack.

The combustion air preheaters are alloy bundle type heat exchangers suspended in the refractory-lined reformer flue gas ducts. The preheaters are designed to preheat the combustion air to about 675°C in two stages.

The feed gas preheaters are also alloy bundle type heat exchangers that are suspended in the reformer refractory lined flue gas ducts situated downstream from the combustion air preheaters. The feed gas enters the feed gas preheaters superheated at approximately 130°C which protects the feed gas preheaters from deposit build-up. The feed gas preheaters heat the feed gas to approximately 400°C in the first pass and then to a final temperature of 580°C after the second pass.

5.4.5 Hot Briquetting System

The briquetting system design includes 4 briquetting machines, 4 briquette strand separators, 4 hot fines recycle systems, 1 by-pass line, and 2 HBI cooling systems.

Hot DRI is supplied to each briquetting machine by a screw feeder. The briquetting machines are roll type machines which produce "pillow" shaped briquettes. Each roll contains dies which form the briquettes. One of the rolls is forced toward the other roll by means of a hydraulic pressure system, which ensures a uniform pressing force.

The continuous briquettes strand exiting the briquetting machine is fed to the strand separators to break the strands into individual briquettes. The briquettes (~+6 mm) are passed to the HBI cooling system for slow cooling and discharge to the product handling system. Any smaller chips, fines, and dust generated during the strand separation process are pneumatically recycled via the Briquette Dust Collection Cyclone back to the briquetter feed system.

Each HBI cooling system consists of a horizontal motion conveyor which conveys the briquettes under a series of quench sprays. The amount of water to the quench sprays and the speed of the slip conveyor can be adjusted to ensure the briquettes are discharged containing just enough latent heat to finish drying the briquettes. Small particles and excess water are gathered in a sump at the discharge end of each quench system.

During the Plant start-up or process upset, off-specification product (remet) bypasses the briquetting machines and is discharged from the PDC through a bypass feed leg to the bypass discharged feeder and then to the HBI cooling system.

The hot briquetting dust collection system is designed to minimize the escape of dust at the briquetting machines. The system consists of an exhaust fan; cyclones; a dust collection scrubber; a sump; an exhaust stack; and associated ducts, hoods, pumps, and valves.

Dust laden air and seal gas are collected and conveyed at a sufficient velocity to prevent settling and accumulation within the ducts. The dust laden gases then enter a cyclone where chips, fines and dust are separated from the gas stream and recycled back to the briquette machine feed screws. The gas stream then enters a venturi scrubber where water spray droplets contact the dust particles to create a slurry.

The dirty water is discharged from the scrubber to a sump and pumped as a slurry to the basin upstream of the clarifier. Cleaned gases are pulled from the dust collection system by the exhaust fan and discharged into the atmosphere through a stack.

A vapor removal system is included to capture and minimize the release of steam into the briquetter area. The system consists of ducts, a direct contact cooler, a fan and a stack. The rising steam vapor is cooled by a water stream in the direct contact cooler and then drawn through the fan to a stack with an exhaust point above the briquetter area.

5.4.6 Ancillary Gas Systems

Seal Gas and Purge Gas System

Inert seal gas for the Plant, which is used primarily for sealing the top and bottom of the furnace, is provided by the seal gas generation system.

This system takes hot reformer flue gas and cools it in a seal gas cooler. The seal gas cooler is a packed bed, direct contact type cooler that cools the reformer flue gas to near ambient temperature.

The cooled seal gas is then compressed by a positive displacement type compressor and then cooled in a shell and tube aftercooler to remove the heat of compression. The cooled seal gas passes through a mist eliminator before it is distributed to the Plant as wet seal gas or passes on to the seal gas dryer.

The seal gas dryer is a refrigerant type unit designed to reduce the dew point of the seal gas to just above 5°C. The dry seal gas is then distributed to various Plant users.

Part of the dry seal gas is compressed by the purge gas compressors and dried in a desiccant dryer. The dry purge gas is stored in tanks to be used for emergency Plant shutdown situations and for small high pressure requirements during normal operation.

Bottom Seal Gas System

The furnace bottom seal gas system consists of a compressor, a dilution hood, a dust collection scrubber, a fan and a stack, to supply and exhaust seal gas for sealing the bottom of the shaft furnace.

The bottom seal gas compressor supplies dry seal gas to the lower seal leg of the shaft furnace at the required pressure. The compressor is a positive displacement type running dry to maintain the dry seal gas conditions.

The bottom seal gas is vented through the PDC vent line, collected in the dilution hood, cleaned in the dust collection scrubber, and exhausted through the bottom seal dust collection fan and stack. The hood captures sufficient air to maintain a mixture of gases that remains below minimum explosive limits in the dust collection system. The scrubber is designed to remove the entrained dust particles exiting the PDC, before the seal gas/air mixture enters the fan and the stack.

In the event of any interruption in the seal gas supply, the inert gas generator or the purge gas system have been designed to supply bottom seal gas for a sufficient time to permit correction of the problem.

Inert Gas System

An inert gas system is provided to supply the required seal gas for the Plant, in the event that the reformer combustion system is not in operation. This system consists of: an inert gas generator where natural gas and air are burned at close to stoichiometric ratio, so that the product of combustion yields a suitable inert gas having a very low oxygen content; a direct contact cooler; a dryer; and a compressor. The inert gas generator is always on-line to ensure a continuous supply of inert gas is available.

5.4.7 Water System

The Core Plant water systems consist of a Machinery Cooling Water circuit and a Process Cooling Water circuit.

Machinery Cooling Water

The machinery cooling water is designed as a closed circuit that supplies cooling water to all indirect coolers such as burden feeders, rotating equipment lubrication oil coolers, briquetting equipment, etc.

5.4 Core Plant (continued)

The machinery cooling water system consists of circulation pumps, a sump, plate and frame heat exchangers, and a scaling/corrosion inhibitor dosing system. The circulation pumps circulate hot water from the machinery cooling water sump through the heat exchanger on one side while cold circulating cooling water is pumped through on the other side to cool the machinery cooling water. Chemicals are added to the machinery make-up water to control scale and/or corrosion in the system.

An emergency head tank is used to supply cooling water to the upper burden feeders.

Process Cooling Water

The process cooling water circuit supplies cooling water to the direct contact coolers and process users such as the top gas scrubber, seal gas cooler, dust collection systems, etc.

The process cooling water system consists of a sump, circulation pumps, circulating cooling water heat exchangers, and a clarifier system.

Dirty, hot process water flows from the users to the clarifier. The clarifier is used to settle out particulate matter and is assisted by a dosing system supplying a flocculating agent. Underflow from the clarifier is sent as a slurry to settling ponds for de-watering. Overflow from the clarifier is sent to the Process Water Sump.

Clean, hot process water flows directly from the users to the Process Water Sump, where it is mixed with the clarifier overflow. The water in the Process Water Sump is cooled by passing through the process water heat exchangers. Cool circulating cooling water from the Cooling Tower is used as the indirect contact cooling fluid.

5.4.8 UPS System

The Plant utilizes an uninterruptible power supply system to ensure safe operation/shut down of the Plant during power outages. The instrumentation control voltage and the DCS/PLC system (controllers, video displays, servers, etc.) are connected to the UPS system. Typically, the UPS system has a 25 kVA power supply with a 25 minute capacity.

5.4 Core Plant (continued)

5.4.9 Gas Turbine Option

With nominal increase in gas consumption (2.77 net Gcal/ton HBI versus 2.60 net Gcal/ton HBI), this option will involve higher capital cost, however, the option will decrease the operating costs and may enhance the overall project viability. The consumption of electricity will reduce to 70 kWh/ton HBI from 130 kWh/ton HBI for the base concept resulting in lower power supply cost during operation.

5.5 Balance of Plant

Balance of Plant facilities and systems include:

- Facility Structures
- Main Substation/Power Distribution System
- Natural Gas Supply System
- Industrial Water Supply and Metering Station
- Fuel Station
- Cooling Water System
- Fire Protection System
- Plant Communication System
- Sewage Treatment System
- Storm Water Management System
- Roads and Parking Areas
- Track Work (Optional)
- Site Security
- Site Finishing and Landscaping

5.5 Balance of Plant (continued)

5.5.1 Facility Structures

Building Description

Pre-engineered buildings with steel roofing and siding will be provided as listed below. The buildings will be insulated and air-conditioned or ventilated, as noted. The lighting and building services will be provided per Industrial Standards. Utilities including, but not limited to, power, natural gas, compressed air and industrial water will be provided, as required. Potable water will be provided, in bottled form. Sanitary waste will be routed to a packaged unit Sewage Treatment System.

Building sizes, finishes, climate control and the fire protection system are summarized in Table 5-1 and Table 5-2. The following is a brief description of each building/facility.

a. *Administration Building* – Single story office building complete with conference room, computer room, toilet facilities and electrical and mechanical equipment rooms.

b. *Storage Building* – Single story warehouse structure for dry storage of core equipment spares. An adjacent fenced yard is provided for storage of oversized items stored under outside conditions.

c. *Lunchroom/Change Facility* – Single story building complete with offices, cafeteria/training room containing vending machines and refrigerator, clean and dirty uniform storage areas, shower rooms and toilet facilities, and electrical and mechanical equipment rooms.

d. *Workship/Equipment Repair Building* – Single story warehouse structure with 10 ton overhead crane. Areas within the building are: mobile equipment repair shop, maintenance workshop, small parts storage, instrumentation office, storage and workshop, tool room, toilet facilities, and electrical equipment room. Additional areas will be provided for conveyor spares and lubricant storage.

e. *Main Control Building* – Three story building with facilities as follows:

   Ground Floor – Cable Room, Sample Laboratory, Wet Chemistry Laboratory, Instrument Laboratory, Office, Toilet Facility and Store Room.

   Second Floor – Motor Control Center/Switchgear Room, Battery Room, and Uninterrupted Power Supply Room.

5.5 Balance of Plant (continued)

Third Floor – Computer Room with raised floor, Process Equipment Station Room, Offices, Toilet Facilities, Kitchen Area and Mechanical Equipment Room.

f. *Compressor Building* – Single story warehouse structure housing Plant Air Compressors, Plant and Instrument Air Dryers, Purge Gas Compressors and Purge Gas Dryer. Air Receivers will be placed outside adjacent to the building.

g. *Analyzer Building* – Single story building to house Gas Analyzing Equipment. The building has an overhanging roof to provide for outside storage of Sample Conditioning Equipment and Gas Bottles.

h. *Machine/Process Water Chemical Additive Building* – Single story shed structure housing Tanks and Pumps for flocculent, pH control, Biocide and Dispersant Addition Systems.

i. *Fire Water Pumphouse* – Single story shed structure housing Diesel, Electric and Jockey Fire Pumps.

j. *Guard House* – Single story building with facilities for monitoring Truck Scale.

k. *SubStation Electrical Building* – Single story pre-fabricated building housing 22 kV Switchgear and accessories.

l. *Cooling Water Chemicals Additive Building* – Single Story shed structure housing Analytical Instruments and a small Wet Chemical Laboratory to control Cooling Water Chemical Treatment.

m. *Cooling Water Chemicals Storage Building* – Single story building (roof only) for storage and receipt of bulk chemical additives, including covered truck unloading station.

n. *Material Handling Operator/Control Building* – Single story building with office, toilet facilities, and electrical equipment room.

o. *General Electrical Utilities Building* – Single story shed building housing electrical equipment.

In addition to the pre-engineered buildings, the following structures will be provided:

5.5 Balance of Plant (continued)

p. *Hydraulic Building* – Single story steel framed building with steel roofing and siding constructed at the base of the Reduction Furnace structure. The building will house process equipment hydraulics, including maintenance monorail and hoist.

q. *Blower Silencer Building* – Single story block building with concrete roof and roof mounted, baffled inlet hood.

r. *Customs House* – Single story structure with office, toilet and kitchen facilities and an electrical equipment room. This building will be incorporated into the overall Port Facility design.

s. *Diesel Generator Building* – Single story steel frame building with steel roofing and siding housing Diesel Generator and a double wall Diesel Fuel Tank.

t. *Fuel Station* – Concrete containment for diesel fuel with facilities for truck unloading and loading.

<u>Heating, Ventilating, and Air Conditioning (HVAC)</u>.

a. The outdoor winter design temperature of the area is 15°C dry bulb. No heating will be provided for any of the Plant buildings due to the warm climate. The following buildings will be provided with air conditioning (cooling) to maintain indoor conditions of approximately 22.2°C and 55 percent maximum relative humidity with outdoor summer design conditions of 35°C dry bulb and 29.4°C wet bulb. Exhaust fans will provided for toilet and locker rooms and laboratory areas. The air conditioning equipment is the air cooled direct expansion refrigerant type, using galvanized steel ductwork as required for airflow distribution. Buildings provided with air conditioning are:

- *Administration Building*
- *Lunchroom/Change Facility*
- *Workshop/Equipment Repair (Offices)*
- *Main Control Building (Control Room Floor, Ground Floor Office and Lab Areas)*
- *Analyzer Building (also ventilated to prevent buildup of harmful gases)*
- *Guard House*
- *Material Handling Operator/Control Room*
- *Customs Building*

b. The following buildings will be provided with ventilation to limit indoor temperatures to 40°C. Ventilation will be supplied using either roof or wall mounted ventilation fans and wall louvers. For electrical equipment rooms, supply air fans with low efficiency filters will be provided to slightly pressurize the rooms for better dust control. Fans will be provided with manual on-off control and will normally run continuously. Buildings provided with ventilation are:

- *Storage Building*
- *Workshop/Equipment Repair (Remaining)*
- *Main Control Building (Second Floor Switchgear Room and Ground Floor Cable Area)*
- *Compressor Building*
- *Machine/Process Water Chemicals Addition Building*
- *Fire Water Pumphouse*
- *Substation Electrical Building (ventilation equipment furnished with building package)*
- *Cooling Water Chemicals Addition Building*
- *General Electrical Utilities Building*
- *Hydraulic Building*
- *Diesel Generator Building*

5.5.2 Main Substation/Power Distribution

The Main Substation will consist of a single 50MVA/66MVA (self cooled/ forced air), 110kV-22kV Transformer to supply normal power to the Plant. The Substation will be complete with metering, relaying, lighting, grounding, switches, bus work, structures, lightning protection, etc.

The 22kV power will be distributed throughout the Plant with a single 22kV metal clad Switchgear assembly and underground conduit/cable duct banks. The 22kV power distribution system also includes a separate incoming breaker for the capability to utilize 22kV power from the utility when the 110kV supply is unavailable. The 22kV feeder from the utility will originate from a different power station than the 110kV. The Plant load will be significantly reduced while running on the 22kV utility feeder.

The 110kV and 22kV take-over points will be isolation switches located at the north corner of the fenced Plant area. The 110kV overhead power feeder will continue to the Substation dead end structure. The 22kV power feeder will continue to the 22kV Switchgear with underground conduit/cable duct banks.

5.5 Balance of Plant (continued)

The MIDREX Core Plant will be supplied with one 22kV power feeder to allow for approximately 35MVA normal process utilization. Midrex will generate intermediate voltage level power as required. This includes, but not limited to, 6300VAC, 380VAC, 220VAC, 110VAC, 110VDC and 24VDC. Midrex's power distribution system will include a Diesel Generator, Power Factor Correction and Harmonic Filtering. The majority of Midrex's power distribution will be done with cable tray, exposed conduit and cable.

The Balance of Plant will consist of one 10MVA/13.33MVA (self cooled/ forced air) 22kV-6.3kV Transformer and seven 1500kVA/2000kVA (self cooled/forced air) 22kV-380VAC Transformers. Intermediate voltage level power will be generated as required. This includes 220VAC, 110VAC, 110VDC and 24VDC. The Balance of Plant power distribution system will include 2 Diesel Generators, Power Factor Correction and Harmonic Filtering as required. The power distribution will be done with embedded conduit, cable tray, exposed conduit and cable. The Diesel Generators will allow the Plant to load and unload ships during extended power outages.

5.5.3 Natural Gas Supply and Metering Station

a. Natural gas will run underground from the property fence to the Midrex supplied Pressure Reducing and Metering Station. The gas will then run in an underground coated and wrapped steel pipe to the Core Plant equipment pipe bridge east end, where it will run on the bridge for distribution to the process users.

b. Natural Gas will also be supplied to several of the buildings to provide hot water for the sinks and showers. However, the following facilities, with few sinks and long distances from the natural gas supply line, will be supplied with individual electric hot water heaters:

- *Administration Building*
- *Workshop/Equipment Repair Building*
- *Main Control Building*
- *The Material Handling Operator/Control Room*
- *Custom Building*.
-

5.5.4 Industrial Water Supply & Metering Station

a. Industrial Water from the local utility will be supplied at the plant property fence line. The slab mounted Industrial Water Metering Station will consist of a shut-off valve, a check valve, a pressure gauge with isolation valve and a water meter. The Industrial Water line will run underground from the property fence to the metering station and from there to the Core Plant users, such as the Process Humidifier Water Preparation System and the Process Water Sump, where it will be used as make-up water for process and fire water system; and as dust agent in the wharf oxide transfer tower.

b. Water will be supplied to sinks and toilets in the following buildings:

- *Administration Building*
- *Lunchroom/Change Facility*
- *Work Shop/Equipment Repair Building*
- *Main Control Building*
- *Material Handling Operator/Control Room*
- *Custom Building*

5.5.5 Fuel Station

The Fuel Station will consist of a horizontal above-ground 35 m^3 capacity steel tank on saddles. The tank and saddles will be surrounded by a spill containment dike capable of holding more than the capacity of the tank.

When the tank level falls below 25 percent full, diesel oil will be supplied by tanker trailers. A metering pump will transfer the fuel oil in a portable tank on a pick-up truck or transferred directly to front-end loader reservoirs.

5.5.6 Cooling Water Cooling Towers

The Cooling Water system will remove heat from the closed loop Process Cooling Water System and the Machinery Cooling Water System of the Core Plant. Heat will be exchanged in a series of plate and frame heat exchangers located in close proximity of the Process and Machinery Cooling Water Sumps.

The major components of the cooling water system include the Cooling Tower, Cooling Water Circulation Pumps, Emergency Cooling Water Pump, Cooling Tower Make-up Pumps, Cooling Water Filter, and Cooling Water Chemical Treatment Systems.

The Cooling Water inventory and quality will be controlled by: (a) the addition of make-up water from the Cai Mep River to the Cooling Tower; (b) by continuously returning a small portion of the cooling water system inventory as blow-down to the River; and (c) by adding water treatment chemicals, such as biocides to control biological growth, dispersant and corrosion inhibitors and sulfuric acid to adjust the pH of the cooling water.

The Cooling Tower will be a mechanical draft type cooling tower designed to cool the circulating cooling water to and from the Core Plant plate and frame heat exchangers.

The Cooling Water Circulation Pumps will circulate water from the Cooling Tower to and from the Core Plant plate and frame heat exchangers and Cooling Water Filter.

The Cooling Tower Make-up Pumps will pump brackish water from a water intake station at the wharf in the Cai Mep River to the Cooling Tower basin.

The Cooling Water Filter will remove suspended particles from the circulating cooling water to decrease the sediment build-up inside the cooling water system. The suspended solids will consist of scale, slime, sludge and particulate matter from the air (dust), make-up brackish river water and water treatment chemical interaction. The filter influent will be pumped by the Cooling Water Circulation Pumps to the filter; filtered water will be returned to the Cooling Tower basin. The filter will be furnished with an automatic backwash system to clean the filter media when the differential pressure across the filter exceeds a certain value. Filter backwash will be returned to the Cai Mep River via the retention basin.

The Cooling Water Chemical Treatment Skids will include storage tanks and pumps for the biocides, corrosion inhibitor, dispersant, and sulfuric acid. The purpose of the chemical addition is to protect the circulating cooling water system. The chemicals will be injected by means of proportioning pumps into the cooling tower basin.

The Emergency Cooling Water Pump will provide cooling water from the Cooling Tower basin to the Core Plant inert gas generation system during a general power failure. Power to the pump will then be provided by the Plant emergency power supply.

5.5.7 Fire Protection System

The Plant will be provided with a dedicated underground yard fire loop with hydrants extending around the main Plant buildings and the oxide storage areas. Hydrants will be typically spaced a maximum of 92m and are located to provide exterior protection for all important Plant areas. A branch will extend to the wharf from the west end of the loop. Branches from the east end will extend to the Administration Building, Storage Building, and Workshop/Equipment Repair Building. Buildings provided with interior sprinkler or hose protection will have branches extending from the yard loop. The wooden Cooling Tower will also be provided with automatic sprinkler protection with a branch taken from the yard loop. The Cooling Tower represents the largest plant fire hazard.

The main fire pumps will consist of one 450 m^3/h electric motor driven pump, one 450m m^3/h diesel engine driven pump, and one pressure maintenance jockey pump housed in the Fire Water Pump House adjacent to the process water sump. During normal plant conditions, the jockey pump will maintain a system pressure of 11 kg/cm^2g. The electric motor driven fire pump will automatically start upon a drop in system pressure with the diesel engine driven pump providing backup in the event of power failure. These pumps will take Process Water from the sump which has the bottom one-third of its capacity (710m^3) dedicated to fire fighting purposes.

A branch from the fire protection loop will supply water to a Midrex furnished booster pump located at the base of the shaft furnace. Carbon-dioxide-total-flooding gaseous fire extinguishing systems will be provided for important electrical rooms and buildings. A Halon substitute gas (FM-200) will be provided for the main control room to allow operators to remain in the room upon a gas discharge.

Fire detection systems will also be provided for many of the Plant buildings and areas with a central panel in the Main Control Room to provide an indication of fire.

All buildings will be provided with portable fire extinguishers for use by building occupants. For electrical areas, carbon dioxide extinguishers will be provided, with other areas served by multi-purpose chemical extinguishers. Some buildings will also be provided with internal hose stations (reels or racks) for use by building occupants. A summary of the Fire Protection System of the Facility Structures is shown in the following table:

5.5 Balance of Plant (continued)

Facility Description	HS	SP	DET	CO_2	EXT
Administration Building	Yes	Yes	Yes		Yes
Storage Building	Yes		Yes		Yes
Lunchroom/Change Facility	Yes	Yes	Yes		Yes
Workshop/Equipment Repair	Yes		Yes		Yes
Main Control Building		Yes	Yes	Yes *	Yes
Compressor Building		Yes	Yes		Yes
Blower Silencer Building		Yes	Yes		Yes
Analyzer Building			Yes	Yes	Yes
Machine/Process Water Chem Add Building			Yes		Yes
Fire Water Pumphouse		Yes	Yes		Yes
Guard House					Yes
Substation Electrical Building			Yes	Yes	Yes
Cooling Water Chem Add Building			Yes		Yes
Material Handling Operator/Control Room			Yes	Yes	Yes
Customs House			Yes		Yes
General Electric Utilities Bldg.			Yes	Yes	Yes
Hydraulic Building		Yes	Yes		Yes
Chemical Storage Building			Yes		Yes
Diesel Generator Building	Yes	Yes	Yes		Yes

*FM-200 (halon substitute) in the Main Control Room

HS = Hose Station (Rack or Reel)
SP = Wet Pipe Sprinkler System
DET = Fire Detection System
CO_2 = Carbon Dioxide Total Flooding Fire Suppression System
EXT = Portable Fire Extinguisher

5.5.8 Plant Communication System

The Plant communication system will consist of a single telephone system with the capacity for 200 phones and internal facility page/party. The telephone system will be distributed throughout the Plant with a single point telephone system via underground conduit/cable duct banks. The facility telephone take-over point will be a junction box located at the north corner of the fenced Plant area. The telephone cable(s) will run to the Plant telephone room with underground conduit/cable duct banks.

5.5.9 Sewage Treatment System

a. The Sewage Treatment System will consist of four duplex pump lift stations to collect and pump raw sewage to a packaged, pad-mounted biological-sewage treatment system. Each of the following geographical areas with significant personnel concentration will be serviced by a duplex lift station:

- *Administration Building*
- *Lunch/Change Facility*
- *Main Control Building*
- *Material Handling Operator/Control Room*

b. Each of the duplex lift stations will pump raw sewage to the Sewage Treatment System equalization tank. Each duplex station will be located outdoors in a prefabricated covered concrete sump, and will consist of individual submersible pumps, lift out rail system, discharge piping, check and block valves, and level control components.

c. The biological Sewage Treatment System will consist of the following components:

- *Equalization Tank*
- *Aerating Tank*
- *Clarifier Tank*
- *Sludge Holding Tank*
- *Chlorination Tank*
- *Odors Control*

d. The wharf facility shall be serviced by a raw sewage collecting tank, requiring draining periodically.

5.5.10 Storm Water Management

Storm water falling on the developed area of the site will be directed to one of two discharge points:

- The western half of the site encompassing the material handling and storage area will be graded to provide sheet flow south to a drainage ditch. This ditch will discharge to a retention basin by means of culvert pipes. The retention basin will provide controlled discharge of storm water west into the estuary.

- The eastern half of the site will encompass the core plant and auxiliary buildings. The buildings will be provided with gutters and downspouts. Storm water in this area will be directed to a system of catch basins which will be piped to a perimeter system of drainage ditches. These ditches will combine to form a single discharge point at the southeast corner of the site. Once off the site, the storm water will be directed to common discharge point for this section of the southern industrial zone discharging into the Rach Nga Tu.

5.5.11 Roads & Parking Area

The Plant site will be serviced by a connector road linking the Southern Industrial Zone with Highway 51, a total distance of 10 km. This road is currently constructed from Highway 51, a distance of 6 km.

Plant roads will be paved around the Core Plant equipment and the auxiliary buildings and unpaved around the material handling area. A truck scale will be provided near the entrance to the plant.

A paved parking area will be provided adjacent to the Administration Building for use by office personnel and a second paved parking area will be provided adjacent to the Workshop/Equipment Repair Building for Plant equipment and vehicles. Roadway and parking area lighting will be provided per Industrial Standards.

5.5.12 Trackwork (Optional)

The Plant site will be accessible by a railroad running adjacent to and parallel with the connector road of the Industrial Zone.

A spur from the railroad will provide rail access onto the site for use during construction and possible export of material at a later date. The railroad, as proposed, will require a railroad crossing across the main entrance to the plant.

5.5.13 Site Security

The Plant site will be fenced around the perimeter utilizing a 2100 mm high fence topped with three rows of barbed wire for a total height of 2400 mm.

5.5 Balance of Plant (continued)

A guardhouse will be provided at the main Plant entrance, manned twenty-four hours per day.

Roadway and Area Lighting will be provided but no additional perimeter lighting is planned.

An additional guardhouse may be required at the landward end of the port facility entrance.

5.5.14 Site Finishing and Landscaping

Crushed stone area surfacing will be provided around the Core Plant equipment and the perimeter of the auxiliary buildings.

Minimal landscaping will be provided around the Administration Building only.

A buffer zone of naturally occurring trees and/or shrubs will be provided at the Plant boundary to act as a screen.

Specific open areas may be treated with herbicide to prevent unwanted growth. The retention pond embankments will be provided with vegetative cover to prevent erosion.

5.6 Equipment Lists

5.6.1 Core Plant

Table 5-3 lists all core plant equipment.

5.6.2 Material Handling System

Table 5-4 lists all equipment of the material handling system including the port facility.

5.6.3 Balance of Plant

Table 5-5 lists all other equipment for the Balance of Plant.

SECTION 6.0

SITE SELECTION AND DATA

6.1 General

A detailed Report outlining the basis of the site selection is included in Appendix III. The selected site is located in the Cai-Mep Industrial Zone, Ba Ria – Vung Tau Province, near the Cai-Mep River Estuary. This section describes, in summary, the findings of that report in the following categories:

- Selection Process.
- Condition of the Selected Site.
- Environmental Considerations for the Proposed Plant.

6.2 Selection Process

6.2.1 Main Criteria

In addition to general requirements of favorable conditions for the construction of plant facilities, two important criteria were established in the selection process of the site. They were:

- The location will ensure the capability of supplying large quantities of natural gas economically.
- The selected site location will allow the construction of a captive Port Facility for the sea-going vessels up to 70,000 DWT for the transportation of incoming iron ores (pellets and lump) and outgoing finished HBI products.

6.2.2 Available Locations

To meet the main criteria, various locations (see location maps included at the end of this section) of the following Provinces in the Southern and Southern-Middle Vietnam, where natural gas fields have been discovered, were studied. They were:

6.2 Selection Process (continued)

- Ba Ria – Vung Tau Province – 3 locations
- Binh Thuan Province – 1 location
- Khauh Hoa Province – 1 location
- Phu Yen Province – 1 location
- Soc Trang Province – 1 location
- Kien Giang Province – 1 location

6.2.3 Natural Gas Supply Consideration

Currently, the Bach Ho and Nam Con Son are the two established gas fields which can provide the required gas quantities to the locations under consideration. The Bach Ho field is situated approximately 180 km to 590 km away and the Nam Con Son field is about 130 km to 640 km away from various locations studied for the proposed site. However, the only pipeline for natural gas which currently exists is from Bach Ho to Ba Ria-Vung Tau Province.

Recently, the Government has approved a plan to build a new gas pipeline from the Nam Con Son to the Phu My Power Plant in Vung Tau Province along the same corridor of the existing pipeline. All other locations in various provinces are not under the plan of the current gas pipeline construction from these fields. Hence, for consideration of natural gas supply, locations in the Vung Tau Province are considered preferable.

6.2.4 Port Construction Consideration

According to the Report on Sea Port System Development Plan, until the year 2010, the ports for the vessels with the capability of over 50,000 DWT will be built in the Southern and Southern-Middle areas of Vietnam. These planned ports, which are located near the main economic regions and have good transportation systems, are mainly in Thi Vai – Vung Tau area. In accordance with the Master Plan of the Port System in Southern Vietnam, the Cai Mep port area and Long Son Port complex which belongs to Thi Vai-Vung Tau Deep Water Port system, and the area on Nga Bay-Thieng Lieng River which belongs to the Ho Chi Minh City Port System, have potential for the construction of ports for the larger vessels.

6.2 Selection Process (continued)

Two areas under the Thi Vai-Vung Tau Port system and one area under the Port System in Ho Chi Minh City were studied.

Based on considerations of various advantages and disadvantages of these areas, the Cai Mep Port complex has been selected for the plant location. Currently, there are various ports which have been planned, and some of them are in construction, in the Cai-Mep area, which runs from Ban Thach Creek to the Cai-Mep Estuary.

6.2.5 Project Site

Based on favorable considerations for both the natural gas supply and deep port construction, the Project site is selected in the Cai Mep Industrial zone, 80 km from Ho Chi Minh City in Hoi Bai Commune, Tan Thanh District, Ba Ria – Vung Tau Province (see location drawing included at the end of this section for the selected site). The site is adjacent to the estuary of the Cai-Mep River on the Ganh Rai Gulf in the Southwest, and, adjacent to the empty land area consisting of forests of mangroves and Treo Gui Estuary in the Southeast. The site also has empty land area with mangroves forests in the North-east and is next to the Industrial Zone main access road from National Highway No. 51 in the Northwest. The land area (50 ha) of the site, which runs in the Northwest – Southwest, is determined by the following A, B, C & D boundary points with their coordinates under the UTM coordinate system, as follows:

POINT	COORDINATES	
	X(m)	Y(m)
A	1160773.350	719959.064
B	1161500.604	720645.432
C	1161157.421	721009.059
D	1160430.166	720322.692

The site is close to the National Highway and 45 km from Vung Tau City by road and 18 km by waterway. Advantages and disadvantages of the selected site are:

6.2 Selection Process (continued)

a. *Advantages*

- For the navigation channel, the site is in the best section of the Thi Vai River. According to the available survey document, the navigation channel in this area is very much settled. This channel can receive larger vessels without much dredging.

- The location is 8km from the National Highway 51 which is the main road connecting Ho Chi Minh City and Dong Nai, Vung Tau and large industrial centres of Southern Vietnam. In the future, the motorway and Trans-Asian road will be built. Thus, the delivery of the finished products over the road to provinces can be made economically and in an efficient manner.

- The Thi Vai River system includes a dense channel network; thus, it is possible to distribute the products to the Mekong Delta's provinces via the waterways at reasonable low freight cost.

b. *Disadvantages*

- There is no infrastructure available at the present time. Therefore, the construction of infrastructures including access road, water supply system connecting from the national water supply system to the plant, water drainage system and electricity supply system will be required.

- The land area of the Plant is a aegiceras forest and marsh. Thus, in order to attain the designed elevation and to satisfy the requirement of bearing capacity of soils, substantial filling work and soil improvement work for the facility construction will be needed.

However, it must be mentioned that most of the other site locations considered for the Plant have the same disadvantages as well.

6.3 Conditions of the Selected Site

6.3.1 Topographic features

a. *On Shore Topography*

- According to the report on "Topographical Survey" prepared by TEDI SOUTH in March 1999 (Appendix IV), the terrain of the plant area is rather complicated in general and is divided into plots by ditches. In addition, in the plant area, there are a large number of mangroves and date palms. The 50ha area of the Plant has average elevations varying from (+) 0.10m to (+) 0.15m (Hon Dau Datum).

b. *Off Shore Topography*

- The planned location for the Port construction is adjacent to Ganh Rai Gulf. The riverbed in this area is rather deep. However, near the land area planned for constructing the Plant (located inside the left bank of the Cai Mep River and at the confluence of the Cai Mep River and the Treo Cui Estuary), the terrain of the riverbed near the riverbank is gradually sloping and shallow.

- Based on the axis of the land area of the plant, the distance from the river bank to the depth line at the depth of (–) 5.00m (Hon Dau Datum) is approximately 500m. In this area, the riverbed has the slope of 1 in 50 to 1 in 100. The distance from the line (–) 5.00m to the line (–) 12.50m is 150m, the slope of the riverbed is of about 1 in 20. Going toward the middle of the river, we can reach the line (–) 25.00m, where the port wharf will be built. At this location, the slope of the riverbed is of about 1 in 7. Continuing to go outside the line (–) 25.00m, the riverbed has a very steep slope.

6.3 Conditions of the Selected Site (continued)

6.3.2 Geological Features

In accordance with the "Report on Soil Investigation" prepared by TEDI SOUTH in March 1999 (Appendix V) there are 10 boreholes that have been drilled in the areas. Among these ten boreholes, 7 boreholes (K2, K5, K6, K7, K8, K9, K10) have been drilled in the plant area and 3 boreholes (K1, K3 and K4) are on the off-shore areas. Generally, the structure of the strata at the boreholes is composed of 4-6 layers and the strata are described as follows:

a. *Layer 1* - FAT CLAY/ELATIC SILT light grey, to dark grey, very soft to soft. The thickness of this layer varies from 33.5m (K5) to 43.3m (K3). This layer was encountered in all boreholes. The elevation of layer bottom varies from (-) 33.1m (K10) to (-) 45.2m (K4). Soils SPT blow varies from 0 to 4.

b. *Layer 2* - Clayey/Silty SAND mixed gravel and SANSTONE, yellow grey, dark grey to green grey, very hard. This layer was encountered in all boreholes, the thickness varies from 0.4m (K6) to 6.0m (K4). The elevation of layer bottom varies from (-) 34.1m (K10) to (-) 51.2m (K4). Soils SPT blow varies from 25 to 50.

c. *Layer 3*: - CLAY/SANDY CLAY, dark grey to grey, grey motley yellow, firm to stiff. This layer only encountered in boreholes K1, K2, K4, K6, K7, the thickness varies from 0.6m (K7) to 11.6 (K3). The elevation of layer bottom varies from (-) 35.7m (K7) to (-)57.4m. Soils SPT blow varies from 12 to 50+.

d. *Layer 4*: - Silty Clayey SAND, grey, yellow, medium dense to dense. It was encountered all through the borehole. The drilled thickness is 34.6m (K5). Soils SPT blow varies from 17 to 50+.

e. *Layer 5*: - CLAY green grey motley white, hard to very hard. This layer has not drilled completely, the drilled thickness is 2.1 m (K2); 6.8m (K8). Lenses of clay (green gray, soft) and silty sand and (light grey to dark grey, medium dense) are also encountered. Soils SPT blow varies from – 45 to >50.

f. *Layer 6*: - GRANITE, weathering degree varies from highly to slightly, brown, yellow, green grey motley white. This layer is encountered at the boreholes K1, K3, K4, K6, K7, K8. The drilled thickness varies from 10.5 (K1) to 1.4m (K7).

6.3.2 Meteoro-Hydrological Feature

a. *Wind and Storm Regime*

The coastal area of Vietnam has two main wind flows – North-east and Southwest with average speed of 5 – 10m/s. According to the data recorded by the meteorological station, relatively short observation at Thi Vai indicates that in the dry season, the main wind direction is Northeast with the wind speed of 1 – 5m/s; and in the rainy season it is Southwest wind with the speed of 5 – 10 m/sec.

From December to early April, the Southwest wind is clearly noticeable; in other months, the wind direction is not specific. In spite of this, during the time of wind observation in the area of Thi Vai, a gust lasting about 15 minutes with the speed of 38m/s was once recorded. According to the data of Ho Chi Minh City hydro-meteorological station, during the period of 1929-1983, there were 6 storms passing by the area of Vung Tau – Ho Chi Minh City, and the maximum wind speed recorded is never over 30m/s. As calculated, the wind speed with frequency of 1 percent is 38m/s.

b. *Rain*

The rainy season runs from May to October. The rainfall of the Thi Vai River area is based upon the data of the Long Thanh Rain Measurement Station (located at the origin of the Thi Vai River and in the same climate zone.) The yearly average rainfall in the Thi Vai area is approximately 2007mm. The rainfall of the rainy season (lasting from May to November) is over 90 percent of the yearly rainfall. The maximum rainfall in a year is 3272mm (recorded in 1952). January, February and March are the months of the year with the lowest average rainfall; the average rainfall in these months is not over 10mm. The maximum daily rainfall observed is 340mm (on 20 October 1952) with the frequency of smaller than 1 percent. Due to the storms, floods are found in the Dong Nai River Basin.

6.3 Conditions of the Selected Site (continued)

Table 3: The Total Rainfall with Different Frequencies
Long Thanh Meteorological Station

Typical values (mm)	Frequency (%)				
	1	3	5	10	25
Annual total rainfall	3511	3060	2854	2564	2180
Daily total rainfall	232	198	182	159	127

c. *Visibility*

Fog rarely appears on the Vung Tau Sea; the annual average number of foggy days is 11-12 days. However, due to heavy rain, the visibility can be restricted for an additional 142 hours per year.

d. *Air temperature and humidity*

- The annual average temperature is 26.8°C. The maximum temperature is 33°C and the minimum is 20.1°C. In general, there is no difference in amplitude of temperature fluctuation between days and nights in the whole year. The difference in temperature between the hottest month (April) and the coldest (December) is approximately 4°C.

- The air humidity is variable according to seasons. In the rainy season, the average humidity is 86.6 percent and attained 90 percent in September. In the dry season, the average humidity is 76 percent. In March, the humidity is only about 73 percent. The months from August to October have the highest average humidity. January, February and March are months with the lowest average humidity. In a day, the air humidity varies in contradiction with the temperature. The highest humidity is at between 1:00 P.M. to 2:00 P.M. in the afternoon and the lowest is at 7:00 A.M. in the morning. The annual average saturated humidity in Thi Vai is 5.6 mb.

6.3 Conditions of the Selected Site (continued)

e. *Hydrological Regime*

The hydrological regime of the Thi Vai River is recorded through the observation of the hydrological process taking place in the area of the East Sea adjacent to the project site (Appendix XX). The change of water levels and currents depend on the semidiurnal tidal regime. The highest water level is (+) 177cm and the lowest is (–) 290cm (Hon Dau datum). The amplitude of the highest water level fluctuation in Thi Vai for the period from July 1986 to August 1987 is 426cm (obtained in January, 1987). Tideway plays an important part in forming the direction of currents. The maximum current speed is 180cm/s (in the Phu My region). On the Thi Vai River, wave is approximately 1m high (the highest wave is 1.2m recorded in Go Gia River). This wave does not affect the operation of the wharf. Furthermore, as the Ganh Rai Gulf is protected by the Vung Tau Peninsula and Can Gio alluvial soil, so the wave is not high.

f. *Sediment Level*

According to the results observed at the Thi Vai station in the period of August, 1988-August, 1989, an inventory of the typical figures of sediment level of water river in months, as well as the line of monthly average sediment level equivalent to the time, are set up. Besides, the line of sediment level observed according to the variation of water level in the two typical months, is also set up. Average sediment level for the two periods of observation is 480 mg/L and fluctuating from 100 mg/L to 2260 mg/L. The sediment state of the river water is specifically variable according to the season. In the early months and ending months of the rainy season, the sediment level reaches its highest value (May and October). The maximum sediment level at the beginning of the rainy season can be explained as follows: the showers at the beginning of the rainy season have dragged the surface soil which has been weathered during the dry season, then the sediment level gradually diminishes and reaches the minimum in June. In the rainy months after that, the rain goes on eroding the surface soil, and this is the second time the rain causes the greatest volume of alluvium of the river water at the end of the rainy season.

6.3 Conditions of the Selected Site (continued)

6.3.2 Infrastructures

a. Road

- The site selected for the plant and its port is in the planned port complex downstream from the Thi Vai and Cai Mep Rivers. This location is about 4km from the National Highway No. 51. The National Highway No. 51 connecting Ho Chi Minh City and Vung Tau is an important road with many projects of rehabilitation and development. Thus, the transport from the plant and port to the national road network is very convenient. The project site is 80km away from Ho Chi Minh City, 50km from Bien Doa Dong Nai and 40km from Vung Tau.

- In addition, there is a project of Sai Gon – Vung Tau motorway of 71 km long which parallels NH 51 for the purpose of serving tourist and freight vehicles. Internal roads for connecting Cai Mep Port area and National Highway 51 are being constructed.

b. Domestic Waterway

- Thi Vai – Go Gia River system is connected with other rivers by canals, rivulets, small streams whose depth is not enough for large vessels but, they can allow the convenient passage of 300 – 800 metric ton barges.

- Going from Long An to the dolphin, it is possible to follow Vam Co Tay River – Vam Co River – Soai Rap River – Long Tau River – Dong Tranh River – Cua Canal – Go Gia River – Ong Truc Canal – Thi Vai River (or from Go Gia River going downstream to Thi Vai River).

- From Tay Ninh going along the Vam Co Dong River – Vam Co River and then taking the waterway as going away from Long An.

- From other provinces of the Mekong Delta, it is possible to take the above waterway.

6.3 Conditions of the Selected Site (continued)

c. *Electricity Supply*

At present, the electricity supply system for the whole region has not yet been constructed; it is planned to extend the 15kV electricity line along the road that is under construction in order to supply electricity for the whole region.

d. *Water Supply and Drainage*

There is no infrastructure of water supply and drainage. Investments need to be made in the new water supply and drainage systems, together with the investment in construction of the DRI Plant and Port. As a result, the construction costs will be higher, but this is in accordance with the scale of the investment and does not depend on the existing infrastructures. The investment in a new water supply and drainage system will facilitate the construction of sewage treatment works to limit the pollution of the environment.

e. *The actual situation of the navigation channel from the East Sea to the port*

The total length of the navigation channel from the East Sea to Ganh Rai Gulf and then to the Thi Vai River is 41km (calculated from the Buoy 0 to the Go Dau Port complex). The characteristics of this channel are as follows:

- The access channel to the Cai Mep Port complex follows the deep water way of Ganh Rai Gulf and then enters the Thi Vai River. The length of the channel from Buoy 0 to the Cai Mep River is approximately 12km. On this channel, there are two shallow sections: the first section is at Ganh Rai Gulf with the length of about 5km, minimum depth of 10.6m; and the second is the sand ground at Cai Mep Estuary with 4 km long, and the minimum depth of 10.6m. Based on the documents obtained before 1975, and prepared by TEDI South in recent years, it is possible to predict that the natural navigation channel has not remarkably changed in depth as well as in the plan.

6.3 Conditions of the Selected Site (continued)

- The depth of the Cai Mep Estuary tends to fluctuate periodically with the amplitude of 1m. In the last 5 years, the depth has been changed inconsiderably and has the value of approximately –13.0m (Mui Nai Datum).

- At present this channel (from the East Sea to the Phu My Port) has been approved and announced for the navigation of vessels with the tonnage of 30,000 to 40,000 DWT.

- The feasibility study on the whole Thi Vai navigation channel, in general, and on the navigation channel from the East Sea to the Cai Mep Port complex for vessels of 70,000DWT, in particular, has been completed and submitted to the authorities for consideration and approvals.

6.4 Environmental Considerations

6.4.1 Impacts During Construction

- Destruction of the mangrove forests influencing forestry industry.

- Filling and leveling of the existing marshy land affecting sensitive ecology of the area.

- Dredging of the navigational channel on the Thi Vai River affecting temporarily the quality of the water and the life of aquatic creatures.

- Silt deposits and erosion of the Cai Mep River Estuary.

6.4.2 Impacts During Operation

The essential activities of the Plant and the Port, which involves a) transportation of materials by waterway and land, b) production activities of the process plant and material handling areas, c) activities of staff and workers, and d) periodic dredging activities of the port and the navigational channel, will have the following impacts:

6.4 Environmental Considerations (continued)

- Air pollution caused by dust and noise.
- Pollution caused by sewage.
- River pollution caused by the dredging during the Port maintenance operations.

6.4.3 A preliminary environmental assessment of the site for the project has been done and included in Appendix VII. Also, measures to limit impacts that will be caused by the Plant are outlined in the "Selection of the Plant Location Report" in Appendix III.

REPORT

ON

FEASIBILITY STUDY

FOR

DIRECT REDUCTION PLANT IN VIETNAM

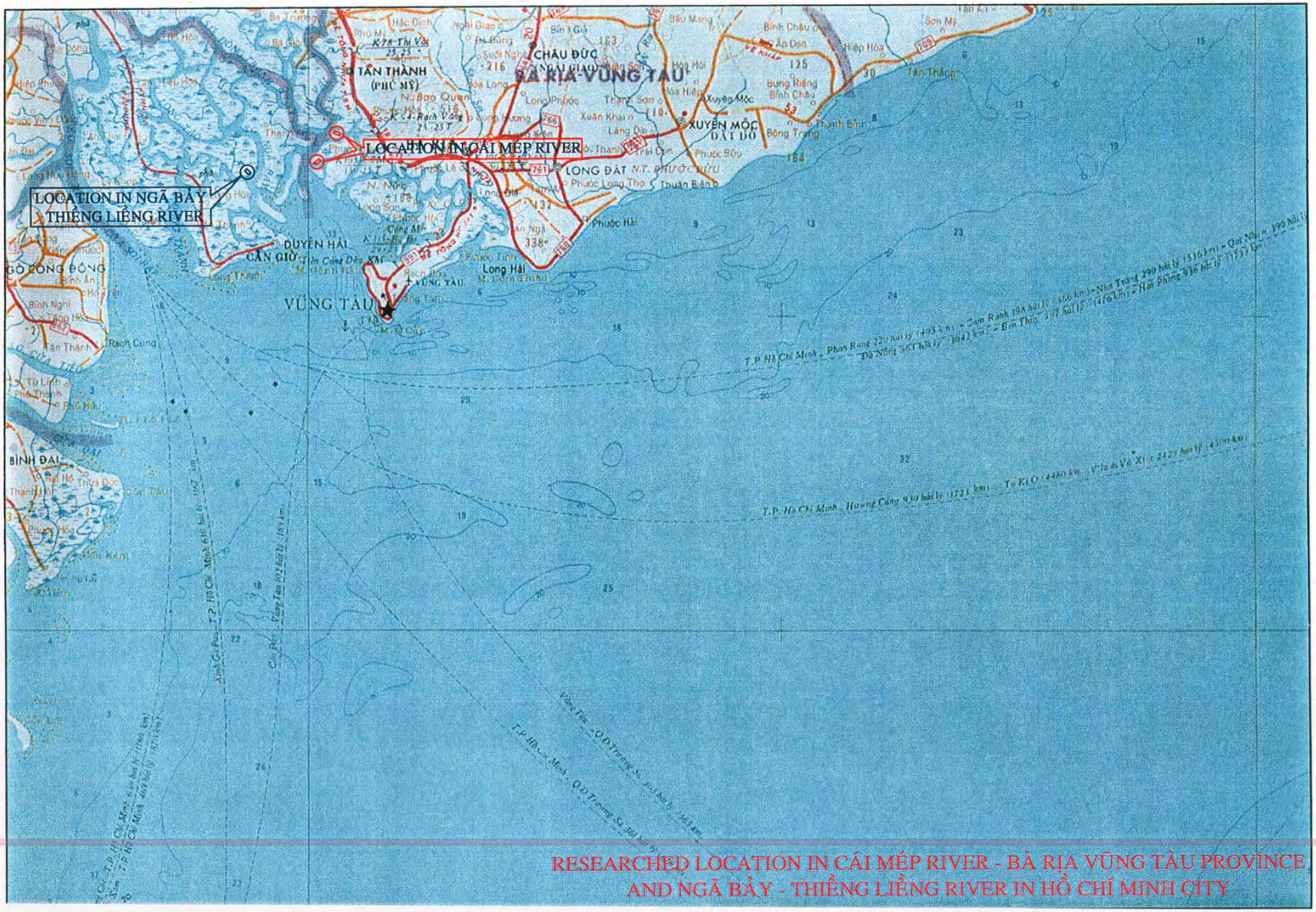
SELECTED SITE AREA MAP

MAP NO. 6-2

(1 - MAP)

LOCATION MAP OF PROVINCES IN THE RESEARCHED AREA

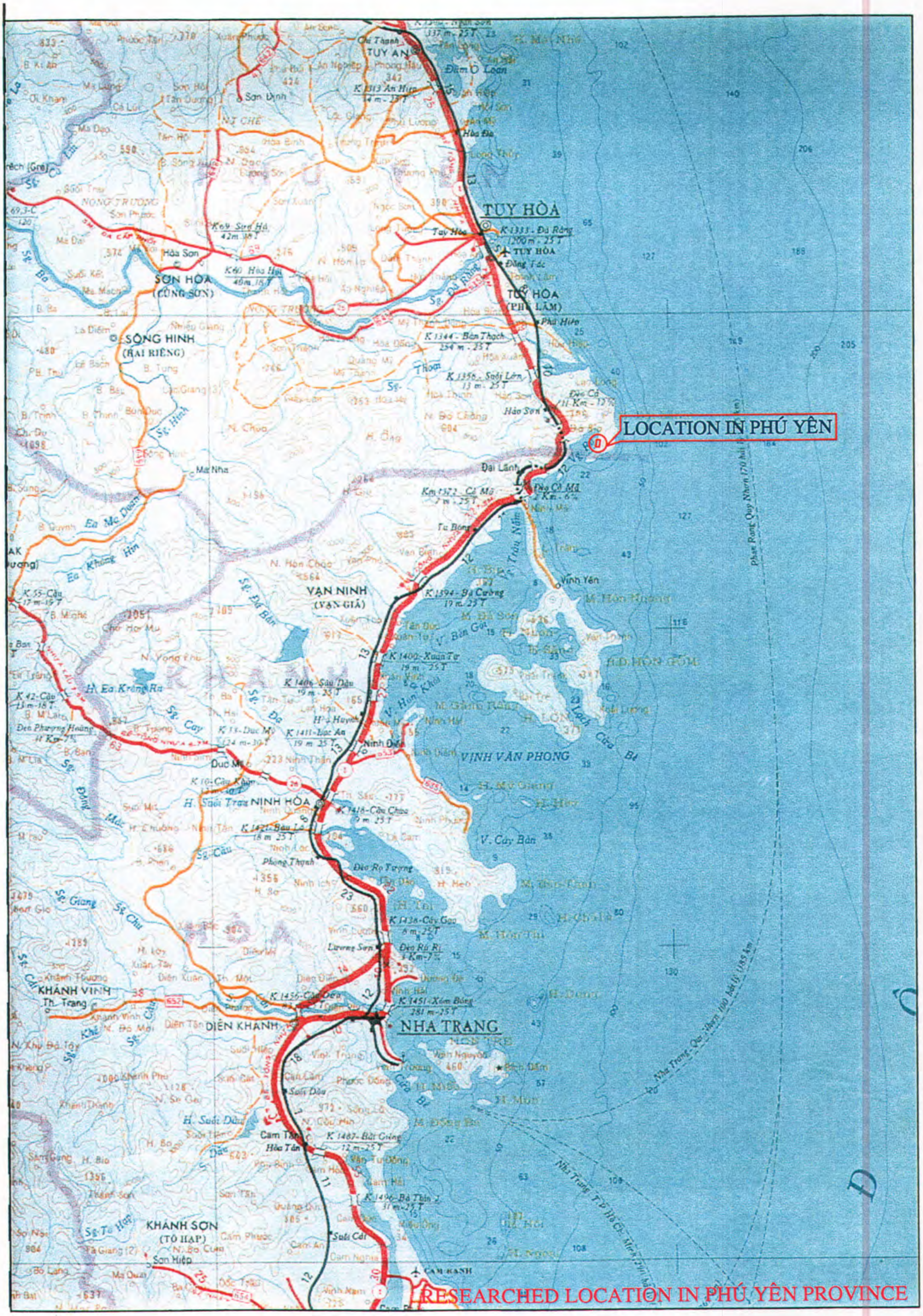
DRW. 1/8

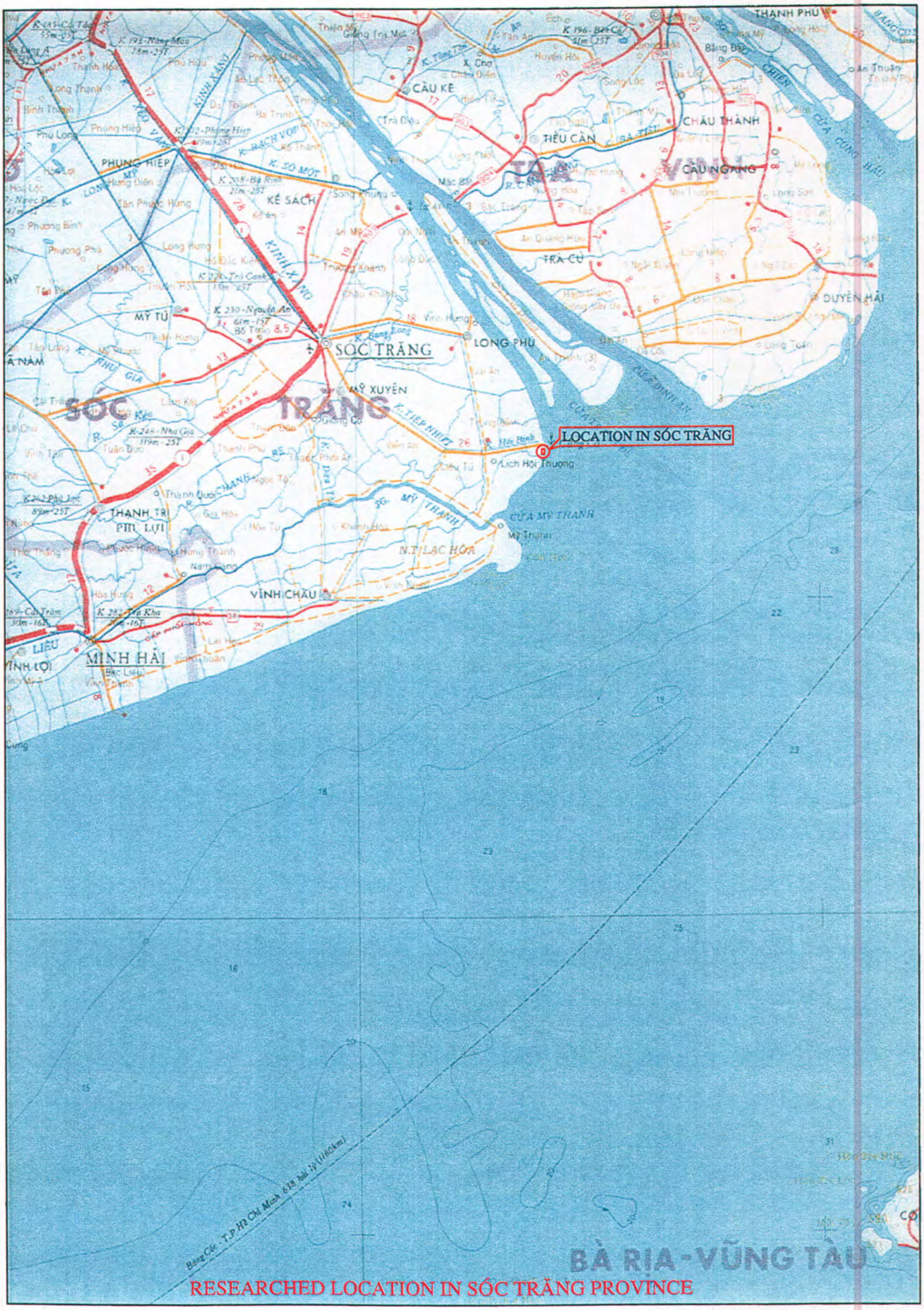


RESEARCHED LOCATION IN CÁI MÉP RIVER - BÀ RỊA VŨNG TÀU PROVINCE AND NGÃ BẢY - THIỀNG LIỀNG RIVER IN HỒ CHÍ MINH CITY


LOCATION IN BÌNH THUẬN
PHAN THIẾT
MŨI NÉ
BẢO LỘC
DI LINH
HÀM THUẬN BẮC
HÀM THUẬN NAM
BẮC BÌNH
(CHỢ LẦU)
TUY PHONG
PHAN RÍ CỬA
HÀM TÂN
(LA GI)
PHAN RANG
THÁP CHÀM
NINH PHƯỚC
VỤNG PHAN RÍ
VỊNH PHAN THIẾT
RESEARCHED LOCATION IN BÌNH THUẬN PROVINCE

TUY HÒA
SƠN HÒA (CỦNG SƠN)
SÔNG HINH (HAI RIÊNG)
VẠN NINH (VẠN GIÃ)
NINH HÒA
VỊNH VÂN PHONG
LOCATION IN KHÁNH HÒA
KHÁNH VĨNH
DIÊN KHÁNH
NHA TRANG
KHÁNH SƠN (TÔ HẠP)
RESEARCHED LOCATION IN KHÁNH HÒA PROVINCE


LOCATION IN PHÚ YÊN
TUY AN
TUY HÒA
SƠN HÒA
(CỦNG SƠN)
SÔNG HINH
(HAI RIÊNG)
VẠN NINH
(VẠN GIÃ)
VỊNH VĂN PHONG
NINH HÒA
KHÁNH VINH
DIÊN KHÁNH
NHA TRANG
KHÁNH SƠN
(TÔ HẠP)
Đại Lãnh
RESEARCHED LOCATION IN PHÚ YÊN PROVINCE



RESEARCHED LOCATION IN SÓC TRĂNG PROVINCE


LOCATION IN KIÊN GIANG
RESEARCHED LOCATION IN KIÊN GIANG PROVINCE
RẠCH GIÁ
HÀ TIÊN
HÒN ĐẤT
TRI TÔN
TỊNH BIÊN
THOẠI SƠN
NÚI SẬP
TÂN HIỆP
CHÂU THÀNH
MINH LƯƠNG
GIỒNG RIỀNG
GÒ QUAO
AN BIÊN
THỨ BA
AN NINH
U MINH
THỚI BÌNH
VĨNH THUẬN
LONG XUYÊN
CHÂU THÀNH
AN CHÂU
CHỢ MỚI
CHÂU PHÚ
CÁI DẦU
KIÊN
GIANG
SÔNG PONG TRACH
VỊNH RẠCH GIÁ
VŨNG RẠCH GIÁ
VŨNG CÂY DƯƠNG
LÂM TRƯỜNG

REPORT

ON

FEASIBILITY STUDY

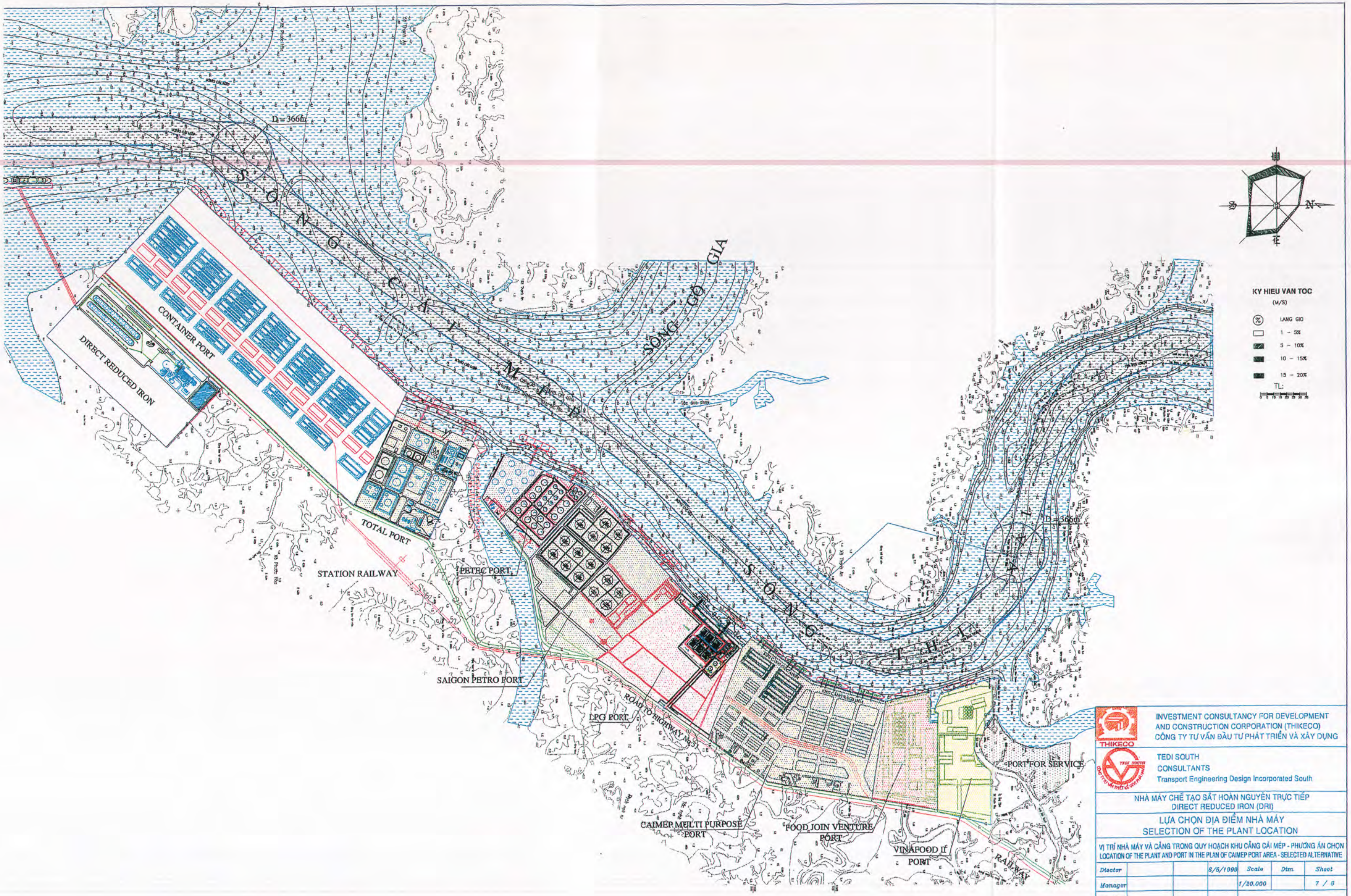
FOR

DIRECT REACTION PLANT IN VIETNAM

SELECTED SITE AREA MAP

MAP NO. 6-2

(1 - MAP)



INVESTMENT CONSULTANCY FOR DEVELOPMENT AND CONSTRUCTION CORPORATION (THIKECO)
CÔNG TY TƯ VẤN ĐẦU TƯ PHÁT TRIỂN VÀ XÂY DỰNG

THIKECO

TEDI SOUTH
CONSULTANTS
Transport Engineering Design Incorporated South

NHÀ MÁY CHẾ TẠO SẮT HOÀN NGUYÊN TRỰC TIẾP
DIRECT REDUCED IRON (DRI)

LỰA CHỌN ĐỊA ĐIỂM NHÀ MÁY
SELECTION OF THE PLANT LOCATION

VỊ TRÍ NHÀ MÁY VÀ CẢNG TRONG QUY HOẠCH KHU CẢNG CÁI MÉP - PHƯƠNG ÁN CHỌN
LOCATION OF THE PLANT AND PORT IN THE PLAN OF CAIMEP PORT AREA - SELECTED ALTERNATIVE

Diector				8/5/1999	Scale	Dim	Sheet
Manager					1/20.000		7 / 8
Checked							
Drawer							

SECTION 7.0

PROCESS TECHNOLOGY

7.1 Direct Reduction Technologies

7.1.1 Background

Steelmaking using an electric arc furnace was demonstrated by Sir William Siemens in 1878 and first practiced on an industrial scale by Heroult in France in 1899. However, the technology remained moribund for half a century because it could not compete with blast furnace/open-hearth steel. By 1950, the availability of reasonably priced electricity and scrap resulted in the growth of mini-mills, EAF-based facilities that source scrap and sell products in the local area. This concept is well suited to regions and countries that need small, local mills supplying construction steel products. Much of the growth in steel production in the developing world has resulted from mini-mills.

In 1946, the Surface Combustion Division of Midland-Ross Corporation in Toledo, Ohio developed a technology that used shaft furnaces to indurate iron oxide pellets. The company had also worked on stoichiometric CO_2 reformers for processing natural gas, and the two technologies were combined to create a process for direct reduction of iron ore. Thus was born the MIDREX Direct Reduction Process. The first plant was built in Portland, Oregon in 1969.

Gas-based direct reduction proved a technical and commercial success and during the 1970's, numerous MIDREX plants were constructed, many in the developing world. Countries such as Argentina, Brazil, Mexico, Qatar, Saudi Arabia and Venezuela needed steel to support development and possessed the capital (much of it via revenues from crude oil sales) and natural gas required for direct reduction.

During the 1980's, EAF production continued to grow due to its considerable capital and operating cost advantages versus the blast furnace/basic oxygen furnace route. These advantages accrue since EAF steel making is less capital and labor intensive, cleaner and has lower economics of scale. The costs of building and maintaining sinter plants, coke ovens, blast furnaces and the associated environmental problems continue to plague integrated steel makers.

By the late 1980's, world steel production began increasing. Continued mini-mill growth increased the "scrap intensity of steel making". This pressure on scrap supplies and higher prices increased demand for DRI. In the developing countries, much direct reduction capacity was built just to provide iron units since those countries often lack EAF charge materials. DRI produced with inexpensive natural gas or coal can produce an economical means to manufacture common grades of steel. In the industrialized countries, demand for DRI and its briquetted form HBI, has been driven primarily by the movement of mini-mills into higher quality products requiring low metallic residuals. These products include wire rod, special quality bar, seamless pipe, and sheet steel.

Due to the need for DRI in the developing world and the industrialized countries, interest in DRI exploded in the early 1990's. While most direct reduction facilities had been associated with steel mills, a number of new merchant plants were built to sell HBI. Also, because of high steel demand and the concomitant need for DRI, deregulation of natural gas and the availability of financing, plants are being built in the United States for the first time since the 1970's. This is being driven largely by the quality metallics demands of the new thin slab casting mini-mills. Clearly, DRI is now an established, important factor in the steel industry.

7.1.2 Fuel and Reductant Options

Iron oxide can be reduced by hydrogen, carbon monoxide and carbon. The specific reduction process and fuel availability will determine how the reducing gas is generated.

Gaseous and Liquid Hydrocarbon Based DR Processes

Natural gas is the most widely used reductant in DR processes. It can be converted relatively easily into a mixture of hydrogen and carbon monoxide by catalytic reforming with steam or by partial oxidation. Installations based on reforming outrank that based on partial oxidation, both in number and capacity of individual plants. In comparison with many coal and petroleum sources, natural gas has the advantage of low sulfur content.

Butane and naphtha can also be catalytically reformed with steam to produce hydrogen and carbon monoxide.

7.1 Direct Reduction Technologies (continued)

Gaseous reductants such as coke oven gas and refinery tail gas contain methane and sulfur. These gases are mostly consumed in-plant and are available only in limited quantities for external use.

Coal Based DR Processes

Reducing gas for coal-based direct reduction can be generated by adding the coal to the iron oxide and feeding the mix to the reduction system where the coal would be used directly as the reductant for fuel.

Coal can be fed into a rotary kiln with iron ore and gasified there by reaction with the oxide and with added air to produce hydrogen and carbon monoxide.

Coal can also be used as a reductant in rotary hearth furnaces. Several variations of the RHF concept for production of DRI from iron ore fines have been developed including the FASTMET process of MIDREX.

Coal can also be converted to reductant gases by gasification with oxygen in a separate gasifier where the carbon and hydrogen in the coal are the source of both the fuel and reductant.

7.1.3 DR Processes

The evolution of DR technology to its present status has included more than a hundred different DR process concepts, many of which have been operated experimentally. Most were found to be economically or technically unfavorable and abandoned. However, several were successful and subsequently improved into full-scale commercial operations. In some instances, the best features from different processes were combined to develop improved processes to eventually supplant the older ones.

Some processes were designed to use particular raw materials or fuels that are no longer available, and were discontinued despite being technically sound. Others were viable under specific circumstances, and continue to operate as they are best suited for indigenous raw materials and fuels.

7.1 Direct Reduction Technologies (continued)

Because of the diversity of raw materials and fuels throughout the world, it is anticipated that that a number of DR processes, both coal-based and gas-based, will remain in commercial operation. At present, these include:

Type	Process
Gas-Based Processes	
Shaft Processes	MIDREX HYL Process Purofer
Fluidized Bed Processes	FIOR/FINMET Iron Carbide Circored
Coal-Based Processes	
Rotary Kiln Processes	SL/RN Krupp-CODIR DRC ACCAR-OSIL Jindal
Retort Process	Kinglor Metor
Rotary Hearth Processes	Inmetco FASTMET Redsmelt Iron Dynamics

7.1.3 DR Process Selection

Most of the proven gas reserves in Vietnam are in the south in the Vung Tau-Ba Ria area close to Ho Chi Minh City. In addition to gas and oil, Vietnam is also rich in coal and has developed a coal industry, which is centered north of Hai Phong Harbor. Between these two energy rich sectors lies Vietnam's largest iron ore reserve.

The DR technologies that are currently the most proven to accomplish the production of DRI in the form of HBI in Vietnam is the MIDREX DR process and HYL III process, both employ natural gas as its reductant. A brief comparison of these processes are summarized in the following table:

7.1 Direct Reduction Technologies (continued)

COMPARISON OF MIDREX & HYL III	
MIDREX	**HYL III**
General Reformer and reduction sections are linked. There is recycle of reactor top gases through the reformer. Less total equipment.	Reformer and reduction sections are independent. There is no recycle of reactor top gases through the reformer. Advantages in 2 reactors, 1 reformer system.
Reformer Special reformer of exclusive design Special catalyst. Low sulfur natural gas required.	Conventional steam reformer. Desulfurization is required.
Reducing Gas Reduction based on CO rich gases (exothermic reactions): H_2 / CO: 1.55 Low reducing potential (H_2 + CO) / CO_2 + H_2O: 11.70 Low Pressure: 2.3 kg/cm^2 Dynamic sealing	Reduction based on H_2 –rich gases (endothermic reactions): H_2/CO: 5.73 High reducing potential (H_2 + CO) / (CO_2 + H_2O): 20.53 High pressure: 5.5 kg/cm^2 Pressure valves for gas seal. More equipment and energy for Quenching and heating the reformed gases.
Iron Ore Limited lump or friable ore; limit on sulfur-containing ore.	More lump or friable ore tolerated.

The gas based MIDREX Megamod DR technology has such a proven record of performance that there is virtually no technical or operating risk. The coal-based FASTMET technology, by comparison, would require further confirmation of the operating parameters and the assumptions based on the use of Vietnam coal. In 1998, about 67 percent of world DRI production was by the MIDREX gas-based process.

7.1 Direct Reduction Technologies (continued)

Based on the MIDREX experience history and other factors, Vietnam Steel Corporation has selected the MIDREX gas-based DR technology for the Detailed Feasibility Study. The government of Vietnam has approved the use of MIDREX DR Technology.

7.2 MIDREX Direct Reduction Process

For simplified Process Flow Sheets, refer to the MIDREX Technical Specifications provided in Appendix VIII.

The MIDREX Direct Reduction Process converts iron oxide lump ore, pellets, or pellet/lump ore mixtures into highly metallized iron, either in the form of direct reduced iron or hot briquetted iron, which are ideal feed materials for high quality steel making.

The Core Plant to be supplied will use the MIDREX MEGAMOD Module concept.

The major components of a MIDREX MEGAMOD Module include the reduction shaft furnace, reformer, process gas system, heat recovery system, and a hot DRI briquetting system. These components are supported by ancillary systems for handling iron ore, cold and hot gases, water, and product. The following paragraphs describe the reduction and reforming steps.

7.2.1 Reduction

Most naturally occurring iron oxide has the chemical composition of hematite, (Fe_2O_3), and contains about 30 percent oxygen by weight. In the MIDREX DR Process, the chemically bonded oxygen in the iron ore is removed at elevated temperatures by reaction with carbon monoxide and hydrogen contained in a reducing gas to produce metallic iron, while liberating carbon dioxide and water vapor. The overall reduction reactions are:

$$Fe_2O_3 + 3H_2 \longrightarrow 2Fe + 3H_2O$$
$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$

7.2 MIDREX Direct Reduction Process (Continued)

An important property of the reducing gas is the reductant/oxidant ratio, or "gas quality". The quality is a measure of the potential for the gas to reduce iron oxide. The quality is defined as the ratio of reductants to oxidants contained in the gas:

Quality = reductant/oxidant ratio

= moles (H_2 + CO)/moles (H_2O + CO_2)

MIDREX has found that the optimum gas quality for hot, fresh reducing gas should be 10 or higher. Also, to obtain essentially complete reduction, the quality of the spent reducing gas exiting the process should be at least 2.

Another important property of the reducing gas is the H2/CO ratio. Control of the H2/CO ratio affords thermally balanced reduction reaction since reduction with carbon monoxide is exothermic, and reduction with hydrogen is endothermic. That is, the heat required by the hydrogen reaction is balanced by the heat supplied by the carbon monoxide reaction. Therefore, proper reduction temperatures are easily maintained.

The specific reducing gas consumption and gas quality also affect the degree of metallization of the DRI product. The degree of metallization is a quantitative means of determining the amount of oxygen removed from the iron oxide during the reduction reactions.

Degree if Metallization, % = {(% Metallic Fe)/(% Total Fe)} x 100

The MIDREX Core Plant production capacity is based on a degree of metallization of 92 to 94 percent, which, in most plants, has been found to optimize direct reduction plant/steel making plant economics.

The reduction process takes place in a patented MIDREX Shaft Furnace with a nominal 6.65 meter I.D. refractory diameter.

Iron ore enters the MIDREX Shaft Furnace through the dynamic upper seal leg and is then uniformly distributed on the stockline by means of a plurality of symmetrical feed pipes.

7.2 MIDREX Direct Reduction Process (continued)

A dynamic seal is created by a small flow of inert seal gas into the upper seal leg of the fumace. This flow of inert seal gas through the oxide material creates a back pressure and hence, by design, a higher pressure in the seal leg. This prevents the escape of fumace gases to the atmosphere, while still allowing the free flow of material by gravity into the furnace, without the use of lock-hoppers or valves.

The iron ore is reduced to metallic iron in the reduction zone (the upper portion of the furnace) by contact with hot hydrogen and carbon monoxide containing gases, which flow counter-current to the descending iron oxide. Uniform reducing gas flow is assured by special designed inlet ports (tuyeres).

Below the reduction zone, the furnace contains burden feeders and a flow device which ensure uniform material flow through the reduction zone of the furnace. The hot DRI leaves the shaft furnace through the dynamic lower seal leg, which operates in the same manner as the upper seal leg. The material then enters the PDC, and finally the briquette machines before cooling.

7.2.2 Reforming

The primary source of energy for the MIDREX DR Process is natural gas, which is reacted with carbon dioxide and water vapor to produce a reducing gas rich in carbon monoxide and hydrogen. The important reforming reactions are:

$$CH4 + CO_2 \text{ -------------}\rightarrow 2CO + 2H_2$$
$$CH4 + H_2O \text{-------------}\rightarrow CO + 3H_2$$

Both of these reforming reactions are endothermic and, therefore, require energy in the form of heat input. The reactions are also catalyzed in order to speed up the reaction rates and maximize reformer efficiency.

Two major features distinguish the MIDREX natural gas reforming process from conventional steam reforming processes.

Conventional steam reforming uses an excess amount of steam as well as high operating pressure to reform the hydrocarbons. Consequently, the reformed gas from the steam reformer must be quenched to remove the excess steam and then reheated. Reheating reformed gas is difficult because at between 600°C and 700°C, reformed gas will aggressively attack the tube materials of the reheater; this process is called "metal dusting".

The MIDREX Reformer produces a reformed gas without excess steam and, consequently, avoids the "metal dusting" and decarburization problems experienced in plants using reformed gas reheaters. Most plants with these reheaters must use a costly sulfur injection to protect the reheater tubes and achieve an acceptable tube life.

The MIDREX reforming process recycles spent reducing gas to the reformer, unlike steam reforming, and thereby reforms both CO2 and H2O. Recycling results in more efficient recovery of unreacted reductants still present in the spent reducing gas stream, without additional processing equipment. About one-half of the total volume of CO/H2 in the reducing gas to the shaft furnace comes from the recycled spent reducing gas, thus reducing the quantity of CO/H2 generated by the reforming of natural gas.

The MIDREX Reformer is a refractory-lined, gas-tight structure which contains vertically suspended heat resistant alloy tubes filled with catalyst and arranged in the fired box in six parallel rows. For ease of installation, the reformer is constructed of modules called "bay".

The reformer tubes are supported at the roof and expand downward through the shell of the reformer. The bottom of each tube is sealed with a flexible expansion seal to prevent air infiltration into the combustion zone of the reformer.

Thirty tubes constitute a so-called reformer "bay" which includes the tubes, required burners, ducting and support steel structure. An arrangement of identical bays along the longitudinal axis of the reformer is the general design for the reformer, and 19 bays will be required to achieve the production of 183.3 metric tons per hour of HBI with the specified natural gas.

Preheated feed gas, a mixture of scrubbed and compressed process gas, low pressure steam, and natural gas, enters the bottom of each reformer tube and flows upward through the static catalyst bed. The natural gas is stoichiometrically reformed with carbon dioxide and water contained in the feed gas stream to produce a hot hydrogen and carbon monoxide containing gas.

The reformed gas exiting from three headers (each tied into two rows of reformer tubes) is collected into a single refractory lined duct that supplies the reducing gas directly to the bustle of the reduction shaft furnace.

7.2 MIDREX Direct Reduction Process (continued)

Heat for the reformer is supplied by the main burners, which are located on the bottom of the reformer box between tube rows and between the outside tube rows and the reformer wall. The fuel for the main burners is a mixture of natural gas and excess spent reducing gas which has been cleaned and cooled in the top gas scrubber to produce top gas fuel.

The required air for combustion of the main burner fuel mixture is supplied by the main air blower. This air is first preheated in the heat recovery system before being sent to the burners.

Natural gas fired auxiliary burners serve to maintain reformer box temperature when the plant is in an idle mode of operation so as to minimize both restart time and thermal cycling of the reformer tubes.

Flue gas is withdrawn from the reformer box in two flue gas headers arranged along the upper parts of both longitudinal walls of the reformer. To ensure uniform heat distribution along the reformer length, each reformer bay has a separate sized flue gas port to each of the flue gas headers.

These flue gas ports are located in the sidewall sections of every bay directly below the reformer roof. The flue gas headers are refractory lined and expansion joints are provided between the single sections of the headers to compensate for thermal expansion. Also, to permit thermal expansion, the reformer structure is anchored at its center and allowed to expand freely in either direction.

Finally, the flue gas existing the reformer box via the flue gas headers flows to the heat recovery system where the waste heat is recovered.

SECTION 8.0

FEED MATERIALS SUPPLY

8.1 Background

The Pre-Feasibility Study Report (Appendix I) identified two iron ore deposits which could be developed as a source for feed materials for the DR Plant. They are:

- Quy Xa deposit in Lao Cai Province with a reserve of 120 million metric tons of Limonite ore @ 54 percent iron of which 100 million metric tons is minable.
- Thach Khe deposit in Ha Tinh Province with a reserve of 544 million tons of Magnetite @ 61.5 percent iron with low percentage of sulphur and phosphate of which 375 million metric tons is minable.

The Thach Khe deposit which is located on the sea coast was considered the most viable source for feed materials.

Based on initial surveys conducted by Vietnamese geologists of the Thach Khe mine, a consortium consisting of Krupp of Germany, Genecor of South Africa, Mitsubishi of Japan and the VSC began its Feasibility Study in October 1995 to examine the mine deposit and its commercial exploitation.

After 2 years of detailed exploration and study, the consortium arrived at a conclusive evidence that the resource body was not economically viable enough to mine. The deposit contained an unacceptable high zinc content, which is a complication in current steel-making processes, and would make it virtually impossible to market. Moreover, the study indicated an increased geological and chemical variability, increased structural complexity and decrease in mineral resource of the deposit. Unless new technologies in the future can enable Vietnam to take advantage from the natural resources at Thach Khe, the availability of feed materials in-country is considered not feasible.

8.2 Characteristics of Feed Material

The major raw material required for the operation of a DR plant is iron oxide in the form of either lump ore or pellets. DR plants in different parts of the world have tried various combinations of iron oxide feed, ranging from 100 per cent pellets to 100 per cent lump ore, as well as a mixture of the two. However, for the production of HBI, a minimum of 20 per cent

8.2 Characteristics of Feed Material

lump iron ore (preferably 30 per cent) should be used in the feed mix to ensure a desirable briquette quality.

Different sources of oxide feed have been tried in DR plants in order to arrive at the most optimum combination of oxide pellets and lump iron ore for a particular plant, depending upon its operating parameters and economic considerations.

For the purpose of the Feasibility Study, a feed mix of 50 per cent pellets and 50 per cent lump iron ore has been considered for the base case and sensitivity analyses for other feed mixes have been performed.

Selection of the iron oxide feedstock suitable for DR processes involves an evaluation of both the chemical and physical characteristics of the raw material feed as well as the reduction characteristics, such as the reducibility, clustering tendency, fragmentation and product strength.

- **Chemical Characteristics**

  The chemical characteristics of oxide feed acceptable for the MIDREX process is shown as follows:

Constituent	Per Cent
Fe	66.0 (min.)
SiO_2	2.0 (max.)
Al_2O_3	1.8 (max.)
S	0.01 (max.)
P(1)	0.03 (max.)
Cu(1)	0.03 (max.)
TiO_2	0.35 (max.)

Note:
(1) These constituents are typical for steel-making requirements.

Other than the sulphur and TiO_2 content, the other chemical constituents indicated above do not affect the DR process, but have an influence on the subsequent steel-making process.

8.2 Characteristics of Feed Material (continued)

Typical chemical analyses of some of the oxide feed used in Midrex DR plants are given below:

Source of Supply	Fe (%)	$SiO_2+AL_2O_3$ (%)	P (%)	S (%)
Pellets				
LKAB, Sweden	67.4	1.20	0.020	0.006
CVRD, Brazil	68.2	1.57	0.020	0.002
Samarco, Brazil	67.6	2.15	0.030	0.005
Kudremukh, India	67.2	2.95	0.020	0.004
GIIC, Bahrain	67.4	1.85	0.030	0.003
SIDOR, Venezuela	66.7	2.10	0.050	0.011
CMP, Chile	67.6	1.96	0.022	0.004
Hierro Peru, Peru	67.4	2.16	0.010	0.005
Alzada, Mexico	66.8	2.37	NA	0.005
Lump Ore				
Ferteco, Brazil	68.0	1.60	0.050	0.060
Mutuca, Brazil	68.3	1.70	0.050	0.006
Mt. Newman, Australia	67.0	2.75	0.027	0.011
San Isidro, Venezuela	68.7	1.53	0.050	0.016
Sishen, South Africa	66.6	3.97	0.037	0.007
Bailadila, India	67.5	2.70	0.04	0.008

- **Physical Characteristics**

For the DR process, the physical properties and reduction characteristics of the oxide feed are of more importance than its chemical characteristics. The acceptable physical and reduction characteristics of DR-grade oxide feed used in the MIDREX process are outlined in Section 11.0, Design Basis, Subsection 11.3.3.

8.3 Global Demand and Availability of DR-Grade Oxides

The present installed capacity of gas-based DR plants worldwide is estimated at about 46 million tons. Considering an average specific consumption of about 1,500kg of iron oxide feed per ton of DRI, the global demand for DR-grade oxide feedstock is around 69 million tons per year.

As against the above demand, the current pelletizing and lump ore mining capacity worldwide is around 98 million tons per year.

8.3 Global Demand and Availability of DR Grade Oxides (continued)

Salient details of plants producing DR-grade pellets, as well as resources of DR-grade lump iron ore, are given in the following tables:

WORLD SITUATION ON DR-GRADE IRON ORES

Source	Country	Capacity (mty)
NMDC - Donimalai	India	1.2
NMDC - Bailadila	India	3.9
MCR - Corumba	Brazil	1.5
Samitri - Sabara	Brazil	0.7
Ferteco - Congontas	Brazil	3.0
MBR - Minas Gerais	Brazil	2.5
ISCOR - Sishen	South Africa	1.0
Ferrominera - Puerto Ordaz	Venezuela	2.5
Total		**16.3**

Sources: 1) Iron Ore Manual, The Tex Report Co. Ltd., 1999-2000
2) World Direct Reduction Statistics, Midrex - 1999

8.3 Global Demand and Availability of DR-Grade Oxides (continued)

PLANTS PRODUCING DR-GRADE PELLETS		
Source	**Country**	**Capacity (mty)**
BHP	Australia	5.5
GIIC	Bahrain	4.0
OEMK	Russia	2.4
LKAB	Sweden	8.1
Mandovi	India	0.7
KIOCL	India	1.0
ESSAR	India	3.3
Khouzestan Steel	Iran	5.0
MSCO-Mobarekh	Iran	4.5
CVRD	Brazil	5.2
SAMARCO	Brazil	6.0
IOC	Canada	2.5
QCM	Canada	4.0
CMP	Chile	1.5
Pena Clorada	Mexico	3.5
HYLSA	Mexico	1.8
Las Encinas	Mexico	1.5
IMEXSA	Mexico	3.5
Benito-Suarez	Mexico	3.0
Sicartsa	Mexico	1.8
Hierro Peru	Peru	3.4
CVG-Ferrominera	Venezuela	3.3
SIDOR	Venezuela	6.4
Total		**81.9**

Sources:
1) Iron Ore Manual, The Tex Report Co., Ltd., 1999-2000
2) World Direct Reduction Statistics, Midrex - 1999
3) Internet Site

8.4 Iron Ore Resources in Vietnam

The available reserves of iron ore in Vietnam have been outlined in the Master Plan prepared by VSC. Salient details of these mining reserves are presented below:

Source	Province	Avg. Fe Content	Proved Reserve	Grade
Quy Sa	Yen Bai	42-55	110	Limonite
Trai Cau	Bac Thai	46-52	9	Magnetite
Tien Bo	Bac Thai	27-53	19	Limonite
Na Rua	Cao Bang	60 (min)	40	Magnetite
Ban Lung	Cao Bang	44-47	10	Magnetite
Tong Ba	Ha Giang	42-46	140	Hematite
Thach Khe	Ha Tinh	60-70	554	Magnetite

It will be noted from the above that there are seven (7) iron ore mines in Vietnam, with total proven reserves of close to 900 million tons. Of these, four (4) mines contain magnetite iron ore, with reserves aggregating about 610 million tons.

Only the Trai Cau mine in Bac Thai Province has so far been exploited. This mine is owned and operated by Thai Nguyen Steel Corporation, and is a captive source of supplies to the Thai Nguyen steel mills.

8.5 Probable Supply Sources

In absence of in-country sources of feed materials, presently 100 percent DR-grade pellet and lump iron ores will be imported for the Plant production.

The procurement source of feed materials mainly depends on the geographical proximity of the plant location with respect to the sources of pellets and iron ore and their qualities. The worldwide availability of DR-grade pellets and lump ores have been discussed earlier. Operating MIDREX plants located in southeast Asia, South Asia and the Gulf region procure DR-grade pellets from various sources and are listed in the following table. Also, most of these MIDREX plants source the lump ore either from Bailadila in India or Mutuca in Brazil.

8.5 Probable Supply Sources (continued)

PRESENT SOURCING POINTS OF PELLETS OF OPERATING MIDREX PLANTS			
Region	**Country**	**Name of Plant**	**Major Pellet Source**
South-East Asia	Malaysia	AMSTEEL	CVRD, Samarco
South Asia	India	ESSAR	Captive(1)
		IIL	GIIC, MPL, KIOCL
The Gulf	Qatar	QASCO	LKAB, CVRD, GIIC
	Saudi Arabia	HADEED	LKAB, CVRD, Samarco, GIIC
	Iran	MSCO	GIIC, MSCO, ASCO
		KSC	ASCO

NOTE:

(1) Since 1997, 1.5 mtpy DR-grade pellet from captive source is consumed in the plant.

For the proposed project in Vietnam, based on availability and geographical proximity, the following are considered to be the potential sources of supply of pellets and lump ores:

Pellets:

- GIIC, Bahrain
- CVRD, Brazil
- Kudremukh, India
- ESSAR, India

Lump Ores:

- Bailadila, India
- Mutuca, Brazil

Several discussions have been held with the potential feed materials suppliers from various countries for consideration of a long-term supply contract and in establishing delivered prices of feed materials in Vietnam. GIIC, ESSAR and Bailadila have already evinced keen interest for supplying the respective feed materials for the proposed project. Close interaction in this regard is also in progress with the other suppliers of pellets and lump ores. However, a long-term supply contract with the respective suppliers needs to be established soon after completion of the F/S.

SECTION 9.0

UTILITIES

9.1 General

The plant will be located in a developing industrial area named Cai Mep Industrial Zone. All utilities to the project site will be brought to the northeast corner as part of development of the Industrial Zone. A report (Appendix VI) has been prepared by THIKECO which addresses all utilities sources of the site. The following sub-sections outline the availability and details of the following utilities:

- **Gas**
- **Electricity**
- **Water**

9.2 Gas Supply

The existing gas supply network in the vicinity is from Bach Ho (white tiger) field of the Cuu Long Basin. A 400 mm diameter, 115 km long pipeline from the field brings wet gas to a Gas Processing Plant, which transmits an average 4 million metric tons per day dry gas (via 245 mm diameter pipe) to the Bach Ho Distribution Plant in Phu My I Industrial Zone. This gas is mostly used for power generation. The existing gas supply capacity may not be adequate for further industrial development of the area.

The Lan Do and the Lan Tay gas fields in the Nam Con Son Basin area, which were discovered in 1992–1993, will provide the gas source for the Cai Mep Industrial Zone. The estimated reserve of their two gas fields, which are separated by 25 km, is 58 billion cubic meters. Good quality of gas with high methane content and low condensate levels is expected from these fields. The planned capacity of the pipeline system is 5-6 billion cubic meter per year (average). The pipeline system will include:

- 650 mm diameter, 372 km long, pipeline from the gas field to the existing Gas Processing Plant.

- 750 mm diameter, 28 km long, pipeline from the Gas Processing Plant to a new Nam Con Son Gas Distribution Plant located near the existing Bach Ho Distribution Plant.

9.2 Gas Supply (continued)

The Cai Mep Industrial Zone is planned to be served by gas from Nam Con Son pipeline. The first gas production is scheduled in the year 2001.

The average composition of gas in the basin is shown in the following table:

Composition	Lan Tay field (Mol %)	Lan Do field (Mol %)
Methane (C1)	88.5	93.9
Ethane (C2)	4.3	2.3
Propane (C3)	2.4	0.5
Iso-butane (iC4)	0.6	0.1
Butane (C4)	0.6	0.1
Condensate (C5+)	1.4	0.2
N2	0.3	1.6
CO2	1.9	1.2
H2S (ppm)	<10	traces

The heating values of crude gas of both Lan Tay field and Lan Do field are shown in the following table:

Composition	Lan Tay field		Lan Do field	
	BTU/ft3	MJ/ft3	BTU/ft3	MJ/ft3
Total Heating Valve	1,200	45	1,080	40
Actual Heating Valve	1,090	41	980	37

It should be noted that the heating value of commercial gas will depend on the separation of the condensate and other components, and also depend on the influence of the mixing of additional gas from other sources into the common system in the future. If all condensate will be separated, the total heating value of dry gas is estimated to be about 1,100 BTU/cubic feet. The crude gas will be treated into dry gas considering the market demand and the design of the total system.

The Gas price, as established by the Vietnam Government, Ministry of Planning and Investment, is US $1.75 per one million BTU for the HBI plant.

9.3 Electricity Supply

Power in the vicinity of the site is supplied by Electricity Department of BaRia – Vung Tau Province.

The existing power supply grid and the planned power grid of Ba Ria – Vung Tau Province related to the Industrial Zones are outlined in the THIKECO's Report on Utilities Sources of the Site (Appendix VI). Power source for the Cai Mep Industrial Zone will be from Phu My Power Plant by 110 kV Line (planned) running along National Road 51. In the interim, power supply to the site will be from Go Dan – Phu My 22 kV line which will be ready in 1999. There will be a diesel generator plant to supply power to industrial zones facilities when National electricity network failures occur. Power will have 50 Hertz frequency.

The electricity tariff for production activities in industrial zones varies with usage. Normal energy usage rate including capacity changes is US $ 0.068 cents per kWh for 110kV and above power and US $ 0.073 per kWh 22 kV power.

9.4 Water Supply

Water supply to the site will be provided by the Water Supply Company of BaRia – Vung Tau Province.

The existing network and the planned network of water supply of the province through year 2010 are outlined in the THIKECO's Report on Utilities Sources of the Site (Appendix VI). Water to the Cai Mep Industrial Zone will be supplied from the 300 mm pipe line from Phu My new city located next to National Road 51.

Water usage supply to the plant fence line will be taken from the main distribution pipeline (150-200 mm diameter) next to the main road of the industrial development. Water rate for industrial production activities is US $ 0.32 cent per cubic meter. Main characteristics of water quality is:

• pH	6.5 – 8.5
• Total Hardness as CaCO3	500 mg/L (maximum)
• Chlorides as NaCL	400 mg/L (maximum)
• Total Dissolved Solids	500 mg/L (maximum)
• Sulfates	400 mg/L (maximum)
• Suspended Solids	5 mg/L (maximum)
• Turbidity	1.0 NTU (maximum)

SECTION 10.0

ENVIRONMENTAL ASSESSMENT

10.1 General

A Preliminary Environmental Assessment has been undertaken as part of the Feasibility Study for the 1.43 million metric per year Direct Reduced Plant producing HBI product. The EA has identified the regulatory policies and guidelines applicable to the design and review of the Project. Appendix VII contains the complete Report.

10.2 Project Description

The Plant will be located on 500,000 m^2 of predominately undeveloped mangrove forest land in Ba-Ria Vung Tau Province, Vietnam. The site is part of an area planned as a future Industrial Zone.

In addition to the Plant, onsite project services will have to be brought from offsite areas. These will include: electric supply; industrial water supply; river cooling tower makeup water; vehicle transportation access; ship or barge access; and a natural gas pipeline. Raw iron ore and pellet products will be shipped to the site from other countries and finished products will leave the site by ship.

During construction, an average of 900 workers will be employed and the construction workforce will peak at approximately 1500. It was believed that a construction camp may not have to be developed for the workers, since it is reported by the local contractors that sufficient housing and services currently exist to support the workforce in the area.

Alternative analyses to the project proposal have considered other technologies and options during the Pre-Feasibility Study. These assessments are documented in a report by Heffernan International, a consultant to the Iron and Steel Industry (Appendix I).

Background environmental and social data were provided by the Environmental Technology Centre of Vietnam. The site region is classified as Tropical Monsoon with mean monthly temperature greater than 18°C. There is a well defined wet and dry season. The air quality of the site area is good because of its sparse development.

10.2 Project Description (continued)

Several small communes are located 5 to 15 km northeast and east of the site. They mostly lie along the National Highway Route 51. The population of each ranges from about 4,000 to 17,100. Predominate occupations are fishing and agriculture. No residences are located on site and there is no known displacement required for the project to proceed. No known cultural resource will be affected by the project.

10.3 Observations

Project definition is incomplete in some areas, but many observations can be made. The EA has identified the following:

- For the emission sources identified, air quality impacts will be less than ambient guidelines.
- Up to 500,000 m^2 of undeveloped mangrove will be filled with the loss of associated habitat.
- Additional unidentified lands will be disturbed to provide soil borrow for site fill operations and land for an engineered landfill will be needed for the disposal of process waste products.
- A number of infrastructure and utility improvements will be needed, including electric supply, (fresh) industrial water, sanitary sewage treatment, natural gas supply, access roads, port facility, worker housing especially during construction.
- No displacement of residences has been identified.
- A construction workers' housing village may not be needed due to close proximity of the selected site to established towns and national highway.
- Wastewater discharges will have minor impacts with adequate treatment.
- There is no anticipated impact of noise on residences due to the isolation of the site.

No assessment can be made of the cumulative impacts of this Project and other development planned for the Cai Mep Industrial Zone.

SECTION 11.0

DESIGN BASIS

11.1 General

This section outlines the basic design criteria to be followed for the Plant design. The following main features define the overall project:

• **Core Plant**	The MIDREX MEGAMOD™ HBI Process Plant.
• **Material Handling System**	Systems for receiving, storing, transporting, and delivery of materials.
• **Port Facility**	Facility for receiving feed materials and the shipment of finished products.
• **Balance Of Plant**	Support facilities and ancillary systems to the Core Process Plant including all required infrastructures for operation of the Plant.

Section 5.0 - "Project Description" of this Report describes these features in detail.

11.2 General Design Standards and Specifications

All systems, components and structures will be designed and constructed to comply with all applicable standards, codes and regulations initiated and issued by national engineering societies, associations, institutes and agencies, as further described herein.

In addition to the above, the work shall comply with all applicable local (Vietnam) codes, standards and regulations, having jurisdiction in the area where the equipment or work will be installed.

11.2 General Design Standards and Specifications (continued)

In case of differences between local building codes (including standards) and any other referenced specifications, standards, and manuals, the requirements of local codes shall prevail, unless indicated otherwise.

11.3 Core Plant

MIDREX will design the Core Plant and supply equipment in accordance with MIDREX's standard practices based on MIDREX's specialized experience.

11.3.1 Codes and Standards

Refer to Section 4.1. of the MIDREX Technical Specification (Attachment VIII).

11.3.2 Plant Capacity

The Core Process Plant capacity will be based on:

• Reaction Module	MIDREX MEGAMOD™
• Type of Product	Hot Briquetted Iron
• Product Specification	93% metallization 1.2 – 1.8% carbon
• Rated Hourly Production Capacity	183.3 t (+6 mm)
• Net Annual Operating Time	325 days/year (7,800 hours/year)
• Scheduled Downtime	20 days/year
• DR-grade Oxide Feed Materials	90% CVRD, LKAB, or Samarco and Others Pellets; 10% MBR Lump Ores
• Daily Operating Mode	Continuous

11.3 Core Plant (continued)

11.3.3 Iron Oxide Feed

The design of the Core Process Plant will be based on oxide feed materials as outlined in Paragraph 11.3.2, which are typically screened to (+) 6mm~ (-) 40mm.

Requirements for the DR Grade Pellets and lump ore for use in the MIDREX Process will be as follows:

a. *Physical Characteristics*	*Lump*	*Pellets*
• Average Cold Strength	N/A	250 kg/pellet min.
• Tumble Index	90% min. (+) 6.73 mm	94% min. (+) 6.73 mm 5% max. (-) 0.5 mm
• Abrasion Index	N/A	4% mean (-) 0.5 mm
• Bulk Density	2.0~2.3 metric ton/m^3	2.0~2.3 metric ton/m^3
• Size Distribution	4% max. 44 ~ 50 mm 94% min. 6 ~ 44 mm 4% max. (-) 6mm	4% max. 18 ~ 50 mm 94% min. 8 ~ 18 mm 4% max. (-) 6mm
• Porosity	N/A	28% min.

11.3 Core Plant (continued)

b. *Chemical Charateristics*	*Lump*	*Pellets*
• Fe (total)	67% min.	67% min.
• SiO2 & A1O3	2.5% max.	2.5% max.
• CaO & MgO	0.01 – 0.1%	0.4 – 1.2%
• P*	0.04% max.	0.03% max.
• S**	0.015% max.	0.010% max.
• H2O	3.0% max.	3.0% max.
• L.O.I	1.0 – 2.0% max.	--
• Fe++	1.0% max.	1.0% max.

(*) Characteristics are typical steelmaking requirements
(**) Maximum feed percentage will be limited if sulfur release of a particular iron ore causes H_2S in reformer feed gas to exceed 5 ppmv.

c. *Reduction*	*Lump*	*Pellets*
• MIDREX Linder Test (760°C)	92% metallization min.	93% metallization min.
• MIDREX Linder Degradation	5% max. (-) 3.36 mm	2% max. (-) 3.36 mm
• Compression Strength	N/A	90 kg/pellet min.
• Fines Formation (Tumbling) of (+) 6.3 mm Metallized Material	80% min. (+) 6.73 mm	85% min. (+) 6.73 mm
• MIDREX Hot Load Test (816°C)	94% metallization min.	94% metallization min.

11.3 Core Plant (continued)

• MIDREX Hot Load Degradation	5% max. (-) 3.36 mm	2% max. (-) 3.36 mm
Clustering (Hot Load Test) (after 10 revs. in tumble drum)	0% (+) 25 mm	0% (+) 25mm

11.3.4 Natural Gas

The Core Process Plant design and natural gas consumption estimate will be based on the following expected natural gas quality:

• Design analysis	Expected range (molar basis)
- CH4	88.5 ~ 93.9%
- C2H6	4.3 ~ 2.3 %
- C3H8	2.4 ~ 0.5%
- i-C4H10	0.6 ~ 0.1 %
- n-C4H10	0.6 ~ 0.1 %
- C5+	<0.3%
- N2	0.3 ~ 1.6 %
- CO2	1.9 ~ 1.2 %
- S as H2S	<10 mg/m3

• Service	Uninterrupted
• Design Rate	60,000 to 65,000 Nm3/h
• Pressure	45 bar gauge

The natural gas feed to the Plant will be first treated in a Coalescent Filter to remove entrained liquids. Based on the above analysis, no pretreatment of the natural gas is required for the removal of sulfur or heavy hydrocarbons.

11.3 Core Plant (continued)

11.3.4 HBI Product

The quality of the HBI produced in the plant is substantially dependent upon the iron oxide feed. Based on MIDREX experience and on the iron oxide feed specifications stated above, typical properties are expected to be as follows:

a. *Metallization*

- 93 percent of the total iron will be in the metallic form

b. *Chemical Analysis*

- Total Iron — approximately 92 percent
- Carbon — 1.2 ~ 1.8 percent

The gangue constituents and trace elements will be relatively unaffected by the Direct Reduction process, but will show a percentage increase due to oxygen removal from the iron oxide, which decreases the mass of the HBI product.

c. Physical Properties

• Apparent Density	5.0 ~ 5.5 g/cm3
• Bulk Density	2.4 ~ 2.7 t/m3
• Nominal Size	120 mm x 50mm x 30mm
• Nominal Volume	120 cm3
• Size Distribution	6 ~ 299 mm (96.0% min.)
• Under 6 mm	4.0% max
• Tumble Index	(-) 6mm = 2% or less

11.3.5 Electricity

Electric Power required for operation of the Core Process Plant will be supplied at the Core Process Plant Battery Limits at 22 kV. The Core Plant includes a substation to distribute and reduce the incoming power to the required voltage levels as further described in Section 5.0 of the MIDREX Technical Specification (Appendix VIII).

11.3 Core Plant (continued)

11.3.7 Industrial Water

Industrial water shall be supplied to the Plant at approximately 35° C and shall have the following characteristics:

- Composition

- Turbidity	1.0 NTU max.
- Total Hardness as $CaCO_3$	500 mg/L max.
- Chlorides as NaCl	400 mg/L max
- Total Dissolved Solids	500 mg/L max
- Sulfates	400 mg/L max.
- Suspended Solids	5 mg/L max.
- pH	6.5 ~ 8.5

• Design Rate	100 m3/h
• Service	Uninterrupted

11.3.8 Core Process Plant Battery Limits

The Battery Limits of the MIDREX Core Process Plant utilities, feed and product streams, are delineated in Paragraph 5.0 of the MIDREX Technical Specification (Appendix VIII).

11.4 Material Handling Systems

11.4.1 Codes and Standards

The following codes and standards will be used in the design, manufacture, inspection, and testing of the material handling system.

• Bearings	ANSI B3.15 and B3.16
• Conveyor systems	CEMA
• Electrical and instrumentation	NEMA, NEC, ISA
• Fire resistant belting	MSHA
• Gears and gear systems	AGMA

11.4 Material Handling Systems (continued)

• Lubricants	AGMA, ASTM
• Materials	ASTM, ASME, AISI
• Safety	OSHA
• Welding (General)	AWS

11.4.2 Site Conditions

• Temperature	Minimum average ~ 20°C Maximum average ~ 39°C
• Ambient humidity	70 ~ 90% relative humidity
• Seismic zone	Zone 1
• Highest wind recorded	30 m/s, July 1972

11.4.3 Material Characteristics

a. *Iron Ore*	*Direct Reduction Grade, MBR Lump Ore*	*Direct Reduction Grade, CVRD Pellets and Others*
• Percentage of Throughput	10 %	90 %
• Annual Tonnage	250,000 t	2,250,000 t
• Bulk Density	2.0 ~ 2.3 t/m^3	2.0 ~ 2.3 t/m^3
• Tumble Index	90% min. (+) 6.73 mm	94% min. (+) 6.73 mm 5% max. (–) 0.50 mm
• Abrasion Index	N/A	4% mean (–) 0.50 mm
• Size Distribution	4% max. 44 ~ 50mm 94% min. 6 ~ 44mm 4% max. (-) mm	4% max. 18 ~ 50 mm 94% min. 8 ~ 18 mm 4% max. (-) 6 mm
• Porosity	N/A	28% min.

11.4 Material Handling Systems (continued)

b. *Hot Briquetted Iron*

• Bulk Density	2.4 ~ 2.7 t/m^3
• Briquette Size	120 mm x 50 mm x 30 mm
• Nominal Volume	120 cm^3
• Abrasion	Extremely Abrasive
• Size Distribution	96% min. 6 ~ 299 mm 4% max. under 6 mm
• Tumble Index	(-) 6 mm = 2% or less

c. *Bulk Densities of Materials for Design*

	Density for Volumetric Design kg/m^3	*Density for Structural Design kg/m^3*
• Pellets	2100	2300
• Ore	2100	2300
• HBI Briquettes	2600	2700
• Ore Fines	2100	2300
• Pellet Fines	2100	2300
• Remet (unfinished product)	1500	1700
• HBI Fines	2500	2700

11.4 Material Handling Systems (continued)

11.4.4 Ship Unloading and Loading

a. *Receiving Berth*

• Unloading Rate	2000 t/h
• Annual Capacity	2,500,000 t
• Ship Size	70,000 t capacity, Panamax Vessel
• Ship Draft	14 m
• Material to be Unloaded	DR Grade Pellets & Lump Ores

b. *Shipping Berth*

• Loading Rate	1000 t/h
• Annual Capacity	1,430,000 t of HBI
• Ship Size	10,000 – 25,000 t capacity normally used, boom must be able to load a 30,000 t capacity vessel
• Ship Draft	up to 14 m
• Material to be Loaded	HBI and Oxide Fines

11.4 Material Handling Systems (continued)

11.4.5 Design Conveying Rates/Storage Capacity

• Peak transfer rate from Wharf to Oxide Storage Pile	2,000 metric t/h
• Peak transfer rate from Oxide Storage Pile to Screening	1,000 metric t/h
• Peak feed rate to Day Bins	1,000 metric t/h
• Peak feed rate to Reduction Furnace	400 metric t/h
• Peak transfer rate, HBI to Storage	500 metric t/h
• Peak loading rate, HBI storage to Ship Loader	1,000 metric t/h
• Iron Oxide Storage Piles	350,000 t
• Day Bin storage capacity	2,500 t/each
• HBI Storage Pile capacity	100,000 t

11.5 Port Facility

11.5.1 Codes and Standards

The design and layout of the Port Facility will be in general, in accordance with:

a. *Vietnamese Codes*

• TCN 219	Design of Seaport
• TCVN 2737	Loads and Impacts
• 22 TCN 222	Loads and Impacts caused by waves and ships

11.5 Port Facility (continued)

a. *Vietnamese Codes* (Continued)

• TCN 21	Standard for the Design of Pile Foundations
• TCN 4116	Reinforced Concrete Structures of Off-Shore Works

b. *International Codes and Standards*

• ACI 318	Building Code Requirements for Reinforced Concrete
• AASHTO	Standard Specification for Highway Bridges
• AWS D.1.1	Structural Welding Code
• BS 6349	Code of Practice for Marine Structure
• BS 8004	Code of Practice for Foundation
• BS 8081	Code of Practice for Ground Anchors

11.5.2 Design Criteria

a. *Design Life*

The structural system of the Port facility, comprising of the structural steel and concrete elements, will be designed for a minimum life of 30 years. This will be achieved by the use of a cathodic protection system and the combination of a protective coating system and a corrosion allowance on all steel members, adequate cover of high quality concrete to all steel reinforcement, and a preventive maintenance program, carried out during the Operations, to identify problem areas and rectify them before serious deterioration can occur.

11.5 Port Facility (continued)

11.5.3 Design Criteria

b. Corrosion Allowance

All exposed steel structural elements above Low Low Water Level will be designed with a 2mm corrosion allowance deducted from the outer exposed face.

c. Design Vessels

The berth will accommodate fully laden ore carriers ranging in size. Dedicated vessels of 70,000 DWT will use the berth on a regular basis, and all berthing and mooring facilities will be designed to cater to these vessels.

d. Dredging Requirements

Since usage of the berth will be limited to vessels of 70,000 DWT, the berth pocket on either side of the platform will be dredged to a clear depth of 15.10 m below LLWL at the Cai Mep Port (LLWL-2.90 m). The design of the berth structure will allow a maximum of 1.0 m overdredging below this depth.

e. Berthing Conditions

The following berthing conditions will be used for normal berthings:

- Vessel approach velocity — 0.1 m/s – 0.15 m/s
- Vessel approach angle — 10° maximum
- Vessel eccentricity — ¼ point berthing

f. Design Loadings

- Continuous Ship Unloader/Ship Loader
  - 955 metric tons plus 660 metric tons for counterweight
  - 32 x 710mm diameter wheels (8 per leg) loaded at 60 metric tons per wheel

11.5 Port Facility (continued)

f. *Design Loadings (Continued)*

- 18.5m span (transverse direction) and 15.0m span (longitudinal direction)

- Conveyor Loadings - Conveyor system w/crossover walkways total loading ~ 500kg/m^2.
- Utility Corridor - total loading ~ 800kg/m^2
- Transfer lower - total loading ~ 1000kg/m^2
- Vehicle loadings
  - Vehicles are Caterpillar – 988 series II type wheel loader, operating weight ~ 50000kg.
- Live loadings - minimum live load ~ 4880 kg/m2

g. *Environmental Loads*

- *Wind Loadings*

  The wind climate in the vicinity of the proposed port is quite mild for most of the year. However, the site has experienced severe tropical rotating storms (cyclones). The structures will be designed for the following design wind velocities:

  - The largest velocity (1%) 38 m/s
  - The largest velocity (2%) 36 m/s

  Due to the deficiency of the AASHTO Bridge Code in regard to cyclonic wind, the Australian Wind Code, AS1170 Part 2, will also be used to evaluate wind forces on the structures where necessary.

- *Wave Loadings*

  A hindcast analysis to estimate the normal wave climate at the site has been carried out for the prevailing winds, but not for the cyclonic winds, which generate much larger waves.

11.5 Port Facility (continued)

- *Wave Loadings (continued)*

  Preliminary estimates indicate maximum wave heights during cyclones would vary between 2.0 and 3.5 m, depending upon the bottom friction co-efficient. A more accurate estimate of the expected wave heights could be made if the model was calibrated by comparing predicted wave heights against satellite readings of wave events, but this has not been carried out.

  For the design of the marine structures, the following wave parameters will be used.

-	Maximum wave height (3 %)	1.8m
-	Wave period	7.0s
-	Wave direction quadrant	East to South

- *Tides*

  Tidal information pertaining to the Cai Mep Port, adjacent to the site of the Port, is as follows:

-	Max. High Water Level (est.) (1%)	(+) 1.80 m
-	Mean Sea Level	(-) 0.23 m
-	Lowest Water Level (1%)	(-) 2.90 m

  (All elevation depths refer to Hon Dau Datum)

- *Currents*

  Information pertaining to tidal currents at the site of the Port is as follows:

-	Maximum flood tide velocity	1.8 m/s
-	Maximum ebb tide velocity	2.0 m/s
-	General current direction	North - South

h. *Seismic Loads*

The site of the proposed Port is not in a recognized seismic area. However, a minimum horizontal static load equal to 5 percent of the gravitational acceleration will be used.

11.5 Port Facility (continued)

11.5.4 Material Specifications

- All tubular steel piling shall conform to JIS – 1998, Grade 3, with a minimum yield stress of 345 MPa.
- All prestress reinforcing steel shall be low alloy deformed bar to AS 3600 – 1988 with a minimum yield stress of 1750 MPa.
- All other structural steel shall conform TCVN, with the minimum yield stress of 270 MPa.
- All structural concrete shall have a minimum compressive strength (cylinders) at 28 days of 40 MPa, with the minimum of 460 kg/m^3 of Type 2 cement (or equivalent) to ASTM C150.

11.5.5 Geotechnical Considerations

a. *Soil Profile*

The basic geotechnical information was derived from the "Report of Geotechnical Investigations "(Appendix V)".

The test drilling program included a number of boreholes (K1, K3, K4) to investigate for the port foundation.

b. *Allowable Pile Load Capacity*

Based on sample geotechnical parameters from the drilling reports, the allowable pile load capacity for four lengths of 600mm diameter pile are assumed as follows:

50m length	167 tons compression	44 tons tension
55m length	396 tons compression	76 tons tension
57m length	437 tons compression	104 tons tension
60m length	520 tons compression	162 tons tension

Assumed capacity of piles will be verified by load tests during construction.

11.6 Balance Of Plant

11.6.1 Utility systems

a. *Cooling Water System*

- *System Design Basis*

The cooling water system will be designed to remove heat from the Core Process Plant Process Cooling Water System and the Machinery Cooling Water System through a series of plate and frame heat exchangers. The circulating cooling water is cooled in a mechanical draft cooling tower. A side stream filter will remove suspended particles from the circulating cooling water to control the sediment build-up inside the cooling water system. Biocides, corrosion inhibitor, dispersant and acid, are injected into the water to control the water chemistry. Makeup water to the system will compensate for evaporation and blowdown losses and is pumped from the Cai Mep River at the wharf intake system to the cooling tower basin.

- *Standards and Specifications*

Applicable Stardards and specifications of the following national organizations will be followed:

- American Concrete Institute
- American Gear Manufacturer's Association
- American National Standards Institute
- American Society of Civil Engineers
- American Society of Mechanical Engineers
- American Society for Testing and Materials
- Anti-Friction Bearing Manufacturer's Association
- Cooling Tower Institute
- Hydraulics Institute Standards
- Institute of Electrical and Electronics Engineers
- International Electrical Commission
- National Electrical Code
- National Fire Protection Association
- Occupational Safety and Health Administration
- Uniform Building Code

11.6 Balance Of Plant (continued)

- *Design Parameters*

The cooling water system design is based on the following parameters:

- Meteorological information from the survey conducted in the Baria Vang Tau Province.
- Design wet bulb temperature of 29.44 °C.
- Design approach is 3.89 °C resulting in a design cooled cooling water temperature of 33.33 °C.
- The materials of construction of the cooling tower structure and internals will be designed to handle the chemistry of the circulating cooling water.
- Design concentration cycle of the cooling tower system is 2.
- Drift losses from the cooling tower will be minimized.
- The side stream filter will handle up to 5% of the circulating flow rate.
- Three (3) cooling water circulating pumps, each having a capacity of 50% of the circulating flow rate will be provided.
- Three (3) cooling tower make-up pumps will be provided, each having a capacity of 50% of the design make-up rate.
- The cooling tower shall be hydraulically capable of accommodating 110% of the design cooling water circulation rate.
- Cooling Tower Make-up Water (Cai Mep River) specification:

pH	6.8-7.6
Color Pt-Co	10-50 mg/L
Turbidity	15-100 mg/L
SO4	1000-1650 mg/L
NaCl	1.59-1.75 % wt.
Hardness	2100-4000 mg/L
NO2-	0.01-0.10 mg/L
NO3-	0.01-0.15 mg/L
NH4+	0.04-0.25 mg/L
PO4	0.01-0.05 mg/L
Total Fe	0.10-0.25 mg/L
COD	7-10 mg/L
BOD5	3-6.5 mg/L

11.6 Balance Of Plant (continued)

DO2	2-5 mg/L
EC	2.7-2.9 S/m
Coliform	1500-3500 MPN/100mL
Temperature	23-31.5 C°

b. *Fire Protection and Detection System*

- *Standards and Specifications*

  Applicable standards and specifications of the following national organizations will be followed:

  - American Society of Mechanical Engineers
  - Factory Mutual
  - Institute of Electrical and Electronics Engineers
  - Insulated Cable Engineers Association
  - International Electrical Commission
  - National Electrical Code
  - National Fire Protection Association
  - National Board of Fire Underwriters
  - National Standard Plumbing Code
  - Occupational Safety and Health Administration

- *Design Basis*

  - An underground fire protection main system with hydrants throughout the main plant area and storage area (including a line to the wharf) will be provided so that all plant areas can be reached by outdoor fire hoses. Maximum spacing of hydrants is approximately 92 m to avoid excessive lengths of hose. This system will serve to limit both financial loss and loss of human life due to fire.

  - Interior hose stations for the larger normally occupied buildings will provide an early response to fire to limit loss.

  - Sprinkler systems in important buildings and larger occupied buildings will provide a quick response to fire to limit loss.

11.6 Balance Of Plant (continued)

- Gaseous fire suppression systems for important electrical rooms including control rooms will be provided for enhanced fire fighting and to avoid spraying water on such equipment.

- Fire detection in most buildings will be provided to allow for early detection and response to fire. Monitoring will be in the main control room.

- Hand operated fire extinguishers will be provided so that building occupants can respond to small fires.

- The fire pump capacity of 450 m3/h is based on serving the largest plant fire hazard which is the wooden cooling tower.

- Fire water will be supplied by three pumps: one electric motor driven pump, one diesel driven pump and one electric motor driven jockey pump.

- Dedicated water storage in the Process Sump of approximately 710 m3 will provide approximately 90 minutes of fire fighting.

- All fire pumps will be located in a fire water pumphouse.

- Plant fire protection is summarized as follows:

11.6 Balance Of Plant (continued)

Building Description	Type of Protection
Administration Building	Hose Station and Sprinkler System
Storage Building	Hose Station
Lunchroom/Change Facility	Hose Station and Sprinkler System
Workshop/Equipment Repair	Hose Station
Main Control Building	Sprinkler System and CO2 System
Compressor Building	Sprinkler System
Blower Silencing Building	Sprinkler System
Analyzer Building	CO2 System
Fire Water Pumphouse	Sprinkler system
Substation Electrical Building	CO2 System
Material Handling Operator Control Room	CO2 System
General Electric Utilities Building	CO2 System
Hydraulic Building	Sprinkler System
Diesel Generator Building	Hose Station and Sprinkler System

c. *Primary Waste Water Treatment System and Sewage Lift Stations*

- The capacity of the Primary Waste Water Treatment system is based on the total daily domestic waste flows from the plant population.
- The plant population is considered to be 200 persons over three shifts with up to 60 percent present during the first shift.
- The equalization tank will be sized to receive batches of raw sewage from any of the lift stations. The aeration tank will be sized for a 1 day retention. The clarifier hopper bottom will be sized for 4 hours retention, and the chlorination system will be sized for 30 minutes of retention. A cover over the treatment plant fitted with a vent scrubber shall control odors.
- The Treatment System will provide effluent of a quality suitable for discharge into a secondary waste water treatment plant to be provided by the Industrial Zone Authority.
- Sewage lift stations are located where needed to pump flow to the System.

11.6.2 Civil/Structural

a. *Codes and Standards*

The following standards and specifications of national organizations will be followed:

- American Association of State Highway and Transportation Officials
  Standard Specifications for Highway Bridges
- American Concrete Institute
  Building Code Requirements for Reinforced Concrete, ACI-318
- American Institute of Steel Construction
  Manual of Steel Construction

11.6 Balance Of Plant (continued)

11.6.3 <u>Civil/Structural</u> (continued)

b. *<u>Codes and Standards</u>*

- Association of Iron and Steel Engineers – Standards
- American Iron and Steel Institute
  Specification for the Design of Cold-formed Steel Structural Members
- American Railway Engineering Association
  Manual for Railway Engineering
- American Institute of Steel Construction
  Specification for the Design, Fabrication and Erection of Structural Steel for Buildings
- American Society for Testing and Materials – Standards
- American Welding Society
  Structural Welding Code, AWS D1.1
- International Conference of Building Officials – Codes & Standards
- National Association of Architectural Metal Manufacturers
  Metal Bar Grating Manual
- Occupational Safety and Heath Administration
- Steel Deck Institute
  Design Manual for Floor Decks and Roof Decks
- Steel Joist Institute
  Standard Specifications
- Steel Structures Painting Council
  Steel Structures Painting Manual
- Uniform Building Code and Standards

b. *<u>General Data</u>*

The structures are divided into two categories:

<u>Core Process Plant supplied by Midrex</u>

<u>Facility structures</u>

Facility structures are defined in the Building sizes and finishes Matrix and the Climate Control and Fire Protection Matrix (Tables 5-1 and 5-2).

11.6 Balance Of Plant (continued)

c. *Design Specifications*

- *Loads and Load Combinations*

All structures and portions thereof will be designed to sustain, within the stress limitations specified in the governing codes, all dead loads, plus imposed loads, stability loads, wind or seismic forces, and the specified combination thereof.

- Unless stated otherwise, all structures will be designed to meet the minimum imposed loading requirements in addition to dead (self-weight) loads as specified by the local (Vietnamese) building codes. The design wind speed is 90 km/hr.

- Minimum live (imposed) loads will be as follows :

Roof	100 kg/m2
Elevated floor	1000 kg/m2
Stairways and landings	500 kg/m2

- In addition to dead and live loads, the following "Collateral" loads will be considered to account for piping and electrical raceway support loadings in the framing design:

  1. A minimum area load of 50 kg/m2 to the bottom chord of roof framing, girders or floor framing.

  2. A "phantom" load of 1400 kg to any roof truss panel point and on girders and primary floor beams to cause maximum stress conditions. The "phantom" load will not be carried to supporting members or columns.

  3. For columns and baseplate, a 10 percent contingency load will be included.

- Crane loadings including impacts on the crane runways and the supporting structures will be as specified on the drawings.

11.6 Balance Of Plant (continued)

- All structures and elements or components of structures will be designed to withstand the external and internal wind pressures corresponding to the specified design wind speed with Exposure Classification as "C" and Importance Factor of 1.0.

- Seismic loads applicable to the site environs (Zone 1 as defined in United States Uniform Building Code) will be considered in design.

- Load combinations for the framing and member connections will be for the most severe of the loading combinations as specified in the governing codes.

- *Foundation Design*

  - General

    Due to the presence of very soft clay of more than 35 meters in thickness, the consolidation settlement is a governing factor for foundation design. To eliminate the long-term settlement concern, the following approach will be considered:

    1. Use piles to support the major structure/equipment loads.

    2. Preload the site to improve bearing capacity of soil and accelerate the consolidation settlement with a surcharge.

  - Piles

    Engineering analysis indicates that a 540 mm square displacement type pile driven to refusal will provide a usable design capacity of 55 tons which includes an estimated downdrag of 82 tons per pile. The uplift capacity is in the order of 27 tons per pile.

  - Preloading

    The project site will be preloaded with a surcharge to eliminate the long-term settlement. The surcharge fill will be a controlled fill, placed in lifts not exceeding 300 mm and compacted to at least 90 percent maximum dry

11.6 Balance Of Plant (continued)

density determined according to Proctor test. Upon completion of preloading, the site will be adequate for an allowable bearing capacity of 100 kPa for spread footing design.

- Minimum Factor of Safety

  Following minimum factors of safety will be used in the design of structures:

Overturning	1.5
Sliding	1.2
Hydrostatic Uplift	1.2

  For temporary conditions during construction, all factors of safety may be reduced to 1.1.

- *Architectural Design*

  The construction materials of the facility structures will be classified as noncombustible. Roof and wall covering materials including insulation and finishes will meet the insurance carrier's limited combustible material classification.

  - Roof Coverings

    All structures will have metal roof coverings, minimum steel thickness 0.76 mm (22gauge) insulated (where specified) with minimum R15.

  - Wall Coverings

    All structures will have metal wall coverings, minimum steel thickness 0.61 mm (24 gauge) insulated (where specified) with minimum R11.

  - Doors

    Mandoors - Hollow metal full flush metal doors, filled with insulation and a vision panel, if exposed to the outside.
    Truck or Rail Doors - Manually and motor operated, prefinished, steel track doors.

11.6 Balance Of Plant (continued)

- Floor Slabs

  Ground floors will be concrete slab on grade, minimum 150 mm thick. Elevated floors will be concrete slab based on loading considerations and stiffness requirements. Elevated concrete slab will be on galvanized metal deck.

- *Steelwork Design*

  The facility structures will be designed as a manufacturing plant rather than a conventional steel mill facility, and as such, cost-effective metal Systems Building design approach will be utilized. In general, all steel design will meet specification requirements of AISC.

- *Concrete Design*

  Reinforced concrete design will be based on "Strength Design" method for building foundations, retaining walls, floor slabs, and underground structures. The "Alternate Design" method (working strength) will be used for heavy equipment foundations. Water, liquid waste, and sewage treatment structures will also meet the specific design requirements of ACI.

- *Civil Design*

  - Roads

Items	Paved Plant Roads	Unpaved Plant Road
Minimum Width	8 m	8 m (main) 4 m (service)
Shoulders – Stone	1 m	—
Maximum Grade	5%	5%
Minimum Radius to Centerline of Road	14 m	19 m (main) 7m (service)
Minimum Overhead Clearance	6.4 m	6.4 m
Minimum Asphalt Binder Course	38 mm	—
Minimum Base Course	150 mm	250 mm

11.6 Balance Of Plant (continued)

- Trackwork (Optional)

  Rails shall be 57 kg/m (115lb.) AREA.
  Ties will be 180 mm by 230 mm by 2600 mm long placed on 500 mm centers.
  Minimum turnout is No. 8.
  Minimum radius will be 90 m within the Plant area.
  Maximum grade is 2 percent.
  Minimum spacing between track centers will be 4600 mm.
  Horizontal clearance to structures from centerline of track will be a minimum of 2440 mm.
  Sub-ballast thickness will be a minimum of 150 mm.
  Ballast thickness will be a minimum of 200 mm.

- Storm Drainage

  The storm water system will consist of overland (sheet) flow to catch basins in the core area and to open drainage ditches beyond the core area.

  A retention basin will be provided to collect and provide controlled discharge for the runoff from the material storage area of the site. The balance of the site will have direct controlled discharge to a predetermined location.

- Earthwork

  The maximum side slopes in cut and fill areas are :

  1 vertical on 2.0 horizontal – permanent slopes.
  1 vertical on 1.5 horizontal – temporary slopes.

- Security Fencing

  Perimeter security fencing will be 2135 mm in height with three strands of barbed wire for a total height of 2440 mm.

11.6.4 Electrical Systems

a. *Codes and Standards*

Applicable standards and specifications of the following national organizations will be followed:

11.6 Balance of Plant (continued)

- International Electrical Commission
- American Society for Testing & Materials
- Institute for Electrical and Electronic Engineers
- Illumination Engineering Society
- Insulated Cable Engineers Association
- National Electric Code
- Uniform Building Code
- National Electrical Safety Code
- National Fire Protection Association
- Occupational Safety and Health Administration
- Federal Communication Commission
- Federal Information Processing Standards Publication 94

b. *Power Distribution System (See drawing 78516-D-170001)*

- *General Description of Electrical Power Systems*

  - The Local Power Company will provide 110kV at the Plant battery limits.

  - The 110kV overhead line will continue to the Plant substation dead-end structure.

  - The main substation power transformer, with load tap changing, will step down the power company supply voltage of 110kV to the plant distribution voltage of 22kV.

  - The 22kV power will be distributed from the main substation to various secondary substations where it will be stepped down to the utilization levels of 6300 volts and 380 volts.

  - The secondary substations will be located adjacent to the areas which they serve.

  - In addition to the normal 110kV power source, the Vietnamese Power Company will provide 22V at the Plant battery limits for plant stand-by power.

  - The 22kV line will continue to the Plant substation 22Kv switchgear with an underground conduit duct bank.

11.6 Balance Of Plant (continued)

- The facility will utilize the following voltages:

110kV AC (+/-) 5%	50hz High Voltage Power
22kV AC (+/-) 5%	50hz Medium Voltage Power
6.3kV AC (+/-) 5%	50hz Medium Voltage Power
380V/220V AC (+/-)5%	50hz Low Voltage Power
220V/110V AC (+/-)5%	50hz Control/Services
110V DC (+/-) 5%	50hz DC Switchgear Control
24V DC (+/-) 5%	50hz I/O Control
4-20mA Instrument Current Signals	

- *Utility Power Source*

The transmission system consists of a single 110kV line and a single 22kV line from the power company's bulk power system to the HBI Plant. The national power grid is not connected to a diesel generator plant. Both lines are in service on a continuous basis and the 110kV line is capable of carrying the full plant load of approximately 50MVA. The 22kV line is capable of carrying a partial load of 22MVA.

- *Main Substation*

The main substation will be single ended. 1- 110/22kV power transformer, with on line load tap changing, will be installed to supply primary power to the HBI Plant facility.

- *Power Factor Correction and Harmonic Filtering*

Capacitor banks will be supplied to the 22kV bus and will be sized to maintain an operating power factor of 0.92. Harmonic filters will be installed as required to satisfy utility power system requirements.

- *22kV Switchgear*

22kV metal-clad switchgear will be supplied at the main substation to provide the means for distributing and controlling 22kV power to the Plant. The incoming breaker units of the switchgear will be connected to the secondary of the main power transformer via non-seg bus. The 22kV switchgear will have an interrupting rating of 25kA at the 24kV voltage level main with bus ampacity of 2500 amps (2000A at tee). The switchgear will consist of the following units:

11.6 Balance Of Plant (continued)

1 -	2500AF	Incoming Breaker
1 -	1250AF	Incoming Breaker
2 -	1250AF	Feeder Breakers
6 -	630AF	Feeder Breakers
1		Equipped Space
1		Meter and Relay Compartment

Each unit will be equipped with panel mounted protective relaying, metering and control devices, as required for the connected load.

- *Primary Feeders*

  22kV copper conductor, ethylene - propylene rubber insulated, shielded and overall flame retardant jacketed power cables will be used as primary feeders from the 22kV switchgear feeder units to distribute power to the secondary substation transformers.

- *Secondary Substations*

  The secondary substations will be located adjacent to the buildings and loads they serve. With the exception of industrial type outdoor cast coil transformers, the equipment for secondary substations will typically be indoors and inside an Electrical Equipment Room. The 6300V switchgear will have an interrupting rating of 50kA at the 6300V voltage level main with bus ampacity of 4000 amps. The 380V switchgear will have an interrupting rating of 65kA at the 380V voltage level with main bus ampacity of 4000 amps.

  Midrex will supply 6300V and 380V AC unit substation as required per the Midrex's power single line.

  Balance of Plant 380/220 Volt Unit Substations will be as follows:

  - The 380/220 volt unit substations are located in proximity to the loads they serve. All 380/220 volt substations will be single-ended. The 1500kVA (AA)/ 2000kVA (FA) transformers will be equipped with a fused primary disconnect switch. The low voltage switchgear as a minimum consists of the following:

11.7 Balance Of Plant (continued)

1	Main Breaker
--	Feed Breakers as required
1	Voltmeter
1	Ammeter

- The 380/220 volt unit substations connected to the facility diesel generators will include additional breakers as indicated on drawing. Power, lighting, building service loads and AC motors (200 HP and smaller) shall be connected to the 380V AC Unit Substations.

Balance of Plant 6300 Volt Substation will be as follows:

- AC motors rated above 200 HP are connected to the 6300 volt distribution system consisting of one unit substation.

- The 6300 volt unit substation is located in proximity to the major user. The 6300 volt substation will be single-ended. The 10MVA transformer will be equipped with a fused primary disconnect switch. The medium voltage switchgear as a minimum consists of the following:

1	Main Breaker
--	Feed Breakers as required
--	Motor Controllers as required
1	Voltmeter
1	Ammeter

- *Motor Control*

  Midrex supplied drives with isolation transformers will be installed for variable speed motor control. Midrex and Balance of Plant supplied 380 volt motor control centers will be installed for AC motors. Remote I/O modules are included with the motor control centers.

- *110VDC Systems and Batteries*

  - Sealed, non-gaseous acid 110VDC battery systems will be installed for breaker control and 110VDC control functions. At least one battery system will be installed in each of the following:

11.5 Balance Of Plant (continued)

11.6	Main Substation	110V to 22kV
	Each EER for Balance of Plant	6300V and 380V
	Core Plant EER	22kV thru 380VAC

- The battery system will include batteries, rack, chargers, and voltage regulation.

- *Diesel Generators*

  Stand-by diesel generators will be installed for essential power and ship loading/unloading power during loss of power from the national power grid. The following diesel generators will be installed:

  1 - generator for the Core Plant process
  2 - generators for the ship unloading/loading
  1 - generator on board the diesel fire pump

- *Temporary Construction Power 380V/220V AC*

  The four 4 - 380/220 volt temporary power substations will be located in proximity to the loads they serve. All substations will be single-ended. The 1500kVA (AA)/ 2000kVA (FA) transformers will be equipped with a fused primary disconnect switch. The low voltage switchgear, as a minimum, consists of the following:

1	Main Breaker
--	Feed Breakers as required
1	Voltmeter
1	Ammeter

  The temporary power substations will be connected to the national power grid at the 22kV level.

- *Telephone and Page Party*

  - The facility will have a 200 phone system. This includes 20 percent spare capacity. The phones will be located throughout the plant and connected via embedded conduit duct banks.

- The facility will have a local page party system supplied by Midrex for the DR process. The balance of plant will have a page/party system included with the telephone system.

- *Computer Systems*

  - The facility will have desktop personal computers and software. No central network system is included with the facility. Dedicated phone jacks will be provided for internet access.

  - The facility will include computer systems and PLC's to control the process (by Midrex) and balance of plant equipment. Networking and communication will be included as required for the process.

a. *Balance of Electrical Equipment and Material*

All electrical equipment, materials and design will be in accordance with the referenced codes and standards. The electrical material and installation design will be based on the NEC. This includes but not limited to cables, conduit, cable tray, grounding, power distribution, wiring, and equipment.

11.6.5 Heating, Ventilating, Air Conditioning (HVAC)

a. *National Codes and Standards*

Applicable standards and specifications of the following national organizations will be followed:

- American Society of Heating, Refrigeration and Air Conditioning Engineers
- American National Standards Institute
- American Refrigeration Institute
- American Society for Testing & Materials, 1986 Edition
- Sheetmetal and Air Conditioning Contractors National Association
- Air Movement and Control Association
- National Fire Protection Association

11.6 Balance Of Plant (continued)

b. *General Design Criteria*

- Due to the warm climate, no heating systems will be provided.
- Ventilating and air conditioning systems will be designed based on using the Plant site outdoor design wet bulb and dry bulb conditions.
- Air conditioning (cooling) systems will be provided for Control Rooms and the Analyzer Building to ensure proper environment conditions for equipment.
- Air conditioning (cooling) systems will be provided for normally occupied buildings to provide comfort for personnel.
- Air conditioning units will be the direct expansion type using environmentally friendly refrigerant. Units will either be self-contained with filters, fan, compressor(s), cooling coil, and condenser coil or split systems with an indoor fan-coil unit with filters and outdoor compressor/condenser unit.
- Air conditioning units filters will be low efficiency throwaway fiberglass type.
- Electrical equipment rooms will be slightly pressurized using filtered outdoor air to help prevent the infiltration of dusty air.
- No active humidity control will be provided for air conditioning systems. The upper level of humidity will be limited by operation of the cooling coil as it provides temperature control.
- Variable air volume type air conditioning systems will be used for multi-room buildings separated into zones for better temperature control.
- Ventilation will be provided for areas where personnel comfort is not a factor or equipment does not require lower environmental temperatures.
- The airflow for ventilated areas will be based on approximately 4-12 air changes per hour depending on the specific building and its use.

SECTION 12.0

PROJECT EXECUTION PLAN AND SCHEDULE

12.1 General

The Plant will be owned and operated by a Joint Venture Company which will be established under the Foreign Investment Law of Vietnam. The Vietnamese entity of the JVC will be the Vietnam Steel Corporation. The foreign parties to the JVC will be the American Steel Corporation Pte Ltd., a Singaporean entity (currently represented by Craft Corporation, a subsidiary of the USA-based Harwell Group), strategy investor, and others who will be directly involved in the implementation of the Plant construction, including material suppliers and offtaker. This section outlines the basic concept of the project execution as planned, highlighting activities of the engineering, procurement and construction phases of the Project. An organization chart of the JVC is shown on Table 12-1.

12.2 Project Organization

The Project will be executed by the engineer/procure/construct contractors of the Core Plant and the Balance of Plant (including Port Facility and Material Handling System). Each contractor will be responsible to the JVC for quality and the schedule of completion of its scope of work. The JVC will nominate a consultant as owner's representative during the project implementation. Each EPC Contractor will assign a Project Manager, an Engineering Manager and a Site Construction Manager, with a full complement of all other required technical and administration support personnel. A typical Project origination chart of the EPC construction is shown on Table 12-2.

12.3 Engineering

12.3.1 Scope of Work

The engineering, both basic and detailed, required for the project will be provided by the Core Plant Contractor and the Balance of Plant Contractor. The battery limit of the core plant engineering is defined in the Technical Specification document submitted by MIDREX (Appendix VIII). The Balance of the Plant Contractor will provide engineering for the rest of the plant facilities.

12.3 Engineering (continued)

12.3.2 Design Coordination and Control

a. *Team Approach*

All successful turnkey projects are the result of teamwork by all participants. Engineering direction and coordination is a key element in project work. Each contractor's assigned Project Engineering Manager will lead the engineering process from conceptual design through approved construction drawings.

The PEM and his design team will work closely with the Core Plant Contractor to develop the project requirements to develop working drawings and specifications needed for procurement and construction.

Frequent design review meetings and close coordination will be constructed to insure the design is completed on time to support construction activities.

The Owner and Construction Manager are important members during the design engineering process and will be included in the design review to provide overview and guidance required for constructibility and maintainability.

12.3.3 Plan

The engineering process will begin with an Owner and Contractor kick-off meeting of all project participants to finalize design criteria. At this meeting, plans and schedules will be finalized. Factors that influence design will be agreed to so that the basic design can proceed. The Core Plant Contractor will perform this vital function under the guidance and support of the Balance of Plant PEM and his staff. Supervision and control of the detailed design will be through the PEM.

The Plant construction will be performed by subcontractors. As such, the design must progress and will be planned in a manner that allows the creation of subcontractor bid packages. The constructibility review will be performed when the design has progressed sufficiently for each package.

12.3 Engineering (continued)

12.3.4 Design Changes

Design changes will be controlled using the Design Change Notice procedures. The DCN will be used to notify of changes regardless of cause (i.e., vendor drawing change, internal change or contract change, field change, etc.). This allows all disciplines and project participants to be made aware of changes so design is coordinated.

12.3.5 Request for Information

Changes to design in the field will not be permitted unless approved by Engineering.

Upon recognition of a problem or question (i.e., interference, or the need for information), the Site Manager will complete an RFI to obtain engineering approval or response.

12.3.6 Alteration Notice

Once a drawing is issued "approved for construction", it will not be changed unless major revisions are required, or if more than four ANs are accumulated. The Master Drawing List will list the ANs issued. An AN will be prepared by Engineering to revise an already "approved for construction" drawing.

Upon identification of a change to an approved for construction drawing, and to expedite notice to the field, an AN will be prepared and sent with a laser plot of the actual drawing area from the CADD File. This will be an 8-1/2"x11" size and transmitted to the site. The Site Manager will, upon receipt, sign the copy and return it immediately and mark up the affected drawings in the field. The "approved for construction" drawing will be updated later with all applicable "ANs" incorporated.

12.3.7 Equipment Modification Instruction

From time to time changes may be required to equipment already delivered to site. If so, an EMI will be issued by the PEM after confirmation with the supplier, describing what changes are necessary. The Site Manager will, upon completion of the modification work, sign and return the EMI to verify the work has been performed.

12.3 Engineering (continued)

12.3.8 Piping Design

An engineer will design all piping 2" and larger and all high energy piping. All high energy piping will have stress analysis. Piping below 2" (other than high energy) will be field routed.

All piping will have isometric drawings. A pipe shop will be set up locally to fabricate piping, with larger spools fabricated at the pipe material supplier.

12.3.9 Cable, Conduit and Termination Design

Contractors will utilize their computer-based Cable and Conduit Schedule. Physical, as well as block diagrams, schematics and elementaries will be produced. The site will record cable pulled and terminated via mark-ups on the schedules.

12.3.10 Valve and Instrument Lists

All pipelines will be uniquely numbered and shown on the P&IDs. Orthographics and isometrics will also show the line number. The line list should show as a minimum:

- P&ID number, orthographic drawing
- From/to routing (particularly field routed)
- Insulation requirements
- Line number
- Size/schedule
- Material
- Service/system
- Test method (i.e., hydro, air, inservice, leak)
- Turnover package

12.3.11 Start-up

In order to expedite and ensure a smooth start-up sequence, construction will prepare a construction completion turnover package which will be issued to start up.

12.3 Engineering (continued)

12.3.12 Record Drawings

An important function of engineering is to provide "Record Drawings". Not all issued for construction drawings will be brought up to "Record" status. Those drawings required for maintenance, troubleshooting and locating underground facilities, will be provided for record. The site will maintain a record of all deviations by marking up the "Approved for Construction" drawings and returning them to the PEM for incorporation of deviations for "record".

12.4 Material Management

12.4.1 Procurement

Equipment and materials will be procured and supplied by Contractors in accordance with their scope of supply. Specifications will be prepared in accordance with an Engineering/Procurement Matrix that will be developed during the detailed engineering phase. Owner's consultant will decide which technical specification will be reviewed by Owner.

12.4.2 Vendor Drawings

All Vendor drawings will be controlled using a "Foreign Print Procedure". Vendor prints are an important part of procurement and critical drawings will be identified in the Purchase Order and penalty will be assessed for failure in accordance with contract provisions.

12.4.3 Expediting

Major and/or critical items will be expedited by Contractor's expeditor. This includes all supplied items. For major equipment, a "kick-off" meeting will be held at the Vendor's shop to confirm in a clear schedule of production, major milestones and list of subvendors, so a expediting plan can be developed. Visits to the various vendor shops, as required, will be made to ensure on-time delivery of both drawings and equipment.

12.4 Material Management (continued)

12.4.4 Export Preparation and Documentation

a. *Customs Clearance*

To support Customs Clearance, it is important that export documentation be correct to avoid delays. Contractors will lead this effort for their scope of supply and prepare all commercial invoices.

b. *Marshalling*

All U.S. sourced equipment and materials will be shipped to a Freight Forwarder. This Freight Forwarder will inventory all materials, complete Material Receiving Reports, complete Over, Short or Damage Reports to ensure all materials have arrived at the Port of Export. To facilitate this, all purchase orders will require the vendor to provide a shipping Bill of Material, which identifies all materials being shipped.

Upon receipt of materials, the Freight Forwarder will export box, arrange for shipping, consolidate to reduce shipping tonnage and prepare the Ocean Bill of Lading and Commercial Invoices. Contractor will control the Ocean Bill of Lading and all Commercial documents.

Expediting will coordinate U.S. export shipments with any non-U.S. shipments.

12.4.5 Field Materials Control

Material control will begin with Engineering by the establishment of a Bill of Materials. All material will be ordered using the tag number as shown on the drawings or some identification number. No "one lot" purchasing will be permitted. All items will be assigned the appropriate account code for budget control. All suppliers are required to tag each piece for identification at site.

All material will be piece marked or tagged and inventoried at site to ensure the shipment is complete. If not complete, an OS&D report will be completed by the site for resolution.

Field Material Control will be implemented by the Site Material Manager in accordance with the project-established Procedure Manual.

12.4 Material Management (continued)

Both Freight Forwarder and Subcontractor will be trained on this procedure. The Site Manager will have the responsibility to enforce the procedures.

12.5 Construction

12.5.1 Construction Approach

The Project will be constructed using a Vietnamese general contractor who will subcontract to multiple subcontractors. The following Work Packages for the Balance Of Plant are anticipated:

- Site Improvement
- Port Facility
- Foundation Piling
- Concrete Work
- Facility Structures
- Material Handling System Installation
- Mechanical/Piping Installation
- Electrical Installation
- Architectural Finishes and Building Services
- Site Finishing

Subcontractors will bid to the quantities engineers develop with a ± 10% band, within which no change order will be allowed. As bid packages will include sufficient design drawings, this will be a minimal risk for the complexity of work. Subcontractors will bid lump sum (to defined quantities). Unit pricing will be included in the contracts to amend the price for increased or decreased quantities. All construction will be by Union Labor.

12.5.2 Bidding and Award Procedure

The procedure will be as follows:

- Prepare Design Package
- Select Bidders/Solicit Bids
- Compare "as designed" Quantities to Budget
- Evaluate Bids
- Negotiate Subcontract
- Approval
- Award
- Closeout

12.5 Construction (continued)

12.5.3 Project Control

The Contractor Project Control Engineer will be full time at site to control cost and schedule. He will be supported by the site General Contractor personnel.

12.5.4 Design Control

Design Control at site will be through Contractor's Site Resident Engineer, utilizing the RFI, AN and DCN procedures.

12.5.5 Site Material Control

Site Material Control will follow the procedures as in Subsection 12.4.

12.5.6 Quality Control

Quality Control will be as specified in the Specifications and any applicable Codes and Industry Standards. Quality program elements will include:

- Organizational Control
- Qualifications of Personnel
- Indoctrination and Training
- Procedures
- Procurement Document Control
- Document Control
- Control of Purchased Material, Equipment and Services
- Identification and Control of Material and Services
- Control of Special Processes
- Inspection
- Testing
- Control of Measuring and Test Equipment

Project-specific quality assurance procedures will be developed to meet these goals.

12.5.7 Turnover

The Plant will be turned over to the Owner's operators and maintenance personnel by subsystem. Turnover Packages will be prepared for these subsystems and presented for acceptance.

12.5 Construction (continued)

Typical content of a turnover package will be a complete description of the system being turned over, drawings, calibration and test records and a list of remaining punch list items.

The punch list will not prevent turnover; however, the punch list will be controlled/resolved by the Site Manager.

12.6 Project Controls

The function of project controls will be to systematically collect meaningful data, to synthesize that data to enable one to draw meaningful conclusions, and to present/report the data and conclusions for appropriate management action. Project controls will be utilized to plan and schedule activities within the work scope, to control engineering and construction budgets and to facilitate execution within schedule requirements. Reporting will be provided at levels of detail required for appropriate project control decisions. Control of changes, as they affect the design process and the scope of the Contractor's service, will be implemented. The Project Controls Manager will be responsible for all project controls activities.

12.6.1 Cost Control

The Contractor will control the Contract value for all areas within its responsibility, including but not limited to:

- Project Management and Engineering
- Detail Design
- Equipment Procurement
- Construction Management
- Construction Materials
- Construction Subcontracts

The Contract value will be revised upon receipt of authorized changes from the Owners. Changes will be incorporated in the budget baseline and earned value measurement system.

The Contract value will be the basis for the Control Budget which will be frozen and become the basis for cost performance measurement. The Control Budget will be broken down according to subcontract packages and purchase orders.

As package definition is finalized, some adjustment will be made by shifting line items from one package to another.

12.6 Project Controls (continued)

Once a package is defined, an "as designed" estimate will be performed and compared to the control budget. Variances will be analyzed and designs adjusted, if possible, to improve budgets.

12.6.2 Performance Measurement

Project performance will be measured using an earned value concept for engineering, design, procurement and construction activities.

Accomplishments will be measured as actual work completed such as drawings issued, specifications issued for bid/award, placement of concrete, etc. Completion of a task or activity will allow the project to earn a portion of the total project value (% complete). Actual accomplishments will be measured against scheduled accomplishments to measure progress.

The earned value measurement (% complete) will form the basis for Contractor's monthly progress invoice.

The project schedule will be resource loaded to allow Contractor to monitor and control labor productivity and manpower. Production curves will be established for major commodity installation.

Construction work progress will be measured on standard earned value concepts and reviewed in weekly site meetings by the site staff for analysis and corrective action.

A monthly progress review meeting will be held with the Owner to review project status.

12.6.3 Schedule Control

The Contractor will prepare an integrated CPM project schedule using Primavera scheduling software to support the required dates in the Project schedule for engineering, detail design, procurement, construction and start-up. This schedule will be based on a CPM network which will be updated monthly. The logic and schedule will be an integrated engineering, procurement and construction schedule, with detailed scheduled activities tied through detailed design, equipment delivery, and phased construction releases. Subcontractor milestone schedules, consistent with this integrated schedule, will be contract

12.6 Project Controls (continued)

requirements in individual construction subcontracts and equipment purchase orders.

Upon acceptance of the schedule, logic and activity durations will not be changed without prior approval of the Project Manager. When required, recovery plans will be established and progressed for work behind schedule while the activities continue to be reported behind schedule and explained until recovery is achieved or a project rescheduling is authorized.

12.6.4 Change Control

No work on Change Orders will proceed without the Owner's approval.

12.6.5 Project Reports

The Contractor will generate a variety of reports during the execution of the project to be used by project management personnel to analyze project status and control schedule. These reports shall include:

- Engineering/Construction Progress Curves
  - % Earned
  - % Schedule
- Engineering/Construction Manpower Histograms
- Specification Status
- Drawing Status
- Installed Quantity Status
- Schedule
  - Contract Schedule
  - Critical Path Analysis
- Engineering/Purchasing Schedule

12.6 Project Controls (continued)

12.6.6 Monthly Progress Report

Reporting shall be monthly. Progress Reports will be issued in conjunction with the Monthly Project Review Meetings.

12.7 Project Schedule

12.7.1 Milestone Schedule

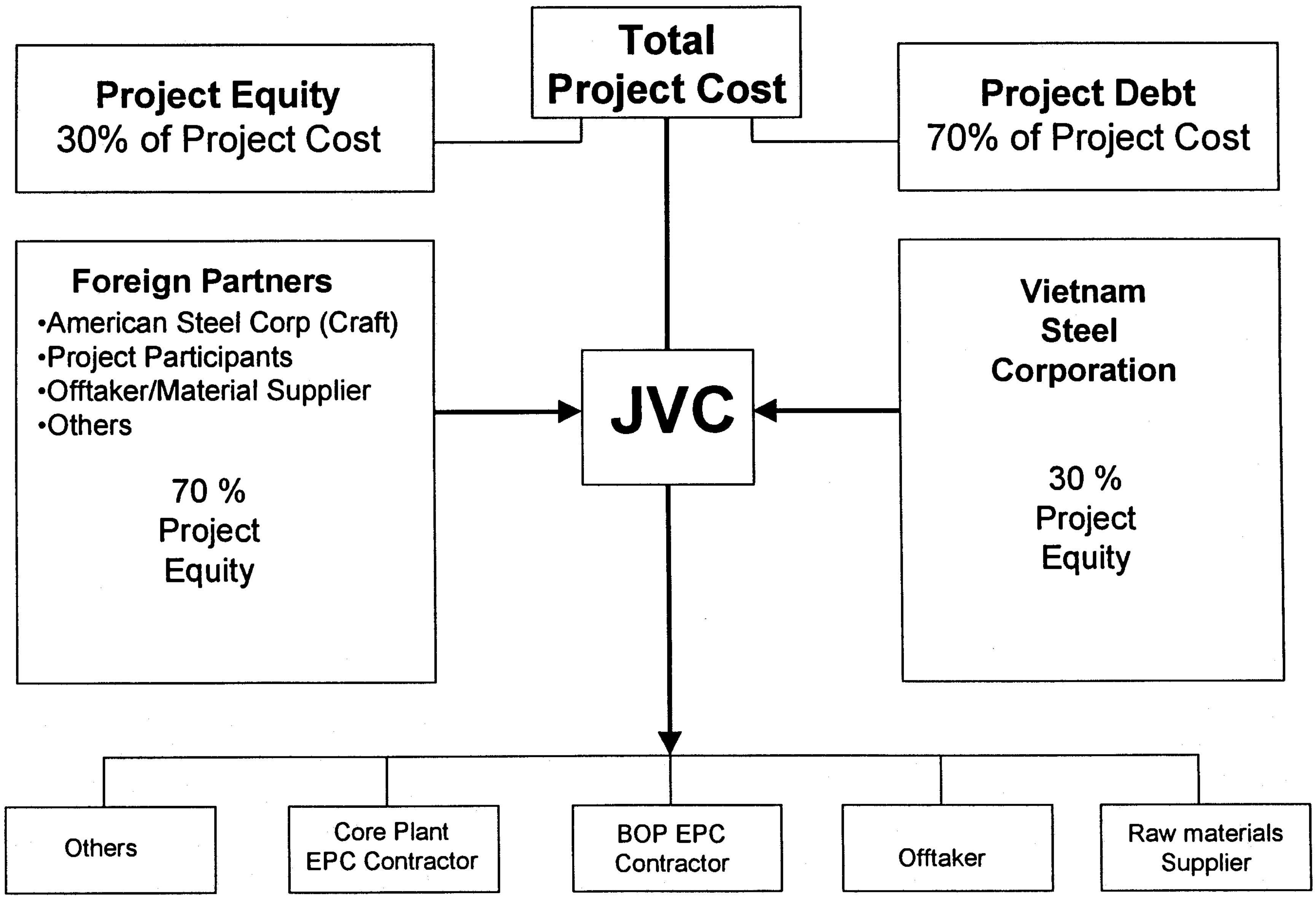
A Project Schedule has been established to complete the Project in the earliest feasible time to produce HBI for export and in-country use. Table 12-3 outlines the Schedule for the Project. It contains both summary and overall project facilities detailed schedules.

The schedule consists of a 10-month Project Development Phase concluding with financial closing. Upon financial closing, a 15 month site improvement work will be required. In parallel, design and construction of the Port Facility will be on-going. Within 3 months of financial closing, EPC contractors for the Core Plant and BOP will be selected and the engineering and procurement phase of the project will start. Foundation piling work for facilities will start in month 13 from financial closing, followed by 22 months of construction, start-up and commissioning activities. Based on JVC's approval to go forward (at financial closing) by September 1, 2001, the project will be completed by August, 2004.

Based on the schedule outlined in Table 12-3, major milestone activities for project implementation are outlined below:

JVC Organization

Table 12-1



12.7 Project Schedule (continued)

12.7.2 Project Development Milestones

The 10-month Project Development Schedule assumes all of the following milestones:

- Confirm JV Partners – Month 1.
- Complete Project Appraisal and Prepare and Sign JV Documents – End of Month 4.
- Prepare and Submit Investment License to Vietnamese Ministry of Industry – End of Month 8.
- Obtain Investment License from MOI – End of Month 9.
- Project Financial Closing – Month 10.

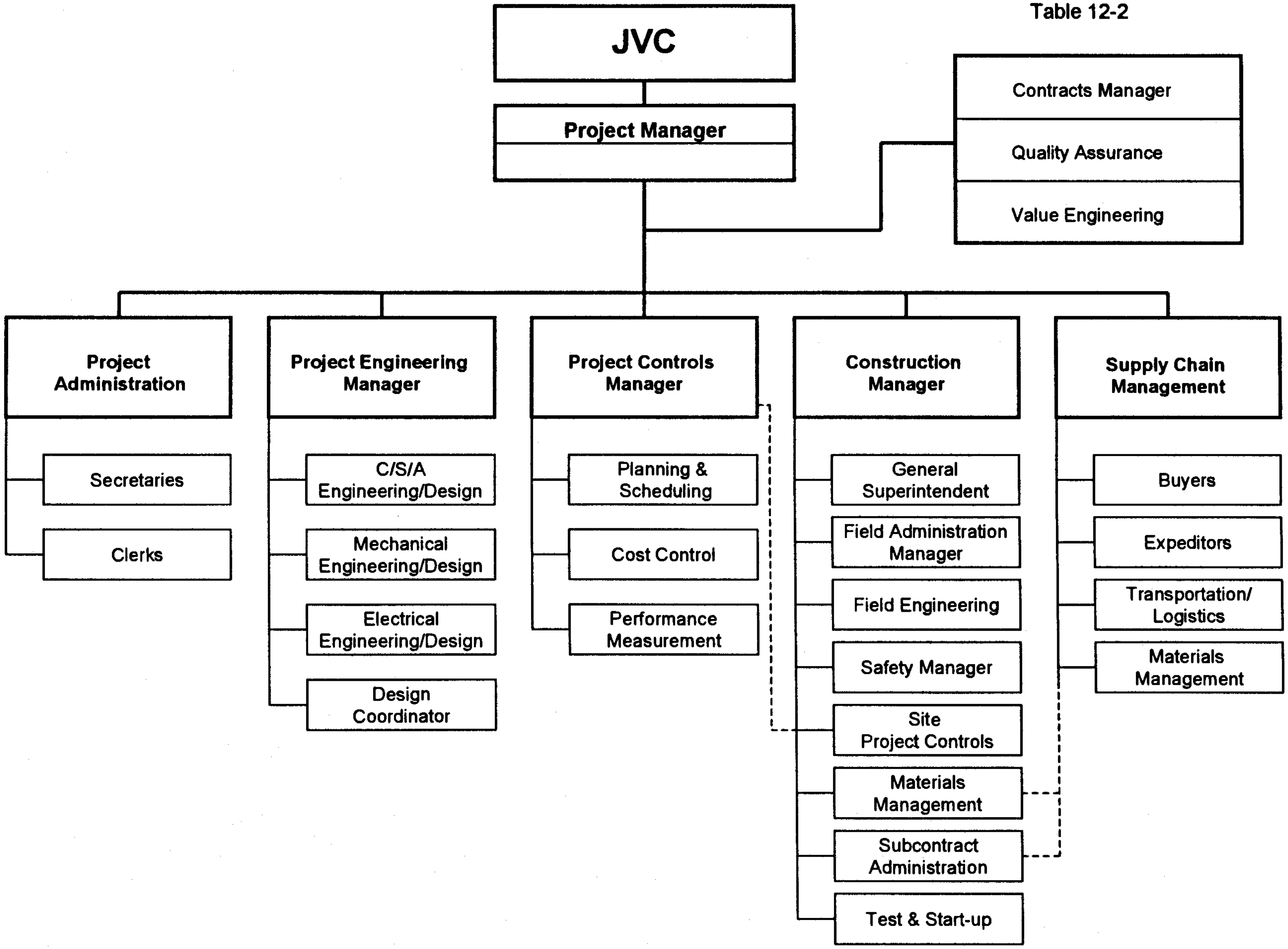
To support these project development milestones, a concerted effort of all parties involved in the JV formation and project implementation will be required.

12.7.3 Critical Path Milestones

The critical path of the overall Project Schedule starts with the inquiry package preparation, award and follow-on activities of the site improvement work; completion of foundation piling, concrete work, structural steel and main shell erection of the Reduction Furnace area; followed by installation of electrical raceway, cable pulling and termination of the Core Plant area; and finally completes with the plant cold and hot commissioning activities.

Project Organization Chart

Table 12-2



12.7 Project Schedule (continued)

MAJOR MILESTONE ACTIVITIES FOR PROJECT IMPLEMENTATION								
Go-ahead	Implementation Schedule Months from Go-ahead							
	Delivery			Construction			Erection	
	P.O.	Start	Finish	P.O.	Start	Finish	Start	Com.
Material handling system	10	16	20	-	16	18	23	32
Core Plant	3	18	29	12	14	22	19	35
Water distribution system	9-13	20	23	-	16	19	22	26
Power distribution system	8-14	15	25	-	16	19	21	29
Natural gas distribution system	14	20	22	-	16	19	23	31
Repair shop					20	25	-	-
Mobile equipment	12	22	27	-	-	-	-	-
Captive port	6	8	17	3-5	8	23	8	23
BOP	4	12	19		6	19	14	21
Site survey				2	3	4		
Soil investigation	-	-	-	2	3	4	-	-
Site development	-	-	-	3	4	15	-	-

REPORT

ON

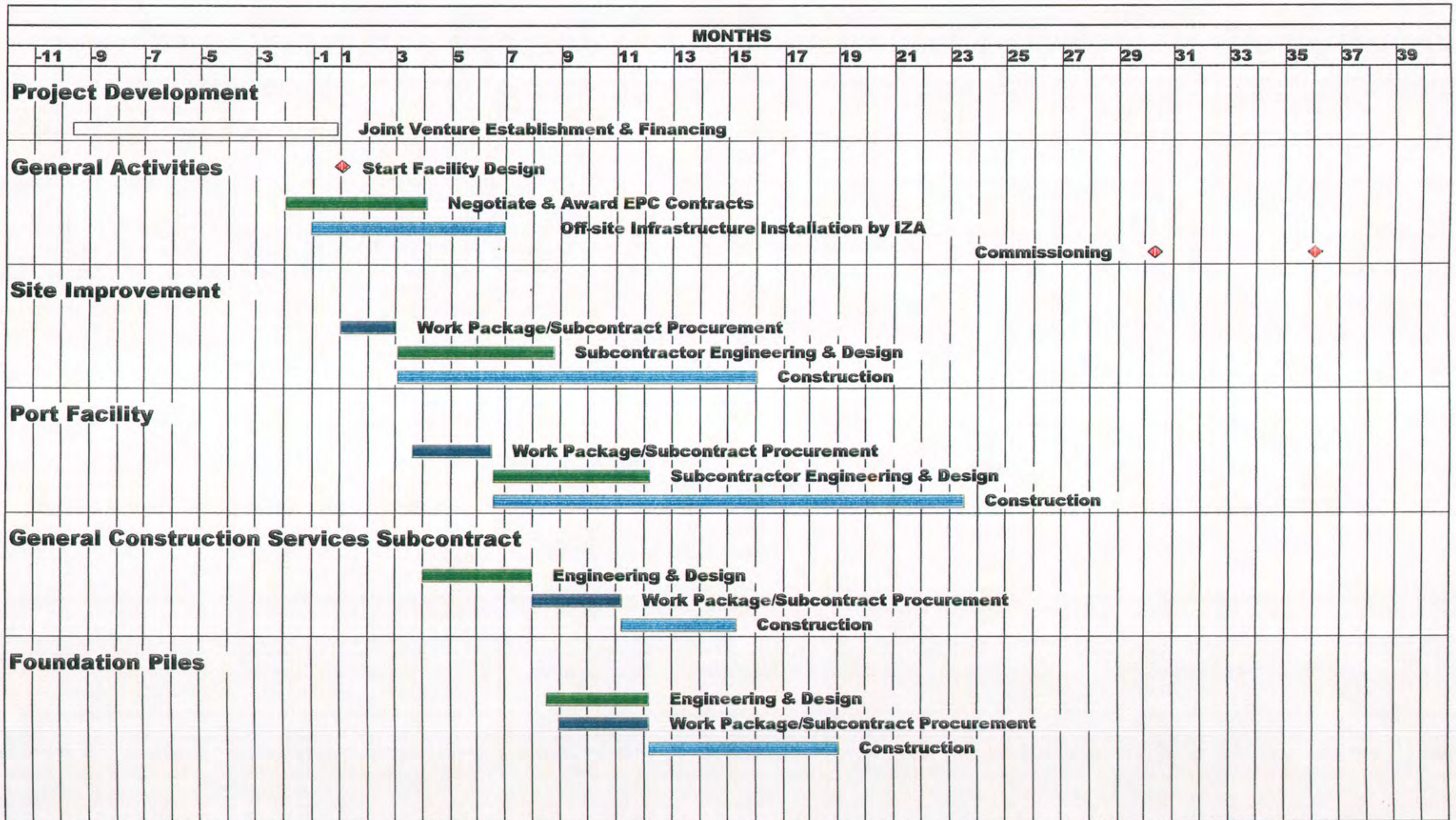
FEASIBILITY STUDY

FOR

DIRECT REDUCTION PLANT IN VIETNAM

PROJECT SCHEDULE – SUMMARY/DETAILS

TABLE 12-3
(15 PAGES)



Plot Date 9DEC99

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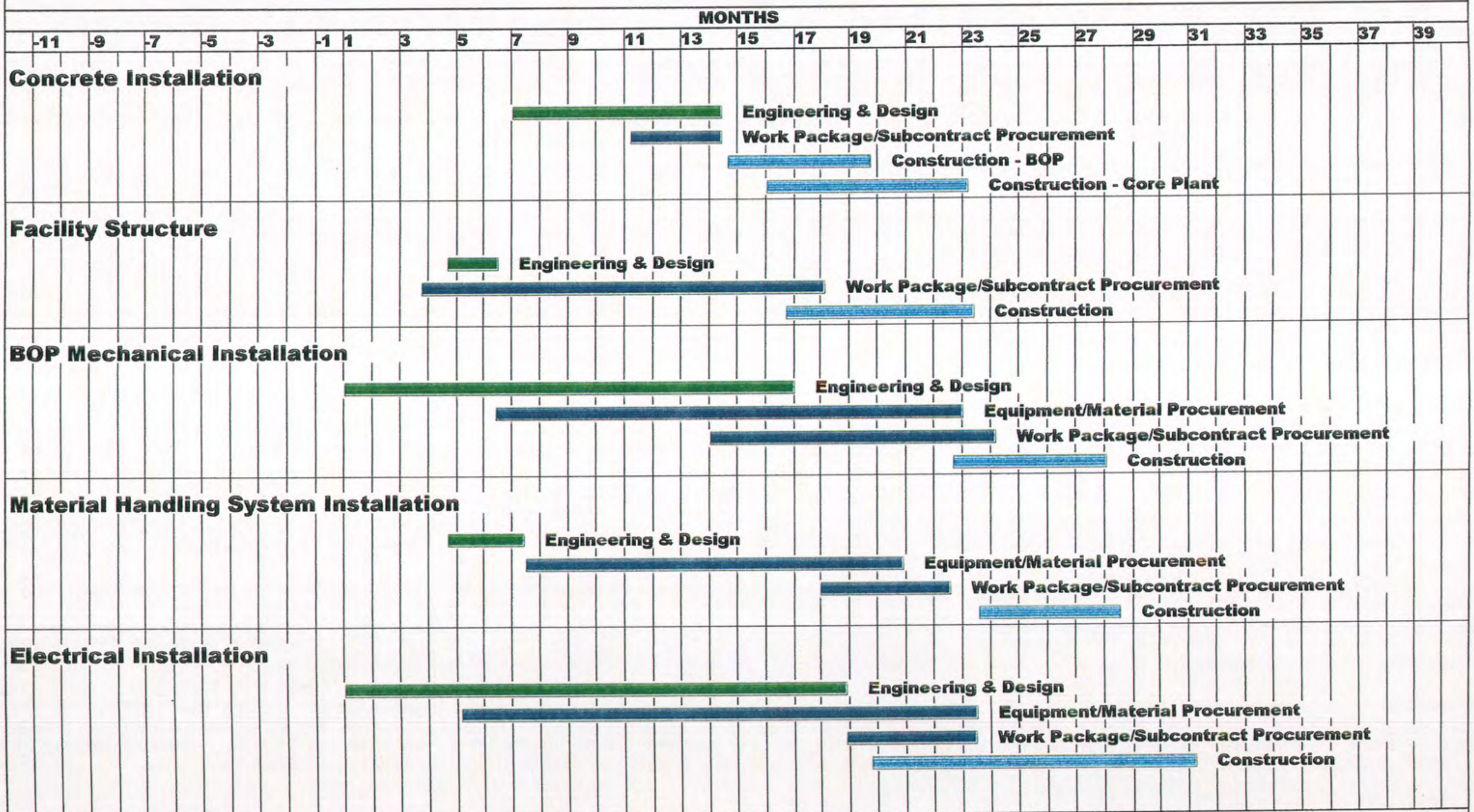
VDR2

Sheet 1 of 3

Vietnam Steel Company
DRI Facility
Summary Schedule

Table 12-3

Date	Revision	Checked	Approved



Plot Date 9DEC99

Legend:
- Engineering & Design
- Eqpt/Material/Subcontract Procurement
- Construction
- Commissioning

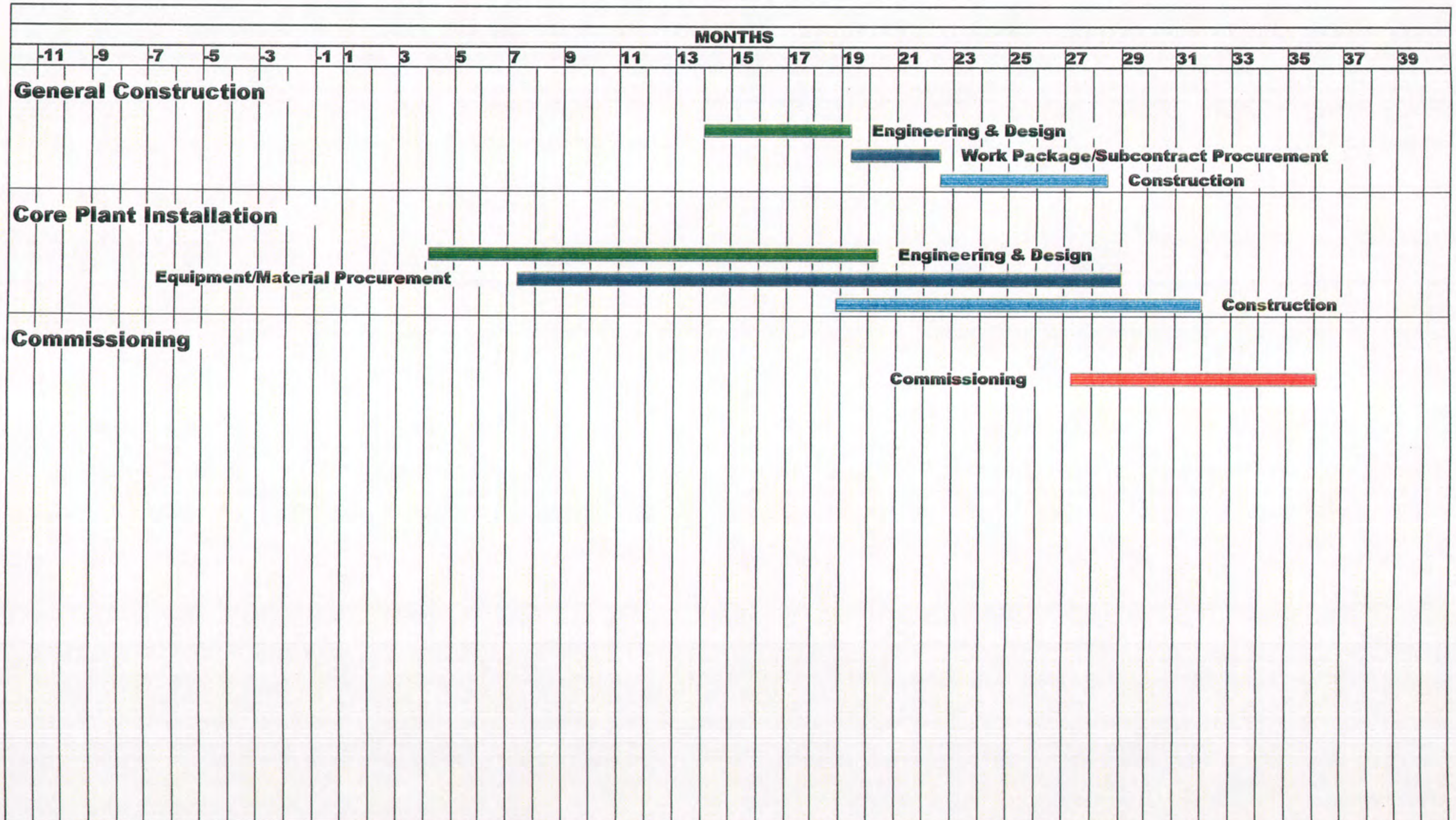
VDR2

Sheet 2 of 3

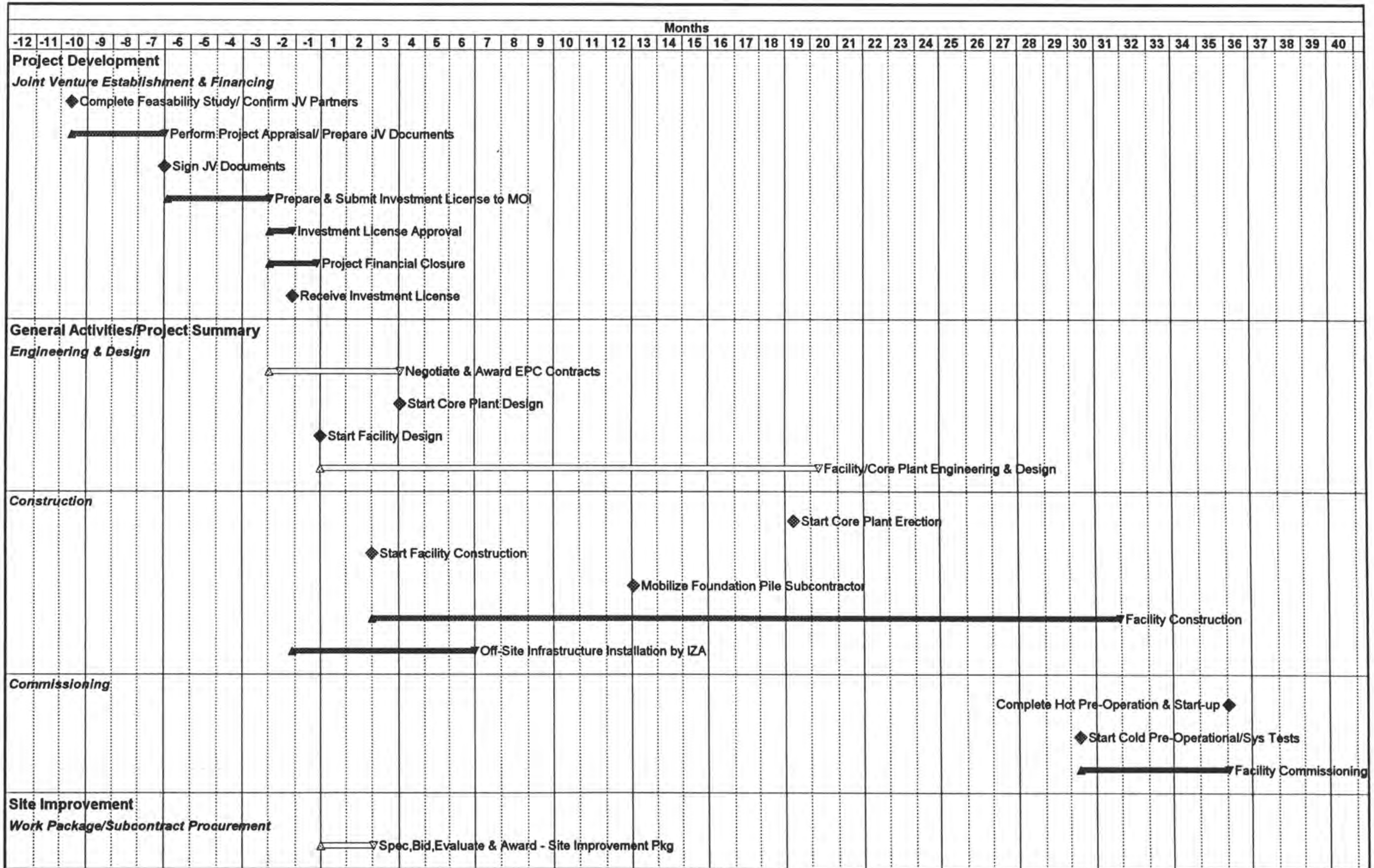
Vietnam Steel Company
DRI Facility
Summary Schedule

Table 12-3

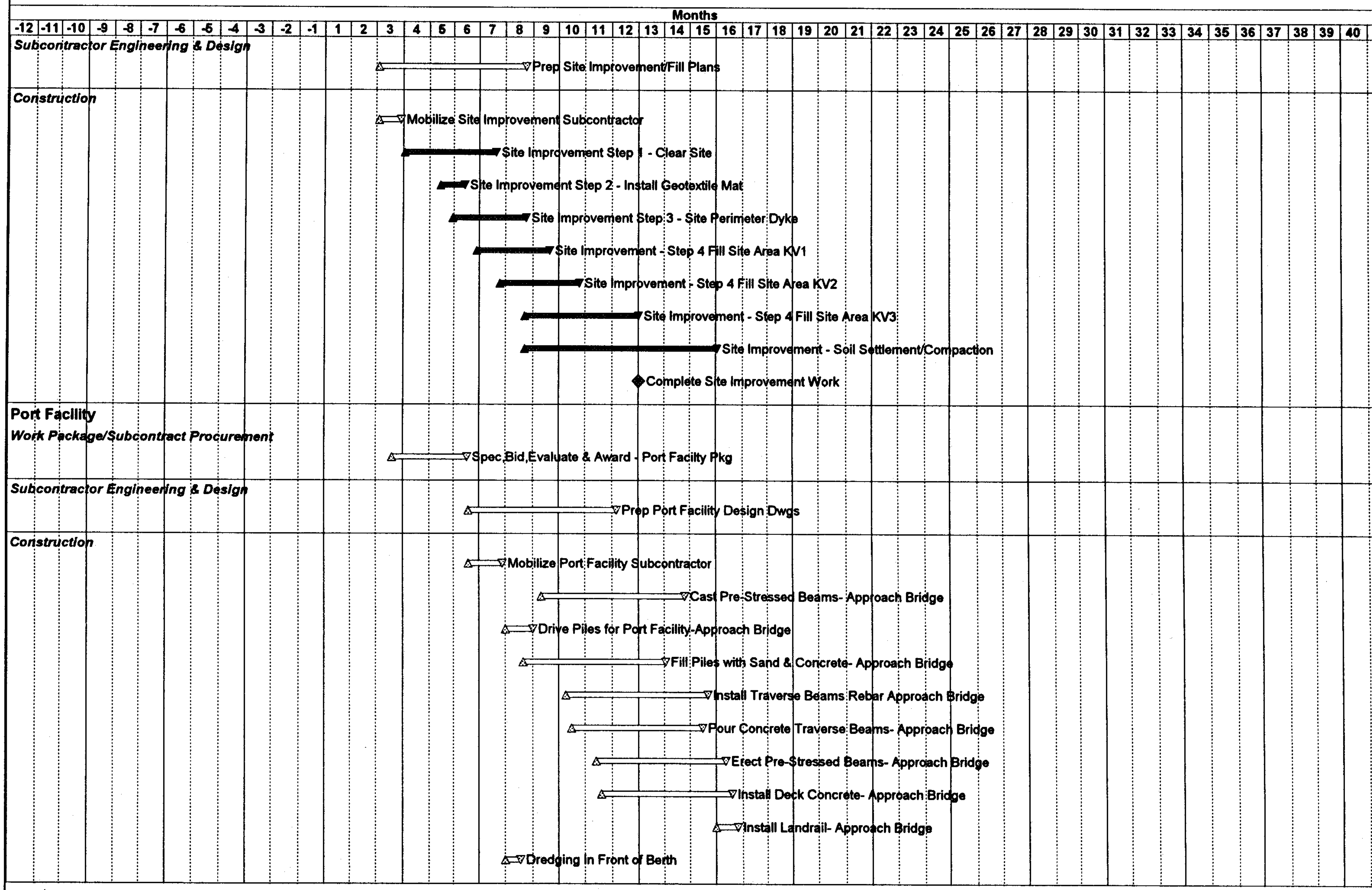
Date	Revision	Checked	Approved



Plot Date 9DEC99 (c) Primavera Systems, Inc.	Legend: Engineering & Design Eqpt/Material/Subcontract Procurement Construction Commissioning	VDR2 Sheet 3 of 3 Vietnam Steel Company DRI Facility Summary Schedule	Table 12-3 Date / Revision / Checked / Approved



Run Date 09DEC99	VDR2	Sheet 1 of 12	Table 12-3		
	Feasibility Study for Direct Reduction Plant in Vietnam Project Schedule		Date	Revision	Checked / Approved



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Feasibility Study for Direct Reduction Plant in Vietnam
Project Schedule

Table 12-3

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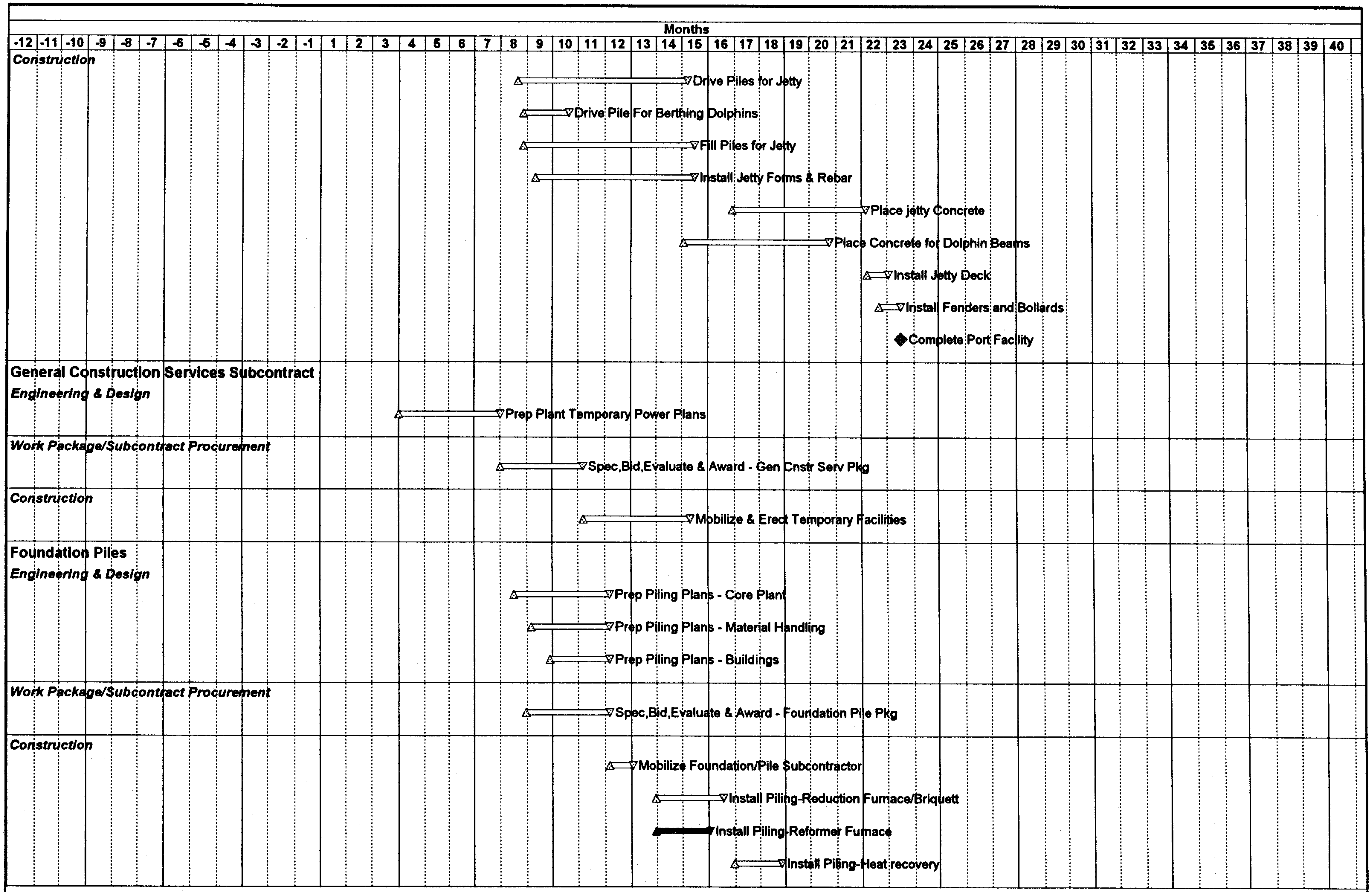

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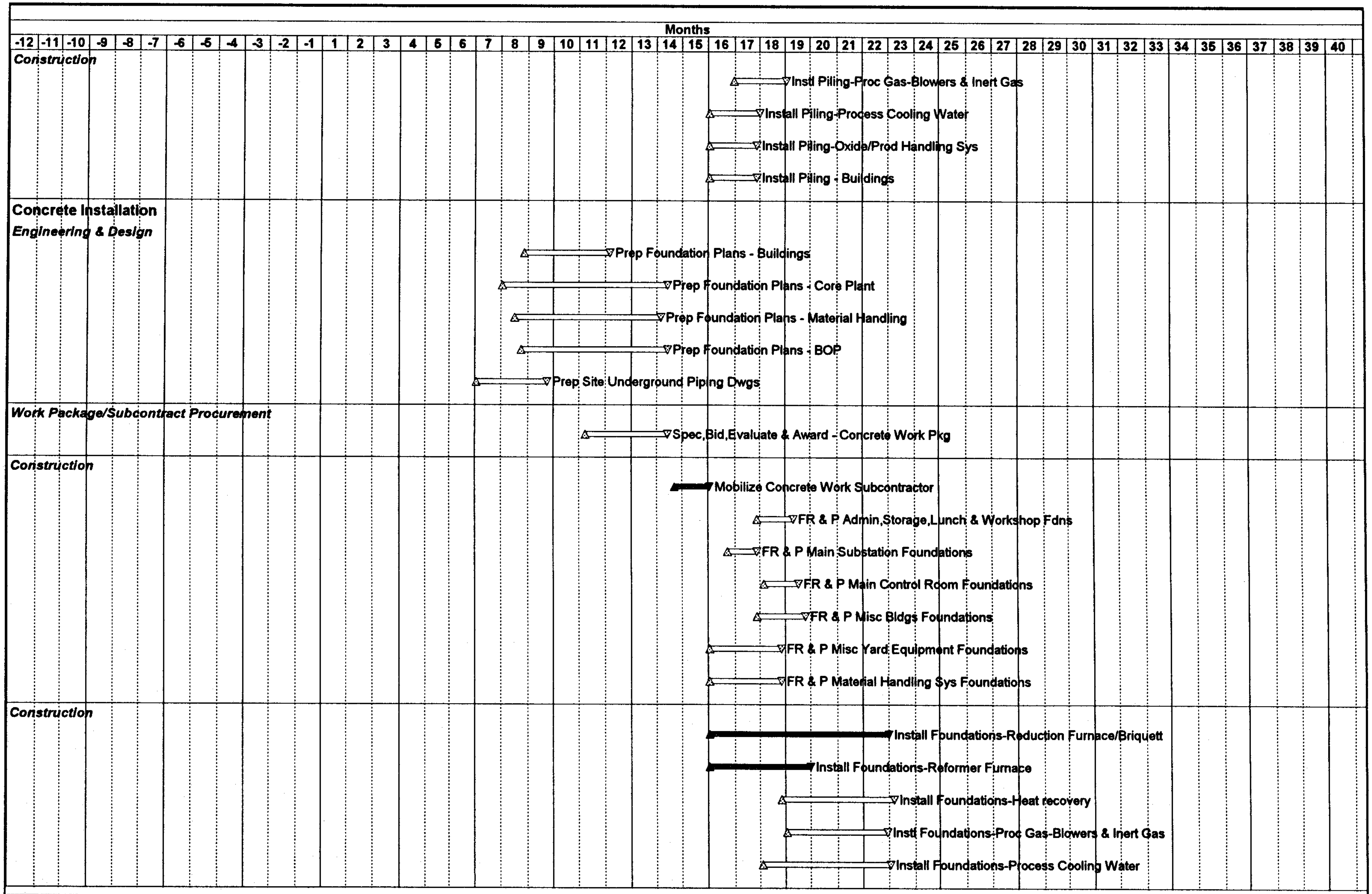

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Early Bar
Progress Bar
Critical Activity

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Table 12-3

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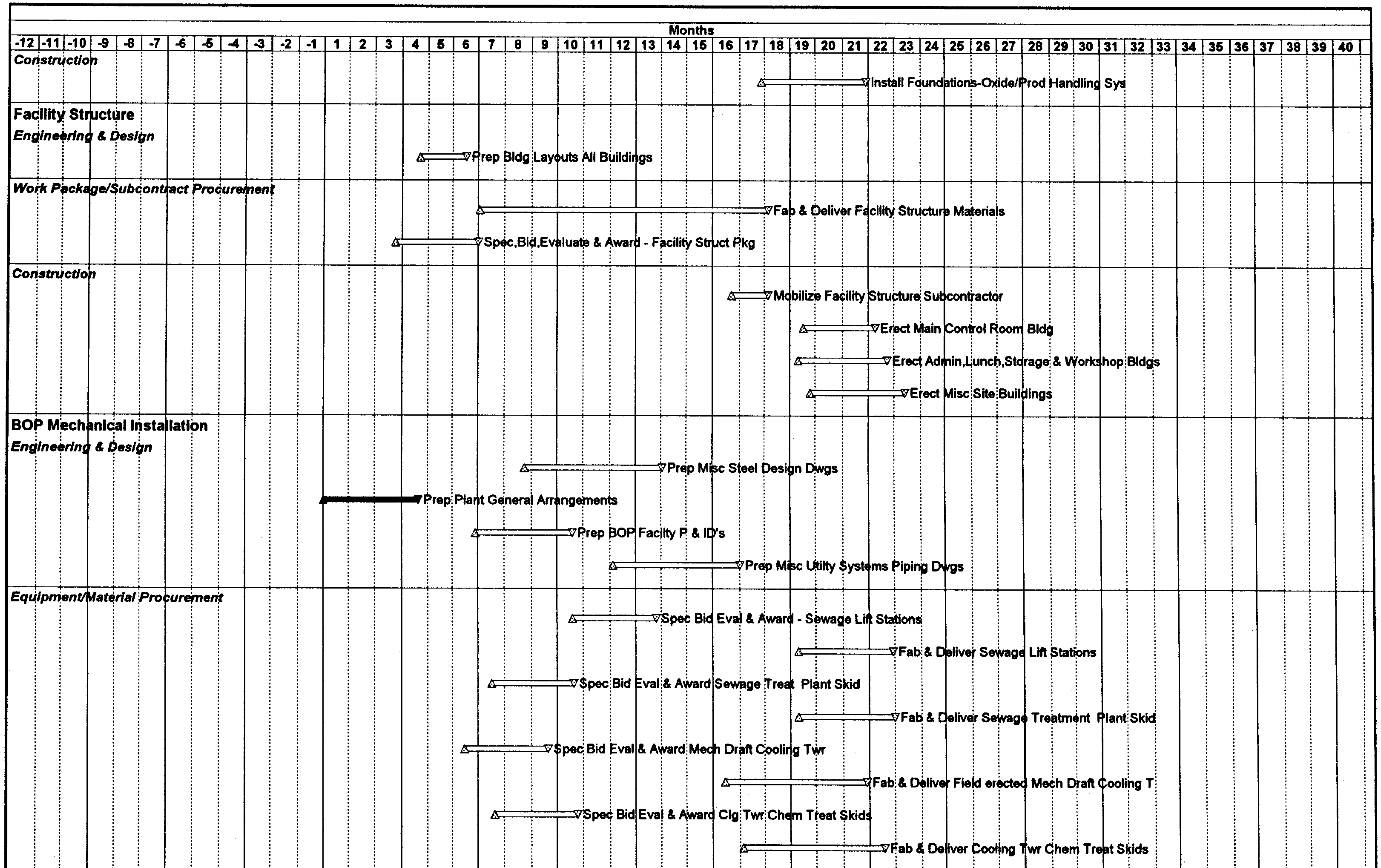

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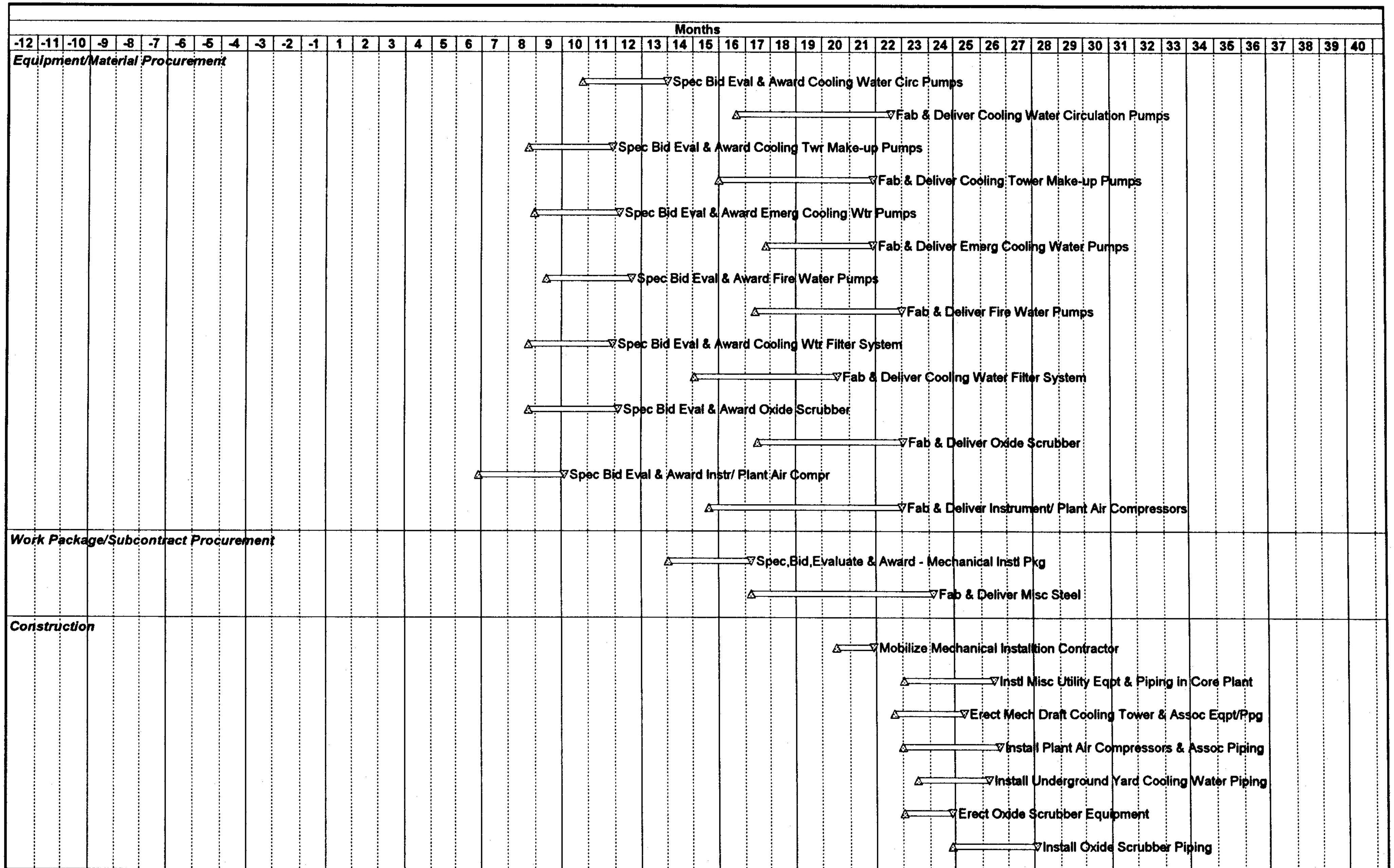

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Early Bar
Progress Bar
Critical Activity

VDR2

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Table 12-3

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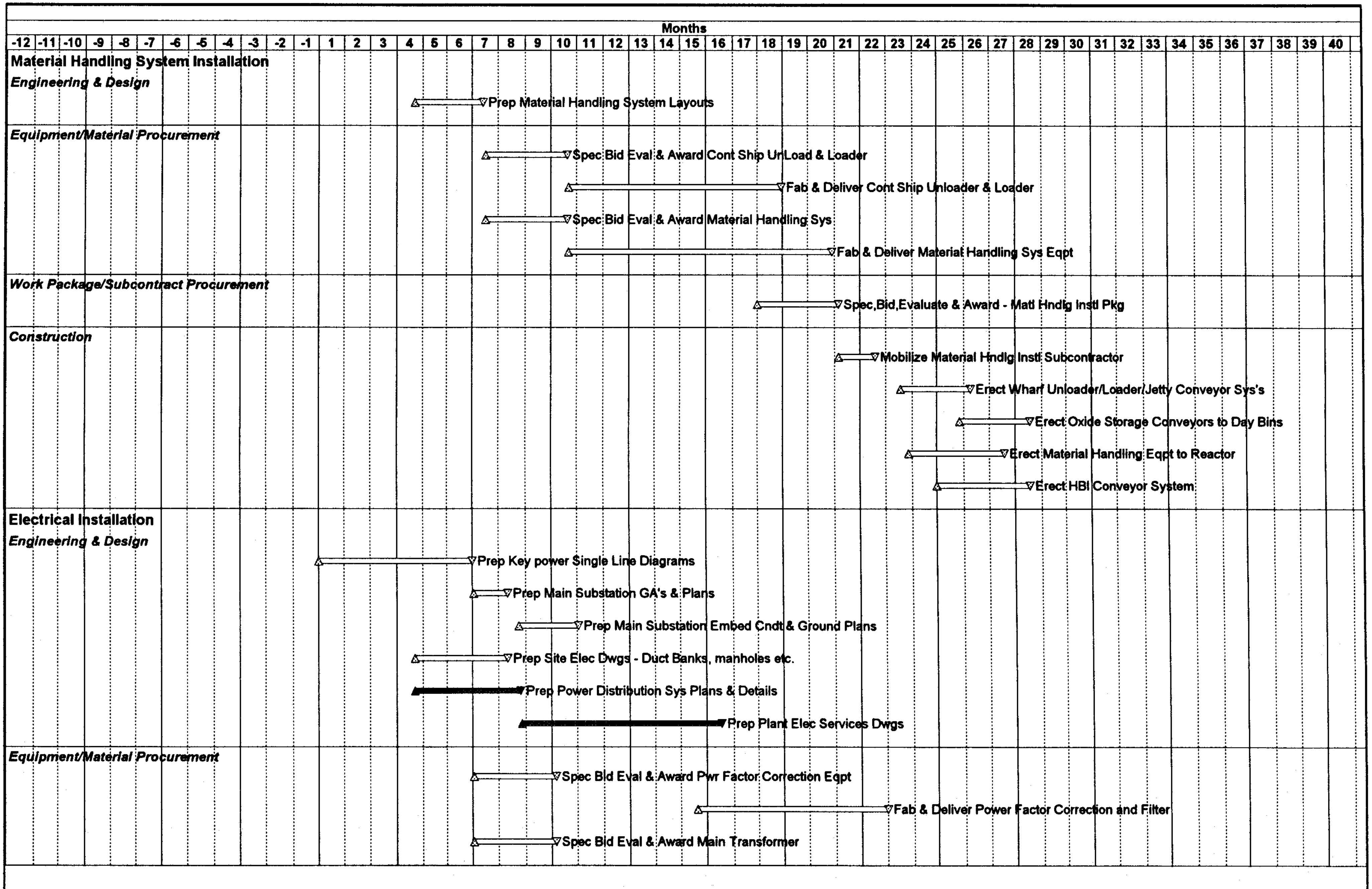

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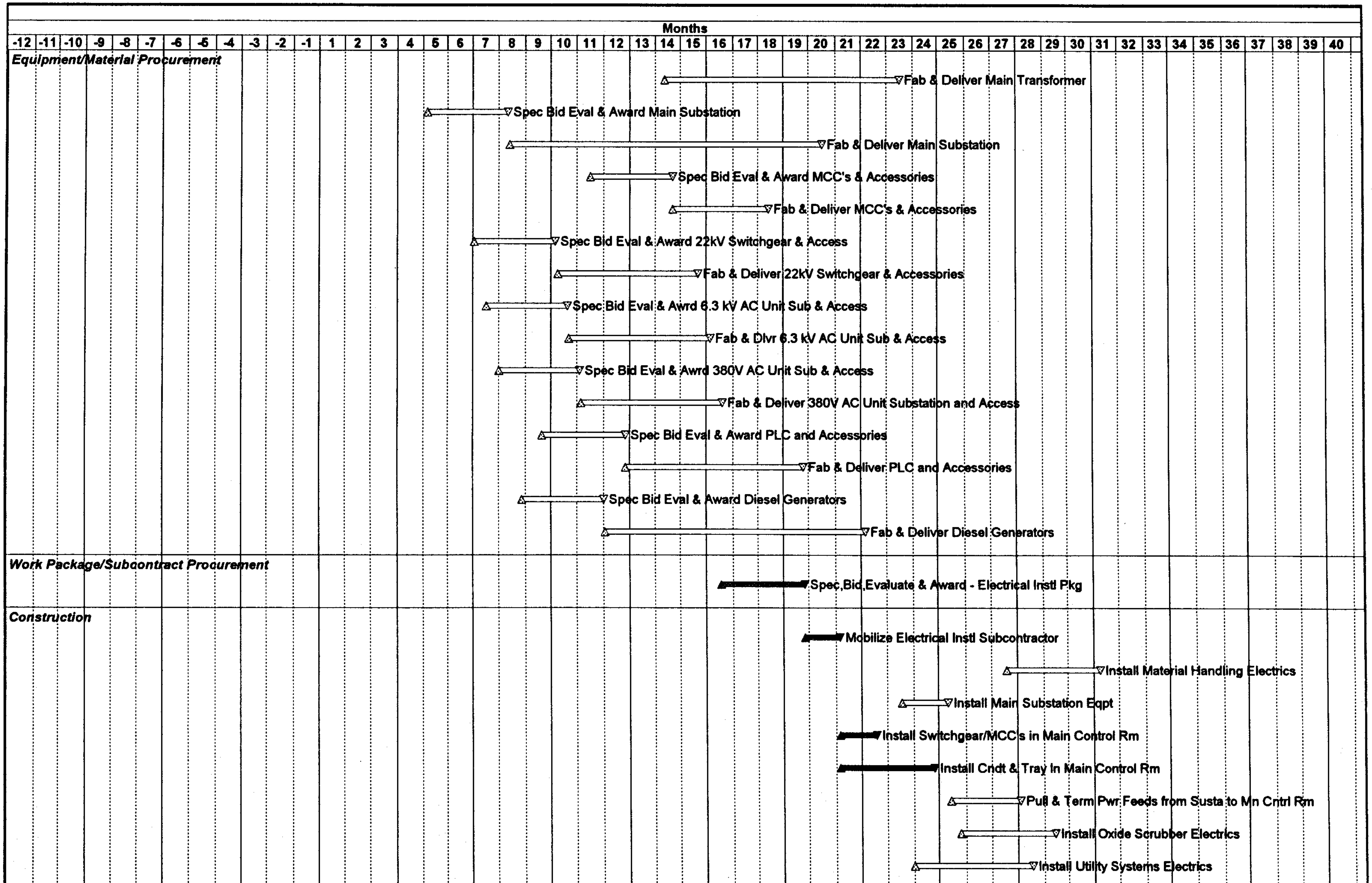

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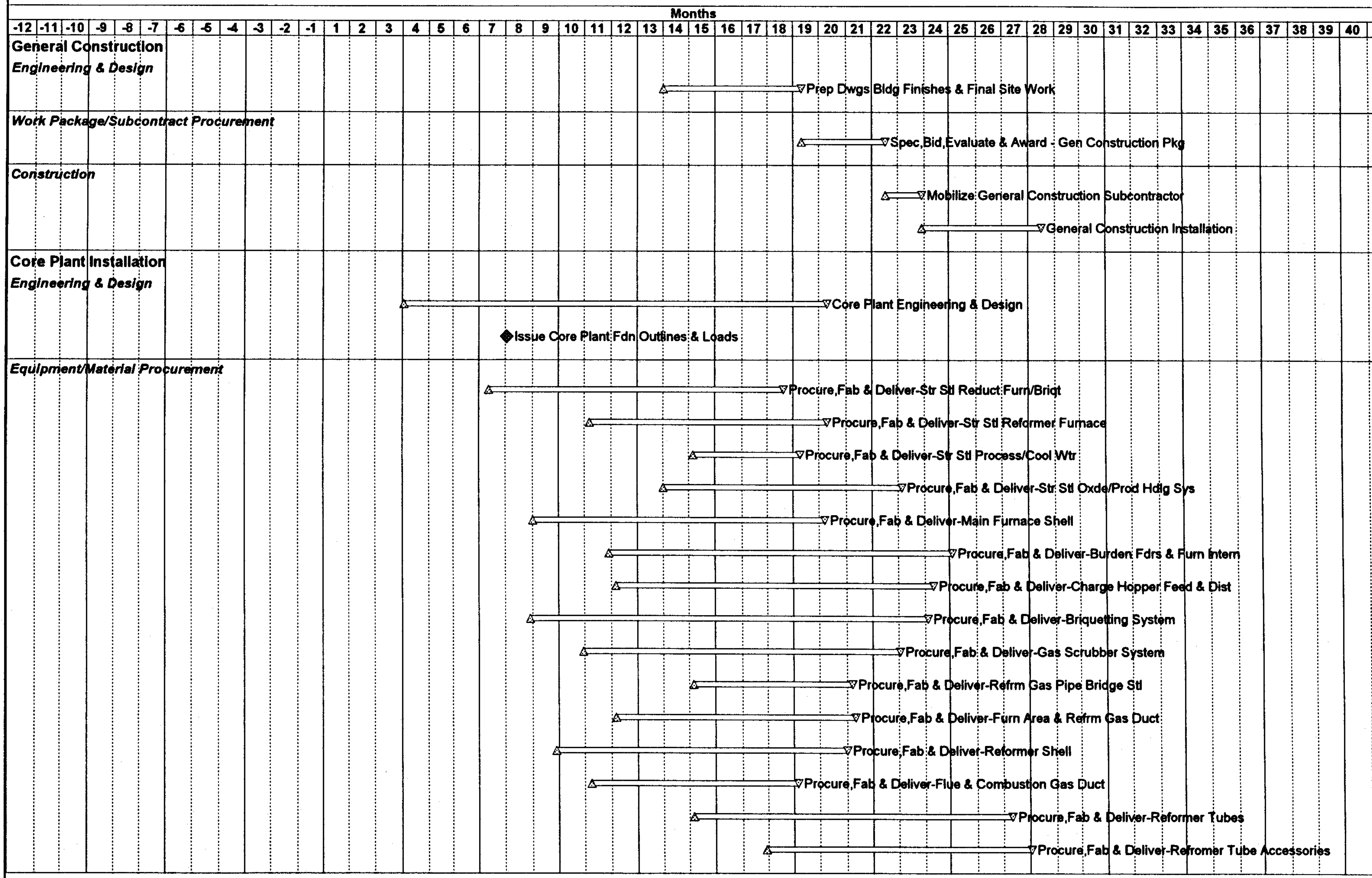

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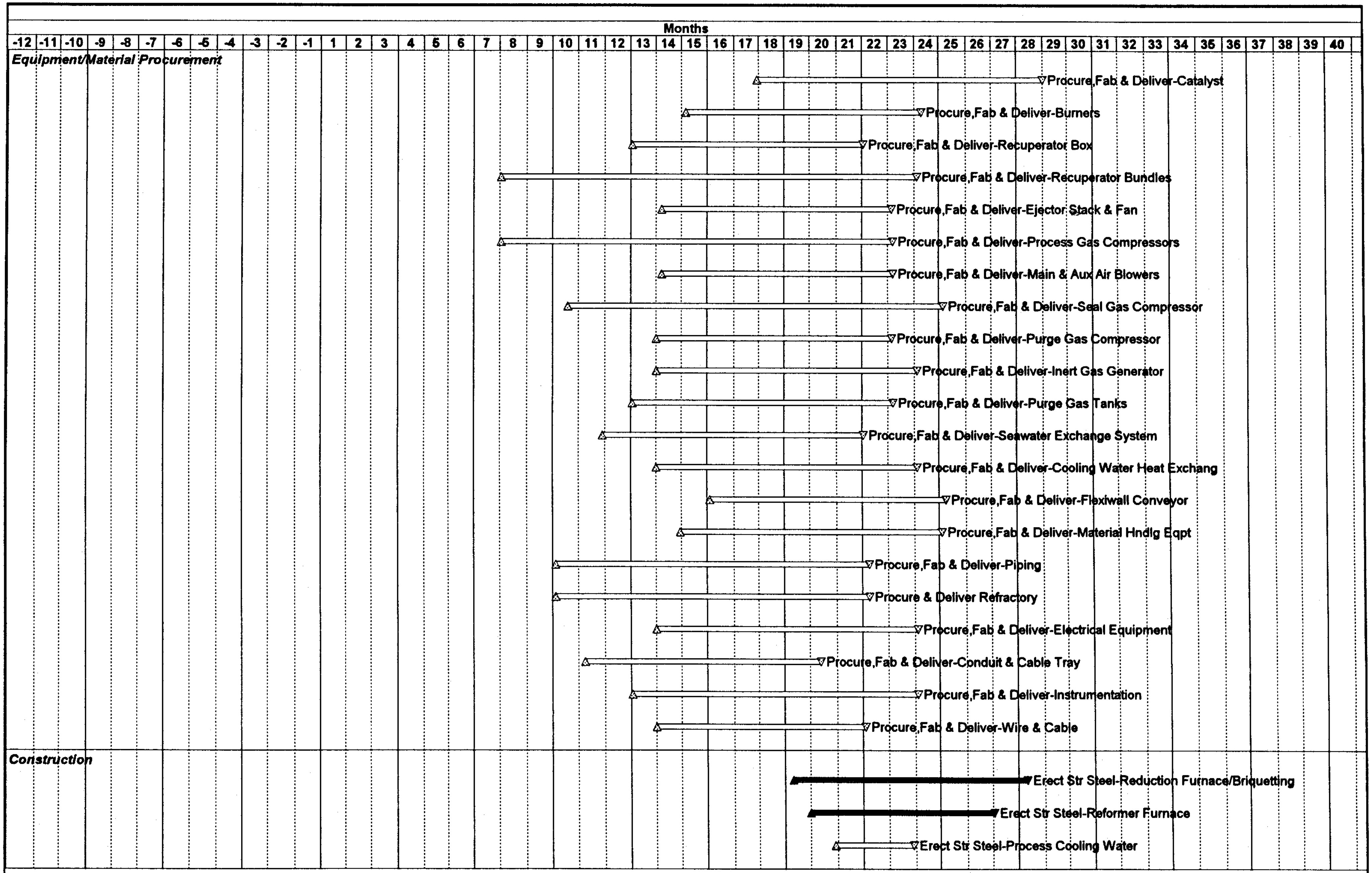

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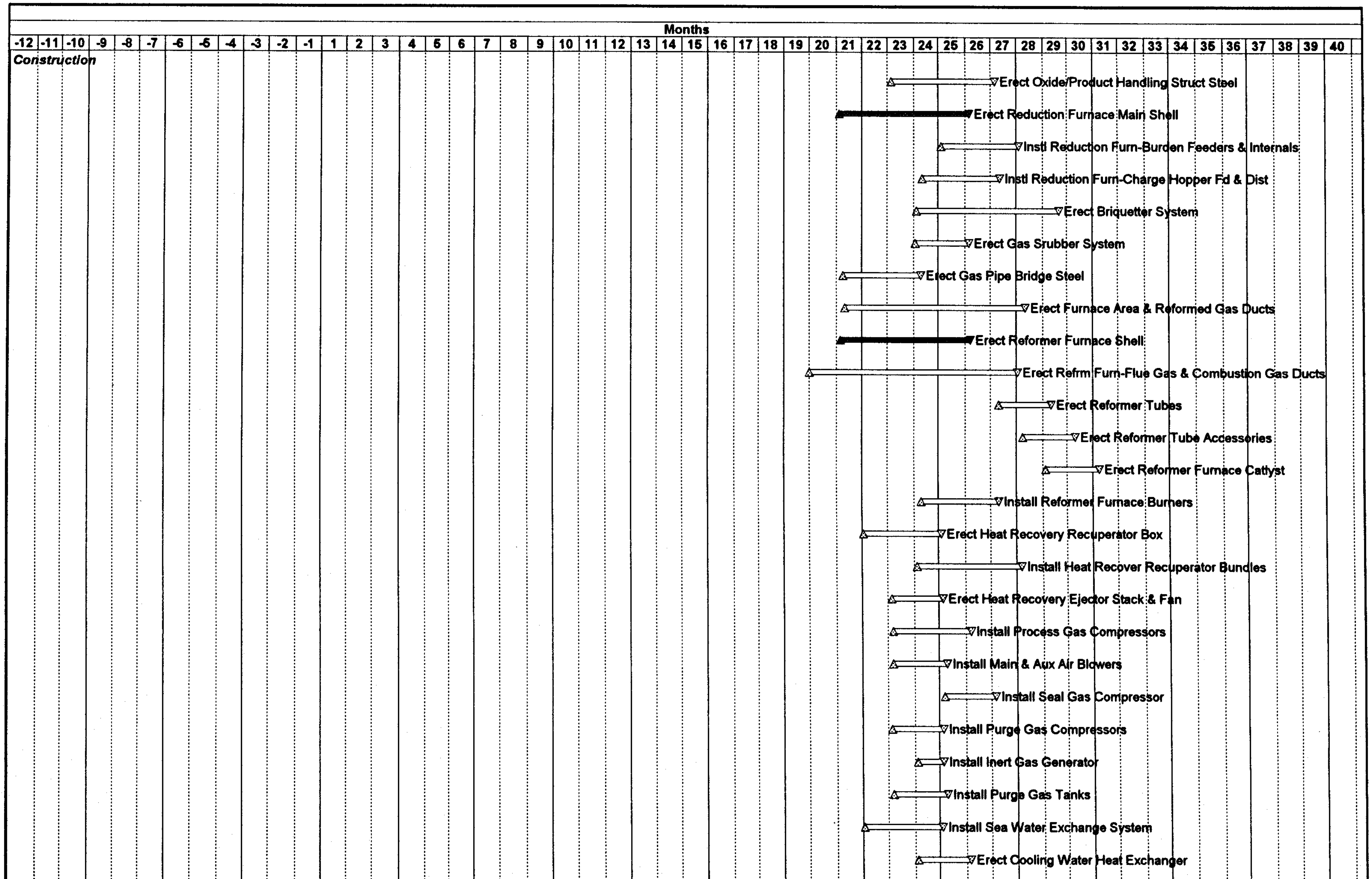

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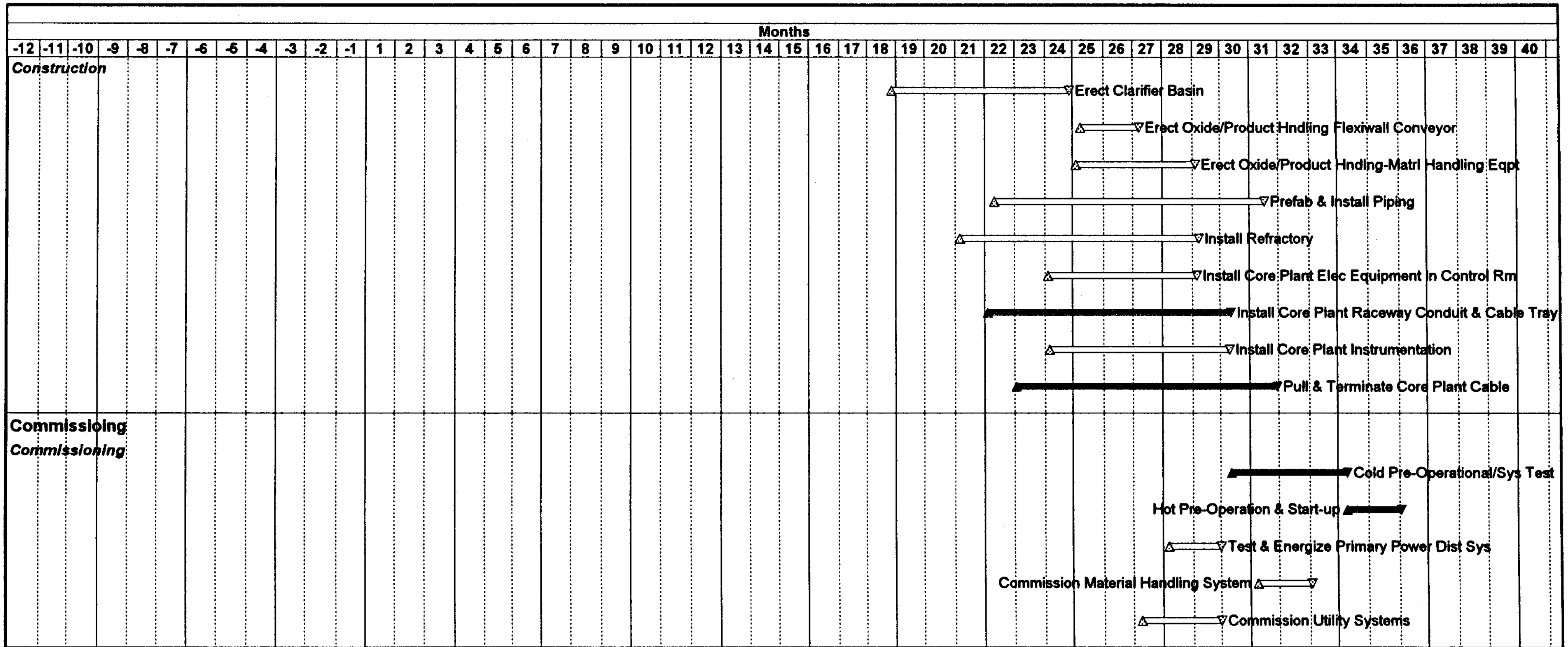

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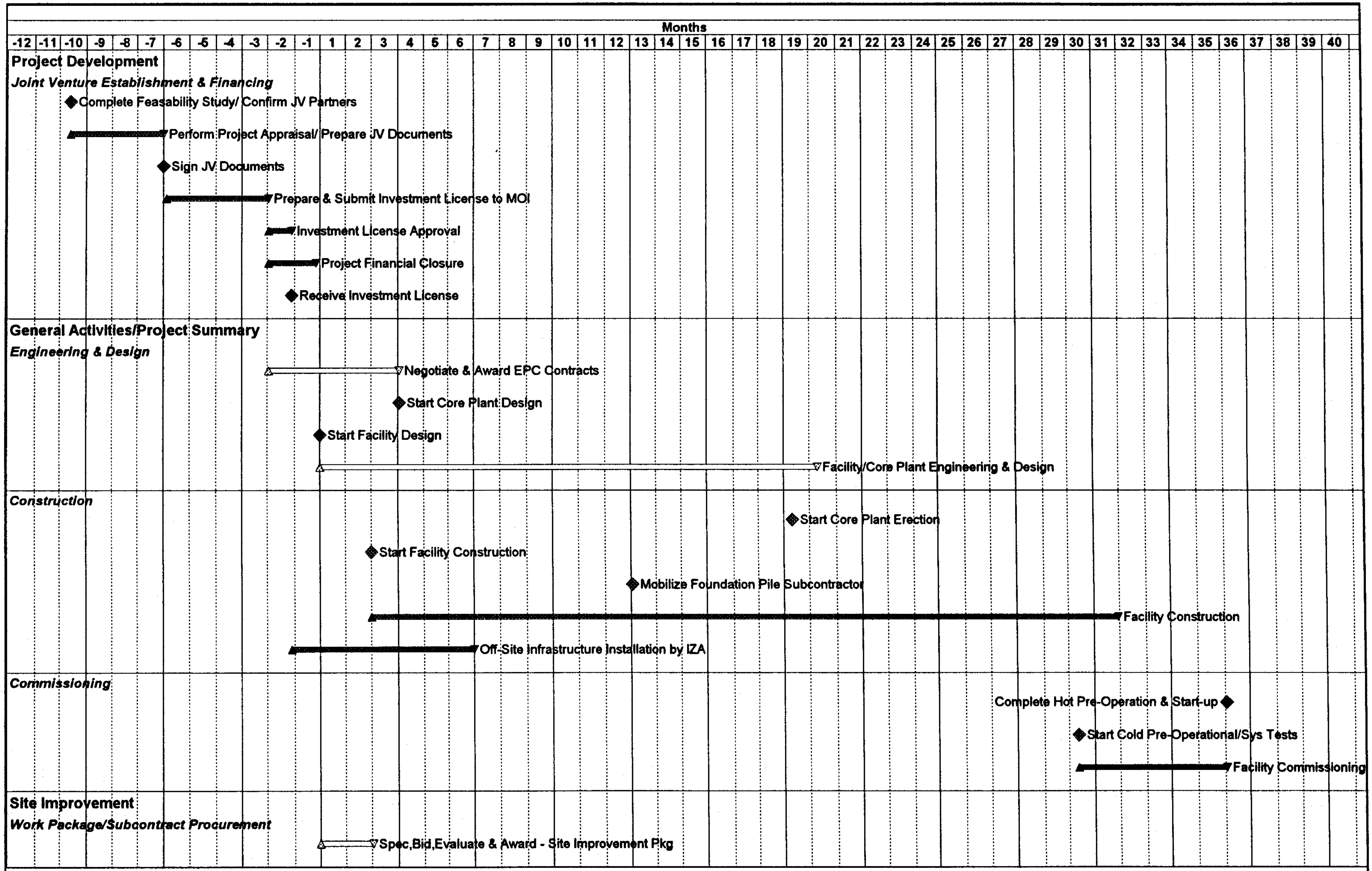

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SECTION 13.0

CAPITAL COST ESTIMATE

13.1 General

The capital cost estimate has been developed for the Project in accordance with the design basis and facility drawings included in the Report. These facility drawings (Appendix IX) have been prepared by both MIDREX (Process Plant Supplier) and UEI based on preliminary engineering efforts conducted for this study. The development of the cost estimate has also been a joint effort; and the total Project Capital Cost of US $398,400,000 can be divided into the following two categories:

- **Plant Capital Cost**
  - Core Plant complete with material handling and civil works within its boundary limits – US $215,000,000.
  - Balance of Plant including port facility, site improvements and remaining material handling system - US $128,500,000.
- **Other Capital Costs**
  - Include costs of financing, insurance, taxes and duties, development, pre-operation expenses and contingencies - US $59,400,000.

The Core Plant cost estimate is based on MIDREX'S historical cost data of equipment, materials and services for the defined Scope of Work for the Project, and one of its authorized construction licensees' budgetary prices for installations, including construction management services.

Non-core equipment and materials prices have been based on various budgetary quotes from USA and Indian vendors. UEI has obtained prices from various Vietnamese subcontractors to establish construction labor and subcontracts costs for the balance of plant estimate.

The costs of land lease and the contribution to the Industrial Zone Authority for offsite improvements have been considered as operating expenses.

13.1 General (continued)

The estimated quantities for the Plant capital costs are included in the Appendix X and a summary in subsection 13.2. The estimate does not include costs of the optional longer berthing area of the Port Facility with separate loader and unloader equipment (estimated $11.5 million), railroad track (estimated $1 million), gas turbine option for the core plant process gas compressors (estimated $8.0 million) and is based on filling the site approximately 60 percent to accommodate the currently planned facilities. No future provisions have been included in the estimate.

The level of accuracy of this estimate shall be considered as (-)5 to (+)10 percent. Escalation of the Plant capital costs is not included.

13.2 Major Commodities Estimate

A summary of the estimated quantities included in the capital cost estimate is tabulated below:

COMMODITIES	QUANTITIES			
	Core Plant	BOP	Port	Total
Piles (m)	89,500	20,500	38,500	148,500
Concrete (m3)	17,800	3,600	13,600	35,000
Steelwork (metric tons)	4,750	300	0	5,050
Piping – All (m)	27,800	16,700	0	44,500
Cables – All (m)	274,000	123,500	0	397,500
Cable Trays (m)	6,350	4,350	0	10,700
Conduits – All (m)	39,700	40,700	0	80,400
Ductwork Casing (metric tons)	925	0	0	925
Insulation (m^2)	4,500	0	0	4,500
Refractory (metric tons)	2,800	0	0	2,800

13.3 Breakdown Of Cost Estimate

13.3.1 Plant Capital Costs (all in US dollars)

• Core Plant Equipment	$ 97,310,000
• Non-Core Equipment (excluding Port Facility)	$ 41,545,000
• Site Filling & Compaction - Complete	$ 8,425,000
• Port Facility – Complete	$ 24,930,000
• Facility Structures – Complete	$ 5,360,000
• Construction Materials[a]	$ 47,625,000
• Construction Labor[a] (including Construction Management & Start-up)	$ 81,165,000
• Professional Services (Engineering and Project Management)	$ 27,490,000
- Core Plant ($12,830,000)	
- Balance of Plant ($14,660,000)	
• Process Technology Fee	$ 9,650,000
• **Sub Total**	**$343,500,000**

(a) Exclude: Site Filling & Compaction, Port Facility and Facility Structures.

A detailed breakdown of the plant costs estimate is in Table 13-1.

13.3 Breakdown Of Cost Estimate (continued)

13.3.2 Other Capital Costs (all in US dollars)

A breakdown of other capital costs between foreign and local currencies is included in Table 13-2.

• Interest During Construction	$28,300,000
• Insurances	$ 1,700,000
• VAT/Local Taxes and Duties[(a)]	$ 0
• Development[(b)]	$10,700,000
• Pre-operation[(c)]	$ 11,800,000
• Contingencies - Non-EPC	$ 2,400,000
• **Subtotal**	**US $ 54,900,000**

(a) The Project is exempt of all Vietnamese Taxes and Duties.

(b) Include: JV Formation Costs, Investment License & Legal Expenses, Permit Fees, Developer's Fee.

(c) Include: Operations, Maintenance and Administrative Personnel Salaries and Expenses during Plant Construction and Start-Up, Host Plant Training Costs, Raw Materials/Utilities Costs during Start-Ups.

13.3.3 TOTAL PROJECT CAPITAL COSTS ESTIMATE - **US $398,400,000**

DIRECT REDUCTION PLANT IN VIETNAM
FEASIBILITY STUDY

PLANT COST ESTIMATE – DETAILED BREAKDOWN
TABLE 13-1

FC = Foreign Currency Equivalent in US$
LC = Local Currency Equivalent to US$

ELEMENTS	INFRASTRUCTURES & BOP			CORE PLANT			TOTAL PLANT		
	FC $X1000	LC $X1000	TOTAL $X1000	FC $X1000	LC $X1000	TOTAL $X1000	FC $X1000	LC $X1000	TOTAL $X1000
A. Facilities Cost-Installed									
1. Raw Material Handling System	19,877	9,566	29,443	-	-	-	19,877	9,566	29,443
2a. Core Plant – Equipment & Structures	-	-	-	157,489	22,610	180,099	157,489	22,610	180,099
2b. Core Plant – Civil	-	-	-	2,344	15,528	17,872	2,344	15,528	17,872
2c. Core Plant – Buildings	-	-	-	1,667	712	2,379	1,667	712	2,379
3. Water Distribution System	6,204	2,182	8,386	-	-	-	6,204	2,182	8,386
4. Power Distribution System	10,953	1,958	12,911	-	-	-	10,953	1,958	12,911
5. N.G. Distribution System	168	164	332	-	-	-	168	164	332
6. Mobile Equipment	5,455	0	5,455	-	-	-	5,455	0	5,455
7. Captive Port	14,543	10,388	24,931	-	-	-	14,543	10,388	24,931
8. BOP	2,204	1,500	3,704	-	-	-	2,204	1,500	3,704
Subtotal (A)	**$59,404**	**$25,758**	**$85,162**	**$161,500**	**$38,850**	**$200,350**	**$220,904**	**$64,608**	**$285,512**
B. Land And Site Development									
1. Land (Excluded)	-	-	-	-	-	-	-	-	-
2. Site Survey	0	128	128	-	-	-	0	128	128
3. Soils Investigation	0	446	446	-	-	-	0	446	446
4. Site Development	0	11,916	11,916	-	-	-	0	11,916	11,916
Subtotal (B)	**0**	**$12,490**	**$12,490**	-	-	-	**0**	**$12,490**	**$12,490**
C. Ancillary Buildings									
1. Repair Shop/Storage	798	262	1,060	-	-	-	798	262	1,060
2. Administration/Lunchroom	970	467	1,437	-	-	-	970	467	1,437
3. Others	53	23	76	-	-	-	53	23	76
Subtotal (C)	**$1,821**	**$752**	**$2,573**				**$1,821**	**$752**	**$2,573**

DIRECT REDUCTION PLANT IN VIETNAM
FEASIBILITY STUDY

PLANT COST ESTIMATE – DETAILED BREAKDOWN
TABLE 13-1

FC = Foreign Currency Equivalent in US$
LC = Local Currency Equivalent to US$

ELEMENTS	INFRASTRUCTURES & BOP			CORE PLANT			TOTAL PLANT		
	FC $X1000	LC $X1000	TOTAL $X1000	FC $X1000	LC $X1000	TOTAL $X1000	FC $X1000	LC $X1000	TOTAL $X1000
D. Engineering & Management Services									
1a. Design Engineering	7,836	500	8,336	12,830	0	12,830	20,666	500	21,166
1b. Procurement	1,810	0	1,810	Included	w/	A.2a	1,810	0	1,810
2a. Construction Management	8,116	127	8,243	Included	w/	A.2a	8,116	127	8,243
2b. Start-up/Commissioning	911	0	911	1,820	0	1,820	2,731	0	2,731
3. Project Management	4,516	0	4,516	Included	w/	D.1 & A.2a	4,516	0	4,516
Subtotal (D)	**$23,189**	**$627**	**$23,816**	**$14,650**	**-**	**$14,650**	**$37,839**	**$627**	**$38,466**
E. Construction Facilities									
1. Site Offices	0	1,823	1,823	Included	w/	A.2a	0	1,823	1,823
2. Construction Storage & Handling	0	608	608	Included	w/	A.2a	0	608	608
3. Construction Water & Power	0	1,846	1,846	Included	w/	A.2a	0	1,846	1,846
4. Construction Roads	0	182	182	-	-	-	0	182	182
5. Construction Camp	0	0	0	-	-	-	0	0	0
Subtotal (E)	**0**	**$4,459**	**$4,459**	**-**	**-**	**-**	**0**	**$4,459**	**$4,459**
Plant Costs (A) + (B) + (C) + (D) + (E)	**$84,414**	**$44,086**	**$128,500**	**$176,150**	**$38,850**	**$215,000**	**$260,564**	**$82,936**	**$343,500**

Note: a) FC and LC Splits are preliminary and meant for Financial Analysis only.

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DIRECT REDUCTION PLANT IN VIETNAM

FEASIBILITY STUDY

BREAKDOWN OF OTHER CAPITAL COSTS

Table 13-2

FC = Foreign currency equivalent in US $

LC = Local currency equivalent to US $

ELEMENTS	FC $ X1000	LC $ X1000	TOTAL $ X1000
1. Interest during construction	23,300	5,000	28,300
2. Insurances	1,300	400	1,700
3. VAT/Local Taxes and Duties	0	0	0
4. Development	4,700	6,000	10,700
5. Pre-operation Costs	8,600	3,200	11,800
6. Contingencies	1,500	900	2,400
TOTAL	**39,400**	**15,500**	**54,900**

SECTION 14.0

PLANT OPERATIONS PLAN

14.1 General

The Plant business program organizational structure is outlined in Table 14-1. The Production Plant, Sales Department and Management and Administration Department will report to the Company General Director, who will be assisted by two deputies. Total company personnel, excluding transportation and security personnel, will be 140. A detailed breakdown of all personnel is included in Subsection 14.2.

The net annual operating time for the plant will be 325 days per year (7,800 hours/year) in a continuous operating mode everyday. The scheduled maintenance downtime for the plant is 20 days per year. The planned production rate is 183.3 tons per hour or 4400 metric tons daily.

14.2 Manning Requirements

The Plant total manning requirements are based on the data furnished Midrex for operations of a core plant, industry practices for operating a similar port facility and material handling systems and VSC's input for the management, administration, and sales personnel. The numbers of personnel by categories are estimated as follows:

- **Board of Directors** **3**
    - General Director (1)
    - Deputy Directors (2)

- **Management and Administration** **12**
    - Chief of Department (1)
    - Chief Accountant (1)
    - Accountant & Financial Officers (2)
    - Human Resources Manager (1)
    - Administrative Assistants (4)
    - Secretaries/Clerks (3)

14.2 Manning Requirements (continued)

- **Operations** **77**

  - Operations Superintendent (1)
  - Process/Operations Engineers (2)
  - Water Treatment Engineer (1)
  - Shift Foremen (4)
  - Control Room Shift Operators (8)
  - Field Shift Operators (16)
  - Material Handling Shift Supervisors (4)
  - Material Handling Shift Operators (14)
  - Port Material Handling Shift Operators (6)
  - Briquetting Machine Shift Operators (8)
  - Process/Laboratory Shift Technicians (4)
  - Shift Labors (9)

- **Maintenance** **43**

  - Maintenance Engineer (1)
  - Mechanical Maintenance Superintendent (1)
  - Electrical/Instr. Maintenance Superintendent (1)
  - General Plant Shift Mechanics (12)
  - Briquetting Machine Shift Mechanics (8)
  - Pipe Filters (2)
  - Welders (2)
  - Shift Electricians/Instr. (10)
  - Shift Laborers (6)

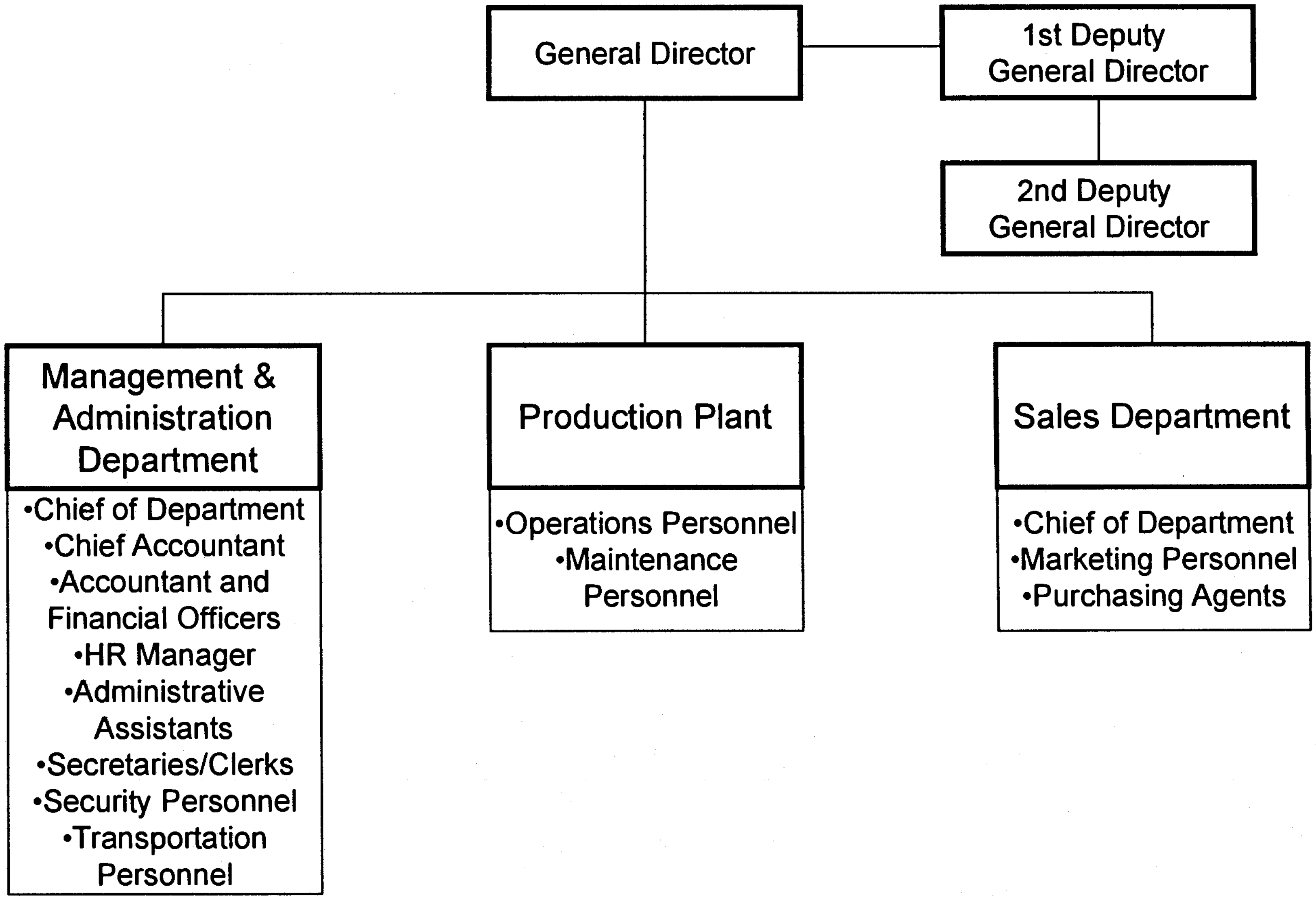
- **Sales & Marketing** **5**

  - Chief of Department (1)
  - Marketing Personnel (2)
  - Purchasing Agents (2)

- **Total Plant Personnel** **140**

Plant Operations Organization Chart

Table 14-1



SECTION 15.0

OPERATIONS COST ESTIMATE

15.1 Operating Parameters

15.1.1 Core Plant

A typical Core Plant operating parameters, based on 4400 metric tons per day with 93% metallization and 1.2 ~ 1.8 % carbon, are listed as follows:

Parameters	Specific Consumption per ton of HBI
Iron Oxide	1.45 t
Natural Gas	2.50 net Gcal
Electricity	120 kWh
Make-up Water	0.5 m^3
Oxide Coating	1 kg
Chemicals for Water Treatment	US $ 0.35
Maintenance Supplies	US $ 5.00 [(1)]
Briquette Segments	US $ 1.00
Personnel	0.16 hour

NOTE: [(1)] US $ 5.30 for Gas Turbine Option

15.1.2 Port Facility and Balance of Plant

The estimated utilities, maintenance supplies and personnel requirements per year are as follows:

- Electricity 23,700,000 kWh
- Natural Gas 36,000 Nm^3
- Industrial Water 50,000 m^3
- Personnel 80,000 hours
- Maintenance Supplies $2,500,000

15.2 Annual Cost of Production

15.2.1 General

The estimates of the annual production cost of the proposed Vietnam HBI project are presented in this subsection. The various cost components have been discussed, and the production cost of HBI has been assessed.

The annual production cost includes manufacturing costs, overheads and fixed charges such as depreciation and financial costs.

15.2.2 Manufacturing Costs

Manufacturing costs cover raw materials, energy, water, labor and supervision, repair and maintenance as well as consumables.

a. *Raw Materials* - The raw materials required for operating the HBI plant are iron oxide pellets and lump iron ore. The potential supply sources of the raw materials and their annual requirements, as well as the assembly cost of the raw materials have been discussed below:

- Potential Supply Sources - MIDREX, the process supplier of the HBI plant, has designed the plant based on a feed mix comprising 90 per cent pellets and 10 per cent lump ore.

  The proportion of pellets and lump ore in the feed mix, as well as the sources for supply of the materials, depend on the economics of raw materials assembly for a particular location, and hence vary from plant to plant.

  Midrex HBI plants worldwide are operating with varying proportions of pellets and lump ore, without comprising the plant productivity. The feed mix in Midrex HBI plants constitutes between 50 to 90 per cent pellets and 10 to 50 per cent lump ore.

15.2 Annual Cost of Production (continued)

For the proposed Vietnam HBI project, based on considerations of availability and proximity, the following are the potential sources of supply of pellets and lump ore:

Pellets

- CVRD, Brazil
- GIIC, Bahrain
- Kudremukh, India
- Essar, India

Lump Ore

- Bailadila, India
- Mutuca, Brazil

Confirmation of interest for supply of the respective feed materials for the project has already been received from GIIC and various other sources in India. A definitive supply arrangement with the respective suppliers on a long-term basis will be established soon after completion of the DFS.

- Annual Requirements - The alternative feed mixes considered for the study and the annual requirements of the raw materials are given in the following table:

15.2 Annual Cost of Production (continued)

Feed Material		Alternative 1		Alternative 2		Alternative 3	
Type	Source	Proportion In Feed Mix	Requirements	Proportion In Feed Mix	Requirements	Proportion In Feed Mix	Requirements
		%	mtpa	%	mtpa	%	mtpa
A. Pellets							
CVRD	Brazil	26	0.54	52	1.07	66	1.37
GIIC	Bahrain	24	0.50	24	0.50	24	0.50
Sub-total (A)		**50**	**1.04**	**76**	**1.57**	**90**	**1.87**
B. Lump Ore							
Bailadila	India	50	1.04	24	0.50	10	0.21
Total (A+B)		**100**	**2.07**	**100**	**2.07**	**100**	**2.07**

Feed Material		Alternative 4		Alternative 5		Alternative 6	
Type	Source	Proportion In feed Mix	Requirements	Proportion In Feed Mix	Requirements	Proportion In Feed Mix	Requirements
		%	mpta	%	mpta	%	mpta
A. Pellets							
CVRD		26	0.54	52	1.07	66	1.37
GIIC		24	0.50	24	0.50	24	0.50
Sub-total (A)		**50**	**1.04**	**76**	**1.57**	**90**	**1.87**
B. Lump Ore							
Mutuca		50	1.04	24	0.50	10	0.21
Total (A+B)		**100**	**2.07**	**100**	**2.07**	**100**	**2.07**

- Prices - International prices of iron oxide pellets and lump ore fell by about 11 to 15 per cent in 1999 as a result of the global recession in the iron and steel industry. However, with the revival of the steel market, there has been a gradual recovery in the demand for iron oxide feedstock, and major international suppliers of pellets and lump ore have been able to strike a deal for increase in prices for the year 2000.

- The unit prices adopted for pellets and lump ore for the study are given below:

Source	Fe Content %	Unit Price US Cents/Fe Units	FOB Cost US$/Ton	Freight US$/Ton	Landed Cost US$/Ton
CVRD Pellets, Brazil	68.20	52.90	36.11	14.00	50.11
GIIC Pellets, Bahrain	67.40	57.86	39.00	6.50	45.50
Bailadila Ore, India	67.00	47.45	31.79	6.00	37.79
Mutuca Ore, Brazil	67.00	49.96	33.47	14.00	47.47

Sources: 1) Skillings Mining Review, March 18, 2000
2) American Metal Market, March 29, 2000

15.2 Annual Cost of Production (continued)

- Assembly Cost of Raw Materials Based on the unit price of pellets and lump ore indicated for the study above, and the alternative feed mixes considered in the following, the assembly costs of raw materials are computed in the following Table:

ASSEMBLY COSTS OF RAW MATERIALS				
Feed Mix	**Raw Material Sources**	**Annual Requirements**	**Landed Cost**	**Total Assembly Cost**
		million tons	US$/ton	million US$
Alternative 1 (Base Feed Mix)	CVRD Pellets, Brazil	0.54	50.11	26.91
	GIIC Pellets, Bahrain	0.50	45.50	22.75
	Bailadila Lump Ore, India	1.04	37.79	39.19
	Sub-Total (alt. 1)	**2.07**	**42.92**	**88.85**
Alternative 2	CVRD Pellets, Brazil	1.07	50.11	53.81
	GIIC Pellets, Bahrain	0.50	45.50	22.75
	Bailadila Lump Ore, India	0.50	37.79	18.90
	Sub-total (alt. 2)	**2.07**	**46.12**	**95.46**
Alternative 3	CVRD Pellets, Brazil	1.37	50.11	68.44
	GIIC Pellets, Bahrain	0.50	45.50	22.75
	Bailadila Lump Ore, India	0.21	37.79	7.82
	Sub-total (alt. 3)	**2.07**	**47.84**	**99.02**
Alternative 4	CVRD Pellets, Brazil	0.54	50.11	26.91
	GIIC Pellets, Bahrain	0.50	45.50	22.75
	Mutuca Lump Ore, Brazil	1.04	47.47	49.23
	Sub-total (alt. 4)	**2.07**	**47.77**	**98.89**
Alternative 5	CVRD Pellets, Brazil	1.07	50.11	53.81
	GIIC Pellets, Bahrain	0.50	45.50	22.75
	Mutuca Lump Ore, Brazil	0.50	47.47	23.74
	Sub-total (alt. 5)	**2.07**	**48.45**	**100.30**
Alternative 6	CVRD Pellets, Brazil	1.37	50.11	68.44
	GIIC Pellets, Bahrain	0.50	45.50	22.75
	Mutuca Lump Ore, Brazil	0.21	47.47	9.83
	Sub-total (alt. 6)	**2.07**	**48.80**	**101.02**

- Adopted Feed Mix - It will be observed from the previous table that the raw materials assembly cost would be the most economical in case of Alternative 1. Accordingly, a feed mix comprising 26 per cent CVRD pellets, 24 per cent GIIC pellets and 50 per cent Bailadila lump ore has been adopted as the Base Case feed mix for the purpose of this study.

b. *Energy* - Energy for the HBI plant is required in the form of natural gas and electrical power. The annual requirements of natural gas and electric power, as well as their unit prices are discussed below:

15.2 Annual Cost of Production (continued)

- Annual Requirements - The overall requirements of energy in terms of natural gas and electric power, estimated on the basis of the operating parameters indicated in the Subsection 15.1 is given in the following table:

ESTIMATED ENERGY REQUIREMENTS		
Energy	**Specific Consumption per ton of HBI**	**Annual Requirement**
A. Natural Gas		
- Core Plant	2.50 net Gcal	3.6 net million Gcal
- Outside Core Plant	-	324 net Gcal [1]
Sub-total (A)	2.50 net Gcal	**3.6 net million Gcal**
B. Electric Power		
- Core Plant	120 kWh	171.6 million kWh
- Outside Core Plant	16.6 kWh	23.7 million Kwh
Sub-total (B)	136.6 kWh	**195.3 million kWh**

NOTE: [1] Equivalent to 36,000 Nm^3

- Unit prices - Based on Circular No. 3863/VPCP-CN of September 28, 1998 issued by the Government of Vietnam as indicated in Section 9.0, Utilities, Subsection 9.2, the cost of natural gas has been capped at US$ 1.75 per million BTU, which is equivalent to about US$ 6.94 per Gcal.

  As indicated in Section 9.0, utilities, Subsection 9.3, 6.8 US cents per kWh has been adopted as the unit cost of electric power.

c. *Water* - The annual requirement and unit cost of water are discussed below:

- Annual Requirements - The make-up requirements of water for the plant is given below:

Plant Area	**Specific Consumption m^3/ton of HBI**	**Annual Requirement m^3**
Core Plant	0.50	715,000
Outside Core Plant	0.03	50,000
Total	0.53	**765,000**

15.2 Annual Cost of Production (continued)

- Unit prices - As indicated in Section 9.0, Utilities, Subsection 9.4, 32 US cents per cu.m has been adopted as the unit cost of water.

d. *Labor and Supervision* - The manpower requirements of the works, and the annual wage bill including benefits, are discussed below:

- Works Manpower Requirements and Salaries - The manpower requirements for operation and maintenance under various categories have been considered as intensified in Section 14.0. The salaries, including associated benefits, for each category have been adopted as indicated by VSC. Total works manpower requirements and annual salaries are presented in the following table.

WORK MANPOWER REQUIREMENTS AND ANNUAL SALARIES			
Category	**No. of Works Personnel**	**Salary Including Benefits**	**Annual Salaries US $**
Executives	2	14,000	28,000
Managers	5	6,500	32,500
Senior Staff	14	5,200	72,800
Junior Staff	84	3,900	327,600
Labor	15	2,600	39,000
Total	**120**		**499,900**

e. *Expatriate Changes* - A provision of $242,000 per annum has been made to cover costs of 5 experts in operation and maintenance of the Midrex HBI Plant for the first 2 years of operation.

f. *Repair/Maintenance and Consumables* - The major items of cost under this category include water treatment chemicals, lime for coating of oxide feed, briquetting machine segments, and expenses towards maintenance of the plant.

15.2 Annual Cost of Production (continued)

The total expenses for repair/maintenance and consumables have been estimated in the following table:

ANNUAL REPAIR/MAINTENANCE AND CONSUMABLE COSTS		
Items	**Specific Consumption per ton of HBI**	**Annual Costs million US $**
Chemicals for Water Treatment		
- Core Plant	US $ 0.35	0.50
- Outside Core Plant	US $ 0.35	0.50
Sub-total	US $ 0.70	**1.00**
Lime for Oxide Coating	1 kg	**0.21**
Maintenance Supplies		
- Core Plant	US $ 5.00	7.15
- Outside Core Plant	US $ 1.75	2.50
Sub-total	US $ 6.75	**9.65**
Briquette Segments	US $ 1.00	**1.43**
Total		**12.29**

15.2.3 Administrative overheads include personnel, rent/leasing costs, material and services and insurance charges. Sales overheads comprise salaries for marketing staff and other direct marketing costs.

a. *Salaries for Administrative and Sales Personnel* - Annual salary for administrative and sales personnel have been estimated based on the number of personnel and annual salaries including associated benefits, as identified in Section 14.0 and is presented in the following table:

15.2 Annual Cost of Production (continued)

ADMINISTRATIVE AND SALES OVERHEADS					
	No. of Personnel				
Category	Administrative	Sales	Total	Salary Including Benefits US$/Man-Year	Total Annual Salaries US$
Board of Directors	-	-	3	14,000	42,000
Executives	1	-	1	14,000	14,000
Manager	2	1	3	6,500	19,500
Senior Staff	3	2	5	5,200	26,000
Junior Staff	3	2	5	3,900	19,500
General	3	-	3	2,600	7,800
Total	**12**	**5**	**20**		**128,800**

b. *Rent/Lease/Other Costs* - Rent/leasing and other costs payable to the Government of Vietnam for utilizing various facilities have been estimated based on the following data/information furnished by VSC:

- 10 hectares of off-shore land @ US$ 75 per hectare per year.
- 50 hectares of on-shore land @ 27 US cents per m^2 per year.
- US $1,000,000 per year towards sea-bed dredging and off-site facilities namely, natural gas pipeline, electric power line and approach road up to the plant boundary.

Provision for material and services as well as for direct marketing have been made to cover all expenses other than salaries and wages for the administrative and sales personnel. Insurance charges for the plant facilities has been provided at 0.50 per cent of the cost of the facilities.

15.2.4 Cost Escalation

Cost escalation has been factored into the annual operating cost estimate, as follows:

- Escalation on salaries, including benefits @ 2 per cent per year.

15.2 Annual Cost of Production (continued)

- Incremental escalation on all other expenses at 5-year intervals.

15.2.5 Capacity Utilization

The past performance record of Midrex plants worldwide has established that rated capacities can be achieved in a fairly steep manner. However, considering the proposed project will be the first of its kind in Vietnam, a reasonable learning curve to rated capacity utilization has been considered as follows:

Year of Operation	Capacity Utilization %
1st (2004)	80
2nd Onwards	100

15.2.6 Annual Production Cost

The annual production cost in the first year of plant operation at 100 per cent capacity utilization level is tabulated in Table 15-1 and summarized below:

ANNUAL PRODUCTION COST FIRST YEAR OF FULL PRODUCTION	
Item	**Production Cost US $ million**
A. Factory Cost	
1 - Raw Material	91.07
2 - Natural Gas	24.83
3 - Labor and Supervision	0.76
4 - Other Costs	26.47
Sub-total (A)	**143.12**
B. Overheads- Administrative/Sales	3.80
C. Total Operating Cost (A+B)	**146.92**

It will be observed from the above table that the production costs in the first year of full production is estimated to be about US $103 per ton HBI.

15.2 Annual Cost of Production (continued)

15.2.7 Effect of Gas Turbine Option

The effect of the use of gas turbines on annual production costs in the first year of plant operation at 100 percent capacity utilization is given below:

Item	Specific con-sumption per ton HBI	Effect on annual manufacturing expenses	
		Consumption	Value million US $
Natural gas	2.66 net Gcal	(+) 0.23 million Gcal	(+) 1.59
Electric power	65 kWh	(-) 78.65 million kWh	(-) 5.48
Repair and maintenance (1)	US $ 5.30		(+) 0.44
Total			**(-) 3.45**

NOTE: (1) Excluding briquette segments

In summary, the total annual production costs will be US $143.47 million, a reduction of US $3.45 million which amounts to net savings of about US $2.40 per ton HBI

15.3 Operating Costs[a] - Summary (US $/ton of HBI)

- Iron Oxides[b] (Pellets & Lump Ores) = $63.69
- Natural Gas = $17.36
- Electricity = $ 9.51
- Water = $ 0.17
- Consumables = $1.90
- Repair & Maintenance Supplies = $6.92
- Labor & Supervision = $0.53
- Administrative/Sales/Leases/Others = $2.65

Total =$102.73

Notes:

(a) With appropriate escalation
(b) Based on 50 percent pellets and 50 percent lump ores.

Table 15-1
ANNUAL PRODUCTION COSTS IN FIRST YEAR OF FULL PRODUCTION
(million US $)

Item	Annual expenses								
	Variable cost			Fixed cost			Grand total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. Factory cost									
1. Raw materials									
- Lump iron ore: Bailadila, India	40.17		40.17				40.17		40.17
- Pellet: CVRD, Brazil	27.58		27.58				27.58		27.58
GIIC, Bahrain	23.32		23.32				23.32		23.32
Sub-total (A.1)	**91.07**		**91.07**				**91.07**		**91.07**
2. Natural gas		19.86	19.86		4.97	4.97		24.83	24.83
3. Labor and supervision				0.24	0.52	0.76	0.24	0.52	0.76
4. Other conversion costs									
- Consumables	2.71		2.71				2.71		2.71
- Power		10.89	10.89		2.72	2.72		13.61	13.61
- Water		0.20	0.20		0.05	0.05		0.25	0.25
- Repair and maintenance	4.95		4.95	4.95		4.95	9.89		9.89
Sub-total (A.4)	**7.66**	**11.09**	**18.75**	**4.95**	**2.77**	**7.72**	**12.60**	**13.86**	**26.47**
Sub-total (A)	**98.72**	**30.95**	**129.68**	**5.19**	**8.26**	**13.45**	**103.91**	**39.21**	**143.12**
B. Administrative overheads									
1. Salary and wages					0.11	0.11		0.11	0.11
2. Material and services					0.21	0.21		0.21	0.21
3. Rent / leasing costs					1.22	1.22		1.22	1.22
4. Insurance					1.72	1.72		1.72	1.72
Sub-total (B)					**3.25**	**3.25**		**3.25**	**3.25**
C. Sales overheads									
1. Salaries					0.03	0.03		0.03	0.03
2. Other direct cost					0.52	0.52		0.52	0.52
Sub-total (C)					**0.54**	**0.54**		**0.54**	**0.54**
D. Manufacturing expenses (A to C)	**98.72**	**30.95**	**129.68**	**5.19**	**12.06**	**17.24**	**103.91**	**43.01**	**146.92**

<u>Note:</u> All costs include appropriate escalation.

SECTION 16.0

FINANCIAL ANALYSIS

16.1 General

This Section presents the financial aspects of the proposed project based on the capital cost discussed in Section 13.0 and the annual production cost presented in Section 15.0 In addition, sensitivity analyses for different capital cost scenarios have been presented in sub-section 16.10.

The financial results over a 15-year operating period have been projected. The internal rate of return, break even point, payback period and debt-service coverage ratio have also been assessed.

Appendix XI contains the Report on Financial Analysis as prepared by Dastur as part of the TDA supplementary grant.

16.2 Means of Financing

The capital cost of the Project has been estimated at about US $398.4 million. The project is proposed to be financed at a 70:30 debt-equity ratio, as indicated by VSC.

An amount of US $32 million is required as working capital, of which US $27 million will be available as short term loan from commercial banks.

The financing pattern for the capital investment and working capital on the project is presented in the following table:

MEANS OF FINANCING			
Financing Pattern	**Foreign Currency million US $**	**Equivalent Local Currency million US $**	**Total million US $**
A. Project			
- Equity	83.92	35.60	119.52
- Long term loan	215.98	62.90	278.88
Sub-total (A)	**299.90**	**98.50**	**398.40**
B. Working Capital			
- Internal generation	-	4.96	4.96
- Short term loan	-	27.15	27.15
Sub-total (B)	-	**32.11**	**32.11**
C. Total Capital Requirement (A + B)	**299.90**	**130.61**	**430.51**

16.3 Capital Phasing

The phasing of the capital requirement for implementation of the Project has been worked out on the basis of the schedule of activities indicated in Section 12.0 Yearwise fund requirements for the project have been estimated assuming that equity will be utilized initially, to be followed by loan withdrawal, and the same is indicated in the following table:

YEARWISE FUND REQUIREMENTS (million US $)			
Construction year (Go-ahead - 2000)	**Equity**	**Loan**	**Total**
1st	69.64	7.07	76.71
2nd	49.88	102.69	152.57
3rd	-	101.73	101.73
4th	-	67.39	67.39
Total	**119.52**	**278.88**	**398.40**

Total financing flow for the project is shown in Table 16-1.

16.4 Income

16.4.1 Sales Revenue

The Market Study on DR products had projected that by 2005 the selling price of HBI would be US $135-155 per ton on fob basis. Accordingly, it is estimated that in the first year of full production, the sales revenue will be about US $207 million, based on an average selling price of US $145 per ton HBI on fob basis.

16.4.2 Interest on Bank Deposit

It is proposed that the cash available every year will be treated as follows:

- Retain 10% profit in each year up to a cumulative of 50% of equity.
- Retain cash in hand to the tune of US $2 million every year to meet any operational contingencies.
- Balance cash will be reinvested on annual basis at an average interest rate of 5% per annun.

On the above basis, it is estimated that the interest earned from bank deposit in the second year of plant operation will be about US $0.65 million.

16.9 Financial Statements (continued)

16.4.3 Total Income

In the first year of full production, which is the second year of plant operation as mentioned in Subsection 15.2.5 (Capacity Utilization), the total income from sales revenue and interest on bank deposit will amount to about US $208 million.

16.5 Working Capital

The basis for estimating the working capital is given in the following table:

BASIS FOR ESTIMATION OF WORKING CAPITAL		
Item	**Minimum days of coverage**	
	Foreign component	**Local component**
Accounts receivable	30	30
Raw materials	30	15
Factory supplies	-	15
Spare parts	30	15
Finished products	-	15
Accounts payable	15	15

The working capital requirement is estimated at US $24 million in the first year of operation. It is assumed that 75 per cent of the working capital requirement will be available as bank loan for all items except wages and salaries. Details of estimation of the working capital requirement are presented in Table 16-2.

16.6 Fixed Charge

16.6.1 Depreciation

Depreciation has been estimated by the straight-line method based on following norms prevalent in Vietnam, as indicated by VSC:

Items	Depreciation norms by straight-line method %
Buildings	4
Plant equipment and machinery	10
Workshop equipment	10
Construction facilities	10

16.6.2 Interest Rates

- Long term loan for the project at 8.5 per cent per annum.

16.9 Financial Statements (continued)

- Short term financing for working capital at 10 per cent per annum.

16.7 Corporate Tax

The standard profit tax in Vietnam is 25 per cent and the preferred tax for iron and steel projects stands at 15 per cent. As indicated by VSC, the Vietnam HBI project, being in the 'Preferred Category Project' range, the preferred tax will be as follows:

Item	Corporate tax %
First 2 years profit	0
Following 3 years operation	7.5 (i.e. 50 per cent of preferred tax)
Balance of 12 years operation	15
After 12 years of operation	25

16.8 Escalation

16.8.1 Annual Manufacturing Expenses

Cost escalation has been factored into the annual manufacturing expenses, as follows:

- Escalation on salaries, including benefits @ 2% per year.Incremental escalation on raw materials, electric power, water, consumables as well as repair and maintenance costs at 5-year intervals as given below:

Year	Escalation %
2005 (1st year of operation)	2.5
2010 (6th year of operation)	2.5
2015 (11th year of operation)	2.5

16.8.2 Annual Sales Realization

The Market Study on DR Products has projected the following probable selling price of HBI up to the year 20010:

Year	Projected price of HBI (fob) US $ per ton
2002	130-145
2005	135-155
2010	145-170

Based on the above, the escalation in sales price of HBI has been adopted as follows:

Year	Adopted sales price of HBI (fob) US $ per ton
2002-04	135
2005-09	145
2010-14	155
2015-19	165

16.9 Financial Statements

16.9.1 Debt Service

It is assumed that long term loan from financial institutions will be repaid in sixteen (16) half-yearly installments commencing from second year of plant operation.

Working capital loan is expected to continue throughout plant operation.

Total debt service is presented in Table 16-3.

16.9.2 Cost of Product Sold

The annual cost of product sold during the 15 years operation of the plant has been estimated by adding fixed charges to the annual manufacturing expenses and the same is given in Table 16-4.

It may be noted that the cost of product sold in the second year of plant operation (first year at 100% capacity utilization) is expected to be about US $143 per ton HBI. However, with the gradual repayment of the debt and a consequent lowering of the interest charges on long term loans, the cost of product sold will come down to about US $110 per ton of HBI in the 11th year of operation of the plant.

16.9.3 Net income and cash flow statements

Taking into account the estimated annual cost of production and sales realization, the net income and cash flow statements have been prepared for a period of 15 years of operation of the Plant. These are presented in Tables 16-5 and 16-6, respectively.

It can be seen from the net income statement given in Table 16-5 that there will be a loss in the first year of operation when the plant is in its learning curve stage. However, there is no cash loss in that year of operation.

16.9.4 Payback period

The payback period for the project works out to be about 7 years from the date of commencement of plant operation.

16.9.5 Break-even capacity

An analysis has been made in Table 16-7 to arrive at the break-even capacity of the project during 15 years of plant operation.

The annual fixed charges have been worked out taking into account elements like labor and supervision, fixed component of operating services and assemblies, administrative and sales overhead costs, depreciation and financial costs. The variable costs comprise expenses towards raw materials, variable components of operating services and consumables.

The plant is expected to break even at about 95 per cent in the first year of full production, which is the second year of plant operation. The break-even capacity will improve in subsequent years of operation with the repayment of the long term loan.

16.9.6 Internal Rate Of Return And Net Present Value

The IRR and NPV have been worked out for 15 years of operation of the plant, considering the first year of construction as the base year.

NPV is worked out at a discounted rate of 9 per cent per year. While calculating the IRR, the residual value of the plant comprising of spares, total fixed assets net of accumulated depreciation and working capital have been considered at the 15th year of plant operation.

These have been worked out on total capital invested as well as the equity capital invested and are shown in Tables 16-8 and 16-9 respectively.

16.9.7 Debt-Service Coverage Ratio

Year-wise calculations of DSCR is shown in Tables 6-10. It may be observed that the average DSCR works out to 1.47 during the loan repayment period.

16.9 Financial Statements (continued)

16.9.8 Balance sheet

The balance sheet for the project is presented in Table 6-11.

16.9.9 Financial highlights

The financial highlights of the project in the first year of production at 100 per cent capacity utilization level (second year of plant operation) is presented in the following table:

FINANCIAL HIGHLIGHTS IN THE FIRST YEAR OF OPERATION AT RATED CAPACITY (SECOND YEAR OF OPERATION)	
Item	**Million US $**
Net sales realization	208
Annual operating cost (1)	147
Gross margin	61
Interest charges	24
Depreciation	33
Profit before tax	4
Corporate tax	0
Profit after tax	4
Break-even capacity	95%

NOTE:
(1) Includes administration and sales overheads.

The financial performance at the end of the 15-year operating period is summarized in the following Table:

FINANCIAL PERFORMANCE AFTER 15-YEAR OPERATING PERIOD	
Item	**Million US $**
Cumulative profit, million US $	552
Cumulative cash, million US $	609
IRR, %	
- On total investment	12.2
- On equity	15.8
NPV (discounted @ 9 per cent):	
- Total investment, million US $	87
- Equity, million US $	107
Pay back period, years	7
Average DSCR	1.47

16.10 Sensitivity Analyses

A series of sensitivity analyses have been conducted to assess the influence of variation in the capital requirement, raw material assembly cost and sales realization on the financial viability of the project. The effect of these variables on the IRR has been determined. The results of the sensitivity analyses are presented as follows:

SENSITIVITY ANALYSES

	Variables							
Capital cost million US $	**Feed-mix (1)**	**Raw material price %**	**Natural gas price** US $/mill BTU	**Power cost** US $/kWh	**Capacity utiliza-tion %**	**Sales realiza-tion %**	**Capital cost %**	**IRR %**
398 (Base)	Alt. 1	-	-	-	-	-	-	12.2
	Alt. 1	(+)5	-	-	-	-	-	11.1
	Alt. 1	-	1.50(2)	-	-	-	-	12.9
	Alt. 1	-	1.50(2)	0.065	-	-	-	13.0
	Alt. 1	-	1.50(2)	0.060	-	-	-	13.3
	Alt. 1	-	1.50	-	-	-	-	13.1
	Alt. 1	-	1.75	0.060	-	-	-	12.6
	Alt. 1	-	-	-	90	-	-	10.5
	Alt. 1	-	-	-	110(3)	-	-	13.6
	Alt. 1	-	-	-	-	(-)5	-	9.7
	Alt. 1	-	-	-	-	(+)5	-	14.7
	Alt. 1	-	-	-	-	-	(+)5	11.5
	Alt. 1	-	-	-	-	-	(+)10	10.8
	Alt. 2	-	-	-	-	-	-	10.6
	Alt. 2	-	-	-	-	(-)5	(-)10	9.3
	Alt. 3	-	-	-	-	-	-	9.6
	Alt. 4	-	-	-	-	-	-	9.9
	Alt. 5	-	-	-	-	-	-	9.4
	Alt. 6	-	-	-	-	-	-	9.2
395 (Case-1)	Alt. 1	-	-	-	-	-	-	12.4
383 (Case-2)	Alt. 1	-	-	-	-	-	-	12.8
362 (Case-3)	Alt. 1	-	-	-	-	-	-	13.7
357 (Case-4)	Alt. 1	-	-	-	-	-	-	13.9
407(4)	Alt. 1	-	-	-	-	-	-	12.7

Notes:

(1) Capital cost cases and raw material mix alternatives are defined in Section 16.0 and Section 15.0 respectively.

(2) With cost escalation of 2.5 per cent every 5 years.

(3) From third year onwards.

(4) With gas turbine.

16.10 Sensitivity Analyses (continued)

From the results of the sensitivity analyses presented above, the following could be concluded:

- Proper sourcing of iron oxide pellets and sized ore and their proportions in the feed mix are essential
- Any possible reduction in the price of natural gas will improve the project viability.
- Overall plant EPC costs need to be reduced.

NOTES:

- **Base Case**

  Plant Total Capital Cost Estimate as defined in Section 13.0 ~ $398 million.

- (Case - 1) - Base Cost Estimate is reduced by $3.0 million by assuming favorable negotiations of certain off-shore purchased equipment ~ $395 million.
- (Case - 2) - Case 2 Cost Estimate is further reduced by $12.0 million with reduced allowances of initial spares ($4.5 million) and lower process license fee ($5 million versus $9.65 million in base case) ~ $383 million.
- (Case - 3) - Case 3 Cost Estimate is further reduced by 20% of the estimated cost of erection, construction management and construction facilities due to favorable negotiations ~ $362 million.
- (Case - 4) - Case 4 Cost Estimate is further reduced by about 5% of the Core Plant equipment/structure costs during final negotiations~ $357 million.

A comparison of plant EPC cost for different cases as outlined above are tabulated as follows:

FOREIGN AND LOCAL CURRENCY COMPONENTS UNDER VARIOUS PLANT COST SCENARIOS (million US $)					
Components	**Base Case**	**Case 1**	**Case 2**	**Case 3**	**Case 4**
Foreign currency					
- Sourced from the US	238	238	227	216	211
- Sourced from the Asian region	23	20	20	20	20
Sub-total	**261**	**258**	**246**	**236**	**231**
Local currency	83	83	83	74	74
Total	**344**	**341**	**329**	**310**	**305**

COMPARISON OF PLANT COST FOR DIFFERENT CASES UNDER CONSIDERATION

	Estimated Plant Cost, million US $				
Item	**Base Case**	**Case 1**	**Case 2**	**Case 3**	**Case 4**
- Material Handling System	29.443	26.740	26.740	25.163	25.163
- Core Plant	182.091	182.091	170.861	162.383	157.351
- Water Distribution System	8.386	8.205	8.205	7.394	7.394
- Power Distribution System	12.911	12.826	12.826	11.867	11.867
- Natural Gas Distribution System	0.332	0.332	0.332	0.269	0.269
- Mobile Equipment	5.455	5.455	5.455	5.455	5.455
- Captive Port	24.931	24.931	24.931	24.548	24.548
- BOP	3.704	3.704	3.704	3.392	3.392
Sub-total (A)	**267.253**	**264.284**	**253.054**	**240.471**	**235.439**
B. Land & Site Development	12.490	12.490	12.490	12.490	12.490
C. Ancillary Buildings	2.573	2.573	2.573	2.271	2.271
D. Engineering & Management Services	56.725	56.725	56.725	50.878	50.878
E. Construction Facilities	4.459	4.459	4.459	3.567	3.567
F. Plant Cost (A to E)	**343.500**	**340.531**	**329.301**	**309.677**	**304.645**

Table 16-1
FLOW OF FINANCIAL RESOURCES
(million US $)

Source of finance		Total value	Constrn. period, yrs			Operating period, years														
			1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Equity capital																				
1. Foreign	FC	83.92	51.68	32.24																
2. Local	LC	35.60	17.96	17.64																
Sub-total (A)		**119.52**	**69.64**	**49.88**																
B. Long term loan																				
1. Foreign	FC	215.98	6.42	83.92	75.38	50.26														
2. Local	LC	62.90	0.65	18.77	26.35	17.12														
Sub-total (B)		**278.88**	**7.07**	**102.69**	**101.73**	**67.39**														
C. Internal generation of working capital	LC	4.96				3.58	0.81	(0.01)			0.29					0.29				
D. Short term finance																				
1. Bank loan for working capita	LC	27.15				20.06	4.79	(0.01)			1.15					1.16				
2. Short term borrowing	LC																			
Sub-total (D)		**27.15**				**20.06**	**4.79**	**(0.01)**			**1.15**					**1.16**				
E. Total financial flow (A to D)																				
1. Foreign	FC	299.90	58.09	116.16	75.38	50.26														
2. Local	LC	130.61	18.62	36.41	26.35	40.77	5.60	(0.02)			1.44					1.44				
Total (E)		**430.51**	**76.71**	**152.57**	**101.73**	**91.03**	**5.60**	**(0.02)**			**1.44**					**1.44**				

Table 16-2
TOTAL WORKING CAPITAL REQUIREMENT
(million US $)

Items	Co-efficient of turnover [1]	Bank finance %	1st year operation			2nd year operation		
			Amount	Bank finance	Margin money	Amount	Bank finance	Margin money
A. Current assets								
1. Total inventory								
- Raw materials								
(i) Pellets	12	75	3.39	2.54	0.85	4.24	3.18	1.06
(ii) Sized iron ore	12	75	2.68	2.01	0.67	3.35	2.51	0.84
Sub-total (i)			**6.07**	**4.55**	**1.52**	**7.59**	**5.69**	**1.90**
- Wage and salaries	24		0.03		0.03	0.03		0.03
- Repair and maintenance	24	75	0.37	0.28	0.09	0.41	0.31	0.10
- Consumables	24	75	0.10	0.07	0.02	0.12	0.09	0.03
- Power and natural gas	24	75	1.35	1.01	0.34	1.60	1.20	0.40
- Work in progress [2]		75						
- Stock of finished goods	24	75	5.04	3.78	1.26	6.12	4.59	1.53
Sub-total (A.1)			**12.95**	**9.69**	**3.26**	**15.88**	**11.89**	**3.99**
2. Accounts receivable	12	75	13.82	10.37	3.46	17.28	12.96	4.32
Sub-total (A)			**26.78**	**20.06**	**6.72**	**33.16**	**24.85**	**8.31**
B. Current liabilities								
1. Raw materials								
- Pellets	24		1.70		1.70	2.12		2.12
- Sized iron ore	24		1.34		1.34	1.67		1.67
Sub-total (B.1)			**3.04**		**3.04**	**3.79**		**3.79**
2. Consumables	24		0.10		0.10	0.12		0.12
3. Power and natural gas								
Sub-total (B)			**3.13**		**3.13**	**3.92**		**3.92**
C. Total working capital								
requirement (A - B)			**23.64**	**20.06**	**3.58**	**29.24**	**24.85**	**4.40**

NOTE:
(1) Co-efficient of turn over = 360/minimum days of coverage
(2) Total residence time of material inside the shaft furnace is about 8 - 10 hours; hence ignored

Table 16-3
TOTAL DEBT SERVICES
(million US $)

Source	Total value	Constrn. period, yrs			Operating period, years														
		1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Total long term loan																			
1. Disbursement	278.88	7.07	102.69	101.73	67.39														
2. Repayment	278.88					34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86						
3. Debt balance end of year		7.07	109.76	211.49	278.88	244.02	209.16	174.30	139.44	104.58	69.72	34.86							
4. Capitalized interest																			
5. Interest payable	112.60				23.70	21.48	18.52	15.56	12.59	9.63	6.67	3.70	0.74						
6. Other financial costs																			
B. Total short term loan																			
1. Disbursement	27.15				20.06	4.79	(0.01)			1.15					1.16				
2. Repayment																			
3. Debt balance end of year					20.06	24.85	24.84	24.84	24.84	25.99	25.99	25.99	25.99	25.99	27.15	27.15	27.15	27.15	27.15
4. Capitalized interest																			
5. Interest payable	38.51				2.01	2.48	2.48	2.48	2.48	2.60	2.60	2.60	2.60	2.60	2.71	2.71	2.71	2.71	2.71
6. Other financial costs																			
C. Total debt service																			
1. Disbursement	306.03	7.07	102.69	101.73	87.45	4.79	(0.01)			1.15					1.16				
2. Repayment	278.88					34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86						
3. Debt balance end of year		7.07	109.76	211.49	298.94	268.86	234.00	199.14	164.28	130.57	95.71	60.85	25.99	25.99	27.15	27.15	27.15	27.15	27.15
4. Capitalized interest																			
5. Interest payable	151.11				25.71	23.97	21.00	18.04	15.08	12.23	9.27	6.30	3.34	2.60	2.71	2.71	2.71	2.71	2.71
6. Other financial costs																			

Table 16-4
ANNUAL COST OF PRODUCT SOLD
(million US $)

Item	Operating period, years														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Capacity utilisation, %	80%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
A. Factory cost															
1. Variable cost															
(i) Raw materials															
- Sized iron ore: Bailadila, India	32.14	40.17	40.17	40.17	40.17	41.17	41.17	41.17	41.17	41.17	42.20	42.20	42.20	42.20	42.20
- Pellet : CVRD,Brazil	22.06	27.58	27.58	27.58	27.58	28.27	28.27	28.27	28.27	28.27	28.98	28.98	28.98	28.98	28.98
GIIC,Bahrain	18.66	23.32	23.32	23.32	23.32	23.90	23.90	23.90	23.90	23.90	24.50	24.50	24.50	24.50	24.50
Sub-total (A.1.i)	**72.85**	**91.07**	**91.07**	**91.07**	**91.07**	**93.34**	**93.34**	**93.34**	**93.34**	**93.34**	**95.68**	**95.68**	**95.68**	**95.68**	**95.68**
(ii) Others															
- Consumables	2.17	2.71	2.71	2.71	2.71	2.78	2.78	2.78	2.78	2.78	2.85	2.85	2.85	2.85	2.85
- Power	8.71	10.89	10.89	10.89	10.89	11.16	11.16	11.16	11.16	11.16	11.44	11.44	11.44	11.44	11.44
- Water	0.16	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
- Natural gas	15.89	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86
- Repair and maintenance	3.96	4.95	4.95	4.95	4.95	5.07	5.07	5.07	5.07	5.07	5.20	5.20	5.20	5.20	5.20
Sub-total (A.1.ii)	**30.89**	**38.61**	**38.61**	**38.61**	**38.61**	**39.08**	**39.08**	**39.08**	**39.08**	**39.08**	**39.56**	**39.56**	**39.56**	**39.56**	**39.56**
Sub-total (A.1)	**103.74**	**129.68**	**129.68**	**129.68**	**129.68**	**132.42**	**132.42**	**132.42**	**132.42**	**132.42**	**135.24**	**135.24**	**135.24**	**135.24**	**135.24**
2. Fixed cost															
(i) Labour and supervision	0.75	0.76	0.53	0.54	0.55	0.56	0.57	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.67
(ii) Power	2.72	2.72	2.72	2.72	2.72	2.79	2.79	2.79	2.79	2.79	2.86	2.86	2.86	2.86	2.86
(iii) Water	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
(iv) Natural gas	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97
(v) Repair and maintenance	4.95	4.95	4.95	4.95	4.95	5.07	5.07	5.07	5.07	5.07	5.20	5.20	5.20	5.20	5.20
Sub-total (A.2)	**13.44**	**13.45**	**13.21**	**13.23**	**13.24**	**13.44**	**13.45**	**13.46**	**13.47**	**13.49**	**13.70**	**13.71**	**13.72**	**13.73**	**13.75**
Sub-total (A)	**117.18**	**143.12**	**142.89**	**142.90**	**142.91**	**145.86**	**145.87**	**145.89**	**145.90**	**145.91**	**148.93**	**148.95**	**148.96**	**148.97**	**148.98**
B. Administrative overheads															
1. Salary and wages	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.14
2. Material and services	0.21	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
3. Rent/leasing costs	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
4. Insurance	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72
Sub-total (B)	**3.25**	**3.25**	**3.26**	**3.26**	**3.26**	**3.27**	**3.27**	**3.27**	**3.27**	**3.28**	**3.28**	**3.28**	**3.29**	**3.29**	**3.29**
C. Sales overheads															
1. Salaries	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
2. Other direct cost	0.41	0.52	0.52	0.52	0.52	0.55	0.55	0.55	0.55	0.55	0.59	0.59	0.59	0.59	0.59
Sub-total (C)	**0.44**	**0.54**	**0.54**	**0.54**	**0.55**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.62**	**0.62**	**0.62**	**0.62**	**0.62**
D. Manufacturing expenses (A to C)	**120.87**	**146.92**	**146.69**	**146.71**	**146.72**	**149.71**	**149.73**	**149.74**	**149.75**	**149.77**	**152.83**	**152.85**	**152.87**	**152.89**	**152.90**
E. Fixed charges															
1. Depreciation	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	2.46	2.46	2.46	2.46	2.46
2. Interest on long term loan	23.70	21.48	18.52	15.56	12.59	9.63	6.67	3.70	0.74						
3. Interest on short term loan	2.01	2.48	2.48	2.48	2.48	2.60	2.60	2.60	2.60	2.60	2.71	2.71	2.71	2.71	2.71
Sub-total (E)	**58.62**	**56.88**	**53.91**	**50.95**	**47.99**	**45.14**	**42.18**	**39.21**	**36.25**	**35.51**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**
F. Cost of product sold (D+E)	**179.49**	**203.80**	**200.61**	**197.66**	**194.71**	**194.85**	**191.91**	**188.95**	**186.01**	**185.28**	**158.01**	**158.02**	**158.04**	**158.06**	**158.08**

Table 16-5
NET INCOME STATEMENT
(million US $)

Item	Operating period, years														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Capacity utilisation (%)	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100
A. Total income	165.88	208.00	208.03	208.27	208.62	223.40	224.48	225.63	226.94	228.41	246.01	249.50	253.12	256.45	259.90
B. Less : variable costs															
1. Raw materials	72.85	91.07	91.07	91.07	91.07	93.34	93.34	93.34	93.34	93.34	95.68	95.68	95.68	95.68	95.68
2. Other variable cost	30.89	38.61	38.61	38.61	38.61	39.08	39.08	39.08	39.08	39.08	39.56	39.56	39.56	39.56	39.56
Sub-total (B)	**103.74**	**129.68**	**129.68**	**129.68**	**129.68**	**132.42**	**132.42**	**132.42**	**132.42**	**132.42**	**135.24**	**135.24**	**135.24**	**135.24**	**135.24**
C. Variable margin (A-B)	62.14	78.32	78.36	78.60	78.94	90.98	92.06	93.21	94.52	95.99	110.77	114.26	117.89	121.22	124.66
D. Less : fixed costs															
1. Labour and supervision	0.75	0.76	0.53	0.54	0.55	0.56	0.57	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.67
2. Marketing	0.44	0.54	0.54	0.54	0.55	0.58	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62	0.62
3. Other fixed cost	15.94	15.94	15.94	15.94	15.95	16.15	16.15	16.15	16.15	16.15	16.35	16.36	16.36	16.37	16.37
4. Depreciation	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	2.46	2.46	2.46	2.46	2.46
Sub-total (D)	**50.04**	**50.16**	**49.93**	**49.94**	**49.95**	**50.20**	**50.22**	**50.23**	**50.24**	**50.26**	**20.06**	**20.07**	**20.09**	**20.11**	**20.12**
E. Operational margin (C-D	12.10	28.17	28.43	28.66	28.99	40.78	41.84	42.98	44.27	45.73	90.71	94.19	97.79	101.11	104.54
F. Less : costs of finance	25.71	23.97	21.00	18.04	15.08	12.23	9.27	6.30	3.34	2.60	2.71	2.71	2.71	2.71	2.71
G. Gross profit / (loss) (E-F	(13.61)	4.20	7.43	10.62	13.91	28.55	32.58	36.68	40.93	43.13	88.00	91.48	95.08	98.39	101.82
H. Less : corporate tax				0.80	1.04	2.14	4.89	5.50	6.14	6.47	13.20	13.72	23.77	24.60	25.46
I. Net profit / (loss)															
1. Current (G-H)	**(13.61)**	**4.20**	**7.43**	**9.82**	**12.87**	**26.41**	**27.69**	**31.18**	**34.79**	**36.66**	**74.80**	**77.76**	**71.31**	**73.80**	**76.37**
2. Cumulative	**(13.61)**	**(9.41)**	**(1.99)**	**7.83**	**20.70**	**47.11**	**74.80**	**105.98**	**140.77**	**177.43**	**252.23**	**329.98**	**401.29**	**475.09**	**551.45**

Table 16-6
CASH FLOW STATEMENT
(million US $)

Item	Constrn. period, yrs			Operating period, years														
	1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Cash inflow																		
1. Inflow funds																		
- Total equity	69.64	49.88																
- Total long-term loans	7.07	102.69	101.73	67.39														
- Total short-term finance				20.06	4.79	(0.01)			1.15					1.16				
Sub-total (A.1)	**76.71**	**152.57**	**101.73**	**87.45**	**4.79**	**(0.01)**			**1.15**					**1.16**				
2. Inflow operation																		
- Sales revenue				165.88	207.35	207.35	207.35	207.35	221.65	221.65	221.65	221.65	221.65	235.95	235.95	235.95	235.95	235.95
- Interest on bank deposit					0.65	0.68	0.92	1.27	1.75	2.83	3.98	5.29	6.76	10.06	13.55	17.17	20.50	23.95
Sub-total (A.2)				165.88	208.00	208.03	208.27	208.62	223.40	224.48	225.63	226.94	228.41	246.01	249.50	253.12	256.45	259.90
Sub-total (A)	**76.71**	**152.57**	**101.73**	**253.33**	**212.79**	**208.03**	**208.27**	**208.62**	**224.55**	**224.48**	**225.63**	**226.94**	**228.41**	**247.16**	**249.50**	**253.12**	**256.45**	**259.90**
B. Cash outflow																		
1. Increase in fixed assets																		
- Total fixed investments	69.64	147.03	86.36	67.05														
- Interest paid	7.07	5.54	15.37	0.34														
Sub-total (B.1)	**76.71**	**152.57**	**101.73**	**67.39**														
2. Increase in working capital				23.64	5.60	(0.02)			1.44					1.44				
3. Operating costs				120.43	146.38	146.15	146.16	146.18	149.13	149.15	149.16	149.17	149.19	152.21	152.23	152.25	152.26	152.28
4. Marketing costs				0.44	0.54	0.54	0.54	0.55	0.58	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62	0.62
5. Costs of finance				25.71	23.97	21.00	18.04	15.08	12.23	9.27	6.30	3.34	2.60	2.71	2.71	2.71	2.71	2.71
6. Corporate tax							0.80	1.04	2.14	4.89	5.50	6.14	6.47	13.20	13.72	23.77	24.60	25.46
7. Loan repayments					34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86						
Sub-total (B)	**76.71**	**152.57**	**101.73**	**237.61**	**211.35**	**202.54**	**200.40**	**197.70**	**200.38**	**198.74**	**196.40**	**194.10**	**158.84**	**170.19**	**169.29**	**179.36**	**180.20**	**181.07**
C. Cash surplus/(deficit)																		
1. Current (A - B)				**15.72**	**1.44**	**5.49**	**7.87**	**10.92**	**24.17**	**25.74**	**29.23**	**32.84**	**69.57**	**76.97**	**80.22**	**73.77**	**76.25**	**78.83**
2. Cumulative				**15.72**	**17.16**	**22.65**	**30.52**	**41.44**	**65.61**	**91.35**	**120.58**	**153.42**	**222.99**	**299.97**	**380.18**	**453.95**	**530.20**	**609.03**

Table 16-7
BREAK EVEN ANALYSIS
(million US $)

Item	Operating period, years														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Variable cost															
1. Raw materials															
- Sized iron ore : Bailadila, India	32.14	40.17	40.17	40.17	40.17	41.17	41.17	41.17	41.17	41.17	42.20	42.20	42.20	42.20	42.20
- Pellet : CVRD,Brazil	22.06	27.58	27.58	27.58	27.58	28.27	28.27	28.27	28.27	28.27	28.98	28.98	28.98	28.98	28.98
GIIC,Bahrain	18.66	23.32	23.32	23.32	23.32	23.90	23.90	23.90	23.90	23.90	24.50	24.50	24.50	24.50	24.50
Sub-total (A.1)	**72.85**	**91.07**	**91.07**	**91.07**	**91.07**	**93.34**	**93.34**	**93.34**	**93.34**	**93.34**	**95.68**	**95.68**	**95.68**	**95.68**	**95.68**
2. Consumables	2.17	2.71	2.71	2.71	2.71	2.78	2.78	2.78	2.78	2.78	2.85	2.85	2.85	2.85	2.85
3. Power	8.71	10.89	10.89	10.89	10.89	11.16	11.16	11.16	11.16	11.16	11.44	11.44	11.44	11.44	11.44
4. Water	0.16	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
5. Natural gas	15.89	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86	19.86
6. Repair and maintenance	3.96	4.95	4.95	4.95	4.95	5.07	5.07	5.07	5.07	5.07	5.20	5.20	5.20	5.20	5.20
Sub-total (A)	**103.74**	**129.68**	**129.68**	**129.68**	**129.68**	**132.42**	**132.42**	**132.42**	**132.42**	**132.42**	**135.24**	**135.24**	**135.24**	**135.24**	**135.24**
B. Fixed cost															
1. Labor and supervision	0.75	0.76	0.53	0.54	0.55	0.56	0.57	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.67
2. Power	2.72	2.72	2.72	2.72	2.72	2.79	2.79	2.79	2.79	2.79	2.86	2.86	2.86	2.86	2.86
3. Water	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
4. Natural gas	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97	4.97
5. Repair and maintenance	4.95	4.95	4.95	4.95	4.95	5.07	5.07	5.07	5.07	5.07	5.20	5.20	5.20	5.20	5.20
6. Administrative overhead costs	3.25	3.25	3.26	3.26	3.26	3.27	3.27	3.27	3.27	3.28	3.28	3.28	3.29	3.29	3.29
7. Marketing costs	0.44	0.54	0.54	0.54	0.55	0.58	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62	0.62
8. Depreciation	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	2.46	2.46	2.46	2.46	2.46
9. Financial costs	25.71	23.97	21.00	18.04	15.08	12.23	9.27	6.30	3.34	2.60	2.71	2.71	2.71	2.71	2.71
Sub-total (B)	**75.75**	**74.12**	**70.93**	**67.98**	**65.03**	**62.43**	**59.48**	**56.53**	**53.58**	**52.86**	**22.77**	**22.79**	**22.81**	**22.82**	**22.84**
C. Net income	165.88	208.00	208.03	208.27	208.62	223.40	224.48	225.63	226.94	228.41	246.01	249.50	253.12	256.45	259.90
D. Contribution (C - A)	62.14	78.32	78.36	78.60	78.94	90.98	92.06	93.21	94.52	95.99	110.77	114.26	117.89	121.22	124.66
E. Break even capacity (B/D) , %	**122**	**95**	**91**	**86**	**82**	**69**	**65**	**61**	**57**	**55**	**21**	**20**	**19**	**19**	**18**

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Table 16-8
IRR AND NPV ON TOTAL CAPITAL INVESTED

(million US $)

Item		Constrn. period, yrs			Operating period, years														
		1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Cash inflow																			
1. Inflow operation																			
- Sales revenue					165.88	207.35	207.35	207.35	207.35	221.65	221.65	221.65	221.65	221.65	235.95	235.95	235.95	235.95	235.95
- Interest on bank deposit						0.65	0.68	0.92	1.27	1.75	2.83	3.98	5.29	6.76	10.06	13.55	17.17	20.50	23.95
Sub-total (A)					**165.88**	**208.00**	**208.03**	**208.27**	**208.62**	**223.40**	**224.48**	**225.63**	**226.94**	**228.41**	**246.01**	**249.50**	**253.12**	**256.45**	**259.90**
B. Cash outflow																			
1. Increase in fixed assets																			
- Total fixed investments		76.71	152.57	101.73	67.39														
2. Increase in net working capital					23.64	5.60	(0.02)	0.00	0.00	1.44	0.00	0.00	0.00	0.00	1.44	0.00	0.00	0.00	0.00
3. Operating costs					120.43	146.38	146.15	146.16	146.18	149.13	149.15	149.16	149.17	149.19	152.21	152.23	152.25	152.26	152.28
4. Marketing costs					0.44	0.54	0.54	0.54	0.55	0.58	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62	0.62
5. Corporate tax								0.80	1.04	2.14	4.89	5.50	6.14	6.47	13.20	13.72	23.77	24.60	25.46
Sub-total (B)		**76.71**	**152.57**	**101.73**	**211.90**	**152.52**	**146.67**	**147.50**	**147.76**	**153.29**	**154.62**	**155.24**	**155.90**	**156.24**	**167.47**	**166.57**	**176.64**	**177.49**	**178.36**
C. Plant residual value																			102.45
D. Net cash flow																			
1. Current (A-B+C)		(76.71)	(152.57)	(101.73)	(46.02)	55.48	61.36	60.77	60.86	70.11	69.87	70.39	71.04	72.17	78.53	82.93	76.48	78.97	183.99
2. Cumulative			(152.57)	(254.30)	(300.32)	(244.84)	(183.48)	(122.71)	(61.86)	8.26	78.12	148.51	219.56	291.73	370.26	453.19	529.67	608.64	792.63
E. NPV (discounted @ 9 % / year)	**87.14**	**(70.38)**	**(128.41)**	**(78.55)**	**(32.60)**	**36.06**	**36.59**	**33.24**	**30.54**	**32.28**	**29.51**	**27.28**	**25.26**	**23.54**	**23.50**	**22.77**	**19.26**	**18.25**	**39.01**
F. IRR (on total capital invested), %	**12.22**																		

Table 16-9
IRR AND NPV ON EQUITY CAPITAL INVESTED
(million US $)

Item		Constrn. period, yrs			Operating period, years														
		1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Cash inflow																			
1. Cash surplus / (deficit)					15.72	1.44	5.49	7.87	10.92	24.17	25.74	29.23	32.84	69.57	76.97	80.22	73.77	76.25	78.83
B. Cash outflow																			
1. Equity capital paid (net of subsidies)		69.64	49.88																
C. Plant residual value																			102.45
D. Net cash return																			
1. Current (A-B+C)		(69.64)	(49.88)		15.72	1.44	5.49	7.87	10.92	24.17	25.74	29.23	32.84	69.57	76.97	80.22	73.77	76.25	181.28
2. Cumulative		(69.64)	(119.52)	(119.52)	(103.81)	(102.36)	(96.88)	(89.00)	(78.09)	(53.91)	(28.17)	1.06	33.90	103.47	180.45	260.66	334.43	410.68	591.96
E. NPV (discounted @ 9 % / year)	**106.64**	**(63.89)**	**(41.98)**		**11.13**	**0.94**	**3.27**	**4.31**	**5.48**	**11.13**	**10.87**	**11.33**	**11.68**	**22.69**	**23.03**	**22.02**	**18.58**	**17.62**	**38.43**
F. IRR (on equity), %	**15.78**																		

Table 16-10
DEBT SERVICE COVERAGE RATIO
(million US $)

Item		Operating period, years														
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Debt coverage																
1. Net profit after tax		(13.61)	4.20	7.43	9.82	12.87	26.41	27.69	31.18	34.79	36.66	74.80	77.76	71.31	73.80	76.37
2. Depreciation		32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	32.91	2.46	2.46	2.46	2.46	2.46
3. Cost of finance		23.70	21.48	18.52	15.56	12.59	9.63	6.67	3.70	0.74						
Sub-total (A)		**43.00**	**58.59**	**58.86**	**58.29**	**58.37**	**68.95**	**67.27**	**67.79**	**68.45**	**69.57**	**77.26**	**80.22**	**73.77**	**76.26**	**78.83**
B. Debt liability																
1. Loan repayments			34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86						
2. Cost of finance		23.70	21.48	18.52	15.56	12.59	9.63	6.67	3.70	0.74						
Sub-total (B)		**23.70**	**56.34**	**53.38**	**50.42**	**47.45**	**44.49**	**41.53**	**38.56**	**35.60**						
C. DSCR (A/B)		**1.81**	**1.04**	**1.10**	**1.16**	**1.23**	**1.55**	**1.62**	**1.76**	**1.92**						
D. Average DSCR [(1)]	**1.47**															

NOTE :
(1) Average during the loan repayment period.

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Table 16-11
PROJECTED BALANCE SHEET
(million US $)

Item	Constrn. period, yrs			Operating period, years														
	1st	2nd	3rd	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
A. Total assets																		
1. Total current assets																		
- Inventory on materials and supplies				7.92	9.76	9.75	9.75	9.75	9.97	9.97	9.97	9.97	9.97	10.19	10.19	10.19	10.19	10.19
- Work in progress																		
- Finished product in stock				5.04	6.12	6.11	6.11	6.11	6.24	6.24	6.24	6.24	6.24	6.37	6.37	6.37	6.37	6.37
- Accounts receivable				13.82	17.28	17.28	17.28	17.28	18.47	18.47	18.47	18.47	18.47	19.66	19.66	19.66	19.66	19.66
- Cash surplus, finance available				15.72	17.16	22.65	30.52	41.44	65.61	91.35	120.58	153.42	222.99	299.97	380.18	453.95	530.20	609.03
- Securities																		
Sub-total (A.1)				**42.49**	**50.31**	**55.79**	**63.66**	**74.58**	**100.29**	**126.03**	**155.26**	**188.10**	**257.67**	**336.19**	**416.41**	**490.18**	**566.43**	**645.26**
2. Total fixed assets net of depreciation																		
- Fixed investment		76.71	229.28	331.01	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40	398.40
- Construction in progress	76.71	152.57	101.73	67.39														
- Less : accumulated depreciation				32.91	65.82	98.73	131.65	164.56	197.47	230.38	263.29	296.20	329.11	331.57	334.03	336.49	338.95	341.41
Sub-total (A.2)	**76.71**	**229.28**	**331.01**	**365.49**	**332.58**	**299.66**	**266.75**	**233.84**	**200.93**	**168.02**	**135.11**	**102.20**	**69.28**	**66.82**	**64.36**	**61.90**	**59.44**	**56.98**
3. Accumulated loss brought forward					13.61	9.41	1.99											
4. Loss in current year				13.61														
Total assets (A)	**76.71**	**229.28**	**331.01**	**421.59**	**396.50**	**364.86**	**332.39**	**308.42**	**301.22**	**294.05**	**290.36**	**290.30**	**326.96**	**403.01**	**480.77**	**552.08**	**625.87**	**702.24**
B. Total liabilities																		
1. Total current liabilities																		
- Accounts payable				3.13	3.92	3.92	3.92	3.92	4.02	4.02	4.02	4.02	4.02	4.12	4.12	4.12	4.12	4.12
- Bank overdraft				20.06	24.85	24.84	24.84	24.84	25.99	25.99	25.99	25.99	25.99	27.15	27.15	27.15	27.15	27.15
Sub-total (B.1)				**23.19**	**28.76**	**28.76**	**28.76**	**28.76**	**30.01**	**30.01**	**30.01**	**30.01**	**30.01**	**31.26**	**31.26**	**31.26**	**31.27**	**31.27**
2. Total long term debt	7.07	109.76	211.49	278.88	244.02	209.16	174.30	139.44	104.58	69.72	34.86							
3. Total equity capital	69.64	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52	119.52
4. Reserve, retained profit brought forward								7.83	20.70	47.11	74.80	105.98	140.77	177.43	252.23	329.98	401.29	475.09
5. Net profit after tax					4.20	7.43	9.82	12.87	26.41	27.69	31.18	34.79	36.66	74.80	77.76	71.31	73.80	76.37
Total liabilities (B)	**76.71**	**229.28**	**331.01**	**421.59**	**396.50**	**364.86**	**332.39**	**308.42**	**301.22**	**294.05**	**290.36**	**290.30**	**326.96**	**403.01**	**480.77**	**552.08**	**625.87**	**702.24**

SECTION 17.0

PROJECT FINANCE

17.1 General

The Project will be executed by a Joint Venture Company to be established under the Foreign Investment Law of Vietnam. The total investment capital of JVC will be US $398.4 million. The legal capital of the JVC will be about 30 percent of the total investment capital – approximately US $119.5 million. The JVC expects to obtain long–term, project-financed debt equal to about 70 percent of the total investment capital – approximately US $278.9 million.

Working capital will be made available as a short term loan from commercial banks.

17.2 Equity Financing

The VSC, who will be the Vietnamese party to the JVC, will hold a 30 percent share of the JVC – approximately US $35.9 million. VSC will contribute land use rights and cash as part of its obligations of the Project finance. VSC may elect to solicit other Vietnamese investors to join the JVC to meet its cash obligations.

The foreign party to the JVC will be the American Steel Corporation Private, Ltd., a Singapore legal entity, who will hold the remaining 70 percent share of the JVC – approximately US $83.6 million.

Currently, the ASC, the sole developer of the Project, is represented by Craft Corporation, Vietnam, a subsidiary of the Harwell Group – a privately held U.S. company. ASC will contribute cash and pre-operational costs as its capital contribution to the JVC legal capital. ASC/Craft may also solicit a co-developer for the Project. It is envisioned that the share holders of the foreign entity of the JVC will also include several partners who are directly involved in the Project in implementation, such as, EPC Contractors, Off-Takers, Feed Materials Suppliers and Process Technology Vendor.

Preliminary discussions about the project finance have been held with all potential participants.

17.3 Debt Financing

There are several sources the JVC believes can be considered for securing suitable project-financed debt for the venture.

- Commercial Banks
- Capital Markets
- Export Credit Agencies (ECA)
- Multilateral Agencies

These sources are described briefly below.

- Commercial Banks

  A commercial bank loan generally involves a small number of institutions which would typically commit to the full term of the loans. Such banks will, in certain circumstances, take construction risks, can provide locked-in pricing and funding amounts and generally do not require a rating from a rating agency, preferring instead to perform their own project evaluation. The commercial bank debt generally tends to be of shorter term and can contain more covenants.

- Capital Markets

  This type of debt financing involves the resale of securities by an accredited investor (such as a bank) to an unlimited number of qualified institutional buyers. Normally these private placements are large blocks of bonds placed with a limited number of investors, often insurance companies or pension funds. Bond offerings are rated by one or more of the prominent rating agencies, and the rating directly affects the cost of the financing. It is also possible to sell bonds in project finance transactions, which are less than investment grade. It is uncertain whether the Project can achieve an investment grade rating. Failure to achieve an investment grade rating would result in increased financing costs. The capital markets are preferred to bank loans because, in general, they often offer: (1) more competitive rates, (2) longer tenor, (3) longer grace periods before start of principal payments, (4) less restrictive covenants, and (5) access to an expanded investor base.

17.3 Debt Financing (continued)

- Export Credit Agencies

The amount of debt that can be supported by an ECA is determined in accordance with certain guidelines. These guidelines limit the loan amount to a certain percentage of eligible equipment which can consist of (1) the cost of equipment and services that are supplied from ECAs country of origin, (2) equipment and services sourced from countries other than that of the supplier, (3) the local installation costs associated with the imported equipment, plus capitalized interest expense on the above items. These guidelines also dictate the general terms under which ECA supported debt can be issued. Typically, the maximum term under the guidelines is ten years following completion of construction, with no grace period on interest (full principle and interest payments to begin six months after the start of operation); therefore, significantly less attractive economically to commercial debt. In addition, such lenders often require some recourse debt or greater future equity injections from the Project Sponsors, beyond the original levels.

Given the structure of the JVC, the two most likely prospects for this type of financing would be from the likely suppliers of the majority of the Project's equipment and services. These would be the United States Export-Import Bank and Japan Export-Import Bank. Direct meetings have not yet been held with these agencies to determine whether they are currently open for involvement in Vietnam and their current terms and conditions.

- Multilateral Agencies

The leading multilateral lending agencies that could be considered for financing for the Project are the World Bank, their private sector arm, the International Finance Corporation, and the Overseas Private Investment Corporation. Their lending programs are briefly described below. Generally, it should be noted that the multilateral banks could require longer periods for closure of financing packages such as that contemplated for this transaction and then can also require more restrictive covenants.

17.3 Debt Financing (continued)

World Bank – In 1994, the World Bank resumed issuing guarantees to private projects. The guarantees can be for specified risks for the length of the financing term (partial risk guarantee), or for all risks during a specified period of the financing term (partial credit guarantee). The partial risk guarantee covers debt service defaults that result from the non-performance of government obligations. For external debt and balance of payments reporting purposes, partial risk guarantees are not considered as government debt or government-guaranteed debt and only appear as a memorandum item (along with any other contingent liabilities) in the monetary statistics compiled by the International Monetary Fund (IMF). The partial credit guarantee is used when there is a need to extend loan maturities, but not necessarily to cover sovereign contractual obligations. Partial credit guarantees are typically used when either the lenders or sponsors are willing to accept the risk of the government defaulting on its obligations. By guaranteeing later maturities, the World Bank helps the lender maximize the loan term.

ICF – The IFC is the world's largest multi-lateral lending institution dedicated to supporting private-sector projects. The IFC provides financing support on a case by case basis depending upon the project's needs. IFC support can take multiple forms; a direct loan ("A" loan), being the lender of record in a syndicate with one or more banks which take a portion of the project risk ("B" loan); a direct equity investment; or a quasi-equity investment.

OPIC – OPIC finances US business expansion overseas by providing long-term project financing to projects involving significant equity participation by US businesses (typically 25% minimum US equity). OPIC's mandate is to support projects that are responsive to the development needs of the host country. OPIC's terms vary on a project basis, but can run up to 15 years repaying following a suitable grace period during which only interest is payable. The interest rate is based on OPIC's assessment of the financial and political risks involved. OPIC has expressed support in this Project and wanted it to be one of the first OPIC financing made in Vietnam. OPIC has indicated a willingness to consider up to their project limit in loan support and is also willing to consider providing political risk coverage to the US sponsor's equity investment.

SECTION 18.0

POLITICAL OVERVIEW AND CONSIDERATIONS

18.1 Political Overview

18.1.1 General

For much of its existence Vietnam has fought off domination by outside powers. China, to the north, ruled Vietnam for 1,000 years. In 1945 Ho Chi Minh declared independence from France. Nine years of warfare ended in the division of the country between the communist north and the US-backed south. Reunification of the country in 1975 gave Vietnam only brief respite. Hanoi's invasion of Cambodia in 1978 - 79 led to more than a decade of isolation from the West and dependence on the Soviet Union. This ended with the Cambodian settlement of October 1991, allowing Vietnam to more fully implement the policy of economic renovation (Doi Moi) proclaimed in 1986.

18.1.2 Political Structure

Vietnam is one of only a few communist countries organized on traditional Leninist lines. The overlap between the Communist Party of Vietnam and the government is extensive at all levels. Efforts are under way to make local government more accountable and transparent but broader political change is not anticipated soon.

18.1.3 Policy Issues

In the short to medium term Vietnam will promote investment, both foreign and domestic, and encourage exports and agricultural output in order to boost GDP growth. Greater attention will be paid to rural investment. Some steps will be taken to address the main outstanding areas of economic reform including strengthening the financial sector legal framework, and restructuring the state-owed enterprises.

18.1.4 Foreign Trade

In 1998 merchandise exports rose by an estimated 3.36% to US $9.4 billion. Merchandise imports remained unchanged at US $10.4 billion. The resulting trade deficit of US $1billion was the lowest in many years.

18.1 Political Overview (continued)

18.1.5 Taxation

Vietnamese and foreign employees and companies are taxed differently. Personal income tax for Vietnamese employed at foreign - invested enterprises starts at 10% on monthly earnings of $215 and rises to a rate of 60% on earnings of more than $700. Expatriate earnings are taxed between 10% and 50%, the latter rate applying to weekly earnings of more than $2100. A similar two-tier system applies to corporations. The standard corporate tax rate for FIEs was raised to 32% in January 1999, but a range of attractive tax incentives are offered, at rates between 25% and 45%. VAT was introduced from January 1, 1999, replacing the turnover tax. Three rates are to be applied (5%, 10% and 15%) and there will be many exemptions.

18.1.6 Political Forecast

Vietnam's political environment is expected to improve slightly overall during the period (from 2000-2004). The major political event upcoming is the Ninth Party Congress, scheduled for May 2001. Congresses occur once every five years and are the focus for leadership changes involving both the Politburo and the Central Committee, although changes can and do occur between congresses. Congress also formulates a statement of policy direction for the next five years.

At the next congress the current ruling troika - Le Kha Phieu, the party general secretary, Tran Duc Luong, the president, and Phan Van Khai, the prime minister - will likely remain in power. There is a small possibility that the ruling troika may be replaced later, but this is unlikely according to the most informed sources. The jockeying for position between now and the congress is unlikely to lead to any loss of overall political stability.

The likelihood of any political change or widespread popular unrest is small. A shift to a more liberal political stance by the party, such as allowing groups to organize on a more independent basis or even permitting the formation of opposition parties is not a prospect any time soon.

As with political reform, the likelihood of bold new economic policy positions being adopted is small, including at the Ninth Congress. The Asian financial crisis did result in a small number of reform oriented changes, which are now beginning to have a positive impact on the business environment (for example, procedures for establishing a private company were simplified and private firms are now able to export directly). However, the impact of the Asian crisis in terms of forcing progress on key structural reforms, such as state enterprise and banking reform, was on the whole disappointing, and this reflects the essentially political nature of the problem. During 2000-04 liberalization will occur incrementally, as has been the case during the historical period. It will be driven as much by informal processes and Vietnam's engagement with the regional and international organizations as by specific government measures.

The formulation and execution of policy will continue to be hindered by weaknesses inherent in the political system. This derives from the fact that political power is not centralized but scattered between a wide range of institutions and individuals. The result is that policymakers tend to consult widely before decisions are made, which leads to delays. Moreover, in times of political uncertainty, such as in the run-up to party congresses, the decision-making process tends to slow down, as politicians become reluctant to take initiatives or simply become preoccupied with maintaining their positions. This is what lies behind the delay in the signing of the bilateral trade accord, rather than the so-called policy debates frequently referred to. As with policy formulation, implementation is also hampered by the fact that power is scattered.

The poor quality of Vietnam's civil service, also represents a major constraint on effective policy implementation. The government's program of administrative reform, which includes efforts to centralize power and introduce greater meritocracy in civil service appointments, is likely to lead to a slow but gradual improvement in policy formulation and implementation over the next five years.

18.1.7 Foreign Policy

The outlook is for a largely stable foreign policy environment during the next 3-4 years. The key to this stability will be a gradually improving relationship with the US and growing economic integration into the international economy, notably with fellow member states in the Association of South-East Asian Nation, the EU and, in time, the US.

Vietnam's historic mistrust of China will not disappear. As reforming communist countries seek to maintain one-party rule, there is a sense that they have shared interests and common

18.1 Political Overview (continued)

objectives but moreover, Vietnam's membership of ASEAN and closer relations with the US makes its job of managing relations with a potentially overbearing China somewhat easier. Relations between China and Vietnam are now on a much firmer footing than they were a decade ago. In December 1999 the two countries signed an agreement settling the demarcation of their 1200 kilometer land boarder. They have also pledged to resolve outstanding territorial differences in the Tonkin Gulf in 2000. This leaves only their competing claims over the Spartly and Paracel islands in the South China Sea. With both sides (and others) claiming sovereignty over the islands, resolution of this issue is unlikely any time soon. It is conceivable that an agreement on joint development of the oil and mineral resources in the disputed areas may be reached in the next few years.

Although the trend is toward closer political and economic ties with the US, there is a risk that in the short term relations will be cool. The delay in signing the bilateral trade accord, which has fallen victim to domestic political maneuvering on the Vietnamese side, has the potential to create frustration on both sides. However, overall, the relationship is on firm footing. There are signs that Vietnam is seeking to renegotiate aspects of the accord. However, the US has said that such a request would not be well received. Having put off signing the accord, for the Vietnamese government to sign it now without amendment would reflect very badly on those involved. Ratification of the trade accord later in 2000 is more likely than not, but there is a risk that the opportunity may be lost on account of the approaching US presidential election and the raised political temperature in Hanoi in the run-up to the party Congress. Once the trade accord is signed, relations with the US will continue to gain ground both politically and economically. However, differences over trade, copyright and human rights are likely to surface periodically.

Population growth in Vietnam is slowing and is already around 1.7% a year, according to the official results of a nationwide census conducted in April 1999. The fertility rate, which measures the number of children that a woman is expected to have in her lifetime, is about 2.8 and is expected to fall to the replacement level of 2.1 within a decade. However, the population is not yet aging to the extent that strains will be placed on social welfare systems.

18.1 Political Overview (continued)

Despite Vietnam's low level of income per head, most social indicators are remarkably good. About 90% of the population is literate, and life expectancy at birth is around 65 years. According to the UN School, enrollment rates have been high and rose particularly strongly in the boom years of 1993-97. Great strides have also been made in reducing poverty. Using the poverty threshold favored by the World Bank, which considers the amount of expenditure needed to provide an adequate amount of calories and other essentials, the percentage of the population deemed to be living in poverty fell about 70% in the mid-1980s, to 30%-35% today. The distribution of income is still relatively equal by world standards, although it has become less so over the past decade.

Growth in the cities, particularly Ho Chi Minh City, Hanoi, and their suburbs, has far outstripped that in rural areas. As a result, by 1997 urban incomes were estimated to be eight times higher than rural incomes (in 1990 they were five times higher). One effect of this discrepancy has been large-scale migration from the countryside to the towns. The government is now paying more attention to rural development. This interest is partly explained by the heavy social economic costs for the cities of supporting populations swollen by rural-urban migration. (Only 30% of the rural poor now depend on farming alone for their incomes, according to the World Bank).

To tackle these problems, the government has declared its intention to redirect some government investment away from large infrastructure projects and towards the development of the more remote parts of the country. In the 1999 budget the allocation for rural development increased by 25%, in a year when overall spending will probably rise by no more than 2.5%. Whether this new-found interest in rural development will be sustained is less clear, given the government's record of focusing on industrialization and on attracting foreign investment, both of which tend to be urban-based.

18.1.8 Policy and Business Outlook

- **Business Environment Rankings**

Economic growth is likely to be slower in 2000-04 than in the past. GDP growth was officially estimated at 4.8% in 1999, compared with 5.8% in 1998. However, the government's figures are disputed by the international financial institutions and some foreign economists, who believe that economic growth has been lower. The IMF, for example, estimates GDP growth in 1999 at 3-3.5%. Although economic growth in 2000-04 will be slower than in the previous five years, it will be on a recovering trend from 2001, boosted especially by access to the US market. Current forecast are predicting 6% growth from 2001 onwards.

- **Fiscal Policy**

Incomplete budget data for 1999 show revenue up by 2.2% on 1998 in nominal terms and 3.9% above target. As a result of this slow growth, revenue as a percentage of GDP has fallen for the third consecutive year to an estimated 17.9%, compared with 19% in 1998 and 21% in 1997. Revenue growth continues to be depressed by the economic slowdown. Taxes collected from state-owned enterprises have been particularly affected. Revenue from SOEs has typically provided around 40% of the total tax take. Last year revenue from this source fell by 20.8%. Customs receipts, which provide around 25% of the total revenue, fell by 5.5% in 1999, while value-added tax (VAT) on imports was 12.5% below budget. The strongest gains in revenue collection came from foreign-invested companies, especially those in the oil and gas sector, which recorded strong earnings gains as a result of large increases in both output and prices. In 1999 foreign-invested companies provided more revenue to the Treasury than the state sector.

In 2000 the government is forecasting the revenue will weaken again in GDP terms to 18%. Some economists are forecasting that from 2001 revenue will recover as a percentage of GDP as economic growth picks up. The importance of customs receipts to total revenue collection will decline during the forecast period, as tariff barriers are lowered in line with Vietnam's commitment to liberalize its grade regime. However, this is expected to be offset by improved receipts from VAT, as teething problems associated with tax's introduction are ironed out. Revenue collection from the private sector, which is currently equivalent to approximately one-third of that from the state sector, is likely to become more important towards the end of the forecast period.

Data on expenditure in 1999 are not yet available. To counter the economic slowdown, the government took steps in mid-1999 to stimulate growth by increasing expenditure. A large proportion of the increased expenditure was to be directed to rural infrastructure, where public investment was expected to rise by 61.5% over its 1998 level. Reports suggested that lagging tax receipts and the slow disbursement of overseas development assistance prevented the increase from being achieved. The failure to meet the revised expenditure targets does, therefore, in part reflect the government's well-established fiscal prudence. It is assumed the government will adhere to the fiscal discipline it has maintained over recent years, and that tax collection and aid disbursement will improve.

The government's desire to increase expenditure at a time when revenue is tight has necessitated the running of a larger budget deficit, financed chiefly by official foreign borrowing and grants. In 1999 some 55.5% of the deficit was expected to be financed from foreign capital sources. The government also sold $286.6 million worth of five-year bonds last year to help finance the deficit. Thus, in 1999 the deficit was expected to rise to 4% of GDP up from 2% in 1998. The slow disbursement of foreign aid and other constraints on expenditure will have kept the deficit below this level. However, the deficit is expected to fall again short of initial budget projections in 2000, but to increase in the later years of the forecast period, as aid disbursement improves and the domestic bond market develops.

During 2000-04 the government's present cautious monetary stance is likely to be maintained. In 2001, for example, although it has targeted a healthy rise in credit growth to 22%, implying some easing of its stance, the brakes will be put on again if inflationary pressures start to build up. Since there are institutional constraints on credit growth owing to the dearth of feasibility projects and the weakness of the banking system, such restraint is not expected to be necessary. More likely is some tightening later in the forecast period, as accelerating economic growth causes overheating. At the same time the government's ability to influence money supply growth will

18.1 Political Overview (continued)

improve, as it becomes less dependent on such blunt instruments as credit ceilings and deserve requirements. Plans to relax interest rate controls to allow credit growth to be more determined on market lines are currently in the pipeline. However, the intention is to move very gradually, and it is unlikely that interest-rate distortions will disappear completely by 2003.

- **Policy Towards Private Enterprise**

Private firms are now able to export directly, whereas in the past they had to go through a state firm. In addition, regulations on establishing a private business have been simplified. More important, private firms are beginning to report that opening a private company is in practice less riddled with red tape than in the past. The government has pledged to tighten up in this area and has signed a copyright accord with the US. A gradual improvement is likely over the forecast period, but since many organizations involved in copyright abuse are politically powerful, clamping down will not be easy.

Compared with as little as a decade ago, property rights are much more widely respected. Vietnam has few remaining price controls. The expectations are prices for land and some utilities. There is also a tendency to interfere administratively to control prices at times of "price fevers" (price instability). However, such practices are likely to decline as are price controls themselves.

- **Policy Towards Foreign Investment**

The outlook is for a gradually improving foreign investment environment during 2000-04. Foreign investment is strongly encouraged in a range of sectors. Investment in some areas is restricted on national security grounds (for example, in power generation) or where local companies are believed to have the necessary capital or technological ability (for example, in some construction projects). In other areas foreign investment is conditional or contains more restrictive contractual terms being met (for example, in oil and gas and telecommunications). In recent years the government has adopted a more flexible attitude towards companies wishing to invest on the basis of 100% foreign

18.1 Political Overview (continued)

ownership, whereas in the past they were usually required to form joint ventures. A number of foreign firms have recently bought out their Vietnamese partners, although the process has often been acrimonious.

There has also been loosening of the terms or foreign equity ownership in Vietnamese companies. A single foreign entity is now permitted to hold a 30% stake in a Vietnamese firm, whereas in the past it had to be divided between three separate investors, (but, as noted, below, the terms for foreign investment in the stock market look like being more restrictive). Over the forecast period there may be some further loosening of restrictions on foreign direct investment. However, national security sensitivities will impose limits on this process.

The risk of foreign assets being expropriated is small. In recent years there have been cases where souring relations with a politically well connected local partner has led to allegations being made which have resulted in assets of the foreign party being lost. However, such cases are rare. Investment protection schemes are now more widely available, notably for US investors.

Since the downturn in foreign investment approvals began in 1996, the government has introduced a series of decrees designed to improve the investment environment. The most recent was Decree 53, which came into effect in July 1999. Among other things, it grants most companies the right to denominate wages in dong rather than dollars. It also pledges to phase out the dual pricing system, whereby foreigners pay more than Vietnamese nationals for utilities and other services, by 2001.

The government recently announced that the Laws on Foreign Investment, which was last revised in 1996, is to undergo a fresh round of amendments. According to the Ministry of Planning and Investment, the objective is to eradicate inconsistencies with other legislation and to bring the law more in line with the requirements of the Association of South-East Asian Nations Investment Area and the World Trade Organization, which Vietnam is seeking to join. The amendments are also expected to include new regulations on the sale of shares to foreign investors by companies undergoing equitisation (the Vietnamese form of privatisation). The planned amendments are scheduled to go before the National Assembly when it meets in April 2000. However, precedent suggests that whatever changes are made will have only a marginal impact on the problems faced by investors, which are largely bureaucratic and political in nature.

- **Foreign Trade and Exchange Controls**

Vietnam has made a sharp improvement in this area. This mainly reflects the expected liberalization of the trade regime and some easing of foreign-exchange regulations covering the current account. Capital flows are highly regulated and are likely to remain so far for duration of the forecast period. This applies to both outgoing and incoming capital. Following the Asian financial crisis, the government twice lowered the amount of capital which could be taken out of the country without a declaration. The amount currently stands at $500, compared with $7,000 before the crisis. It is likely that the amount will be raised in 2000-04.

Membership of ASEAN and the associated ASEAN Free-Trade Area is resulting in annual cuts in trade tariffs. Tariffs are to be reduced to below 5% on a large list of products by 2006. The draft bilateral trade accord with the US, which was signed in July 1999 but has yet to be ratified, also embodies trade liberalizing measures, including tariff cuts. Despite the current delay in finalizing the accord, most of the measures incorporated in the agreement are due to be implemented by 2004. Vietnam's membership of the Asia-Pacific Economic Co-operation forum and its desire to join the WTO will lead to further trade liberalization over the next five years. Import barriers in the form of quota restrictions on a number of named products remain in place. However, these are less widespread than a few years ago and their decline is likely to continue, although the process will be slow because the areas still protected tend to be the most sensitive and are often controlled by powerful political interests.

18.1 Political Overview (continued)

Since the Asian financial crisis, the government has reiterated its commitment to move towards full dong convertibility. In fact, the Asia crisis and the associated foreign-exchange liquidity shortages have resulted in tighter exchange control. Moreover, the crisis served as a reminder that companies still do not have a legal right to convert dong to dollars. Restriction are now being eased. Last September a decree which required companies to sell 80% of surplus foreign currency to commercial banks was relaxed. In early 2000 the authorities announced plans to allow companies to open more than one foreign-exchange bank account and also to permit Vietnamese citizens receiving overseas remittances to withdraw them in the currency of their choice. Full dong convertibility on the current account before the end of the forecast period is not out of the question, although it would require faster expansion of the reserves than is currently forecast.

- **Financing**

The outlook for a gradual improvement in financing is strong. Access to medium-term finance remains difficult, especially for genuinely private companies. In the current climate, which has seen sustained downward pressure on lending rates coupled with continued regulatory weaknesses relating to collateral and foreclosure, banks are reluctant to lend. Some of the problems affecting availability of bank finance will ease during 2000-04, although it is likely to be some time before banks are given the freedom to set interest rates sufficiently high to compensate for risk. A plan whereby banks will be given more freedom to adjust interest rates in relation to a base rate is under consideration and is likely to be introduced shortly. This is a step in the right direction, although the changes are expected to apply only to dong, and not to dollar, lending rates. It is unlikely the rates will be entirely market-determined by 2004.

The access of foreigners to the local capital market is very limited. Local banks are generally not a viable source of capital. Vietnam still does not have a stock market. A limited stock market will become operational within 2 years, it is expected. However, it will remain a minor source of capital throughout most of 2000-04. Regulations released in January 2000 impose tight restrictions on foreign participation in the future stock market: foreign investors can jointly hold a maximum of 20% of a listed company's equity, and a single institutional investor is not permitted to hold more than 7%.

Recent years have seen a proliferation of new domestic banks as well as the arrival of many foreign banks. However, the local bank sectors suffers from a high level of bad dept, reflecting the prevalence of political criteria over commercial criteria in lending decisions. This is the case even with the new banks, which usually have party and government companies as their dominant shareholders. The activities of foreign banks are restricted. They can take only limited dong deposits and cannot accept land as collateral. Early this year central bank officials suggested that they were considering easing existing limits on dong deposits.

- **Labor Situation**

The low cost of labor is one of Vietnam's main attractions to international business. The move last year to allow companies registered under the Law on Foreign Investment to denominate wages in dong rather than dollars has enhanced this attractiveness in the light of the dong's gradual depreciation. Foreign representative offices, banks and law firms are excluded from the ruling, but this is likely to change. Higher unemployment, which has followed the economic slowdown, will keep labor costs down in the short term. Even as economic growth accelerates from 2001, labor costs will remain internationally competitive.

The government stipulates minimum wages for both foreign and domestic companies, otherwise wages are regulated by supply and demand and companies need to pay competitive salaries if they want to keep good workers. Minimum wages will remain in place, but they will probably be raised at least once during 2000-04, although not by a large amount.

The dollarised nature of the economy and the fact that foreigners have historically paid more for certain services than Vietnamese has meant that the cost of living for expatriates is not as cheap as it might be.

18.1 Political Overview (continued)

However, it is still competitive internationally and will remain so, especially as the dual pricing system is phased out.

- **Infrastructures**

Telecommunication Provisions - Although low in terms of nationwide density, it is expected to improve, reflecting the relative availability of investment capital in this area. Already telecommunications in the main urban areas is adequate.

Port infrastructure is expected to come under increased strain during 2000-04. Increasing international trade turnover, along with slow progress in upgrading existing port infrastructure, account for this deterioration. At present, delays encountered at Vietnam's port are moderate and more often the result of red tape than inadequate capacity.

Both the **road and rail networks** are poor. The road network has attracted aid money which has resulted in some improvement to the main highways. The same cannot be said for the railways, where plans to develop the network have had to be put on hold because of lack of funds. This pattern of a gradually improving road network and of a capital-short railway system is likely to persist over the next five years.

Electricity shortages have been eliminated in the short term as a result of slower economic growth. There is, however, a need for large-scale investment in the energy sector, including in the distribution system, if future problems are to be avoided. Last year there were signs of progress in individual build-operate-transfer projects. This opened the possibility that private-sector participation in infrastructure projects, notably in the energy sector, may become easier during the forecast period. However, progress in this area continues to be slow.

Computer penetration is growing fast in the main cities but is slow on a nationwide basis. This pattern of growth is likely to continue. Government expenditure on research and development is constrained by budgetary weaknesses.

18.1 Political Overview (continued)

Because of technical shortcomings the know-how needed to target funds correctly is also lacking. Expenditure on R&D is unlikely to raise GDP terms during 2000-04.

- **Economic Summary**

  - Annual real GDP growth is forecast to average 6.1% during 2000-04. Economic recovery is expected to take root from 2001, driven by higher domestic and external demand. Higher levels of public and private investment and increased consumer spending will also underpin the recovery.

  - Inflation is expected to rise as economic growth picks up. However, against the backdrop of relatively modest growth rates the risk of overheating is slight. Thus, the average annual rate of inflation in forecast to remain in single digits (averaging 8.3% per year).

  - On annual average basis dong is forecast to depreciate by 36% against the dollar during 2000-04. This will occur gradually over the forecast period, reflecting the government's customary caution, motivated by a desire not to undermine confidence in the currency or fuel inflation. A larger one-off adjustment is possible if China devalues the Renminbi.

  - Export growth in dollar terms is expected to remain below historical levels during the forecast period, even allowing for access to the US market from 2001. Import growth is forecast to accelerate more rapidly than exports, leading to a narrowing of the trade surplus and the prompt return of the current account of deficit. However, the current account deficit will also remain small by historical levels and will be easily financed by continued inflows of aid and foreign investment.

18.1.9 Context of Regional & Global Outlook

The pick-up in world economic growth will be accompanied by a recovery in world trade. An important component of this will be increased trade in Asia, which remains Vietnam's largest export market despite recent diversification. Stronger intra-Asian trade opens up the prospect that the recent sluggishness in demand for Vietnamese exports will disappear.

18.1 Political Overview (continued)

Vietnam's export earnings are still heavily dependent on export of crude oil and unprocessed agricultural products. During 1999 the sharp rise in oil prices contributed significantly to Vietnam's overall export growth. Oil prices are expected to peak in 2000, but they will not fall significantly during the forecast period. Weak non-oil commodity prices, however, have had a depressing effect on Vietnam's total export earnings. During the years 2000-04, prices are expected to recover, but not to the levels reached in the first half of the 1990s.

The dollar is expected to be marginally weaker against major currencies, benefiting the dong as it depreciates against the dollar, particularly in its yen-denominated trade with Japan. A devaluation of China's currency could force the Vietnamese government to reassess its policy of allowing the dong to depreciate very gradually. Global interest rates are likely to rise during the forecast period, but this is of limited relevance to Vietnam, given its general isolation from international capital markets. Real GDP growth is forecast to average 6.1% per year in 2000-04, compared with 7.5% in the previous five years. Although growth is expected to be slower in the forecast period, it will be on a rising trend from 2001. Agricultural growth is expected to average 3.4% over the next five years, compared with 4.5% in 1995-99. The growth is expected to come largely from the expansion of commercial crops, such as tea, coffee and rubber, and less from food grain production, such as rice, where output is likely to level out. More rapid growth in agriculture will not be possible without productivity gains or the introduction of greater competition in agricultural purchasing and trading. Progress on both fronts is expected to be slow.

18.1.10 Industrial Growth

Under a broad definition that includes construction, the growth is expected to average 8.6% in 2000-04, although it will grow more strongly towards its original growth in 2004. During 1999 industrial growth was an estimated 7.7% year-on-year, compared with 8.6% the previous year. Besides the contraction of the construction sector, the slowdown reflects difficulties in Vietnam's state-owned enterprise, where industrial growth was just 4.5% in 1999, and a less robust performance by industry with foreign-invested capital. In the more difficult economic climate it has also experienced a tightening of credit both the budget and from state-owned commercial banks. Non-state industry performed relatively well in 1999, expanding by 8.8% - the first time it grew faster than state industry. In part this can

18.1 Political Overview (continued)

be attributed to the fact that equitised SOEs made their first appearance in non-state industry statistics, but it also reflects some improvement in the climate for the private sector in the wake of the Asian crisis.

During the next few years industrial growth will continue to be constrained by ongoing difficulties in the state sector and also by lower levels of foreign investment. As a result, the 20% plus rates of growth enjoyed by the foreign-invested sector in recent years will slow. Non-state industry will continue to outperform state industry, reflecting its greater flexibility and the gradual improvement for expansion of the non-state sector will continue to be limited by the banking system and anti-competitive barriers.

The services sector has undergone a steady decline in annual growth rates since the mid-1990s. This has occurred uniformly throughout the sector, but the slowdown has been particularly marked in the real estate, tourism and financial service sectors. During 2000-04 the services sector is expected to average annual growth of 5.3%, compared with 8.6% in 1995-99. However, services growth will be on a recovering trend throughout the forecast period. Financial services and tourism are likely to be the first to see growth problems. The real estate sector is likely to remain subdued until later by the still high levels of over capacity built up in the boom years of the 1990s. Meanwhile, growth in the trade sector will pick up in step with overall GDP growth.

During the next few years private consumption, which is still rather depressed, is likely to recover to around the same level (at 5.9%) as that averaged in the (5.6%). In urban areas downward pressure on wages, higher unemployment and the fear of unemployment in the aftermath of the Asian financial crisis dampened private consumption growth. However, as economic growth picks up from 2001, the situation is likely to improve. Private consumption in the countryside has been affected by lower world commodity prices, including rice. Systemic weaknesses in rural purchasing and distribution networks which exert downward pressure on farmgate prices have also depressed rural consumption. Commodity prices are expected to strengthen from 2000, but downward pressure on farmgate prices will continue, ensuring the rural private consumption remains well below its potential during 2000-04.

18.1 Political Overview (continued)

Government consumption is expected to strengthen in the next 4 years, growing at an average annual rate of 6.7% compared with 3.4% previously. During the early period, when the fiscal position will be tight and aid disbursement continues to be sluggish, the government will opt to maintain current spending, if necessary at the expense of capital spending. As the economy becomes more buoyant, government consumption is likely to rise as a result of higher levels of investment in infrastructure, health and education.

Administration expenditure is also expected to increase over the next five years in light of government plans to raise the salaries of civil servants as part of its program of administrative reform.

Gross fixed investment is forecast to record annual average growth of 8.2% in 2000-04. This is slightly higher than before (although lower than in the years leading up to the Asian crisis), reflecting faster growth later. Public investment through the budget will pick up in tandem with the recovery in the domestic economy, improvements in revenue collection as problems with value-added tax are ironed out, and an upturn in aid disbursement. The strongest growth in investment in the next five years is likely to come from the domestic non-state sector. This will lead to a rise in its contribution to total fixed investment, although as a percentage of the total it will remain small. State-enterprise investment is likely to be subdued in the next few years, reflecting continued lack of profitability in the sector and the weakness of the banking sector. However, state-enterprise investment will pick up later with the emergence of a smaller but more robust core of SOEs. For most of the next five years foreign investment is likely to remain below the levels recorded during the mid-1990s, but it will pick up later, as government measures to improve the foreign investment environment bears fruit.

Growth in exports of goods and services is expected to average 13.8% per year during 2000-04. This is slightly above the average annual rate, but substantially down on the levels attained in the early years. During 1999 exports, expanded by estimated 9.5%. However, this was in large part attributable to higher oil output and the availability of spare capacity in the manufacturing sector, which could be deployed to meet recovering Asian and other demands. Such gains are not likely to be repeated in the next five years. However, the award of normal trade relations status by the US will open up this all-important market for Vietnamese exporters. Administrative obstacles to exporters are also likely to lessen: the opening up of the foreign trade sector to private companies in 1999 probably also helped to boost exports. The overvalued dong is a factor in constraining exports (although probably not a significant one), and its depreciation during 2000-04 will give a modest boost to exports of manufacturing, in particular.

Imports of goods and services are expected to grow slightly faster than exports of goods and services. However, their rate of growth is unlikely to return to pre-Asian crisis levels. During 1999 import growth was still negative, reflecting weak domestic demand and the accumulation of stockpiles over the previous year. As domestic and external demand begins to pick up from 2000, so, too, will demand for all the main categories of imports - consumer, intermediate and capital goods - unlike in 1999, when the only category of imports that was growing was intermediate goods, mainly inputs for the export-oriented subsector. Moreover, the constraint on imports imposed by government restrictions will gradually be lifted, as quotas are progressively abolished and tariffs fall to meet Vietnam's obligations under the increasing number of treaties - with ASEAN, the US and ultimately the WTO - to which Vietnam will be committed.

18.1.11 <u>Wage and Price Inflation</u>

In 1999 inflation fell to an annual average rate of just 4.3%, compared with 8.8% the previous year. Indeed, Vietnam experienced month-on-month deflation for eight consecutive months last year. This followed a fall-off in domestic demand as economic growth slowed. Much reduced inflationary pressure was also a consequence of good rice harvests, which depressed food prices. (Rice accounts for as much as 60% of Vietnam's consumer price index).

During 2000-04 it is forecast there will be a modest rise in consumer price inflation, as demand recovers with faster economic growth. However, prices are not expected to rise particularly rapidly, with inflation remaining in single digits for the duration of the forecast period. This reflects the fact that economic growth is not expected to return to the high levels recorded in the first half of the last decade. Since November last year, the consumer price index has again been recording month-on-month inflation. This followed serious flooding in the central provinces, which led to higher prices, notably of food. The return of inflation - if at a modest level - may also reflect marginally stronger domestic demand, which is evident especially in private-sector industrial growth, as well as seasonal price increases associated with the run-up to the Tet lunar new year holiday. During the next few years some increase in inflation will derive from a gradual depreciation in the dong, which will lead to higher import prices. It is not expected that the running of a larger budget deficit in 2000 will be inflationary, since it would be financed by concessionary foreign lending and bond issues, not by monetisation.

18.1.12 Financial Market

In the absence of a stockmarket, Vietnam's financial markets are dominated by the banks. However, the banking sector remains weak and underdeveloped, both in terms of its ability to attract savings and a provider of credit to business. The savings rate was equivalent to 18% of GDP in 1998, which is low by South-East Asian standards. Moreover, it has remained at this level for some years now, reflecting continued popular mistrust of the banking sector. Bank credit was equivalent to about 25% of GDP in 1998, which is also low by developing country standards. Despite a series of cuts in the interest-rate ceiling on dong loans in 1999, in real terms rates remained high and credit growth was low, at 12%, against an increase in deposits of 26%.

During 2000-04 Vietnam's financial markets will develop slowly. The stockmarket is likely to become operational early on. However, it will probably suffer from over-regulation, including heavy restrictions on foreign participation. Its growth will also be constrained by the slow progress of the equitisation program and its heavy concentration on the smaller state enterprises, which will limit the number and capitalization of listed companies. This points to the likelihood of light trading until the authorities gain enough confidence in the market to loosen controls.

The government has repeatedly stated its commitment to a program of banking reform, affecting both the state-owned banks and the joint-stock banks, the majority of which are saddled with high level of non-performing loans. Some progress was made last year towards closing and merging the weaker joint-stock banks. The state-owned banks have been audited and the government is considering a plan to recapitalize them, including the possible sale of their bad debts to an asset management company. Further progress in these areas is likely.

The creation of a more robust banking sector depends ultimately on placing the relationship between the banks, especially but not exclusively the state-owned banks, and state enterprises on a more commercial footing. By necessity, the soft credit constraint has been hardened in the wake of the Asian crisis and the economic slowdown. It is too early to say whether this will remain the case when the economy picks up. In all probability, preferential access to credit by state enterprises will not disappear completely. However, credit will be targeted more judiciously than in the past.

During 1999 the dong depreciated on an average annual basis by just 4.6%, compared with 11.6% the previous year. This compares with a maximum possible depreciation of around 30% under the crawling-peg system introduced in February 1999. Much greater stability of the dong is a consequence of barely positive import growth last year, supplemented by reasonable capital inflows, which resulted in a fall in demand for dollars. Reflecting this, the differential between the formal and black-market exchange rate was generally only around D10-20 last year and never rose above D50. That the currency, which is still marginally overvalued relative to the currencies of Vietnam's main regional competitors, did not depreciate by more also reflects the government's long-standing preference for a very gradual downward adjustment in the dong. This is in part justified by the argument that a large devaluation is not necessary to boost exports - indeed, last year's export growth would rather seem to confirm this, the higher oil price notwithstanding - while it would carry potentially heavy costs in terms of higher inflation, a higher dept burden and damage to the still fragile confidence in the currency.

Economists generally forecast the dong to continue to depreciate gradually at a rate of 5.8% on an annual average basis. Demand for dollars will increase from 2000 as imports rise. However, the severe liquidity shortages of 1997-98 are unlikely to be repeated. This is partly because lower levels of foreign investment will keep import growth below the rates achieved in the historical period, and partly because inflows on the capital account are expected to continue to be reasonably abundant. A devaluation in China could result in a somewhat larger downward adjustment in the dong. However, this would only be a temporary departure from the government's policy of permitting the dong to depreciate gradually.

18.1 Political Overview (continued)

18.1.13 External Sector

The pattern of small trade deficits which has been a feature of the merchandise trade account since the Asian Financial crisis continued in 1999. Import growth was positive, at 0.9% year on year in dollar terms, reflecting continued weak domestic demand. However, exports expanded by a robust 23.1% compared with 0.9% in 1998.

The greatest boost to export growth came from sharp rises in the price and output of oil. However, large volume increases in exports of some primary products, notably rice and coffee, offset some of the weakness in commodity prices. In addition, light manufacturing exports, such as textiles and garments, footwear, and electronics and computers, also recorded strong growth last year, benefiting from reviving Asian demand and the availability of spare manufacturing capacity domestically.

Export growth is likely to remain subdued by historical standards. Growth will also be below the rate achieved in 1999, particularly since no further leaps in the oil price are expected (in fact, the oil price is forecast to peak in 2000 before weakening somewhat thereafter). Moreover, several years of low investment will act as a drag on the growth of manufactured exports. However, exports will benefit from favorable market access agreements with the EU and, more importantly, will receive a strong boost from the word of normal trade relations (NTR) status by the US, probably in 2000, with the impact beginning to be felt in new export sales the following year. However, gaining a market share in the US will not be easy. Moreover, the experience of other countries which have received NTR (such as Cambodia) is that it can be quickly followed by quantitative restrictions on exports, notably of textiles and garments. Similar restrictions are likely in Vietnam's case. There has been some progress in reducing administrative obstacles to exporters, and gradual progress will continue to be made during 2000-04. A healthy rate of export growth over the next five years can therefore be expected, averaging 15.3% per year, but this is well below the 23.2% rate recorded in the previous five years.

Import growth is expected to accelerate to an annual average rate of 17.5% (compared with the 12% rate recorded in the previous five-year period). As demand picks up, domestic industry, which is still very import-dependent, will start to import more in order to feed the demand for inputs to meet the expanding needs of both domestically and export-oriented industry. However, import growth will remain below the levels achieved in the early and mid-1990's chiefly because realized foreign investment will remain relatively subdued. The trade balance will remain in modest surplus on a fob-fob basis.

The current account, by contrast, is expected to return to deficit this year, where it will remain for the next few years. The deficits will, however, be small by historical standards, peaking at $919 million, or 2.9% of GDP, in 2002. Rising trade turnover will widen the services deficit, but its size will be moderated by the strong growth of receipts from tourism - last year's revival in tourism looks sustainable for some time to come on the basis of returning regional prosperity and abundant spare hotel capacity. Higher global interest rates and repatriated profits will widen the deficit on the income account, but these outgoings will be more or less exactly offset by the impact of higher workers' remittances, transfers by overseas Vietnamese and rising disbursement of rant aid on the transfers account.

18.1.14 Foreign Debt

Vietnam's international financial standing has been on a much firmer footing since the successful conclusion of debt agreements with the Paris Club of official creditors after 1993 and with the London Club of commercial creditors in 1998. Some of the nonconvertible currency debt has also been renegotiated, but the bulk of it, now owed to Russia, has still to be settled because of differences between the two countries on what dollar valuation to put on the debt.

The change in the profile of Vietnam's debt stock since the mid-1990s, which has increased the proportion of medium-and long-term debt relative to short-term debt, will continue through 2004. By the end of 2004 the proportion of medium-and-long-term debt in the total debt stock will still be at around its current level (at close to 90%). This trend reflects the improved disbursement of overseas development assistance and the scarcity of short-term credits. However, within this total a larger share will come from private sources, reflecting the upturn in foreign investment inflows towards the end of 2004.

Disbursements of official medium-and long-term loans (excluding IMF credits) are expected to increase to an average of $2.2 billion (although this figure is inflated by the assumed settlement of the outstanding transferable double debt to Russian in 2001).

18.1 Political Overview (continued)

Inflows on this scale are more than sufficient to meet the financing requirement, but will not seriously worsen Vietnam's present favorable debt ratios: the debt-service ratio will remain below 10% throughout the forecast period, while the debt/GDP ratio will be a manageable 60.5% by end-2004.

18.1.15 Market Opportunities

Vietnam's economic potential lies in the fact that it has a larger population, now approaching 80 million. During the 1990s annual population growth was 1.7%, representing a significant slowdown on earlier levels. Similar or slightly slower population growth rates are likely during the foreseeable future, reflecting the relative success of the government's "one or two" child policy.

Slow population growth will help buoy incomes per head. Relatively slow economic growth during 2000-04 will constrain the rise in disposable incomes, however. Although a large market, Vietnam will remain relatively poor overall. There will continue to be large discrepancies between urban and rural areas, and within the rural areas between the mostly subsistence Red River Delta in the north and the more outward-looking Mekong River Delta in the south. Market opportunities will continue to be greatest in the cities of Hanoi, Ho Chi Minh City, Haiphong and Danang.

Companies which have been most successful to date are the ones that have targeted the lower end of the market. The market for electronic and white goods has, at times, shown signs of saturation in the main urban centers. However, demand for such products will be maintained overall. Vietnam's population is young, and among the urban middle class there is a strong desire to own the latest model of anything - especially from the US.

18.2 Political Considerations

Several commitments, considerations and concessions from the Government of Vietnam, and its agencies will be needed to make the Project economically viable and to assist the JVC to secure financing for the Project. There are:

18.2 Political Considerations (continued)

- Priority allocation of credit capacity available under the limitations which the Government has agreed with the IMF to observe (as part of the Fund's Extended Structural Adjustment Facility) to the depth required to finance the Project.
- Guarantee regarding foreign exchange availability, convertibility and rate fluctuations.
- Authorization for the JVC to export a portion of the HBI or to make sales to foreign - invested enterprises in foreign currency.
- Issuance of guarantees under bilateral export financing programs to be used to purchase equipment for the Project.
- Right of foreign investors timely repatriation of funds.
- Endorsement of the Project as a priority project and confirmation of such status to multilateral financing agencies.
- Adequate positive measures to protect the competitiveness of the Project, including necessary restriction on the grant of further licenses to any entity that would compete with this Project.
- Assistance of the Government with the infrastructure and the construction of the Port facility through the use of multilateral or bilateral concessioning organizations or assistance programs available to the Government or relevant ministries or agencies.
- Timely issuance of all licenses, permits and approvals from governmental agencies.
- Considerations for natural gas prices at less than US $1.75 per million BTU and electrical power costs of US 0.07 per KWH to enhance competitiveness in the international market of DR products, as determined by the Market Study.

Note: The following sources have been used in gathering data contained in the Section 18.1

a. OECD

b. UNDP

c. EIU

d. Vietnam Government Offices

- Ministry of Finance
- Ministry of Trade

18.2 Political Considerations (continued)

- Ministry of Planning & Investment

e. Brent (Oil Data)

f. Nhan Dan, Vietnam Investment Review

SECTION 19.0

CONCLUSIONS

A detailed Feasibility Study to construct a Direct Reduced Iron Plant in compliance with the Master Plan of the Steel Industry to meet the increasing demand of steel products in Vietnam and to serve as an export facility of HBI for the regional demand has been conducted under a Grant Agreement between US TDA and VSC. The primary conclusions, based on this study, are as follows:

- Demand of steel products in Vietnam has been estimated to rise to about 2 million tons by year 2000 and 6 million tons by 2010 compared to the current annual rolled steel production of about 1.15 million tons.

- Demand of DRI/HBI, which is critical ingredients of steel making via EAF, in Asia is expected to rise from 1997 level of about 8 million tons to about 19 to 27 million tons within the next decade. Market potential of Vietnam HBI plant will be 5 to 7 million tons in year 2005 and 7 to 10 million tons in 2010.

- Considering market potential of the region and in-country demand, Vietnam can consider building a 1.5 million tons per year HBI plant. The Plant capacity may be expended in the future by adding a second module of similar capacity.

- From a technical perspective, it is believed that a plant can be designed and constructed to produce the required output and quality of HBI product desired by the JVC. Additionally, there appears to be sufficient natural resources in the form of natural gas and electricity to support the Project. However, feed materials for the Plant (iron pellets and lump ore) need to be imported due to quality problems in the in-country iron ore reserves. Further work will be required to confirm suitability of in-country iron ore reserves.

- The following technical reports prepared for the Study are included as appendices:

  - Market Study
  - Selection of the Plant Location
  - Topographic and Hydrological Surveys
  - Geotechnical Investigations
  - Utilities Sources of the Site
  - Environmental Assessment
  - Midrex MEGAMOD™ DRI Plant
  - Financial Analysis

19.0 Conclusions (continued)

- Initial discussions with primary suppliers for the Project suggest that suitable contracts can be achieved that will have sufficient pricing and terms to proceed with development. There are, however, some key issues that still need to be resolved with several of the contracts. In particular, substantial work will be required on the EPC contracts to reduce the Plant capital costs.

- There does not appear to be any significant problems with securing environmental permits for the facility.

- The Project is expected to be able to raise financing with about 30 percent equity and 70 percent debt. The current debt markets, however, are quite challenging for both the Vietnam and steel markets, in general. Allowing some time for the markets to return to better conditions would improve the Project economics. Currently, the steel market is still unsettled as a result of poor economic conditions in various critical regions of the world and a resulting drop in prices and overcapacity.

- Financial analysis for the Base Case of the study yields a 12.2% IRR on total capital investment which may not meet the desired return threshold level of the JVC. In order to proceed with development of the Project, the economic return needs to be improved. The most likely area that can improve the economics is a reduction in the capital cost of the facility. This would need to come through either a substantial reduction in the EPC cost, or a reconfiguration of the Project on a different site. Various scenarios in the financial models have been considered. A 10% recent reduction in the plant capital cost will improve IRR to about 14%. An added factor could be in reducing the cost of materials (e.g. iron ore, natural gas, electricity). Favorable considerations from the Government of Vietnam are needed in establishing favorable utility tariffs for operations and to minimize risks of foreign investments in Vietnam.

- The Project would have several important benefits for Vietnam in the form of providing numerous jobs for construction and operation of the Plant, tax revenues, and substantial revenues in the form of natural gas, electricity and HBI sales in regional foreign markets.

- In summary, the Study indicated that the Project is viable. However, before proceeding actively with development of the Project as currently envisioned, the following 3 items need to happen: (1) steel market conditions and HBI price must show signs of improvement to

19.0 Conclusions (continued)

confirm the Market Study assumption, (2) Project financing markets must show signs of improvement and (3) the project economics must get better by reducing total capital investments and/or operating costs with favorable utility tariffs. In addition, firm commitments of all potential JVC Partners need to be confirmed, and following the critical project specific agreements, the following should be addressed:

- Feed Materials Supply
- Gas Supply
- Electricity Supply
- Water Supply
- Land Lease
- Product Off-Take
- Operations & Technical Assistance
- Maintenance
- Waste Disposal

It is envisioned that, based on a 3-month review period of the Report by VSC and other interested parties including final confirmation of all JV partners and a 10-month project development phase as outlined in Section 12.0, the anticipated start date of the Project will be September 1, 2001 and the plant will be ready for operation by August, 2004.