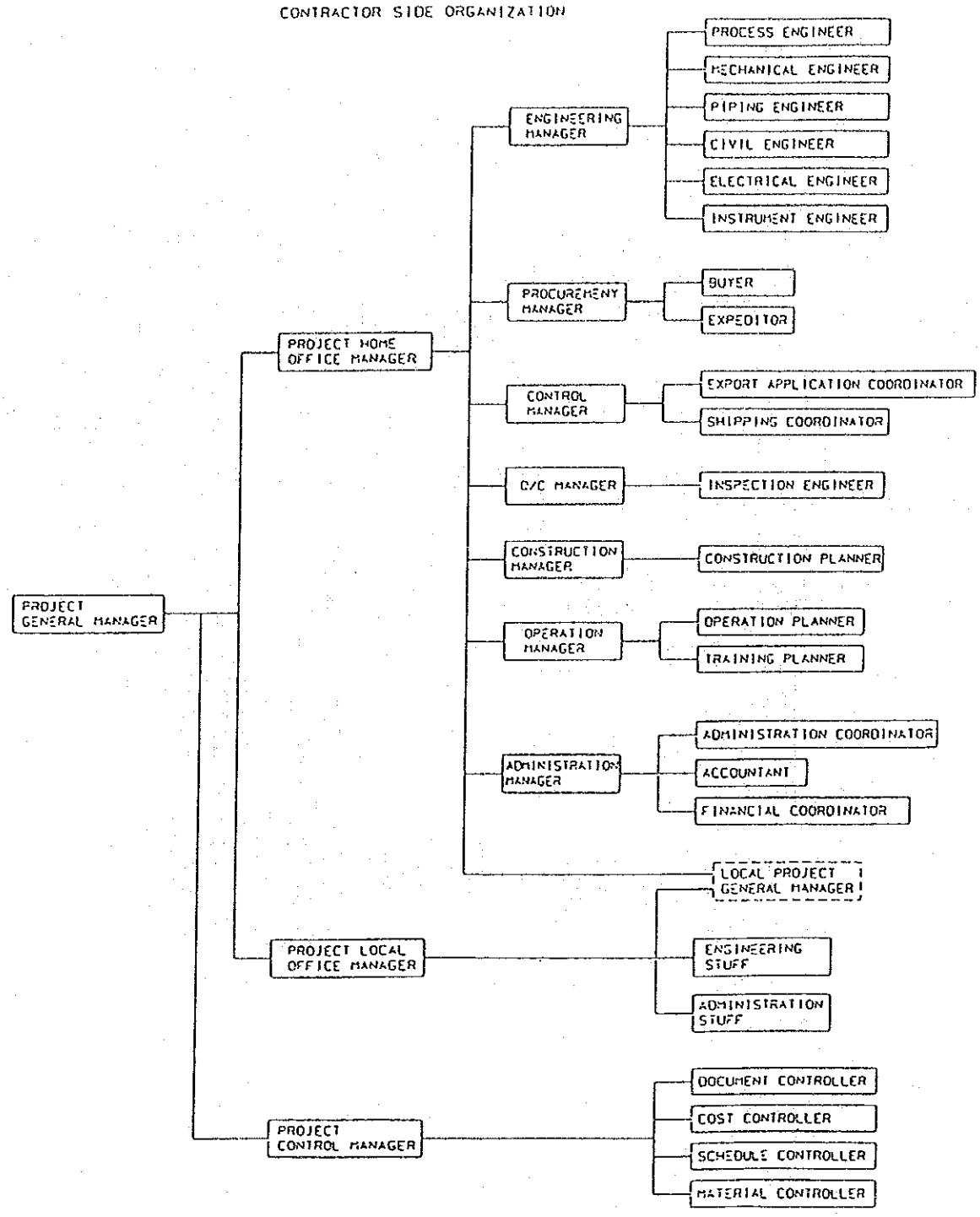
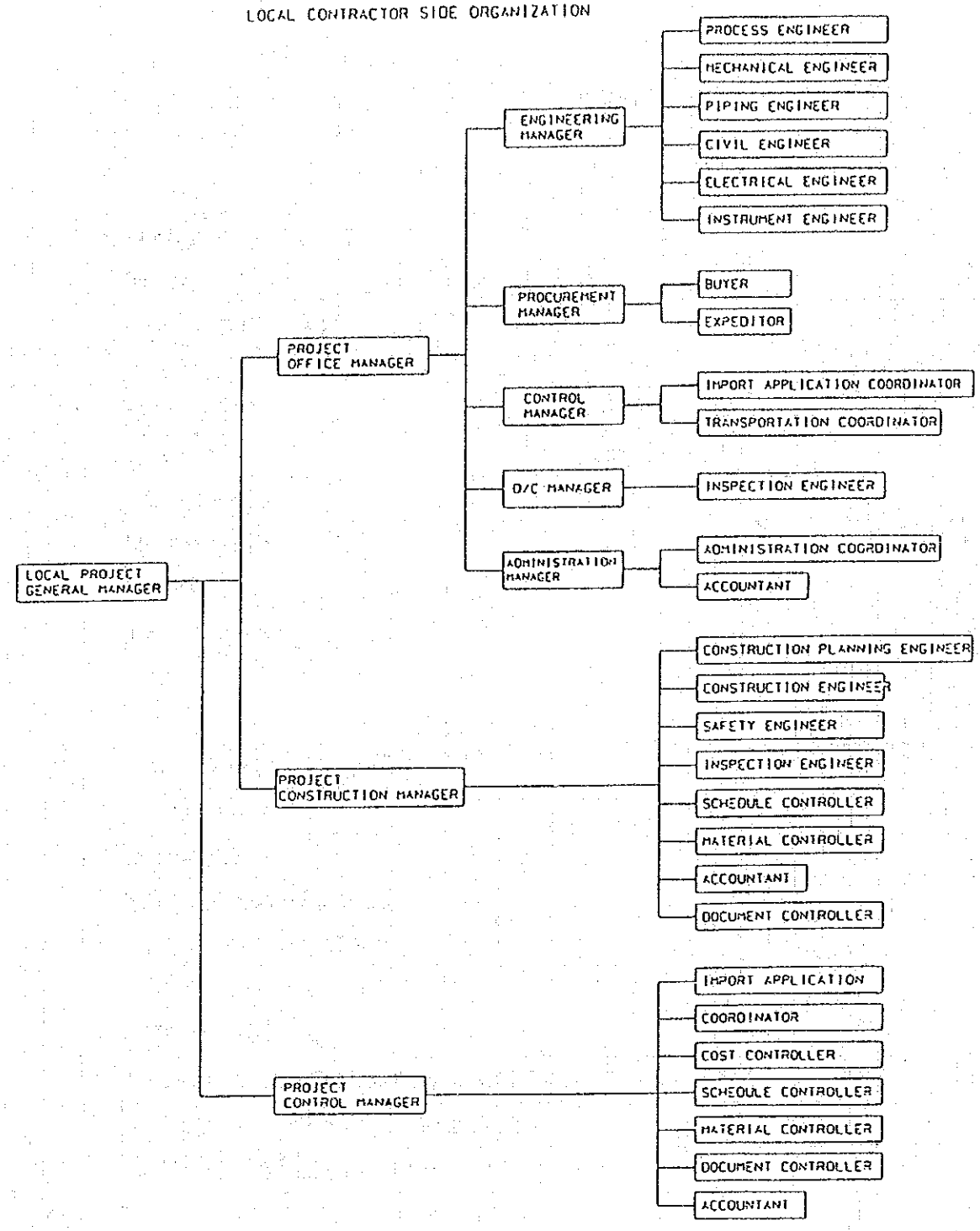


THE PRE-FEASIBILITY STUDY ON THE SRC DEVELOPMENT IN INDIA

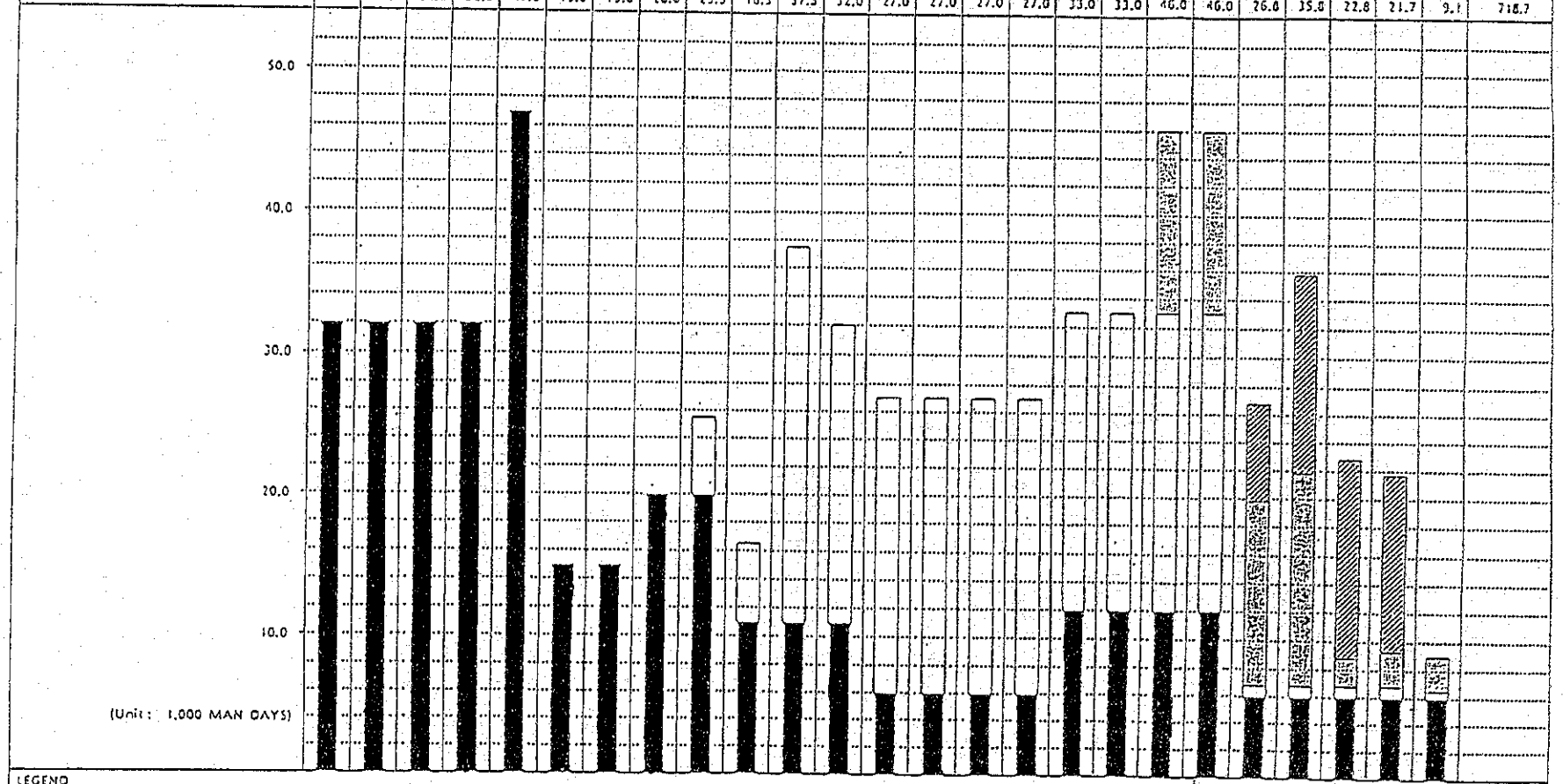
CONTRACTOR SIDE ORGANIZATION

Figure 7.11.3 | JICA



THE PRE-FEASIBILITY STUDY ON THE SRC DEVELOPMENT IN INDIA	
LOCAL CONTRACTOR SIDE ORGANIZATION	
Figure 7.11.4	JICA

	MONTH																									
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	TOTAL
CIVIL & ARCHITECT	32.0	32.0	32.0	32.0	47.0	15.0	15.0	20.0	20.0	11.0	11.0	11.0	6.0	6.0	6.0	6.0	12.0	12.0	12.0	12.0	6.0	6.0	6.0	6.0	6.0	300.0
PIPING & MECHANICAL									5.5	5.5	26.5	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	0.8	0.8	0.8	0.8	0.8	220.3
ELECTRICAL & INSTRUMENT																			13.0	13.0	13.0	15.0	2.0	2.5	2.5	61.0
PAINT & INSULATION																					7.0	14.0	14.0	12.4	0	47.4
TOTAL	32.0	32.0	32.0	32.0	47.0	15.0	15.0	20.0	25.5	16.5	37.5	32.0	27.0	27.0	27.0	27.0	33.0	33.0	46.0	46.0	26.8	35.8	22.8	21.7	9.1	718.7



LEGEND

- CIVIL & ARCHITECT LABOUR
- PIPING & MECHANICAL LABOUR
- ELECTRICAL & INSTRUMENT LABOUR
- PAINT & INSULATION LABOUR

THE PRE-FEASIBILITY STUDY ON THE SRC DEVELOPMENT IN INDIA

CONSTRUCTION LABOUR'S HISTOGRAM

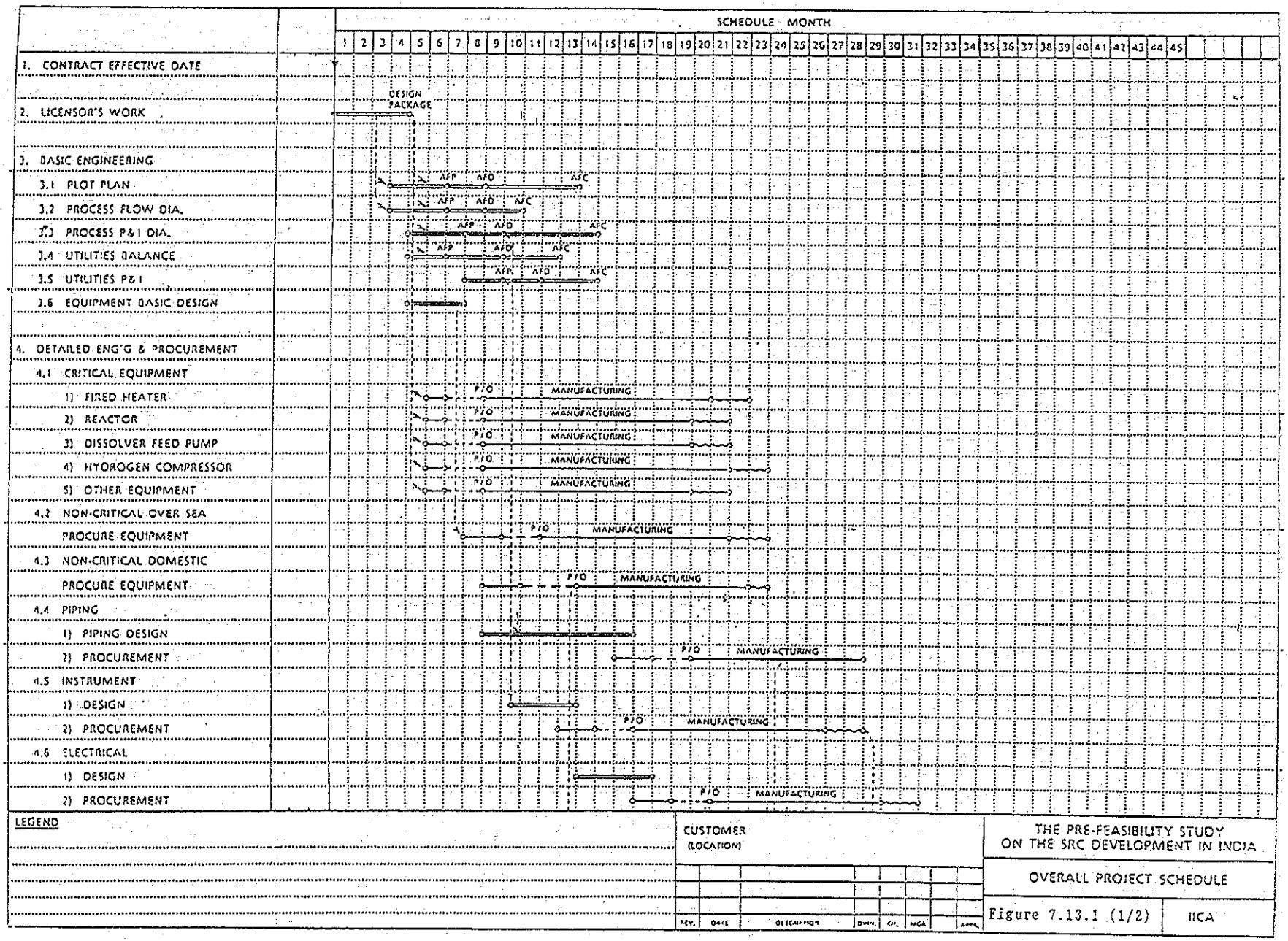
Figure 7.11.5 | JICA

Table 7.12.1 ESTIMATED MANNING REQUIREMENT

SALARIED PERSONNEL	DAY SHIFT ONLY	SHIFT WORK 4 SHIFTS	TOTAL
1. Director	1	-	1
Secretary	1	-	1
Subtotal			(2)
2. Administration Dept.			
Manager (General Affairs)	1	-	1
Specialist	1	-	1
Clerk	1	-	1
Manager (Purchasing)	1	-	1
Specialist	1	-	1
Clerk	1	-	1
Subtotal		-	(6)
3. Operation Management Sect.			
Manager (Planning)	1	-	1
Staff Engineer	1	-	1
Clerk	1	-	1
Manager (Technical)	1	-	1
Staff Engineer	3	-	3
Clerk	3	-	3
Subtotal			(10)
4. Operation Sect.			
Manager (Process)	1	-	1
Staff Engineer	2	-	2
Clerk	2	-	2
Manager (Utility)	1	-	1
Staff Engineer	1	-	1
Clerk	1	-	1
Subtotal			(8)
5. Maintenance Sect.			
Manager (Maintenance)	1	-	1
Staff Engineer	1	-	1
Clerk	1	-	1
Manager (Store, Transportation)	1	-	1
Staff Engineer	1	-	1
Clerk	1	-	1
Subtotal			(6)
6. Operation Personnel (Superintendent or Foreman)			
Superintendent	1	-	1
Fire Service and Safety	1	-	1
Laboratory	1	-	1
Process and Utility	-	2	8
Maintenance	4	1	8
Store and Transportation	1	-	1
Subtotal			(20)
TOTAL SALARIED PERSONNEL			(52)

Table 7.12.2 ESTIMATED MANNING REQUIREMENT

WAGES PERSONNEL	DAY SHIFT ONLY	SHIFT WORK 4 SHIFTS	TOTAL
1. Guardman	-	2	8
Office Service	2	-	2
(Administration Sect. Subtotal)			(10)
2. Laboratory Analysis	6	-	6
(Analysis Sect. Subtotal)			(6)
3. Process Operator (Area #100-300)	-	6	24
Process Operator (Area #400)	-	2	8
Process Operator (Area #500-800)	-	5	20
Utility Operator (System #1000-1500)	-	6	24
Utility Operator (System #1600-1990)	-	5	20
Utility Operator (Electric power supply)	-	1	4
(Operation Sect. Subtotal)			(100)
4. Mechanics	2	3	14
Electricians	2	1	6
Instrument Fitters	2	1	6
Store Operators	2	-	2
Feedstock/Product Operators	2	-	2
Transportation Operators	4	1	8
(Maintenance Dept. Subtotal)			(38)
TOTAL WAGE PERSONNEL			154
TOTAL PLANT PERSONNEL			206


SCHEDULE MONTH
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
1. CONTRACT EFFECTIVE DATE
2. LICENSOR'S WORK
DESIGN PACKAGE
3. BASIC ENGINEERING
3.1 PLOT PLAN
3.2 PROCESS FLOW DIA.
3.3 PROCESS P&I DIA.
3.4 UTILITIES BALANCE
3.5 UTILITIES P&I
3.6 EQUIPMENT BASIC DESIGN
AFP
AFD
AFC
4. DETAILED ENG'G & PROCUREMENT
4.1 CRITICAL EQUIPMENT
1) FIRED HEATER
2) REACTOR
3) DISSOLVER FEED PUMP
4) HYDROGEN COMPRESSOR
5) OTHER EQUIPMENT
P/O
MANUFACTURING
4.2 NON-CRITICAL OVER SEA
PROCURE EQUIPMENT
4.3 NON-CRITICAL DOMESTIC
PROCURE EQUIPMENT
4.4 PIPING
1) PIPING DESIGN
2) PROCUREMENT
4.5 INSTRUMENT
1) DESIGN
2) PROCUREMENT
4.6 ELECTRICAL
1) DESIGN
2) PROCUREMENT
LEGEND
CUSTOMER
(LOCATION)
REV. DATE DESCRIPTION DWN. CH. MGR. APPR.
THE PRE-FEASIBILITY STUDY
ON THE SRC DEVELOPMENT IN INDIA
OVERALL PROJECT SCHEDULE
Figure 7.13.1 (1/2)
JICA

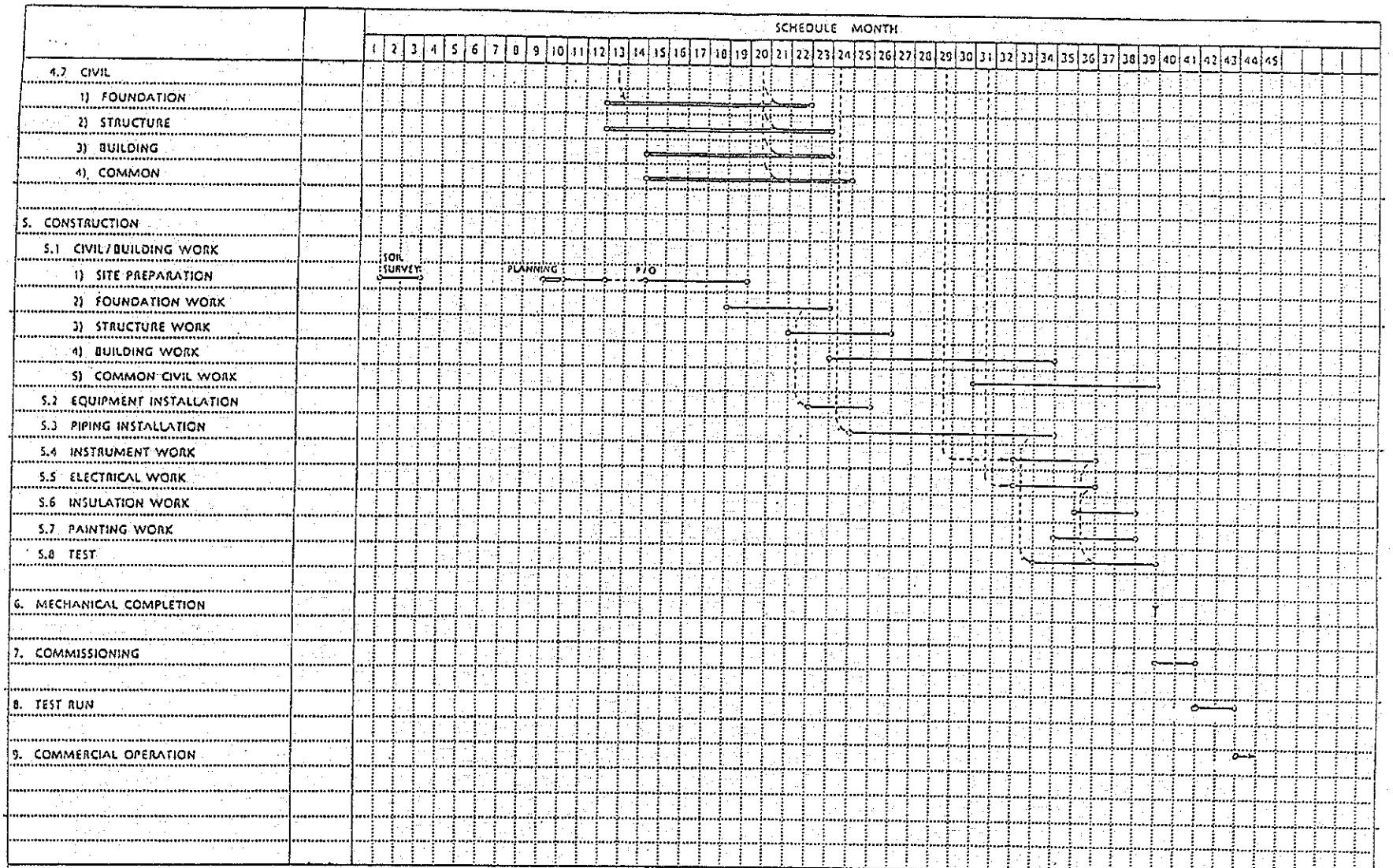

SCHEDULE MONTH
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
4.7 CIVIL
1) FOUNDATION
2) STRUCTURE
3) BUILDING
4) COMMON
5. CONSTRUCTION
5.1 CIVIL/BUILDING WORK
1) SITE PREPARATION
SOIL SURVEY
PLANNING
P/O
2) FOUNDATION WORK
3) STRUCTURE WORK
4) BUILDING WORK
5) COMMON CIVIL WORK
5.2 EQUIPMENT INSTALLATION
5.3 PIPING INSTALLATION
5.4 INSTRUMENT WORK
5.5 ELECTRICAL WORK
5.6 INSULATION WORK
5.7 PAINTING WORK
5.8 TEST
6. MECHANICAL COMPLETION
7. COMMISSIONING
8. TEST RUN
9. COMMERCIAL OPERATION
LEGEND
DESIGN
PROCUREMENT SPECIFICATION
TRANSPORTATION
AFP : APPROVAL FOR PLANNING
AFD : APPROVAL FOR DESIGN
AFC : APPROVAL FOR CONSTRUCTION
P/O : PURCHASE ORDER
CUSTOMER
(LOCATION)
REV. DATE DESCRIPTION DWN. CH. JICA APPR.
THE PRE-FEASIBILITY STUDY
ON THE SRC DEVELOPMENT IN INDIA
OVERALL PROJECT SCHEDULE
Figure 7.13.1 (2/2)
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Table 7.14.1 TOTAL PLANT COST ESTIMATION SUMMARY

Items	Foreign Currency mm¥	Local Currency 10^5Rs
1. Plant direct cost		
(1) Equipment and materials		
- Equipment and materials for area #100-#1980	7,103	12,934
- Spare parts	548	856
Sub-total	7,651	13,790
(2) Erection and installation works	0	1,707
(3) Civil and building works	0	3,565
Plant direct cost total	7,651	19,062
2. Expenses		
(1) Ocean freight and insurance	185	0
(2) Local handling and inland transportation	0	92
(3) Indirect field expense	0	568
Expense fee total	185	660
3. Engineering fee		
(1) License fee	370	0
(2) Basic design	114	0
(3) Engineering service	921	836
(4) Project Management	360	358
Engineering fee total	1,765	1,194
Total	9,601	20,916
4. Contingency	837	2,014
Grand Total	10,438	22,930
5. Additional facilities		
Railway siding	0	34

Table 7.14.2 EQUIPMENT AND MATERIALS COST OF PROCESS AREAS

Areas and Items	Foreign Currency mm¥	Local Currency 10^5Rs
1.1 Plant area #100 (Coal preparation area)		
- Itemized equipment	0	1,836
- Bulk materials	0	300
Sub-total	0	2,136
1.2 Plant area #200 (Coal dissolving area)		
- Itemized equipment	2,252	128
- Bulk materials	316	1,263
Sub-total	2,568	1,391
1.3 Plant area #300 (Hydrogen recovery and purification area)		
- Itemized equipment	624	286
- Bulk materials	44	488
Sub-total	668	774
1.4 Plant area #400 (Fractionation area)		
- Itemized equipment	147	458
- Bulk materials	43	595
Sub-total	190	1,053
1.5 Plant area #500 (Solid/liquid separation area)		
- Itemized equipment	1,915	416
- Bulk materials	72	750
Sub-total	1,987	1,166
1.6 Plant area #600 (SRC solidification area)		
- Itemized equipment	25	115
- Bulk materials	5	228
Sub-total	30	343
1.7 Plant area #700 (Hydrogen separation area)		
- Itemized equipment	1,246	39
- Bulk materials	54	515
Sub-total	1,300	554
1.8 Plant area #800 (Sulfur recovery area)		
- Itemized equipment	139	0
- Bulk materials	0	0
Sub-total	139	0
1.9 Process plant area total		
- Itemized equipment	6,348	3,278
- Bulk materials	534	4,139
Total	6,882	7,417

Table 7.14.3 EQUIPMENT AND MATERIALS COST OF UTILITY AND SUPPORTING FACILITIES (1/2)

Areas and Items	Foreign Currency mm¥	Local Currency 10^5Rs
1.10 Plant area #1000		
(Steam and condensate system)		
- Itemized equipment	22	3,510
- Bulk materials	21	378
Sub-total	43	3,888
1.11 Plant area #1100		
(Water system)		
- Itemized equipment	0	5
- Bulk materials	0	20
Sub-total	0	25
1.12 Plant area #1200		
(Waste water treatment system)		
- Itemized equipment	55	91
- Bulk materials	0	57
Sub-total	55	148
1.13 Plant area #1300		
(Cooling Water System)		
- Itemized equipment	21	95
- Bulk materials	0	107
Sub-total	21	202
1.14 Plant area #1400		
(Fire fighting system)		
- Itemized equipment	0	125
- Bulk materials	0	80
Sub-total	0	205
1.15 Plant area #1500		
(Fuel system)		
- Itemized equipment	0	11
- Bulk materials	0	45
Sub-total	0	56
1.16 Plant area #1600		
(Air and nitrogen system)		
- Itemized equipment	19	83
- Bulk materials	0	62
Sub-total	19	145

Table 7.14.3 EQUIPMENT AND MATERIALS COST OF UTILITY AND SUPPORTING FACILITIES (2/2)

Areas and Items	Foreign Currency mm¥	Local Currency 10^5Rs
1.17 Plant area #1700 (Flare system)		
- Itemized equipment	52	11
- Bulk materials	0	69
Sub-total	52	80
1.18 Plant area #1900 (Hot oil system)		
- Itemized equipment	0	107
- Bulk materials	0	104
Sub-total	0	211
1.19 Plant area #1950 (Flushing oil system)		
- Itemized equipment	0	4
- Bulk materials	0	9
Sub-total	0	13
1.20 Plant area #1980 (Interconnecting Piping)		
- Itemized equipment	0	0
- Bulk materials	0	421
Sub-total	0	421
1.21 Plant area #1990 (Power receiving and emergency power facilities		
- Itemized equipment	0	0
- Bulk materials	31	123
Sub-total	31	123
Utility and supporting facilities total		
- Itemized equipment	169	4,042
- Bulk materials	52	1,475
Total	221	5,517
Plant total		
- Itemized equipment	6,517	7,320
- Bulk materials	586	5,614
Grand total	7,103	12,934

Chapter 8 FINANCIAL AND ECONOMIC ANALYSIS OF DEMONSTRATION PLANT

Chapter 8 FINANCIAL AND ECONOMIC ANALYSIS OF DEMONSTRATION PLANT

8.1 Calculation of Total Capital Requirement

8.1.1 Outline of the Project

This section is an outline of the present project for the purpose of clarifying the assumptions on which the financial and economic analysis of the demonstration plant is made, as well as indicating the aspects which differentiate the present project from ordinary industrial projects.

(1) Need for SRC

While India possesses considerable coal resources (of non-coking coal) for fuel it has only small reserves of coking coal for metallurgical coke production and the ash content of these is high. It is not possible to reduce the high ash content to the level desirable for coke production by the use of normal coal washing methods and this is a hindrance to improvements in the productivity of blast furnaces.

For some time past India has pursued a policy of importing the raw coal requirement for blending with domestic coal as a response to the above situation. However this can not be seen as a long term solution given the loss of foreign currency it entails.

Therefore India desires to employ SRC technology since this makes it possible to use the plentiful non-coking coal as a substitute coke feedstock and thereby reduce consumption of imported coal and domestic coking coal.

(2) Role of the Demonstration Plant

The First Phase of the SRC Development Program in India is to carry out (through the present project study) a technical and economic evaluation. The technical evaluation is based on a coal analysis and autoclave tests. If the results of this evaluation are satisfactory then technical data is to be collected in the bench scale operations which constitute Phase 2. On the basis of this technical data a demonstration plant of 500 t/d capacity is to be constructed and if the achievement results of this plant are found satisfactory then SRC plants will be generally implemented in India.

As it is judged that bench scale operations as envisaged in the initial program are essential to evaluation, the starting date for construction of the demonstration plant is scheduled for 1996 and the beginning of operations for 1999.

(3) Proposed Construction Site

In order to realize the aims of the present study it is assumed that the construction site for the demonstration plant will be inside the plant site of SAIL's subsidiary the Rourkela Steel Plant (RSP).

Justification -

- It is possible to supply the RSP utilities and COG (Coke Oven Gas, which serves as the hydrogen source).
- It is possible to use the existing facilities of RSP for handling the by products and for treatment of the wastes from SRC.
- The existence of technical, personnel and equipment resources available to support operations of the demonstration plant.
- The evaluation of the SRC project (including aspects of SRC production, coke production and hot metal

production) is facilitated.

(4) Implementing Body

At present the implementing body and business formation to be chosen for the implementation of the demonstration plant have not yet been concluded upon. Since it is essential to obtain the complete cooperation of SAIL for operation of the demonstration plant it is considered advisable at the present stage that a department of the SAIL Subsidiary RSP be charged with implementation.

(5) Outline of the Evaluation

The economic benefit of SRC production arises from the reduction in coke production costs due to the substitution of part of the raw coal feedstock by non-coking coal, the saving on foreign currency achieved through reduced use of imported coal and the prolonging of the service life of domestic coking coal collieries through a reduction in the domestic coking coal consumption.

Therefore a financial and economic analysis of the demonstration plant involves an evaluation which also covers the coke production aspects of the project. To calculate profitability the investment will be evaluated in the case of production employing a large amount of imported coal as heretofore and this will be compared to the investment cost when coke production is carried out using non-coking coal blended with an SRC content so as to show the difference resulting. It is therefore necessary to calculate the production cost of coke in RSP at present and the production cost of coke using blended SRC.

The present evaluation of SRC production costs was carried out taking Assam coal (Case A) to be the main case in accordance with the selection of this variety

as SRC feedstock coal outlined in Chapter 6. Moreover, a comparative evaluation of this case to one using Samla coal (Case S) was carried out as well as the case to using both Assam coal and Samla coal (Case H). Further, the price of SRC used for coke production only covers production cost and does not include any profit margins.

Moreover, the COG and utilities of RSP are taken to be supplied at production cost. The non-coking coal used in blending for the production of coke is assumed to be Samla coal. Since the 500 t/d demonstration plant under examination has sufficient output to meet the needs of one battery of coke ovens in RSP it can be considered as constituting a general production line. However, this capacity was actually selected in view of its safety for technical development and it does not represent a commercial scale plant in terms of SRC demand. Even if the demonstration plant does not prove economically viable, as long as a commercial plant on a 3,000 t/d scale is proved to have economic viability this will suffice to prove the development of SRC technology meaningful.

Given the particular characteristics of the Indian coal industry, together with the fact that this is a demonstration plant and will form a section of the RSP facilities as noted above, cost calculations for the present project took account of the fact that existing facilities can be used and that costs are to be kept to the lowest level possible while the local procurement content of the demonstration plant is to be improved.

The investment cost needed for implementation of the proposed demonstration plant project was estimated according to the assumptions and procedures explained below:

8.1.2 Basis for Estimates

(1) Currency and Exchange Rates

The US dollar is used as the basic currency in the present study and conversion calculations are based on the following exchange rates effective on August 16, 1991 shown by MECON in the second on site survey.

1 US$ = 25.71 Indian Rupees
1 US$ = 136.32 Japanese Yen

Observing the trend of Indian Rupee against US dollar from July to October in 1991, there was no substantial change during this period so that the above exchange rate was employed in the analysis. The plant construction costs are also calculated on the basis of the above exchange rate assuming no price escalation for two months from June 19, 1991 which was a basic date of estimation.

(2) Pricing Level

Expenses and prices were taken to be those of the fixed prices effective in August, 1991 and do not account for any subsequent price increases.
Since construction of the aforesaid demonstration plant will take place more than six years after the inspection visit a long range forecast of prices is deemed difficult

(3) Economic Indicators

The various economic indicators forming the basis for the present analysis are shown in Table 8.1.1.

8.1.3 Total Capital Requirement

The present section is concerned with the estimation of other expenses in the case using Assam coal as a feedstock for SRC production forming part of the total capital requirement besides the construction costs explained in the previous chapter.

(1) Land Cost

As shown in Figure 7.9.1 of Chapter 7, a land area of 110,000 sq. metres is required for the demonstration plant.

However, the Rourkela Steel Plant has adequate land available for the demonstration plant site and on the assumption of the free use of this, land acquisition costs have not been earmarked for the present. Also since the cost of land preparation is considered to be small this has not been earmarked either.

(2) Physical Contingency

The present expense is earmarked to meet an excess in the capital requirement arising from unforeseeable factors or imperfect estimations at the time of the present calculations.

The following expenses are earmarked in section 7.14.2 to meet this contingency.

for equipment and materials	: 10%
for erection and installation works	: 10%
for civil engineering and construction works	: 15%
others	: 0%

Taking the overall average this represents 9.0% of the Base Project Cost (on a 1991 price basis).

(3) Price Contingency

The present item is earmarked to meet the increases in prices which may arise in the future. However, as mentioned in the previous section, this expense is not given consideration since evaluation is to be carried out on the basis of the fixed price basis.

(4) Import Duties

Based on the discussion with the MECON, a double evaluation has been made in the event of payment at an average of 80% import duties on imported equipment and materials, and also in the event of no import duties being paid.

(5) Local Tax

In the Project, the following taxes are added on the local goods and equipment to present cost estimation.

1) Excise duty : 16.5% for mechanical equipment
: 22% for electrical and instrumentation equipment

2) Sales tax : 4% including the above

Since the electrical and instrumentation equipment are estimated at 15% of local goods and equipment as explained in previous chapter, this represents 18% of local goods and equipment taking the above overall average.

3) Research and Development Cess (R&D Cess):

5% of basic design and engineering services on foreign portion

(6) Pre-operating Expenses

The present expenses include the following costs incurred in the tasks for preparation of project implementation directly undertaken by the implementing body.

1) Expenses for promotion and planning of the project
2) Personnel recruitment expenses
3) General administrative expenses including for office supplies
4) Overseas training expenses (assumed to be Japan)
5) Loss during trial run period
6) Others

In order to estimate the present costs in the event of a completely new and independent organization being charged with these tasks the following costs are to be earmarked.

Breakdown of the Pre-operating Expenses

(Unit: thousand dollars)

Item	Expenses	Comments
- Initial Cost of Utilities and Chemicals	1,882	Refer to Tables 7.6.1 and 7.6.2
- Loss during Trial Run Period	1,793	Equal to 2 months variable costs in initial year
- Labor Costs during Construction Period	602	Based on Table 8.2.6
- General administrative Costs Other Managerial Costs	301	50% of the above earmarked
- Cost of Overseas Training	50	Given five trainees for 2 months period.
TOTAL	4,628	

Further, it is assumed that personnel will be recruited according to the following schedule drawn up on the basis of Table 8.2.5.

No. of Months from Contract Award	No. of Personnel	Rank
1	9	Manager
13	11	Chief
25	70	1/2 of Staff A
37	116	Remaining Staff
Total	206	

(7) Interest During Construction

The capital source for the present project has not yet been decided. However, in accordance with the assumption concerning capital funding indicated in section 8.1.5 it is assumed that a low interest loan will be provided by a foreign financial institution. Therefore the annual interest for the present evaluation is taken to be 6.0%. The loan position is assumed to represent 80% of the capital requirement, both domestic and overseas.

The interest for the loan position of the capital expense incurred for individual years during the construction period is calculated for the period from the expenditure concerned to the end of the year of payment using the following equation:

$$IDC = (PC + IDC) \times L \times \{d1(1 + i)^{3.5} + d2(1 + i)^{2.5} + d3(1 + i)^{1.5} + d4(1 + i)^{0.5} - 1\}$$

Where; IDC : Interest during construction
PC : Erected plant costs and pre-operating expenses excluding IDC and initial working capital
L : Loan ratio (80%)
i : Interest (6.0% annually)
dn : Disbursement schedule in year n
d1 = 0.05
d2 = 0.35
d3 = 0.40
d4 = 0.20

(8) Initial Working Capital

The present expense covers costs of the SRC finished product inventory and SRC feedstock coal inventory. This expense is to be financed just before operations commence and it is assumed that it will not therefore be the object of interest during construction.

Breakdown of Working Capital

(Unit: US$1,000)

Item	Capital	Comments
- SRC Product Inventory	1,643	Representing one months production cost in initial year excluding depreciation
- SRC Feedstock Coal Inventory	341	Representing 0.5 months of raw material costs in the initial year
TOTAL	1,984	

(9) Total Capital Requirement

The total capital requirement for realisation of the proposed demonstration plant is shown in Table 8.1.2.

8.1.4 Calculation of Capital Requirement if Samla Coal is Used for SRC Production and Both Assam Coal and Samla Coal is Used for SRC Production

Following the procedures laid down in section 8.1.3 for calculating capital requirement in conjunction with the estimates for equipment costs described in 7.15 and 7.16 in Chapter 7 the total capital requirement assuming the use of Samla coal as well as the use of both Assam and Samla coal was calculated and results are shown in Table 8.1.3 and Table 8.1.4.

8.1.5 Financing Plan

It is assumed that the total capital requirement estimated in the previous section for the proposed demonstration plant will be funded with the following conditions:

(1) Debt-Equity Ratio and Financing Disbursement

It is assumed that 20% of the total capital requirement will be funded from equity and the rest will be financed with a long term loan from overseas.

The construction schedule including the test run period is assumed to take 43 months as of the conclusion of the contract. The contract is scheduled to be completed in May, 1996 and operations of the demonstration plant set to commence in December, 1999.

It is assumed that two funding sources will be utilised to meet capital expenditure in accordance with the individual ratios accounted for by the loan and capital elements.

Disbursement Schedule

Project Year	Disbursement Schedule, %
1996	5%
1997	35%
1998	40%
1999	20%
Total	100%

(2) Financial Conditions of the Long Term Loan

For the purposes of the present study it is assumed that the financial conditions of the foreign loan will be as follows:

1) Interest : A annual interest of 6.0%.

2) Grace Period : A six year period from beginning of construction

3) Repayment terms : Equal annual installments for 20 years after grace period. However, outstanding payments which exceed the project life noted below are assumed to be paid in the last year of the project.

(3) Other Conditions

If a capital shortage occurs during the operational phase of the present project this is generally to be met by short term financing. Since the present

project is assumed to be supported by the overall profit of the steel plant for convenience the above shortage is to be recorded as a minus. Thus, in this study, the interest on the short term loan is not considered.

8.2 Calculation of SRC Production Costs

8.2.1 Basic Assumptions for Cost Accounting

As noted already in section 8.1.2 of the present chapter, the currency employed for accounting is the US dollar and all prices and costs are according to the fixed price basis of August, 1991 and do not take account of price rises. The production cost thus calculated shall be termed "the 1991 fixed price basis".

The beginning of SRC production is scheduled for December, 1999. Taking the project year to be from December to the following November the first year of operations is designated as the year 2000.

The project life is taken to be 24 years consisting of four years for construction and 20 years of operation.

The salvage value is taken to include land cost, undepreciated assets of investment and working capital shall be credited in the final year of the project.

8.2.2 Basic Assumptions of SRC Production Costs

The main evaluation of SRC production costs was conducted on the assumption of the use of Assam coal as the SRC feedstock coal. A second evaluation was also carried out for an alternative case assuming the use of Samla coal. In addition to above, an evaluation for the case assuming the use of Assam coal and Samla coal was carried out. These postulated cases are classified as follows:

Case A : assuming the use of Assam coal 100%
(the base case)
Case S : assuming the use of Samla coal 100%
Case H : assuming the use of Assam coal 50% and
Samla coal 50%

The following table shows the main items (500 t/d dry coal basis) relating to the present project.

Material Balance of SRC Demonstration Plant

ITEM	CASE A	CASE S	CASE H
SRC Process Plant*, TPD	500	500	500
Operable Days, DPY	330	330	330
Feed Coal Input*, TPY	165,000	165,000	165,000
Yield of SRC Product, %	67.92	48.89	65.38
Output, TPY			
- SRC Product	112,063	80,669	107,878
- Light Distillate	5,931	0	5,148
- Middle Distillate	950	0	0
- Residue	14,303	32,168	28,037
- Return Gas, MM, kcal	713,698	658,605	738,323
(TPY)	(106,049)	(96,548)	(109,708)
Input, TPY			
- Feedstock Coal**	182,724	199,758	188,299
- Coke Oven Gas, MM, kcal	731,396	661,336	764,641
(TPY)	(104,544)	(94,530)	(109,296)
- Fuel Coal**	65,736	65,736	65,736
- Electricity, MM KWH	10.375	10.375	10.375
- Filter Aid	1,848	10,168	3,596
- Fuel Oil	0	0	6,059

* Dry Coal Basis

** Purchased Coal Basis

(1) Production Schedule

It is assumed that the SRC production capacity on a dry coal basis will be 500 t/d and that there will be a total of 330 stream days per year, as shown in the above table. Since the SRC product yield varies for the proposed coal feedstocks the annual SRC output will be as follows:

Case	SRC product yield	SRC output
A	67.92%	112,063 t/y
S	48.89%	80,669 t/y
H	65.38%	107,878 t/y

In view of technical considerations, the following yearly operating rates are assumed for the demonstration plant in operation. After taking a one month stock of SRC product into account the output delivered to RSP is taken as the SRC product output. The operating rates on a fiscal year basis (ending in March) are given for reference.

(Unit: %)

Project Year	Operating Rate	Inventory Increase	Output Ratio	Operating Rate (fiscal year)
1999	-	-	-	26.7
2000	80.0	8.3	71.7	83.3
2001	90.0	-	90.0	93.3
2002	100.0	-	100.0	100.0
|	|	-	|	|
2018	100.0	|	100.0	100.0
2019	100.0	(-)8.3	108.3	66.7
Total	1,970.0	-	1,970.0	1,970.0

(2) Variable Costs

Variable costs include those for the non-coking coal which is the SRC feedstock, the COG and Utilities provided by RSP, and for SRC by-products. These by-products are noted as deductible items in the present section. The various prices of the variable costs at August, 1991 are shown in Table 8.2.4.
As a by-product, sulfur credit is not taken account of since sulfur used for SRC production is in short and sulfur shortage is to be supplied from RSP.

(3) Operating Personnel Expenses

Personnel expenses including those of bonus payments and social welfare costs have been established on the basis of data for RSP wages. The wage levels at RSP for 1990-91 including those of manager were as shown below:

Rank	Category	Personnel Expenses	
		(Rs./Man year)	($/Man year)
Manager	Senior Manager *	123,000	4,784
Chief	Manager/Assistant Manager	94,000	3,656
Staff A	Skilled Labour	57,000	2,217
Staff B	Semi-/Unskilled Labour	41,000	1,595

* Including Managing Director

Table 8.2.5 indicates the personnel numbers by section and rank while Table 8.2.6 shows the wages, in accordance with the SRC organizational structure as explained in Chapter 7. 134 staff are directly engaged in operational works and the average personnel cost is Rs.57,230 per man year (US$2,226 per man year). Operating personnel expenses have therefore

been estimated at Rs.7,669,000 per year (US$298,000 per year). 50% of the above personnel expenses has been added to the budget to account for overheads.

(4) Repairs and Maintenance

In the present analysis 1.5% of the erected plant cost (excluding the engineering service) is earmarked for repair expenses arising from normal repair services. Moreover since a staff of 53 personnel is engaged in repairs the average personnel expenses of the repair department have been added to the above expenses. Therefore the annual expenses for repairs and maintenance are estimated to be as follows:

(Unit: thousand US$)

	Case A	Case S	Case H
Repair costs	3,134	3,844	3,353
Personnel costs	118	118	118
Total	3,252	3,962	3,471

(5) Depreciation and Amortization

The erected plant costs are depreciated using the following method:

- Method of depreciation : Straight line methods
- Salvage value : 5%
- Service life : 20 years

Further the salvage value of pre-operating expenses and interest during construction is taken to be zero and uniform redemption is to be carried out over 20 years.

(6) Other Fixed Costs

Tax and public imposition, insurance premium and general administrative expenses are included under the present heading.

- Tax and public imposition, insurance premium :
  an amount equaling 0.5% of the book value of fixed assets

- General administrative expenses :
  personnel expenses of the general administrative section plus an amount for various expenses equaling that for personnel expenses are to be earmarked

The interest on the long term loan mentioned in section 8.1.4 of the present chapter is also covered by the present expense. However, in view of the nature of the present project the following expenses are not taken into account.

- interest on the short term loan
- sales expenses

In connection with these, the taxes usually taken into consideration for normal businesses (at present the tax rate of RSP is 51.75%) and dividends are not considered in the present analysis.

(7) Working Capital

An initial working capital is necessary to initial financial budgeting and after project operations have commenced a supplementary working capital is needed for smooth running of operations. In normal accounting practice, as can be seen in a balance sheet made at the end of the accounting year, the working capital is the remainder left after the current liabilities has been deducted from the current assets.

In cases where the remainder in question exceeds that of the previous accounting year this is termed the "Change in Working Capital" and is calculated as an item of payment on the funds flow statement.

In the present analysis the sum for the change in working capital is used for the calculation of profitability of coke production instead of the sum for initial working capital.

The working capital is based on the SRC product inventory and SRC feedstock coal inventory as mentioned in section 8.1.3 and evaluation is conducted on a "first in first out" method (FIFO).

8.2.3 SRC Production Costs

Annex 8.2.1 indicates details of the SRC production costs calculated on the basis of all the various above mentioned assumptions. Tables 8.2.1, 8.2.2 and 8.2.3 summarize these results.

(1) SRC Production Costs for Base Case

SRC production costs as of 2009 which is 10 years after production start are shown as follows. The value as of 2009 is regarded as an average cost of the project for financial analysis purpose.

SRC Production Cost

(Unit : US$/t)

	Case A	Case S	Case H
1) Excluding D&I	159.82	216.32	171.95
2) Including D&I	338.77	515.34	369.59

D&I : Depreciation and Interest

Though having disadvantage of a long distance transportation cost, above table indicates that Case A using Assam coal as SRC feedstock coal is some 57 US$/t cheaper than that of Case S and some 12 US$/t cheaper than that of Case H in SRC production cost excluding D&I.
The reason of above is mainly due to the difference of SRC product yield.
With above results, in respect of Case A, while SRC production costs are calculated on assumed changes of investment cost, SRC production cost including D&I of Item 2) is used for the calculation of coke production cost and SRC production cost excluding D&I of Item 1) is used for the calculation of profitability of coke production.

(2) SRC Production Costs in Varying Investment Costs

SRC production costs are calculated in Case A in case of reducing following investment costs:

- Import duties on imported machinery and equipment are exempted as R&D project
- Elimination of solid separation process
- Exemption and elimination of above both

In line with the elimination of solid separation process, the consumption of utilities (electricity, steam) is reduced as well as major catalysts and chemicals are not required. Residue is not produced either.
Detail of this is shown in Table 8.2.1.

As same in basic case, SRC production costs as of 2009 are as below:

SRC Production Cost

(Unit: US$/t)

Import Duty	Zero	80%	Zero
Solid Separation	Yes	No	No
Investment Cost, $, MM	200.14	214.03	174.06
Utilities inc. cat/chem. (US$/t of SRC)	37.39	22.63	22.63
1) Excluding D&I	151.83	139.81	134.00
2) Including D&I	292.08	289.88	255.96

D&I: Depreciation and Interest

8.3 Calculation of Coke Production Costs for the Existing Steel Plant

For the purpose of analysing profitability in SRC demonstration plant, the costs both of SRC production at demonstration plant and of coke production stage are to be jointly compared.

The components of coke production costs to be used for financial evaluation are taken based on past coke production costs records at RSP as well as material balance data of coke and by-products, as follows:

Table 8.3.1 indicates past 3 years coke production costs at RSP. Figures 6.2.3 and 6.2.4 indicate past material balance.

At RSP, following is generally observed in respect of coke production.

As can be seen from the above-stated table and figures the average output at RSP of coke production on a dry basis has been almost level at 1,286,000 t/y the last three years.

Statistically an 89% share of the total coke output is accounted for by the output of hard coke and nut coke which are classified as BF cokes and are used as raw materials in hot metal production.

Further, the gross coke yield of the input coal is 76% on average.

While the output of coke production remained level as shown above, production costs increased 23.7% in 1988-89 compared to the previous year, and 10.7% in 1989-90 while in 1990-91 the increase in relation to the previous year was 8.3% so that the tonnewise cost for 1990-91 was 1,997 Rupees. A breakdown of this cost shows that the major part of cost is accounted for by the coal element including handling loss. The breakdown of coal costs shows that imported coal is 1.46 times higher than average domestic coal with the exception of H.V.C.

After taking consideration of past 3 years production condition, the latest 1990-91 data are adapted as base figures for financial evaluation.
Details are as follows:

1. Characteristic wise coal proportion

PCC	37.9%
MCC	32.5%
HVC	0.4%
IMP	29.2%
	100.0%

2. Coke Yield

BF coke yield against total coal input

64.16%

3. Reduction of by-products against BF coke

486.47 Rs/t

4. Coke breeze credit against BF coke

84.32 Rs/t

5. Operating and other cost against BF coke

operating cost : 384.28 Rs/t
other cost : 216.60 Rs/t

6. Ash content in coke

22.7%

8.4 Evaluation of Production Cost of Coke Using SRC

The assessment of the SRC Production Plant focuses on the blending of SRC to effect a reduction of the blend ratio of imported coal or domestic prime coking coal while maintaining the present product quality. The SRC blend will permit savings on foreign currency and the prolongation of the service life of domestic prime coking coal collieries. Of course if the cost of coke production itself can also be reduced this would further increase the SRC benefit. Moreover if the mixing of SRC results in improvement of coke quality this would increase blast furnace efficiency and so realize large benefits. However this present comparison is limited to a consideration of production of coke of the same quality as that currently manufactured.

It is stated in Chapter 6 that the postulate case proposed takes the Rourkela Steel Plant as the construction site for the demonstration plant and Assam as the coal to be used for SRC production. Chapter 7 is an assessment of the design of the demonstration plant, construction costs, material balance and yields carried out with these conditions. Chapter 8 considers remaining conditions and aspects relevant to an economic and financial assessment.

8.4.1 Calculation of Coke Production Cost

Generally, coke yield and by-products yield in coke plant vary depending on the quality (blending ratio) of raw coal. Ash content forming a part of coke quality is primarily influenced on ash content of raw coal, further, ash content in produced coke influences volume efficiency and heat efficiency in blast furnace which may lead to increase hot metal production cost.

Above characteristics are to be considered as cost factors when SRC is used in coke oven and accordingly blend ratio of coal is changed.
In this study, following is considered:

(1) Coke Yield

Generally following formula is used in Japanese coke plants in respect of the relation between coke yield and volatile matter in coal:

$$Y = (98 - 0.84 \times VM) \times (100 - WC)/100$$

Y : coke yield (%)
VM : volatile matter in coal (%)
WC : moisture content in coal (%)
(here in this study, WC is taken as an average of corresponding proportion of blended coal)

By using this formula, yield Y is calculated, then coke yield of coke oven at RSP is corrected and coke yield in case of blend ratio changing is calculated.

(2) Reduction of by-products

For by-products yield per coke ton, in relation to above coke yield, following formula is established.

$$BP = 0.84 \times VM \times (100 - WC)/Y$$

BP : by-products yield (against coke) (%)
VM : volatile matter in coal (%)
Y : coke yield (%)
WC : moisture content in coal (%)

By using this formula, by-products yield is calculated, then reduction amount of by-products adjusting required coke amount by ash content mentioned in below (3) at RSP is corrected.

(3) Correction on coke cost due to ash content in coke and assumption on equaling coke quantity

Assuming that net carbon quantity in coke (total quantity minus ash content) is equal, coke quantity and coke cost in each case under coke production

tests using SRC (case in 1990-91 at RSP, case SRC not used and 4 cases of SRC used) are corrected. In line with above, the amount of coke breeze credit is corrected.

(4) Operation cost and other cost

It is assumed that all the cases, they are the same.

8.4.2 Coke Production Cost under Coke Production Tests using SRC

Taking account of above-mentioned 4 points, coke cost in each case is calculated, and then coal quantity and reduction amount of by-products and coke breeze in "without" case which becomes the basis of profitability evaluation to be stated latter section. Table 8.4.1 and 8.4.2 show coal blending ratio, volatile matter, ash content and coal price in each case. Coke production cost including interim result is as follows:

Coke Production Cost

Case	Coke Yield for BF Coke, %	COG & B.P Yield, %	Relative Volume	Coke Production Cost*, Rs/t
RSP '90	64.16	25.71	1.0021	2,262.1
Test A1	63.88	26.12	1.0000	2,276.9
Test A2	63.07	27.20	1.0058	2,371.2
Test A5	62.27	28.29	1.0119	2,467.1
Test A8	61.47	29.41	1.0181	2,564.6
Test B3	63.40	27.52	1.0448	2,249.5

* Not adjusted by ash content

** Other cases, which have coke strength less than that of existing level, are excluded from this calculation.

Further, coke production cost for following cases due to difference of feedstock and investment condition under blend ratio of test-A5 which becomes basic condition is calculated.
This cost is coke cost of ash content in coke being adjusted.

Coke Production Cost

(Unit: Rs/t)

Feedstock	Assam	Assam	Assam	Assam	A&S *
Import Duty	80%	Zero	80%	Zero	80%
Solid Separation	Yes	Yes	No	No	Yes
SRC Production Cost	8,710	7,509	7,453	6,581	9,502
Coke Cost	2,496.5	2,406.6	2,402.4	2,337.1	2,555.8

* Assam and Samla

8.4.3 Coke Production Cost in Additional Case in Respect of Coke using SRC

Based on the technical evaluation as stated in item 4.6, the coke production cost including interim result in additional case is carried out. This cost is coke cost of ash content in coke not being adjusted as this cost is for comparing to coke production cost shown in previous section.

The case not using SRC corresponding to case-I using SRC (namely, using more of MCC and imported coal not used) is above-stated Test A1, while for the case not using SRC corresponding to case-II (namely, both LVMC and imported coal are used), the averaged blend on case-I and case-II (namely, LVMC coal 45% and imported coal 55%) is adopted.

Coke Production Cost

Coke	Coke Yield for BF Coke %	COG & BP Yield %	Relative Volume	Coke Production Cost, Rs/t
Case-I				
Test A1	63.88	26.12	1.0000	2,276.9
Case C1	62.08	29.86	1.0119	2,397.9
Case C2	62.04	29.71	1.0149	2,349.4
Case-II				
Without SRC	65.32	23.36	1.0000	2,845.5
Case P1	65.70	23.09	1.0181	2,808.9
Case P2	65.89	23.00	1.0278	2,822.4
Case P3	66.10	22.75	1.0355	2,709.1

8.5 Evaluation of Profitability of Coke Production with SRC Blend

The FIRR (Financial Internal Rate of Return) is used for the justification of profitability, and is calculated based on the cost difference between coke production without SRC and with SRC and non-coking coal, and the investment cost of the SRC plant.

The major items for calculating profitability and calculation method are as follows:

Material Balance of "Without" minus "With" Cases at RSP
- Feedstock of SRC: Assam Coal -

(No.)	Items (No. of Test)	Without (A1)	With A-A5 (A5)
(1)	SRC Production, TPY, Dry	-	112,063
(2)	SRC Blend Ratio	-	5%
			<1> = w(1)/w(2)
(3)	Total Coal for Coke, TPY	2,180,434	2,241,260
	Each Coal, TPY and Blend Ratio, Dry		
	PCC	654,130 (30%)	672,378 (30%)
	MCC	872,174 (40%)	896,504 (40%)
	IMP	654,130 (30%)	336,189 (15%)
	NCC	-	224,126 (10%)
	SRC	-	112,063 (5%)
	Total (Dry)	2,180,434(100%)	2,241,260(100%)
	Total (Wet)	2,347,078(100%)	2,436,663(100%)
		<4> = wo(5)/wo(4)	
(4)	Coke Yield	63.88%	62.27%
			<2> = w(3) x w(4)
		<3>	
(5)	Coke Production,TPY	1,499,387 <-	1,517,268
		<5> = wo(5)	<3> = w(5) x wo(8)/w(8)
		<6>	
(6)	COG&B.P Production, TPY	1,499,387 ->	1,623,986
			<6> = wo(6) x w(7)/wo(7)
(7)	Relative COG&B.P Yield	1.000	1.0831
(8)	Relative Coke Requirement	1.000	1.0119

(Note) < >: Order of Calculation
w( ): Item No. of With Case
wo( ): Item No. of Without Case

Following previous calculation method saving benefit of coke production in "Without" minus "With" case is calculated in a below stated manner.
For coal blending ratio, Test A1 is adopted in "Without" case, while Test A5 is adopted in "With" case.

<1> Total coal quantity on a dry basis in "With" case is calculated from SRC production and SRC blend ratio, then each coal quantity is distributed according to coal blend ratio (determined on a dry basis).

<2> Coke production quantity is calculated from wet based total coal quantity obtained from above total coal quantity taking account of moisture content in each coal and then this wet based total coal quantity being multiplied by coke yield ratio.

<3> Coke production quantity in "Without" case is calculated from above coke production quantity and relative coke requirement ratio.

<4> Total coal quantity on wet basis in "Without" case is calculated from coke production quantity obtained at above <3>, divided by coke yield ratio, then total coal quantity on dry basis is calculated from above calculation. And finally it is distributed to each coal according to coal blend ratio.

<5> By-products and coke breeze production quantity in "Without" case is assumed to be the same as coke production quantity obtained at <3>.

<6> By-products production quantity in "With" case is calculated from by-products production quantity as stated above and relative COG and B.P yield ratio. Coke breeze production quantity is assumed to be the same as coke production quantity obtained at <2>.

In a coal price for calculating profitability, the average coal

price on a dry basis as shown in Table 8.4.2 is used with due consideration of coal blend ratio, since dry based coal quantity is adopted for calculation convenience.

For by-products and coke breeze credits, the figures shown in Section 8.4 are used.

8.5.1 Financial Internal Rate of Return on SRC Blended Coke Test

Financial internal rate of return based on above assumption and for imported coal being based on at RSP purchase price basis (namely, not considering premium against imported coal) is as follows:

Financial Internal Rate of Return (FIRR)

(Unit :%)

Case	(A-A5)				(S-A5)	(H-A5)
Feedstock	Assam	Assam	Assam	Assam	Samla	A & S*
Import Duty	80%	Zero	80%	Zero	80%	80%
Solid Separation	Yes	Yes	No	No	Yes	Yes
FIRR	-2.77	-0.38	0.18	2.35	-10.69	-4.49

* Assam and Samla

Above results indicate that the case using 100% Assam coal is superior to other cases and if reduction of investment cost is achieved, the profitability is improved.

In calculations on Test A2 and A8 blends the similar results as above would be obtained, since SRC substitute ratio against imported coal is same as Test A5.

Further, the financial internal rate of return on Test B3 blends is calculated. Actually, due to high ash content in coke as shown in Table 8.4.1, this case is not adopted.

However, in the event that more appropriate coal than Samla coal is to be selected for coke production, there is a possibility to raise the ratio against SRC more than 2. On above possibility, this case is taken for profitability evaluation.

Financial Internal Rate of Return (FIRR)

(Unit:%)

Case	A-B3				S-B3	H-B3
Feedstock	Assam	Assam	Assam	Assam	Samla	A & S*
Imported Duty	80%	Zero	80%	Zero	80%	80%
Solid Separation	Yes	Yes	No	No	Yes	Yes
FIRR	3.24	6.03	5.99	8.56	-3.85	1.67

* Assam and Samla

In terms of profitability, Test-B3 has higher FIRR than that of Test-A5.

At the time when the survey team visited India for explanation of draft final report, the team was suggested to consider the premium against imported coal. Thus, for the imported coal price with premium, the price obtained from adding 20% on CIF price first plus various domestic charges and then converted into dry basis is used for calculation. The explanation hereafter limits only for feedstock being Assam coal.

The financial internal rate of return taking account of the premium against imported coal is as follow:

Financial Internal Rate of Return (FIRR)

(Unit: %)

Feedstock	Assam	Assam	Assam	Assam
Imported Duty	80%	Zero	80%	Zero
Solid Separation	Yes	Yes	No	No
Case	(A-A5)			
FIRR	0.77	3.38	3.60	5.98
Case	(A-B3)			
FIRR	7.14	10.28	10.00	12.90

Above results indicate that FIRR is higher than the case not considering premium against imported coal.
It is due to increasing saving benefit by highly appreciating imported coal.

The financial analysis has been undertaken not only base case but other cases such as reduction of investment cost and price increase in imported coal on a reasonable assumption basis.

To find out the elements contributing to improving profitability, sensitivity analysis on following elements were undertaken.

Itme (2) was taken as main element of reducing production cost. Item (3) and (4) were those which raised by Indian counterpart at the time of the mission for explanation of draft final report.

(1) Case in which price of imported coal increased.
(2) Case in which price of domestic non-coking coal reduced.
(3) Case in which capital investment cost reduced.
(4) Case in which price of domestic non-coking coal reduced 5% and capital investment cost reduced.

Sensitivity Analysis of Return on Investment

(Unit: %)

Case	(A-A5)	(A-A3)
Base Case	-2.77	3.24
(1) Imported Coal		
+5%	-1.49	4.63
+10%	-0.32	5.91
+15%	0.75	7.11
+20%	1.74	8.24
(2) Domestic Non-coking Coal		
-5%	-1.96	3.56
-10%	-1.20	3.87
-15%	-0.48	4.18
-20%	0.20	4.48
(3) Capital Investment Cost		
-5%	-2.29	3.80
-10%	-1.78	4.39
-15%	-1.23	5.04
-20%	-0.65	5.74
(4) Capital Investment Cost including Domestic Non-coking Coal (5% down)		
-5%	-1.47	4.12
-10%	-0.95	4.73
-15%	-0.39	5.38
-20%	0.21	6.08

8.5.2 Financial Internal Rate of Return on Additional Case in Respect of Coke using SRC

Financial internal rate of return on additional case in respect of coke using SRC based on assumptions stated in section 8.4.3 was calculated.

Financial Internal Rate of Return (FIRR)

(Unit: %)

Case	(A-C1)	(A-C2)	(A-P1)	(A-P2)	(A-P3)
FIRR w/o Premium	0.13	1.64	4.33	3.37	6.13
FIRR with Premium	4.25	5.49	8.25	7.24	10.14

Both Case C1 and Case C2 those for developed from above stated Test-B3 basis were requested for profitability evaluation at the time of draft final report explanation mission.
As shown in Table 8.4.1, while ash content in coke on both cases maintained almost same figure as Test-A5, these FIRRs resulted in lower figures than Test-B3.

In addition, taking account of future demands on SRC from private steel industries, the blend ratio of P series (Case P1, Case P2, and Case P3) was further requested from Indian counterpart.
As a result, higher FIRRs than the cases at RSP as previously explained were obtained in each case.

The results of above stated profitability analysis and the details of the amount of foreign currency saving which are described in a latter section are shown in Annex 8.2.1.

8.6 Calculation of Savings on Foreign Currency

The actual contribution to India's foreign currency position to result from the implementation of the present project is calculated using the following method.

(1) Assuming the use of non-coking coal in the case of blending with SRC, the total amount of imported coal is calculated on imported coal substitution effected by one ton of SRC. The coal blending ratio was applied to be Samla coal 2 to SRC 1 (Test A5).

(2) Amount of foreign currency savings is calculated with above calculated total amount of imported coal multiplied by CIF price of imported coal (on a dry basis).

(3) Although on the funding side loans effected will represent an inflow of foreign currency these will be offset by the payments made to cover construction costs. The repayments and interest payments taking place after operation start up will be an outflow of foreign currency.

(4) It is assumed that the repair costs expended (excepting those for repair section personnel costs) will constitute an outflow of foreign capital. The ratio of the repair costs will be in proportion with the investment costs.

(5) The actual saving on foreign currency is found by subtracting the foreign currency outflow items (3) and (4) from the savings on foreign currency shown in (2) above.

The foreign currency saving was calculated on the above method for the four cases of Assam coal being the feedstock. Judging from the results, foreign currency saving can be anticipated for all cases from the initial year of operation.

Foreign Currency Savings

(Unit: US$, MM)

Case Import Duty Solid Separation	(A-A5) 80% Yes	Zero Yes	80% No	Zero No
1st Year	5.7	8.3	7.9	9.8
10th Year	7.2	11.1	10.4	13.2
Total	141.9	218.6	204.4	260.0

Further, even greater foreign currency saving as shown below can be anticipated from the initial year of operations in (Alt. Case) in which financing would be only through a long term loan equaling the foreign currency portion (38.3% of capital investment cost).

Foreign Currency Savings

(Unit: US$ MM)

Case Loan Ratio	Base Case 80%	Alt. Case 38.3%
1st year	5.7	12.1
10th year	7.2	16.7
Total	141.9	327.4

Foreign currency saving of US$ 98 million in the project life period is anticipated in the case of both Assam and Samla coal being the feedstock, however, foreign currency saving can not be anticipated throughout the project life period in the case of Samla coal being the feedstock.

Foreign currency saving on other cases of different coal blend ratios of Assam coal being feedstock was calculated.

In all cases, foreign currency saving can be anticipated from the initial year of operation.

Foreign Currency Savings

(Unit: US$ MM)

Case	(A-B3)	(A-C1)	(A-C2)	(A-P1)	(A-P2)	(A-P3)
1st Year	18.2	14.5	15.1	20.3	18.2	24.5
10th Year	24.7	19.5	20.4	27.7	24.7	33.5
Total	486.0	382.8	400.0	543.3	486.0	658.0

8.7 Evaluation of the Demonstration Plant in Socio-Economic Terms

8.7.1 Evaluation Method

The cost benefit analysis based on "the OECD and L/M methods", used worldwide, has been applied to the economic evaluation of the demonstration plant.

The objective of the present project is to employ SRC in order to make use of the plentiful resources of non-coking coal available in India as an import substitute and reduce the imported coal requirement. Therefore, an import substitution model has been applied to the analysis of the present project.

The following characteristics can be noted with regard to application of "the OECD and L/M methods".

- Economic values have been indicated in numeral form as foreign currency (in the present project US dollars have been employed).
- Tradable goods have been left as they are but non-tradable goods have been corrected to international values using a conversion factor.
- Unskilled labour is calculated by the shadow wage rate.
- All taxes, duties and interests have been excluded from economic values as transfer items of the national economy.

8.7.2 Assumptions Underlying the Economic Analysis

The following is a summary of the main assumptions which were employed during the economic analysis.

(1) Assumed Indicators

The same currencies, exchange rates and pricing levels shown in 8.1.2 and 8.2.1 were employed in the economic analysis.

(2) Classification as Tradable Goods and Non Tradable Goods

Generally, in order to determine how much difference there is between the domestic price and international value of a service or goods the following steps are taken (a) goods and services are separated into categories of tradable goods and non-tradable goods, (b) non-tradable goods are further divided into tradable and non-tradable goods, (c) the tradable goods figures are totaled and this is taken to represent the assessment of the international value, (d) any aspects of the non-tradable goods which might be distorted are corrected. For the purposes of the study the separation of non-tradable goods was not carried out.

Therefore, while the tradable goods item was evaluated using the CIF price of imports the non-tradable goods item was corrected to the international value using the standard conversion factor (SCF). Generally speaking non-tradable goods refers to (a) those physically difficult to transport, (b) those of no economic value, (c) those of no international value and those goods which have only domestic value.

The standard conversion factor was determined by the following procedure.

$$SCF = \frac{Im + Ex}{Im\ (1+t) + Ex(1-tx+s)}$$

Where, Im = Gross value of imports (CIF price)
Ex = Gross value of exports (FOB price)
t = Weight average of import duty rates
tx = Weight average of export tax rates
s = Weight average of export subsidy rates

Indian export-import statistics over the last five years are shown in Table 8.7.1. Taking the average for these five years the standard conversion factor is calculated to be 0.76.

(3) Skilled and Unskilled Labour

It is judged that the wages of skilled labour will reflect opportunity costs and in the case of personnel ranked above Staff A position a financial calculation of labour costs was made excluding tax elements (which are taken to be 5% for Staff A and 12% for Manager and Chief class personnel).

On the other hand, in view of the high unemployment in Orissa where the RSP is situated it was decided after consultation with MECON to apply a shadow wage rate (50%) in the case of unskilled labour.

8.7.3 Economic Cost of Investment

On the basis of the assumptions outlined above the same investment cost used in financial estimates of the foreign currency portion in plant construction costs was employed, while for the domestic currency portion in plant construction costs, the figure corrected by a standard conversion factor was employed. Transfer items of the national economy, import duties and interest during construction were excluded from the investment cost. The pre-operating expenses and initial working capital were calculated for each element.

8.7.4 Production Cost according to Economic Value

(1) Coal Price

Coking coal domestically produced in India is seen as a tradable good and is evaluated by the CIF price of coal imported into Japan from Australia in principle. Table 8.7.2 indicates the CIF coal price for Australian coal imported to Japan over the last five years.

The average coal price of coking coal for 1990 has been used as follows:

Coal	Coal Price
P.C.C	58.16 US$/t
M.C.C	52.57 US$/t

For the purpose of the present study, according to the opinion by SAIL described in JICA report in 1987 titled "Study on the Modernization of Burnpur Steel Mill in India", domestic non-coking coal is judged to be as non-tradable good.

The CIF price of Australian imported coal to India at RSP is calculated based on the CIF price with adding domestic various charges (corrected by SCF) excluding custom duty. The premium against imported coal is excluded from economic price as it is considered as a sort of import surcharge or tax.

(Unit:US$/t)

	Economic Value	Financial Value
- CIF Price, Port	72.00	72.00
- Custom Duty	-	3.60
- Inland Freight, etc.	14.96	19.69
CIF Landed Price, RSP	86.96	95.29

Coal prices used for above explanation are converted to dry based coal prices. In this dry basis conversion, 8% of moisture content for coking coal was adopted.

(2) Other Variable Costs

The following cost items are judged to be non-tradable goods and are corrected using the SCF.

COG, return gas, residue, electricity, steam, make-up water and nitrogen

As the 1990 CIF price of fuel oil in Japan has no difference in financial price, light distillate and middle distillate are judged to be tradable and are evaluated at the same level as the financial price.

Furthermore, by-products and coke breeze for coke, catalyst and chemicals are taken to be tradable goods but are evaluated at the same level as the financial price.

(3) Direct Fixed Costs

Labour costs have been calculated on the basis of the assumptions shown in section 8.7.2(3) and the wage structure shown in Table 8.2.5. As the plant construction cost has been corrected to economic cost the same ratios as employed for financial estimates

were applied to repair costs and insurance premiums.

Tax and public imposition being a transfer item is not included under this heading.

8.7.5 Calculation of Economic Internal Rate of Return

Annex 8.7.1 shows details of economic analysis and the economic internal rate of return (EIRR) resulting from above stated assumptions is as follows:

Economic Internal Rate of Return (EIRR)

(Unit: %)

Case	(A-A5)	(A-B3)	(A-C1)	(A-C2)
EIRR	3.11	1.50	4.02	5.22

8.8. Evaluation of the Commercial Plant

In order to carry out a financial evaluation of the commercial plant scheduled for the final stages of the present project collection of technical data is to be proceeded with along the following lines on the basis of the design results of the demonstration plant.

Two cases of plant capacity for 1,000 t/d and 3,000 t/d on a dry coal basis are postulated for evaluation given the assumed SRC requirement (depending on the SRC blending ratio) of the SAIL steel plant in the year 2000.

Other than being a flat area near to the Rourkela Steel Plant no other concrete conditions for the site are set. Therefore the use of existing utilities or auxiliary facilities is not assumed and these are taken to be newly installed. The hydrogen source important to the SRC process is not taken to be supplied from the COG gas but is to be obtained by the steam reforming of naphthalene oil.

The following design details are assumed.

(1) Plant Capacity

Case A1000 : 1,000 t/d
Case A3000 : 3,000 t/d

(2) Annual Stream Day

330 days per year

(3) Feedstock Coal

Assam coal (same as in demonstration plant)

(4) Hydrogen production

The total requirement is to be produced by steam reforming of naphtha.

(5) Operations and Products

Operational conditions, yields and product specifications are the same as those for the demonstration plant.

(6) Plant Construction

1) Process Plant

To have the same structure as in the demonstration plant with the exception of the hydrogen production process. Hydrogen is to be produced by the steam reforming of naphtha.

2) Steam and Condensate System

A high pressure boiler is to be installed using turbines so that the system will reduce the consumption of electricity.

3) Fuel System

The complete output of produced gas, butane, middle distillate and heavy distillate produced as by-products is to be consumed in-house and any shortages remaining are to be met by intake of fuel oils from outside.

4) Other Utilities and Auxiliary Facilities

Are to be organized the same as in the demonstration plant.

(7) Plant Site

Is assumed to be a flat area close to the Rourkela Steel Plant.

Tables 8.8.1 and 8.8.2 indicate respective estimated plant costs and capital investment costs for the two cases of 1,000 t/d and 3,000 t/d capacity. Further, the range and assumptions underlying the estimates are shown below:

- Estimation date : June 19, 1991
- Escalation : Not considered
- Allocation of deliveries : Items shown in 7.14 to be met with deliveries from overseas.
- Allocation of works : The allocation of works set down in 7.14 is to be observed.
- Contingency for estimations : The contingencies as stated in 7.14 have been adopted for any errors in estimations.

The overall material balance is the same in the two cases and is shown in Table 8.8.3. The unit consumption as in the demonstration plant is used for feedstock coal and by-products of produced SRC. However, there are assumed to be differences in the energy balance of the produced gas, residue, etc. and the public utility use depending on the site conditions.
Annex 8.8.1 shows details of calculation for the 1,000 t/d and 3,000 t/d cases. The SRC production cost for the 1,000 t/d and 3,000 t/d cases are shown in Tables 8.8.4 and 8.8.5.

The financial internal rate of return in each case is as follows:

Financial Internal Rate of Return (FIRR)

(Unit: %)

Case	(A-A5)	(A-B3)
FIRR for 1000 t/d	-1.89	4.88
FIRR for 3000 t/d	2.21	9.69

Foreign currency saving for the following cases of Assam coal being feedstock was calculated.
In all cases, foreign currency saving can be anticipated throughout the project life period.

Foreign Currency Savings

(Unit: US$,MM)

Case	(A1000-A5)	(3000-A5)	(A1000-B3)	(A3000-B3)
Total	430.8	1858.1	1118.9	3922.5

Table 8.1.1 HISTORICAL TREND OF BASIC ECONOMIC DATA IN INDIA (1/2)

Year	Year	Total Population (MM)	GNP Factor Cost 1980 (Rs MMM)	GNP Current Price (Rs MMM)	Per Capital GNP		Exchange	Per Capital GNP	
					1980 Price (Rs)	Current Price (Rs)	Rate Rs/US$	1980 Price US$	Current Price US$
1975-76	1975-76	603.50	1046.60	709.46	1734.00	1176.00	8.43	206.00	140.00
76-77	76-77	617.20	1059.96	763.03	1717.00	1236.00	9.08	189.00	136.00
77-78	77-78	631.30	1139.03	871.18	1804.00	1380.00	8.82	205.00	156.00
78-79	78-79	645.70	1203.02	937.24	1860.00	1452.00	8.28	225.00	175.00
79-80	79-80	660.30	1143.79	1025.95	1732.00	1554.00	8.02	216.00	194.00
80-81	80-81	675.20	1227.72	1227.72	1818.00	1818.00	7.91	230.00	230.00
81-82	81-82	690.10	1299.28	1432.56	1883.00	2076.00	8.97	209.00	231.00
82-83	82-83	705.20	1332.99	1587.61	1890.00	2251.00	9.67	195.00	233.00
83-84	83-84	720.40	1438.61 +	1857.79 +	1997.00	2579.00	10.34	193.00	251.00
84-85	84-85	735.60	1492.92 +	2071.53 +	2030.00	2816.00	11.89	171.00	237.00
85-86	85-86	750.90	1553.99 +	2320.47 +	2070.00	3090.00	12.24	169.00	252.00
86-87	86-87	766.10	1609.75 +	2572.50 +	2117.00	3358.00	12.78	164.00	263.00
87-88	87-88	781.40	1677.03 +	2916.47 +	2155.00	3732.00	12.97	165.00	288.00
88-89	88-89	796.60	1855.43 *	3491.05 *	2337.00	4382.00	14.48	161.00	303.00
89-90	89-90	811.80	1952.37	3925.24	2405.00	4835.00	16.65	144.00	290.00
90-91	90-91	827.1					17.94		

+: Provisional

*: Quick estimates

Table 8.1.1 HISTORICAL TREND OF BASIC ECONOMIC DATA IN INDIA (2/2)

Year	Index of No. of Industrial Production		Price Index No.		External Trade		Balance of Payment (Rs MM)	Foreign Exchange Reserves (Rs MM)**	Chemical Engineering Plant Cost Index
	Mining 1980-81=100	Manufacturing 1980-81=100	Consumer (Industrial worker) General Index 1960=100 *	Wholesales (all commodities) 1970-71=100	Gross Value of Imports (CIF, Rs MM)	Gross Value of Exports (Fob, Rs MM)			
1975-76									
76-77	90.50	90.00	301.00	176.60					192.10
77-78	92.50	93.30	324.00	185.80					204.10
78-79	95.20	99.70	331.00	185.80					218.80
79-80	95.90	99.10	360.00	217.60					238.70
80-81	100.00	100.00	401.00	256.20	125492	67107	(-) 26395	48221	261.20
81-82	117.70	107.90	451.00	281.30	136080	78060	(-) 40674	33545	297.00
82-83	128.90	110.10	486.00	288.70	142927	88034	(-) 34286	42653	314.00
83-84	147.80	115.60	547.00	316.00	158315	97707	(-) 25079	54979	316.90
84-85	160.80	124.80	582.00	338.40	171342	117437	(-) 12439	68168	322.70
85-86	167.50	136.90	620.00	357.80	196577	108946	(-) 31871	73844	325.30
86-87	177.90	149.70	674.00	376.80	200960	124524	(-) 37884	76452	318.40
87-88	184.60	161.50	736.00	405.40	222440	156740	(-) 54101	72871	323.80
88-89	199.10	175.60	803.00	435.40	282350	202310	(-) 63089	66046	342.50
89-90	211.60	190.70	855.00	467.60	354160	276810		57870	355.40
90-91	219.10	208.20	947.00	515.50	431710	325270		43880	357.60

Note: *The new series of CPI for Industrial Workers with 1982 bases has been introduced w.e.f. October, 1988. The earlier series on base 1960=100 has been simultaneously discontinued. The conversion factor from the new to the old series is 4.93 in regard to the General Index.

**include Foreign assets of the Reserve Bank of India but exclude Gold & SRD

Table 8.1.2 CAPITAL INVESTMENT COST FOR CASE (A)

- Feedstock Coal: Assam Coal -

Items	Capital Investment Cost, US$, MM		
	Foreign Currency	Local Currency	Total
1. Land & Site Development	-	0.0	0.0
2. Plant Direct Cost	55.75	74.47	130.22
- Equipment and Materials	(52.11)	(50.31)	(102.42)
- Spare Parts	(3.64)	(3.52)	(7.16)
- Erection and Installation Works	(-)	(6.64)	(6.64)
- Civil and Building Works	(-)	(13.87)	(13.87)
- Additional Facilities	(-)	(0.13)	(0.13)
3. Ocean Freight and Insurance	1.35	-	1.35
4. Local Handling and Inland Transportation	-	0.36	0.36
5. Indirect Field Expenses	-	2.21	2.21
6. Engineering Services	12.95	4.64	17.59
- License Fee	(2.71)	(-)	(2.71)
- Basic Design	(0.84)	(-)	(0.84)
- Engineering Services	(6.76)	(3.25)	(10.01)
- Project Management	(2.64)	(1.39)	(4.03)
Base Project Cost - 1991	70.05	81.68	151.73
7. Contingency	5.58	8.13	13.71
- Physical Contingency	(5.58)	(8.13)	(13.71)
- Price Escalation	(Not considered in the analysis)		
8. Tax and Duty	-	61.11	61.11
- Import Duty	-	(50.14)	(50.14)
- Excise Duty, Sales Tax and R & D Cess	-	(10.97)	(10.97)
Erected Plant Cost - 1991	75.63	150.92	226.55
9. Pre-Operation Expenses	-	4.63	4.63
10. Interest during Construction (F:6%)	22.00	-	22.00
11. Initial Working Capital	-	1.98	1.98
Capital Investment Cost - 1991	97.63	157.53	255.16

Table 8.1.3 CAPITAL INVESTMENT COST FOR CASE (S)

- Feedstock Coal: Samla Coal -

Items	Capital Investment Cost, US$, MM		
	Foreign Currency	Local Currency	Total
1. Land & Site Development	-	0.00	0.00
2. Plant Direct Cost	75.25	81.19	156.44
- Equipment and Materials	(70.33)	(56.59)	(126.92)
- Spare Parts	(4.92)	(3.96)	(8.88)
- Erection and Installation Works	(-)	(6.64)	(6.64)
- Civil and Building Works	(-)	(13.87)	(13.87)
- Additional Facilities	(-)	(0.13)	(0.13)
3. Ocean Freight and Insurance	1.35	-	1.35
4. Local Handling and Inland Transportation	-	0.36	0.36
5. Indirect Field Expenses	-	2.21	2.21
6. Engineering Services	12.95	4.64	17.59
- License Fee	(2.71)	(-)	(2.71)
- Basic Design	(0.84)	(-)	(0.84)
- Engineering Services	(6.76)	(3.25)	(10.01)
- Project Management	(2.64)	(1.39)	(4.03)
Base Project Cost - 1991	89.55	88.40	177.95
7. Contingency	7.53	8.80	16.33
- Physical Contingency	(7.53)	(8.80)	(16.33)
- Price Escalation	(Not considered in the analysis)		
8. Tax and Duty	-	79.60	79.60
- Import Duty	-	(67.30)	(67.30)
- Excise Duty, Sales Tax and R & D Cess	-	(12.30)	(12.30)
Erected Plant Cost - 1991	97.08	176.80	273.88
9. Pre-Operation Expenses	-	4.45	4.45
10. Interest during Construction (F:6%)	26.49	-	26.49
11. Initial Working Capital	-	1.83	1.83
Capital Investment Cost - 1991	123.57	183.08	306.65

Table 8.1.4 CAPITAL INVESTMENT COST FOR CASE (H)

- Feedstock Coal: Assam Coal + Samla Coal -

Items	Capital Investment Cost, US$, MM		
	Foreign Currency	Local Currency	Total
1. Land & Site Development	-	0.0	0.0
2. Plant Direct Cost	61.85	76.52	138.37
- Equipment and Materials	(57.80)	(51.67)	(109.47)
- Spare Parts	(4.05)	(3.62)	(7.67)
- Erection and Installation Works	(-)	(6.64)	(6.64)
- Civil and Building Works	(-)	(13.87)	(13.87)
- Additional Facilities	(-)	(0.72)	(0.72)
3. Ocean Freight and Insurance	1.35	-	1.35
4. Local Handling and Inland Transportation	-	0.36	0.36
5. Indirect Field Expenses	-	2.21	2.21
6. Engineering Services	12.95	4.64	17.59
- License Fee	(2.71)	(-)	(2.71)
- Basic Design	(0.84)	(-)	(0.84)
- Engineering Services	(6.76)	(3.25)	(10.01)
- Project Management	(2.64)	(1.39)	(4.03)
Base Project Cost - 1991	76.15	83.73	159.88
7. Contingency	6.19	8.27	14.46
- Physical Contingency	(6.19)	(8.27)	(14.46)
- Price Escalation	(Not considered in the analysis)		
8. Tax and Duty	-	66.77	66.77
- Import Duty	-	(55.51)	(55.51)
- Excise Duty, Sales Tax and R & D Cess	-	(11.26)	(11.26)
Erected Plant Cost - 1991	82.34	158.77	241.11
9. Pre-Operation Expenses	-	4.71	4.71
10. Interest during Construction (F:6%)	23.40	-	23.40
11. Initial Working Capital	-	2.02	2.02
Capital Investment Cost - 1991	105.74	165.50	271.24

Table 8.2.1 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE A (1/4)

1. Project

Title	: SRC Demonstration Plant Project
Location	: Rourkela, India
Executing Agency	: SAIL, MECON and RSP
Project Case	: Base Case (Case A)
Selected Coal	: Assam Coal
Maximum Operable Days	: (365.25 - 35.25) x 100% = 330 SDPY
Feed Coal Input(Dry Coal Basis)	: 500 TPD x 330 DPY = 165,000 TPY
Yield of SRC Product	: 67.92% of Feed Coal Input
Production Start Year	: 1999
Monetary Unit	: US dollars($) in terms of fixed price in August, 1991
Exchange Rate for Caluculation	: 1 US$ = 25.71Rs = 136.32 Yen as of August 16, 1991

2. Schedule

Contract Award	: May, 1996
Mechanical Completion	: July, 1999
Production Start	: December, 1999
Project Phase Out	: November, 2019
Project Life	: 20 Years from Production Start
Project Year	: December to November
Construction and Commissioning including Test Run	: 43 months from Contract Award

3. Financing Required and Financing Plan in 1991 Price Base

Financing Required	US$, MM
Land/Site Development	0.0
Erected Plant Cost	226.55
- Process	
- Utility	
- Offsite	
- Project Infrastructure	
Pre-Operational Expense	4.63
Interest during Construction	22.00
Fixed Capital Cost	253.18
Initial Working Capital	1.98
Financing Required	255.16

Financing Plan		US$, MM
Equity	: 20.0%	51.03
Foreign Soft Loan	: 80.0%	204.13
- Interest: 6.0%		
Financing Plan		255.16

Table 8.2.1 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE A (2/4)

4. Inputs and Pricing (CIF at the Plant in 1991 Price Base)

Inputs	Unit		Per Feed Coal(Dry)		Per SRC	Annual as of 2009	
	Unit	Cost	Consumption	Cost	Cost	Consumption	Cost
		$/Unit	Unit/Unit	$/Unit	$/Unit	Unit	$, MM
Raw Material							
- Feedstock Coal (Purchase)	Ton	56.02	1.10742	62.04	91.34	182,724	10.236
- Coke Oven Gas	Ton	65.42	0.6336	41.45	61.03	104,544	6.839
Utilities							
- Fuel Coal	Ton	30.21	0.3984	12.04	17.72	65,736	1.986
- Electricity	kwh	0.0401	62.88	2.52	3.71	10.375×10^6	0.416
- Steam(57kg/cm^{2}G)	Ton	9.776	0.48	4.69	6.91	79,200	0.774
- Make-up Water	m^3	0.03	9.60	0.29	0.43	$1,584 \times 10^3$	0.048
- Nitrogen	Nm^3	0.0288	24.0	0.69	1.02	$3,960 \times 10^3$	0.114
- Catalyst(Iron Ore)	Ton	35.71	0.0309	1.10	1.62	5,100	0.182
- Catalyst (Sulfur)	Ton	136.13	0.0074	1.01	1.48	1,212	0.165
- Chem.(Filter Aid)	Ton	250.00	0.0112	2.80	4.12	1,848	0.462
- Chemicals, etc.	Ton	-	-	-	0.38	-	0.043
(1) Variable Cost	-	-	-	-	189.76	112,063	21.265
Operating Labor	M-Y	2226			2.66	134	0.298
Overhead	Ope. Labor x 50%				1.33	-	0.149
Maintenance(Materials)	E&M, CIF x 1.5%				27.97	-	3.134
(Labor)	M-Y	2227			1.05	53	0.118
Administration (Supplies)	Admi. Staff x 100%				0.45	-	0.050
(Staff)	M-Y	2633			0.45	19	0.050
Tax & Insurance	Book Value x 0.5%				5.89	-	0.661
(2) Direct Fixed Cost	-	-	-	-	39.80	-	4.460
Credits							
- Return Gas	Ton	62.93	0.6427	40.45	59.56	106,049	6.674
- Light Distillate	Ton	156.20	0.036	5.61	8.26	5,931	0.926
- Middle Distillate	Ton	147.22	0.006	0.88	1.25	950	0.140
- Residue	Ton	5.266	0.087	0.46	0.67	14,303	0.075
(3) Total Credits	-	-	-	-	69.74	-	7.815
(4) Production Cost = (1)+(2)-(3)					159.82	112,063	17.910
(5) Depreciation & Interest (D & I)	See Item 5.				178.95	-	20.054
(6) Total Production Cost inc. D&I = (4)+(5)					338.77	112,063	37.964

Table 8.2.1 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE A (3/4)

5. Operation Schedule

	Project Year								(Unit: %)
	(-)4	(-)3	(-)2	(-)1	1	2	3	..20	Total/
	96	97	98	99	00	01	02	2019	Avarage
- Financing Disbursement	5	35	40	20					
- Production									
- Rated Capacity Utilization					80	90	100	100	1,970
- Inventory Increase					8	0	0	(-)8	0
- Inventory					8	8	8	0	0
- Sales					72	90	100	108	1,970

- Depreciation/Salvage Value — 20 years straight line/5% salvage value
- Amortization/Salvage Value — 20 years straight line/Zero salvage value

- Debt Service

Loan Type	Maximum Grace + Maturity	Annual Interest Rate	Installments
- Long Term Loan/Foreign 1/	6 + 18	6.00	20

1/ Balance of payment over project life is assumed to be paid in last year of project life.

- Product Inventory (SRC) — 1.0 month
- Material Inventory (Feedstock Coal) — 0.5 month

6. Assumption on Changes of Investment Cost
- Capital Investment Cost-1991, $, MM

Import Duty Solid Separation	No Yes	Yes No	No No
Base, Project Cost	151.73	131.29	131.29
Contingency	13.71	11.66	11.66
Tax and Duty	10.97	46.44	10.02
Erected Plant Cost	176.41	189.39	152.97
Pre-operation Expenses	4.63	4.42	4.42
Interest during Const.	17.23	18.45	14.98
Initial Working Capital	1.87	1.77	1.69
Capital Investment Cost	200.14	214.03	174.06

Table 8.2.1 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE A (4/4)

- Utilities, Catalyst/Chemical and Residue

(Unit/Year)

Solid Separation	Yes	No
Electricity, MM, kwh	10.375	8.601
Steam, Ton	79,200	0
Catalyst (Iron Ore),Ton	5,100	0
Catalyst (Sulfur),Ton	1,212	0
Chem (Filter Aid),Ton	1,848	0
Residue, Ton	14,303	0

Table 8.2.2 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE S (1/3)

1. Project

Title	: SRC Demonstration Plant Project
Location	: Rourkela, India
Executing Agency	: SAIL, MECON and RSP
Project Case	: Base Case (Case S)
Selected Coal	: Samla Coal
Maximum Operable Days	: (365.25 - 35.25) x 100% = 330 SDPY
Feed Coal Input(Dry Coal Basis)	: 500 TPD x 330 DPY = 165,000 TPY
Yield of SRC Product	: 48.89% of Feed Coal Input
Production Start Year	: 1999
Monetary Unit	: US dollars($) in terms of fixed price in August, 1991
Exchange Rate for Caluculation	: 1 US$ = 25.71Rs = 136.32 Yen as of August 16, 1991

2. Schedule

Contract Award	: May, 1996
Mechanical Completion	: July, 1999
Production Start	: December, 1999
Project Phase Out	: November, 2019
Project Life	: 20 Years from Production Start
Project Year	: December to November
Construction and Commissioning including Test Run	: 43 months from Contract Award

3. Financing Required and Financing Plan in 1991 Price Base

Financing Required	US$, MM
Land/Site Development	0.0
Erected Plant Cost	273.88
- Process	
- Utility	
- Offsite	
- Project Infrastructure	
Pre-Operational Expense	4.45
Interest during Construction	26.49
Fixed Capital Cost	304.82
Initial Working Capital	1.83
Financing Required	306.65

Financing Plan		US$, MM
Equity	: 20.0%	61.33
Foreign Soft Loan	: 80.0%	245.32
- Interest	: 6.0%	
Financing Plan		306.65

Table 8.2.2 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE S (2/3)

4. Inputs and Pricing (CIF at the Plant in 1991 Price Base)

Inputs	Unit		Per Feed Coal(Dry)		Per SRC	Annual as of 2009	
	Unit	Cost	Consumption	Cost	Cost	Consumption	Cost
		$/Unit	Unit/Unit	$/Unit	$/Unit	Unit	$, MM
Raw Material							
- Feedstock Coal (Purchase)	Ton	30.21	1.21066	36.57	74.81	199,758	6.035
- Coke Oven Gas	Ton	65.42	0.5729	37.48	76.66	94,530	6.184
Utilities							
- Fuel Coal	Ton	30.21	0.3984	12.04	24.62	65,736	1.986
- Electricity	kwh	0.0401	62.88	2.52	5.16	10.375×10^6	0.416
- Steam(57kg/cm^{2}G)	Ton	9.776	0.48	4.69	9.59	79,200	0.774
- Make-up Water	m^3	0.03	9.60	0.29	0.60	$1,584 \times 10^3$	0.048
- Nitrogen	Nm^3	0.0288	24.0	0.69	1.41	$3,960 \times 10^3$	0.114
- Catalyst(Iron Ore)	Ton	35.71	0.0309	1.10	2.26	5,100	0.182
- Catalyst (Sulfur)	Ton	136.13	0.0074	1.01	2.05	1,212	0.165
- Chem.(Filter Aid)	Ton	250.00	0.0112	2.80	31.51	10,168	2.542
- Chemicals, etc.	Ton	-	-	-	0.53	-	0.043
(1) Variable Cost	-	-	-	-	229.20	80,669	18.489
Operating Labor	M-Y	2226			3.69	134	0.298
Overhead	Ope. Labor x 50%				1.85	-	0.149
Maintenance(Materials)	E&M, CIF x 1.5%				47.65	-	3.844
(Labor)	M-Y	2227			1.46	53	0.118
Administration (Supplies)	Admi. Staff x 100%				0.62	-	0.050
(Staff)	M-Y	2633			0.62	19	0.050
Tax & Insurance	Book Value x 0.5%				9.87	-	0.796
(2) Direct Fixed Cost	-	-	-	-	65.76	-	5.305
Credits							
- Return Gas	Ton	62.93	0.5851	40.45	75.32	96,548	6.076
- Light Distillate	Ton	156.20	0	0	0	0	0
- Middle Distillate	Ton	147.22	0	0	0	0	0
- Residue	Ton	8.368	0.1950	0.46	3.33	32,168	0.269
(3) Total Credits	-	-	-	-	78.65	-	6.345
(4) Production Cost = (1)+(2)-(3)					216.31	80,669	17.449
(5) Depreciation & Interest (D & I)	See Item 5.				299.03	-	24.123
(6) Total Production Cost inc. D&I = (4)+(5)					515.34	80,669	41.572

Table 8.2.2 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE S (3/3)

5. Operation Schedule

	Project Year								(Unit: %)
	(-)4	(-)3	(-)2	(-)1	1	2	3	..20	Total/
	96	97	98	99	00	01	02	2019	Avarage
- Financing Disbursement	5	35	40	20					
- Production									
- Rated Capacity Utilization					80	90	100	100	1,970
- Inventory Increase					8	0	0	(-)8	0
- Inventory					8	8	8	0	0
- Sales					72	90	100	108	1,970

- Depreciation/Salvage Value 20 years straight line/5% salvage value
- Amortization/Salvage Value 20 years straight line/Zero salvage value

- Debt Service

Loan Type	Maximum Grace + Maturity	Annual Interest Rate	Installments
- Long Term Loan/Foreign 1/	6 + 18	6.00	20

1/ Balance of payment over project life is assumed to be paid in last year of project life.

- Product Inventory (SRC) 1.0 month
- Material Inventory (Feedstock Coal) 0.5 month

Table 8.2.3 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE H (1/3)

1. Project

Title	: SRC Demonstration Plant Project
Location	: Rourkela, India
Executing Agency	: SAIL, MECON and RSP
Project Case	: Base Case (Case H)
Selected Coal	: Assam Coal and Samla Coal
Maximum Operable Days	: (365.25 - 35.25) x 100% = 330 SDPY
Feed Coal Input(Dry Coal Basis)	: 500 TPD x 330 DPY = 165,000 TPY
Yield of SRC Product	: 65.38% of Feed Coal Input
Production Start Year	: 1999
Monetary Unit	: US dollars($) in terms of fixed price in August, 1991
Exchange Rate for Caluculation	: 1 US$ = 25.71Rs = 136.32 Yen as of August 16, 1991

2. Schedule

Contract Award	: May, 1996
Mechanical Completion	: July, 1999
Production Start	: December, 1999
Project Phase Out	: November, 2019
Project Life	: 20 Years from Production Start
Project Year	: December to November
Construction and Commissioning including Test Run	: 43 months from Contract Award

3. Financing Required and Financing Plan in 1991 Price Base

Financing Required	US$, MM	Financing Plan		US$, MM
Land/Site Development	0.0	Equity	: 20.0%	54.25
Erected Plant Cost	241.11	Foreign Soft Loan	: 80.0%	216.99
- Process		- Interest: 6.0%		
- Utility				
- Offsite				
- Project Infrastructure				
		Financing Plan		271.24
Pre-Operational Expense	4.71			
Interest during Construction	23.40			
Fixed Capital Cost	269.22			
Initial Working Capital	2.02			
Financing Required	271.24			

Table 8.2.3 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE II (2/3)

4. Inputs and Pricing (CIF at the Plant in 1991 Price Base)

Inputs	Unit		Per Feed Coal(Dry)		Per SRC	Annual as of 2009	
	Unit	Cost	Consumption	Cost	Cost	Consumption	Cost
		$/Unit	Unit/Unit	$/Unit	$/Unit	Unit	$, MM
Raw Material							
- Feedstock Coal (Assam)	Ton	60.02*	0.54526	32.73	50.06	89,967	5.400
- Feedstock Coal (Samla)	Ton	36.68*	0.59595	21.86	33.43	98,331	3.607
- Coke Oven Gas	Ton	65.42	0.6336	41.45	66.28	109,296	7.150
Utilities							
- Fuel Oil	Ton	145.48	0.0367	5.34	8.17	6,059	0.881
- Fuel Coal	Ton	30.21	0.3984	12.04	18.41	65,736	1.986
- Electricity	kwh	0.0401	62.88	2.52	3.86	10.375×10^6	0.416
- Steam(57kg/cm^{2}G)	Ton	9.776	0.48	4.69	7.17	79,200	0.774
- Make-up Water	m^3	0.03	9.60	0.29	0.44	$1,584 \times 10^3$	0.048
- Nitrogen	Nm^3	0.0288	24.0	0.69	1.06	$3,960 \times 10^3$	0.114
- Catalyst(Iron Ore)	Ton	35.71	0.0309	1.10	1.69	5,100	0.182
- Catalyst (Sulfur)	Ton	136.13	0.0082	1.12	1.71	1,354	0.184
- Chem.(Filter Aid)	Ton	250.00	0.0218	5.45	8.33	3,596	0.899
- Chemicals, etc.	Ton	-	-	-	0.40	-	0.043
(1) Variable Cost	-	-	-	-	201.01	107,878	21.684
Operating Labor	M-Y	2226			2.76	134	0.298
Overhead	Ope. Labor x 50%				1.38	-	0.149
Maintenance(Materials)	E&M, CIF x 1.5%				31.08	-	3.353
(Labor)	M-Y	2227			1.10	53	0.118
Administration (Supplies)	Admi. Staff x 100%				0.46	-	0.050
(Staff)	M-Y	2633			0.46	19	0.050
Tax & Insurance	Book Value x 0.5%				6.52	-	0.703
(2) Direct Fixed Cost	-	-	-	-	43.76	-	4.721
Credits							
- Return Gas	Ton	62.93	0.6649	41.84	64.00	109,708	6.904
- Light Distillate	Ton	156.20	0.031	4.87	7.45	5,148	0.804
- Middle Distillate	Ton	147.22	0	0	0	0	0
- Residue	Ton	5.266	0.170	0.90	1.37	28,037	0.148
(3) Total Credits	-	-	-	-	72.82	-	7.856
(4) Production Cost = (1)+(2)-(3)					171.94	107,878	18.549
(5) Depreciation & Interest (D & I)	See Item 5.				197.65	-	21.322
(6) Total Production Cost inc. D&I = (4)+(5)					369.59	107,878	39.871

* Excluding D&I of Coal Washing Unit

Table 8.2.3 PROJECT PROFILE AND FINANCIAL ANALYSIS SUMMARY FOR CASE II (3/3)

5. Operation Schedule

	Project Year								(Unit: %)
	(-)4	(-)3	(-)2	(-)1	1	2	3	..20	Total/
	96	97	98	99	00	01	02	2019	Avarage
- Financing Disbursement	5	35	40	20					
- Production									
- Rated Capacity Utilization					80	90	100	100	1,970
- Inventory Increase					8	0	0	(-)8	0
- Inventory					8	8	8	0	0
- Sales					72	90	100	108	1,970

- Depreciation/Salvage Value — 20 years straight line/5% salvage value
- Amortization/Salvage Value — 20 years straight line/Zero salvage value

- Debt Service

Loan Type	Maximum Grace + Maturity	Annual Interest Rate	Installments
- Long Term Loan/Foreign 1/	6 + 18	6.00	20

1/ Balance of payment over project life is assumed to be paid in last year of project life.

- Product Inventory (SRC) — 1.0 month
- Material Inventory (Feedstock Coal) — 0.5 month

Table 8.2.4 PRICE LIST OF INPUT/OUTPUT ON FINANCIAL/ECONOMIC ANALYSIS IN RSP

Items	Specification	Unit	Present Price Rs/Unit (US$/Unit) at Aug.,1991		Economic Price, CIF Port (US$/Unit) at Aug.,1991	
1. Purchased Coal						
P.C.C (Washed,Ave.Price)		Ton	1009.92	(39.28)	T	(58.16)
M.C.C (Washed,Ave.Price)		Ton	995.20	(38.71)	T	(52.57)
Imported Coal (Australia)		Ton	2450.00	(95.29)	T	(72.00)
Non-Coking Coal (Unwashed, Samla)		Ton	776.68	(30.21)	N-T	(22.96)
Feedstock Coal (Unwashed, Samla) for Case S		Ton	776.68	(30.21)		
Feedstock Coal (Unwashed, Assam) for Case A		Ton	1440.28	(56.02)	N-T	(42.58)
Feedstock Coal (Washed, Samla) for Case H		Ton	950.00	(36.95)		
Feedstock Coal (Washed, Assam) for Case H		Ton	1550.00	(60.29)		
2. Coking Oven Gas		Nm^3	0.96	(0.03734)		
COG	1752Nm^3/Ton	Ton	1681.92	(65.42)	N-T	(49.72)
COG	6996Mkcal/Ton	Mkcal	0.2404	(0.00935)		
3. Utilities and Cat/Chem.						
Fuel Coal (Samla)		Ton	776.68	(30.21)	N-T	(22.96)
Fuel Coal (Samla)	6142Mkcal/Ton	Mkcal	0.1265	(0.00492)		
Electricity		Kwh	1.031	(0.0401)	N-T	(0.0305)
Steam (57kg/cm^2G)		Ton	251.34	(9.776)	N-T	(7.430)
Make-up Water		m^3	0.77	(0.03)	N-T	(0.0228)
Nitrogen		Nm^3	0.74	(0.0288)	N-T	(0.0219)
Iron Ore for Catalyst		Ton	918.10	(35.71)	T	(35.71)
Sulfur		Ton	3500.00	(136.13)	T	(136.13)
Filter Aid		Ton	6427.50	(250.00)	T	(250.00)
Fuel Oil		Ton	3740.24	(145.48)	T	(145.48)
Fuel Oil	9500Mkcal/Ton	Mkcal	0.39371	(0.01531)	T	(0.01531)
4. Return Gas and By-Products						
Return Gas	4775kcal/Nm^3	Nm^3	1.1479	(0.04465)		
Return Gas	1409.5Nm^3/Ton	Ton	1617.97	(62.93)	N-T	(47.83)
Light Distillate	10200Mkcal/Ton	Ton	4015.84	(156.20)*1	T	(156.20)
Middle Distillate	9640Mkcal/Ton	Ton	3795.36	(147.22)*1	T	(147.22)
Residue for Case A,H	2175Mkcal/ton	Ton	135.40	(5.266)*2	N-T	(4.00)
Residue for Case S	3456Mkcal/Ton	Ton	215.14	(8.368)*2		
5. Additional Price for Commercial Plant						
Naphtha		Ton	2647.00	(102.96)	Fertilizer Use	
B.F.W		Ton	5.14	(0.20)		
Heavy Distillate	9412MKcal/Ton	Ton	3705.60	(144.13)*1		

Note: *1 Fuel Oil Base
*2 50% x Fuel Coal
T = Tradable Goods and Services
N-T = Non-Tradable Goods and Services

Tablle 8.2.5 MANPOWER REQUIREMENT

	Number of Staff				
	Manager	Chief	Staff A	Staff B	Total
1. Administrative Division					
1.1 Director Room	1		1		2
1.2 General Section	1	1	10	2	14
1.3 Purchasing Section	1		2		3
Administrative Division Total	3	1	13	2	19
2.Production Division					
2.1 Operation Management	2	4	4		10
2.2 Process Section	1	3	41	17	62
2.3 Utility Section	1	1	37	16	55
2.4 Laboratory			7		7
Production Division Total	4	8	89	33	134
3.Maintenance Division					
3.1 Maintenance Section	1	1	27	8	37
3.2 Store, Transportation	1	1	10	4	16
Maintenance Division Total	2	2	37	12	53
Grand Total	9	11	139	47	206

Table 8.2.6 SALARIES AND WAGES CALCULATION

(Unit 1,000 US$)

	Salaries and Wages				
	Manager	Chief	Staff A	Staff B	Total
Man-Year	4.784	3.656	2.217	1.595	
1. Administrative Division					
1.1 Director Room	4.78		2.22		7.00
1.2 General Section	4.78	3.66	22.17	3.19	33.80
1.3 Purchasing Section	4.78		4.43		9.22
Administrative Division Total	14.35	3.66	28.82	3.19	50.02
2.Production Division					
2.1 Operation Management	9.57	14.62	8.87		33.06
2.2 Process Section	4.78	10.97	90.90	27.12	133.76
2.3 Utility Section	4.78	3.66	82.03	25.52	115.99
2.4 Laboratory			15.52		15.52
Production Division Total	19.14	29.25	197.31	52.64	298.33
3.Maintenance Division					
3.1 Maintenance Section	4.78	3.66	59.86	12.76	81.06
3.2 Store, Transportation	4.78	3.66	22.17	6.38	36.99
Maintenance Division Total	9.57	7.31	82.03	19.14	118.05
Grand Total	43.06	40.22	308.16	74.97	466.40

Table 8.3.1 ACTUAL COKE PRODUCTION COST FOR PAST 3 YEARS

Year	1988 - 89				1989 - 90				1990 - 91				
1. Annual Production (TPY, dry)													
1) Gross Coke			1,319,687	(100.00 %)			1,318,503	(100.00 %)			1,218,802	(100.00 %)	
2) Hard Coke			1,098,633	(83.25 %)			1,098,314	(83.30 %)			1,015,263	(83.30 %)	
3) Nut Coke			82,144	(6.22 %)			78,710	(5.97 %)			67,502	(5.54 %)	
4) Mixed Coke			138,910	(10.53 %)			141,479	(10.73 %)			136,037	(11.16 %)	
2. Coke Production Cost (Rs/T of Coke)	Var.	Fix.	Total Rs.	(%)	Var.	Fix.	Total Rs.	(%)	Var.	Fix.	Total Rs.	(%)	Total US$ (US$=25.71Rs.)
Raw Matli:(Incl. Handling Losses													
Washed Coal-PCC	578.12	-	578.12	(34.70)	615.18	-	615.18	(33.35)	593.95	-	593.95	(29.74)	23.10
Washed Coal-MCC	498.14	-	498.14	(29.90)	559.83	-	559.83	(30.35)	538.88	-	538.88	(26.98)	20.96
High Volatile Coal.	25.06	-	25.06	(1.50)	18.52	-	18.52	(1.00)	7.47	-	7.47	(0.37)	0.29
Imported Coal.	518.57	-	518.57	(31.13)	582.69	-	582.69	(31.59)	826.82	-	826.82	(41.40)	32.16
a) Total Material Cost	1619.89	-	1619.89	(97.23)	1777.22	-	1777.22	(96.36)	1967.12	-	1967.12	(98.49)	76.51
Labour	2.79	22.44	25.23	(1.51)	2.17	21.73	23.90	(1.30)	2.22	25.02	27.24	(1.36)	1.06
Consumables and Others.	21.22	0.86	22.08	(1.33)	25.55	1.09	26.64	(1.44)	6.35	1.56	7.91	(0.40)	0.31
Power & Fuels	139.41	16.35	155.76	(9.35)	155.33	14.76	170.09	(9.22)	156.76	12.97	169.73	(8.50)	6.60
Services	6.28	17.81	24.09	(1.45)	8.44	21.21	29.65	(1.61)	17.02	21.36	38.38	(1.92)	1.49
Repair & Maint.													0.00
(Incl. Maint. Labour.)	6.20	58.03	64.23	(3.86)	6.96	67.30	74.26	(4.03)	22.50	69.20	91.70	(4.59)	3.57
Capital Repairs	0.09	33.72	33.81	(2.03)	0.07	42.60	42.67	(2.31)	1.47	47.85	49.32	(2.47)	1.92
b) Total Operating Cost.	175.99	149.21	325.20	(19.52)	198.52	168.69	367.21	(19.91)	206.32	177.96	384.28	(19.24)	14.95
Total Cost (Coke + Gas)	1795.88	149.21	1945.09	(116.75)	1975.74	168.69	2144.43	(116.27)	2173.44	177.96	2351.40	(117.73)	91.46
Less, Credit for													0.00
C.O Gas & B.P.	-347.95	-28.91	-376.86	(-22.62)	-383.23	-32.73	-415.96	(-22.55)	-449.66	-36.81	-486.47	(-24.36)	-18.92
Cost of Coke (Gross Coke) At Split-off.	1447.93	120.30	1568.23	(94.13)	1592.51	135.96	1728.47	(93.72)	1723.78	141.15	141.15	(7.07)	5.49
+ Overheads	-	83.24	83.24	(5.00)	-	102.57	102.57	(5.56)		113.63	113.63	(5.69)	4.42
+ Coke Handling	7.01	19.41	26.42	(1.59)	6.78	19.58	26.36	(1.43)	9.68	23.47	33.15	(1.66)	1.29
(-) Credit for Coke Breeze	-76.89	-	-76.89	(-4.62)	-80.59	-	-80.59	(-4.37)	-84.32	-	-84.32	(-4.22)	-3.28
+ Cost of Breeze Disposal	0.31	0.78	1.09	(0.07)	0.29	0.70	0.99	(0.05)	0.43	0.75	1.18	(0.06)	0.05
Total Works Cost (BF.)	1378.36	223.73	1602.09	(96.16)	1518.99	258.81	1777.80	(96.39)	1649.57	279.00	1928.57	(96.56)	75.01
Total Cost	1378.36	287.63	1665.99	(100.00)	1518.99	325.39	1844.38	(100.00)	1649.57	347.64	1997.21	(100.00)	77.68

Table 8.4.1 ASH CONTENT IN COAL AND COKE BY VARIOUS COAL MIXTURE

	Present Ope	Cases Using SRC					
	RSP '90	Test A2	Test A5	Test A8	Test B3	Case C1	Case C2
Ash in Blended Coal [%]	18.2	18.1	18.2	18.3	20.4	18.2	18.3
Ash in Coke [%]	22.7	23.0	23.5	23.9	25.9	23.5	23.7
Coal Blend Ratio [%]							
--PCC	(37.9)	(30.0)	(30.0)	(30.0)	(28.2)	(30.0)	(10.0)
Bhojudih	19.0	15.0	15.0	15.0	14.1	15.0	5.0
Sudamdih	12.6	10.0	10.0	10.0	9.4	10.0	0.0
Chasnala	6.3	5.0	5.0	5.0	4.7	5.0	5.0
--MCC	(32.5)	(40.0)	(40.0)	(40.0)	(65.8)	(47.0)	(72.5)
Kargali	8.1	10.0	10.0	10.0	18.8	10.0	20.0
Swang	8.1	10.0	10.0	10.0	18.8	10.0	20.0
Rajrappa	16.3	20.0	20.0	20.0	28.2	27.0	32.5
--HVC	(0.4)					(10.0)	(5.0)
--IMPORTED COAL	(29.2)	(22.5)	(15.0)	(7.5)	(0.0)	(8.0)	(7.5)
--NCC	(0.0)	(5.0)	(10.0)	(15.0)	(0.0)	(0.0)	(0.0)
--SRC		(2.5)	(5.0)	(7.5)	(6.0)	(5.0)	(5.0)
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

	W/o SRC	Case P1	Case P2	Case P3
Ash in Blended Coal [%]	14.0	15.3	16.0	16.5
Ash in Coke [%]	17.2	18.7	19.4	20.0
--IMPORTED COAL	(55.0)	(39.0)	(30.0)	(25.0)
--LVMC	(45.0)	(58.0)	(65.0)	(70.0)
--SRC	(0.0)	(3.0)	(5.0)	(5.0)
Total	100.0	100.0	100.0	100.0

[Acoke]=[Acoal]/[yield]
[yield]=[yield0]*f(x)/f(x0)
f(x)=(98-0.84*[vm])*(1-[wa])

[Acoke]: ash in coke
[Acoal]: ash in coal
[yield]: BF coke yield
[vm]: volatile matter[%]
[wa]: water in coal[-]
f(x): formula estimating coke yield
suffix 0:figure in With-out Case

Table 8.4.2 ASH CONTENT, VOLATILE MATTER AND COAL PRICE BY VARIOUS COAL MIXTURE

	Moisture (%)	Ash Content (%)	Volatile Matter (%)	Coal Price (Rs/t,Wet)	(Rs/t, Dry)
--PCC					
Bhojudih	6.0	24.00	20.30	1007.85	1072.18
Sudamdih	6.0	24.20	21.70	1010.93	1075.46
Chasnala	6.0	17.80	24.80	1014.12	1078.85
--MCC					
Kargali	6.5	19.50	24.40	1002.01	1071.67
Swang	8.5	21.80	22.30	1005.20	1098.58
Rajrappa	7.0	20.90	29.50	986.80	1061.08
--HVC					
Assam	9.7	5.00	41.60	1940.28	1594.99
--IMPORTED COAL					
Australia	8.0	9.10	23.80	2450.00	2663.04
With Premium	8.0	9.10	23.80	2820.22	3065.46
--NCC					
Samla	17.4	13.80	34.60	776.68	940.29
--LVMC	6.0	20.00	20.00	1009.92	1074.38
--SRC					
Assam exc.D&I	5.0	4.80	33.50	3903.52	4108.97
Assam inc.D&I	5.0	4.80	33.50	8274.29	8709.78

Table 8.7.1 EXPORTS AND IMPORTS IN INDIA

(Unit: Rs 10 million)

	1984-85	1985-86	1986-87	1987-88	1988-89	Total/Average
(1) Gross value of imports (CIF)	17,134	19,658	20,096	22,244	28,235	107,367
(2) Gross value of exports (FOB)	11,744	10,895	12,452	15,674	20,231	70,996
(3) Import Dutes	7,103	9,601	11,524	13,891	16,029	58,148
(4) Export Tax	84	83	94	73	25	359
(5) Export Subsidy	-	-	-	-	-	-
(6) = (1)+(2)	28,878	30,553	32,548	37,918	48,466	178,363
(7) = (1)+(2)+(3)-(4)+(5)	35,897	40,071	43,978	51,736	64,470	236,152
(8) SCF = (6)÷(7)	0.804	0.762	0.740	0.733	0.752	0.755

Sources (1), (2) : Data obtained from MECON

(3), (4) : Reserve Bank of India

Notes : Other revenue, refunds and drawbacks on customs are excluded because of a low impact on SCF.

Table 8.7.2 CIF COAL PRICE FROM AUSTRALIA TO JAPAN

(Unit CIF, US$ per MT)

Fiscal Year	1986	1987	1988	1989	1990*
(1) From Australia to Japan					
Coking Coal (P.C.C)					
Ash<8%	60.87	54.22	50.95	55.33	57.47
Ash>8%	57.59	52.75	50.86	55.49	58.84
Coking Coal (Others)					
Ash<8%	52.38	50.09	48.08	51.60	52.16
Ash>8%	50.74	45.46	44.24	51.05	52.97
Coking Coal Average	51.49	46.18	49.86	53.38	55.55
Non-Coking Coal Average*	44.08	41.72	43.34	50.33	51.84
(2) From Major Countries to Japan					
Coking Coal Average	56.27	52.43	56.35	59.22	60.64
Non-Coking Coal Average	43.58	40.74	44.28	49.78	50.55

Source : Trade Statistics, Ministry of Finance in Japan

Note * : Calendar Year Basis

Table 8.7.3 PROJECT PROFILE AND ECONOMIC ANALYSIS SUMMARY (1/3)

1. Project

Title	: SRC Demonstration Plant Project
Location	: Rourkela, India
Executing Agency	: SAIL, MECON and RSP
Project Case	: Base Case (Case A)
Selected Coal	: Assam Coal
Maximum Operable Days	: (365.25 - 35.25) x 100% = 330 SDPY
Feed Coal Input(Dry Coal Basis)	: 500 TPD x 330 DPY = 165,000 TPY
Yield of SRC Product	: 67.92% of Feed Coal Input
Production Start Year	: 1999
Monetary Unit	: US dollars($) in terms of fixed price in August, 1991
Exchange Rate for Caluculation	: 1 US$ = 25.71Rs = 136.32 Yen as of August 16, 1991

2. Schedule

Contract Award	: May, 1996
Mechanical Completion	: July, 1999
Production Start	: December, 1999
Project Phase Out	: November, 2019
Project Life	: 20 Years from Production Start
Project Year	: December to November
Construction and Commissioning including Test Run	: 43 months from Contract Award

3. Financing Required and Financing Plan in 1991 Price Base

Financing Required	US$, MM
Land/Site Development	0.0
Erected Plant Cost	143.89
- Process	
- Utility	
- Offsite	
- Project Infrastructure	
Pre-Operational Expense	4.43
Interest during Construction	0.00
Fixed Capital Cost	148.32
Initial Working Capital	1.65
Financing Required	149.97

Financing Plan		US$, MM
Equity	: 20.0%	29.99
Foreign Soft Loan	: 80.0%	119.98
- Interest: 6.0%		
Financing Plan		149.97

Table 8.7.3 PROJECT PROFILE AND ECONOMIC ANALYSIS SUMMARY (2/3)

4. Inputs and Pricing (CIF at the Plant in 1991 Price Base)

Inputs	Unit		Per Feed Coal(Dry)		Per SRC	Annual as of 2009	
	Unit	Cost	Consumption	Cost	Cost	Consumption	Cost
		$/Unit	Unit/Unit	$/Unit	$/Unit	Unit	$, MM
Raw Material							
- Feedstock Coal (Purchase)	Ton	42.58	1.10742	47.15	69.42	182,724	7.780
- Coke Oven Gas	Ton	49.72	0.6336	31.50	46.38	104,544	5.198
Utilities							
- Fuel Coal	Ton	22.96	0.3984	9.15	13.47	65,736	1.509
- Electricity	kwh	0.0305	62.88	1.92	2.82	10.375×10^6	0.316
- Steam(57kg/cm^{2}G)	Ton	7.43	0.48	3.57	5.25	79,200	0.588
- Make-up Water	m^3	0.0228	9.60	0.22	0.32	$1,584 \times 10^3$	0.036
- Nitrogen	Nm^3	0.0219	24.0	0.53	0.78	$3,960 \times 10^3$	0.087
- Catalyst(Iron Ore)	Ton	35.71	0.0309	1.10	1.62	5,100	0.182
- Catalyst (Sulfur)	Ton	136.13	0.0074	1.01	1.48	1,212	0.165
- Chem.(Filter Aid)	Ton	250.00	0.0112	2.80	4.12	1,848	0.462
- Chemicals, etc.	Ton	-	-	-	0.38	-	0.043
(1) Variable Cost	-	-	-	-	146.04	112,063	16.366
Operating Labor	M-Y	1913			2.28	134	0.256
Overhead	Ope. Labor x 50%				1.14	-	0.128
Maintenance(Materials)	E&M, CIF x 1.5%				17.05	-	1.911
(Labor)	M-Y	1931			0.91	53	0.102
Administration (Supplies)	Admi. Staff x 100%				0.40	-	0.045
(Staff)	M-Y	2359			0.40	19	0.045
Insurance	Book Value x 0.5%				3.47	-	0.389
(2) Direct Fixed Cost	-	-	-	-	25.66	-	2.876
Credits							
- Return Gas	Ton	47.83	0.6427	30.74	45.26	106,049	5.072
- Light Distillate	Ton	156.20	0.036	5.62	8.26	5,931	0.926
- Middle Distillate	Ton	147.22	0.006	0.88	1.25	950	0.140
- Residue	Ton	4.00	0.087	0.35	0.51	14,303	0.057
(3) Total Credits	-	-	-	-	55.28	-	6.195
(4) Production Cost = (1)+(2)-(3)					116.42	112,063	13.047

Table 8.7.3 PROJECT PROFILE AND ECONOMIC ANALYSIS SUMMARY (3/3)

5. Operation Schedule

	Project Year								(Unit: %)
	(-)4	(-)3	(-)2	(-)1	1	2	3	..20	Total/
	96	97	98	99	00	01	02	2019	Avarage
- Financing Disbursement	5	35	40	20					
- Production									
- Rated Capacity Utilization					80	90	100	100	1,970
- Inventory Increase					8	0	0	(-)8	0
- Inventory					8	8	8	0	0
- Sales					72	90	100	108	1,970

- Depreciation/Salvage Value 20 years straight line/5% salvage value
- Amortization/Salvage Value 20 years straight line/Zero salvage value

- Debt Service

Loan Type	Maximum Grace + Maturity	Annual Interest Rate	Installments
- Long Term Loan/Foreign 1/	6 + 18	6.00	20

1/ Balance of payment over project life is assumed to be paid in last year of project life.

- Product Inventory (SRC) 1.0 month
- Material Inventory (Feedstock Coal) 0.5 month

Table 8.8.1 PLANT COST ESTIMATION AND CAPITAL INVESTMENT COST FOR 1000 T/D PLANT (1/2)

Items	Foreign Currency mm¥	Local Currency 10^5 Rs
1. Plant direct cost		
(1) Equipment and materials		
- Equipment and materials for area #100-#1980	12,269	19,582
- Spare parts	859	1,371
Sub-total	13,128	20,953
(2) Erection and installation works	0	2,732
(3) Civil and building works	0	4,967
Plant direct cost total	13,128	28,652
2. Expenses		
(1) Ocean freight and insurance	262	0
(2) Local handling and inland transportation	0	132
(3) Indirect field expense	0	787
Expense fee total	262	919
3. Engineering fee		
(1) License fee	780	0
(2) Basic design	154	0
(3) Engineering service	1,005	920
(4) Project Management	400	400
Engineering fee total	2,339	1,320
Total		
4. Contingency	1,313	3,114
Grand Total	17,042	34,005

Table 8.8.1 PLANT COST ESTIMATION AND CAPITAL INVESTMENT COST FOR 1000 T/D PLANT (2/2)

- Feedstock Coal: Assam Coal -

Items	Capital Investment Cost, $, MM		
	Foreign Currency	Local Currency	Total
1. Land & Site Development	-	0.00	0.00
2. Plant Direct Cost	96.30	111.44	207.74
- Equipment and Materials	(90.00)	(76.16)	(166.16)
- Spare Parts	(6.30)	(5.33)	(11.63)
- Erection and Installation Works	(-)	(10.63)	(10.63)
- Civil and Building Works	(-)	(19.32)	(19.32)
3. Ocean Freight and Insurance	1.92	-	1.92
4. Local Handling and Inland Transportation	-	0.51	0.51
5. Indirect Field Expenses	-	3.06	3.06
6. Engineering Services	17.16	5.14	22.30
- License Fee	(5.72)	(-)	(5.72)
- Basic Design	(1.13)	(-)	(1.13)
- Engineering Services	(7.37)	(3.58)	(10.95)
- Project Management	(2.94)	(1.56)	(4.50)
Base Project Cost - 1991	115.38	120.15	235.53
7. Contingency	9.63	12.11	21.74
- Physical Contingency	(9.63)	(12.11)	(21.74)
- Price Escalation	(Not considered in the analysis)		
8. Tax and Duty	-	102.75	102.75
- Import Duty	-	86.28	86.28
- Excise Duty, Sales Tax and R&D Cess	-	16.47	16.47
Erected Plant Cost - 1991	125.01	235.01	360.02
9. Pre-Operation Expenses	-	8.81	8.81
10. Interest during Construction (F:6%)	35.11	-	35.11
11. Initial Working Capital	-	4.63	4.63
Capital Investment Cost - 1991	160.12	248.45	408.57

Table 8.8.2 PLANT COST ESTIMATION AND CAPITAL INVESTMENT COST FOR 3000 T/D PLANT (1/2)

Items	Foreign Currency mm¥	Local Currency 10^5 Rs
1. Plant direct cost		
(1) Equipment and materials		
- Equipment and materials for area #100-#1980	24,278	43,798
- Spare parts	1,700	3,066
Sub-total	25,978	46,864
(2) Erection and installation works	0	7,083
(3) Civil and building works	0	10,337
Plant direct cost total	25,978	64,284
2. Expenses		
(1) Ocean freight and insurance	575	0
(2) Local handling and inland transportation	0	295
(3) Indirect field expense	0	1,625
Expense fee total	575	1,920
3. Engineering fee		
(1) License fee	1,714	0
(2) Basic design	194	0
(3) Engineering service	1,089	1,000
(4) Project Management	432	430
Engineering fee total	3,429	1,430
Total		
4. Contingency	2,598	6,945
Grand Total	32,580	74,579

Table 8.8.2 PLANT COST ESTIMATION AND CAPITAL INVESTMENT COST FOR 3000 T/D PLANT (2/2)

- Feedstock Coal: Assam Coal -

Items	Capital Investment Cost, $, MM		
	Foreign Currency	Local Currency	Total
1. Land & Site Development	-	0.00	0.00
2. Plant Direct Cost	190.57	250.04	440.61
- Equipment and Materials	(178.10)	(170.35)	(348.45)
- Spare Parts	(12.47)	(11.93)	(24.40)
- Erection and Installation Works	(-)	(27.55)	(27.55)
- Civil and Building Works	(-)	(40.21)	(40.21)
3. Ocean Freight and Insurance	4.22	-	4.22
4. Local Handling and Inland Transportation	-	1.15	1.15
5. Indirect Field Expenses	-	6.32	6.32
6. Engineering Services	25.15	5.56	30.71
- License Fee	(12.57)	(-)	(12.57)
- Basic Design	(1.42)	(-)	(1.42)
- Engineering Services	(7.99)	(3.89)	(11.88)
- Project Management	(3.17)	(1.67)	(4.84)
Base Project Cost - 1991	219.94	253.07	483.01
7. Contingency	19.05	27.01	46.07
- Physical Contingency	(19.05)	(27.01)	(46.07)
- Price Escalation	(Not considered in the analysis)		
8. Tax and Duty	-	207.43	207.43
- Import Duty	-	171.08	171.08
- Excise Duty, Sales Tax and R&D Cess	-	36.35	36.35
Erected Plant Cost - 1991	239.00	497.51	736.51
9. Pre-Operation Expenses	-	23.24	23.24
10. Interest during Construction (F:6%)	72.31	-	72.31
11. Initial Working Capital	-	11.10	11.10
Capital Investment Cost - 1991	311.31	531.85	843.16

Table 8.8.3 OVERALL MATERIAL BALANCE (1/4)

	Consumption	Production
(1)1,000 t/d plant		
Raw coal	365,448	
(Purchase)		
Naphtha	60,984	
SRC		224,120
Lt. distillate		11,864
Md. distillate		1,901
Produced gases		38,721
(2)3,000 t/d plant		
Raw coal	1,096,344	
(Purchase)		
Naphtha	182,952	
SRC		672,360
Lt. distillate		35,592
Md. distillate		5,702
Produced gases		116,392

Table 8.8.3 OVERALL MATERIAL BALANCE (2/4)

Utilities Summary

Utility Name	Consumption	Note
(1) 1,000 t/d plant		
Electric Power	4,140 KWH/h	
Fuel Fuel Coal	19.3 t/h	
Water Treated Water Boiler Feed Water Drinking Water	400 t/h 27 t/h as required	
Nitrogen and Air Nitrogen Plant Air	1,000 Nm^3/h	
Process Solvent	1,600 tonne	Anthracene oil initial charge
Hot Oil	60 tonne	initial charge
Butane	40 m^3	initial charge
(2) 3,000 t/d plant		
Electric Power	10,800 KWH/h	
Fuel Fuel Coal	57.8 t/h	
Water Treated Water Boiler Feed Water Drinking Water	1,200 t/h 79 t/h as required	
Nitrogen and Air Nitrogen Plant Air	1,000 Nm^3/h	
Process Solvent	4,800 tonne	Anthracene oil initial charge
Hot Oil	180 tonne	initial charge
Butane	120 m^3	initial charge

Table 8.8.3 OVERALL MATERIAL BALANCE (3/4)

Chemicals Summary

Name	Area o System	Initial Charge	Consumption	Specification
(1) 1,000 t/d plant				
Liquefaction Cat.	200		1,288 kg/h	Iron ore
Liquefaction Promotor	200		306 kg/h	Sulfur from OSBL
DEA	200 & 300	3 tonnes	4 kg/d	Commercial grade
Filter Aid	500		11.2 t/d	
Hydrotreater Cat.	700	3 m^3/ 1 charge	life 3 years	CCI C49-1 or equivalent
Desulfurizer Cat.	700	19 m^3/ 1 charge	life 1 years	CCI C7-2 or equivalent
Steam Reformer Cat.		4 m^3/ 1 charge	life 2 years	CCI C11-9 or equivalent
H.T.S. Converter Cat.		6 m^3/ 1 charge	life 3 years	CCI C12-1 or equivalent
L.T.S. Converter Cat.		7 m^3/ 1 charge	life 2 years	CCI C18-1 or equivalent
Methanator Cat.		4 m^3/ 1 charge	life 3 years	CCI C13-4 or equivalent
Sulfur Recovery Cat.	800	1,400 kg	2 kg/d	Takahaks catalyst
Corrosion Inhibitor	1300		1.8 kg/h	
Scale Dispersant	1300		1.8 kg/h	
Coaguration Polymer-1	1200		2.2 kg/d	
Coaguration Polymer-2	1200		3.2 kg/d	
Nutriment	1200		16 kg/d	K_2HPO_4
Nutriment	1200		16 kg/d	$FeSO_4$
Floccutant	1200		38 kg/d	$Al_2(SO_4)_3$
Neutalarization Agent	1200		30 kg/d	NaOH

Table 8.8.3 OVERALL MATERIAL BALANCE (4/4)

Chemicals Summary

Name	Area o System	Initial Charge	Consumption	Specification
(2) 3,000 t/d plant				
Liquefaction Cat.	200		3,864 kg/h	Iron ore
Liquefaction Promotor	200		918 kg/h	Sulfur from OSBL
DEA	200 & 300	3 tonnes	12 kg/d	Commercial grade
Filter Aid	500		33.6 t/d	
Hydrotreater Cat.	700	9 m^3/ 1 charge	life 3 years	CCI C49-1 or equivalent
Desulfurizer Cat.	700	57 m^3/ 1 charge	life 1 years	CCI C7-2 or equivalent
Steam Reformer Cat.		12 m^3/ 1 charge	life 2 years	CCI C11-9 or equivalent
H.T.S. Converter Cat.		18 m^3/ 1 charge	life 3 years	CCI C12-1 or equivalent
L.T.S. Converter Cat.		21 m^3/ 1 charge	life 2 years	CCI C18-1 or equivalent
Methanator Cat.		12 m^3/ 1 charge	life 3 years	CCI C13-4 or equivalent
Sulfur Recovery Cat.	800	4,200 kg	6 kg/d	Takahaks catalyst
Corrosion Inhibitor	1300		5.4 kg/h	
Scale Dispersant	1300		5.4 kg/h	
Coaguration Polymer-1	1200		6.6 kg/d	
Coaguration Polymer-2	1200		9.6 kg/d	
Nutriment	1200		48 kg/d	K_2HPO_4
Nutriment	1200		48 kg/d	$FeSO_4$
Floccutant	1200		114 kg/d	$Al_2(SO_4)_3$
Neutalarization Agent	1200		90 kg/d	NaOH

Table 8.8.4 PRODUCTION COST OF SRC FOR 1000 T/D PLANT

Inputs and Pricing (CIF at the Plant in 1991 Price Base)

Inputs	Unit		Per Feed Coal(Dry)		Per SRC	Annual as of 2009	
	Unit	Cost	Consumption	Cost	Cost	Consumption	Cost
		$/Unit	Unit/Unit	$/Unit	$/Unit	Unit	$, MM
Raw Material							
- Feedstock Coal (Purchase)	Ton	56.02	1.10742	62.04	91.34	365,448	20.472
- Naphtha	Ton	102.96	0.1848	19.03	28.02	60,984	6.279
Utilities							
- Fuel Coal	Ton	30.21	0.4632	13.99	20.60	152,856	4.618
- Electricity	kwh	0.0401	99.36	3.98	5.86	32.789 x 10^6	1.315
- B.F.W.	Ton	0.20	0.648	0.13	0.19	213,840	0.043
- Make-up Water	m^3	0.03	9.60	0.29	0.43	3,168 x 10^3	0.095
- Nitrogen	Nm^3	0.0288	24.0	0.69	1.02	7,920 x 10^3	0.228
- Catalyst(Iron Ore)	Ton	35.71	0.0309	1.10	1.62	10,200	0.364
- Catalyst (Sulfur)	Ton	136.13	0.0074	1.01	1.48	2,424	0.330
- Chem.(Filter Aid)	Ton	250.00	0.0112	2.80	4.12	3,696	0.924
- Chemicals, etc.	Ton	-	-	-	0.38	-	0.086
(1) Variable Cost	-	-	-	-	155.06	224,120	34.754
Operating Labor	M-Y	2226			1.33	134	0.298
Overhead	Ope. Labor x 50%				0.67	-	0.149
Maintenance(Materials)	E&M, CIF x 1.5%				22.60	-	5.066
(Labor)	M-Y	2227			0.53	53	0.118
Administration (Supplies)	Admi. Staff x 100%				0.22	-	0.050
(Staff)	M-Y	2633			0.22	19	0.050
Tax & Insurance	Book Value x 0.5%				4.71	-	1.055
(2) Direct Fixed Cost	-	-	-	-	30.28	-	6.786
Credits							
- Return Gas	Ton	62.93	0.1173	7.38	10.87	38,721	2.437
- Light Distillate	Ton	156.20	0.036	5.61	8.27	11,864	1.853
- Middle Distillate	Ton	147.22	0.006	0.88	1.25	1,901	0.280
- Residue	Ton	5.266	0.000	0.00	0.00	0	0.000
(3) Total Credits	-	-	-	-	20.39	-	4.570
(4) Production Cost = (1)+(2)-(3)					164.95	224,120	36.970
(5) Depreciation & Interest (D & I)					142.98	-	32.044
(6) Total Production Cost inc. D&I = (4)+(5)					307.93	224,120	69.014

Table 8.8.5 PRODUCTION COST OF SRC FOR 3000 T/D PLANT

Inputs and Pricing (CIF at the Plant in 1991 Price Base)

Inputs	Unit		Per Feed Coal(Dry)		Per SRC	Annual as of 2009	
	Unit	Cost	Consumption	Cost	Cost	Consumption	Cost
		$/Unit	Unit/Unit	$/Unit	$/Unit	Unit	$, MM
Raw Material							
- Feedstock Coal (Purchase)	Ton	56.02	1.10742	62.04	91.34	1,096,344	61.417
- Naphtha	Ton	102.96	0.1848	19.03	28.02	182,952	18.837
Utilities							
- Fuel Coal	Ton	30.21	0.4624	13.97	20.57	457,776	13.829
- Electricity	kwh	0.0401	86.40	3.46	5.10	85.536×10^6	3.430
- B.F.W.	Ton	0.20	0.632	0.13	0.19	625,680	0.125
- Make-up Water	m^3	0.03	9.60	0.29	0.43	$9,504 \times 10^3$	0.285
- Nitrogen	Nm^3	0.0288	8.0	0.23	0.34	$7,920 \times 10^3$	0.228
- Catalyst(Iron Ore)	Ton	35.71	0.0309	1.10	1.62	30,603	1.093
- Catalyst (Sulfur)	Ton	136.13	0.0074	1.01	1.47	7,271	0.990
- Chem.(Filter Aid)	Ton	250.00	0.0112	2.80	4.12	11,088	2.772
- Chemicals, etc.	Ton	-	-	-	0.38	-	0.258
(1) Variable Cost	-	-	-	-	153.58	672,360	103.264
Operating Labor	M-Y	2226			0.44	134	0.298
Overhead	Ope. Labor x 50%				0.22	-	0.149
Maintenance(Materials)	E&M, CIF x 1.5%				15.75	-	10.587
(Labor)	M-Y	2227			0.18	53	0.118
Administration (Supplies)	Admi. Staff x 100%				0.07	-	0.050
(Staff)	M-Y	2633			0.07	19	0.050
Tax & Insurance	Book Value x 0.5%				3.24	-	2.172
(2) Direct Fixed Cost	-	-	-	-	19.97	-	13.424
Credits							
- Return Gas	Ton	62.93	0.1176	7.40	10.89	116,392	7.325
- Light Distillate	Ton	156.20	0.036	5.61	8.27	35,592	5.560
- Middle Distillate	Ton	147.22	0.006	0.88	1.25	5,702	0.839
- Residue	Ton	5.266	0.000	0.00	0.00	0	0.000
(3) Total Credits	-	-	-	-	20.41	-	13.724
(4) Production Cost = (1)+(2)-(3)					153.14	672,360	102.964
(5) Depreciation & Interest (D & I)					98.26	-	66.069
(6) Total Production = (4)+(5) Cost inc. D&I					251.40	672,360	169.033

Chapter 9 FORMULATION OF THE SRC DEVELOPMENT PROGRAMME

Chapter 9 SRC DEVELOPMENT PROJECT

Generally speaking, the objective of SRC Production Technology research is not only to establish the SRC Process for producing good quality coke from the blending of non-coking coal as treated in the present Report, but also to provide a substitute fuel for oil. However, the present Report is limited to a consideration of the SRC Development Project in terms of SRC for coke production.

The United States, Germany and Japan have been engaged for a long time in research into the technology relating to the hydrogenation of coal in solution, coal liquification and SRC production. In India, there has also been research conducted in these fields using Indian domestic coals. In some countries tests on a pilot plant level have been carried out in addition to autoclave and bench scale tests. When a rapid rise in oil prices was occurred, plans for the construction of commercial SRC Plants were also made, and projects proceeded with in line with such planning. However, subsequently oil prices stabilised and so the plans for realisation of commercial plant projects have remained unimplemented to the present day. Nevertheless, research on a bench and pilot plant scale was continued in anticipation of eventual commercialisation, and a variety of research relating to equipment and materials has been followed up and pursued.

As a result of the world context for development of SRC production technology outlined above, a commercial plant has yet to be constructed anywhere. Moreover, it is essential that the coal feedstock selected for the SRC production process be of a suitable variety, and the financial and economic evaluation of SRC production is heavily influenced by the properties of the coal selected. Coal has an extremely complicated nature and since physical properties vary considerably depending on where the coal is mined, a thorough examination of such aspects is necessary.

For the above reasons, it is necessary to confirm the possibility of using Indian coal as feedstock for production of SRC to be used to make coke. To this end, the Preliminary Study Team

agreed with its Indian Counterpart on the following plan of action. First, a preparatory survey involving autoclave tests would be conducted. From autoclave tests results, a comparison of the SRC and byproduct yields for each coal variety proposed and for the various reaction conditions would be obtained. Further, an evaluation on coke production using the SRC samples thus obtained would be carried out. If results of the preparatory survey were satisfactory then a series of continuous bench scale tests using Indian coal would be carried out next. These tests would allow for accurate results on the material balance and properties of products to be grasped in view of detailed planning of the plant and plant equipment. Therefore, the bench scale tests using Indian coal would permit a more accurate technical and economic forecast of the project outlines to be established.

If the full stage F/S findings (including the results of the bench scale tests) are found to be satisfactory, in view of the fact that the long term operation of a pilot plant on a 200 ton per day scale has already been effected in the world it would be possible to proceed immediately to the next step of constructing a Demonstration Plant. After this, construction of a Commercial Plant could be carried out taking into consideration the domestic Indian market configurations and the Economies of Scale involved.

As a result of Discussions between the Indian Counterpart and the First Report Mission the above plan of action was confirmed, and stage details decided. (with an 0.1 t/d scale for the bench scale plant, a 500 t/d coal intake for SRC production at the Demonstration Plant designed with preheater capacity at 500-750 t/d, and a 3000 t/d Commercial Plant with a reactor at capacity sufficient to meet the maximum production requirements).

With a Demonstration Plant of a 500 t/d scale using Assam coal for SRC production, and a coke blend ratio of 5% SRC content it is possible to produce coke to meet with the scale of coke production currently attained at the Rourkela Steel Plant, so that supplies can be integrated into daily coke production.

Since the amount of coal needed is 1.08 times the 19.65 million