# TECHNO-ECONOMIC FEASIBILITY REPORT

**ON**

# INTEGRATED STEEL PLANT IN ODISHA

**TO**

# JSW UTKAL STEEL LIMITED

**FEBRUARY 2021**

DASTUR

**M. N. DASTUR & COMPANY (P) LTD**
**CONSULTING ENGINEERS**

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**DRAWINGS**

Dwg. 11467-02-0001 – Plant Materials Flowsheet for Phase-I
Dwg. 11467-02-0002 – Plant Materials Flowsheet After Phase-II
Dwg. 11467-02-0003 – Plant Materials Flowsheet After Phase-III
Dwg. 11467-03-0001 – Plant General Layout
Dwg. 11467-06-0001 – Single Line Diagram for Overall Power Distribution System
Dwg. 11467-06-0002 – Schematic Water Flow Diagram

**EXECUTIVE SUMMARY**

## 1.0 BACKGROUND

The flagship company of JSW Group and one of India's leading integrated steel producers, JSW Utkal Steel Limited (JSWUSL), a subsidiary of JSW Steel (JSWS), is contemplating setting up a green field Integrated Steel Plant (ISP) with a capacity of about 13.2 mtpy crude steel, at a site already identified by JSWS near the coast in Jagatsinghpur district of Odisha.

The plant will be based on BF-BOF route with pellet plant that will use iron ore slurry received through pipe line from Joda/Nuagaon grinding and desliming plant of JSWUSL.

## 2.0 KEY OBJECTIVE

In this context, the key questions to be addressed are as follows:

a) Phasing of the capacities to get feasible financial numbers in each phase.

b) Total capital expenditure involved to complete the project.

c) The production cost of various products.

d) The key financial indicators of phase-wise expansion?

## 3.0 PHASED CAPACITY BUILD-UP AND PRODUCT BASKET

### 3.1 Plant Capacity

The production capacity of the plant has been envisaged based on the many factors comprising indigenous available iron ore as well as other raw materials as per present industry practice, available infrastructure facilities, likely future market etc. The entire plant of 13.2 mtpy capacity crude steel is envisaged to be built over multiple phases. This will mitigate the difficulty and complexities of management and construction involved in installation of a plant of such large capacity in a single phase. Also, capacity build-up in multiple phases will ensure distribution of the expenditures over a longer time period, so that the earnings from the previous phase/phases being available for utilisation in the subsequent phase, resulting in a healthy financial reconciliation. The proposed phase-wise facilities are given in Table 1.

**TABLE 1 – PHASE-WISE PLANT CONFIGURATION**

| Sl. no. | Description | Design capacity | | | Production after Phase-III, mtpy |
|---|---|---|---|---|---|
| | | Phase-I | Added in Phase-II | Added in Phase-III | |
| 1. | Pellet plant | 2 x 8.0 mtpy | 1 x 8.0 mtpy | 1 x 8.0 mtpy | 32 |
| 2. | Coke oven | 4 x 62 ovens | 2 x 62 Ovens | 2 x 62 ovens | 6 |
| 3. | Sinter plant | 1 x 500 sq m | - | - | 5.775 |
| 4. | Blast furnace | 1 x 5350 cu m | 1 x 5350 cu m | 1 x 5350 cu m | 13.5 |
| 5. | COG based DR plant | - | - | 1 x 1.2 mtpy | 1.2 |
| 6. | Steelmaking | SMS#1 | SMS#1 | SMS#2 | |
| | - Basic oxygen Furnace | 2 x 350 ton | 1 x 350 ton | 2 x 180 ton | 13.49 |
| | - Ladle furnace | 2 x 350 ton | 1 x 350 ton | 2 x 180 ton | 13.49 |
| | - RH degasser | 1 x 350 ton | 1 x 350 ton | 1 x 180 ton | 4.01 |
| | - Slab caster | 2 x 2 - Strand | 1 x 2 - Strand | - | 10.29 |
| | - Billet caster | - | - | 1 x 8 - Strand | 2.91 |
| | - Billet cum bloom caster/beam blank | - | - | 1 x 6 - Strand | |
| 7. | HSM | 1 x 5.5 mtpy | 1 x 5.5 mtpy | - | 8.82 |
| 8. | Plate mill | - | - | 1 x 1.5 mtpy | 1.18 |
| 9. | Cold rolling complex consisting of | | | | |
| | - PLTCM | 1 x 2.3 mtpy | 1 x 2.3 mtpy | - | Cold rolled annealed coil - 1.944 mtpy |
| | - CGL | 2 x 0.5 mtpy | 2 x 0.5 mtpy | - | |

Executive Summary (cont'd)

| Sl. no. | Description | Design capacity | | | Production after Phase-III, mtpy |
|---|---|---|---|---|---|
| | | Phase-I | Added in Phase-II | Added in Phase-III | |
| | - CAL | 1 x 1.0 mtpy | 1 x 1.0 mtpy | - | Colour coated steel - 0.995 mtpy<br><br>Cold rolled galvanised steel - 1.044 mtpy<br><br>Tinplate coil - 0.455 mtpy |
| | - RCL | 2 x 0.25 mtpy | 1 x 0.25 mtpy | - | |
| | - CCL | 2 x 0.25 mtpy | 2 x 0.25 mtpy | - | |
| | - Tinplate | 1 x 0.25 mtpy | 1 x 0.25 mtpy | - | |
| 10. | Silicon steel CRNO | 1 x 0.25 mtpy | 1 x 0.25 mtpy | - | 0.495 mtpy |
| 11. | Long mill | - | - | | |
| | - Rebar mill | - | - | 1.2 mtpy | 2.8 |
| | - Wire rod mill | - | - | 0.6 mtpy | |
| | - Medium section Mill | - | - | 1.0 mtpy | |
| 12. | Calcined lime plant | 2 x 600 tpd | 2 x 600 tpd | 2 x 600 tpd | 0.972 |
| 13. | Calcined dolo plant | 1 x 600 tpd | - | | 0.134 |
| 14. | Oxygen plant | 2 x 2100 tpd | 2 x 2100 tpd | 2 x 2100 tpd | |
| 15. | Tar distillation plant | - | - | 0.3 mtpy | |
| 16. | Benzol refining plant | - | - | 0.1 mtpy | |
| 17. | Power plant | 1 x 300 MW | 1 x 300 MW | 1 x 300 MW | |
| 18. | Portland slag cement plant | 1 x 3.75 mtpy | 1 x 3.75 mtpy | - | 7.5 mtpy |
| 19. | Pozzolona Portland cement | 1 x 1.25 mtpy | 1 x 1.25 mtpy | - | 2.5 mtpy |

## 3.2 Product Basket

The broad product-mix of the plant has been envisaged based on future market demands, JSWS's presence in the respective product-mix and net sales realisation from the products. The saleable product-mix envisaged for the plant is presented in Table 2.

**TABLE 2 – BROAD PRODUCT-MIX**
(million tons)

| Sl. no. | Product | Deficit quantity in 2030-31 | Production envisaged |
|---|---|---|---|
| **A.** | **Flat** | | |
| 1. | HR coil/sheets/strips | 20.5 | 3.60 |
| 2. | CR coils/sheets | 26.5 | 3.88 |
| 3. | Electrical steel | NIL | 0.49 |
| 4. | Tinplate | 1.0 | 0.455 |
| 5. | Plate | 4.8 | 1.18 |
| **B.** | **Long** | | |
| 1. | Rebars | 43 | 1.20 |
| 2. | Wire rod | | 0.60 |
| 3. | Medium sections | 3.8 | 1.00 |

## 4.0 ANNUAL REQUIREMENT OF MAJOR RAW MATERIALS

The gross procurement of major raw materials after Phase-III along with the mode of transport is presented in Table 3.

**TABLE 3 – ANNUAL REQUIREMENTS OF MAJOR RAW MATERIALS**

| Sl. no. | Major raw materials | Estimated quantity, tons | Mode of transport |
|---|---|---|---|
| 1. | Coking Coal and Pet Coke | 7,831,900 | Sea |
| 2. | Anthracite | 192,000 | Sea |
| 3. | Iron ore (Lump) | 1,187,900 | Rail (50%)/ Road (50%) |
| 4. | Iron ore concentrate | 30,000,000 | Slurry Pipeline from Joda Plant |
| 5. | Iron ore fines | 4,695,300 | Rail |
| 6. | PCI coal | 2,700,000 | Sea |
| 7. | Limestone | 4,934,500 | Sea (50%)/ Rail (40%)/ Road (10%) |
| 8. | Dolomite | 2,350,100 | Sea (15%)/ Rail (70%)/ Road (15%) |
| 9. | Steam coal | 2,700,000 | Rail |
| 10. | Bentonite | 320,000 | Sea |
| 11. | Quartzite | 270,000 | Sea (10%)/ Rail (50%)/ Road (40%) |
| 12. | Clinker | 5,116,000 | Sea |
| 13. | Gypsum | 232,000 | Rail 50%)/ Road (50%) |

## 5.0 POWER SCENARIO

The phase-wise power requirement and generation are given in Table 4. The required power for proposed plant will be supplied by captive power generation system and grid power supply system.

**TABLE 4 – POWER BALANCE**

| | Phase-I | Phase-II | Phase-III |
|---|---|---|---|
| Max demand of proposed plant in MW | 646 | 1,076 | 1,230 |
| In-plant generation in MW | 306 | 612 | 918 |
| Drawal of power from Grid when all the generators are working: | | | |
| - In MW | 340 | 464 | 312 |
| - In MVA at 0.9 p.f | 378 | 516 | 347 |
| Drawal of power from Grid during outage of one 300 MW generator: | | | |
| - In MW | 610 | 734 | 582 |
| - In MVA at 0.9 p.f | 678 | 816 | 647 |

## 6.0 BY-PRODUCT FUEL GAS SCENARIO

The steel plant will generate large quantities of by-product fuel gases, i.e. Blast Furnace (BF) gas, Coke Oven (CO) Gas and LD Gas (Converter Gas). These by-product fuel gases will be first utilised as fuel for various heating applications (BF stove heating, coke oven under-firing, various mill furnaces, sinter plant etc.) of the steel plant. Balance available gases will be utilised for steam and power generation in the power plant.

The by-product fuel gas generation and consumption figures for the project are given in Table 5.

**TABLE 5 – BY-PRODUCT GAS GENERATION AND CONSUMPTION**
(Cumulative, N cu m/hr)

| By-product gases | Generation | | | Consumption | | |
|---|---|---|---|---|---|---|
| | Phase-I | Phase-II | Phase-III | Phase-I | Phase-II | Phase-III |
| BF gas | 776,800 | 1,553,600 | 2,330,400 | 647,400 | 1,134,400 | 1,676,300 |
| CO gas | 153,200 | 229,800 | 306,400 | 105,200 | 182,900 | 290,500 |
| LD gas | 39,500 | 79,000 | 124,900 | 198 | 395 | 625 |

## 7.0 OXYGEN REQUIREMENT

The requirement of oxygen, nitrogen and argon are as given in Table 6. Accordingly, the capacity of air separation plant in different phases has been designed.

**TABLE 6 – REQUIREMENT OF OXYGEN, NITROGEN AND ARGON**
(Cumulative, N cu m/hr)

| Consumers | Phase-I | Phase-II | Phase-III |
|---|---|---|---|
| **Consumption of oxygen** | | | |
| BF plants | 48,000 | 96,000 | 144,000 |
| SMS (Including casters) | 37,000 | 74,000 | 111,000 |
| DR plant | - | - | 11,000 |
| WRM | - | - | 70 |
| Rebar mill | - | - | 140 |
| HSM | 180 | 360 | 540 |
| MSM | - | - | 120 |
| **Consumption of nitrogen** | | | |
| BF plant | 4000 | 8000 | 12000 |
| SMS (Including casters, RH degassers, LF etc.) | 30,000 | 60,000 | 90000 |
| DR plant | - | - | 2,000 |
| HMDP | 220 | 440 | 660 |
| Rebar mill | - | - | 270 |
| HSM | 2700 | 5400 | 8,100 |
| WRM | - | - | 2700 |
| MSM | - | - | 65 |
| **Consumption of argon** | | | |
| SMS (including casters, RH degassers etc.) | 800 | 1,600 | 2400 |

## 8.0 WATER REQUIREMENT

It is estimated that the total raw water quantity for Phase-I, II and III will be about 3,900 cu m/hr, 6,740 cu m/hr and 9,300 cu m/hr respectively.

## 9.0 MANPOWER REQUIREMENT

The total manpower requirement on pay roll for the project will be about 5,000, 8,500 and 12,000 after Phase-I, Phase-II and Phase-III respectively.

## 10.0 COST AND FINANCIALS

The cost estimates are based on price levels, taxes & duties and exchange rates prevailing during 4th quarter of FY 2020-21. The estimated capital cost of the project is given in Table 9.

### TABLE 9 – PHASE WISE CAPITAL COST

| Sl. no. | Description | Phase-I, Rs. crore | Phase-II, Rs. crore | Phase-III, Rs. crore | Total, Rs. crore |
|---|---|---|---|---|---|
| **A.** | **Plant Cost** | | | | |
| | Land and land development | 487.2 | 16.2 | 12.3 | 515.6 |
| | Civil and structural steelwork | 6,920.5 | 4,650.2 | 5,226.6 | 16,797.3 |
| | Plant & Equipment as erected | 19,161.2 | 13,317.8 | 13,249.9 | 45,728.9 |
| | Infrastructure facilities | 150.1 | - | - | 150.1 |
| | DE&ADC | 1,176.3 | 798.4 | 811.0 | 2,785.8 |
| | Contingency | 1,382.4 | 939.1 | 965.0 | 3,286.5 |
| | **Total (A)** | **29,277.7** | **19,721.7** | **20,264.8** | **69,264.3** |
| | | | | | |
| **B.** | **Other Costs** | | | | |
| | Margin money | 1,165.6 | - | - | 1,165.6 |
| | Preliminary and Pre-operative Expenses | 162.1 | 105.2 | 108.1 | 375.3 |
| | Interest during construction (IDC) | 1,807.3 | 1,207.7 | 1,245.4 | 4,260.4 |
| | **Total (B)** | **3,135.0** | **1,312.9** | **1,353.5** | **5,801.4** |
| | | | | | |
| **C.** | **Capital Cost (Gross of Input Tax)** | **32,412.8** | **21,034.5** | **21,618.3** | **75,065.6** |
| | | | | | |
| D. | Input Tax Credit | 4,257.3 | 2,861.9 | 2,946.5 | 10,065.7 |
| | | | | | |
| **E.** | **Capital Cost (Net of Input Tax)** | **28,155.5** | **18,172.7** | **18,671.8** | **65,000.0** |

The production build-up for the facilities for expansion project has been considered as below:

| | Comm. period | Duration | Production Build-up | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (months) | (months) | 1st yr | 2nd yr | 3rd yr | 4th yr | 5th yr | 6th yr | 7th yr | 8th yr | 9th yr |
| **Phase-I** | 0-36 | 36 | 80% | 90% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Phase-II** | 25-60 | 36 | | | 80% | 90% | 100% | 100% | 100% | 100% | 100% |
| **Phase-III** | 49-84 | 36 | | | | | 80% | 90% | 100% | 100% | 100% |

The cumulative annual manufacturing expenses after each phase in the first year of rated operation of each phase have been worked out under the four heads, viz. input materials, manpower, other conversion costs and overheads. Based on this, the cumulative annual manufacturing expenses in the year of stabilised operation after each phase are given in Table 10.

**TABLE 10 – CUMULATIVE ANNUAL MANUFACTURING EXPENSES AT STABILISED YEAR OF OPERATION AFTER EACH PHASE**

| Sl. no. | Item | Phase-I, Rs. crore | Phase-II, Rs. crore | Phase-III, Rs. crore |
|---|---|---|---|---|
| A. | Input material | 21,355.9 | 27,902.4 | 34,184.0 |
| B. | Salaries and wages | 841.8 | 1,434.0 | 2,035.7 |
| C. | Other conversion cost | | | |
| | - Power | 1,390.2 | 2,383.7 | 2,914.6 |
| | - Purchased Fuel (Propane) | 314.4 | 628.8 | 1,127.8 |
| | - Consumables | 3,395.6 | 6,624.2 | 7,464.9 |
| | - Refractories | 187.0 | 372.4 | 580.8 |
| | - Water | 120.9 | 120.9 | 122.2 |
| | - Repair & Maintenance | 526.4 | 891.7 | 1,255.2 |
| D. | Overheads | 294.3 | 508.0 | 701.9 |
| | **Total** | **28,426.5** | **40,866.3** | **50,387.1** |

The net sales realisations, cumulative annual sales quantity and amount of annual sales realisations of salable finished products in the year of stabilised operation after each phase have been indicated in Table 11.

## TABLE 11 – ANNUAL SALES REALISATION

| Sl. no. | Salable products | NSR, Rs./ton | Salable qty | | | Amount | | |
|---|---|---|---|---|---|---|---|---|
| | | | Phase-I, ton p.a. | Phase-II, ton p.a. | Phase-III, ton p.a. | Phase-I, Rs. crore | Phase-II, Rs. crore | Phase-III, Rs. crore |
| 1 | HRC | 37,427 | 1,494,000 | 2,988,100 | 3,610,100 | 5,591.5 | 11,183.4 | 13,511.4 |
| 2 | Tinplate coil | 47,173 | 227,760 | 455,520 | 455,520 | 1,074.4 | 2,148.8 | 2,148.8 |
| 3 | CRCA coils | 42,779 | 972,500 | 1,944,000 | 1,944,000 | 4,160.3 | 8,316.3 | 8,316.3 |
| 4 | Colour coated | 49,173 | 497,500 | 995,000 | 995,000 | 2,446.4 | 4,892.8 | 4,892.8 |
| 5 | Galvanized | 47,173 | 522,625 | 1,044,250 | 1,044,250 | 2,465.4 | 4,926.1 | 4,926.1 |
| 6 | Silicon steel | 47,173 | 247,500 | 495,000 | 495,000 | 1,167.5 | 2,335.1 | 2,335.1 |
| 7 | Plates | 37,193 | - | - | 1,183,000 | - | - | 4,399.9 |
| 9 | Rebar | 36,308 | - | - | 1,200,000 | - | - | 4,356.9 |
| 10 | Wire rod | 36,988 | - | - | 599,400 | - | - | 2,217.0 |
| 11 | Medium sections | 32,908 | - | - | 1,007,000 | - | - | 3,313.9 |
| 13 | Iron ore concentrate | 3,086 | 14,448,000 | 6,672,000 | - | 4,457.9 | 2,058.6 | - |
| 14 | Pellet | 5,801 | 14,011,700 | 15,220,400 | 14,811,200 | 8,128.6 | 8,829.8 | 8,592.4 |
| 15 | DRI | 17,234 | - | - | 378,000 | - | - | 651.4 |
| 17 | Cement | 3,740 | 5,000,000 | 10,000,000 | 10,000,000 | 1,870.0 | 3,740.0 | 3,740.0 |
| 18 | **Crude tar distillation** | | | | | | | |
| 19 | - DNO | 18,000 | - | - | 1,100 | - | - | 2.0 |
| 20 | - Napthalene | 29,400 | - | - | 8,100 | - | - | 23.8 |
| 21 | - Pitch | 18,000 | - | - | 72,800 | - | - | 131.0 |
| 22 | - PCM | 18,000 | - | - | 164,700 | - | - | 296.5 |
| 23 | - Creosote | 18,000 | - | - | 5,400 | - | - | 9.7 |
| 24 | - Anthracene Oil | 19,250 | - | - | 5,400 | - | - | 10.4 |
| 25 | - Road Tar | 17,500 | - | - | 12,200 | - | - | 21.4 |
| 26 | - Wash oil | 19,600 | - | - | 300 | - | - | 0.6 |
| 27 | - Crude Tar | 17,500 | 135,000 | 202,500 | - | 236.3 | 354.4 | - |
| 28 | Sulphur | 2,000 | 6,000 | 9,000 | 12,000 | 1.2 | 1.8 | 2.4 |
| 29 | **Benzole refining plant** | | | | | | | |
| 30 | - N G Benzene | 33,460 | - | - | 43,900 | - | - | 146.9 |
| 31 | - N G Toluene | 36,820 | - | - | 7,600 | - | - | 28.0 |
| 32 | - Xylene | 39,200 | - | - | 1,100 | - | - | 4.3 |
| 33 | - Crude benzol | 27,300 | 36,000 | 54,000 | - | 98.3 | 147.4 | - |
| 34 | LD slag | 200 | 591,400 | 1,231,900 | 2,023,500 | 11.8 | 24.6 | 40.5 |
| 37 | BF coke | 23,843 | 1,120,400 | 784,600 | 435,100 | 2,671.3 | 1,870.7 | 1,037.4 |
| 38 | Coke breeze | 10,950 | - | - | 13,815 | - | - | 15.1 |
| 39 | Iron scrap | 12,500 | 35,500 | 71,000 | 106,071 | 44.4 | 88.8 | 132.6 |
| 40 | Steel scrap | 24,000 | - | - | 12,511 | - | - | 30.0 |
| | **Total** | | | | | **34,425.3** | **50,918.6** | **65,334.5** |

The financial highlights in the stabilised year of production of the project after each phase are presented in the Table 12.

**TABLE 12 – FINANCIAL HIGHLIGHTS IN THE STABILISED YEAR OF OPERATION AFTER EACH PHASE**

| Description | After Phase-I, Rs. crore | After Phase-II, Rs. crore | After Phase-III, Rs. crore |
|---|---|---|---|
| Annual sales realisation | 34,425.3 | 50,918.6 | 65,334.5 |
| Annual generating expenses | 28,426.5 | 40,866.3 | 50,387.1 |
| Gross profit before interest, depreciation & tax | 5,998.8 | 10,052.3 | 14,947.4 |
| Interest | 1,710.4 | 2,047.0 | 1,873.8 |
| Depreciation & Amortisation | 1,167.9 | 2,004.0 | 2,901.7 |
| Profit before income tax | 3,120.5 | 6,001.3 | 10,171.9 |
| Provision for income tax | 672.4 | 1,293.2 | 2,191.9 |
| Profit after income tax | 2,448.0 | 4,708.1 | 7,979.9 |

The salient financial indicators for the three phases of the project are given in Table 13.

**TABLE 13 – FINANCIAL INDICATORS**

| Sl. no. | Item | After Phase-I | After Phase-II | After Phase-III |
|---|---|---|---|---|
| A. | Internal rate of return (post tax), % | 11.7% | 12.0% | 12.6% |
| B. | Payback period, years | 7.5 | 8.1 | 8.6 |
| C. | Debt Service Coverage Ratio (DSCR) | 1.9 | 2.1 | 2.4 |
| D. | Breakeven capacity utilisation, % | 57.9% | 54.4% | 48.9% |
| E. | Cash breakeven capacity utilisation, % | 42.1% | 38.5% | 33.4% |

Based on the technical and financial review carried out in this Report, it is concluded that the project is techno-economically viable and merits consideration for detailed study before implementation.

# 1 - INTRODUCTION

## 1.1 BACKGROUND

JSW Steel (JSWS) is the flagship company of JSW Group and one of India's leading integrated steel producers, with a total installed capacity of around 18 million tons per year (mtpy). At present, JSWS operates the following Integrated Steel Plants (ISPs) in India:

a) 12 mtpy plant at Vijaynagar, Karnataka,
b) 5 mtpy plant at Dolvi, Maharashtra and
c) 1 mtpy plant at Salem, Tamil Nadu.

JSW Utkal Steel Limited (JSWUSL), a subsidiary of JSW, is contemplating setting up a green field ISP with a capacity of about 13.2 mtpy crude steel, at a site already identified by JSWS near the coast in Jagatsinghpur district of Odisha.

The iron ore concentrate from Joda/Nuagaon grinding and desliming plant will be transported to Jagatsinghpur ISP area through single slurry pipeline. The slurry will be received and de-watered at de-watering station located at Jagatsinghpur ISP area. The concentrate will be fed to ISP pellet plants at Jagatsinghpur ISP area. The excess pellets after meeting the requirement of blast furnaces and direct reduction plant at ISP will be transferred to other JSWS plants or sold. The overall concept of proposed project is shown in Fig. 1-1. The project details are given in subsequent chapters.

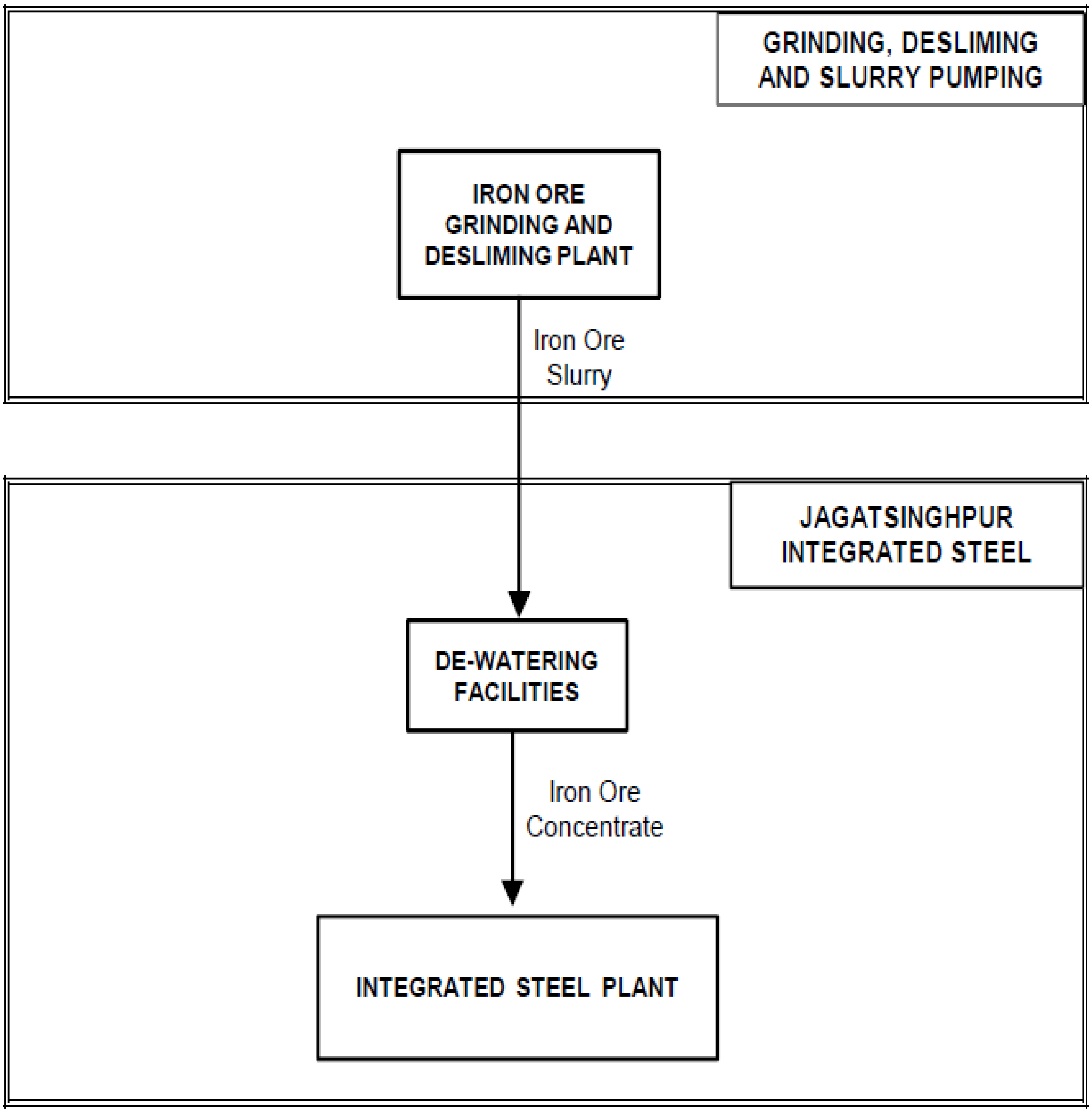



**FIG. 1-1 – OVERALL PROJECT CONCEPT**

## 1.2 AUTHORISATION

JSWS, vide Contract #JSW/VJNR/CODISHA/TEFR/001 dated 27th September 2017, authorised M. N. Dastur & Company (P) Ltd (CONSULTING ENGINEERS) to prepare a bankable Techno-Economic

Feasibility Report (TEFR) for a 13.2 mtpy port based greenfield integrated steel plant and 900 MW captive power plant.

## 1.3 MARKET STUDY NOTE

As per the terms of reference of the Contract #JSW/VJNR/C/ODISHA/TEFR/001 dated 27th September 2017, on 1st November 2017 DASTUR had submitted a note on Market Study. The findings of the Market Study Note were utilised for preparation of this TEFR.

## 1.4 PROJECT CONCEPT NOTE

As per the terms of reference of the Contract# JSW/VJNR/C/ODISHA/TEFR/001 dated 27th September 2017, on 3rd August 2018, DASTUR had submitted the Project Concept Note. The findings of the Project Concept Note have been utilised for preparation of the TEFR.

## 1.5 STRUCTURE OF THE TEFR

The TEFR shall cover the following:

Executive Summary
Chapter 1 - Introduction
Chapter 2 - Project Concept
Chapter 3 - Plant Location and Layout
Chapter 4 - Raw Materials
Chapter 5 - Major Plant Facilities
Chapter 6 - Utilities and Service Facilities
Chapter 7 - Environmental Pollution Mitigation Measures
Chapter 8 - Manpower

Chapter 9 - Plant Construction and Implementation Schedule

Chapter 10 - Cost and Profitability

## 1.6 ACKNOWLEDGEMENT

CONSULTING ENGINEERS gratefully acknowledge the co-operation and assistance extended by the officials of JSW during the site visit and several discussions for the preparation of the TEFR.

# 2 - PROJECT CONCEPT

The plant capacity, product basket and configuration have already been discussed in Project Concept Note submitted to JSWS. However, for ease in reading the TEFR, the same have been enumerated again below:

## 2.1 PLANT CAPACITY

The production capacity of the plant has been envisaged based on the following:

a) Indigenous available iron ore as well as other raw materials.

b) Available infrastructure facilities.

c) Land area.

d) Likely future market.

e) Profitability.

f) Experience of operating large capacity steel plant.

Based on all the above factors, the production capacity of the major facilities envisaged are as follows:

| | | |
|---|---|---|
| Hot metal, mtpy | .. | 13.5 |
| DRI, mtpy | .. | 1.2 |
| Liquid steel, mtpy | .. | 13.5 |
| Crude steel, mtpy | .. | 13.2 |
| Flat products (HRC/plate)/CR annealed and galvanised, coated products, CRNO silicon steel), mtpy | .. | 9.7 |
| Long products (bar/wire rod/medium sections), mtpy | .. | 2.8 |

## 2.2 PRODUCT BASKET

The broad product-mix of the plant has been envisaged based on the following factors:

a) Future market demands.
b) JSWS's presence in the respective product-mix.
c) Net sales realisation from the products.

The market study report has been prepared after making suitable adjustment to the demand forecast made in the National Steel Policy (NSP), taking into consideration the present and future scenario. Based on these factors an overall steel demand of 185 mtpy has been worked out for 2030-31 against a demand forecast of 230 mtpy in the NSP.

The additional capacity requirement has been worked out considering a reasonable capacity utilisation factor. The saleable product-mix envisaged for the plant is presented in Table 2-1.

**TABLE 2-1 – BROAD PRODUCT-MIX**
(million tons)

| Sl. no. | Product | Deficit quantity in 2030-31 | Production envisaged |
|---|---|---|---|
| **A.** | **Flat** | | |
| 1. | HR coil/sheets/strips | 20.5 | 3.60 |
| 2. | CR coils/sheets | 26.5 | 3.88 |
| 3. | Electrical steel | NIL | 0.49 |
| 4. | Tinplate | 1.0 | 0.455 |
| 5. | Plate | 4.8 | 1.18 |
| **B.** | **Long** | | |
| 1. | Rebars | 43 | 1.20 |
| 2. | Wire rod | | 0.60 |
| 3. | Medium sections | 3.8 | 1.00 |

As may be seen from the above except CRNO, all other grades are envisaged to have adequate additional capacity requirement. CRNO is a value added steel with high NSR and its demand is worked out to about 720,000 tpy in 2030-31. RSP (SAIL) has an installed capacity of 75,000 tpy while the other units, which are mostly secondary producers, are either in the project stage or are yet to stabilize their commercial production. JSWS's CRNO, with assured supply of HRC at lower cost, is expected to be competitive in the domestic market.

### 2.2.1 Product-mix

The product-mix envisaged from the plant and the respective input semis required are discussed hereunder.

### 2.2.2 Hot Strip Mill

***Input:*** Continuous cast slab will be used as input for the hot strip mill.

| | | |
|---|---|---|
| Width, mm | .. | 800-2100 |
| Thickness, mm | .. | 230[1] |
| Length, mm | .. | 11,000 |
| Slab weight (max), ton | .. | 40 |

**Note:**

(1) HSM will be designed for 230 to 250 mm thick slabs.

***Grades of steel:*** The HSM will be designed for rolling low, medium and high carbon steels; API X-80 steel; IF; dual phase and multi-phase steels; high strength low alloy steel and silicon steel (non-grain oriented).

***Finished product:*** The HR coil size will be as follows:

| | | |
|---|---|---|
| Width, mm | .. | 800-2100 |
| Thickness, mm | .. | 1.2-25 |
| Coil weight (max), ton | .. | 40 |

### 2.2.3 Plate Mill

***Input material:***

| | | |
|---|---|---|
| Material | .. | Continuous cast slabs |
| Thickness, mm | .. | 230, 250, 300[(1)] |
| Width, mm | .. | 1,200-2,600 |
| Length, mm | .. | 2,500-4,800 |

**Note:**

(1) Plate mill will be designed for slabs of thickness 180 mm to 300 mm.

***Grades of steel:*** The plate mill will be designed for rolling structural, boiler quality, ship building, pressure vessel, API up to X-100, high tensile steel.

**Finished material:**

| | | |
|---|---|---|
| Material | .. | Finished plate |
| Thickness, mm | .. | 5-100 |
| Width, mm | .. | 1,500-4,800 |
| Length, m | .. | 6–24 |
| Plate weight (max), ton | .. | 30 |

### 2.2.4 Cold Rolling Complex

The product envisaged from the cold rolling complex are as follows:

a) Continuous annealed coil (CRCA).
b) Galvanising coil/sheets.
c) Colour coated coil.
d) Tin plated coil.
e) Silicon steel coil (CRNO).

***Input material:*** The size range and weight of the HR coils for CRM complex are envisaged as follows:

| | | |
|---|---|---|
| Strip width, mm | .. | 800-1,890 |
| Strip thickness, mm | .. | 2.0-6.0 |
| Coil weight, tons | .. | 38 (max.) |

***Output material:*** The size range and weight of the output CR coils for CRM complex are envisaged as follows:

**Output coil size of CRCA:**

| | | |
|---|---|---|
| Strip width, mm | .. | 750-1,850 |
| Strip thickness, mm | .. | 0.3-3.2 |
| Coil weight, ton | .. | 38 (max.) |

**Output coil size of galvanizing coil:**

| | | |
|---|---|---|
| Strip width, mm | .. | 750-1,850 |
| Strip thickness, mm | .. | 0.28-3.2 |
| Coil weight, tons | .. | 38 (max.) |
| Range of coating (both sides together), gm/sq m | .. | 70-450 |

**Output coil size of tin plated coil:**

| | | |
|---|---|---|
| Strip width, mm | .. | 850-1,250 |
| Strip thickness, mm | .. | 0.35-0.65 |
| Coil weight, tons | .. | 25 (max.) |
| Electrical insulation solution varnish | .. | As per ASTM |

### 2.2.5 Rebar Mill

***Input:*** Continuously cast billets will be used as input to the rebar mill:

| | | |
|---|---|---|
| Section, mm | .. | 160 x 160 |
| Length, mm | .. | 12,000 |

***Finished product:*** Output from rebar mill will be as follows:

| | | |
|---|---|---|
| Size | .. | 10-40 mm dia rebars |
| Cut to length | .. | 6-12 m |

***Grades of steel:*** The mill will roll construction grade steel. The mill will be designed to achieve finished product tolerances equivalent to DIN 488/IS 1786. The average material yield will be 96 per cent.

### 2.2.6 Wire Rod Mill

***Input:*** Continuously cast billets will be used as input to the WRM:

| | | |
|---|---|---|
| Section, mm | .. | 160 x 160 |
| Length, mm | .. | 12,000 |

***Finished product:***

| | | |
|---|---|---|
| Size (dia), mm | .. | 5.5-20 |

***Grades of steel:*** The mill will roll low, medium, high carbon steel, including special steels such as CHQ, spring steel, electrode steel, bearing steel, case hardening, tyre bead, etc. It will also be designed with facilities for thermo-mechanical rolling of billets.

### 2.2.7 Medium Section Mill

***Input:*** The input semis for the medium section mill come from the billet cum bloom-cum-beam blank caster. The size of input bloom/beam blanks to the mill will be as follows:

| | | |
|---|---|---|
| Bloom, mm | .. | 270 x 155 (322 kg/m) |
| Beam blank, mm | .. | 346 x 265 x 70 (420 kg/m) |
| | | 390 x 320 x 100 (645 kg/m) |

***Finished product:*** The list of finished sections is as given below:

a) HE 100-280 mm (A, B, M)
b) IPE 120-550 mm, 600 mm
c) Channel 100-400 mm
d) Equal angle L120-200 mm
e) Unequal angle 100-200 mm

***Grades of steel:*** The steel grades to be rolled in the mill will be S235, S275, S355, S460, A 36-Gr.65.

## 2.3 PHASED CAPACITY BUILD-UP

### 2.3.1 Capacity Build-up and Plant Configuration

The entire plant of 13.2 mtpy capacity crude steel is envisaged to be built over multiple phases. This will mitigate the difficulty and complexities of management and construction involved in installation of a plant of such large capacity in a single phase. Also, capacity build-up in multiple phases will ensure distribution of the expenditures over a longer time period, so that the earnings from the previous phase/phases being available for utilisation in the subsequent phase, resulting in a healthy financial reconciliation. Accordingly, the distribution of phases has been conceptualised based on the following considerations:

a) Saleability of the products.

b) The profitability at each phase.

c) Even distribution of steel production to the extent possible.

***Phase-I:*** The total capacity of 13.2 mtpy has been envisaged to be built in three phases with one blast furnace installed in each phase. The sinter plant has been envisaged to be installed in Phase-I along with two pellet plants.

The product-mix in Phase-I has been envisaged to be flat products, with part HRC and value addition of the balance through cold rolling complex. Commensurate with the product-mix, SMS-1 to be installed in Phase-I will have two 350-ton converters, required secondary metallurgy units and two twin strand slab casters. SMS-1 will consume the entire hot metal produced from the blast furnace and produce about 4.15 mtpy slabs. Although the shop will have an inherent capacity more than the above, production will be commensurate with the available hot metal.

The rolling facilities will comprise one HSM and one cold rolling complex. The proposed facilities in Phase-I and the corresponding production from each unit are given in Appendix 2-1.

***Phase-II:*** The second of the three blast furnaces will be installed in the second phase with another pellet plant, with a total hot metal capacity of 9 mtpy.

The third line of converter, secondary metallurgy and caster will be added in SMS-1 to complete the facilities of the shop. The production from the shop is envisaged to be about 8.37 mtpy slabs. Even in Phase-II, SMS-1 will not be able to realise its full potential due to restriction of hot metal availability.

The second HSM and the second cold rolling complex will be added in Phase-II. The facilities added in Phase-II, along with the facilities already installed in Phase-I, and the corresponding production from each unit after Phase-II is given in Appendix 2-2.

***Phase-III:*** The entire capacity of the plant will be built up in this phase. The 3rd blast furnace will be installed along with the fourth pellet plant. The DR unit will also be installed in Phase-III.

This phase will be mainly built for diversification of product basket along long products line. Rebars, wire rods and medium sections have been envisaged as the major long products. In order to cater to this product-mix, SMS-2 will be installed with two 180-ton converters, matching secondary metallurgy units and two long casters, with provision for producing 2.9 mtpy billets, blooms and beam blank as long product semis.

SMS-1 will realise its full capacity in Phase-III, producing about 10.3 mtpy slabs.

In Phase-III, the flat products basket will be enhanced with the installation of a plate mill. This will enable JSWS to better cater to the changing market demands.

With regard to long products, one rebar mill, one wire rod mill and one medium section mill will be installed in Phase-III. The facilities added in Phase-III, along with the facilities of Phase-I and Phase-II, and the corresponding production from each unit after Phase-III are given in Appendix 2-3.

## 2.4 PLANT MATERIALS FLOW SHEET

The plant materials flow sheets of each of Phase-I, Phase-II and Phase-III are given in Drawing 11467-02-0001, 11467-02-0002 and 11467-02-0003 respectively.

# 3 - PLANT LOCATION AND LAYOUT

This Chapter presents the information on the plant site such as location, land availability, site features and existing infrastructure such as rail and road linkages, port facilities, sources of water and power. This chapter also presents the salient features of the plant general layout.

## 3.1 PLANT SITE

JSWUSL has identified a location for setting up of the greenfield project to produce 13.2 mtpy crude steel within the jurisdiction of Ershma Tehsil of Jagatsinghpur district near Paradeep of Odisha. The plant will be developed phasewise. The location of site is shown in Fig. 3-1.

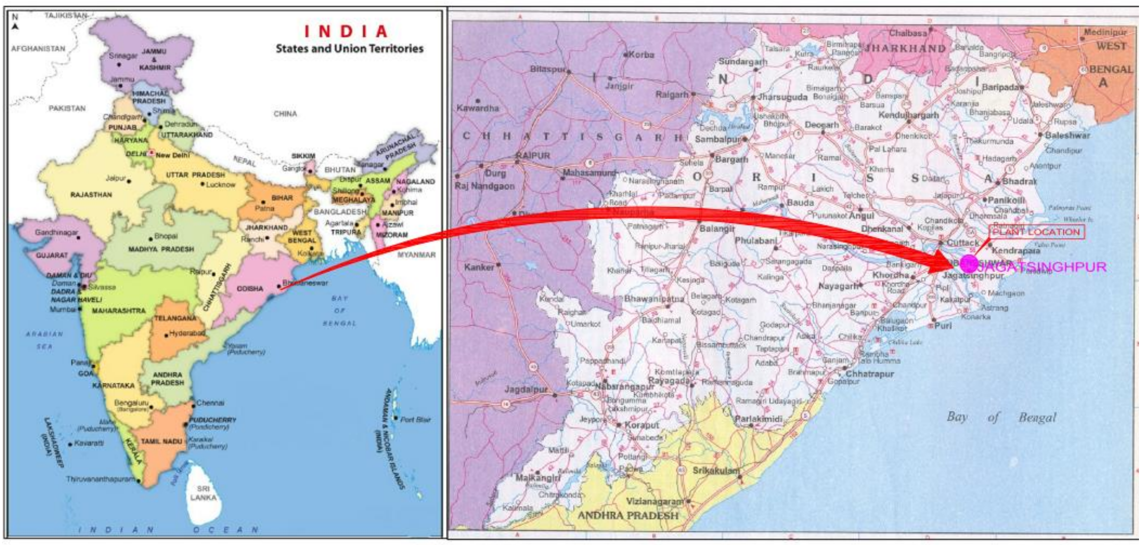



**FIG. 3-1 – SITE LOCATION**

National Highway NH-53 connecting Paradeep and Chandikhol road and State Highway SH-12 connecting Cuttack and Paradeep road are at the north side of the proposed site. Jatadhar Mohan River is passing close to the proposed site and drained into Bay of Bengal at the south east of proposed site. The Jatadhar Mohan river witnesses the tidal influence of the Bay of Bengal and therefore it attracts CRZ notification dated 1991 and as amendment in 2011. IOCL is located to the north of the proposed site.

The villages within the selected site near Paradeep are Polanga, Gobindapur, Dhinkia, Nuagaon, Polonga, Jatadhara, Bayanala Kandha, Noliasahi, all in Ershma Tehsil of Jagatsinghpur district.

### 3.1.1 General Information of Plant Site

| | | |
|---|---|---|
| Approximate geo co-ordinates | .. | The tentative coordinate of the plant site is 20°13' N/86°33' E |
| Total land (approx.) | .. | 2,780.58 acre has been earmarked for the proposed ISP and 169.73 acre for Captive Jetty. The land boundary of proposed site along with the proposed water front line for captive jetty, being done by other agency, has been provided by JSWUSL. |
| Nearest highway | .. | Nearest National Highway is NH53 connecting Paradeep - Chandikhol road and State Highway SH12 connecting Cuttack-Paradeep Road are located at the northern side of site. |

| | | |
|---|---|---|
| Nearest railway station | .. | Paradeep Railway Station, Bagadia PH station, Badabandha Road Railway station and Siju station under East Coast Railway about 8 to 10 km away from proposed site. Paradeep-Cuttack railway connectivity is existing and Haridaspur-Paradeep connectivity is in advanced stage. |
| Nearest seaport | .. | Paradeep sea port about 12 km from proposed site towards north. |
| Nearest airport | .. | Bhubaneswar Airport. |

### 3.1.2 Land and Terrain

Existing ground level is lower than the flood level. Hence, the land for the proposed steel plant is to be developed to have higher finished ground level (FGL). The chart datum (CD) at Paradeep port and IOCL complex are (+) 5.5 m and (+) 6 m respectively. FGL of the proposed site is suggested at CD (+) 6.5 m, which is (+) 8.16 m from Mean Sea Level (MSL). The fill materials are planned to be made available from the dredging of Jatadhar Mohan River, required for building the captive jetty.

## 3.2 INFRASTRUCTURE

### 3.2.1 Water

Jobra barrage of Mahanadi River near Cuttack has been identified as the source of raw water for the proposed Steel Plant. It would be required to lay 87 km long pipeline to bring water from upstream of Jobra barrage to the plant. Water will be supplied to a small reservoir inside the plant premises.

### 3.2.2 Electric Power

The required power for proposed plant will be supplied by both the following power sources:

a) Captive power generation system.
b) Grid power supply system.

## 3.3 PLANT GENERAL LAYOUT

The plant facilities for about 13.2 mtpy crude steel capacity with diverse and value added product-mix, and supplementary facilities for utilising by-products and waste are accommodated within the land boundary of approx 2780.58 acre furnished by JSWUSL including necessary greenbelt.

The plant will be developed phasewise. Following major units have been considered for developing the plant general layout Drawing 11467-03-0001:

a) Dewatering facility for Iron ore concentrate.

b) Pellet plant.

c) Coke oven.

d) Sinter plant.

e) Blast furnace.

f) DR plant.

g) Steelmelt shop.

h) Hot strip mill.

i) Cold rolling mill complex.

j) Lime and dolo calcining plant.

k) Oxygen plant.

l) Billet, boom & slab caster.

m) Plate mill.

n) Long mill (Rebar mill, wire rod mill, medium section mill).

o) Cement plant.

p) Captive power plant.

The basic parameters which have been taken into consideration for developing the plant general layout are as follows:

a) The plant facilities including green belt envisaged upto 13.2 mtpy has been accommodated within the present land boundary of about 2780.58 acres.

b) Logical arrangement of various plant units based on the process flow and functional interdependence of plant units and growth in phases.

c) Unidirectional process flow as far as possible to ensure optimum in-plant movement of materials. Primary objective is to optimise conveyor length, cable length, pipe/duct length, track length at the extent possible.

d) Smooth and uninterrupted receipt and despatch of raw materials and finished products respectively.

e) Two stock yards have been planned, one for Jetty bound material and other for rail bound indigenous materials.

f) Raw water will be brought to the plant from the north side following the common utility corridor and enter the plant from eastern side. A small intermediate raw water reservoir with limited capacity within the plant has been considered. A larger reservoir of adequate capacity, taking the limited supply of raw water during the lean period into consideration, to be built at a suitable location outside the plant.

g) All service lines like gas pipe lines, water pipe lines, power cables etc. will be made through common overhead galleries. For this purpose, provision of space including for expansion has been kept on both the sides of the roads.

h) No plant units have been planned within the present set back line (CRZ) except captive jetty and its related facilities like storage for imported raw materials, railway tracks (non-hot metal) and roads.

i) Greenbelt for 13.2 mtpy stage has been considered within the present available land area keeping the prevailing norms.

j) Generally 20 m wide greeneries have been considered, wherever possible, along the periphery of the present land area expect captive jetty area.

k) Iron ore concentrate will be brought from mines to the plant through pipe line in the form of slurry. The slurry pipeline would enter to the plant from eastern side along railway corridor. In view of that the location of terminal facilities for I/O slurry has been considered.

l) Finishing facilities, i.e., have been placed away from relatively more polluting facilities like raw material storage, sinter plant, pellet plant, coke ovens, coal based captive power plant etc. on the southern side of the plant.

m) Storage space has been considered in all the mills.

n) Railway track connection to mills has been provided.

o) Central despatch yard considered for despatch through rail.

p) For sinter plant, base mix yard has not been considered.

q) Captive coal based power plant with ash pond has been considered close to coal storage area.

r) Metal recovery plant and debris dump for SMS-1 and SMS-2 has been considered at the north side of the plant near Gate-3. So that during the evacuation or dispatch, in-plant vehicle movement has not been disturbed.

s) MRSS (GIS) complex has been considered near western boundary to optimise incoming high tension transmission line and at a moderately central location to optimize further distribution network.

t) ASP has been placed at the southern end of the plant.

u) In order to optimise the length of yard piping, facilities Central effluent treatment plant (CETP), central chilled water plant, compressed air station are proposed to be placed almost at central location in north-south direction.

v) Due to existence of forest land (which could not be acquired) within the proposed site, the length of conveyors and utility galleries to and from jetty side will be more. In addition to that road and rail movement also will be more.

# 4 - RAW MATERIALS

This chapter discusses the annual requirement of major raw materials, quality and indicates their likely sources of supply for meeting the production requirements planned for various units.

## 4.1 ANNUAL REQUIREMENT OF MAJOR RAW MATERIALS

The annual requirements of major raw materials after Phase-III, including moisture, handling and screening losses as applicable, is presented below in Table 4-1. Major raw materials handled would be approximately about 62.36 mtpa and the sea-borne raw materials will be 51.93 mtpa.

**TABLE 4-1 - ANNUAL REQUIREMENTS OF MAJOR RAW MATERIALS – PHASE-III**

| Sl. no. | Major raw materials | Estimated quantity, tons | Mode of transport |
|---|---|---|---|
| 1. | Coking Coal and Pet Coke | 7,831,900 | Sea |
| 2. | Anthracite | 192,000 | Sea |
| 3. | Iron ore (Lump) | 1,187,900 | Rail (50%)/ Road (50%) |
| 4. | Iron ore concentrate | 30,000,000 | Slurry Pipeline from Joda Plant |
| 5. | Iron ore fines | 4,695,300 | Rail |
| 6. | PCI coal | 2,700,000 | Sea |
| 7. | Limestone | 4,934,500 | Sea (50%)/ Rail (40%)/ Road (10%) |
| 8. | Dolomite | 2,350,100 | Sea (15%)/ Rail (70%)/ Road (15%) |
| 9. | Steam coal | 2,700,000 | Rail |
| 10. | Bentonite | 320,000 | Sea |
| 11. | Quartzite | 270,000 | Sea (10%)/ Rail (50%)/ Road (40%) |
| 12. | Clinker | 5,116,000 | Sea |
| 13. | Gypsum | 232,000 | Rail 50%)/ Road (50%) |

## 4.2 IRON ORE

The iron ore concentrate required for the pellet plants is planned to be received from the proposed captive grinding and desliming plant at Joda/Nuagaon through long distance slurry pipelines. The iron ore lump and fines required for blast furnace/SMS and sinter plant respectively, is envisaged to be procured from the major iron ore producers in Joda-Barbil, Koira and Nayagarh mines region. The likely chemical analyses are given in Table 4-2.

**TABLE 4-2 - CHEMICAL COMPOSITION OF IRON ORE**

| Type of ore | Fe, % | $SiO_2$, % | $Al_2O_3$, % | LOI, % |
|---|---|---|---|---|
| Sized iron ore | 64 to 64.5 | 1.5 to 2.0 | 2.0 to 2.5 | 2.0 to 2.5 |
| Iron ore fines | 63.5 to 64.0 | 2.5 to 3.0 | 2.5 to 2.7 | 3.0 to 4.0 |

## 4.3 COAL

### 4.3.1 Coking Coal

It is envisaged that the entire requirement of prime/hard and semi-soft coking coal with low ash content for the steel plant will be met through imports. The possible sources are Mozambique, Australia and Canada. The typical quality of different varieties of coking coal is given below in Table 4-3:

**TABLE 4-3 – TYPICAL QUALITY OF DIFFERENT VARIETIES OF COKING COAL**

| Parameters | Prime/hard coking coal | Semi-soft coking coal |
|---|---|---|
| Ash, % | 8 to 9 | 9 to 10 |
| Volatile matter (VM), % | 21 to 22 | 23 to 27 |
| Sulphur (S), % | 0.6 max. | 0.6 max. |
| Crucible Swelling No (CSN) | 7 to 8 | 4 to 6 |

### 4.3.2 Coal for Injection

Coal with low volatile matter and ash content will be used for pulverised coal injection (PCI) in blast furnace and the same is proposed to be imported from countries like Australia, South Africa and Indonesia. The typical chemical analysis is given below in Table 4-4:

**TABLE 4-4 – TYPICAL CHEMICAL ANALYSIS OF PCI COAL**

| Ash, % | VM, % | FC, % | S, % |
|---|---|---|---|
| 9 to 10 | 18 to 20 | 68 to 70 | 0.6 max. |

### 4.3.3 Anthracite

Anthracite coal will be used in pellet plant. The requirement of same will be met through imports from countries like South Africa, Vietnam and Indonesia. The typical chemical analysis is given in Table 4-5 below:

**TABLE 4-5 – TYPICAL CHEMICAL ANALYSIS OF ANTHRACITE**

| Ash, % | VM, % | FC, % |
|---|---|---|
| 9 to 10 | 8 to 10 | 80 to 84 |

### 4.3.4 Non-Coking Coal for Power Plant

The requirement of non-coking coal for use in the power plant will be met from mines/collieries of Mahanadi Coalfields Limited (MCL) and South Eastern Coalfields Limited (SECL). The typical analysis of non-coking coal is presented in Table 4-6 below:

**TABLE 4-6 – TYPICAL CHEMICAL ANALYSIS OF NON-COKING COAL**

| Non-coking coal | Ash, % | VM, % | FC, % | GCV, kcal/kg |
|---|---|---|---|---|
| Domestic (MCL and SECL) | 50 to 52 | 23 to 25 | 23 to 26 | 3,100 to 3,400 (G-14 grade) |

## 4.4 LIMESTONE

Requirement of BF grade limestone for use in sinter plant and pellet plant will be met through purchases from the quarries located in Jukehi-Katni-Niwar area in Central India or mines located in Bagalkot area, Karnataka. SMS grade limestone for use in calcining plant will be met through imports from Middle East countries (UAE and Oman). The typical chemical analyses of limestone considered for this report is given in Table 4-7 below:

**TABLE 4-7 – TYPICAL CHEMICAL ANALYSIS OF LIMESTONE**

| Item | $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % | LOI, % |
|---|---|---|---|---|---|
| BF grade | 4.0 to 5.0 | 1.5 to 1.7 | 47.0 to 48.0 | 2.5 to 2.8 | 41.0 |
| SMS grade | 0.5 to 0.6 | 0.2 to 0.3 | 54.0 to 54.5 | 1.0 | 43.0 |

## 4.5 DOLOMITE

The entire requirement of dolomite is envisaged to be met through purchases from mines located in Sundargarh district, Odisha as well as from mines in Katni-Bilaspur region, Central India. A typical chemical composition of dololmite considered for this report is given in Table 4-8.

**TABLE 4-8 – TYPICAL CHEMICAL COMPOSITON OF DOLOMITE**

| $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % | LOI, % |
|---|---|---|---|---|
| 1.1 to 1.5 | 0.5 | 28.0 to 30.0 | 19.0 to 20.0 | 45.0 |

## 4.6 QUARTZITE

Quartzite will be used in the blast furnace. It is envisaged that the entire requirement of quartzite will be procured from local sources. A typical chemical analysis of quartzite considered for this report is given in Table 4-9.

**TABLE 4-9 – CHEMICAL COMPOSITION OF QUARTZITE**

| $SiO_2$, % | $Al_2O_3$, % |
|---|---|
| 97.0 | 1.0 |

## 4.7 BENTONITE

The bentonite for use in pellet plant is envisaged to be procured from Gujarat/Rajasthan regions. The typical analysis is given below in Table 4-10:

**TABLE 4-10 – TYPICAL CHEMICAL COMPOSITON OF BENTONITE**

| $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % |
|---|---|---|---|
| 53.0 | 15.0 | 1.6 | 1.5 |

# 5 - MAJOR PLANT FACILITIES

This chapter discusses the major plant facilities, viz. raw materials handling system, pellet plants, sinter plant, DR plant, steelmelt shop, lime calcining plant, rolling mills, cement plant, captive power plant etc. This chapter also describes the facilities of tar distillation and benzol refining plant.

## 5.1 RAW MATERIALS HANDLING SYSTEM

This section describes facilities provided for receipt of raw materials, unloading, storage and stockpiling, reclamation and subsequent distribution of the various raw materials to the different consuming units.

### 5.1.1 Receipt and Unloading of Raw Materials

All imported materials like coking coal, PCI coal, limestone (SMS grade) will be brought to the respective stockyard in plant by conveyor from ship unloading area of the port.

Materials like Iron ore fines, steam coal, lump ore, limestone, and dolomite will be brought to the plant by railway wagons. The rail bound materials will be unloaded by wagon tippler and stored in the storage yard by stacker/reclaimer. All road bound materials like bentonite, dolomite fines will be unloaded in the ground hopper at vicinity of pellet plant for the onward transmission.

Iron ore concentrate will be brought from mines in Joda, Koira and Nayagrah of Odisha region through pipeline. The daily average quantity of raw materials to be handled and their mode of receipt are given in Table 5-1.

**TABLE 5-1 – RECEIPT AND MODE OF TRANSPORT OF MAJOR RAW MATERIALS**

| Unit | Raw materials | Mode of receipt | Gross quantity[1] |
|---|---|---|---|
| | | | Daily, tpd |
| Pellet plant | Iron ore concentrate | Pipeline | 104,624 |
| | Limestone | Rail | 5,048 |
| | Dolomite | Rail | 5,932 |
| | Bentonite | Truck/Road | 1,040 |
| | Anthracite coal | Ship/Conveyor | 650 |
| Sinter plant | Iron ore Fines | Rail | 15,050 |
| | Limestone fines | In-plant | 670 |
| | Dolomite Fines | Truck/Road | 730 |
| Coke oven | Prime/Hard coking coal | Ship/conveyor | 4,860 |
| | Semi soft coking coal | Ship/conveyor | 16,980 |
| | Pet coke | Ship/Road | 2,230 |
| Blast furnace | Iron ore lump | Rail | 3,270 |
| | Quartzite | Truck/Road | 810 |
| | PCI coal | Ship/conveyor | 8,655 |
| SMS 1 & 2 | Iron ore | Rail | 400 |
| | Ferro alloy | Truck/Road | 306 |
| Calcining plant | Limestone | Ship/conveyor | 7,880 |
| | Dolomite | Truck/Road | 1,100 |
| CPP | Steam coal | Rail | 4,610 |

**Note:**

(1) The daily average quantities have been derived considering the following days of working for the process plants:

| | | |
|---|---|---|
| Sinter plant | .. | 330 |
| Blast furnace | .. | 350 |
| Steelmelt shop | .. | 350 |
| Coke Oven | .. | 365 |
| LCP | .. | 330 |

### 5.1.2 Storage and Stockpiles of Raw Materials

For rail bound materials three wagon tipplers will be considered in Phase-I. Raw materials will be unloaded by tippler and stored in the storage yard with the help of stacker/reclaimer. One more wagon tippler will be considered in Phase-II.

It is envisaged to consider twenty days storage for imported material and ten days storage for indigenous materials. PCI and coking coal will be unloaded from ship and will be conveyed through conveyor to the respective stock yard, and stored with the help of stacker/reclaimer. A storage capacity of twenty days for PCI and coking coal has been considered.

Fines/sized limestone and dolomite generated in the LCP and DCP will be transported by dumper and unloaded to ground hopper located in the stock yard for storing under covered shed. Coke breeze shall also be stored in the separate storage area in the similar manner as described for limestone/dolomite.

### 5.1.3 Despatch of Raw Materials to Various Consuming Units

***Despatch of raw materials to BF:*** Various raw materials required for blast furnace, including lump ore will be reclaimed by stacker/reclaimer (one material at a time) and will be dispatched to the stockhouse of blast furnace. Sinter will be fed to the BF stockhouse through conveyor system. Feeding of coke and pellet will be done in similar fashion as indicated for sinter.

PCI reclaimed by stacker/reclaimer will be fed to the conveyor for its onward transmission to the bins at the blast furnace area.

***Despatch of raw materials to coke ovens:*** Hard coking coal, semi soft coking coal and pet coke reclaimed by stacker/reclaimer will be transferred to the blending bunker building by conveyors. After blending, the blended coal will be passed through the primary and secondary crushing/screening system by conveyors. After crushing and screening the ground coal will be fed to the coal tower by conveyor.

***Despatch of raw materials to pellet plants:*** Various raw materials of pellet plant like iron ore concentrate, lime stone, dolomite reclaimed by stacker/reclaimer will be fed to pellet plants by conveyors. Bentonite reclaimed by pay loader will be unloaded on a conveyor and transported to the pellet plants.

***Despatch of raw material to sinter plant:*** Iron ore fines will be reclaimed from the storage yard by stacker/reclaimer and conveyed to the respective stock bins of proportioning bin building of sinter plant. Limestone, dolomite will be reclaimed from storage yard in similar fashion and conveyed to flux crushing and screening system. From there, crushed material will be conveyed to the respective stock bins of proportion bin building of sinter plant. Coke breeze after reclaiming from the storage yard will be conveyed to the respective stock bins at proportion bin building. Other additives like mill scale and flue dust will be conveyed to respective stock bins by conveyors.

***Despatch of raw material to LCP:*** Limestone after reclaiming by stacker/reclaimer from storage yard will be conveyed to screening building through a set of conveyor system. Sized limestone after screening will be discharged to the weigh hopper for onward charging to the lime kilns. The product lime from kilns will be dispatched to lime storage bunkers through conveyor system.

***Despatch of lump ore to BOF shop:*** Lump ore from yard shall be reclaimed by stacker/reclaimer and conveyed to the bins at BOF shop through conveyor system. Lime from lime storage building will be conveyed to lime screen building and after screening lime shall be stored in the bins at BOF shop through conveyor system.

***Despatch of raw materials to steelmelt shop:*** Lime from lime storage will be screened to the required size and after screening will be conveyed to SMS building and stored in respective stock bins. Lump iron ore and pet coke will also be conveyed to respective stock bins from stockyard. Lime required for LF as well as fluorspar, ferro-alloys and other additives will be stored to respective stock bins of LF by bottom discharge bucket conveyor.

***Despatch of raw material to cement plant:*** Clinker received at port dispatch area, will be conveyed through a conveyor to clinker storage silo. Granulated slag from blast furnace will be conveyed through conveyor and stored in a stock yard located inside the cement plant.

## 5.2 PELLET PLANT

It is envisaged that pellet will constitute a significant part of the blast furnace burden. Other than the blast furnaces, pellet will also be consumed in the DR plant that will come up in Phase-III. It is envisaged that the pellet plants will progressively be installed for the blast furnaces in Phase-I, Phase-II and in Phase-III for DR plant.

### 5.2.1 Design Basis

The design of pellet plants is based on the desired capacity, quality of raw materials, product quality as well as the process parameters to be established through appropriate test work. In absence of specific test result for pellet making, suitable assumptions have been made for design of the system including equipment selection, based on CONSULTING ENGINEERS' experience in similar projects and in-house information on the subject.

| | | |
|---|---|---|
| Annual throughput of the pellet plants, million tons | .. | 32.0 |
| No. of working days/year | .. | 330 |
| Working hours per day in 3-shift operation | .. | 24 |

### 5.2.2 Quality of Raw Materials

The typical analyses of input raw materials envisaged for the production of pellets are given in Table 5-2.

**TABLE 5-2 – TYPICAL ANALYSIS OF INPUT RAW MATERIALS**

| Raw materials | Fe, % | $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % | LOI, % |
|---|---|---|---|---|---|---|
| Iron ore concentrate | 63.5-64.0 | 2.7-2.8 | 2.5-2.7 | - | - | 3.0-4.0 |
| Bentonite | 12.0-14.0 | 46.0-48.0 | 14.0-16.0 | 1.5-1.7 | 3.4-3.6 | - |
| Limestone | - | 4.0-5.0 | 1.5-1.7 | 47.0-48.0 | 2.5-2.8 | 41.0 |
| Dolomite | - | 1.1-1.5 | 0.5 | 28.0-30.0 | 19.0-20.0 | 45.0 |

The expected quality of imported coal shall be as follows:

| | | |
|---|---|---|
| Moisture, % | .. | 8-10 |
| Ash, % | .. | 9-12 |
| Volatile matter, % | .. | 9-11 |
| Fixed carbon, % | .. | 78-80 |
| Calorific value, kcal/kg | .. | >6000 |
| Ash melting temperature, $^oC$ | .. | >1350 |

### 5.2.3 Pellet Quality

The expected chemical analysis of pellet is shown in the Table 5-3.

**TABLE 5-3 – TYPICAL CHEMICAL ANALYSIS OF PRODUCT PELLET**

| | Fe, % | $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % | $CaO/SiO_2$, Ratio |
|---|---|---|---|---|---|---|
| BF grade | 62.0-63.0 | 3.2-3.7 | 2.7-2.9 | 2.9-3.7 | 0.9-1.1 | 0.85-1.1 |
| DR grade | 64.5-65.1 | 3.1-3.7 | 2.6-3.0 | 0.6-1.0 | 0-0.2 | 0.2-0.3 |

The desired physical and metallurgical characteristics of the pellet to be produced in the plant are given in Table 5-4.

**TABLE 5-4 – SOME OF THE DESIRED CHARACTERISTICS OF PRODUCT PELLET**

| Property | Value |
|---|---|
| Size distribution | |
| +16 mm | 5% max |
| -16 +6 mm | 92% min |
| -6 mm | 3% max |
| Compressive strength | 200-260 kg/pellet |
| Tumbling index | |
| +6.3 mm | 92% |
| -500 micron | 6% |
| Reducibility | 55% |

It is suggested that the above properties will be attained by ensuring adoption of appropriate process parameters established through necessary test work before implementation of the project. Pot grate tests shall have to be carried out to ascertain productivity, product quality and process parameters for efficient operation.

### 5.2.4 Raw Material Consumption

The consumption of raw materials on net and dry basis for production of pellets is given in Table 5-5. These shall have to be computed on the basis of test results at appropriate time.

**TABLE 5-5 – CONSUMPTION OF RAW MATERIALS FOR 4 X 8 MTPY PELLET PLANT (NET & DRY)**

| Materials | Annual consumptions, tpy | | |
|---|---|---|---|
| | **Phase-I (2 x 8.0 mtpy)** | **Phase-II (3 x 8.0 mtpy)** | **Phase-III (4 x 8.0 mtpy)** |
| Beneficiated iron ore concentrate from beneficiation plant | 15,664,000 | 23,328,000 | 31,441,000 |
| Beneficiated iron ore concentrate (Purchased) | - | - | 1,441,000 |
| Bentonite | 160,000 | 240,000 | 323,100 |
| Anthracite coal | 240,000 | 216,000 | 192,000 |
| Dolomite | 656,000 | 1,128,000 | 1,128,000 |
| Limestone | 560,000 | 960,000 | 1,085,600 |
| Coke breeze | - | 144,000 | 288,000 |

### 5.2.5 Major Equipment and Facilities

The major equipment and facilities envisaged for the pelletising plant are described below:

a) Receipt of iron ore concentrate.

b) Storage, handling and preparation of binder and additive.

c) Proportioning and mixing.

d) Balling, heat treatment and cooling.

e) Finished product handling and storage.

***Receipt of iron ore concentrate:*** Concentrate shall be received from the concentrate storage yard through conveyor to proportioning bins. Necessary handling facilities for the same shall be considered.

***Storage, handling and preparation of binder and additive:*** Limestone and dolomite of 10 to 50 mm size will be brought and stacked in ground stockpile, from where limestone and dolomite shall be reclaimed and fed to a surge bin by conveyor for grinding.

Limestone and dolomite will be drawn out and will be delivered to a pulverising unit through belt conveyor. A hot air swept vertical ring roller mill will be provided for pulverising the limestone and dolomite to minus 200 mesh size and the same will be pneumatically conveyed to the proportioning bin in mixing section. Pulverising of limestone and dolomite will be carried out in batches. Separate pulverising unit will be used for grinding bentonite and coal on time sharing basis.

Bentonite will be procured as lumps (minus 50mm size) brought by road, unloaded and stacked in ground stockpile at the plant site. Bentonite lumps will be reclaimed from the stockpile and fed to the surge bin by conveyor. Bentonite will be withdrawn and delivered to the same pulverising unit mentioned above by belt conveyor. The bentonite pulverised to minus 200 mesh shall be pneumatically conveyed to the proportioning bin in the mixing section.

Coal having low ash content and high ash fusion temperature, will be imported and brought to be stacked in ground stockpiles at the plant site. Coal shall be reclaimed and fed to the surge bin. Coal will be withdrawn from the bin and delivered to the pulverising unit by belt conveyor. Pulverised coal of minus 200 mesh size will be pneumatically conveyed to the proportioning bin in mixing section.

***Proportioning and mixing:*** In this section, iron ore concentrate, limestone, bentonite and coal will be stored in separate bins. The materials from these bins will be drawn out in requisite proportions and fed into intensive mixers. Water shall be added in the mixers to adjust moisture content in the mix to about 8 per cent.

***Balling, heat treatment and cooling:*** The thoroughly mixed pre-wetted material will be conveyed and distributed to mixed material bins in the balling section. For production of green balls, parallel balling circuits will be provided. Each of these circuits will comprise a mixed material bin, a variable discharge belt feeder, balling disc. Green pellets predominantly of 6 to 16 mm size will be produced. Pellets will be fed through an oscillating conveyor and wide belt conveyor to a double deck roller screen for top and bottom size control. The oversize and undersize fractions will be separated and disintegrated in a shredder and recycled to the plant. The sized green pellets will be discharged across the width of the traveling grate for heat treatment.

Heat treatment of green pellet is carried out in the induration furnace in stages comprising drying, pre-heating, induration and cooling. These process steps can be carried out either in two grate kiln furnace or straight grate furnace.

### 5.2.6 Pelletising Technology

***Grate-kiln technology*:** Grate-kiln type induration furnace shall be of three main segments, i.e. travelling grate, rotary kiln and annular cooler. Green pellets shall be dried and pre heated on the travelling grate, hardened and indurated in the rotary kiln and cooled in the annular cooler. The green pellets from the balling unit will be laid across the full width of the chain grate. The green balls are dried and preheated on the chain grate at about 300°C and pre-heating from 300°C to 1000 to 1050°C respectively with exhaust gas from the kiln, hot air from the cooler and few secondary burners in the chain grate machine. The heat treatment in the chain grate removes the moisture and imparts adequate strength to the pellets to withstand the transfer to the kiln. The dried and preheated pellets at about 1050°C from the chain grate will be discharged to the rotary kiln for induration at a temperature over 1300°C which is obtained from a main burner. The tumbling action in the rotary kiln exposes the pellets to high temperatures and enables them to attain the desired characteristics and strength.

***Straight grate*:** The green pellets are laid over a traveling grate and are subjected to drying, preheating, firing and cooling on-line in sequence in respective zones of the grate. The green ball drying takes place at about 300 to 350°C, pre-heating from 350 to 1250°C and induration takes place from 1250 to 1350°C. Thermal conditions of different zones are controlled by re-circulating hot air from burners suitably by means of circulation fans.

### 5.2.7 Selection of Technology

Both grate kiln and straight grate systems are proven technologies for heat hardening of green pellets.

Technically, performances of both the machines have been proved for different ore types in a number of installations all over the world. However, the final selection of induration technology will be done during the implementation stage by techno-economic comparison of the firm offers based on the commercially proven process from the reputed technology suppliers for pellet plant and performance guarantee parameters provided by bidders.

### 5.2.8 Finished Product Handling and Storage

The hardened and cooled pellets shall be screened for removal of minus 6 mm pellets generated during transfer and heat treatment. Undersize material from the screen shall be recycled to the plant. The 6 to 16 mm pellets shall be conveyed and stacked in a ground stockpile through tripper conveyor system. Pellets shall be reclaimed by the help of pay loaders from the ground stockpile onto trucks for further transportation.

### 5.2.9 Dust Abatement Facilities

The pelletising plant comprising various process units, accessories and handling facilities, shall be provided with adequate dust suppression and dust extraction facilities to restrict the particulate emission level within acceptable limits.

The systems will consist of water spraying facilities, mechanical gas cleaning equipment, dust recycle arrangement and exhaust stack. Exhaust gas from drying and grinding system shall be cleaned using fans, ductings, suction hoods, cyclones, bag filters, ESPs etc. as applicable.

The indurating furnace gas will be treated in electrostatic precipitator (ESP) before being released to the atmosphere.

The system will be designed in such a way that no solid or liquid waste shall be discharged outside the system. Solid or liquid waste shall be recycled back to the system.

## 5.3 SINTER PLANT

### 5.3.1 Production Programme

One sinter machine of around 500 sq m will be installed to produce 5,775,400 tpy of product sinter which will be adequate for around 68 per cent, 35 per cent and 25 per cent sinter feed to the blast furnaces in Phase-I, Phase-II and Phase-III respectively.

### 5.3.2 Design Basis

The design basis considered for sinter plant is given in Table 5-6.

**TABLE 5-6 – DESIGN BASIS OF SINTER PLANT**

| | | |
|---|---|---|
| Product sinter, tpy | .. | 5,775,400 |
| Charge sinter, tpy | .. | 4,909,100 |
| Screening at BF stock house, % | .. | 15 |
| Operating days/year | .. | 330 |
| Daily product sinter, tpd | .. | 17,500 |
| No. of strand | .. | 1 |
| Approx. suction area, sq m | .. | 500 |
| Product sinter size, mm | .. | 5 to 50 |
| Temperature of sinter at cooler discharge, °C | .. | 100 |

### 5.3.3 Raw Materials

The typical analyses of input raw materials (dry basis) for sinter production are given in Table 5-7.

**TABLE 5-7 – TYPICAL ANALYSIS OF RAW MATERIALS FOR SINTER PRODUCTION**

| | Fe, % | $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % | LOI, % |
|---|---|---|---|---|---|---|
| Iron ore fines | 63.5-64.0 | 2.5-3.0 | 2.5-2.7 | - | - | 3.0-4.0 |
| Limestone | - | 4.0-5.0 | 1.5-1.7 | 47.0-48.0 | 2.5-2.8 | 41.0 |
| Dolomite | - | 1.1-1.5 | 0.5 | 28.0-30.0 | 19.0-20.0 | 45.0 |
| Calcined lime | - | 2.50 | 2.00 | 92.00 | 1.90 | 2.00 |
| Quartz fines | - | 97.0 | 1.0 | - | - | - |
| Flue dust | 37.00 | 6.50 | 4.20 | 3.60 | 1.10 | 38.00 |
| Mill scale | 69.50 | 1.23 | 1.22 | 0.68 | 0.25 | 5.00 |
| Coke breeze | 0.50 | 6.75 | 3.50 | - | - | 84.5-87.5 |

### 5.3.4 Sinter Quality

The expected phase-wise chemical analysis of sinter from sinter plant is as follows:

| | Fe, % | FeO, % | $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % | CaO/$SiO_2$, Ratio |
|---|---|---|---|---|---|---|---|
| Phase-I | 57.3-57.9 | 8.0-9.0 | 4.7-4.8 | 2.7-2.9 | 8.1-8.3 | 1.7-1.9 | 1.65-1.8 |
| Phase-II | 55.8-56.4 | 8.0-9.0 | 4.6-4.8 | 2.6-2.8 | 10.2-10.4 | 2.05-2.15 | 2.15-2.2 |
| Phase-III | 55.5-56.1 | 8.0-9.0 | 4.6-4.8 | 2.6-2.8 | 10.5-10.7 | 2.05-2.15 | 2.2-2.25 |

Physical and metallurgical properties of sinter shall be as follows:

| | | |
|---|---|---|
| ISO tumbler index (+6.3 mm) | .. | 76% (min) |
| Reducibility index | .. | 65% (min) |
| RDI (-3.15 mm) | .. | 28% (max) |
| Sinter size range | .. | 5-50 mm |
| Sinter mean size | .. | 18 mm |

### 5.3.5 Consumption of Input Materials

The annual input material consumption for production of 4,909,095 tpy charge sinter is given in Table 5-8.

**TABLE 5-8 – CONSUMPTION OF INPUT MATERIALS**

| Materials | Annual consumptions[1], tpy | | |
|---|---|---|---|
| | Phase-I | Phase-II | Phase-III |
| Iron ore fines | 3,868,300 | 3,618,000 | 3,603,700 |
| Pellet fines | 39,800 | 175,600 | 343,800 |
| Limestone | 427,100 | 608,700 | 650,400 |
| Dolomite | 255,200 | 358,200 | 251,700 |
| Flue dust | 44,200 | 44,200 | 43,950 |
| Mill scale | 121,700 | 183,800 | 264,800 |
| Calcined lime | 73,600 | 73,600 | 90,100 |
| Quartz fines | 58,900 | 54,000 | 54,000 |
| LD slag | 49,100 | 49,100 | 49,100 |
| Calcined dolo | 7,400 | 14,800 | 33,700 |
| Coke breeze | 319,100 | 319,100 | 319,000 |

**Note:**

(1) Net and dry basis.

For the purpose of this report, it has been envisaged that blending of raw materials for sinter making will be done in sinter plant itself. The raw materials, viz. iron ore fines, flux, coke breeze, calcined lime and mill scale will be fed to the bins in the proportioning section of sinter plant and shall be proportioned through weigh feeders provided below the proportioning bins. Microfines generated at various dedusting units of the plant will be fed to the proportioning bins by pneumatic conveying.

***Grain size of input materials:*** The grain size of input materials will be as follows:

| | | |
|---|---|---|
| Iron ore fines | .. | 0-10 mm with 15-20%-100 mesh |
| Limestone | .. | 0-3 mm |
| Dolomite | .. | 0-3 mm |
| Calcined lime | .. | 0-1 mm |
| Coke breeze | .. | 0-3 mm |
| Flue dust | .. | 0-3 mm (+1 mm 20%) |

### 5.3.6 Plant Facilities

The facilities envisaged are:

a) Fuel and flux crushing & screening system.
b) Proportioning system.
c) Mixing and nodulising system.
d) Sinter machine.
e) Sinter cooling system.
f) Sinter screening system.
g) Waste gas system.
h) Plant dedusting system.
i) Cranes and hoists.
j) Sinter storage.
k) Plant electrics.
l) Instrumentation, automation and control system.
m) Communication system.
n) Water system.
o) Utility system.
p) Fire fighting system.
q) Air-conditioning and ventilation system.

For various types of input materials, including sinter return fines and dust from various plants, adequate number of proportioning bins mounted on load cells to ascertain material level in each bin will be provided. Under each bin an electronic weigh feeder will be provided to draw required materials in proportions.

Mixing and nodulising drum with internals and water proportioning system will be provided for the sinter machine which will facilitate stage-wise intimate mixing and rolling of sinter mix. Appropriate amount of water will be added in this area.

Sinter machine will be complete with hearth layer feeding system, raw mix feeding system comprising anti segregation filling method at the top of raw mix feed bin and drum feeder, ignition furnace, sinter breaker, crash deck, segregation chute and the sinter strand proper comprising lifting wheel assembly, lowering wheel assembly, support structure, sliding bars, thermal compensation device, wind boxes with compensators, spillage chute, SG iron pallet assembly with spring loaded sealing and high chrome grate bar, lubrication system etc. Sintering will be performed during the movement of the bed from ignition furnace to the discharge end.

A suitable segregation chute with adequate sandwiching capability will be provided for efficient operation of sinter cooler, keeping SPM level of dust pollution within limits. Sinter breaker will break hot sinter cake to suitable size. One elevator will be provided in sinter machine building.

A suitable forced draft type circular cooler comprising adequate number of fans, drives, cooler troughs, sealing etc. will be provided in order to discharge sinter below 100°C from cooler. The cooler discharge hopper shall be load cell mounted.

Waste heat recovery system from cooler for ignition furnace combustion system will be adopted for the sinter machine and post heating of sinter bed.

Cooled sinter from sinter cooler will be fed to screening system for separation of hearth layer material (10 to 20 mm), plant return fines (0 to 5mm) and product sinter (5 to 50 mm).

Waste gas system will be provided with ESP (dry type) of suitable capacity in order to maintain the dust emission from the stack as per the norms of the pollution control board/agency. A separate ESP (dry type) will be provided to handle/cater the dust generated from the different transfer points of the sinter plant in order to maintain dust emission. Collected dust will be recycled.

One waste gas fan of sinter machine with electric motor, silencer and heat and sound insulation will be provided. A metallic/concrete self supported stack, lined with acid proof brick lining, will be provided. The sinter plant will be provided with adequate cranes and hoists for maintenance of the equipment.

Necessary repair shop and store for sinter plant will be considered in sinter plant area.

Provision for one day production of sinter storage will be made available for sinter plant. Facilities will also be provided to discharge sinter from the storage onto the conveyor for transporting to blast furnace stockhouse.

## 5.4 COKE OVEN AND BY-PRODUCT PLANT

Stamped charged by-product recovery type coke oven plant has been envisaged for meeting the requirement of coke in blast furnaces. The coke production, qualities of coal and coke and facilities for the coke oven batteries, including coal preparation and coke sizing systems and by-product plant are discussed here.

### 5.4.1 Design Basis

Coke and coal requirements and their qualities as envisaged for the project are given below. Coking coal requirement is based on the gross coke yield of about 76 per cent over coal blend on dry basis.

### 5.4.2 Requirement of Coke

Based on coke rate in blast furnaces and the requirement of clean coke oven gas as plant fuel, the computed requirements of coke and coal are given in Table 5-9 after completion of each of the three phases. To fulfill the requirement of charge coke for blast furnace and clean coke oven gas as plant fuel, the coke oven capacity of 3,000,000 tpy gross coke has been consider for Phase-I. The capacity for production of gross coke will be enhanced in subsequent two phases of implementation, by 1,500,000 tpy in each phase. The ultimate production capacity after full implementation of the project will be 6,000,000 tpy of gross coke. The excess coke from coke oven will be made available for inter-plant transfer to other plant units of JSW Steel Ltd. The undersize (-10 mm) generated from screening of coke will be utilised as fuel in sinter plant and pellet plants.

**TABLE 5-9 – REQUIEMENT OF COKE AND COAL**

| Parameter | Quantity | | |
|---|---|---|---|
| | After Phase-I | After Phase-II | After Phase-III |
| Hot metal production, tpy | 4,500,000 | 9,000,000 | 13,500,000 |
| Charge coke requirement (hard + nut), tpy | 1,576,500 | 3,240,000 | 4,914,000 |
| Gross coke production, tpy | 3,000,000 | 4,500,000 | 6,000,000 |
| Dry coal for carbonisation, tpy | 3,947,000 | 5,921,000 | 7,832,100 |
| Hard+nut coke sent to BF stock house, tpy | 1,624,600 | 3,332,900 | 5,054,900 |
| Excess hard coke from coke ovens, tpy | 1,120,400 | 784,600 | 435,100 |

### 5.4.3 Coke Quality

The quality of coke that is envisaged for production is given in Table 5-10.

**TABLE 5-10 – COKE QUALITY (DRY BASIS)**

| Parameter | Value |
|---|---|
| Ash content, % | 12.5 (max) |
| Volatile matter, % | 1.0 (max) |
| Moisture, %<br>- CDQ<br>- Wet quenching | <br>0.5 (max)<br>5 (max) |
| Sulphur, % | 0.6 to 0.7 |
| Coke Strength<br>- $M_{40}$<br>- $M_{10}$ | <br>82.5 (min)<br>7 (max) |
| CSR | 62 (min) |
| CRI | 22 to 25 |
| Hard coke, mm | 25 to 80 |
| Nut coke, mm | 10 to 25 |
| Coke breeze, mm | Below10 |

### 5.4.4 Coal Quality

Based on the selected coke making technology, the blend composition considered is given on the next page.

| | Proportion in blend, % | Ash, % |
|---|---|---|
| Imported hard coking coal | 20 | 8-9 |
| Imported semi-soft coking coal | 70 | 10-12 |
| Pet coke | 10 | <1 |

Based on the above blend constituent's typical analysis of coal blend considered is given in Table 5-11.

**TABLE 5-11 – TYPICAL ANALYSIS OF COKING COAL BLEND**

Proximate analysis (dry basis)

- Volatile matter, % .. .. 24 (average)
- Ash, % .. 9.5 (avg)
- Sulphur, % .. 0.5 to 0.55
- Fixed carbon .. By difference

Moisture (as received), % .. 10 (max)
Mean reflectance ($R_0$) .. ~1.05
CSN .. 4-6

Annual requirement of different grades of coal is given in Table 5-12.

**TABLE 5-12 – DIFFERENT GRADES PF COKING COAL**

| Type of coal | Quantity, tpy (net and dry) | | |
|---|---|---|---|
| | After Phase-I | After Phase-II | After Phase-III |
| Imported hard coking coal | 789,500 | 1,184,200 | 1,578,900 |
| Imported semi-soft coking coal | 2,763,200 | 4,144,700 | 5,526,300 |
| Pet coke | 394,700 | 592,100 | 726,900 |

### 5.4.5 Production Programme

The annual production of dry coke and by-products is given in Table 5-13.

**TABLE 5-13 – PRODUCTION OF COKE AND BY-PRODUCTS**

| Product | Quantity | | |
|---|---|---|---|
| | After Phase-I | After Phase-II | After Phase-III |
| **Coke** | | | |
| Hard coke (25 to 80 mm), tpy | 2,550,000 | 3,825,000 | 5,100,000 |
| Nut coke (10 to 25 mm), tpy | 195,000 | 292,500 | 390,000 |
| Coke breeze (0 to 10 mm) from coke ovens, tpy | 240,000 | 360,000 | 480,000 |
| CDQ dust, tpy | 15,000 | 22,500 | 30,000 |
| | | | |
| **By-products** | | | |
| Clean coke oven gas, N cu m/hr | 114,200 | 216,300 | 286,100 |
| Crude tar, tpy | 135,000 | 202,500 | 270,000 |
| Crude benzol, tpy | 36,000 | 54,000 | 72,000 |
| Sulphur (99.5% pure), tpy | 6,000 | 9,000 | 12,000 |

The by-product plant will be designed for nominal crude coke oven gas handling capacity of 300,000 N cu m/hr.

### 5.4.6 Coke Oven Gas Quality

The calorific value and typical composition of the coke oven gas are given in Table 5-14.

**TABLE 5-14 – QUALITY OF COKE OVEN GAS**

| Description | Value |
|---|---|
| Calorific value of clean coke oven gas, kcal/N cu m | 4,100 |
| Typical composition of clean coke oven gas, % (v/v): | |
| - $H_2$ | 56 to 58 |
| - $CH_4$ | 24 to 26 |
| - CO | 7 to 8 |
| - CnHm | 2 to 3 |
| - $CO_2$ | 2 to 3 |
| - $O_2$ | 0.2 to 0.3 |
| - $N_2$ | Balance |

| Description | Value |
|---|---|
| Typical impurities level in clean coke oven gas (COG): | |
| - Hydrogen sulphide, mg/N cu m | 200 |
| - COG | 150 to |
| - Naphthalene, mg/N cu m COG | 200 |
| - Benzol, gm/N cu m COG | 2.5 to 3.0 |
| - Ammonia, mg/N cu m COG | 30 |
| - HCN, mg/N cu m COG | 500 |
| - Pyridine | Traces |
| - Tar fog, mg/N cu m | 10 to 20 |

### 5.4.7 Proposed Facilities and Layout

The coke oven plant will consist of following major facilities:

a) Coal preparation plant comprising, blending, crushing and conveying.

b) Stamp charged by-product recovery type coke oven batteries with oven machines and auxiliaries.

c) Coke dry quenching plant with standby wet quenching station.

d) Coke screening facilities, including distribution.

e) By-product plant with recovery of crude tar & crude benzol, removal of sulphur & ammonia and desulphurisation of coke oven gas and recovery as sulphur.

f) Phenolic effluent treatment plant.

### 5.4.8 Coal Preparation and Handling System

The blended coal from the blending bins will be conveyed to the crushing station for crushing of coal up to 90 per cent below 3.15 mm. From the crushing station, the crushed coal will be conveyed to the batteries. Facilities will be provided for controlled addition of moisture in the coal blend. Suitable dust extraction/suppression facilities will be provided at all transfer points and crushing stations to restrict emission of particulate matters within the prescribed limit.

### 5.4.9 Coke Oven Battery

***Design basis:*** By-product recovery type stamp charged (SC) ovens have been considered for the coke oven plant. Eight batteries, each having 62 ovens, will be required to produce 6,000,000 tpy of gross coke. Four batteries will be installed in Phase-I of the project along with by-product recovery and coke dry quenching facilities. The rest of the four batteries will be installed successively in Phase-II and Phase-III with two batteries in each phase. By-product plant to be installed in Phase-II will be designed to handle coke oven gas generated from both Phase-II and Phase-III batteries. The basic design parameters of the coke oven battery are given in Table 5-15.

**TABLE 5-15 – BASIC DESIGN PARAMETERS OF COKE OVEN BATTERY**

| Description | Value |
|---|---|
| Length (cold)between door plugs, mm | 16,190 |
| Height (cold)of oven chamber, mm | 6,175 |
| Average chamber width (cold), mm | 540 |
| Oven centre to centre distance, mm | 1,500 |
| Normal carbonisation time (gross), hrs | 24 |
| Coal cake volume, cu m | 45.6 |
| Bulk density of stamped cake (dry basis), ton/cu m | ~1.0 |

Coke oven battery will be twin flue, under jet, compound, and regenerative type. In normal operating practice, the batteries will be heated by mixed gas having a calorific value 1,000 to 1,100 kcal/N cu m. Based on the pushing schedule required to achieve the per day production from coke oven batteries, stamping-cum-charging-cum-pushing machines have been consider for the project.

***Facilities:*** The major units of the coke oven batteries are given in Table 5-16.

**TABLE 5-16 – MAJOR UNITS OF COKE OVEN BATTERY**

| Facility/Machinery | After Phase-I | After Phase-II | After Phase-III |
|---|---|---|---|
| No. of batteries | 4 | 6 | 8 |
| No. of ovens/battery | 62 | 62 | 62 |
| No. of oven machines | | | |
| - Stamping-cum- charging-cum-pushing machine | 2W+1S | 3W+2S | 4W+2S |
| - Coke guide car | 4 W | 6 W | 8 W |
| - Gas transfer car | 4 W | 6 W | 8 W |
| - Quenching car with electric loco | 2W+2S | 3W+3S | 4W+4S |
| No. of stand-by wet quenching stations | 2 | 3 | 4 |
| No. of chimneys | 2 | 3 | 4 |
| Charging emission control systems with HPLA | 2 sets | 3 sets | 4 sets |
| Coke side pushing emission control station | 2 sets | 3 sets | 4 sets |

### 5.4.10 Coke Dry Quenching Plant

***Design basis*:** CDQ facility will be provided to cool the red hot coke from oven at 1,000 to 1,050°C to about 180 to 190°C with facilities to recover the available energy in hot coke. CDQ plant will operate for 340 to 345 days. Four wet quenching stations are envisaged as stand-by for operation when CDQ units are not in operation.

The typical design parameters of the CDQ plant are given in Table 5-17.

**TABLE 5-17 – TYPICAL BASIC DESIGN PARAMETERS OF CDQ PLANT**

| Parameter | After Phase-I | After Phase-II | After Phase-III |
|---|---|---|---|
| Design capacity (Normal), tph | 2 x 190 | 3 x 190 | 4 x 190 |

***Facilities***: The major units of the CDQ plant are given in Table 5-18.

**TABLE 5-18 – MAJOR UNITS OF CDQ PLANT**

| Facility/Machinery | After Phase-I | After Phase-II | After Phase-III |
|---|---|---|---|
| CDQ chamber | 2 | 3 | 4 |
| Travelling and lifting crane | 2 | 3 | 4 |
| Discharging device | 2 | 3 | 4 |
| Circulating fan | 2 | 3 | 4 |
| Auxiliary fan | 2 | 3 | 4 |
| WHB and auxiliary | 2 | 3 | 4 |
| Dust catcher (primary and secondary) and disposal system | 2 sets | 3 sets | 4 sets |
| Coke bucket carriage | 2W+1S | 3W+2S | 4W+2S |
| Rotary coke bucket | 2W+1S | 3W+2S | 4W+2S |

**TABLE 5-19 – TECHNICAL PARAMETERS OF WASTE HEAT BOILER**

| Facility/Machinery | After Phase-I | After Phase-II | After Phase-III |
|---|---|---|---|
| Steam output from boiler, tph | 170 | 255 | 340 |
| Steam pressure at super heater outlet, ksca | 68 | 68 | 68 |
| Steam temperature, °C | 535 | 535 | 535 |
| Feed water temperature at economiser inlet, °C | 104 | 104 | 104 |
| Inlet gas temperature, °C | 900-950 | 900-950 | 900-950 |
| Exit gas temperature, °$^0$C | 160-180 | 160-180 | 160-180 |

**5.4.11 Coke Handling Facilities**

The coke screening and handling plant will operate 365 days in a year, three shifts per day basis.

***Facilities:*** Quenched coke from the coke oven will be conveyed to the coke screening building through a system of belt conveyors. Heat and oil resistant conveyor belt will be provided up to the screening station. The coke will first be screened in primary screen to separate coke with size greater than 80 mm. The undersize from primary screens will be taken to the secondary and tertiary screens for segregating the coke into three size fractions, hard coke (25 to 80 mm), nut coke (10 to 25 mm) and undersize coke (0 to 10 mm). Separation of hard coke will be achieved in secondary screen and the tertiary screen will separate the nut coke and undersize coke. Hard coke and nut coke will be transferred through separate conveyor systems/road transport up to the blast furnace stock house.

**5.4.12 By-product Plant**

***Design basis:*** The by-product plant will be designed to handle crude coke oven gas make of 150,000 N cu m/hr after Phase-I and 300,000 N cu m/hr after Phase-II. The by-product plant facilities have been planned for the production of clean COG for use as plant fuel and recovery of crude tar, crude benzol and sulphur. Following units will be provided in the by-product plant:

a) Gas cooling and tar-liquor condensation section.
b) Combined ammonia and hydrogen sulphide scrubber.
c) Deacidifier and ammonia stripper unit.
d) Claus reactor and sulphur recovery unit.
e) Benzol scrubbing with production of crude benzol.
f) Phenolic effluent treatment plant.
g) Auxiliary facilities.

Clean coke oven gas will be made available from coke oven at about 350 to 400 mm WC pressure for use as plant fuel. Crude tar and crude benzol from the by-product plant may either be utilised as feed for the proposed Tar Processing Plant and Benzol Refining Plant respectively or can be directly sold to the market.

***Gas cooling and tar-liquor condensation section:*** Coke oven gas evolved during carbonisation of coal in the ovens will be collected in the gas collecting main, where it will be cooled with direct spray of ammonia liquor. Crude gas from the gas collecting main will be sucked by exhausters through primary gas coolers and electrostatic tar precipitators.

Crude coke oven gas after the down-comers will be cooled to a temperature of about 21°C in indirect, cross tube type primary gas coolers in two stages; in the upper stage with circulating cooling water and in the lower stage with circulating chilled water. Coke oven gas after being cooled in the primary gas coolers will enter electrostatic tar precipitators (ETP) for separation of tar mist from the coke oven gas. The coke oven gas exhausters will be electric motor driven and will be provided with required lubrication, safety, idling, and suction condition control arrangement.

Tar and liquor condensed in the crude gas pipelines, primary gas coolers, ETPs, and exhausters will be processed in the tar-liquor condensation unit. This will consist of decanting tanks with thick tar/ammonia liquor separators, tar centrifuges, condensate pit tanks, flushing liquor pumps, condensate pumps etc. Separated tar will be transferred to the oil depot. Liquor will be transferred by flushing liquor pumps to the gas collecting main for cooling of gas. Excess liquor from tar Ammonia liquor separating tank is taken to a separating tank for separation of Heavy oil from it and is finally pumped out with excess liquor pump to the filtering system.

***Combined ammonia-hydrogen sulphide removal unit:*** Coke oven gas will be cleaned in respect of ammonia and hydrogen sulphide by scrubbing with soft water and circulating stripped liquor.

Coke oven gas leaving the exhauster will be admitted to $H_2S$ scrubbers. The lower section of $H_2S$ scrubbers will be designed for final cooling. Scrubbing of $H_2S$ will be carried out by enriched ammonia liquor and de-acidified water. For enrichment of ammonia liquor, steam-ammonia mixture from ammonia stripper will also be admitted to the $H_2S$ scrubbers. Soda lime solution will be used at the final stage of the $H_2S$ scrubber. After $H_2S$ scrubbing, the gas will be taken to ammonia scrubbers arranged in series. The ammonia will be removed from coke oven gas by scrubbing with cooled stripped liquor from ammonia still. Soft water and excess ammonia liquor will be admitted at the top and bottom stages of ammonia scrubbers respectively.

The enriched liquor from $H_2S$ scrubber containing ammonia, $H_2S$, carbon dioxide and HCN will be stripped in the de-acidifier. A portion of ammonia vapour will also be admitted to the de-acidifier. A portion of de-acidifier liquor will be treated in ammonia still for stripping of ammonia. Alkali solution admitted to the $H_2S$ scrubbers will be utilised for decomposition of fixed ammonia.

The vapour leaving the de-acidifier will contain ammonia, $H_2S$, carbon dioxide and HCN along with water vapour. For cooling of stripped liquor, inter stage circulation and suitable heat recovery tubular heat exchangers have been considered. The circulation of liquors will be achieved through pumps.

***Sulphur recovery unit:*** The vapours from the top of the de-acidifier containing ammonia, hydrogen sulphide, water vapour, hydrogen cyanide and carbon dioxide etc. will be fed into the sulphur recovery plant for destruction of ammonia and production of sulphur. In the reactor, the acid gas will be brought into contact with the required quantity of air. Secondary air will also be added at the lower part of the reactor. Suitable temperature will be maintained in the reactor. The heat generated in the reactor will be utilised for generation of steam in the heat recovery boiler. Most of the heat required for the reaction will be generated by partial burning of hydrogen sulphide. The ammonia and hydrogen cyanide present in the acid gas is decomposed into hydrogen, nitrogen and carbon monoxide by catalytic cracking. The Claus conversion will be continued by the catalytic method in the Claus reactors arranged in series. Each Claus reactor will be followed by a sulphur condenser and separator where sulphur will be removed from the process gas. Low pressure steam will be produced in the sulphur condenser. The molten sulphur will then be fed to the solidification plant for the production of sulphur pellets. The sulphur produced by this process will be of high purity (min. 99.5 per cent). The tail gas from the reactor will be introduced to the coke oven gas in the foul gas main.

The sulphur pellets are packed and finally transported out with truck dispatch.

***Benzol recovery section:*** Coke oven gas leaving the top of the ammonia scrubbers will be admitted to benzol scrubbers. Scrubbing of benzol will be carried out with lean oil from crude benzol stripper units.

The enriched oil from the bottom of the benzol scrubbers will be heated and fed to the crude benzol strippers for steam-stripping. The vapours from the top of the benzol strippers containing benzol and water vapour will be condensed and crude benzol, after separation of water, will be sent to the oil depot. Lean oil, after cooling, will be fed to the benzol scrubbers. The clean coke oven gas, after benzol removal, will be fed to the coke oven gas holders.

***Oil depot:*** Separate storage for crude tar, crude benzol, wash oil, caustic soda will be provided. Suitable facilities for loading of crude tar and crude benzol in to road tankers will be provided.

## 5.5 TAR PROCESSING AND BENZOL REFINING PLANT

### 5.5.1 Design Basis

Crude tar and Crude benzol of the following quantities will be generated from by-product plant, after completion of each phase:

| Product | After Phase-I | After Phase-II | After Phase-III |
|---|---|---|---|
| Crude tar, tpy | 135,000 | 202,500 | 270,000 |
| Crude benzol, tpy | 36,000 | 54,000 | 72,000 |

It is envisaged that the proposed Tar processing and Benzol refining plant will be installed in Phase-III of the project. The plant will be designed for processing 270,000 tpy of crude tar and for refining 72,000 tpy of crude benzol.

### 5.5.2 Coal Tar Distillation Process

The various components present in the coal tar will be separated by distillation process. Coal tar after preheating and de-hydration will be fed to fractionating column in which various fractions, e.g. light oil, middle fraction oil, anthracene oil, phenol oil, wash oil, creosote oil, pitch-creosote mixture etc. will be separated depending on product-mix.

***Oils - light oil, phenol oil & anthracene oil production:*** The top fraction contains phenol oil, the middle fractions contain naphthalene oil along with phenol oil & wash oil and the bottom product contains anthracene oil and creosote oil.

***Binder grade pitch production:*** For production of coal tar pitch (Binder grade), first soft pitch will be generated from the pitch-creosote mixture at the bottom of fractionating column. The produced soft pitch will be converted into modified pitch in modified pitch section which also can be sold as product.

High QI (Quinoline insolubles) pitch will be blended with modified pitch to produce Binder pitch. A pitch melting system will be used for melting of High QI pitch.

***Carbon Black Oil (CBO) production:*** For the production of Carbon Black Oil, soft pitch will be blended with anthracene oil produced in distillation process.

***Refined naphthalene production:*** Vapors containing crude naphthalene oil generated in distillation process will be continuously cooled in condensers and collected by gravity into receivers. The collected and cooled mixture will be transferred to refined naphthalene section. In refined naphthalene section crude naphthalene will be enriched and purified using crystallizer. The refined naphthalene will be solidified using flakers.

The process flow of tar distillation is shown in fig. 5-1.

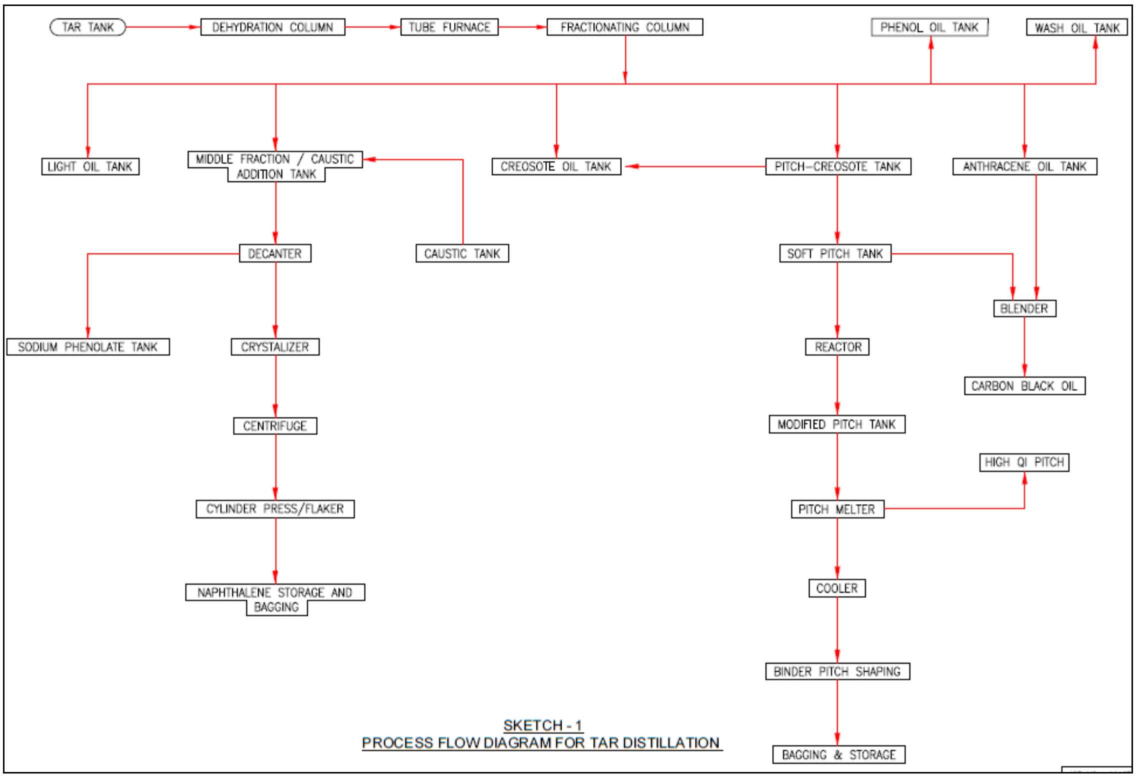



**FIG. 5-1 – PROCESS FLOW DIAGRAM FOR TAR DISTILLATION**

***Major facilities:*** The following major facilities are proposed for the Tar Distillation Plant:

i) Crude tar storage tank.
ii) De-hydration column.
iii) Fractionating column.
iv) Light oil tank.
v) Middle oil tank (Caustic addition tank).

vi) Phenol oil tank.
vii) Wash oil tank.
viii) Pitch-creosote mixture tank.
ix) Creosote oil tank.
x) Anthracene oil tank.
xi) Carbon black oil tank.
xii) Caustic soda tank.
xiii) Sodium phenolate tank.
xiv) Soft pitch tank.
xv) Modified pitch tank.
xvi) Decanter.
xvii) Crystalliser.
xviii) Centrifuge.
xix) Cylinder press/flaker.
xx) Naphthalene storage & bagging unit.
xxi) Pitch melter.
xxii) Pitch reactor.
xxiii) Binder pitch shaping unit.
xxiv) Binder pitch bagging & storage unit.
xxv) Heat exchangers.
xxvi) Condensers
xxvii) Pumps
xxviii) Loading stations.

***Tentative product-mix:*** The following chemicals are envisaged for recovery inside the proposed tar distillation plant. The product-mix may undergo changes depending on market scenario.

| **Product** | **Tentative annual quantity, tpy** |
|---|---|
| Binder grade pitch | 144,400 |
| Naphthalene | 11,300 |
| Anthracene oil | 5,400 |
| Phenol | 2,200 |
| Other chemicals:<br>- Light oil<br>- Pitch-creosote mixture<br>- Creosote oil<br>- Wash oil<br>- Carbon black oil | 98,500 |

### 5.5.3 Benzol Refining Process

The various components present in the benzol will be separated by refining process.

***Cleaning of crude benzol:*** The crude benzol will be washed to remove the unsaturates. In the acid/alkali process, the crude benzol will be washed with concentrated sulphuric acid to remove most of the unsaturated compounds (chiefly mono olefins). This will be discharged from the bottom of the wash tank as sludge acid. The sludge will be an intimate mixture of unused acid, entrained light oil and resins.

Cleaned benzol will be removed from the top of the tank and passed to a neutraliser, where it will be first washed with dilute solution of sodium hydroxide for removing any acid trace and later with water. The cleaned crude benzol will be moved to the storage tank for distillation. It will take approximately one shift to carry out the washing. The yield of cleaned crude benzol will be 94 to 96 per cent of the feed.

The process flow of benzol refining is shown in Fig. 5-2 on the next page.

***Distillation of crude benzol:*** The crude benzol will be fractionally distilled in a fractionating column for the final products. Indirect steam heated batch stills will be used for obtaining benzene, tolune, xylene and solvent naphtha of various standard grades. The residue from the batch still as well as the sludge from acid alkali process can be used as fuel.

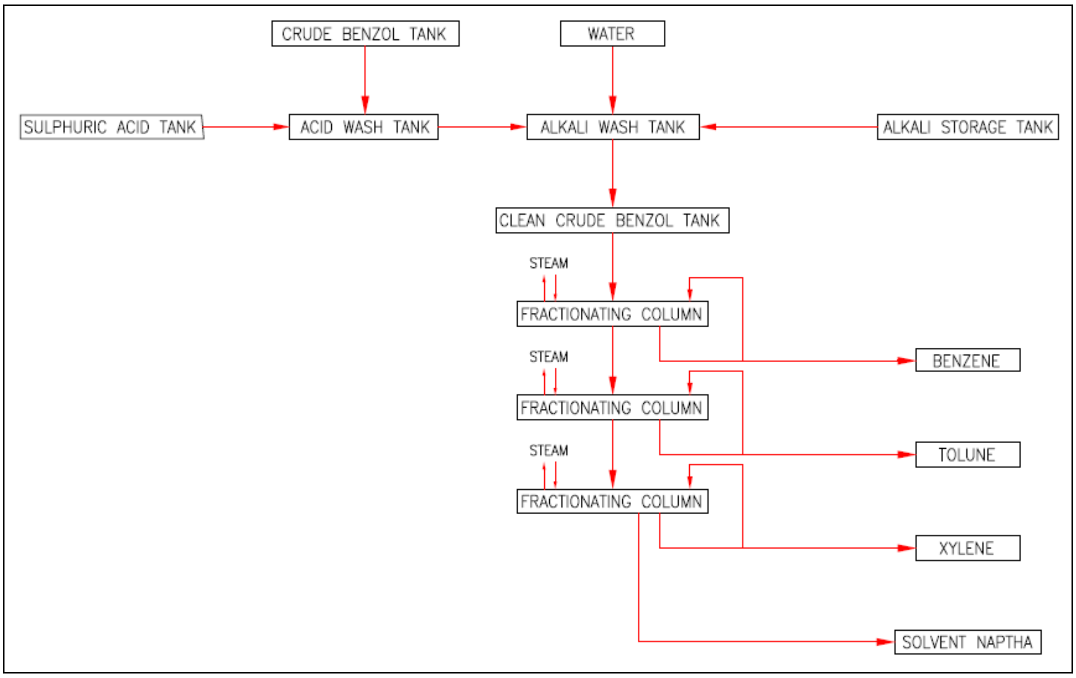



**FIG. 5-2 – PROCESS FLOW DIAGRAM FOR CRUDE BENZOL REFINING PLANT**

***Major facilities:*** The following major facilities are proposed for the Tar Distillation Plant:

a) Fractionating columns.
b) Crude benzol tank.
c) Sulphuric acid tank.
d) Acid wash tank.
e) Alkali wash tank.
f) Alkali storage tank.
g) Cleaned crude benzol tank.
h) Product tanks.
i) Heat exchangers.
j) Pumps.
k) Loading station.

***Tentative product-mix:*** The following chemicals are envisaged for recovery inside the proposed tar distillation plant.

| Product | Tentative annual quantity, tpy |
|---|---|
| Benzene | 48,000 |
| Toluene | 7,600 |
| Xylene | 1,800 |
| Solvent oil | 1,000 |
| Bottom oil | 2,900 |

## 5.6 BLAST FURNACE

To cater to the requirement of the SMS, installation of blast furnaces of capacity of about 5,350 cu m (UV) has been envisaged in each phase. The hot metal production from each of the proposed BFs will be 4,500,000 tpy which will be fed to the BOF. Facilities will be provided for granulation of hot metal when there is no off-take at SMS.

### 5.6.1 Design Basis

The blast furnace will incorporate all the modern technological features. The design basis of blast furnace is given in Table 5-20.

**TABLE 5-20 – DESIGN BASIS OF BLAST FURNACE**

| Item | Phase-I | Phase-II | Phase-III |
|---|---|---|---|
| | BF-1 | BF-2 | BF-3 |
| Hot metal production, tpy | 4,500,000 | 4,500,000 | 4,500,000 |
| Useful volume, cu m (appx.) | 5,350 | 5,350 | 5,350 |
| Operating days | 350 | 350 | 350 |
| Productivity, t/(useful volume)/day (appx.) | 2.4 | 2.4 | 2.4 |
| Burden:<br>- Pellet, %<br>- Sinter, %<br>- Lump ore, % | <br>27<br>68<br>5 | <br>60<br>35<br>5 | <br>70<br>25<br>5 |

| Item | Phase-I | Phase-II | Phase-III |
|---|---|---|---|
| | BF-1 | BF-2 | BF-3 |
| Oxygen enrichment, % | 8 | 8 | 8 |
| Coke rate (including nut), kg/thm | 351 | 360 | 364 |
| Coal injection rate, kg/thm | 200 | 200 | 200 |
| Slag rate, kg/thm | 300 | 300 | 300 |
| Coke ash, % | 12.5 | 12.5 | 12.5 |
| Si in metal, % | 0.5-0.7 | 0.5-0.7 | 0.5-0.7 |

### 5.6.2 Raw Materials

The major raw materials for the proposed BF comprises iron ore, sinter, additives and coke. Pulverised coal will be injected through tuyeres as auxiliary fuel. The typical analysis of raw materials envisaged is given in Table 5-21.

**TABLE 5-21 – TYPICAL RAW MATERIALS ANALYSIS (DRY BASIS)**

| | Fe, % | $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % |
|---|---|---|---|---|---|
| Sinter | | | | | |
| - in Phase-I | 57.3-57.9 | 4.7-4.8 | 2.7-2.9 | 8.1-8.3 | 1.7-1.9 |
| - in Phase-II | 55.8-56.4 | 4.6-4.8 | 2.6-2.8 | 10.2-10.4 | 2.05-2.15 |
| - in Phase-III | 55.5-56.1 | 4.6-4.8 | 2.6-2.8 | 10.5-10.7 | 2.05-2.15 |
| Lump ore | 64.0-64.5 | 1.5-2.0 | 2.0-2.5 | - | - |
| Limestone | - | 4.0-5.0 | 1.5-1.7 | 47.0-48.0 | 2.5-2.8 |
| Dolomite | - | 1.1-1.5 | 0.5 | 28.0-30.0 | 19.0-20.0 |
| Quartzite | | 97.0 | 1.0 | - | - |

| | Ash, % | Moisture, % | CSR, % | CRI, % |
|---|---|---|---|---|
| Coke | 12.5 | 0.5 | 62 (min) | 22-25 |

### 5.6.3 Coal for PCI Application

Ash, % (dry basis) .. 9-10
Fixed carbon, % .. 68-70

### 5.6.4 Consumption of Input Materials

The requirement of annual input materials on dry and net basis is given in Table 5-22.

**TABLE 5-22 – ANNUAL REQUIREMENT OF RAW MATERIALS**

| Material | Annual requirement(1), tpy | | |
|---|---|---|---|
| | Phase-I | Phase-II | Phase-III |
| Charge pellet | 1,948,500 | 8,604,000 | 15,147,900 |
| Charge sinter | 4,909,100 | 4,909,100 | 4,909,100 |
| Lump ore | 355,500 | 711,000 | 1,053,000 |
| Charge coke | 1,579,500 | 3,240,000 | 4,914,000 |
| PCI coal | 900,000 | 1,800,000 | 2,700,000 |
| Limestone | - | 216,000 | 540,000 |
| Dolomite | - | 54,000 | 189,000 |
| Quartzite | 54,000 | 180,000 | 270,000 |

**Note:**

(1) Quantities are on net and dry basis.

### 5.6.5 Hot Metal Quality

The expected hot metal analysis is given below:

Si, % .. 0.5-0.7
S, % .. 0.045 (max)
P, % .. 0.15

### 5.6.6 Major Facilities

The plant will comprise the following facilities:

a) BF proper.
b) Cast house.
c) Slag granulation plant.
d) Hot blast stoves.
e) Gas cleaning plant.
f) Stock house and charging system.
g) Hot metal handling system.
h) Cranes and hoists.
i) Coal dust injection system.

j) Hot metal granulation.
k) Ladle repair shop.
l) Stockhouse & Casthouse de-dusting system.
m) Air blowing system.
n) Top recovery turbine.
o) Plant electrics.
p) Instrumentation, automation and control system.
q) Communication system.
r) Water system.
s) Utility system.
t) Fire fighting system.
u) Air-conditioning and ventilation system

The sinter from sinter plant, pellet from pellet plant, coke from coke oven, lump ore and fluxes from the raw material storage yard will be received on separate conveyors and will be distributed to the stock house of blast furnaces through common conveyor gallery. The stock house operation will be fully automated. The furnace will be provided with conveyor belt charging system. Return fines will be transported to sinter plant/raw material storage yard by means conveyors.

Facility for crushing coal for injection will be provided. Raw coal will be transported via conveyors to the coal grinding unit in blast furnace area. It will be transferred to the raw coal silo in the coal preparation plant by a conveyor. Pulverised coal will be injected through tuyeres in the blast furnace.

Blast furnace will be designed for at least 2.5 kg/sq cm top pressure and 1200°C hot blast temperature. The useful volume of the furnaces will be about 5,350 cu m. Each BF will have four tap holes. The furnace will be self-supporting free standing type. The top equipment and platform at various levels around the furnace will be supported by an independent tower structure. Blast furnace will be provided with bell less top charging system. It will be provided with modern facilities like above burden probe, heat flux and pressure profile measurement etc. The cooling system will comprise of staves. Staves will be provided for cooling refractory from hearth to the stack. Cooling system will be complete with all piping, valves, pumps etc. One emergency overhead tank will also be provided in blast furnace re-circulating circuit which will be operated during power failure.

The hearth bottom including tap hole will be lined with high conductive carbon in blast furnace. Bosh to lower shaft is lined with silicon carbide/high alumina. Rest of the shaft will be lined with high $Al_2O_3$ brick and the cone portion will be gunnited with CO resistant refractory materials.

Automation and control system, which will include control of hot blast temperature, charging etc., will be provided to take care of smooth operation of blast furnace. Instruments for measuring flow, pressure, temperature etc. will also be provided.

Each blast furnace will be served by three stoves, along with a provision for a fourth stove, provided with ceramic burners to supply hot blast at a temperature of about 1200°C. The stoves will be fired with blast furnace gas. Combustion air fans will be provided for supply of combustion air to stove burner. One chimney will be provided for the stove system. The upper high temperature zone of stoves will be lined with high alumina refractory and other portions will be lined with fire clay refractory except for the dome which will be lined with silica refractory. Hot blast main and bustle main will be lined with high alumina refractory. The stoves will be provided with necessary platforms for providing approach to various valves, fittings etc. Necessary lifting beams with hoist will be provided above the stove valves to facilitate maintenance. The stove valves will be hydraulically/pneumatically actuated and the stove changing will be PLC controlled.

The blast furnace will be provided with two cast houses, having two tap holes each. Hydraulic mudgun and drilling machine will be provided in cast house. Slag granulation system and dry slag pit will be provided along with granulated slag handling system. The slag runner arrangement will be made such that it can flow either to the slag pit or to the granulator of the slag granulation plant. Granulated slag bunkers will be provided for collecting the granulated slag. The storage capacity for granulated slag will be about 6 to 8 hrs. The granulated slag will be transported from the bunkers to the slag yard for onward dispatch to outside plant area.

The gas cleaning plant for the blast furnace will consist of a dust catcher and a dry/wet gas cleaning system. The top gas of furnace will be drawn through off-takes which extend upward to form vertical bleeder pipes provided with bleeder valves at the top. The off-take and up-take pipes are connected to form down-comer, which terminates at the dust catcher. Dry dust disposal from dust catcher will be by road transport. The gas leaving dust catcher will flow into vessels containing bag filters or wet scrubbers for final gas cleaning. The disposal of dust/slurry will be done by road transport using trucks/tankers. The cleanliness of blast furnace gas will be 5 mg/N cu m of clean gas. Flare stack of adequate capacity will be provided.

Fume extraction and dust extraction facilities will be provided for casthouse and stockhouse respectively to keep the work level dust concentration within the stipulated norms. Disposal of dust from the stock house dust extraction system and cast house dust extraction system will be by road transport.

Hot metal granulation system of adequate capacity will be installed for production of granulated iron. Recirculating water system for water required for the granulation process including a hot well, cold well, cooling tower etc. will be installed. Granulated iron will be stored in the storage yard.

Electric blowers of adequate capacity will be provided for blast furnace.

Hot metal will be transported to steelmaking shop by rail in torpedo ladles. The torpedo repair shop will have facilities for servicing, cooling, repairing and relining of hot metal ladles. The shop will have facilities for drying and heating of relined torpedo ladles. Necessary repair shop and store for blast furnace will be considered in blast furnace area.

## 5.7 DIRECT REDUCTION (DR) PLANT

To cater to the requirement of the SMS, installation of a coke oven gas based direct reduction plant of capacity of about 1.2 mtpy has been envisaged in Phase-III. The direct reduced iron (DRI) produced from proposed DR plant will be fed to the BOFs.

### 5.7.1 Design Basis

The DR plant will incorporate all the modern technological features. The design basis of DR plant is given in Table 5-23.

**TABLE 5-23 – DESIGN BASIS OF DR PLANT**

| Item | Description |
|---|---|
| DRI production, tpy | 1,200,000 |
| Operating hours | 8,000 |
| Burden:<br>- Pellet, % | 100 |
| Product | Cold DRI |
| Reductant | Clean COG with BTX less than 32 g/N cu m and tar less than 0.05 g/N cu m |
| Production rate, tph | 150 |
| Oxygen injection, N cu m/ton | 70 |

### 5.7.2 Raw Materials

The major raw materials for the proposed DR plant comprise acid grade pellets with 64.8 per cent iron.

### 5.7.3 Consumption of Input Materials

The requirement of annual input materials on dry and net basis is given in Table 5-24.

**TABLE 5-24 – ANNUAL REQUIREMENT OF RAW MATERIALS**

| Material | Unit | Annual requirement |
|---|---|---|
| | | Phase-III |
| Charge pellet(1) | tons | 1,692,000 |
| Coke oven gas | Mill Gcal | 2.76 |
| Power | Mill kWh | 180 |
| Make-up water | Mill cu m | 2.4 |
| Oxygen | Mill Nc u m | 84 |

**Note:**

(1) Quantities are on net and dry basis.

### 5.7.4 DRI Quality

The expected DRI analysis is given below:

| | | |
|---|---|---|
| Total iron, % | .. | 87 |
| Metallisation, % | .. | 93 |
| Carbon, % | .. | 0.15 |

### 5.7.5 Major Facilities

The plant will comprise the following facilities:

a) Oxide feed charging system.

b) Thermal reactor system (including COG metering station, compressors, heat exchangers and thermal reactors).

c) Reduction furnace.

d) $CO_2$ removal system.

e) Gas compressors and mist eliminator.

f) Top gas waste heat boilers.

g) Gas handling and DRI handling facilities.

h) Cold DRI silos.

i) Water, utility electrics, Instrumentation, automation and communication systems.

## 5.8 STEELMELT SHOP

### 5.8.1 Plant Configuration

With consideration to production capacity, investment and operating expenses, two steel-melt shops (SMS-1 and SMS-2) have been envisaged to produce the flat and long products, respectively, to achieve target liquid steel production of 13.5 mtpy. SMS-1 will have an annual capacity of around 10.5 mtpy and SMS-2 will have annual capacity of around 3.0 mtpy and two steelmelt shops will be installed in phases.

SMS-1 will be constructed in Phase-I and Phase-II and SMS-2 will be constructed in Phase-III along with necessary upstream and downstream facilities.

Phase-wise steelmelt shop configuration will be as follows:

| **Phases** | **Equipment/Facilities** | |
|---|---|---|
| | **SMS-1** | **SMS-2** |
| Phase-I | a) 2 x 350 ton converters.<br>b) 2 x 350 ton ladle furnaces.<br>c) 1 x 350 ton RH degassing unit.<br>d) 2 x 2 strand conventional slab casters | - |
| Phase-II | a) 3 x 350 ton converters.<br>b) 3 x 350 ton ladle furnaces<br>c) 2 x 350 ton RH degassing units.<br>d) 3 x 2-strand conventional slab casters. | - |
| Phase-III | a) 3 x 350 ton converters.<br>b) 3 x 350 ton ladle furnaces.<br>c) 2 x 350 ton RH degassing units.<br>d) 3 x 2-strand conventional slab casters. | a) 2 x 180 ton converters.<br>b) 2 x 180 ton ladle furnaces.<br>c) 1 x 180 ton RH degassing unit.<br>d) 1 x 8-strand billet caster.<br>e) 1 x 6-strand billet cum bloom cum beam-blank caster. |

The production facilities will be adequately supported by necessary auxiliary facilities such as raw materials unloading and storage, proportioning of raw materials, electric power receiving and distribution stations, various utility facilities, water treatment and distribution system etc.

### 5.8.2 Production Programme

Total crude steel capacity of 13.2 mtpy has been envisaged to be built in 3 phases with one blast furnace installed in each phase.

***Phase-I:*** SMS-1 will be installed with two 350 ton converters, required secondary metallurgy units and two twin strand slab casters. Total metallic requirement of Phase-I will be met by hot metal from BF-1 and plant return scrap. The product-mix in the Phase-I has been envisaged to be flat product with part HRC and part value added through cold rolling complex. In Phase-I, SMS-1 will consume the hot metal produced in the blast furnaces and is envisaged to produce about 4.15 mtpy slabs. Although the shop will have an inherent capacity more than the above, the production will be restricted by the available hot metal.

***Phase-II:*** The third line of converter, secondary metallurgy and third twin strand slab caster will be added in Phase-II (SMS-1) to complete the facilities of the SMS-1. The second blast furnace will be installed in Phase-2 and necessary metallic requirement will be met by hot metal from BF-1 and BF-2 and plant return scrap.

***Phase-III:*** The entire capacity of the plant will be build up in this phase. The third blast furnace and a DR plant will be installed in this phase. This phase will be mainly built for expansion in long products. In order to cater to this product mix, the new SMS-2 will be installed with two 180 ton converters, matching secondary metallurgy units and two billet and billet-cum-bloom-cum-beam blank caster, with provisions for producing billets, blooms and beam blank as long product semis to cater to the required long product-mix. Necessary metallic requirement will be met by hot metal produced from BFs, DRI produced from DR plant and plant return scrap.

***Heat size:*** Since the product-mix from the steelmelt shops involve flat as well as long products, one shop (SMS-1 with higher heat size of 350 ton) will be utilised to produce flat product while other shop (SMS-2 with lower heat size of 180 ton) will be utilised to produce long product. Taking above into consideration, following BOF shop configuration is selected:

a) SMS-1 – 3 x 350 ton BOF,
b) SMS-2 – 2 x 180 ton BOF.

***Tap-to-tap time:*** The envisaged tap-to-tap time of converter for SMS-1 and SMS-2 is given in Table 5-25.

**TABLE 5-25 – CONVERTER TAP-TO-TAP TIME**

| Activity | Time, min |
|---|---|
| Charging of scrap | 2 |
| Charging of hot metal | 5 |
| Oxygen blowing | 16 |
| Deslagging and sampling | 5 |
| Reblow | 2 |
| Steel tapping | 6 |
| Slag off | 3 |
| Vessel inspection | 2 |
| Slag splashing | 2 |
| Unforeseen delays | 2 |
| **Tap-to-tap time** | **45** |

### 5.8.3 Converter Availability ( for SMS-1 and SMS-2)

***Lining life:*** An average life of around 6,000 heats is envisaged with the use of magnesia carbon bricks for lining. Considering the same, number of campaign for converters in SMS-1 and SMS-2 will be 5 campaigns/year and 3 campaigns/year respectively. Considering relining/ repairing time of 7 days/campaign, converters in SMS-1 will be under shutdown for 35 days and converters in SMS-2 will be under shutdown for 21 days for relining.

***Mid campaign maintenance:*** In view of the higher campaign life envisaged, provision for three mid campaign shutdowns for maintenance, especially for gas cleaning equipment, have been kept for 3 days/campaign. So, in a year, converters will be out of operation for the mid campaign maintenance for 15 days and 9 days respectively for SMS-1 and SMS-2.

***Annual maintenance:*** It has been assumed that each converter will be overhauled once in every 3 years and the duration for the same will be 15 days (excluding campaign shutdown time).

***Converter availability:*** Considering relining time, mid campaign maintenance, annual maintenance and unplanned outage of 2.5 per cent for each converter, total downtime for converters for SMS-1 and SMS-2 is furnished below:

| | **SMS-1** | **SMS-2** |
|---|---|---|
| Relining time | 35 | 21 |
| Mid-campaign maintenance | 15 | 9 |
| Annual maintenance | 15 | 10 |
| Unplanned outage | 27 | 18 |
| **Total** | **92** | **58** |

So, the annual converter availability for SMS-1 and SMS-2 will be as follows:

**SMS-1:**

| | | |
|---|---|---|
| 2 converter, days | .. | 92 |
| 3 converters, days | .. | 273 |

**SMS-2:**

| | | |
|---|---|---|
| 1 converter, days | .. | 58 |
| 2 converters, days | .. | 307 |

### 5.8.4 Caster Availability

For converting the liquid steel into semis (slabs/billets/ blooms/beam blanks), three twin-strand slab casters have been envisaged at SMS-1 and one eight strand billet caster and one six strand billet cum bloom cum beam blank caster have been envisaged for SMS-2. The availability of casters for SMS-1 and SMS-2 is furnished below:

***SMS-1 (Slab caster):*** Apart from the complete shop shut down for one day in a year, each caster will be out of operation for 35 days as given below:

| | **Days** |
|---|---|
| Monthly shut down, 2 x 12 hrs, each | 12 |
| Annual shut down, days | 5 |
| Unplanned outage, 5% | 18 |
| **Total** | **35** |

***SMS-2 (Billet caster and billet cum bloom cum beam blank caster):*** For billet caster, apart from the complete shop shut down for one day in a year, each caster will be out of operation for 35 days as given on the next page.

| | Days |
|---|---|
| Monthly shut down, 2 x 12 hrs, each | 12 |
| Annual shut down, days | 5 |
| Unplanned outage, 5% | 18 |
| **Total** | **35** |

For billet cum bloom cum beam-blank caster, apart from the complete shop shut down for one day in a year, each caster will be out of operation for 50 days as given below:

| | Days |
|---|---|
| Monthly shut down, 2 x 12 hrs, each | 12 |
| Annual shut down, days | 5 |
| Unplanned outage, 5% | 18 |
| Time for section size changing with other associated work | 15 |
| **Total** | **50** |

### 5.8.5 Estimation of Production Capacity of Continuous Casters

***Slab casters (SMS-1):*** The production capacity of continuous slab casting machines of SMS-1 has been estimated at 10.5 million tons considering the following operational parameters as given in Table 5-26.

**TABLE 5-26 – PRODUCTION CAPACITY ESTIMATION FOR SLAB CASTERS**

| Description | Parameter |
|---|---|
| **3 x 2-Strand Slab Caster** | |
| Heat size, tls | 350 |
| Reference slab size for calculation | 230 x 1,500 |
| Reference casting speed, m/min | 1.45 |
| No. of strand | 2 |
| Throughput, tons/min. | 7.65 |
| Average casting time, min | 46 |
| No. of heats in sequence | 32 |
| Preparation time, min | 50 |
| Sequence time, min | 1,522 |
| No. of sequence/day/caster | 0.95 |
| Possible no. of heats/day/caster | 30 |

| Description | Parameter |
|---|---|
| Caster availability, days | 330 |
| No. of heat cast per year/caster | 9,900 |
| Production capability, mtpy/caster | 3.5 |
| No. of caster | 3 |
| Production capability of casting shop | 10.5 |

***Billet caster and Billet cum bloom beam blank caster:*** The production capacity of continuous billet casting machine and billet cum bloom cum beam blank caster of SMS-2 has been estimated in table 5-27 and 5-28 respectively.

**TABLE 5-27 – PRODUCTION CAPACITY ESTIMATION FOR BILLET CASTERS**

| Description | Parameter |
|---|---|
| **1 x 8-Strand Billet caster** | |
| Heat size, tls | 180 |
| Reference section size | 160 x 160 |
| No. of strand considered for calculation | 7 |
| Average casting speed, m/min | 3.0 |
| Throughput, tons/min. | 3.71 |
| Average casting time, min. | 49 |
| No. of heats in sequence | 12 |
| Preparation time, min. | 40 |
| Sequence time, min. | 628 |
| No. of sequence/day | 2.30 |
| Possible no. of heats/day/caster | 27 |
| Caster availability, days | 330 |
| No of heat cast per year | 8,910 |
| Production capability per year per caster (mtpy of liquid steel) | 1.60 |
| No. of caster | 1 |
| Production capability of billet caster | 1.60 |

**TABLE 5-28 – PRODUCTION CAPACITY ESTIMATION FOR BILLET CUM BLOOM CUM BEAM-BLANK CASTERS**

| Description | Parameter |
|---|---|
| Heat size, tls | 180 |
| Reference section size | 280 x 320 |
| Throughput considered, tons/min | 3.2 |
| Average casting time, min. | 56 |
| No. of heats in sequence | 8 |
| Preparation time, min. | 48 |
| Sequence time, min. | 496 |
| No. of sequence/day | 2.90 |
| Possible no. of heats/day/caster | 23 |
| Caster availability, days | 315 |
| No of heat cast per year | 7240 |
| Production capability per year per caster (mtpy of liquid steel) | 1.30 |
| No. of caster | 1 |
| Production capability of billet cum bloom cum beam-blank caster | 1.30 |

**5.8.6 Charge-mix**

Considering the availability of hot metal, the proposed charge-mix for the converter shop for SMS-1 after Phase-I and Phase-II will be as shown below:

| | Specific consumption, kg/tls |
|---|---|
| Hot metal | 988 |
| Cold pig iron | 58 |
| Scrap | 66 |
| Iron ore | 10 |
| DRI | - |

Charge-mix for SMS-1 and SMS-2 after Phase-III will be as shown below:

| | **Specific consumption, kg/tls** |
|---|---|
| Hot metal | 939 |
| Cold pig iron | 54 |
| Scrap | 58 |
| Iron ore | 10 |
| DRI | 61 |

### 5.8.7 Raw Materials and Utilities Requirement

Hot metal produced from blast furnace is envisaged to have the following average specification:

Si .. 0.60%
P .. 0.45% max
S .. 0.045% max

It is envisaged that 100 per cent hot metal will be desulphurised to have low input 'S' in the converter. Based on the input hot metal chemistry and charge-mix, the lime requirement has been estimated as 72 kg/ton.

Low silica dolomite will be charged to the converter to enhance lining life. Dolomite portion in total flux charge will be determined by MgO saturation limit in BOF slag.

Sized plant return scrap, cold pig iron and iron ore will be used as basic coolant for converter heats upto Phase-II. Apart from the above coolants, DRI will be additionally used as coolant after Phase-III. Calcined lime will be used as flux. Ferro manganese, ferro silicon, silico manganese and aluminium will be used for deoxidising and alloying of steel. Fine lime, aluminium dross and sinter fines are envisaged to be used for hot metal pre-treatment.

Yield of liquid steel from metallic input has been envisaged around 90 per cent and that of cast slab and cast billets from liquid steel as 98 per cent and 97.5 per cent respectively. Estimated requirement of major charge materials and utilities are indicated in Table 5-29.

**TABLE 5-29 – CHARGE MATERIALS AND UTILITIES REQUIREMENT**

| | Unit | Annual consumption | | |
|---|---|---|---|---|
| | | Phase-I | Phase-II | Phase-III |
| **Raw materials** | | | | |
| - Hot metal | tons | 4,240,000 | 8,480,000 | 12,730,000 |
| - Scrap | tons | 282,000 | 564,000 | 821,000 |
| - Cold pig | tons | 247,000 | 494,000 | 731,500 |
| - Lime | tons | 307,440 | 614,880 | 971,280 |
| - Dolime | tons | 42,700 | 85,400 | 134,900 |
| - DRI | tons | | | 823,000 |
| **Utilities** | | | | |
| - $O_2$ | Mill N cu m | 312 | 623 | 984 |
| - $N_2$ | Mill N cu m | 260 | 521 | 823 |
| - Ar | Mill N cu m | 7 | 14 | 22 |

### 5.8.8 Major Facilities in SMS

The major facilities proposed to be installed in the SMS-1 are briefly described below:

***Scrap handling facilities:*** Processed scrap will be received by road in the scrap aisle where about 2 to 4 days requirement of scrap can be stocked. The aisle will be served by two EOT magnet cranes. Scrap will be loaded into scrap boxes for charging into the converters. Two self-propelled transfer cars will transfer the scrap boxes from the scrap aisle to the charging aisle. Each transfer car will be equipped with a track scale. Scrap charging will be done in the charging aisle using either hot metal charging crane or dedicated scrap charging crane. Scrap handling methodology will remain same for both SMS-1 and SMS-2.

**Scrap Balance for Phase-I**

Plant return scrap in tpy:

| | | |
|---|---|---|
| BOF | .. | 29,890 |
| Slab casters | .. | 64,050 |
| HSM | .. | 56,500 |
| CRM | .. | 133,050 |
| **Total** | **..** | **283,490** |
| Scrap to be used in BOFs | .. | 283,490 |
| Scrap to be purchased | .. | - |

**Scrap Balance for Phase-II**

Plant return scrap in tpy:

| | | |
|---|---|---|
| BOF | .. | 59,780 |
| Slab casters | .. | 128,100 |
| HSM | .. | 113,000 |
| CRM | .. | 266,000 |
| **Total** | **..** | **566,880** |
| Scrap to be used in BOFs | .. | 566,880 |
| Scrap to be purchased | .. | - |

**Scrap Balance for Phase-III**

Plant return scrap in tpy:

| | | |
|---|---|---|
| BOF | .. | 94,430 |
| Slab casters + Billet caster | .. | 202,350 |
| HSM + Plate mill | .. | 205,120 |
| Wire rod/Rebar/Medium section mill | .. | 77,000 |
| CRM | .. | 243,700 |
| **Total** | **..** | **822,600** |
| Scrap used in BOFs | .. | 822,600 |
| Scrap to be purchased | .. | - |

***Hot metal handling & treatment facilities:*** Hot metal will be supplied in torpedo ladle car of capacity around 370 tons. Hot metal from torpedo ladle will be poured into hot metal charging ladle placed on a transfer car. There will be two torpedo pits and three torpedo car tracks for unloading of hot metal into the charging ladle.

To meet the quality requirement of various steel grades, three mechanical stirring type desulpherisation stations will be provided for SMS-1 (two desulphurisarisation station will be installed in Phase-I and third desulphurisation station will be installed in Phase-II) and two desulphurisation station will be installed for SMS-2. These stations will be capable of processing 100 per cent of hot metal on daily basis. The desulphursiation units will be equipped with lime and other additive addition facility. The stations will be complete with day bins, dispensers, hot metal transfer cars and slag raking facilities. Fume extraction facility has also been envisaged.

***Converter and associated facilities:*** Three number 350 ton BOFs of symmetrical shape with useful volume of about 330 cu m are envisaged for SMS-1(two BOF will be installed in Phase-I and third BOF will be installed in phase Phase-II) and two 180 ton BOFs of symmetrical shape with useful volume of about 170 cu m are envisaged for SMS-2.

The converters will have integral bottom and will be provided with hollow trunnions for installation of combined blowing facilities. Slag splashing system will also be considered. Provision for sub-lance installation will be kept in the converter for better end-point control, reducing re-blows and allowing direct tapping practice.

Major design parameters for the 350 ton BOF and 180 ton BOF will be as follows:

| | **SMS-1 (350 ton)** | **SMS-2 (180 ton)** |
|---|---|---|
| Specific volume, cu m/ton | 0.94 | 0.94 |
| h/D ratio | 1.4-1.5 | 1.4-1.5 |
| Speed of rotation, rpm | 0.1-1.0 | 0.1-1.0 |
| No. of motors tilt drive | 4 | 4 |
| Number of holes in lance | 6 | 6 |
| Number of holes for bottom stirring | 14 | 8 |

***BOF gas cleaning plant:*** The converters of both the shops (SMS-1 and SMS-2) will be equipped with gas collection, cleaning and recovery system. The gas cleaning system will be designed with an air factor of 0.10. The gas cooling system will be of evaporative cooling type. Sensible heat of the off gas will be utilised to generate steam. The gas cleaning system will be dry type (comprises gas conditioning tower, ESP, gas cooling tower) and will have necessary analysers and automation. The ID fan will have adequate capacity to handle the generated gas. The initial gas before the start of collection will be flared in a flare stack. The dust emission level in the flare stack shall be within 20 mg/N cu m. The gas cleaning system will be designed taking into consideration the following parameters:

Maximum oxygen flow rate for SMS-1 and SMS-2 in N cu m/min:

| | **SMS-1 (350 ton)** | **SMS-2 (180 ton)** |
|---|---|---|
| Total | 1,400 | 720 |
| From lance | 1,100 | 560 |
| From iron ore | 300 | 160 |
| Maximum iron ore feed rate, kg/min | 1500 | 800 |

| | SMS-1 (350 ton) | SMS-2 (180 ton) |
|---|---|---|
| Air factor | 0.1 | 0.1 |
| Dust load of clean gas at ID fan outlet, mg/N cu m | 10 | 10 |

The dust level of the LD gas at the inlet of the gas holder or outlet of the gas cooling tower is 10 mg/N cu m. For gas recovery from SMS-1and SMS-2, one gas holder of 150,000 cu m has been envisaged. A gas export system has been envisaged downstream of the gas holder comprises duct, dampers, booster fans, U-seal etc.

Proper handling of dust from gas cleaning facilities to dust briquetting/pelletising plant is envisaged by using pneumatic conveying system to dust silo and dust carrying tanker.

***Secondary emission control:*** Secondary emission control facilities will be provided to collect and clean the fugitive gases and fumes generated at the time of converter charging/tapping/blowing, argon rinsing operation, desulphurisation stations, deslagging etc. System shall be designed for work zone dust level within 3 mg/N cu m over and above the ambient dust concentration and stack emission up to 30 mg/N cu m.

***Flux handling facilities:*** Calcined flux, iron ore and other materials will be transported by a conveyor from a junction house and charged to the high level bunkers in the converter aisle by a shuttle conveyor. A set of high level bunkers complete with vibratory-feeders, weigh hoppers, chutes, surge bins etc. will be provided for each converter. Flux handling methodology will remain same for both SMS-1 and SMS-2.

***Ferro-alloy handling facilities:*** Ferro-alloys will be received in the converter building by a conveyor from a junction house and charged to the designated bins in the converter aisle by a shuttle conveyor. Automatic batching, sequencing and charging system, including control of vibrating feeders, weigh hoppers etc. from the control room as well as from tapping pulpit will be provided. Ferro-alloys handling methodology will remain same for both SMS-1 and SMS-2.

***Steel handling facilities:*** After tapping the heat, the steel ladle will be transferred to the online argon rinsing station by steel ladle transfer car and subsequently to the secondary refining aisle for further secondary metallurgical treatment.

***Slag handling facilities:*** The BOF slag will be poured into slag pots placed on the transfer car running below the converters and moved to the slag aisle. The liquid slag will be dumped into pit and disposed off by pay-loader and dumper after cooling. Alternately, converter slag granulation can be considered. In both the cases, metallic portion from the slag will be recovered for reuse in the steel plant. The non-metallic portion can be used for road making, ground filling and railway ballast.

***Inert gas rinsing station:*** Online inert gas rinsing facility will be provided after each converter. Rinsing can be through bottom porous plug and/or top lance. The liquid steel will be rinsed with argon/nitrogen for equalising the temperature and the composition. Facility for ferro-alloy addition and aluminium addition through wire feeder is also envisaged to be installed. Auto-coupler will be provided for bottom purging of ladle through porous plug.

***Ladle furnaces:*** Three 350 ton ladle furnaces will be located in secondary refining aisle for SMS-1 and two 180 ton ladle furnaces will be located in secondary refining aisle for SMS-2. The ladle furnaces will be capable of performing heating, alloy adjustment, desulphurisation, inert gas stirring, carbon injection and wire feeding. The unit will be complete with facilities for alloy storage, batching and charging, sampling and temperature measurement and wire addition facilities. The furnaces will be equipped with water cooled furnace cover with raising and lowering facilities. The salient features of the ladle furnaces for SMS-1 and SMS-2 are as follows:

| | **SMS-1** | **SMS-2** |
|---|---|---|
| Type of unit | Arc heating and inert gas stirring | |
| Heat size, tons | 350 | 180 |
| Rate of heating, °C/min | Approx 4 | Approx 4 |
| Transformer rating | Approx. 50 MVA | Approx. 30 MVA |

***RH degassing unit:*** Two RH degassing units will be located in the secondary refining aisle of SMS-1 and one RH degassing unit will be located in the secondary refining aisle of SMS-2. The RH will be provided to produce quality steel by removal of carbon, hydrogen and oxygen to the desired level. A ferro-alloy addition system will be provided for addition of trimming alloys under vacuum.

***Ladle preparation facilities:*** The steel teeming ladles will be equipped with slide-gate nozzle, adequate free-board and porous plug. Slide gate setting, ladle cleaning, preheating facilities will be provided in the ladle preparation aisle. Online ladle heaters will be provided over the steel transfer car track for preheating the ladle while waiting for tapping. Vertical ladle driers will be provided for heating newly relined ladles. Ladle debricking, deskulling and relining facilities will also be provided.

***Continuous casting machines:*** Major design considerations for slab casters for slabs to be produced for HSM:

| | | |
|---|---|---|
| Number of strands | .. | 2 |
| Slab width, mm | .. | 800-2,100 |
| Slab thickness, mm | .. | 230,250 |
| Maximum slab weight, ton | .. | 50 |
| Maximum slab length, mm | .. | 12,000 |

Major design considerations for slab casters for slabs to be produced for HSM and plate mill:

| | | |
|---|---|---|
| Number of strands | .. | 2 |
| Slab width, mm | .. | 1200-2,600 |
| Slab thickness, mm | .. | 230,250,300 |
| Maximum slab weight, ton | .. | 30 |
| Maximum slab length, mm | .. | 4,800 |

The 2-strand slab caster(s) will be provided with the following:

a) Ladle turret, ladle cover manipulator and ladle shroud manipulator.

b) Tundish & tundish cars.

c) Tundish pre-heater.

d) Emergency equipment.

e) Mould, automatic mould level control system, EMBr.

f) Mould fumes exhaust system etc.

g) Mould oscillation equipment.

h) Segments with secondary water spray system.

i) Roll gap monitoring system.

j) Dummy bar and storage system.

k) Bending unit.

l) Torch cutting equipment.

m) Marking equipment.

n) Utilities, lubrication & hydraulic systems.

o) Technological steel structures.

p) Tundish preparation facilities.

q) Mould and segment repair & maintenance facilities.

Considering the potential of primary steel making units, the casters shall be designed with provision of additional segments. The installation of additional segments will increase caster metallurgical length and thereby, help in increasing caster productivity.

Billet caster and billet cum bloom cum round caster will be provided with the following:

a) Ladle turret.

b) Ladle shroud manipulator.

c) Tundish and tundish handling device.

d) Tundish preheater.

e) Emergency equipment.

f) Submerged entry nozzle.

g) Mould.

h) Mould oscillation equipment.

i) Automatic mould level control system.

j) Strand guide system.

k) Mould cooling, spray cooling and machine cooling systems.

l) Steam exhaust system.

m) Withdrawal and straightening units.

n) Dummy bar system.

o) Cutting equipment.

p) Utilities, lubrication and hydraulic systems.

q) Technological steel structures.

r) Tundish preparation facilities.

s) Mould repair and maintenance facilities.

***Discharge equipment:*** The discharge section for slab caster will consist of run out roller table, disappearing stops and collecting bed. Considering the caster capacity, slab lifting arrangement from two different bays is envisaged. The discharge section for billet and billet cum bloom cum beam blank caster will consist of intermediate roller table, cutting roller table, transport roller table, discharge roller table and walking beam cooling bed.

***Slab handling:*** Slabs produced from the three casters will be stored and inspected in slab storage area. The slabs will be fed to the hot strip mill and plate mill which will be connected by slab transfer cars. Slab storage capacity of the yard is as follows:

| | | |
|---|---|---|
| Slab yard capacity, tons | .. | 163,000 |
| Storage available for, days | .. | 5-6 |

***Billet handling:*** Billets/blooms/beam blanks produced from two billet casters will be stored and inspected in the billet storage area. The billets will be fed into the wire rod mill and rebar mill and Blooms and beam blanks will be fed to medium section mill. Billet storage capacity of the yard is as follows:

| | | |
|---|---|---|
| Billet yard capacity, tons | .. | 71,000 |
| Storage available for, days | .. | 7-8 |

## 5.9 CALCINING PLANT

The calcining plant will produce lime and dolime to be used in steelmelt shops. The size of calcined products will be 10 to 80 mm and calcined products will be screened before conveying to steelmelt shops. The undersize lime and dolime fines will be transferred to Sinter/Pellet plant. Considering the total liquid steel capacity as about 13.5 mtpy, the phase wise net annual requirement of calcined products for steelmelt shops has been estimated and given in Table 5-30.

**TABLE 5-30 – NET REQUIREMENT OF CALCINED PRODUCTS**

| Calcined product | Net requirement | | |
|---|---|---|---|
| | **Phase-I** | **Phase-II** | **Phase-III** |
| Lime, tpy | 307,000 | 614,000 | 972,000 |
| Dolime, tpy | 42,000 | 84,000 | 134,000 |

### 5.9.1 Plant Capacity and Configuration

Based on the flux requirement in steelmelt shop, it is proposed to install two vertical shaft kilns each of 600 tpd capacity in each phases and one vertical shaft kiln in Phase-I only to meet the requirement of lime and dolime respectively.

### 5.9.2 Design Basis

It is proposed to install vertical shaft kiln of proven design to produce soft burnt highly reactive lime and dolime for all the phases. On the basis of net requirement, the phase wise gross production of flux is indicated in Table 5-31.

**TABLE 5-31 – GROSS REQUIREMENT OF FLUX**

| Calcined product | Gross production | | |
|---|---|---|---|
| | **Phase-I** | **Phase-II** | **Phase-III** |
| Lime, tpy | 361,200 | 722,400 | 1,143,500 |
| Dolime, tpy | 49,400 | 98,800 | 157,600 |

The gross production figures include the product dust loss and undersize which will be screened out. It is considered necessary to keep extra capacity by about 10 per cent in the kiln to take care of the fluctuation in the specific consumptions and variation in raw materials quality. Hence, based on 330 days working in a year, the phase wise daily peak requirement of calcined products are given in Table 5-32.

**TABLE 5-32 – PEAK REQUIREMENT OF CALCINED PRODUCTS**

| Calcined product | Peak requirement | | |
|---|---|---|---|
| | **Phase-I** | **Phase-II** | **Phase-III** |
| Lime, tpd | 1203 | 2407 | 3811 |
| Dolime, tpd | 164 | 329 | 525 |

In view of above, it is proposed to install two vertical shaft kilns each of 600 tpd capacity in each phases and one vertical shaft kiln in Phase-I to meet the requirement of lime and dolime respectively. It is not required to install any vertical shaft kiln for the production of dolime in any other two phases, as the installation of dolime kiln will meet the requirement of entire dolime requirement. The installed kiln in Phase-I for dolime production can also be used for production of lime in batches.

### 5.9.3 Raw Materials

The limestone and raw dolomite imported from Middle-East countries having low impurities are proposed to be used. The typical chemical analysis of this limestone and raw dolomite is given in Table 5-33.

**TABLE 5-33 – RAW MATERIALS ANALYSIS**

| **Limestone** | | | | |
|---|---|---|---|---|
| **CaO, %** | **MgO, %** | **$SiO_2$, %** | **$Al_2O_3$, %** | **LOI, %** |
| 54-54.5 | 1.0 | 0.5-0.6 | 0.2-0.3 | 43.00 |
| **Raw Dolomite** | | | | |
| **CaO, %** | **MgO, %** | **$SiO_2$, %** | **$Al_2O_3$, %** | **LOI, %** |
| 28-30 | 19-20 | 1.1-1.5 | 0.50 | 45.00 |

The feed size of raw materials will be in the range of 40 to 80 mm.

### 5.9.4 Consumption of Input Materials

In order to produce soft burnt, highly reactive lime and dolime it is required to charge limestone and raw dolomite in the kilns. On the basis of net flux requirement, the phase wise consumption of raw material is indicated in Table 5-34.

**TABLE 5-34 – CONSUMPTION OF RAW MATERIAL**

| **Raw material** | **Peak requirement** | | |
|---|---|---|---|
| | **Phase-I** | **Phase-II** | **Phase-III** |
| Limestone, tpy | 742,500 | 1,484,900 | 2,350,700 |
| Raw Dolomite, tpy | 101,600 | 203,200 | 324,000 |

### 5.9.5 Product Quality

Flux required in steelmelt shop will be in the size range of 10 to 80 mm. Temperature of discharged calcined flux shall be maximum 100°C. Reactivity of the calcined flux will be more than 350 ml 4 (N) HCL in 5 mins on the average.

### 5.9.6 Plant Facilities

The calcining plant will comprise of facilities for raw materials storage, screening and handling, kiln with kiln feed building, calcined products storage, handling and screening facilities.

***Raw materials handling:*** Sized limestone and raw dolomite will be delivered to the plant over a system of belt conveyors to the kiln feed building bunkers. In order to separate out the fines generated during handling, raw materials will be screened before being fed into the kiln. The kiln feed building will house raw materials screening facilities. The screened limestone and raw dolomite will be fed into the kilns by means of skip hoist and stone distribution system located at kiln top.

***Shaft kiln:*** The shaft kilns will be installed on a specially designed RCC platform. The kilns will be designed with required combustion system, instruments and controls. The kilns will be lined with suitable grade of refractories. The kilns will be provided with interconnecting structural platforms at different heights, stairs and common freight cum passenger elevator for operation and maintenance. Mixed gas (BF+CO+BOF gas) having calorific value of 1800 kcal/N cu m will be used as fuel for calcination purpose.

***Product handling:*** For conveying calcined products from below the kilns, belt conveyors will be provided. Calcined products will be stored in bunkers. The undersize fraction of calcined products will be stored in separate bunker and will be despatched in close container to sinter/pellet plant.

***Other facilities:*** In order to house the blowers, electrical equipment, instrument and controls, a multi-storied building will be constructed. The kiln automation system will be housed in this building. Various utilities, such as electric power, water, compressed air etc, as well as fuel will be made available to the plant. The plant will be provided with kiln waste gas cleaning system and dedusting system for raw material and product handling facilities.

## 5.10 HOT STRIP MILL (HSM)

It is proposed to install two hot strip mills, one each in Phase-I and Phase-II. Each hot strip mill will be designed for a production of 5.5 mtpy of Hot Rolled Coils (HRC). Keeping in view the production capacities desired, the upstream facilities and availability of land, a semi-continuous hot strip mill has been selected.

### 5.10.1 Design Basis

The design basis for the hot strip mill will be as follows:

***Input:*** Continuous cast slab of following size will be used as input for the hot strip mill:

| | | |
|---|---|---|
| Width, mm | .. | 800-2,100 |
| Thickness, mm | .. | 230(1) |
| Length, mm | .. | 11,000 |
| Slab weight (max), tons | .. | 40 |

**Note:**

(1) HSM will be designed for 230 to 250 mm thick input slabs.

***Grades of steel:*** The HSM will be capable of rolling low, medium and high carbon steel; API X-80 steel; IF; dual phase and multi-phase steels; high strength low alloy steel and silicon steel (non-grain oriented).

***Finished product:*** The HR coil size will be as follows:

| | | |
|---|---|---|
| Width, mm | .. | 800-2,050 |
| Thickness, mm | .. | 1.2-25.0 |
| Coil weight (max), tons | .. | 1.2-25.0 |

***Mill availability:*** The annual mill availability is expected to be about 7,900 hrs, based on 90 per cent working ratio.

***Yield:*** An average yield figure of 98.0 per cent has been considered from slabs to hot rolled coils.

***Slab requirement:*** The slab requirement for production of 5.5 mtpy hot rolled coils, considering the above yield figure will be about 5.61 mtpy.

### 5.10.2 Process Flow

Continuous cast slabs will be received in the slab yard of HSM and charged into the reheating furnaces, according to the HSM rolling schedule.

The slabs will be heated in walking-beam type reheating furnace. The heated slabs will be extracted by slab extractors located at furnace discharge side. The scale on the slabs will be removed by a high pressure water jet. The hot slabs will be rolled to transfer bars by reversing passes in two roughing mill stands.

A delay table will be provided between the second roughing mill stand and finishing mill to accommodate the transfer bar, and a crop shear will be provided before the finishing mill to crop the head and tail ends of the bar. The transfer bar will then pass through the secondary descaler to remove the secondary scale. The descaled transfer bar will be rolled further to the desired thickness in the finishing mill train. The rolled strip coming out of the finishing stands will be cooled to the desired coiling temperature on the run-out table, provided with laminar water cooling sprays. The strip will then be coiled in the downcoiler.

The coiled strip will be transported by conveyors to the coil yard for storage and despatch.

### 5.10.3 Major Equipment/Facilities

The major equipment/facilities proposed to be installed will include the following:

a) Slab yard equipment (hot charging roller table from SMS to slab reheating furnace and slab transfer car).

b) Three 350 tph walking beam type slab reheating furnaces. However the number and capacity of the reheating furnace will be finalised during execution stage.

c) High pressure water descaling system at a) primary descaler and b) secondary descaler. Water at approx. 200 bar pressure will be sprayed on the slabs/transfer bar for descaling.

d) Roughing mill equipment comprising; 2-hi and 4-hi reversing roughing mill stands with attached vertical edgers.

e) Delay roller table with heat retention covers.

f) Seven finishing mill stands. Finishing mill stands will be provided with quick work roll changing, profile and flatness control system and work roll bending system. Work rolls will be transferred directly to roll shop.

g) Measuring gauges will be provided at the exit of finishing mill for temperature, thickness, strip profile and flatness. Automatic surface inspection system for top strip surface at the exit of finishing mill and for bottom at the entry of downcoilers will be provided.

h) Run-out roller table with laminar cooling water system suitable for all the grades as per production programme.

i) Three hydraulic downcoilers.

j) Coil conveyors with coils transported with coil eye horizontal. Sampling station for sample cutting and coil inspection line will be provided. Coil strapping, weighing and marking machines will be provided along with coils storage and handling system

k) Roll shop with CNC work roll grinding machines and CNC back-up roll grinding machine will be provided. In addition, work roll cooling; chock changing; bearing cleaning and inspection; chock tilter; lathe; shear blade grinder etc. will also be provided in the roll shop.

l) Express laboratory.

Other than the above the shop will be provided with, recirculating water system, and utility services, i.e. fuel system, compressor, chiller plant etc.

## 5.11 PLATE MILL

A 5 m wide plate mill is proposed to be installed in Phase-III of the project. The plate mill will be designed for a production of 1.5 mtpy of plates.

### 5.11.1 Design Basis

The design basis for the plate mill will be as follows:

**Input material**

| | | |
|---|---|---|
| Material | .. | Continuous cast slabs |
| Thickness, mm | .. | 230,250,300[(1)] |
| Width, mm | .. | 1,200 - 2,600 |
| Length, mm | .. | 2,500 - 4,800 |

**Note:**

(1) Plate mill will be designed for slab of thickness 180 mm to 300 mm.

***Grades of steel:*** The plate mill will be capable of rolling structural, boiler quality, ship building, pressure vessel, API up to X-100 steel etc.

**Output material**

| | | |
|---|---|---|
| Material | .. | Finished plate |
| Thickness, mm | .. | 5 - 100 |
| Width, mm | .. | 1,500 - 4,800 |
| Length, mm | .. | 6 - 24 |
| Plate weight, ton | .. | 30 (max.) |

***Mill availability***: The annual mill availability is expected to be about 7,600 hours, based on about 87 per cent working ratio.

***Yield:*** An average yield figure of 92 per cent has been considered from slabs to hot rolled coils.

***Slab requirement:*** The slab requirement for production of 1.5 mtpy of plates, considering the above yield figure will be about 1.63 mtpy.

**5.11.2 Process Flow**

The continuous cast slabs from the caster shop will be received in the slab yard of the mill. The slabs will be inspected and conditioned as required. Slabs will be charged onto the charging roller table of the reheating furnace by EOT crane. Slabs will be heated to a temperature of around 1250°C. The hot slabs will be put on the furnace discharge roller table by a slab discharging mechanism and will be descaled in a high pressure descaler.

The slabs will be rolled in a 4-hi reversing roughing mill through cross rolling, as required. The mill stand will be provided with the following facilities:

a) Vertical edger.
b) Turntable and centering guides at entry and exit.
c) Work-roll bending.
d) HAGC system.

The intermediate slabs will be further rolled in a 4-high reversing finishing mill. The finishing stand will have the following facilities:

a) Turn table.
b) Centering guides at entry and exit.
c) Work-roll bending and shifting.
d) HAGC system.

The finished rolled plate will be processed in hot pre-leveller followed by accelerated cooling facility. Thereafter the plates will pass through hot leveller and will go to the cooling beds. Heavy plates (>50 mm thickness) will pass through walking beam type cooling bed, and plates below 50 mm thickness will pass through disc type cooling bed.

The heavy plates will be placed on a slow cooling grid and then inspected and flame cut. Lighter plates will pass through finishing facilities comprising of inspection, testing, shearing, trimming, slitting, dividing, leveling and marking.

**5.11.3 Major Equipment/Facilities**

The major equipment/ facilities for the plate mill will include the following:

i) Two walking beam type reheating furnace of 180 tph capacity each.

ii) Primary descaling box.

iii) Roughing stand with edger, turntables and centering guides.

iv) Delay roller table.

v) Finishing stand with turntable and centering guides.

vi) Thickness gauge, width gauge, profile gauge.

vii) Preleveller.

viii) Direct quenching and accelerated cooling system.

ix) Hot leveler.

x) Hot marking machine.

xi) Walking beam type cooling bed.

xii) Slow cooling grid.

xiii) Plate turnover device for heavy plates.

xiv) Flame cutting machine.

xv) Disc type cooling bed.

xvi) Inspection table with turnover device.

xvii) Ultrasonic testing (UST) machine.

xviii) Crop shear.

xix) Double side trimmer shear.

xx) Slitting shear.

xxi) Dividing shears.

xxii) Cold leveler.

xxiii) Marking machines.

xxiv) Plate pilers.

xxv) Normalising facilities.

xxvi) Warm leveler.

xxvii) Future provision for quench and temper line.

xxviii) Roll shop, recirculating water system, laboratory, cranes etc.

Other than the above the shop will be provided with, utility services, i.e. fuel system, compressor, chiller plant etc.

## 5.12 COLD ROLLING MILL COMPLEX

The cold rolling mill complex is planned to produce cold rolled continuous annealed (CRCA) coils, galvanised coils (commercial and autobody grade), colour coated coils, cold rolled non-oriented (CRNO) silicon steel and tinplate coils from the HR coils.

### 5.12.1 Design Basis

***Input material:*** The size range and weight of the HR coils for CRM complex are envisaged as follows:

| | | |
|---|---|---|
| Strip width, mm | .. | 800-1,890 |
| Strip thickness, mm | .. | 2.0-6.0 |
| Coil weight, tons | .. | 38 (max.) |

***Product-mix:*** Two cold rolling mill complex will be installed, one each in Phase-I and Phase-II. The design capacity of cold rolled products are summarised in Table 5-35. However, the production envisaged in respective phases of development is as per the availability of semis as given in material balance for respective phases.

**TABLE 5-35 – DESIGN CAPACITY OF COLD ROLLED PRODUCTS**

| Product | Phase-I, mtpy | Addition in Phase-II, mtpy | Overall configuration after Phase-II, mtpy |
|---|---|---|---|
| Continuous Annealing line Coil (CRCA) | 1.0 | 1.0 | 2.0 |
| Galvanised coil/sheets | 1.0 | 1.0 | 2.0 |
| Colour coated coil | 0.5 | 0.5 | 1.0 |
| Tin plated coil | 0.25 | 0.25 | 0.5 |
| Silicon steel coil (CRNO) | 0.25 | 0.25 | 0.5 |

***Major units in CRM complex:*** Major units of CRM complex are given in Table 5-36 alongwith their design capacities.

**TABLE 5-36 – DESIGN CAPACITY OF COLD ROLLING FACILITIES**

| Facility | Phase-I, mtpy | Addition in Phase-II, mtpy | Overall configuration after Phase-II, mtpy |
|---|---|---|---|
| Pickling Line and Tandem Cold Rolling Mill (PLTCM) | 1 x 2.3 | 1 x 2.3 | 2 x 2.3 |

| Facility | Phase-I, mtpy | Addition in Phase-II, mtpy | Overall configuration after Phase-II, mtpy |
|---|---|---|---|
| Continuous Annealing Line (CAL) | 1 x 1.0 | 1 x 1.0 | 2 x 1.0 |
| Hot dip Continuous Galvanising Line (CGL) | 2 x 0.5 | 2 x 0.5 | 4 x 0.5 |
| Colour coating line | 2 x 0.25 | 2 x 0.25 | 4 x 0.25 |
| Pickling line for tin plate | 1 x 0.25 | 1 x 0.25 | 2 x 0.25 |
| Reversing cold rolling mill for tinplate | 1 x 0.25 | 1 x 0.25 | 2 x 0.25 |
| Continuous annealing line for tinplate | 1 x 0.25 | 1 x 0.25 | 2 x 0.25 |
| Temper mill for tinplate | 1 x 0.25 | 1 x 0.25 | 2 x 0.25 |
| Electrolytic tinning line | 1 x 0.25 | 1 x 0.25 | 2 x 0.25 |
| Tandem annealing and coating line | 1 x 0.25 | 1 x 0.25 | 2 x 0.25 |

Other than the above, finishing facilities, i.e. recoiling and inspection line, slitting line, shearing line and packaging lines will be provided. The facilities envisaged for the above mentioned production units are presented in the following pages.

### 5.12.2 Pickling Line and Tandem Cold Mill (PLTCM)

***Process description:*** The combined continuous pickling and cold rolling process has significant advantages over "batch process" in terms of productivity, yield and cost. The coupled process eliminates the following process steps:

a) Rewinding coil at the exit of pickling line.

b) Oiling the pickled coil.

c) Coil banding.

d) Pickling line exit side conveyors.

e) Storage and handling of semi finished pickled and oiled coils.

f) Coil preparation line for the mill.

g) Pay-off reel for the mill.

Further, it requires less space by avoiding intermediate coil storage and coil handling. Capital cost will also be lower compared to provision of separate continuous pickling line and continuous tandem cold mill.

***Design basis*:** The design basis for the PLTCM is as follows:

| | | |
|---|---|---|
| Nominal capacity, mtpy | .. | 2.3 |
| Pickling medium | .. | Hydrochloric acid |

**Input coil size**

| | | |
|---|---|---|
| Strip width, mm | .. | 800-1,890 |
| Strip thickness, mm | .. | 2.0-6.0 |
| Coil weight, ton | .. | 38 (max.) |

**Output coil size**

| | | |
|---|---|---|
| Strip width, mm | .. | 750-1,850 |
| Strip thickness, mm | .. | 0.28-3.2 |
| Coil weight, ton | .. | 38 (max.) |

***Mill availability:*** The annual mill availability is expected to be about 7,896 hrs, based on 90 per cent working ratio.

***Yield:*** An average yield of 98 per cent has been considered from HR coil to full hard coil produced form PLTCM.

***HR coil requirement:*** HR coil requirement for production of 2.3 mtpy of full hard coils, considering the above yield figure will be about 2.35 mtpy.

***Grades of steel:*** The line will be capable of processing construction and automotive grades.

***Major equipment*:** The PLTCM will have the following major process equipment:

a) Entry coil conveyor.
b) Entry coil car.
c) Coil preparation stations.
d) Pay-off reel.
e) Welder.
f) Entry looper.
g) Pickling line.
h) Exit looper.
i) Side trimmer.
j) 4/6-hi five stand tandem mill.
k) Exit shear.
l) Carousel reel/tension reel.
m) Exit coil car.
n) Exit coil conveyor.

Auxiliary facilities will include matching capacity of acid regeneration plant and neutralisation plant, roll shop, recirculating water system, repair post etc.

### 5.12.3 Continuous Annealing Line (CAL)

For this project, two CALs has been selected one each in Phase-I and Phase-II. The capacities of each line will be about 1,000,000 tpy.

***Design basis*:** The design basis for the CAL will be as follows:

Nominal capacity, tpy .. 1,000,000

**Coil size**

| | | |
|---|---|---|
| Strip width, mm | .. | 750-1,850 |
| Strip thickness, mm | .. | 0.3-3.2 |
| Coil weight, ton | .. | 38 (max.) |

The strip dimension for individual CALs can be planned, as one CAL dedicated for thinner strip and other for thicker strip, however the same could be finalised during engineering stage.

***Process description:*** The annealing process comprises heating, holding of the material at an elevated temperature (soaking), and gradual cooling of the material. The annealing of cold rolled coils is conventionally conducted by stacking and heating the coils in batches stacked in a batch/bell type annealing furnace. This process is called "batch annealing".

However, for Dual Phase (DP) steel, IF steel and other high strength steels, it is recommended to anneal through the CAL in order to impart special desired properties which is not possible in batch/bell annealing furnaces (BAF). CAL is advantageous as the process results in strip with better shape and uniform quality. It can also cater to fairly large volume of production.

***Line availability:*** The annual line availability is expected to be about 7896 hours, based on 90 per cent working ratio.

***Yield:*** An average yield of 97.5 percent has been considered from FHCR coil to annealed coil.

***FHCR coil requirement:*** FHCR coil requirement for production of 1 mtpy of continuous annealed coils, considering the above yield figure will be about 1.025 mtpy.

***Grades of steel:*** The line will be capable of processing construction and automotive grades.

***Major equipment*:** The CAL will have the following major process equipment:

a) Entry coil conveyor.
b) Entry coil car.
c) Pay-off rell.
d) Flattener.
e) Shear.
f) Welder.
g) Cleaning section.
h) Vertical entry accumulator.
i) Annealing furnace.
j) Delivery accumulator.
k) Skin pass mill.
l) Tension leveler.
m) Strip dryer.
n) Side trimmer.
o) Inspection station.
p) Electrostatic oiler.
q) Shear.
r) Tension reel.
s) Exit coil car.
t) Exit coil conveyor.

### 5.12.4 Continuous Galvanising Lines (CGL)

Four CGLs are proposed for both automotive and construction grades, two each in Phase-I and Phase-II.

***Design basis*:** The design basis for the CGLs is as follows:

| | | |
|---|---|---|
| Capacity, tpy | .. | 500,000 (each) |

**Coil size**

| | | |
|---|---|---|
| Strip width, mm | .. | 750-1,850 |
| Strip thickness, mm | .. | 0.28-3.2 |
| Coil weight, tons | .. | 38 (max.) |
| Range of coating (both sides together), gm/sq m | .. | 70-450 |

***Process description*:** There are mainly two types of coating processes - hot dip coating and electrolytic coating. Electrolytic coating is often used to apply a thin coat of expensive zinc, and hot dip is used for heavy coating of less expensive zinc. Typical hot-dip coated products include galvanised strips for automobiles, construction and white goods product.

Hot dip galvanising process involves degreasing of strips prior to annealing and zinc coating. The annealing furnace applies necessary heat to obtain the required mechanical properties and activate the surface with a reducing gas for easy zinc coating. The coating weight is controlled by a purge gas jet above the zinc pot to remove excess molten zinc. The galvanising line is usually equipped with a skin pass mill, a tension leveller and chemical treatment equipment for chromating.

***Line availability:*** The annual line availability is expected to be about 7,896 hrs, based on 90 per cent working ratio.

***Yield:*** An average yield of 97.5 per cent has been considered from FHCR coil to galvanised coil.

***FHCR coil requirement:*** FHCR coil requirement for production of 0.5 mtpy of galvanised coil, considering the above yield figure will be about 0.513 mtpy.

***Grades of steel:*** The line will be capable of processing construction and automotive grades, i.e. CQ, DQ, DDQ, EDQ, HSLA, BH, IF and DP.

***Major equipment*:** Each CGL will have the following major process equipment:

a) Entry coil conveyor.
b) Entry coil car.
c) Pay-off reel.
d) Leveller.
e) Crop shear.
f) Welder.
g) Entry accumulator.
h) Cleaning section
i) Vertical heat treatment furnace.
j) Coating section.
k) Cooling after coating.
l) Skin pass mill.
m) Tension leveler.
n) Chromating section.
o) Exit accumulator.
p) Strip dryer.
q) Electrostatic oiler.
r) Shear.
s) Tension reel.
t) Exit coil car.
u) Exit coil conveyor.

**5.12.5 Colour Coating Line (CCL)**

Four CCLs are proposed to be installed, two each in Phase-1 and Phase-2 of about 0.25 mtpy capacity each.

The pre-metal coated coils are planned to be used as the base material for this line. The range of width and thickness is indicated below:

| | | |
|---|---|---|
| Width range, mm | .. | 750-1600 |
| Thickness range, mm | .. | 0.28-1.3 |
| Substrate | .. | Pre-metal (zincalume) coated strip without oiling. |

The line will be designed to produce colour coated products with special features and conventional roll coaters.

***Major equipment:*** The major equipment is as follows:

**Entry section**

a) Pay-off reels – Two nos. with associated centre positioning control (CPC), coil skids, coil cars and peeling devices etc.

b) Two pinch rolls.

c) Two shears.

d) Double-row strip joiner with roll masher, notcher and hole punch.

e) Tension bridle.

f) Entry accumulator.

**Surface treatment section**

a) Tension bridle.

b) Cleaning and brushing units.

c) Stage rinsing.

d) Hot air drier.

e) Chemical coater.

f) Hot air chemical drying oven.

g) Cooling rolls.

**Coating section**

a) Tension bridle.

b) Top and bottom prime coater with paint recirculation system.

c) Oven for drying the prime coatings.

d) Water quench.

e) Squeegee rolls with air knives for drying.

f) Finish coater A for the top surface.

g) Finish coater B as standby for quick change of the top coater in the event of change of colour.

h) Back coater for coating the underside.

i) Oven for drying the finish coatings.

j) Quench and drying unit.

k) Coating thickness measuring gauges.

**Exit section**

a) Tension bridle.

b) Exit accumulator.

c) Cold laminator.

d) Exit shear.

e) Tension reel with belt wrapper and edge position control (EPC).

f) Coil car with storage skid

g) Weighing machine.

h) Label printer with bar code facility.

i) Coil bander.

### 5.12.6 Tandem Annealing and Coating Line (TACL)

The cold rolled coils will be processed in a continuous annealing and coating line for production of normal grades of CRNO coils. The continuous tandem annealing and coating line (TACL) is provided for production of fully processed CRNO silicon steel strip coated with electrical insulation coatings. The coating provides inter-laminar insulation and normally organic and inorganic coatings are followed, although combined (semi-organic) coating may be used.

***Design basis:*** The design parameters for the TACL with anominal capacity of 250,000 tpy are given below:

**Input material**

| | | |
|---|---|---|
| Steel grade | .. | CRNO |
| Silicon content, % | .. | 0.6-3.5 |
| Carbon content, % | .. | 0.003 (max.) |

**Input CR coil data**

| | | |
|---|---|---|
| Strip width, mm | .. | 850-1,250 |
| Strip thickness, mm | .. | 0.35-0.65 |
| Coil weight, tons | .. | 25 (max.) |

**Output coil data**

| | | |
|---|---|---|
| Strip width, mm | .. | 850-1,250 |
| Strip thickness, mm | .. | 0.35-0.65 |
| Coil weight, tons | .. | 25 (max.) |
| Electrical insulation solution varnish | .. | As per ASTM |

***Process description*:** The final annealing and coating of silicon steel is planned through tandem annealing and coating line. Strand annealing at about 900 to 1100°C is required to recrystallise the material and produce critical grain growth for optimisation of magnetic properties. The annealing mainly comprises of a low temperature (850°C) decarburisation annealing in wet hydrogen atmosphere and a high temperature (900 to 1100°C) annealing in a dry hydrogen atmosphere for grain growth. After cooling, the strip is coated with insulation coating solution and cured in a drying furnace and cooled.

The total length of the above line is generally very long. The present trend is to take out the load of decarburisation from this stage of annealing at the CRM complex, by decarburising the steel to a level of 0.002 per cent carbon at the steelmelt shop through vacuum degassing facility. This will eliminate the necessity of decarburisation at the later stage of annealing and thereby allow the total length of the tandem annealing and coating line to be considerably reduced.

***Major equipment:*** The line consists essentially of:

a) Entry section with two pay-off reels.
b) Welding machine.
c) Entry looper.
d) Cleaning section.
e) Furnace section.
f) Cooling section.
g) Coating section.
h) Varnish drying section.
i) Exit looper.
j) Exit section with one tension reel with belt wrapper.
k) Exit coil skids.
l) Exit weighing section.

Auxiliary system of the line mainly consists of:

a) Entry and exit hydraulic system.

b) Pneumatic, lubrication and grease system.

c) Cleaning solution preparation system.

d) Cleaning solution and rinsing water recirculation system.

e) Insulation coating solution preparation system.

f) Fume exhaust system and chimney with incineration system.

g) Chiller unit and water demineralisation plant.

### 5.12.7 Tin Plate

***Process steps for production of tinplate coil:*** The process steps for the production of electrolytic tin plate from HR coils are outlined below:

a) Descaling of hot rolled coils by treatment with a dilute mineral acid (usually hydrochloric acid) in a pickling line

b) Cold rolling of the pickled coils to the required thickness in a reversing mill. Considering the volume of production,twin stand reversing mill may be considered. However, the same will be finalized during the execution stage.

c) Cleaning of the strip from oil, dirt etc. and recrystallisation annealing in an inert atmosphere to relieve the internal stress developed during cold rolling and to recrystallise the deformed grains in continuous annealing furnaces.

d) Temper rolling (skin passing) of annealed coils in twin-stand temper mill to suppress yield point elongation phenomenon and to improve flatness in the first stand and thereafter brighten the surface in second stand.

Also double cold reduction is carried out in this mill to reduce the thickness and increase the temper value.

e) Coating of black plate coils by electrolytic deposition either of tin in the Electrolytic Tinning Line (ETL) for production of electrolytic tin plate (ETP) or chrome plated strip which is popularly known as Tin-Free Steel (TFS).

f) A part of the above coils will be further processed in a Tin Plate Shearing Line (SHL) to produce ETP in sheet form.

***Facilities for production of tinplate coil:*** As per the process route indicated above for production of tin plate product of about 250,000 tpy each in Phase-I and Phase-II, following facilities has been proposed:

a) **Pickling line:** One continuous pickling line.

b) **Reversing mill:** One 6-Hi reversing mill for rolling the strip to required thickness.

c) **Continuous annealing line:** FHCR coil will be further processed in continuous annealing line for recrystallisation annealing.

d) **Temper mill:** One twin stand temper mill will be provided for production of SR and DR product.

e) **Electrolytic tinning line:** One electrolytic tinning line for production of tin plate coil. The inline edge trimmer will be installed which will eliminate the requirement of coil preparation line.

f) **Shearing line:** Shearing lines for production of tin plate sheets.

g) **Coil packaging line:** for packaging of ETP in coil form.

**Tin plate coil data**

| | | |
|---|---|---|
| Strip width, mm | .. | 600-1,250 |
| Strip thickness, mm | .. | 0.12-0.5 |
| Type | .. | SR, DR |
| Coating, gms/sq m/side | .. | 0.56-11.2 |

***Pickling line:*** For pickling of input HR coils a pickling line has been proposed. This unit is envisaged to pickle hot rolled coils of required quality for final production of 250,000 tpy of tinplate coil.

***Major facilities:*** The major facilities in the pickling unit will comprise the following:

a) Coil storage saddle.
b) Entry coil car.
c) Pay-off reel.
d) Leveller.
e) Scrap shear.
f) Square shear.
g) Side crimping shear (notch).
h) Pinch roll.
i) Pickling tanks.
j) Cold spray tank.
k) Hot water rinse tank.
l) Side trimmer.
m) Scrap chopper.
n) Scrap conveyor.
o) Upcut shear.
p) Tension reel.
q) Exit coil car.
r) Coil storage saddle.
s) Weighing machine.

A separate acid regeneration plant will be installed to cater to the pickling unit.

***Reversing cold rolling mill:*** The hot rolled pickled coils will be cold rolled in reversing cold rolling mill. Considering the volume to be processed, twin stand reversing mill may be considered. However, the same will be finalised during the execution stage.

**Major equipment:** The major list of equipment for reversing cold mill will be as follows:

**Entry section**

a) Coil saddles.

b) Coil car.

c) Pay-off reel.

d) Pinch roll and levelling unit.

e) Reversing tension reel.

f) Coil car for reversing tension reel.

g) Strip press with side guide.

h) Mill stand.

i) Deflector roll.

j) Bending roll to act as an off centre snubber roll over the deflector roll.

k) Pivoted strip guide table.

l) Reversing tension reel.

m) Coil car.

n) Coil storage saddle with coil weighing system, coil strapping facility.

o) Automatic marking machine for printing.

p) Emulsion system.

q) Fog exhaust system.

r) Hydraulic system.

***Continuous annealing line:*** The annealing facilities are envisaged for recrystallisation annealing of cold rolled coils.

**Major equipment**

General configuration of Continuous Annealing Line (CAL) shall be as follows:

a) Un-coiler (two) and entry section with welder.

b) Electrolytic cleaning.

c) Vertical entry looper.

d) Protective atmospheric zoned furnace comprising of Pre heating, heating, soaking, rapid cooling over aging section, final cooling section and quench section.

e) Exit looper.

f) Shear.

g) Re-coiler (two).

***Twin stand Skin Pass Mill (SPM):*** The annealed CR coils meant for production of TMBP coils require two skin pass operations. During the first pass shot blasted/EDT/Chrome coated work rolls are used to impart skin hardening effect to eliminate stretch strain (also known as Lüder lines) by suppressing the yield point elongation phenomenon during cold working of low carbon mild steel, by which the surface of the strip becomes dull/wrought. The tempered strip thereafter requires another pass in the mill with grind finished work rolls to bring back its shining surface by ironing out the dull surface with grind finished work rolls. This is why a twin-stand skin pass mill is required so that both the passes can be carried in tandem fashion at one go to achieve higher production.

***Electrolytic Tinning Line (ETL):*** The ETL is composed of the following sections:

**Entry section:** The entry section consists of the following major equipment:

a) Two entry coil skid.
b) Two entry coil cars
c) Two pay-off reels.
d) Lap seam welder/mash welder.
e) Edge trimming facility.

**Entry looper:** Vertical entry looper for storage of strip.

**Pre-treatment section:** The pre-treatment section consists of the following:

a) One bridle roll.
b) One steering roll.
c) One deflector roll.
d) Alkali dunk tank.
e) Electrolytic alkali cleaning tank.
f) Alkali rinse tank.
g) Tension leveller with entry and exit bridles.
h) Electrolytic pickling tank.
i) Pickling rinse tank.
j) Brush scrubber unit.
k) Conductor and sink rolls.

**Tin plating section:** The tin plating section consists of the following:

a) Conductor and sink rolls.
b) Pre-dipping tank.
c) Plating tanks.
d) Drag out tanks.
e) Anodes and anode bridges.
f) One hot air dryer.
g) Fume exhaust unit.

**Post treatment section:** The post treatment section consists of the following:

a) Coating weight gauge.

b) Grounded rolls.
c) Conductor rolls.
d) Chemical tank.
e) Chemical rinse tanks.
f) One hot air dryer.
g) One fume exhaust system.
h) Electrostatic oiler unit.

**Delivery looper:** The vertical delivery looper for storage of strip.

**Delivery section:** The delivery section consists of the following:

a) Deflector rolls.
b) Inspection mirror.
c) Measuring roll.
d) Delivery carryover conveyor.
e) 2 tension reels.
f) 2 threading conveyors.
g) 2 belt wrappers.
h) 2 delivery coil cars.
i) 2 delivery coil skids.

### 5.12.8 Finishing Facilities

Finishing facilities, i.e. recoiling and inspection line, slitting line, shearing line and packaging lines for inspection of coils, production of slit coils and sheets and packaging of finished product will be provided as given below:

***Recoiling and coil inspection line (RCL):*** A portion (about 30 per cent) of the coils from CGL and coils from CAL, both automotive grade and commercial grade will be fed into RCL to be installed, for surface inspection and preparation. For this purpose two RCL for coils coming from CAL (one each in Phase-I and Phase-II) and one RCL (in Phase-I) for CGL coil has been provided.

**Major equipment:** The list of equipment for RCL is as follows:

a) Coil saddle.
b) Coil preparation station.
c) Coil car.
d) Pay-off reel with CPC.
e) Pinch roll with flattener.
f) Hydraulic crop shear.
g) Edge trimmer + edge cropper
h) Burr masher rolls.
i) Splitting unit to split wide coils into 2 narrow coils.
j) Welder.
k) Bridle roll.
l) Tension leveler.
m) Bridle roll.
n) Space provision for width gauge.
o) Inspection station (both for horizontal and vertical).
p) Electrostatic oiler.
q) Ink marker.
r) Dividing shear.
s) Recoiler with CPC.
t) Belt wrapper.
u) Coil car.
v) Coil storage saddle.
w) Weighing station.

***Slitting line and cut-to-length line:*** One each slitting line and one each cut-to-length line will be set up for annealed CR coils in Phase-I and Phase-II.

Two shearing line will be provided for production of tin plate sheet one each in Phase-I and Phase-II.

Two slitting lines and one cut-to-length line will be set up each in Phase-I and Phase-II for silicon steel.

**Major equipment:** The list of equipment for the slitting line is as follows:

a) Coil car.
b) Coil storage saddle.
c) Decoiler with peeler table and hold down roll.
d) Pinch roll.
e) Entry shear.
f) Leveller.
g) Steering unit.
h) Slitting unit.
i) Slitting head preparation stand.
j) Edge cropper.
k) Loop pit.
l) Tension controller.
m) Width separator.
n) Press block.
o) Coiler.
p) Weighing station.

The list of equipment for the cut-to-length is as follows:

a) Coil car.
b) Coil storage saddle.
c) Decoiler with peeler table and hold down roll.
d) Pinch roll.
e) Leveller.
f) Loop pit.
g) Side trimmer.
h) Feed roll.
i) Length measuring unit.
j) Shear head.
k) Stacker.
l) Exit conveyor system.

## 5.13 REBAR MILL (RBM)

It is proposed to install a rebar mill of 1.2 mtpy capacity to produce rebars in straight length.

### 5.13.1 Design Basis

***Input:*** Continuously cast billets will be used as input to the rebar mill:

| | | |
|---|---|---|
| Section, mm | .. | 160 x 160 |
| Length, mm | .. | 12,000 |

***Finished product:*** Output from rebar mill will be as follows:

| | | |
|---|---|---|
| Size | .. | 10-40 mm dia. rebars |
| Cut to length | .. | 6-12 m |

***Grades of steel:*** The mill will roll construction grade steel. The mill will be designed to roll finished products conforming to DIN 488/IS 1786.

***Mill availability:*** The annual mill availability is expected to be about 8,000 hours, based on 91 per cent working ratio.

***Yield:*** An average yield figure of 97.0 per cent has been considered from billet to rebar.

***Billet requirement:*** The billet requirement for production of 1.2 mtpy rebar, considering the above yield figure, will be about 1.24 mtpy.

**5.13.2 Process Flow**

Continuous cast billet from the billet caster will be charged into reheating furnace or cold billets will be transferred from the cold charging grid (cold billet) through charging roller table into the reheating furnace. The billets will be reheated to the required metallurgical temperatures. Heated billets discharged from the furnace will pass through descaling unit located before the roughing group of stands. After descaler the billet passes through roughing and intermediated group of stands for rolling into the required dimension of transfer bar. Finished rolling of will be carried out in two groups of finishing blocks. Each group of finishing blocks will be suitable for single-strand. The finish rolled material, delivered from each group of finishing stands, will pass through separate in-line water cooling sections. The finished bars will be cut to cooling-bed lengths by dividing shears located downstream of the water cooling lines. Cold shear will cut the bar layers into order lengths of 9 to 12 m. Batches of finished length rebars will be transferred to automatic bar bundling stations which will count and sort the rebars and form bundles.

### 5.13.3 Major Equipment/Facilities

The major equipment/facilities will include the following:

a) Billet charging and discharging equipment with warm charging facility.

b) 230 tph reheating furnace with side charging and side discharging.

c) Mill equipment comprising continuous roughing and intermediate housingless stands; finishing blocks with tungsten carbide roll rings; mill shears; loopers, pinch rolls, water boxes for quenching of bars, dividing shears etc.

d) Finishing facilities including cooling bed, cold shear, chain transfers, bar counters, bundling station, strapping machines and unloading stations.

e) Roll and guide shop.

f) Express laboratory.

g) Recirculating water treatment facilities.

## 5.14 WIRE ROD MILL (WRM)

It is proposed to install a wire rod mill of 0.6 mtpy capacity to produce plain wire rods in coil form.

### 5.14.1 Design Basis

***Input:*** Continuously cast billets will be used as input to the WRM:

| | | |
|---|---|---|
| Section, mm | .. | 160 x 160 |
| Length, mm | .. | 12,000 |

***Finished product:***

| | | |
|---|---|---|
| Size, mm dia | .. | 5.5-20 |

***Grades of steel:*** The mill will roll low, medium, high carbon steel, including special steels such as CHQ, spring steel, electrode steel, bearing steel, case hardening etc.

The mill will be designed to achieve finished product tolerance of (±) 0.1 mm (for 5.5 to 15 mm dia. rods) and (±) 0.125 mm (for 16 to 20 mm dia rods). Latest technological developments and metallurgical control models will be incorporated to produce uniform metallurgical properties with low rejections.

***Mill availability:*** The annual mill availability is expected to be about 7,900 hours, based on 90 per cent working ratio.

***Yield:*** An average yield figure of 97.0 per cent has been considered from billet to wire rod.

***Billet requirement:*** The billet requirement for production of 0.6 mtpy wire rods, considering the above yield figure, will be about 0.62 mtpy.

### 5.14.2 Process Flow

Continuous cast billet from the billet caster will be charged into reheating furnace or cold billets will be transferred from the cold charging grid (cold billet) through charging roller table into the reheating furnace. The billets will be reheated to the required metallurgical temperatures. A high-pressure descaler located at the furnace exit will remove the scales formed on the billet prior to rolling. The mill configuration will comprise roughing train, intermediate train, pre-finishing, pre-finishing block and a reducing and sizing block. The pre-finishing mills, finishing blocks and sizing mills will have tungsten carbide roll rings for increased roll life and close dimensional tolerances of the rounds. However, the configuration of the mill will be decided during the project execution. The transfer bars and wire rods delivered from each pre-finishing trains, No-Twist mono blocks and sizing mills will pass through in-line water cooling section, air cooling section, pinch roll and loop laying head and subsequently deposit the convulated wire rod in air cooling conveyor. The convulated wire rod shall proceed to coil reformers and down-enders and shall be loaded in power and free hook conveyor. The coil shall be compacted and tied by compacting machine, weighed by on-line weighment scale, tagged and transferred to collecting tables.

### 5.14.3 Major Equipment/Facilities

The major equipment/facilities for WRM will include the following:

a) Billet charging and discharging equipment with warm charging facility.

b) 130 tph walking beam type reheating furnace with side charging and side discharging.

c) Mill equipment and facilities comprising hydraulic descaler; single strand high speed roughing mill stands; double strand intermediate mill stands; pre-finishing mills; finishing blocks and post-finishing reducing and sizing blocks; mill shears; automatic on-line units for size measurement and detection of surface defects of finished products.

d) Finishing equipment comprising water cooling and equalisation facilities, loop laying head; air cooling conveyor system; coil reforming station; coil conveyor system including in-line automatic compacting and strapping facilities; coil unloading stations.

e) Roll and guide shop.

f) Finishing mill maintenance and ring grinding shop.

g) Express laboratory.

h) Recirculating water treatment facilities.

## 5.15 MEDIUM SECTION MILL (MSM)

It is proposed to install a Medium Section Mill of about 1 mtpy capacity for production of various section products.

### 5.15.1 Design Basis

***Input:*** The input semis for the medium section mill will come from the bloom-cum-beam blank caster. The size of input bloom/beam blanks to the mill will be as follows:

| | | |
|---|---|---|
| Bloom, mm | .. | 270 x 155 |
| Beam blank, mm | .. | 346 x 265 x 70 |
| | | 390 x 320 x 100 |

***Finished product:*** The list of finished sections is as given below:

a) HE 100 to 280 mm (A, B, M).
b) IPE 120 to 550 mm.

c) Channel 100 to 400 mm.
d) Equal angle 120 to 200 mm.
e) Unequal angle 100 to 200 mm.

***Grades of steel:*** The steel grades to be rolled in the mill will be S235, S275, S355, S460, A 36-Gr.65.

The mill will incorporate latest technological concepts inclusive of cooling controls and automatic on-line profile measurement unit to produce products with low rejection level. The mill will be designed to achieve finished product dimensional tolerances conforming to EN10034, EN10279, EN10056-2 and equivalent International Standards.

***Mill availability:*** The annual availability of the mill is expected to be about 7,500 hrs, based on 86 per cent working ratio.

***Yield:*** An average yield figure of 95 per cent has been considered from input material to finished sections.

***Bloom/beam blank requirement:*** The bloom/beam blank requirement for production of about 1 mtpy of section products will be about 1.05 mtpy.

**5.15.2 Process Flow**

Input material (Bloom or beam blank) from continuous caster will be transferred from the cold charging grid through charging roller table into the reheating furnace. The input material will be reheated to the required metallurgical temperatures. The heated input material will be reduced in cross section in a break down mill, which will be further processed into the reversing tandem mill. The material will processed in sizing/finishing stand after tandem mill. The number of stands and mill configuration will be finalised during project execution in discussion with the equipment supplier. Following the sizing/finishing stand, the material passes through cooling line before the cooling bed. The material after cooling bed is straightened in horizontal straightener. After straightener the product will passes through magnetic stackers, bundling and unloading station.

### 5.15.3 Major Equipment/Facilities

The major equipment/facilities for MSM will include the following:

a) Bloom/beam blank charging and discharging equipment.
b) 240 tph walking beam reheating furnace.

c) Mill equipment and facilities comprising hydraulic descaler; break-down stand; tandem reversing mill; sizing/finishing stand; on-line automatic profile measurement unit; hot saw.

d) Finishing facilities with cooling bed; horizontal straighteners; cold saws; inspection beds; magnetic stackers; strapping machines and unloading stations.

e) Roll and guide shop.

f) Express laboratory facilities.

g) Recirculating water treatment facilities.

## 5.16 CEMENT PLANT

Portland slag cement plant produced from the plant will be sold to the market. The target markets for the cement produced by JSW, Odisha as a part of their integrated steel plant are the states of eastern and south-eastern region of India. The infrastructure segment which has been growing in the region is expected to continue to grow with many major projects expected in the region. The Portland slag cement plant has been proposed to utilise the slag generated at the iron making unit of the integrated steel plant which will mixed in right proportion with clinker and gypsum to be procured from outside and fly ash generated in the captive power plant inside the integrated steel plant. The remaining fly ash generated in the captive power plant in three phases will be fully utilised to produce Portland pozzolna cement.

### 5.16.1 Plant Capacity and Configuration

Based on the availability of the granulated blast furnace slag from the iron making unit of the integrated steel plant and proportionate amount of clinker, gypsum and fly ash in approximate ratio of 16:20:1:1, it is proposed to install Two vertical roller mills with integral classifier each of 400 tph capacity in each phases and One paddle mixer of 800 tph capacity along with adequate bagging, packing and dispatching facilities to meet the rated production capacity 3.75 mtpy Portland slag cement in each of the first two phases.

In order to utilise the entire amount of fly ash generated in the captive power plant will be mixed in 3:7 ratio with clinker sourced from outside to produce Portland pozzolona cement. It is proposed to install one vertical roller mills with integral classifier each of 200 tph capacity in each phases along with adequate bagging, packing and dispatching facilities to meet the rated production capacity 1.25 mtpy Portland pozzolona cement in each of the first two phases.

Raw material and product handling and storage facilities will also be considered on the basis of the production capacity of the cement plant. On completion of Phase-III, the production capacity of the portland slag cement plant will be 10 mtpy.

### 5.16.2 Design Basis

In order to consider 3.75 mtpy of portland slag cement production capacity in each of the two phases, it is proposed to install two vertical roller mill of proven design for grinding of raw material. One vertical roller mill will be considered with a capacity of 400 tph for grinding clinker, gypsum and fly ash to produce ordinary Portland cement (OPC) of fineness 3400 sq cm/g and one another vertical roller mill of same capacity will be considered for grinding slag at 4000 blaines. Later on the ground products from two vertical roller mills as indicated above will be mixed in paddle mixer of 800 tph capacity to produce requisited amount of Portland slag cement.

In order to consider 1.25 mtpy of Portland pozzolona cement production in each of the two phases, it is proposed to install one vertical roller mill with a capacity of 200 tph of proven design for grinding of fly ash and clinker.

Adequate bagging and packing facilities along with two bulk loader of 150 tph capacity each, six truck loaders of 150 tph capacity each have been considered for Portland slag cement in each of the two phases. One bulk loader of 150 tph capacity, three truck loaders of 150 tph capacity each have been considered for Portland pozzolona cement in each of the two phases. Sixteen wagon loaders of 100 tph capacity each will be considered to ensure packing and dispatch of the products.

Considering the availability of granulated blast furnace slag from iron making unit of the integrated steel plant, fly ash generated from the captive power plant and the requirement of clinker and gypsum, the phase wise production capacity of the cement plant is as follows:

**TABLE 5-37 – RATED CAPACITY OF CEMENT UNIT**

| Rated capacity, tpy | | | |
|---|---|---|---|
| | **Phase-I** | **Phase-II** | **Phase-III** |
| Portland slag cement | 3750,000 | 7500,000 | - |
| Portland pozzolona cement | 1250,000 | 2500,000 | - |

In first two phases, the full rated capacity of the cement plant cannot be achieved as the amount of slag and fly ash availability will be lower than the required value. However, rated capacity of the plant can be utilised after completion of Phase-III of integrated steel plant when the requisite amount of slag and fly ash will be available.

**TABLE 5-38 – PHASE-WISE CEMENT PRODUCTION (ACTUAL)**

| Actual production, tpy | | | |
|---|---|---|---|
| | **Phase-I** | **Phase-II** | **Phase-III** |
| Portland slag cement | 3000,000 | 6000,000 | 7500,000 |
| Portland pozzolona cement | 433,000 | 964,900 | 2500,000 |

Gross production figures include the product dust loss and other handling losses. The proportion of mixing slag, clinker, gypsum and fly ash for production of Portland slag cement and Portland pozzolona cement is given in Table 5-39.

**TABLE 5-39 – PROPORTION OF MIXING RAW MATERIALS FOR PRODUCTION OF PORTLAND SLAG CEMENT AND PORTLAND POZZOLONA CEMENT**

| Sl. no. | Product description | Proportions, % |
|---|---|---|
| 1. | **OPC** | |
| | - Clinker | 90 |
| | - Gypsum | 6 |
| | - Fly ash | 4 |
| 2. | **PSC** | |
| | - OPC | 57.5 |

| Sl. no. | Product description | Proportions, % |
|---|---|---|
| | - Slag | 42.5 |
| 3. | **PPC** | |
| | - Clinker | 70 |
| | - Fly ash | 30 |

Availability of the plant has been considered as 330 days in a year while sizing the equipment considered for this plant in each of the two (2) phases.

### 5.16.3 Raw Materials

The Portland slag cement unit has been proposed to utilise the granulated blast furnace slag available from the iron making section of the integrated steel plant. Typical composition of granulated blast furnace slag is given in Table 5-40.

**TABLE 5-40 – TYPICAL COMPOSITION OF GRANULATED BLAST FURNACE SLAG**

| $SiO_2$, % | $Al_2O_3$, % | CaO, % | MgO, % |
|---|---|---|---|
| 33-35 | 18-21 | 34-35 | ~8 |

Along with the same 12 to 15 per cent moisture is considered to be there in granulated blast furnace slag.

Clinker will be sourced from clinker manufacturers in India or abroad. The following four compounds which essentially occur in Clinker are as follows:

a) Tri-calcium silicate [$3CaO.SiO_2$ ($C_3S$)]: $C_3S$ is the active component in the clinker. It is mainly responsible for high early strength.

b) Di-calcium silicate [$2CaO.SiO_2$ ($C_2S$)]: There are at least four modifications of $C_2S$ which are stable at different temperatures. $C_2S$ is responsible for latter strength.

c) Tri-calcium aluminate [$3CaO.Al_2O_3$ ($C_3A$)]: $C_3A$ is very reactive and contributes high early strength. It helps in coating formation.

d) Tetra-calcium alumino ferrite [$4CaO.Al_2O_3.Fe_2O_3$ ($C_4AF$)]: It does not influence the development of strength. It is formed due to the fluxing compounds present in raw mix. It also helps in coating formation.

Typical chemical composition of the clinker is as follows:

**TABLE 5-41 – TYPICAL COMPOSITION OF CLINKER**

| $C_3S$, % | $C_2S$, % | $C_3A$, % | $C_4AF$, % |
|---|---|---|---|
| 55 | 25 | 10 | 10 |

Fly ash (with typical moisture content of 5%) of flowing typical chemical composition will be conveyed pneumatically from the captive power plant of the integrated steel plant for mixing with clinker.

**TABLE 5-42 – TYPICAL COMPOSITION OF FLY ASH**

| CaO, % | MgO, % | $SiO_2$, % | $Al_2O_3$, % | $Fe_2O_3$, % | $SO_3$, % | LOI, % |
|---|---|---|---|---|---|---|
| 1.68 | 4.54 | 59.60 | 17.27 | 12.44 | 0.06 | 2.31 |

Two types of gypsum have been considered for the grinding unit namely natural gypsum and phospho gypsum. Phospho gypsum may be sourced from nearby fertilizer plants in Odisha or West Bengal. Typically 5 per cent moisture content may be considered for this raw material.

### 5.16.4 Consumption of Input Materials

In order to produce Portland slag cement, ground granulated blast furnace slag and ordinary Portland cement from two vertical roller mills will be mixed in a paddle mixer in around 21:29 ratio. This ratio of mixing has been worked out on the basis of desired capacity of the cement plant and availability of granulated blast furnace slag. Ordinary Portland cement will be produced by grinding Clinker, gypsum and fly ash together in 45:3:2 ratio in the vertical roller mill.

On the other side, remaining fly ash generated from the captive power plant will be mixed with clinker in around 3:7 ratio and ground in vertical roller mill to produce desired quality of Portland pozzolona cement.

Annual consumption of different raw materials for the cement plant in three phases are given below. In first two phases, the full rated capacity of the cement unit cannot be achieved unless excess clinker is sourced from outside. However, at the completion of Phase-III, the rated capacity of the cement plant, i.e. 10 mtpy can be achieved.

**TABLE 5-43 – CONSUMPTION OF RAW MATERIAL**

| Raw material | Consumption, tpy | | |
|---|---|---|---|
| | Phase-I | Phase-II | Phase-III |
| Granulated BF slag | 1282,500 | 2565,000 | 3848,000 |
| Clinker | 2114,900 | 4301,100 | 5116,000 |
| Gypsum | 126,500 | 253,000 | 232,000 |
| Fly Ash | 218,400 | 468,000 | 936,000 |

### 5.16.5 Product Quality

Portland slag cement will be produced by mixing 57.5 per cent ground mix of clinker, fly ash and gypsum with 42.5 per cent ground granulated blast furnace slag in the cement plant. On the other side Portland pozzolona cement will be produced by mixing and grinding 70 per cent with 30 per cent fly ash. Composition of the major ingredients is given below:

**TABLE 5-44 – COMPOSITION OF PORTLAND SLAG CEMENT**

| Product | Component | % |
|---|---|---|
| Portland slag cement | OPC | 57.5 |
| | Slag | 42.5 |
| Portland pozzolona cement | Clinker | 70 |
| | Fly ash | 30 |

### 5.16.6 Plant Facilities

The portland cement plant will comprise of facilities for raw materials storage and handling, vertical roller mills, paddle mixer, product storage, handling, bagging and dispatch facilities.

### 5.16.7 Raw Materials Handling and Storage

Granulated blast furnace slag will be delivered to the plant over a system of belt conveyors to the stock piles of 3 x 6000 ton capacity for catering all the phases in totality. Three days storage capacity of slag has been considered in Phase-I, 1.5 days in Phase-II and 1 day in Phase-III roughly. The same will be conveyed to the vertical roller mill by another belt conveyor through weigh feeder. In addition to the above, around 130,000 ton granulated blast furnace slag storage in the form of longitudinal stock pile will also be considered for common use of the integrated steel plant and the cement unit in case of exigency.

Clinker will be procured globally and is primarily considered to be unloaded at the port dedicated to the integrated steel plant in geared vessels. The same will be loaded in the eco-hoppers kept at the wharf by grab cranes located in the geared vessels. The material will then be transferred by movable conveyors to permanent conveyor for conveying to the clinker tanks located at the cement plant for storage. 2 x 100,000 ton capacity clinker tanks have been considered for catering three phases in totality and proposed to be constructed in Phase-I and Phase-II respectively. Clinker may also be transported to the integrated steel plant by railways followed by conveying to the cement production unit through belt conveyor to clinker tank. The same will be conveyed to the vertical roller mill by another belt conveyor through weigh feeder placed after proportioning bins.

Phospho and natural gypsum will be procured globally. Gypsum will be brought to the plant by means of roadways and will be unloaded by truck tippler for storing at longitudinal stockpiles of 2 x 4,000 ton capacity for catering three phases in totality. Gypsum will be stacked by tippler belt conveyor in the covered longitudinal storage. The same will be crushed further by a 100 tph capacity crusher and then conveyed to the vertical roller mill through proportioning bins (one for each mill) by another belt conveyor through weigh feeder placed after proportioning bins. There is a by-pass arrangement of crusher to by-pass crushing, in case, if crushing is not required.

Fly ash will be sourced from captive power plant of the integrated steel plant and will be brought to the plant by means of roadways. Trucks will be unloaded pneumatically and the material will be stored in two 2 x 5,000 ton silos to be constructed in Phase-I and Phase-II respectively. Measured quantity of fly ash from fly ash hopper will be fed to the mill just below the classifier by air slide. Thus fine ash is separated and coarse goes to the grinding table for inter grinding with clinker and gypsum.

### 5.16.8 Vertical Roller Mills

Two vertical roller mills of 400 tph capacity each for Portland slag cement and one vertical roller mill of 200 tph capacity for Portland pozzolona cement have been considered in each of the two phases for grinding granulated blast furnace slag and components of ordinary portland cement for Portland slag cement and fly ash and clinker for Portland pozzolona cement separately.

Vertical roller mills with integrated classifier capable of drying slag having moisture content around 15 per cent will be installed. Blast furnace gas available from the steel plant will be used for heating air to around 90°C. This hot air shall be used for drying of slag while grinding in vertical roller mill. The residue of the slag after grinding shall be 12 per cent over 90 microns. HT motor of capacity around 9.5 MW may be envisaged for the vertical roller mill dedicated for slag grinding.

Exhaust gas from the slag grinding mill will be dedusted by a bag filter. All other material transfer points are also dedusted by suitably sized nuisance filter.

The ground slag collected in the bag house hoppers are transported to one no. ground slag silo of capacity 5,000 ton by series of screw conveyors.

Clinker, gypsum and fly ash will be ground in another vertical roller mill to prepare ordinary Portland cement. HT motor of same capacity with the motor considered for the vertical roller mill dedicated for slag grinding may be envisaged for this purpose.

For Portland pozzolona cement, fly ash and clinker will be ground in a vertical roller mill of 200 tph capacity. HT motor of around 6.5 MW capacity with the motor considered for the vertical roller mill

Exhaust gas from ordinary portland cement mill will be dedusted by a bag house and the cement collected in the bag house hoppers transported by means of air slides and a bucket elevator to the ordinary portland cement silo of 5,000 ton capacity.

In-built 3rd generation classifier will be considered as a part of vertical roller mill for separating fines and coarse materials.

### 5.16.9 Mixing and Blending

In case of ordinary Portland cement, ground slag and ordinary Portland cement stored separately in two silos will be conveyed separately by air slides and bucket elevators to separate buffer bins and then is taken into a paddle mixer of 800 tph capacity through weigh feeders. Ground slag and ordinary portland cement will be mixed in the mixer in 21:29 ratio to produce portland slag cement which is eventually the final product from the proposed Portland slag cement plant.

### 5.16.10 Product Handling and Storage

In case of Portland slag cement, final product from the mixer will be conveyed to the product storage silos of 4 x 15,000 ton capacity by means of screw conveyors followed by bucket elevators and air slides. 4 days storage capacity of the product has been considered for each of the phases.

In case of Portland pozzolona cement, final product from the bag house after vertical roller mill will be conveyed to the product storage silos of 2 x 15,000 ton capacity by means of screw conveyors followed by bucket elevators and air slides. 7 days storage capacity of the product has been considered for each of the phases.

**5.16.11 Bagging, Loading and Despatch of Product**

Stored Portland slag cement form the silos will be packed in 50 kg bags with four 240 tph roto packers having double outlets. For truck loading six auto truck loader of 150 tph each and two bulk loaders with capacity 150 tph each will be considered in each of the phases.

Stored Portland pozzolona cement form the silos will be packed in 50 kg bags with two 240 tph roto packers having double outlets. For truck loading three auto truck loader of 150 tph each and one bulk loaders with capacity 150 tph each will be considered in each of the phases.

For bulk loading system cement will be extracted from the bin above the packer through controlled valve. Weigh bridges of suitable capacity will also be considered for the same.

For wagon loading sixteen wagon loaders each of capacity 100 tph with capability of loading wagons from both sides through swivelling will be considered. System of automatic bag applicator, bag cleaner, online bag counter for under/overweight short weight detection and rejection system will also be provided. Approximately, dispatching of 55 per cent product has been considered through railways, 35 per cent through trucks and 10 per cent through bulk carriers at the completion of Phase-III. Wagon loading facility with capability of catering three phases in totality will be constructed in Phase-I, whereas the module for loading the trucks and bulk carriers will be constructed in each phases.

**5.16.12 Other Facilities**

In order to house quality control laboratories, control room, servers, offices etc., a three-storied building will be constructed. Plant automation system will be housed in this building. MCC rooms, electrical substations, water system comprising of cooling tower, make up water tank, pumps and fire fighting system, compressed air station for fly ash handling, gate house with weigh bridge control room at plant boundary will also be considered separately and phase by phase.

Various utilities, such as electric power, water, compressed air required for various operations including cement conveying & packing, except fly ash handling, etc, as well as requisite amount of hot blast furnace gas for air heating required at vertical roller mill will be made available to the cement plant from the integrated steel plant. Adequate pollution control measures like dust extraction system will also be provided phase by phase to comply with the prevailing CPCB norms of India.

## 5.17 CAPTIVE POWER PLANT

The by-product gases from blast furnace, coke ovens and steelmelt shop will be utilised by various steel plant consumers, they also will be utilised for captive power generation.

Total power generation from the captive power plant for all the three phases will be around 900 MW. 300 MW capacity plant will be installed in the first phase of captive power plant and another 300 MW capacity plant will be installed in phase II and balance 300 MW will be installed in Phase-III respectively. Coal will be used as a primary fuel and BFG, COG & LD Gas shall be used as a secondary fuel for power generation. LDO or COG shall be used during start up and low load operation.

### 5.17.1 Plant Power Generation Capability

| After Phase-I | After Phase-II | After Phase-III |
|---|---|---|
| Total power generation will be around 300 MW | Total power generation will be around 600 MW | Total power generation will be around 900 mw |
| Power generation from by product gases will be around 169 MW | Power generation from by product gases will be around 306 MW | Power generation from by product gases will be around 348 mw |
| Power generation from coal will be around 131 MW | Power generation from coal will be around 294 MW | Power generation from coal will be around 552 mw |

It is envisaged that under Phase-I, other than captive power plant about 40 MW of power can be generated from Coke Dry Quenching (CDQ) boilers, about 36 MW of power can be generated from Blast Furnace Top Recovery Turbine (BF TRT) and about 11 MW of power can be generated from the Sinter Cooler Boiler.

Under Phase-II of the expansion scheme, additional to captive power plant, about 60 MW of power can be generated from Coke Dry Quenching (CDQ) boilers, about 72 MW of power can be generated from Blast Furnace Top Recovery Turbine (BF TRT) and about 11 MW of power can be generated from the Sinter Cooler Boiler.

Under Phase-III of the expansion scheme, additional to captive power plant, about 80 MW of power can be generated from Coke Dry Quenching (CDQ) boilers, about 108 MW of power can be generated from Blast Furnace Top Recovery Turbine (BF TRT) and about 11 MW of power can be generated from the Sinter Cooler Boiler.

All the CDQ boilers and the sinter cooler boiler will come (through a common steam header) to the steam turbine - generator sets to generate power. All the boilers will raise steam at a fixed pressure and temperature. The entire steam will be fed into a steam bus. This will carry the steam to the turbogenerator sets for pressure drop and power generation.

### 5.17.2 Design Basis

***Power generation possible from by-product gases:*** The following are the maximum excess waste gases available from the steel plant for power generation.

| Sl. no. | Description | Fuel energy available, kcal/N cu m | Fuel Quantities, N cu m/hr | | |
|---|---|---|---|---|---|
| | | | After Phase-I | After Phase-II | After Phase-III |
| 1. | Blast furnace gas (BFG) | 850 | 129,400 | 419,100 | 654,000 |
| 2. | Coke oven gas (COG) | 4,300 | 48,000 | 46,900 | 15,900 |
| 3. | BOF gas | 1,650 | 39,300 | 78,700 | 124,300 |

Out of the total estimated power requirement for steel plant, about 169 MW/hr shall be generated from the above waste gases and balance power 131 MW/hr will be generated using Indian coal for Phase-I, 306 MW/hr will be generated from the above waste gases and 294 MW will be generated using Indian coal after completion of Phase-II and 348 MW will be generated from waste gases and 552 MW will be generated using Indian coal after completion of Phase-III.

***Steam cycle:*** Unit system configuration will be adopted having each boiler steam output connected to its turbogenerator system. The power plant cycle for each unit comprise the boiler, the steam turbine generator, the condenser, the condensate extraction, heating system, deaerator and boiler feed water pumping and heating system, turbine governing system, lubricating and control oil system along with all other necessary auxiliary equipment.

The main steam from the boiler superheater outlet will be fed to the HP steam turbine through control valves. The exhaust steam from the HP turbine is re-circulated back to the boiler as cold reheat cycle, the steam is heated to the temperature of main steam by flue gas. The hot reheated steam is connected to the LP turbine. The exhaust steam from the LP turbine will be condensed in the main condenser by circulation of required quantity of cooling water and its vacuum will be maintained by one of the two 100 per cent capacity vacuum pumps for maintaining a backpressure of 0.1 ata.

The condensate drawn from condenser hot well by 3 x 50 per cent (2 working + 1 standby) capacity condensate extraction pumps will be pumped to the deaerator through the LP heaters. The water in each deaerator will be deaerated using steam from turbine extraction. The feed water from deaerator will be pumped to the boiler by means of 2 x 100 per cent capacity (1 working + 1 standby) boiler feed pumps and the feed water will be heated through a set of high pressure heaters for each boiler.

Main steam header, feed water header, boiler and TG auxiliary headers shall be interconnected for flexibility to operate all boilers and TG's.

***Technical profile of boilers:***

| Unit size | 300 MW |
|---|---|
| Type | Single drum, natural circulated, water tube, pulverised coal, BFG, COG & LD gas fired |
| Maximum continuous rating (MCR) at super heater outlet, tph | 1000 |
| Steam pressure at Superheater outlet, ksca | 175 |
| Steam temperature at super heater outlet, °C | 550 (±) 5 |
| Reheat steam pressure at CRH inlet, ksca | 41 |
| Reheat steam temperature at CRH inlet, °C | 335 |
| Reheat steam pressure at HRH outlet, ksca | 38 |
| Reheat Steam temperature at HRH outlet, °C | 550 (±) 5 |
| Feed water temperature, °C | 270 – 290 |
| Fuel to be used | Coal, BFG, COG & LD gas |
| Start-up fuel | LDO or COG |
| Suspended particulate matter in flue gas at the outlet of chimney, mg/N cu m | 30 |
| SOx emission at 6% $O_2$ Level | 100 mg/N cu m |
| NOx emission at 6% $O_2$ Level | 100 mg/N cu m |

***Technical profile of turbogenerator:***

| **TURBINE** | |
|---|---|
| Output under turbine maximum continuous rating (TMCR) at generator terminals, MW | 300 |
| Turbine throttle steam pressure, ksca | 170 |
| Turbine throttle main steam/ reheat steam temperature, °C | 545/545 (±) 5°C |
| Turbine speed, rpm | 3000 |
| Final feed water temperature | 270~290 |

| | |
|---|---|
| at the inlet of economiser, °C | |
| Cooling medium for condenser | Water |
| Condenser pressure, ksca | 0.10 |
| Circulating water temperature at inlet/outlet of condenser, °C | 34/42 |
| **GENERATOR** | |
| Rated output, MW | 300 |
| Rated Voltage, kV | 20 |
| Rated current, A | 10189 |
| Power factor (Lagging) | 0.85 |
| Speed, RPM | 3000 |
| Frequency, Hz | 50 |
| No of phase | 3 |
| Cooling method | |
| Stator winding | Direct water cooled |
| Rotor winding | Direct hydrogen cooled |

### 5.17.3 Plant Facilities

The proposed coal and gas based power plant will have total of three (3) units of 300 MW and each unit will be installed in phases. The following plant facilities will be provided in Phase-I.

a) Boiler and auxiliaries.

b) Steam turbine and auxiliaries.

c) Coal handling system (designed for first two phases).

d) Ash handling system.

e) Water system.

f) Fire fighting system.

g) Utility system.

h) Cranes, hoists and elevators.

i) Power generation, distribution and evacuation system.

j) Instrumentation and control system.

k) Plant communication system.

l) Civil and structural works.

The above facilities will be executed for Phase-II and Phase-III respectively at later date. Extension of tripper conveyor above bunker for Boiler-2, shall be carried out in Phase-II and second stream of coal handling system & extension of tripper conveyor will be executed in Phase-III.

# 6 - UTILITIES AND SERVICE FACILITIES

This Chapter presents the electric power distribution system, instrumentation, automation, communication, water system, utilities and auxiliary facilities required for the proposed project.

## 6.1 PLANT POWER DISTRIBUTION SYSTEM

This section discusses the power requirements, nature of plant loads, source of power, plant power distribution system, selection and standardisation of electrical equipment, plant earthing, lightning protection, illumination system etc. for proposed facilities of the ISP at JSW, Odisha, Paradeep.

### 6.1.1 Plant Power Requirements

Basis of power requirements and overall power distribution system design for the proposed facilities of ISP are briefly described below.

***Basis of plant power requirements:*** The plant power requirements have been estimated on the following basis:

a) Plant material flowsheet.

b) Annual operating period of each process unit.

c) Load factor of each process unit.

d) System losses and diversity of operation amongst various process units.

***Steel plant power requirements:*** The estimated overall power requirements for the proposed facilities of ISP are given in Table 6-1.

**TABLE 6-1 – ESTIMATED PLANT POWER REQUIREMENT**

| | Phase-I | Phase-II | Phase-III |
|---|---|---|---|
| 15-min. maximum demand, MW | 646 | 1,076 | 1,230 |
| 1-min. peak demand, MW | 728 | 1,210 | 1,382 |

***Basis for the plant power system design:*** The estimates given above form the basis for the design of the plant power distribution system and also determine the quantum of power to be drawn from grid with due consideration of the generation of captive power plant.

### 6.1.2 Characteristics of Plant Loads

The major consumers comprising dewatering and filtration unit, pellet plant, DR plant, sinter plant, coke oven plant, blast furnace, calcining plant, BOF shop, mill with auxiliaries, ASP, cement plant, tar distillation and benzol refining plant and the utilities and auxiliary facilities will impose more or less a steady load on the power system. However, the other major loads, viz. ladle furnace of BOF shop as well as main drives of mill will be fluctuating in nature.

The plant power system will have to supply power to the above loads and therefore must be capable of stable operation without adversely affecting the system voltage and frequency.

### 6.1.3 Source of Power

The required power for proposed plant will be supplied by both the following power sources:

a) Captive power generation system.
b) Grid power supply system.

***Captive power generation system:*** The proposed captive power plant power generation units are given in Table 6-2.

**TABLE 6-2 – PROPOSED CAPTIVE POWER GENERATING UNITS**

| | Phase-I, MW | Phase-II, MW | Phase-III, MW |
|---|---|---|---|
| Sent-out power from 3x300 MW captive power generating units based on coal and various off gases of steel plant. | 270 | 540 | 810 |
| Sent-out power from 3x36 MW captive power generating units based on BF TRT. | 36 | 72 | 108 |

Power balance at the instance of occurrence of the plant maximum power demand, considering firm sent-out capability of the in-plant power generating units is described in Table 6-3.

**TABLE 6-3 – POWER BALANCE**

| | Phase-I | Phase-II | Phase-III |
|---|---|---|---|
| Max demand of proposed plant in MW | 646 | 1,076 | 1,230 |
| In-plant generation in MW | 306 | 612 | 918 |
| Drawal of power from Grid when all the generators are working: | | | |
| - In MW | 340 | 464 | 312 |
| - In MVA at 0.9 p.f | 378 | 516 | 347 |
| Drawal of power from Grid during outage of one 300 MW generator: | | | |
| - In MW | 610 | 734 | 582 |
| - In MVA at 0.9 p.f | 678 | 816 | 647 |

### 6.1.4 Plant Power Distribution System

Basic scheme, main features of power distribution scheme, selection of system voltages and system short circuit levels have been briefly described below:

***Basic scheme:*** The power distribution system has been planned on the basis of the plant general layout showing relative locations of various units and the estimated power demand of the individual units as well as of the plant as a whole.

The single line representation of the proposed power distribution facilities is shown in Drawing 11467-06-0001 enclosed herewith.

The basic power distribution scheme proposed is as follows:

a) Power for the proposed plant facilities will be received at Main Receiving Substation (MRS) from Grid at 220 kV over multiple numbers of double circuit transmission lines.

b) 3x300 MW coal and off-gas based CPPs will be connected at 220 kV level over adequately rated unit connected generator transformers.

c) Power at 220 kV will be distributed to three numbers of Main Power Distribution Substation (MPDS) located strategically at three major load centres of the ISP at 220 kV level through 220 kV power cables.

d) Power at 220 kV will be stepped down to 33 kV level over adequately rated 220/34.5/34.5 kV three-winding transformers and/or 220/34.5 kV two-winding transformers at MPDS. Power at 33 kV will be distributed to various Load Block Step-down Substations (LBSSs) located at individual plant units, namely, dewatering & filtration unit, RMHS, cement plant, coke oven plant, sinter plant, DR plant, pellet plant, BF proper and stock house, SMS, oxygen plant, CRM complex, tin plate mill, hot strip mill, rebar mill, medium section mill, calcination plant, plate mill and wire rod mill at 33 kV level through 33 kV power cables.

e) At respective LBSSs, power at 33 kV will be stepped down to 6.6 kV level over adequately rated 33/6.9 kV transformers to cater various HT loads at 6.6 kV. 3 x 36 MW BF TRT based CPPs will be connected at 33 kV level at LBSSs for BFs over adequately rated unit connected generator transformers. Power for tar distillation and benzol refining plant will be received at Load Block Distribution Substation (LBDS) at 6.6 kV level from LBSS 6.6 kV outgoing feeders through 6.6 kV power cables.

f) For feeding power at low voltage, 6.6/0.433 kV Load Centre Substations (LCSSs) will be established at individual plant units.

g) Reactive power compensation will be provided as required to improve the power factor.

h) Local diesel generator sets will be provided to supply power at 415 V to emergency loads and illumination system during power failure. The 415 V switchboard for the above loads shall be provided with two incomers and automatic bus transfer facility. One incomer shall be fed from local diesel generator and other incomer shall be fed from other source.

i) The system earthing to be adopted at different voltage levels are as follows:

| | | |
|---|---|---|
| 220 kV | .. | Solidly earthed |
| 33 kV | .. | Solidly earthed |
| 6.6 kV | .. | Resistance earthed |
| 415 V | .. | Solidly earthed |

j) 220 kV, 33 kV, 6.6 kV and 415 V distributions inside the plant will be established with cross-link polyethylene (XLPE) insulated cables. All interplant cables will be routed through cable tunnel/cable trench/overhead cable gallery.

### 6.1.5 Selection of System Voltages

Voltages selected for primary voltage distribution, secondary voltage distribution, medium & low voltage distributions are briefly described below:

***Primary distribution:*** For catering the quantum of power to various plant units and the major plant loads at 33 kV, 33 kV has been selected as the plant primary power distribution voltage, which will be generated by stepping down from 220 kV.

***Secondary distribution:*** For catering the quantum of power to various plant units and various HT loads at 6.6 kV, 6.6 kV has been selected as the plant secondary power distribution voltage, which will be generated by stepping down the plant primary distribution voltage, i.e. 33 kV.

***Medium and low voltage system:*** For catering the various medium and low voltage loads at 415 to 240 V, 415 to 240 V has been selected for medium and low voltage power distribution voltage, which will be generated by stepping down from the plant secondary distribution voltage, i.e. 6.6 kV.

***Voltage levels & scheme for illumination along long distance conveyor & junction houses:*** The voltage level for lighting supply along the long conveyor route can be 415 V, 3-phase, 4 wire.

### 6.1.6 Details of Power Distribution Facilities

This will mainly comprise main receiving substation, main power distribution substation, load block step down substations, load block distribution substations, load centre substations, emergency DG power supply, protective relaying, metering, instrumentation, reactive power compensation and substation automation system. These are briefly described below:

***Main Receiving Substation (MRS):*** Major equipment at MRS will be 220 kV GIS, outdoor 220 kV transmission line termination gantries and switchyard.

The GIS will be indoor, floor mounted, metal clad, SF6 gas insulated and have double busbar, circuit breaker, CT, PT, isolator etc.

220 kV outdoor switchyard will comprise of 220 kV termination gantries, LA, isolator, CT and PT for tariff metering purpose.

***Main Power Distribution Substation (MPDS):*** Major equipment at MPDS will be 220 kV GIS, 220/34.5/34.5 kV three winding and/or 220/34.5 kV two winding power transformers and 33 kV GIS. The GIS will be indoor, floor mounted, metal clad, SF6 gas insulated and have double busbar, circuit breaker, CT, PT, isolator etc.

***Load Block Step-down Substations (LBSS):*** LBSS will consist of 33 kV switchboard, 33/6.9 kV power transformers and 6.6 kV switchboards.

All 33 kV and 6.6 kV switchboards will be indoor, floor mounted, three phase, metal clad, air insulated type having single main busbar and vacuum circuit breakers. The switchboards will comprise requisite number of outgoing feeders, bus coupler breaker, bus PTs, line PTs etc.

***Load Block Distribution Substations (LBDS):*** LBDS will have 6.6 kV switchboards to distribute various loads at 6.6 kV.

All 6.6 kV switchboards will be indoor, floor mounted, three phase, metal clad, air insulated type having single main busbar and vacuum circuit breakers. The switchboards will comprise requisite number of outgoing feeders, bus coupler breaker, bus PTs, line PTs etc.

***Load Centre Substations (LCSS):*** For supplying power at 415 V, 415 V LCSS will be provided at individual plant units.

Each 415 V LCSS will comprise of 6.6 kV incoming circuit-breakers wherever required, 6.6/0.433 kV step-down transformers and 415 V switchboards. Two different types of LCSS, namely double-ended and triple-ended will be provided.

The transformer sizes standardised will be 630, 1000, 1600, 2000 and 2500 kVA. The transformers will be of AN type and busduct will be provided for connection between LV terminal of transformer and PCC/PMCC.

The rating of the transformers in a double or triple-ended LCSS will be so selected that it will be possible to meet the full load of the substation even with the outage of one transformer.

The 415 V switchboards will comprise incoming and bus-section air circuit-breakers, as well as requisite number of outgoing air/moulded case circuit breakers. All air-circuit breakers will be provided with microprocessor based releases. Suitable interlocking will be provided between incoming and bus-section circuit breakers to prevent persistent parallel operation of the transformers.

***General requirements for all the above substations:*** The 33 kV and 6.6 kV circuit breakers will be of vacuum type and will be provided with manual as well as motorised spring actuated closing mechanism.

The current transformers will be of cast resin type. Each current transformer will be provided with adequate number of cores as required for metering and protection.

The potential transformers will be of cast resin, inductive type. Each potential transformer will have two secondary cores, one for metering and the other for protection.

For auxiliary power distribution of substations, two 6.6/0.433 to 0.250 kV transformers and a 415 V switchboard with auto-bus transfer arrangement will be provided.

For DC control power supply and distribution, 110 V battery banks with charger and DC distribution board will be provided.

Equipment in the substation will be provided with earth connections, in accordance with the provisions of Indian Electricity Rules and Indian Standard Codes of Practice.

The substation buildings will be masonry building provided with R.C.C. roof. The ground floor will be used as a cable vault. Other auxiliary facilities may be provided in the ground floor. A room for storage of emergency spares shall also be provided in all substation buildings.

On the 6.6 kV sides of the transformers either cable connections or busduct connections will be adopted, depending on the rating of the transformers, to feed the 6.6 kV switchboards. The bus-coupler circuit breakers of 6.6 kV switchboards will be normally kept open to avoid parallel operation of the transformers. Each bus section of the switchboard shall be provided with indoor type bus PTs with HT side fuses on draw out type trolley.

Simplex type separate control and relay will be provided for the 33 kV switchboards. For 6.6 kV, switch board mounted relay along with separate control panel will be provided. The transformer tap-changer controls will also be mounted on a separate control panel.

***Emergency power supply:*** To meet any exigency of total power failure, provision will be made for local emergency diesel generator (DG) sets of required capacity to ensure human safety and safeguard critical equipment of various plant units. Emergency lighting power supply for these plant units will also be taken from the DG sets. For other areas not provided with DG sets, provision will be made for taking emergency lighting power supply in the substations, control rooms etc. from the control battery banks, where provided, or from the portable emergency lighting units.

***Diesel generator sets:*** Diesel powered silent type environment friendly generator sets of adequate capacity with auto mains failure and control panel shall be provided to take care of the backup power requirements and long power outages. DG set power wherever applicable shall be extended for lighting power supply.

***Battery powered emergency lighting system:*** Portable SEP (Static Emergency Power) supply (AC) along with VLRA battery backup shall be provided for feeding emergency lights. The emergency lighting system should have LED based luminaries.

***Protective relaying, metering and instrumentation:*** Adequately rated, quick acting circuit-breakers aided by reliable and selective communicable type numerical relays will be adopted for quick isolation of fault and protection of various equipments. Numerical relays shall be provided with local graphical display with provisions of DI/D0 so as to take care of interlocking/remote closing/tripping logics etc. Micro-processor based releases will be adopted for isolation of fault in low voltage system. Relays/releases will be properly graded for discriminative and selective tripping. For measurements of various electric parameters at different points of the power system, indicating, integrating and recording type instruments will be adopted.

***Reactive power compensation:*** Extensive reactive power compensation with power factor improvement capacitor banks are envisaged in various substations to improve the average power factor in the range of 0.9 to 0.95. For general application, reactive power compensation with capacitor banks will be adopted.

***Substation automation system:*** Each substation shall be provided with state of the art Substation automation system (SAS) upto 6.6 kV voltage level for supervisory control and data acquisition system considering on IEC 61850 Ed2 standard with a Gateway for interfacing with Plant SCADA system on IEC 60870-5-104 or latest protocol for control centre SCADA.

The system will run on a latest & proven Windows operating platform with latest HMI PC as workstations. The network will be fibre optic based with dual ring type 100 MBPS Ethernet on Parallel Redundancy Protocol (PRP) standard to provide high scalability and reliability. The Bay control units (BCU) upto 33 kV level will be considered along with numerical relay working as intelligent electronic device.

The BCU/numerical relays will be based on IEC 61850 Ed2 communication standard which will provide all status monitoring inputs, remote control command to breakers, isolators and remote transformer tap changing facilities and real time measuring parameters.

The latest available proven version of substation automation application software will be considered which will be compatible with IEC 61850 Ed 2 communication standard meeting the power system & functional requirement.

### 6.1.7 Selection and Standardisation of Electrical Equipment

The type and ratings of various electrical equipment proposed to be adopted for the plant are briefly reviewed below:

***Power transformers:*** The power transformer ratings, proposed to be adopted for the power distribution system, are given in Table 6-4.

**TABLE 6-4 – POWER TRANSFORMER RATINGS**

| Nominal rating | Type | Capacity | Type of cooling | Type of tap changer |
|---|---|---|---|---|
| kV | | MVA | | |
| 220/34.5/34.5 | Outdoor | 160/200 | ONAN/ONAF | On-load |
| 220/34.5/34.5 | Outdoor | 143/180 | ONAN/ONAF | On-load |
| 220/34.5/34.5 | Outdoor | 130/163 | ONAN/ONAF | On-load |
| 220/34.5/34.5 | Outdoor | 113/143 | ONAN/ONAF | On-load |
| 220/34.5 | Outdoor | 63/80 | ONAN/ONAF | On-load |
| 220/34.5 | Outdoor | 50/63 | ONAN/ONAF | On-load |
| 33/6.9 | Outdoor | 25/31.5 | ONAN/ONAF | On-load |
| 33/6.9 | Outdoor | 25 | ONAN | On-load |
| 33/6.9 | Outdoor | 20/25 | ONAN/ONAF | On-load |
| 33/6.9 | Outdoor | 20 | ONAN | On-load |
| 33/6.9 | Outdoor | 16/20 | ONAN/ONAF | On-load |
| 33/6.9 | Outdoor | 12.5/16 | ONAN/ONAF | On-load |
| 6.6/0.433 | Indoor | 2.5 | AN | Off-circuit |
| | Indoor | 2.0 | AN | Off-circuit |
| | Indoor | 1.6 | AN | Off-circuit |
| | Indoor | 1.0 | AN | Off-circuit |
| | Indoor | 0.63 | AN | Off-circuit |

***Switchboard:*** Ratings of switchboard, proposed to be adopted, are given in Table 6-5 on the next page.

**TABLE 6-5 – RATINGS OF SWITCHBOARD**

| Voltage ratio | Type of switchboard | Type of circuit breakers | Continuous current rating, in amp | Interrupting current rating, in |
|---|---|---|---|---|
| 33 kV | Indoor, gas insulated | SF6 vacuum | 1,250 | 40 kA for 3 sec. |
| | | | 2,000 | 40 kA for 3 sec. |
| | | | 2,500 | 40 kA for 3 sec. |
| | Indoor, air insulated | Vacuum | 1,250 | 31.5 kA for 3 sec. |
| | | | 2,000 | 31.5kA for 3 sec. |
| | | | 2,500 | 31.5 kA for 3 sec. |
| 6.6 kV | Indoor, air insulated | Vacuum | 1,250 | 40.0 kA for 3 sec. |
| | | | 1,600 | 40.0 kA for 3 sec. |
| | | | 2,000 | 40.0 kA for 3 sec. |
| | | | 2,500 | 40.0 kA for 3 sec. |
| | | | 3,150 | 40.0 kA for 3 sec. |
| 415 V | Indoor, air insulated | Air | 630 | 50.0 kA for 1 sec. |
| | | | 800 | 50.0 kA for 1 sec. |
| | | | 1,000 | 50.0 kA for 1 sec. |
| | | | 1,250 | 50.0 kA for 1 sec. |
| | | | 1,600 | 50.0 kA for 1 sec. |
| | | | 2,000 | 50.0 kA for 1 sec. |
| | | | 2,500 | 50.0 kA for 1 sec. |
| | | | 3,200 | 50.0 kA for 1 sec. |

***Main mill drive motors and controls:*** Due to proven technology and advantages of AC drive system over conventional DC drive system which has become nearly obsolete, AC drive system has been considered for all variable speed applications in the proposed mills. The mill stands will be powered by specially designed AC squirrel cage induction/synchronous motors with overload capabilities as per IEC standard for non-reversing/reversing rolling mill applications and suitable for feeding from variable voltage variable frequency IGBT based inverters without causing overheating and insulation damage for the specified application. These motors will be of B3 construction, class F or

H insulation with temperature rise limited to class B or F respectively at 100 per cent continuous loading. Individual motor ventilation unit will be mounted on the respective motor with necessary instruments.

Medium voltage AC drive system shall be adopted for feeding the main stand AC motors. For a logical group, regenerative type IGBT/IGCT/IEGT based common Active Front End (AFE) converter, common DC Bus (Copper) fed individual vector controlled PWM Inverters will be considered for individual stand motors of the group. Individual regenerative AFE converter and vector controlled PWM Inverter will be considered depending on the rating of the stand motor. However, grouping or individual feeding arrangement will be decided with a view to standardise the rating of the converter transformers and drive modules. Proper care will be taken for regenerative mode of operation to avoid device failure while delivering power to the bus. The converter will be capable of maintaining rated DC voltage at all values of load current including short time service current rating at 90 per cent rated AC voltage considering incoming voltage fluctuation as stipulated.

Special requirement, if any, for the cables between inverter to motor (flexible copper conductor cable with copper screen etc.) will be considered so that there is no failure of the motor bearings due to common mode voltage. Noise level of the drive panels will be limited to 65 db as measured from 1 m distance. Overload capability of the inverter units will match with that of the motors. In order to avoid failure of semi-conductor power devices due to higher ambient temperature or undue loading, design of the converter/inverter will be done considering safe temperature limit for operation of semi-conductor devices 15OC less than the manufacturer specified temperature limit of devices. Apart from built-in panel door mounted console, basic parameter programming, drive diagnostics and troubleshooting will also be possible from one point through Drive LAN.

Only two types of frame sizes for the stand motors and one type of converter transformer will preferably be selected for standardisation purpose and lower inventory. However, this aspect will be finalised after review of equipment offered by various bidders.

***Auxiliary mill and other drive motors and their controls:*** In-line auxiliary drives that require speed and/or position controls e.g. shears etc. will be powered by AC induction motors. Suitable groups will be considered with each group comprising associated converter transformer, common rectifier/converter, DC bus and individual PWM type IGBT inverter units (4-quadrant operation) with microprocessor based fully digital regulation and control system in line with the system adopted for main drives. Roller table motors are proposed to be fed from similar IGBT based group inverters with standard V/F control. Adequate number of roller table distribution boards (RTDB) is envisaged for distribution of roller table motors, to be located in the shop floor, comprising incoming isolator and requisite number of breakers. The variable speed AC motors will be specially designed for rolling mill applications and suitable for feeding from variable voltage variable frequency IGBT based inverters without causing overheating and insulation damage for the specified application. These motors will preferably be of B3 construction, class F or H insulation with temperature rise limited to class B or F respectively at 100 per cent continuous loading. Other technical features and facilities including parametering and diagnostic facilities will be similar to those mentioned above for the AC main drive system.

Off line auxiliary applications, e.g. pumps, blowers etc. will be powered by general purpose AC induction motors of totally enclosed, fan-cooled design. The control of these motors will be logically grouped to form motor control centres (MCCs). All switching and interlocking will be carried out through PLC.

***Energy saving scheme-V/F control:*** AC variable speed IGBT based drive (constant V/F control) over open loop control with digital regulation system, instead of conventional DOL starting, will be considered for higher rated pumps and fans/blowers including sinter plant exhausters where output is variable based on the process requirements. The general technical features will be similar to those described above for auxiliary adjustable speed motors and drives. Based on the requirement and load, unit type drive system fed from 415 V system may be used.

***Field mounted devices and instruments:*** Motor mounted devices and other field mounted devices, e.g. limit/proximity switches, hot metal detectors (HMDs), light barriers, instruments, sensors etc. will be provided as required. All field mounted sensors and instruments will be of latest state-of-the-art design. All transmitters will be SMART type and will have LCD type configurable local digital indication with engineering units. Special instruments like pyrometer, image based loop scanner etc. will be provided as required. Dust-proof and drip-proof enclosures will be considered for all kinds of field sensors/instruments. Input to output isolation will be provided for all sensors.

***Motors and controls for other systems:*** The plant drives can be broadly classified into two categories, namely:

| | | |
|---|---|---|
| Those requiring accurate speed control, large speed range or position control | .. | AC squirrel cage induction or synchronous motors |
| Those not requiring such controlled operation | .. | Standard 3-phase AC squirrel cage induction motors |

In case of other applications including those for cranes where control of speed is required, squirrel cage induction motors are proposed. Specially designed AC motors with variable voltage variable frequency static inverters having digital regulation system is proposed.

For devices, which do not require controlled operations, standard 415 V, 3-phase, AC squirrel cage induction motors will be used. These motors will have Class F insulation with temperature rise limited to Class B. For continuous duty, it is proposed to adopt general purpose industrial type, squirrel cage induction motors of totally enclosed, fan cooled design. In case of intermittent operation, AC squirrel cage induction motors will also be adopted. Motors, which are too large for 415 V system, generally beyond 200 kW, will be wound for 6.6 kV supply.

All 415 V AC motors will be provided with direct-on-line starters comprising MCCBs/ACBs/MPCBs, magnetic contactors, micro processor based overload relays/electronic overload relays/thermal overload relays etc. Where a group of motors are associated with a certain process, group control in the form of factory assembled and wired motor control centre (MCCs) will be adopted. The MCCs will be of multi-tier, compartmental arrangement with modular construction. The 6.6 kV motors will be controlled from the 6.6 kV switchboards at LBDS' and HVLC' over individual motor control circuit breakers.

For process MCCs, intelligent modules will be considered which will be compatible with the PLC/DCS system.

Various field mounted devices such as limit switches, proximity switches, hot metal detectors, tacho-generators, pulse generators, encoders, brakes and other transducers will be adopted for smooth control of process, as required. It is proposed to standardise various control devices provided for the plant.

All sequencing, interlocking and control functions for various processes will be through state-of-the-art micro-processor based control systems/programmable controllers having in-built diagnostic features.

***220 kV grade cables:*** 220 kV (E) grade, XLPE insulated cables will be used for 220 kV system and will comprise of aluminium conductor, conductor screening followed by extruded semi-conducting compound, non-woven water swellable semi-conducting taped, seamless metallic sheath of extruded Lead alloy 'E', bedded with semi-conducting tape concentric copper screening by helically applied annealed copper wires followed by open helix of copper tape binder, overall PVC sheath (with conducting layer of graphite coating over outer sheath).

***33 kV and 6.6 kV grade cables:*** 33 kV (E) and 6.6 kV (UE) grade cables will be used for 33 kV and 6.6 kV systems respectively and will comprise of compacted stranded aluminium conductors with semi-conducting conductor screen, XLPE insulation, semi-conducting tape and copper wire insulation screen, extruded PVC inner sheath, galvanised steel wire/flat armour and extruded PVC outer sheath.

***1.1 kV grade cables:*** Cables for 415 V systems will be of 1.1 kV grade, XLPE insulated, PVC sheathed unarmoured/armoured and overall PVC sheathed type with aluminium conductors. Multi-core, PVC insulated, PVC sheathed unarmoured/armoured and overall PVC sheathed cables with copper conductors will be used for control applications. Special cables with copper conductors will be used for signal/data transmission as required. Cables of special heat resistant type will be provided in locations having high ambient temperatures.

***Earthing and lightning protection:*** The plant's 6.6 kV systems will be earthed through resistance, so as to reduce the earth fault current. The 220 kV, 33 kV, 690 V and 415 V systems will be solidly earthed.

In designing the plant electrical installation, due attention will be given to the necessity for effective and efficient earthing of all non-current carrying metallic parts of various electrical equipment. A detailed earthing design evaluation shall be done and accordingly the number of earth pits, type of earth pits etc. to be decided. Separate earth pits to be considered for lightning arrestors.

In order to provide effective protection against travelling waves due to lightning strokes on the overhead lines as well as switching surges, station type lightning arresters are proposed at the receiving end and near the step-down transformers at each substation.

Lightning protection system as required will be provided for substations, plant buildings including ancillary buildings, chimneys, overhead tanks etc. Special surge protection system will also be provided for protection of critical items from voltage transient as required.

### 6.1.8 Plant Lighting System

General requirements, selection of lighting fittings and type of wiring, outdoor lighting fittings, lighting power supply and distribution, aviation obstruction lighting system and emergency lighting are briefly described below.

***General requirements:*** The lighting system inside and outside plant units will be designed taking into consideration the desired illumination level, architectural arrangement, building dimensions including mounting height, environmental conditions, ease of maintenance and reliability of the lighting distribution network.

Based on the levels recommended by Bureau of Indian Standards and latest practices, average illumination levels in plant units/areas will be as given below. Supplementary lighting will be provided in addition to the general illumination in specific areas of a plant unit for specialised operation, such as inspection of materials etc., where a higher illumination level will be locally called for considering 30 to 40 per cent fitting outage.

**TABLE 6-6 – AVERAGE ILLUMINATION LEVELS IN PLANT UNITS/AREAS**

| Plant unit | Illumination level |
|---|---|
| Process plant | 150-200 |
| Captive power plants | 150-200 |
| Air separation plant, and pump house | 100-150 |
| **Electrical premises** | |
| - Computer room | 300-500 |
| - Control room | 200-300 |
| - Switchgear room | 150-200 |
| Basement, oil cellars, gangway stairway | 30-50 |
| Laboratory | 300-400 |
| Repair and maintenance shops | 200-350 |
| Open storage yard and loading/ unloading areas | 15-20 |
| Material storage section | 50-100 |
| Office | 200-300 |
| Conference room, executive room | 250-500 |
| **Roads** | |
| - Important | 15-20 |
| - Unimportant (4 m wide) | 10 |

The type of lighting fittings, proposed to be adopted, for various areas within the plant, are given in Table 6-7.

**TABLE 6-7 – TYPE OF LIGHTING FITTINGS FOR VARIOUS AREAS**

| Area of installation | Type of fittings | Plant units |
|---|---|---|
| Highbay area lighting | Highbay type fittings with high pressure sodium vapour (HPSV) lamps | Process plant buildings, air separation plant and captive power plant |
| Low bay area lighting | Direct or semi-direct type fluorescent fittings, weather/vapour proof well glass type fittings with HPSV lamps and flame-proof mercury vapour lamps | All low bay areas of plant units including switch rooms, basement, cellars, tunnels etc. |

| Area of installation | Type of fittings | Plant units |
|---|---|---|
| Building lighting | Direct or semi–direct, open/totally enclosed/ decorative type fluorescent fittings | Offices, canteens, control rooms etc. |
| Area lighting | Flood light fittings with sodium vapour lamps mounted on high mast towers | Outdoor stock yards |
| Road lighting | Road lighting fittings with HPSV lamps mounted on poles/existing structures | Roads |
| Special lighting application | Metal halide lamps | Inspection bays |

A part of the lighting will be switched off during daytime for shop lighting and during non-peak traffic hours for street lighting through automatic switching by synchronous timers.

Special care will be taken for selection of lighting fittings considering heavy vibration and water splashing in some plant areas.

***Selection of lighting fittings and type of wiring:*** Types of lighting fittings and wiring, to be adopted for various areas within the plant, will generally be as given in Table 6-8 on the next page.

**TABLE 6-8 – TYPE OF LIGHTING FITTINGS AND WIRING**

| Plant units/ departments | Type of lighting fittings | Type of wiring for lighting fittings |
|---|---|---|
| Conveyor gallery, stair case/platform/ walkways on structural shop | 70 W HPSV integral type well glass fittings | Exposed wiring in tray/conduit/flexible conduit with PVC cables |
| **Junction house, crusher house, screen house, pump house, water treatment plant, booster house, compressor house, DG room etc.** | | |
| Low bay area (up to 4 m height) | 70 W HPSV integral type well glass fittings | Exposed wiring in tray/conduit/flexible conduit with PVC cables |
| Medium bay area (above 4 m upto 7 m height) | 150 W HPSV non-integral type fittings or, 250 W HPSV non-integral type fittings | Exposed wiring in tray/conduit/flexible conduit with PVC cables |
| High bay area (above 7m height) | 400 W HPSV non-integral type fittings | Exposed wiring in tray/conduit/flexible conduit with PVC cables |
| Cable vault and cable gallery | 70 W HPSV integral type well glass fittings | Exposed GS conduit wiring with PVC cables |
| **Main plant building (process plant, captive power plant, air separation plant etc.)** | | |
| Low bay area (up to 4 m height) | 70 W HPSV integral type well glass fittings | Exposed GS conduit wiring with PVC cables |
| Medium bay area (above 4 m upto 7 m height) | 150 W HPSV non-integral type fittings or, 250 W HPSV non-integral type fittings | Exposed GS conduit wiring with PVC cables |
| High bay area (above 7 m) | 400 W HPSV non-integral type fittings | Exposed GS conduit wiring with PVC cables |

| Plant units/ departments | Type of lighting fittings | Type of wiring for lighting fittings |
|---|---|---|
| **Electrical premises** | | |
| Control room | Decorative mirror Optics type single/twin 28 W, T5 type fluorescent fittings | Concealed wiring in PVC conduit |
| Computer room, PLC room, automation room, etc. | Decorative mirror Optics type single/twin 28 W, T5 type fluorescent fittings | Concealed wiring in PVC conduit |
| Cable cellar & transformer cell | 70 W HPSV integral type well glass fittings | Exposed GS conduit wiring with PVC cables |
| Electrical switch/MCC room, compensation equipment room etc. | Industrial rail type single/twin 28 W, T5 type fluorescent fittings | Exposed wiring in GS conduit |
| Battery room | Open type vapour proof twin 28 W, T5 type fluorescent fittings having aluminium body | Exposed PVC conduit wiring with PVC cables |
| **Office** | | |
| General | Industrial rail type single/twin 28 W, T5 type fluorescent fittings | Concealed/exposed wiring in PVC conduit |
| Conference room, senior executive room etc. | Decorative mirror optics type single/twin 28 W, T5 type Fluorescent fittings | Concealed wiring in PVC conduit |
| **Plant road** | | |
| 4 m wide roads | 150 W HPSV street light fittings on pole (8 m mounting height) | Wiring with PVC(A) cable buried underground |
| 7 m and 11 m wide roads | 250 W HPSV street light fittings on pole (10 m mounting height) | Wiring with PVC(A) cable buried underground |
| 14 m wide roads | 400 W HPSV street light fittings on pole | Wiring with PVC(A) cable buried |

| Plant units/ departments | Type of lighting fittings | Type of wiring for lighting fittings |
|---|---|---|
| | (10 m mounting height) | underground |
| 22 m wide road with central verge | 250 W HPSV street light fittings on pole (10 m mounting height) | Wiring with PVC(A) cable buried underground |
| Outdoor areas/yards | 400W HPSV flood light fittings on 30 m high mast tower | Wiring with PVC(A) cable buried underground |
| Hazardous areas | Flame proof well glass/bulk head fittings | Exposed wiring with PVC(A) cables using flame proof accessories |
| Chemically active corrosive atmosphere | Open type twin 28 W, T5 type fluorescent fittings having aluminium body suitable for corrosive atmosphere | Exposed PVC conduit wiring with PVC cables |

***Outdoor lighting fittings:*** Road lighting fittings will be mounted on tubular/octagonal galvanised steel poles with single or double outreach brackets having HPSV lamps. Adoption of solar power based individual road lighting poles will also be explored during implementation to reduce the consumption of electrical energy.

For lighting of open storages like stock yards etc., 30 m galvanised high mast towers will be provided with flood light fittings and HPSV lamps. Busy railway tracks, not covered by flood light towers, will be illuminated by means of flood lights with HPSV lamps mounted on tubular/octagonal galvanised steel poles.

The high mast towers will be of continuously tapered, polygonal cross section. The structure will be suitable for wind load in the plant area.

The mast will consist of three telescopic sections of suitable length and each section will be hot dip galvanised both on the inside and outside. Bottom section shall have a base plate to fix with concrete foundation block.

The mast will be electrically driven complete with capping section, lantern carriage, pulleys, winch assembly, wire ropes, junction boxes, flexible copper cables, plug and socket, contactor starter and all necessary accessories. The lantern carriage will be of three-point suspension type with integral motor operated winch.

***Lighting power supply and distribution:*** In major plant units where the lighting loads justify the installation of separate lighting LCSS, the lighting power supply will be taken from separate double-ended LCSS and distributed over requisite number of lighting distribution boards and miniature circuit-breaker (MCB) lighting sub-distribution boards.

In smaller plant/auxiliary units where lighting loads do not justify the formation of a separate LCSS, the lighting power supply will be taken from combined power and lighting LCSS or from local power distribution boards. Wherever required, power to the main lighting distribution board will be fed through intermediate dry type 415 V isolation transformer having Dyn11 connection.

Plant road and yard lighting will be fed from separate road and yard lighting distribution boards located suitably in nearby substations and control rooms. Outdoor feeder pillar distribution boards may be provided for proper distribution of load. Lighting distribution boards will generally be fed from power or lighting load-centres of units located in the immediate vicinity. The lighting system will be provided with remote and automatic switching facilities.

Each outgoing feeder of main lighting distribution board will feed one MCB lighting sub-distribution board (MCB board). Each 240 V single-phase circuit taken from MCB board will control a group of fittings with the loads equally distributed on all the three phases to the extent possible. The rating of MCBs will be selected on the basis of lamp starting current for vapour lamps and continuous current for fluorescent/incandescent lamps such that the total load does not exceed about 70 per cent of the MCB rating. For offices and control rooms, where specifically called for, ELCBs with 30 mA sensitivity will be provided for lighting system.

In plant buildings, 1,100 V grade PVC insulated and PVC sheathed lighting cables will generally be laid exposed along columns, underneath crane girders, walkways, structural members etc. In areas where cables are liable to get damaged due to mechanical or other hazards, including high ambient temperature, the cables will be laid in GS conduits. Also, cabling in false ceilings shall be done in GS conduits, using PVC unsheathed copper conductor cables.

For road lighting, 4-core underground cable will be run along road side and connection to individual poles given from alternate phases and neutral.

Cable sizes for lighting circuits will be selected based on voltage drop considering starting current of the lamps in circuit. The continuous current carrying capacity of such cables will in no case be less than the thermal trip setting of the MCB protecting the circuit.

***Aviation obstruction lighting system:*** The aviation obstruction lighting system will be as per recommendation of International Civil Aviation Organisation. Aviation obstruction lighting system will comprise LED based aviation obstruction lamp of effective light intensity in accordance with the Aerodrome Design Manual, Part-4. The LED banks with series-parallel combination will be fitted in cast aluminium alloy body with transparent red polycarbonate cover. Aviation obstruction lamp will be fixed and flashing type with red colour lamp in IP65 enclosure. Necessary control panel with battery back-up will be provided with aviation obstruction lighting system.

***Emergency lighting:*** In the event of total power failure, it is considered necessary to provide emergency lighting for evacuation, operation of the vital plant controls from various operators' stations as well as in the switch rooms and control rooms. For this purpose, in the substations, control rooms etc. where station switchboard control batteries are available, emergency lighting will be provided from the battery source over mains failure changeover units to feed the emergency fittings, so as to give minimum desired illumination under emergency conditions. For substation emergency lighting from 110 V battery bank, the fitting shall be LED type. For other emergency lighting suitable energy efficient fittings shall be considered.

In some of the production premises in addition to operational lighting, emergency lighting will be provided for possible evacuation or temporary continuation of work in case the main operational lighting system goes out. For emergency lighting in such production premises, lighting power supply will be taken from the emergency diesel generator sets. Emergency lighting when tapped from DG source will be through proper isolation transformer.

Where emergency diesel generator set and battery bank has not been provided, portable emergency lighting units with internal battery and automatic charging units will be provided at strategic locations to facilitate evacuation or operation of vital control equipment.

## 6.2 UTILITIES

This section discusses the requirement of various utilities/ industrial gases and describes the proposed plant and equipment installation for meeting these requirements. It also deals with the generation and consumption of various Fuel gases purchased stored fuel units, required for the plant processes. The air-conditioning and ventilation system, fire detection and alarm system and pipe-work for the plant are also discussed in this section.

### 6.2.1 Compressed Air System

***Requirements:*** Compressed air will be required for the operation of pneumatic devices for instruments and controls, pneumatic tools and for general purposes, cleaning etc. The operating pressure of compressed air will be 8 kscg and temperature will be ambient.

Dry compressed air or instrument air (required for instrumentation purpose mainly) with dew point of (-)40°C and pressure of 6 to 8 kscg will be available from the air dryers installed inside the compressed air stations.

The requirement of compressed air and dry compressed air will be met by installing dedicated compressors in a centralised compressed air station.

***Facilities:*** A centralised compressed air plant is envisaged for generation of compressed air to cater to the need of the Steel Plant in 3 phases of expansion. The compressors will be centrifugal type with delivery pressure 8 kscg. The compressed air station will be complete with compressors, drive motors, refrigerated type air dryers (for generation of dry air), air receivers of adequate capacity, pipework and necessary electrics & instrumentation.

There will be a single centralised compressed air station located suitably within the plant premises in which compressors and dryers will be added on phase wise, to cater to the compressed air and dry air requirement of the Plant in 3 phases of expansion. The requirement of compressed air is given in Table 6-9.

**TABLE 6-9 – REQUIREMENT OF COMPRESSED AIR IN 3 PHASES OF EXPANSION**
(N cu m/hr)

| | **Total consumption in Phase-I** | |
|---|---|---|
| **Consumers** | **Plant air** | **Dry air** |
| BF plants | 2,800 | 1,600 |
| Coke ovens | 1,400 | 200 |
| Sinter plants | 1,000 | 200 |
| Lime dolo calcining plant | 2,000 | 300 |
| SMSs | 700 | 170 |
| DR plant | 1,400 | 200 |
| Pellet plants | 1,000 | 100 |
| Rebar mill | 0 | 0 |
| HSM | 1,600 | 2,800 |
| Slab caster | 400 | 200 |
| Billet and bloom caster | 0 | 0 |
| Cement plant | 1,000 | 300 |
| CRM | 1,600 | 2,800 |

| | **Total consumption in Phase-II** | |
|---|---|---|
| **Consumers** | **Plant air** | **Dry air** |
| BF plants | 5,600 | 3,200 |
| Coke ovens | 2,800 | 400 |
| Sinter plants | 2,000 | 400 |
| Lime dolo calcining plant | 4,000 | 600 |
| SMSs | 1,400 | 340 |
| DR plant | 2,800 | 400 |
| Pellet plants | 2,000 | 200 |
| Rebar mill | 0 | 0 |
| HSMs | 3,200 | 2,800 |
| Slab caster | 800 | 400 |
| Billet and bloom caster | 0 | 0 |
| Cement plant | 2,000 | 600 |
| CRM | 3,200 | 5,600 |

| | **Total consumption in Phase-III** | |
|---|---|---|
| **Consumers** | **Plant air** | **Dry air** |
| BF plants | 8,400 | 4,800 |
| Coke ovens | 4,200 | 600 |
| Sinter plants | 3,000 | 600 |
| Lime dolo calcining plant | 6,000 | 900 |
| SMSs | 2,000 | 500 |
| DR plant | 4,000 | 500 |
| Pellet plants | 3,000 | 300 |
| Rebar mill | 6,000 | 9,000 |
| HSMs | 4,800 | 8,400 |
| Slab caster | 1,200 | 600 |
| Billet and bloom caster | 1,200 | 600 |
| Cement plant | 3,000 | 1,000 |
| CRM | 4,800 | 8,400 |

The centralised compressed air station will initially house four (4) compressors (3W+1S) each having a capacity of 10000 N cu m/hr after Phase-I. Similarly, also after Phase-I there will be installed three refrigerated type air dryers (2W+1S) of 5000 N cu m/hr capacity each, to cater solely to the dry air need of the plant.

After Phase-II, there will be installed additional three compressors each having capacity of 10000 N cu m/hr along with three additional refrigerated air dryers of capacity 5000 N cu m/hr each.

After Phase-III, there will be installed additional three compressors each having capacity of 10000 N cu m/hr along with three additional refrigerated air dryers of capacity 5000 N cu m/hr each.

Compressed air (both plant grade and dry grade) will be piped to the various consumers of the expansion scheme in 3 phases at an average pressure of 8 kscg. For pneumatic tools, on-line lubricators will be provided, terminating with hose connections. Ring mains will be suitably provided around the shops.

### 6.2.2 Fuel System

Under 3 phases of the expansion facility, the steel plant will generate large quantities of by-product fuel gases, i.e. Blast Furnace (BF) gas, Coke Oven (CO) Gas and LD Gas (Converter Gas). These by-product fuel gases will be first utilised as fuel for various heating applications (BF stove heating, coke oven under-firing, various mill furnaces, sinter plant etc.) of the steel plant. Balance available gases will be utilised for steam and power generation in the power plant.

The by-product fuel gas generation and consumption figures for the 3 phases of expansion scheme are given in Table 6-10 to 6-12 respectively.

**TABLE 6-10 – BY-PRODUCT GAS GENERATION AND CONSUMPTION FIGURES IN PHASE-I**

| By product gases | Generation, N cu m/hr | Consumption in various plant units, N cu m/hr | Balance available for power generation, N cu m/hr |
|---|---|---|---|
| BF gas | 776,800 | 647,400 | 129,400 |
| CO gas | 153,200 | 105,200 | 48,000 |
| LD gas | 39,500 | 198 | 39,300 |

**TABLE 6-11 – BY-PRODUCT GAS GENERATION AND CONSUMPTION FIGURES IN PHASE-II**

| By product gases | Generation, N cu m/hr | Consumption in various plant units, N cu m/hr | Balance available for power generation, N cu m/hr |
|---|---|---|---|
| BF gas | 1,553,600 | 1,134,400 | 419,100 |
| CO gas | 229,800 | 182,900 | 46,900 |
| LD gas | 79,000 | 395 | 78,700 |

**TABLE 6-12 – BY-PRODUCT GAS GENERATION AND CONSUMPTION FIGURES IN PHASE-III**

| By product gases | Generation, N cu m/hr | Consumption in various plant units, N cu m/hr | Balance available for power generation, N cu m/hr |
|---|---|---|---|
| BF gas | 2,330,400 | 1,676,300 | 654,000 |
| CO gas | 306,400 | 290,500 | 15,900 |
| LD gas | 124,900 | 625 | 124,300 |

Together with the in house by-product fuel gas generation, the steel plant will also have to acquire purchased fuel like liquid Propane/LPG, to supply fuel to some of the consumer units (Lime dolo calcining plant, billet/bloom caster, rebar mill furnace etc. only in the 3$^{rd}$ Phase of expansion).

Propane/LPG will also be required as sub-pilot/pilot fuel for Flare Stacks, cutting of billet/bloom/slabs in casters, start-up fuel for many furnaces etc. in all the 3 Phases of expansion.

It is estimated that about 700 tpd of liquid propane will be required at the end of Phase-III expansion. For that purpose and also for providing propane as pilot fuel to flare stacks, cutting of billets/blooms in the casters , start-up fuel for mill furnaces etc. (throughout all the 3 Phases of expansion), a propane storage and distribution facility of suitable capacity (consisting of unloading pumps, and vaporisers, piping manifold, electrics and instrumentation) is envisaged. This Propane Storage and Distribution facility will have capacity addition at the end of each Phase depending upon requirement of additional Propane.

### 6.2.3 Chilled Water Plant

A centralised chilled water plant of suitable Tonnage of Refrigeration (TR) capacity is proposed to be installed to cater to the air-conditioning requirement of the various premises of the steel plant under the expansion scheme. Chilled water will come out of the centralised chilled water plant at 7°C, and will be piped to various consumer units through insulated chilled water pipes. The chilled water will return to the chilled water plant at a temperature of 14°C. Chilled water pipe ring mains will be constructed to supply chilled water to the various consumer units of the plant.

The centralised chilled water plant will have provisions for additional capacity enhancements at the end of each phase of expansion. It is envisaged that at the end of the Phase-III, the total chilled water plant capacity will be around 8000 TR.

### 6.2.4 Process Steam System

Process steam (Low pressure steam) will be required for various heating applications in the steel plant. Process steam will be supplied in the plant network from bled steam of the Steam Turbines of the Power Plants.

### 6.2.5 Air-conditioning and Ventilation System

***Air-conditioning:*** Air-conditioning of control rooms, computer rooms, PLC/VVVF rooms, main office rooms etc. will be done through chilled water based AC system with Air Handling units, fans, louvers and ductwork .

***Ventilation:*** Main production buildings including Power Plant, maintenance shops etc., will be provided with side louvers and roof monitors for natural ventilation.

The details of the ventilation systems required for other premises are given in the Table 6-13.

**TABLE 6-13 – DETAILS OF VENTILATION SYSTEMS**

| Premises to be covered | Type | Maintenance parameters |
|---|---|---|
| Cable basements, cable tunnels, cable cellars, air compressor rooms, pump house etc. | Dry ventilation | Inside temperature 5°C above ambient |

### 6.2.6 Fire Detection and Alarm System

The fire detection and alarm systems proposed are indicated in Table 6-14.

**TABLE 6-14 – DETAILS OF FIRE DETECTION AND ALARM SYSTEMS**

| Premises to be covered | Type |
|---|---|
| Electrical control buildings, control rooms, computer rooms, control pulpits, Switch gear rooms, MCC rooms, transformer rooms, hydraulic rooms | Intelligent addressable microprocessor based automatic fire detection and alarm systems consisting of microprocessor based intelligent type fire alarm panel, intelligent addressable detectors and modules PC, printer and other interface units as applicable. |
| Outdoor transformers | High velocity water spray system |
| All other areas including above areas | Fire extinguishers of $CO_2$, DCP, ABC and FOAM type fire extinguishers. |

The microprocessor based FDA system will be software controlled automatic system, and will provide necessary programmed activities and various controls. The system will consist of central processing units, various man machine interface module transmission system, microprocessor based fire alarm control panels, PC, printer, video display unit, addressable intelligent automatic sensors and interface unit, as applicable.

Micro-processor based-intelligent fire alarm control panels: Fire alarm control panel will function as communication interface between central processing unit and sensors and controlled devices. Control panel will be intelligent, each with its own microprocessor and memory.

***Fire protection system:*** The Inergen based fire protection system is proposed to be mainly used in control rooms.

***Fire hydrant system:*** Fire hydrants of ring main types of suitable size and capacities are also envisaged for the various Steel Plant units.

### 6.2.7 Pipework

The main utility service pipelines to be laid under the expansion scheme include BF gas, CO gas, LD gas, compressed air, dry compressed air, nitrogen, oxygen, argon, steam and chilled water.

The yard portion of the pipework for all services will be laid on overhead towers and trestles with a clear height of 7 m above finished ground level (FGL). Shop internal pipework will generally be routed in multiple rows through building columns taking support from buildings and girders. Depending upon requirement, additional pipelines for each utility service may be laid over existing racks of towers/trestles with each Phase of expansion.

## 6.3 AIR SEPARATION PLANT

To meet the requirement of industrial gases like oxygen, nitrogen and argon for various process facilities of the steel plant under 3 Phases of expansion, one centralised Air Separation Plant (ASP) of suitable capacity is proposed to be installed whose capacity will be added on after every Phase to cater to additional requirement.

The requirement of oxygen, nitrogen and argon in 3 phases of expansion are as given in Table 6-15.

**TABLE 6-15 – REQUIREMENT OF OXYGEN, NITROGEN AND ARGON IN 3 PHASES OF EXPANSION**

(N cu m/hr)

| | **Total consumption of oxygen** | | |
|---|---|---|---|
| **Consumers** | **Phase-I** | **Phase-II** | **Phase-III** |
| BF plants | 48,000 | 96,000 | 144,000 |
| SMS (Including casters) | 37,000 | 74,000 | 111,000 |
| DR plant | - | - | 11,000 |
| WRM | - | - | 70 |
| Rebar mill | - | - | 140 |
| HSM | 180 | 360 | 540 |
| MSM | - | - | 120 |

| | **Total consumption of nitrogen** | | |
|---|---|---|---|
| **Consumers** | **Phase-I** | **Phase-II** | **Phase-III** |
| BF plant | 4,000 | 8,000 | 12,000 |
| SMS (Including casters, RH degassers, LF etc.) | 30,000 | 60,000 | 90,000 |
| DR plant | - | - | 2,000 |
| HMDP | 220 | 440 | 660 |
| Rebar mill | - | - | 270 |
| HSM | 2700 | 5400 | 8,100 |
| WRM | - | - | 2,700 |
| MSM | - | - | 65 |

| | **Total consumption of argon** | | |
|---|---|---|---|
| **Consumers** | **Phase-I** | **Phase-II** | **Phase-III** |
| SMS (including casters, RH degassers etc.) | 800 | 1,600 | 2,400 |

### 6.3.1 Facilities Proposed

Total oxygen requirement for the Phase-I, II and III expansion schemes comes to around 4200 tons per day (tpd), 8400 tpd and 12600 tpd respectively.

At end of Phase-I, a 2 x 2100 tpd unit will be installed. At the end of Phase-II, an additional 2 x 2100 tpd unit will be added to it and at the end of Phase-III, another additional 2 x 2100 tpd unit will be added to the system, making the total capacity of the ASP to 4200 tpd, 8400 tpd and 12600 tpd at the end of Phase-I, II and III respectively.

## 6.4 WATER SYSTEM

This section deals with the water system for the proposed integrated steel plant. Water is primarily required in the steel plant for equipment cooling. In addition, it is also used for process use, for collecting and conveying of scales, control of dust and debris; for drinking and sanitation; for fire-fighting. The method of collection, treatment and disposal of plant effluent and rain water harvesting also have been discussed.

### 6.4.1 Water Requirement

It is estimated that the total raw water quantity for Phase-I, II and III will be about 3,900 cu m/hr, 6,740 cu m/hr and 9,300 cu m/hr respectively. The estimated consumer-wise break-up of the make-up water requirement for Phase-I, II and III are given in Table 6-16 to 6-18 respectively:

**TABLE 6-16 – MAKE-UP WATER REQUIREMENT FOR PHASE-I**

| Sl. no. | Consumers | Make-up water, cu m/hr | Soft water, cu m/hr | DM water, cu m/hr |
|---|---|---|---|---|
| 1. | Raw material handling | 120 | - | - |
| 2. | Sinter plant | 60 | 5 | - |
| 3. | Pellet plant | 310 | 10 | 310 |
| 4. | Coke oven & By-product plant including CDQ | 450 | - | 450 |
| 5. | Blast furnace including slag granulation plant | 465 | 40 | - |

| Sl. no. | Consumers | Make-up water, cu m/hr | Soft water, cu m/hr | DM water, cu m/hr |
|---|---|---|---|---|
| 6. | HMDS1 | 5 | - | - |
| 7. | Steelmelt Shop (SMS-1) consisting of BOF, ladle furnace, RH degasser, slab caster | 580 | 29 | 120 |
| 8. | Hot strip mill | 670 | - | - |
| 9. | Cold rolling mill complex | 225 | - | 45 |
| 10. | Tin plate | 70 | - | 5 |
| 11. | Cement plant | 75 | 18 | - |
| 12. | Calcining plant | 10 | - | - |
| 13. | Oxygen plant | 300 | - | - |
| 14. | Power plant | | - | 40 |
| 15. | Chilled water plant | 80 | - | - |
| 16. | Softening plant | 115 | - | - |
| 17. | DM plant | 455 | - | - |
| 18. | Fire fighting | 5 | - | - |
| 19. | Drinking & sanitation | 100 | - | - |
| 20. | Other miscellaneous | 140 | - | - |
| | **Total** | **4,235** | 102 | 410 |
| | **Recovery from effluent treated in CETP for reuse** | **580** | | |
| | Net Make-up water requirement for ISP | 3,655 | | |
| | Water requirement for Jetty | 87 | | |
| | **Raw water required to be drawn from source (considering losses in raw water reservoir and treatment facilities)** | **3,900** | | |
| | Evaporation loss in CETP | 40 | | |
| | Reject water to be discharged to sea | 185 | | |
| | Recovery from dewatering iron ore slurry | 1500 | | |
| | Sea water for CPP equipment cooling (once through system) | 43350 | | |

**Notes:**

(1) *Discharge of recovered water from slurry to be done during initial stages and continually reduced during commissioning of plant facilities

| Sl. no. | Consumers | Make-up water, cu m/hr | Soft water, cu m/hr | DM water, cu m/hr |
|---|---|---|---|---|

(2) After commissioning of plant facilities withdrawal from Jobra barrage will further decrease by 1500 cum/hr

(3) Blowdown from the various shops will be collected at the common effluent treatment plant (CETP) and the same will be treated and reused to the consumers of plant low end application.

(4) Waste backwash of filtration plants of various contaminated circuits will be treated and reused within respective systems.

(5) Sea water would be used in CPP for once-through cooling system.

**TABLE 6-17 – MAKE-UP WATER REQUIREMENT FOR PHASE-II**

| Sl. no. | Consumers | Make-up water, cu m/hr | Soft water, cu m/hr | DM water, cu m/hr |
|---|---|---|---|---|
| 1. | Raw material handling | 180 | - | - |
| 2. | Sinter plant | 60 | 5 | - |
| 3. | Pellet plant | 460 | 20 | - |
| 4. | Coke oven & By-product plant including CDQ | 675 | - | 300 |
| 5. | Blast furnace including slag granulation plant | 930 | 80 | |
| 6. | HMDS1 | 5 | - | - |
| 7. | Steelmelt Shop (SMS-1) consisting of BOF, ladle furnace, RH degasser, Slab caster | 890 | 44 | 180 |
| 8. | Hot strip mill | 1340 | - | - |
| 9. | Cold rolling mill complex | 450 | - | 90 |
| 10. | Tin plate | 145 | - | 10 |
| 11. | Cement plant | 150 | 36 | |
| 12. | Calcining plant | 10 | - | - |
| 13. | Oxygen plant | 600 | - | - |
| 14. | Power Plant | | | 80 |
| 15. | Chilled water plant | 160 | - | - |
| 16. | Softening plant | 205 | - | - |
| 17. | DM plant | 735 | - | - |
| 18. | Fire fighting | 10 | - | - |
| 19. | Drinking & sanitation | 150 | - | - |
| | | | | |

| Sl. no. | Consumers | Make-up water, cu m/hr | Soft water, cu m/hr | DM water, cu m/hr |
|---|---|---|---|---|
| 20. | Other Miscellaneous | 170 | - | - |
| | **Total** | **7,325** | **185** | **660** |
| | Recovery from effluent treated in CETP for reuse | 945 | | |
| | Net Make-up water requirement for ISP | 6380 | | |
| | Water requirement for Jetty | 87 | | |
| | Raw water required to be drawn from source (considering losses in raw water reservoir and treatment facilities) | 6,740 | | |
| | Evaporation loss in CETP | 65 | | |
| | Reject water to be discharged to sea | 305 | | |
| | Recovery from dewatering iron ore slurry | 1500 | | |
| | Sea water for CPP equipment cooling (once through system) | 86,700 | | |

**Notes:**

(1) *Discharge of recovered water from slurry to be done during initial stages and continually reduced during commissioning of plant facilities

(2) After commissioning of plant facilities withdrawal from Jobra barrage will further decrease by 1500 cu m/hr

(3) Blowdown from the various shops will be collected at the common effluent treatment plant and the same will be treated and reused to the consumers of plant low end application.

(4) Waste backwash of filtration plants of various contaminated circuits will be treated and reused within respective systems.

(5) Sea water would be used in CPP for once-through cooling system.

## TABLE 6-18 – MAKE-UP WATER REQUIREMENT FOR PHASE-III

| Sl. no. | Consumers | Make-up water, cu m/hr | Soft water, cu m/hr | DM water, cu m/hr |
|---|---|---|---|---|
| 1. | Raw material handling | 240 | - | - |
| 2. | Sinter plant | 60 | 5 | - |
| 3. | Pellet plant | 600 | 20 | - |
| 4. | Coke oven & By-product plant including CDQ | 900 | - | 400 |
| 5. | Blast furnace including slag granulation plant | 1,395 | 120 | - |
| 6. | HMDS1&2 | 10 | - | - |
| 7. | Direct Reduction Iron (DRI) plant | 380 | | 20 |
| 8. | Steelmelt Shop (SMS-1) consisting of BOF, ladle furnace, RH degasser, slab caster | 890 | 44 | 180 |
| 9. | Steelmelt Shop (SMS-2) consisting of BOF, ladle furnace, RH degasser, billet and billet-cum-bloom caster | 270 | 12 | 60 |
| 10. | Hot strip mill | 1340 | - | - |
| 11. | Cold rolling mill complex | 450 | - | 90 |
| 12. | Tin plate | 145 | - | 10 |
| 13. | Plate mill | 250 | - | - |
| 14. | Rebar mill | 90 | - | - |
| 15. | Wire rod mill | 65 | - | - |
| 16. | Medium section mill | 85 | - | - |
| 17. | Cement plant | 150 | 36 | |
| 18. | Calcining plant | 10 | - | - |
| 19. | Tar processing plant | 60 | - | - |
| 20. | Benzol refining plant | 15 | - | - |
| 21. | Oxygen plant | 900 | - | - |
| 22. | Power Plant | | - | 120 |
| 23. | Chilled water plant | 250 | - | - |
| 24. | Softening plant | 260 | - | - |
| 25. | DM plant | 970 | - | - |
| 26. | Fire fighting | 10 | - | - |
| 27. | Drinking & sanitation | 220 | - | - |
| 28. | Other Miscellaneous | 200 | - | - |
| | **Total** | **10,215** | **237** | **880** |
| | Recovery from effluent treated in CETP for reuse | 1,370 | | |

| Sl. no. | Consumers | Make-up water, cu m/hr | Soft water, cu m/hr | DM water, cu m/hr |
|---|---|---|---|---|
| | Net make-up water requirement for ISP | 8845 | | |
| | Water requirement for Jetty | 87 | | |
| | Raw water required to be drawn from source (considering losses in raw water reservoir and treatment facilities) | 9,300 | | |
| | Evaporation loss in CETP | 100 | | |
| | Reject water to be discharged to sea | 435 | | |
| | Recovery from dewatering iron ore slurry | 1,500 | | |
| | Sea water for CPP equipment cooling (once through system) | 1,30,000 | | |

**Notes:**

(1) *Discharge of recovered water from slurry to be done during initial stages and continually reduced during commissioning of plant facilities.

(2) After commissioning of plant facilities withdrawal from Jobra barrage will further decrease by 1500 cu m/hr

(3) Blowdown from the various shops will be collected at the common effluent treatment plant and the same will be treated and reused to the consumers of plant low end application.

(4) Waste backwash of filtration plants of various contaminated circuits will be treated and reused within respective systems.

(5) Sea water would be used in CPP for once-through cooling system.

The water requirements for various purposes have been classified in accordance with its quality as follows:

a) Industrial water will be generally used in the plant water system as make-up to recirculating systems, as once-through usage and for fire-fighting etc.

b) Soft water will be used for closed recirculating systems of furnace, steelmelt shop etc.

c) Demineralised water will be used for steam raising in captive power plant boilers, coke oven & by product plant, process requirement in CRM etc. and blast furnace for closed recirculating system.

c) Potable water will be supplied to meet the drinking and sanitary needs of the plant personnel and other specific users.

**6.4.2 Raw Water Intake**

Upstream of Jobra barrage of Mahanadi River near Cuttack has been identified as the source of raw water for the proposed Steel Plant. It would be required to lay 87 km long pipeline to bring water from upstream of Jobra barrage to the plant. The raw water will be drawn from the proposed intake pump houses at 3,900 cu m/hr for Phase-I, at 6,740 cu m/hr for Phase-II and at 9300 cu m/hr for Phase-III.

**6.4.3 Raw Water Reservoir**

Water will be supplied to a main reservoir of 30 days storage outside the plant premises. It is envisaged that adequate storage capacity of 30 days will meet the plant water requirement to take care eventualities like maintenance of intake pump house and raw water rising mains. From there water will be supplied to small water reservoir within the plant premises. The requisite quantity of water will be continuously withdrawn from the reservoir and will be treated in the Raw Water Treatment Plant to make-up water quality. This grade of water will be supplied as make-up to the various consumers of plant water system through make up water pump house.

**6.4.4 Plant Water System**

In order to conserve water to the maximum possible extent, independent re-circulating systems with cooling towers, pump houses and treatment units, wherever required, will be considered for various units of the plant. The plant water system will comprise of industrial quality make-up water system, soft water system, DM water system, re-circulating water systems, drinking water system, water based fire-fighting system, waste water and effluent water system and distribution system.

The schematic water flow diagram for the proposed plant is given in Drawing 11467-06-0002.

The different plant water systems considered in this section, their respective consumers and broad facilities provided for each system are indicated in Table 6-19, which reflects a conceptual water supply scheme for plant water systems.

**TABLE 6-19 – MAJOR WATER SYSTEMS**

| Sl. no. | System | Main consumer/source | Main facilities |
|---|---|---|---|
| 1. | Make-up water system | Cold wells of various recirculating systems, consumptive & once-through water systems, softening & DM plant etc. | Raw water treatment plant, make-up water storage tank, pump house with pumpsets & accessories, distribution pipework. |
| 2. | Drinking water system | Plant personnel and laboratory. | Pumpsets, filters, chlorination unit, overhead tank, distribution pipework. |
| 3. | Water based fire fighting system | Yard/shop hydrant. | Motor driven and diesel engine driven pumpsets, jockey pumps, storage reservoir of required capacity, ring main, yard and shop hydrant system. |
| 4. | Soft water system | Various close-loop cooling systems. | Softening plant with regeneration system, supply pumps and pipework. |

| Sl. no. | System | Main consumer/source | Main facilities |
|---|---|---|---|
| 5. | Demineralised water system | Various close-loop systems in coke oven, CRM, power plant etc. | Demineralisation plant, supply pumps and pipework. |
| 6. | Water system for raw material handling facility | Consumers like dust suppression system etc. | Pumphouses, pumpsets and pipework |
| 7. | Sinter plant recirculating system | Close-loop & open-loop indirect cooling systems. | Pump houses, pumps and associated equipment, cooling towers. |
| 8. | Pellet plant recirculating system | Close-loop & open-loop indirect cooling systems. | Pump houses, pumps and associated equipment, cooling towers, heat exchangers and pipework. |
| 9. | Coke-oven & byproduct plant including CDQ recirculating system | Various close-loop and open-loop indirect cooling systems, contaminated direct cooling water system. | Pumphouses, pumps and associated equipment, cooling towers heat exchangers, settling tank, BOD plant etc. |
| 10. | Calcining plant recirculating system. | Open-loop indirect cooling systems. | Pumphouses, pumps and associated equipment, cooling towers and pipework. |
| 11. | DRI plant recirculating system | Open-loop indirect cooling systems. | Pumphouses, pumps and associated equipment, cooling towers and pipework. |
| 12. | Blast furnace recirculating system | Various close-loop and open-loop indirect cooling systems. | Pumphouses, pumps and associated equipment, cooling towers, heat exchangers, emergency OHT and pipework. |
| 13. | Blast furnace hot metal granulation plant | Contaminated open cooling circuit. | Pumphouses, pumps and associated equipment, settling tank and pipework. |
| 14. | Blast furnace Slag granulation plant water system | Contaminated open cooling circuit. | Pumphouses, pumps and associated equipment, settling tank and pipework. |
| 15. | SMS-1 consisting of basic oxygen furnace, ladle furnace, RH unit, slab caster recirculating | Various close-loop and open-loop indirect cooling system. | Pumphouses, launders, pumps and associated equipment, cooling towers, heat exchangers, emergency OHT and pipework. |

| Sl. no. | System | Main consumer/source | Main facilities |
|---|---|---|---|
| | system | | |
| 16. | SMS-2 consisting of BOF, ladle furnace, RH unit, billet & bloom caster recirculating system | Various close-loop and open-loop indirect cooling system. | Pumphouses, launders, pumps and associated equipment, cooling towers, heat exchangers, emergency OHT and pipework. |
| 17. | Hot strip mill recirculating system. | Various close-loop and open-loop indirect cooling system and contaminated direct cooling system. | Pumphouses, pumps and associated equipment, cooling towers, flumes, scale pit, settling tank, emergency OHT, pressure filters and pipework. |
| 18. | Cold rolling mill recirculating system. | Various close-loop and open-loop indirect cooling system and contaminated direct cooling system | Pumphouses, pumps and associated equipment, cooling towers, Effluent treatment facilities and pipework. |
| 19. | Plate mill recirculating system. | Various close-loop and open-loop indirect cooling system and contaminated direct cooling system | Pumphouses, pumps and associated equipment, cooling towers, flumes, scale pit, settling tank, emergency OHT, pressure filters and pipework. |
| 20. | Wire rod mill recirculating system. | Various close-loop and open-loop indirect cooling system and contaminated direct cooling system | Pumphouses, pumps and associated equipment, cooling towers, flumes, scale pit, settling tank, emergency OHT, pressure filters and pipework. |
| 21. | Medium section mill recirculating system. | Various close-loop and open-loop indirect cooling system and contaminated direct cooling system | Pumphouses, pumps and associated equipment, cooling towers, flumes, scale pit, settling tank, emergency OHT, pressure filters and pipework. |
| 22. | Rebar mill recirculating system. | Various close-loop and open-loop indirect cooling system and contaminated direct cooling system | Pumphouses, pumps and associated equipment, cooling towers, flumes, scale pit, settling tank, emergency OHT, pressure filters and pipework. |
| 23. | Tar processing and Benzol refining | Open-loop indirect cooling system & | Pumphouses, pumps and associated equipment, |

| Sl. no. | System | Main consumer/source | Main facilities |
|---|---|---|---|
| | plant water system | once-through system for process use | cooling towers and pipework. |
| 24. | Captive Power plant | Condenser cooling and other open-loop indirect cooling systems, demineralised water system, sea water will be used for once-through cooling system | Pumphouses, pumps and associated equipment, cooling towers and pipework. |
| 25. | Cement plant water system | Open-loop indirect cooling system & once-through cooling system | Pumphouses, pumps and associated equipment, cooling towers and pipework. |
| 26. | Oxygen plant re-circulating system | Open-loop indirect cooling system | Pumphouse, pumps and associated equipment and cooling towers and pipework. |
| 27. | Chilled water plant re-circulating system | Open-loop indirect cooling system | Pumphouse, pumps and associated equipment and cooling tower and pipework. |
| 28. | Effluent water treatment system | Waste effluent generated from various shops | Central effluent treatment plant consisting of various suitable treatment facilities for plant reuse. |
| 29. | Miscellaneous services including compressor cooling etc. | Open-loop indirect cooling system | Pump house, pumps and associated equipment and cooling towers and pipework. |

### 6.4.5 Industrial Make-up Water System

Industrial quality make-up water of required quantity will be generated in the raw water treatment plant. The make-up water will be stored in a make-up water reservoir. From this reservoir, make-up water will be supplied to the various consumers of plant water system through make- up water pump house.

### 6.4.6 Soft Water System

Soft water will be made available from softening plant where industrial quality make-up water will be fed for removing hardness. The soft water thus produced will be distributed to various consumers.

### 6.4.7 DM Water System

DM water will be made available from DM plant where industrial quality make-up water will be fed for producing demineralised water. The DM water thus produced will be distributed to various consumers.

### 6.4.8 Drinking and Sanitary Water System

The drinking water system will cater to the water requirements of plant personnel for drinking and sanitary purposes, central & area laboratories, canteens and miscellaneous users in the plant. Raw water will be clarified, filtered and chlorinated to convert it into drinking quality water. The drinking water will be stored in an overhead tank from which drinking water will be supplied to various consumers.

### 6.4.9 Fire-fighting Water System

Water based fire fighting system comprising of fire fighting pump house, motor driven & diesel engine driven main pumps, jockey pumps, ring main and fire hydrants at regular interval conforming to The Tariff Advisory Committee (TAC) norms will be provided to cater to any fire outbreak inside the shops and in the yard.

### 6.4.10 Waste Water and Effluent Treatment Management

Waste water generated from the different areas of the plant will be treated to the desired extent in suitable treatment facilities and recycled back to the process as make-up, facilitating adequate re-use of water in the respective re-circulating systems and economising the make-up water requirement. Blowdown generated from ICW circuit will be used as make-up to contaminated cooling circuits to the possible extent. Part of the effluent containing low TDS will be re-used after primary treatment in CETP for low end applications such as firefighting system, dust suppression and horticulture. Effluent generated from cooling towers blow down, BOD Plant, DM water plant, soft water plant, CRM etc. will be treated in Central Effluent Treatment Plant (CETP) for re-use in the plant. Sewage generated from toilet blocks etc. will be suitably collected for treatment in sewage treatment plant and the treated sewage will be transported to CETP. Reject water generated from CETP RO plant will be discharged into the sea after meeting the discharge standards. Sea-water used for cooling in the CPP would also be discharged into the sea.

The iron ore slurry coming from Joda/Nuagaon grinding and desliming plant will be filtered. Around 1,500 $m^3$/hr of water would be available from dewatering of slurry, which would be progressively reused in the operation period to further reduce fresh make-up water requirement. However, during construction period, the recovered water from slurry would be discharged to the sea after meeting the prescribed standards

### 6.4.11 Distribution System

Different types of water will be distributed/circulated through pipelines of generally mild steel construction. The pipe work will comprise all necessary pipes, valves, fittings and all other accessories as required conforming to the relevant standards. In the yard, all recirculating water pipework will be laid overhead. Make-up, fire and drinking water pipework will be generally laid underground in the yard with necessary corrosion protection.

### 6.4.12 Rainwater Harvesting

Adequate arrangement will be made for rain water harvesting by collecting the rain water in the plant area. The rain water will be stored in a storm water collection reservoir and sent to raw water treatment plant for further treatment.

## 6.5 LABORATORIES

The following area laboratories have been envisaged for the project in Phase-I, II and III. The laboratories will be implemented and augmented as per the implementation plan of major plant facilities to which it will serve. The implementation strategy of laboratory facilities in phases are given below:

| Sl. no. | Name of laboratory | Implementation time-line | | |
|---|---|---|---|---|
| | | Phase-I | Phase-II | Phase-III |
| 1. | Ironmaking laboratory | New lab | Augmentation with equipment | - |
| 2. | Pellet plant laboratory | New lab | Augmentation with equipment | - |
| 3. | Steel melt shop (SMS) laboratory | New lab for SMS-1 | Augmentation with equipment | 2nd new lab for SMS-2 |
| 4. | Hot strip mill (HSM) and Plate Mill laboratory | New lab | - | Augmentation with equipment |

| **Sl. no.** | **Name of laboratory** | **Implementation time-line** | | |
|---|---|---|---|---|
| | | **Phase-I** | **Phase-II** | **Phase-III** |
| 5. | Long mill laboratories | - | - | 3 new labs |
| 6. | Cold rolling mill laboratory | New lab | Augmentation with equipment | - |
| | CRNO laboratory | New lab | Augmentation with equipment | - |
| 7. | Calcining plant laboratory | New lab | Augmentation with equipment | - |
| 8. | Chemical plant laboratory | New lab | Augmentation with equipment | - |

The area laboratories will be located close to the departments they are intended to serve. The functional part of the laboratories will generally be divided into two major sections:

a) Sample preparation section.
b) Testing section.

The sample preparation section will prepare samples for making it suitable for testing. After testing the result will be transmitted to process control computer by means of fibre optic cables. The samples are generally received by the laboratory manually. However, for steelmelt shop laboratories and iron making laboratory, sample conveying will be carried out by pneumatic tubes.

## 6.6 REPAIR AND MAINTENANCE

To cater to the needs of maintenance services and repair activities in the steel plant, the following shops are planned:

a) Central repair shop.
b) Electrical equipment repair shop.
c) Mobile equipment repair shop.
d) Loco and loco crane repair complex.
e) Rail-road mover repair shop.
f) Wagon inspection area.

In addition to above, area repair shops are proposed for serving the major production departments. These repair shops will have facilities for cutting, machining, fitting, welding etc. and will be equipped with lathes, cutting machines, shapers, hacksaw etc. for undertaking the repair and maintenance activities of equipment of respective production units.

### 6.6.1 Stores

All incoming materials will be received in the respective stores, checked, inspected, stocked, preserved and issued to various consuming departments. The road weighbridge shall be used for weighing the in-coming materials to various stores. Checking and monitoring the materials received at various stores will be carried out at the respective stores. All the buildings will have requisite lighting, telephone, toilet, drinking water and fire-fighting facilities.

***Central store*:** The central store will be used for the storage of small items of equipment, spare parts, auxiliary and consumable materials including bearings, tools, abrasives, electrical accessories, water and gas fittings, special steels etc. Part of the store shall be provided with racking system for storing mechanical spares, electrical spares consumables and rubber goods. Necessary dock leveler and hoist shall be provided for unloading the materials. Balanced portion shall be used as storage of heavy spares and the same shall be handled by EOT crane.

***Heavy equipment store:*** All heavy spare parts shall be stored in this section. It shall be provided with EOT crane for movement of materials.

***Refractory store:*** The refractory store will have provision to stock operational requirement of refractory and insulating bricks and stock requirement of imported refractory. The refractory store will be housed in a building provided with EOT crane. Proper road approach will be kept for easy movement of trucks into the building. Office, store-keeper's room, issue and receipt section will be suitably provided in the building. Refractory bricks will be received in trucks in packed condition in cartons/pallets and it shall be unloaded and stacked on the floor with the help of EOT crane. Insulating bricks received in loose or in cartons will also be stacked on the floor. At one end of the building, mortars and monoliths received in bags and containers will be stored on the floor. At other end of the building, racks have been provided for storing special refractory. Forklifts and pallet trucks will be provided for handling and stacking of refractory in pallets. The refractory store will normally operate in the general shifts.

***Ferro-alloys store:*** Ferro-alloy store will be a totally covered shed. One office block with one sampling room will be constructed adjacent to this store. Ferro-alloys will be received in plant by trucks inside the store. Materials will be unloaded by shop crane or manually and stocked inside the building. There will be several numbers of strong cabinets, made of bricks for storing valuable ferro-alloys. The ferro-alloy store will have periphery wall with gates for ensuring security. The ferro-alloys store is designed to stock the operational requirement of ferro-alloys, heat insulating compound etc. The ferro-alloys store is also envisaged to store various other ferro-alloys and additives, which will be required in comparatively smaller amounts. To ascertain the quality of various materials being received in the store, samples will be sent to the laboratory for carrying out necessary tests.

## 6.7 ANCILLARY BUILDINGS

A number of ancillary buildings have been provided to serve the plant requirement and they are grouped under four categories as follows:

**i) Office buildings**

a) Administrative building,
b) Works office,
c) Shop offices.

**ii) Service buildings**

a) Training centre,
b) Fire brigade stations,
c) Other miscellaneous buildings.

**iii) Welfare buildings**

a) Crèche,
b) Plant medical units,
c) Central kitchen,
d) Ablution blocks.

**iv) Security structure**

a) Security office/Gate house,
b) Boundary wall and watch towers.

### 6.7.1 Basis of Building Design

***Space allocation:*** Building elements will be reasonably standardised to achieve speed, uniformity and economy in construction. Space allocations for various categories of personnel shall generally conforms to the recommendations of the Bureau of Public Enterprises (BPE). However, if desired, smaller or larger areas may be provided as per requirement of JSWS. The stipulated norm for office space allocation as per BPE is as indicated in Table 6-20.

**TABLE 6-20 – NBE NORMS FOR AREA ALLOCATION FOR VARIOUS PERSONNEL**

| Category | Area per person, sq m | Nature of accommodation |
|---|---|---|
| Sr. Executive | 22.0 | Room |
| Executives | 15.0 | Room |
| Officers | 7.5 to 8.5 | 2 persons/room |
| Jr. Officers | 5.5 to 7.0 | Hall |
| Technical Assistants | 5.5 to 7.5 | Hall |
| Office Assistants such as stenographers, clerks/typists etc. | 5.0 to 6.0 | Hall |
| Conference room | 3.0 to 4.0 | Room |
| Dining space in canteens | 1.2 to 1.6 | Hall/Room |

In general, reinforced concrete framed structures will be used with external cladding in bricks, concrete blocks or structural glazing and the internal partitions in brick or light weight partitioning system.

### 6.7.2 Other Miscellaneous Buildings

Various other miscellaneous structures such as car and two-wheeler parks will be constructed at suitable locations outside the plant areas. Car and two wheeler parks shall also be provided in the campus of the Administrative Building and the Training Centre.

## 6.8 TRANSPORTATION SYSTEM

The section describes the transportation and logistics of handling of inbound, in-plant and outbound traffic, materials and products.

### 6.8.1 Inbound

a) Bulk imported raw materials like coking coal, anthracite, PCI coal, SMS grade limestone for LCP and clinker for production of cement will be received by ship through the captive jetty and stored in the jetty side stock yard except clinker. Clinker will be stored within the cement plant area. All the transfer from Jetty to stock yard will be carried out by conveyors. From stock yard raw materials will be conveyed to respective units by conveyors.

b) Bulk indigenous raw materials like thermal coal, flux for BF, iron ore fines for sinter plant, lump ore etc. would be received by rail and unloaded through wagon tipplers/track hopper. After unloading, the materials will be stored in respective stock piles by conveyors. For this purpose a railway yard with multiple unloading facilities have been considered with merry-go-round concept. However, type of wagons will be finally dictated by Railways, which is separately being taken up by JSWUSL. Based on the Railways requirement, type of unloading station and yard configuration will be finally decided during preparation of DPR for Railways by railway approved consultant.

c) In order to comply the EOL requirement of Railways, unloading yard with Merry-go-round has been considered. However this can be retained or altered in consultation with Railways during the finalisation of DPR for Railway network.

d) Raw materials like gypsum, required for cement production would be received by road and stored in the stock piles and silos respectively within the cement plant complex. Fly ash from CPP to Cement plant to be conveyed through pneumatic conveying system.

e) Provision of ground hopper with conveying system has been considered to handle few low volumes inbound raw materials which may be received by road.

f) It is assumed that 50 per cent of total finished products will be exported, which will be despatched through captive jetty. For this purpose a storage space has been considered in jetty. Remaining 50 per cent of finished product will be dispatched through surface transport. It is considered that 30 per cent will be dispatched by rail and 20 per cent will be by road. However, heavy railway network has been considered to take care of rail traffic for the purpose of despatch of saleable product.

g) Predominately pellet, as saleable finished product will be dispatched by ship through captive port. In view of that, a pellet storage yard has been considered near captive port. However, for dispatch of pellet by rail, two pellet wagon loading station has been kept in the in-plant track network. from pellet plant to pellet wagon station, pellet will be conveyed by conveyors.

h) Concept of central despatch yard has been considered for despatch of finished products by rail. Few more yards have been considered for gathering of empty and loaded rakes.

i) Railway track connection has been considered inside most of the mills for despatch.

j) Plant railway system will be suitably connected to the existing Cuttack-Paradeep and/or Haridaspur-Paradeep line of Indian Railway. This is being studied by JSWUSL separately.

k) In order to finalise the railway infrastructure JSWUSL has to appoint a railway approved consultant to study the railway network inside the plant in details and submit a DPR to Indian Railways and obtain 'Approval'.

l) Multiple truck parking has been considered near the mills for dispatch of finished products.

m) During the initial stage of construction and plant operation Gate No. 4 will be used.

n) In order to ensure safe and smooth traffic movement, separate gates have been considered for movement of personnel, raw materials and finished products. Gate No. 1 at the southern end for finished products, Gate No. 2 for personnel located at the western boundary and Gate No.3 for raw materials and other materials.

o) Plant roads will also be suitably connected with the external highways. Feasibility of this connectivity is being studied by JSWUSL separately. After completion of the feasibility study of external Road network, the location of gates may get altered, if required.

### 6.8.2 In-plant

a) Raw materials will be mostly transferred to different consuming units by conveyors. Hot metal from any blast furnace to any steel melt shop by rail through torpedo ladle cars of suitable capacity.

b) It is envisaged that entire blast furnace slag would be consumed by the cement plant. Hence, the BF slag storage has been considered within the cement plant complex. BF slag would be transported from iron making unit of the ISP to the respective slag stock pile by belt conveyor.

c) Provision of direct transfer of 'semis' to the mills as far as possible.

d) Suitable roads will be provided all over the plant. Roads will be straight and orthogonal as far as possible. Width of carriageway of major roads will be minimum 7 m. However, based on the traffic volume and type of movement the width will be increased.

### 6.8.3 Outbound

a) It is assumed that 50 per cent of total finished products will be exported, which will be despatched through captive jetty. For this purpose a storage space has been considered in jetty. Remaining 50 per cent of finished product will be despatched through surface transport. It is considered that 30 per cent will be despatched by rail and 20 per cent will be by road. However, heavy railway network has been considered to take care of rail traffic for the purpose of dispatch of saleable product.

b) Predominately pellet, as saleable finished product will be despatched by ship through captive port. In view of that, a pellet storage yard has been considered near captive port. However, for despatch of pellet by rail, two pellet wagon loading station has been kept in the in-plant track network. From pellet plant to pellet wagon station, pellet will be conveyed by conveyors.

c) Concept of central despatch yard has been considered for despatch of finished products by rail. Few more yards have been considered for gathering of empty and loaded rakes.

d) Railway track connection has been considered inside most of the mills for despatch.

e) Plant railway system will be suitably connected to the existing Cuttack–Paradeep and/or Haridaspur-Paradeep line of Indian Railway. This is being studied by JSWUSL separately.

f) In order to finalise the railway infrastructure JSWUSL has to appoint a railway approved consultant to study the railway network inside the plant in details and submit a DPR to Indian Railways and obtain 'Approval'.

g) Multiple truck parking has been considered near the mills for despatch of finished products.

h) During the initial stage of construction and plant operation Gate No. 4 will be used.

i) In order to ensure safe and smooth traffic movement, separate gates have been considered for movement of personnel, raw materials and finished products. Gate No. 1 at the southern end for finished products, Gate No. 2 for personnel located at the western boundary and Gate No. 3 for raw materials and other materials.

j) Plant roads will also be suitably connected with the external highways. Feasibility of this connectivity is being studied by JSWUSL separately. After completion of the feasibility study of external Road network, the location of gates may get altered, if required.

# 7 - ENVIRONMENTAL POLLUTION MITIGATION MEASURES

The production facilities for the proposed integrated steel plant have been described in the earlier chapters. These production units would generate wastes in different forms, the recipient of which would be air, water and land environment leading to pollution of these environmental aspects.

This chapter outlines the various mitigation measures for abating environmental pollution in compliance with the Environment Protection Acts and Rules of the country.

## 7.1 REVIEW OF POLLUTION POTENTIAL

The proposed integrated iron and steel plant near Paradeep, Odisha would be based on BF-BOF process route of iron and steel making. The major process units would be DR plant, pellet plant, sinter plant, by-product recovery type coke ovens, blast furnace (BF), basic oxygen furnace (BOF), casters and flat & long product mills. In addition, there would be captive power plant and cement grinding unit based on BF slag, fly ash & purchased clinker. There would be emissions of particulate dusts, oxides of sulphur and nitrogen, dioxins, furans and carbon dioxide to the ambient air, unless suitable mitigation measures are adopted.

Similarly, the process effluent discharge, contaminated with suspended and dissolved solids, B.O.D, C.O.D, oil and grease etc., would pollute the receiving body of waste water unless adequate treatment and conservations are adopted.

The land environment would be affected due to temporary storage of industrial solid wastes like BF slag, BOF slag, sludges, debris, fly & bottom ash etc. and other hazardous wastes unless maximum utilisation of solid wastes are planned.

## 7.2 CONSIDERATION OF POLLUTION MITIGATION MEASURES

From the review of the pollution potential of the proposed project, the following mitigation measures would be required:

a) Air pollution control (APC) measures to control fugitive dusts, point sources emission of particulates, dioxins, furans, $CO_2$, $SO_2$ and NOx.

b) Water pollution control (WPC) measures to control release of suspended & dissolved solids, oil and grease etc. in the effluent stream.

c) Solid wastes categorisation, handling, storage and re-use/safe disposal.

The following text gives a brief outline of such measures:

## 7.3 AIR POLLUTION MITIGATION MEASURES

### 7.3.1 Raw Materials Handling (RMH)

Fugitive dusts emissions in the open area of RMHS would be controlled by water sprinkling at regular intervals especially during the dry months of the year. All conveyers would be of covered types and leak proof to prevent any emissions of dusts during transport of raw material and intermediate products. Other closed zone raw material handling, conveyor transfer points, screening or crushing house would be provided with dry fogging systems or dust extraction (DE) systems with bag filters and DE stack of adequate height.

### 7.3.2 Coke Ovens

Emissions from coke ovens would mainly result from coal charging and coke pushing. Fugitive emissions may result from various leakages from oven doors, charging lids, ascension pipe (AP) covers etc. Charging emissions would be controlled by High Pressure Liquor Aspiration (HPLA) injection in goose neck during charging. Coking emissions would be controlled by efficient sealing of oven doors, water sealing arrangement of AP cap etc. Land based fume extraction system would be adopted for charging and pushing emission control. The hot coke would be quenched by coke dry quenching (CDQ) with recovery of sensible heat for steam generation.

The raw coke oven gas (COG) would be cleaned in by-product recovery plant with recovery of tar, ammonia and sulphur to make it suitable for use as plant fuel and reductant in the DR plant.

### 7.3.3 Sinter Plant

The conventional air pollution systems like DE systems of sinter stock house based on electrostatic precipitator (ESP) and waste flue gas cleaning by dry type ESP would be installed. The particulate dust emission from the product sinter screening units would be controlled by DE systems complete with duct, fabric filters and stack of adequate height. Partial recirculation of waste gas would be adopted for heat recovery and energy conservation measures. MEROS (Maximised Emission Reduction of Sintering) Process for reduction of oxides of sulphur, heavy metals and organic compounds would be considered.

### 7.3.4 Pellet Plant

DE system comprising of bag filters would be provided to arrest fugitive emission during feed preparation & product handling. The flue gas generated from the indurating furnace would be passed through ESP and finally through a stack of adequate height.

### 7.3.5 Blast Furnace

Other than cleaning the BF gas in dry type gas cleaning plant (GCP), the main sources of air pollution would be the stock house and cast house. The BF stock house would be equipped with DE systems complete with ducts, ESP, ID fan and a stack of appropriate height. Cast house would be provided with Fume Extraction (FE) system to collect fumes during tapping of hot metal and slag, and taken into bag filters/ESP for separation of particulates before venting out through a stack of adequate height.

Heat recovery from stove waste gas shall be installed for preheating of BF gas and combustion air for stoves. In addition, energy conservation would be carried out through installation of TRT and pulverised coal injection.

### 7.3.6 DR Plant

The flue gas generated from the shaft furnace would mainly contain $CO_2$, $H_2O$ and NOx along with CO. After removal of $CO_2$, this gas would be recirculated in the furnace for reduction using the remaining CO and the spent gas would be passed through a stack of adequate height.

### 7.3.7 Calcining Plant

The emissions arising due the fuel burning in lime calcining plant is taken through a bag filter to separate out the lime/dolo fines. The lime/dolo fines thus collected would be recycled to the sinter plant. The kilns in the calcining plant and other dust generation areas would be provided with separate DE systems, complete with bag filters and stack of adequate height to clean the particulates.

### 7.3.8 BOF

The dry type cleaning of BOF gas would be done through ESP. There would be secondary emissions from charging/tapping/ blowing, argon rinsing operation, desulphurisation stations, deslagging etc. operations. The secondary fume emission would be controlled by APC comprising of doghouse with collection hood, ID fan, bag filter and stack of appropriate height.

### 7.3.9 LF

The primary emissions extracted from the LF would be collected by fume extraction (FE) devices. Dust laden fumes would be indirectly cooled and cleaned through a bag filter for separation of particulates and the clean gas would be vented into the atmosphere through a tall stack of adequate height. The secondary emissions would be controlled through canopy hood extraction, which would be integrated with the main system to clean the fugitive emissions during charging and tapping operations.

### 7.3.10 Caster

The water required for cooling the hot cast billets would generate hot fumes comprising mainly water vapour, hot waste water and suspended particulates. The casting area would be provided with adequate ventilation in order to have the water vapour properly dispersed.

**7.3.11 Rolling Mill**

Clean by-product gases would be used in the reheating furnaces as fuel. Burning of the gases would give rise to the emission of particulates, $CO_2$ and NOx. NOx emissions would be controlled by optimising the excess air supply and proper burner design. In addition fume extraction (FE) system would be installed. The flue gas, which is fairly clean, would be vented through a stack of adequate height. The acid pickling line of CRM would be provided with a scrubber system for fume extraction (FE).

For annealing/galvanising/colour coating of cold rolled (CR) coils, it would be heated in the inline annealing furnaces prior to its respective treatments. The waste produced due to burning of fuel would be vent to the atmosphere through a stack of adequate height.

The non-annealed cold rolled coils would undergo hot dip galvanisation in molten zinc baths followed by passivation. These processes would generate vapours and fumes which would be controlled by fume extraction systems.

Oil mist collector would be provided for oil fumes from the rolling process.

**7.3.12 Cement Grinding and Mixing Unit**

There would be grinding of slag, fly ash and clinker in vertical roller mills (VRM) and BF gas would be used to heat air for drying of slag during grinding in VRM. The exhaust containing particulates would be cleaned using bag filter. There would be generation of fugitive dust during operations like mixing of ground clinker with BF slag, fly ash and gypsum and bagging operations. DE system complete with suction hood, bag filter and stack of adequate height would be provided to capture the particulates and maintain the emissions to air within stipulated norms.

### 7.3.13 Captive Power Plant (CPP)

There would be captive power plant based on combustion of coal and excess byproduct fuel gases post their uses as in-plant fuel. The flue gas from boilers of CPP (for coal) containing particulates, $SO_2$ and NOx would be vented off to the atmosphere through tall stack of suitable height after passing through ESP where fly ash would be captured. Flue gas from the gas based boilers would mainly contain NOx. NOx emission would be controlled by using low NOx burners and controlling excess air during combustion.

### 7.3.14 Workzone Comfort

In addition to natural ventilation, selected areas like control rooms would be provided with air-conditioning. Where ambient temperature is above 35°C, man-coolers would be provided in selected areas at the shop floor. Mechanical sweeper/industrial vacuum cleaner, air circulator and water mopper would be used to keep the shop floor clean from settled dusts. The process control rooms, cubicles etc. would be air conditioned.

## 7.4 WATER POLLUTION CONTROL (WPC) MEASURES

The various types of process effluent streams that would be generated from the steel plant complex and their treatment schemes are as follows:

a) Effluent from Coke Ovens containing BOD, COD, phenol, cyanide etc. would be treated in Biological Oxidation and Dephenolisation (BOD) plant and further passed through Reverse Osmosis (RO) unit, and the clean water would be recycled.

b) The wastewater generated from the different cooling circuits would be routed through cooling towers and pressure filters as appropriate for recycling purpose. Cooling tower blow down would generally be used for dust suppression, slag quenching etc.

c) Effluent stream from caster, mills etc. containing mostly suspended solids (SS), oil and grease (O&G) for which mostly physico-chemical treatment schemes like oil separation, settling, clarification, filtration etc. would be employed.

d) The power plant effluent is the backwash of DM water plant, which would be neutralised in the neutralisation pit and the treated waste water would be recycled.

e) The plant sanitary waste water including canteen effluent is treated in a sewage treatment plant for separation of floating oil and reduction of BOD and the treated effluent is partly used for plant greeneries, road washing etc.

f) Water recovered from dewatering of iron ore slurry would be treated by clarification and would be reused.

Wastewater generated from the various units would be treated in suitable treatment facilities and recycled back to the process as make-up, facilitating adequate re-use of water in the respective re-circulating systems and optimising the make-up water requirement. Blowdown generated from ICW circuit would be used as make-up to contaminated cooling circuits to the possible extent. Part of the effluent containing low TDS would be re-used after primary treatment in CETP for low end applications such as firefighting system, dust suppression and green belt maintenance. High TDS bearing effluents would be further treated in RO of CETP and reused as fresh make-up water. Reject water generated from CETP RO plant will be discharged into the sea after meeting the discharge standards.

The treatment of effluents in the individual units and further treatment in CETP would also lead to maximum utilisation of wastewater and lesser requirement of fresh make-up water from Jobra barrage.

## 7.5 NOISE POLLUTION ABATEMENT

The overall aim towards control of noise pollution is not only to restrict the ambient and workzone noise within the specified norms, but also to have minimum noise above the prevailing ambient noise levels in the vicinity of the steel plant. Fluid noise of rotary equipment like fans and blowers would be kept low by suitable equipment design.

Isolation of the operational staff from high noise prone zone would be adopted by providing noise proof control room/cubicles, so that they are not exposed to Leq noise level more than 85 dB (A) for a continuous exposure of 8 hrs.

Peak noise emission due to venting of high pressure steam or compressed air would be abated by providing silencers so as to have workzone noise level not exceeding the threshold value of Leq 110 dB(A) for a period of 30 mins.

The ambient noise at the plant boundary would be maintained well within the specified norms of 55 dB (A) and 45 dB (A) at daytime and nighttime respectively.

## 7.6 SOLID WASTE/BY-PRODUCT MANAGEMENT

The following table presents the major solid wastes/by-products would be generated from the steel plant:

| Solid wastes | Expected generation, mtpy | Management scheme |
|---|---|---|
| BF slag | 3.84 | Granulation in slag granulation plant and used in cement manufacturing in captive cement plant. |
| BOF slag | 2.02 | Recovery of metallics & non-metallics for in-plant use. Balance utilised as railway ballast, in construction aggregrate, after processing. |
| LF slag | 1.35 | |
| Flue dusts | 0.2 | Reuse in agglomeration. |
| Mill scales | 0.26 | Reuse in agglomeration. |
| Chrome & other sludge | 0.0015 | Transferred to authorised agency. |
| Fly ash | 0.94 | Used to produce cement in the captive cement plant. |
| Bottom ash | 0.24 | Would be stored in ash pond and used for road making. |

Besides the above, there would be other solid wastes like clarifier sludges, ESP/Bag Filter dust, refractory debris etc. generated from the proposed steel plant. These would be reused/recycled within the plant to the extent possible and the balance would be transferred to Authorised agencies for reuse/recovery of materials/disposal as per prevailing regulations.

## 7.7 PLANT GREENBELT AND LANDSCAPING

During development of plant general layout, it is mandatory to reserve 33 per cent of the plant area for greenbelt as per the recent statutory requirements. The greenbelt, thus developed, would not only prevent the fugitive dust emissions but also improve the plant peripheral appearance from aesthetics view point. Unpaved areas, if any, within the plant boundary would be provided with grass cover.

### 7.8 PLANT SAFETY

Plant safety measures would be an integral part of the environment protection plan of the proposed plant. Workers' safety would be of highest degree of concern as required by the Factories Act 1948 and OSHAS 18001-2007 so as to avoid any personal injury or untoward incident. In-built safety measures of the plant and machinery would be made adequate in order to avoid hazardous events causing damage to the life and property.

# 8 - MANPOWER

This chapter deals with the preliminary estimates of manpower requirement for the proposed project.

The objective of this manpower estimate is primarily to derive the labour component of production cost and to indicate the order of manpower requirement. However, it will be necessary to review the manpower requirements at a later date on the basis of the final layout & logistics, equipment and facilities installed, degree of automation, actual mode of operation practice and management policies adopted.

## 8.1 ORGANISATION STRUCTURE

The organisation structure for the integrated steel plant has been developed indicating the major functional divisions of the organization. The principal executives responsible for functions of each division is shown in Fig. 8-1 on the next page. However, the proposed organisation structure may have tobe reviewed from time to time and modified according to the changing need of the plant.

### 8.1.1 Major Functions

The major functions of the proposed organisation after full development are briefly outlined below:

The Board of Directors formulates the policy and exercises overall control of the organisation through the Managing Director who is the full time chief executive of the proposed plant and deals with all aspects of management namely functional management, production management, maintenance management and quality management.

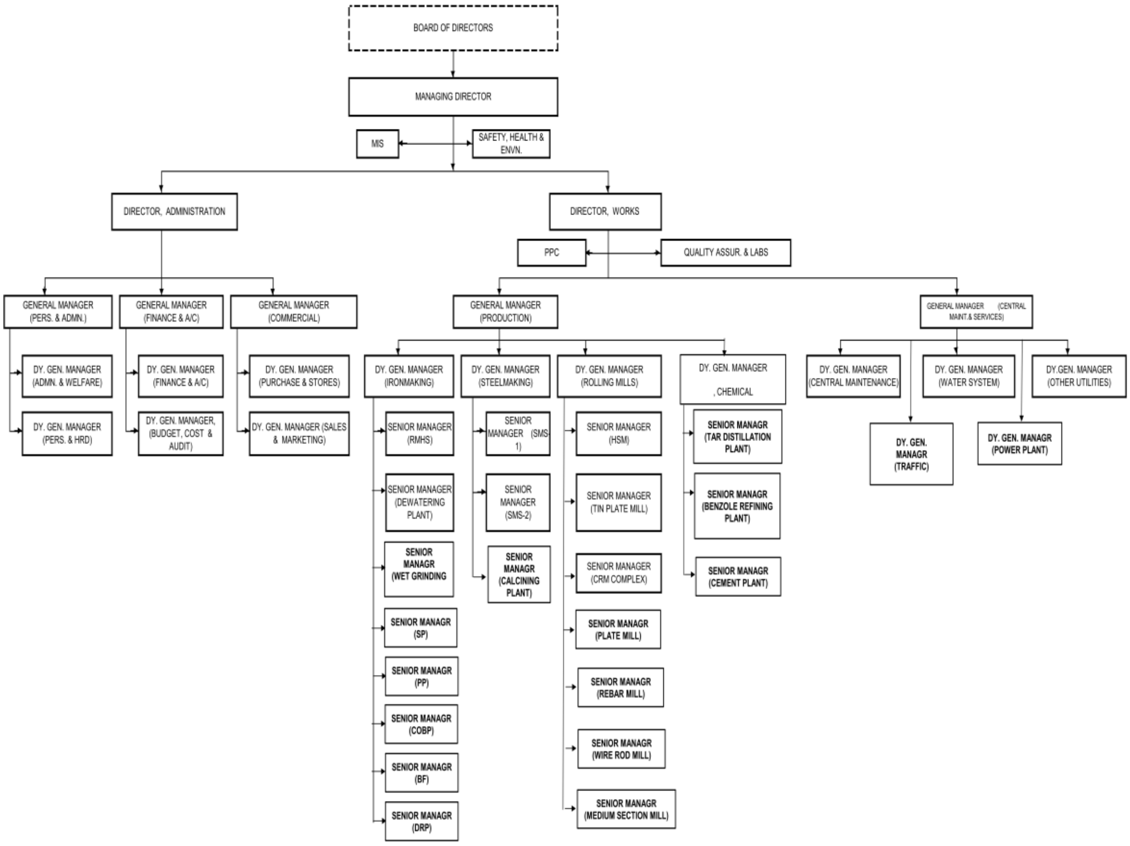



**FIG. 8-1 – PROPOSED ORGANISATION STRUCTURE**

The Managing Director holds a dual office as a member of the Board, he shares the corporate responsibility of the other directors; as Chief Executive, he is responsible to the Board of Directors. In this capacity, he is the link between the Board and the rest of the organisation. He interprets and implements the policies laid down by the Board.

To enable the Managing Director exercise efficient control over the entire organisation, the management functions are grouped into two major divisions, namely administration and works. Over and above, there will be a management information services (MIS) cell and safety, health and environment under Managing Director and a Company Secretary who will look after company matters, proceedings of board meetings and legal affairs and will directly report to Managing Director.

***Major functions of administration division:*** The administration division will be under the control of Director, Administration who will be assisted by three general managers, namely General Manager (Personnel and Administration), General Manager (Finance and Accounts) and General Manager (Commercial).

General Manager (Personnel and Administration) will look after general administration, law, personnel, industrial relation, labour welfare, public relations, recruitment, training, placement, horticulture and landscaping, sanitary and house-keeping, fire-fighting, vigilance and security services. He will be dealing with the Ministry of Labour and Social Affairs of the State Government on matters relating to regulation of labour relations as when required. He will have by two managers, one for HRD and personnel management and the other for general administration and welfare. However, it is suggested that some of the services such as canteen and catering services, horticulture and landscaping, personnel transportation, major fire-fighting, general cleaning and up-keep of the entire plant and sanitary services are to be outsourced but overall supervision of these functions will be taken care of departmentally.

General Manager (Finance and Accounts) will be responsible for financial planning and control, cost accounting, tax management, custody of funds, payment of wages and salaries, credits and collections, insurance, internal audit, general accounting and budgeting. He will exercise control through standard costing methods and budgetary planning. He will advise the management on matters relating to pricing and sales policies. He will be dealing with company auditors and Government Agencies on excise, tax and other financial matters. For carrying out his functions, he will be assisted by two managers, one for finance and accounts and the other for cost, budget, internal audit and financial planning.

General Manager (Commercial Services) will be responsible for procurement of raw materials, spares, consumables, ferro-alloys, refractories etc. from local and foreign markets and storage, prevention and issue of these materials to the consuming departments except bulk raw materials. He is also responsible for sales/marketing of the products. For carrying out his functions, he will be assisted by two managers, one for purchase and stores and the other for sales and marketing.

***Major functions of works division:*** The works division will be under the control of Director, Works who will be responsible for all the plant operations including planning, production, quality, costs, maintenance and services, environment and safety. He will supervise the functions of various production, maintenance and service departments, planning, quality assurance and laboratory services and ensure effective co-ordination between them. He will co-ordinate with commercial department in regard to inventory control and procurement of raw materials, spares, consumables, scheduling of production and despatch of finished products. He will also co-ordinate with finance and cost department in matters relating to plant budget and costs. For carrying out his functions, the Director, Works will be assisted by two general managers, one for production and the other for central maintenance and services. Moreover, production planning and control function will be directly under his control.

There will be four departments under the General Manager (Production), namely ironmaking, steelmaking, rolling mills and chemicals. Each will be headed by a senior manager. Raw materials handling, sinter plant, pellet plant, coke oven plant, blast furnace shop, direct reduction plant, dewatering plant and wet grinding plant will constitute ironmaking department. Steelmaking department will comprise SMS-1, SMS-2 and calcining plant. Rolling Mills will comprise HSM, tin plate mill, CRM complex, plate mill, rebar mill, wire rod mill and medium section mill. Chemical department will comprise tar distillation plant, benzol refining plant and cement plant.

General Manager (Central Maintenance and Services) is in-charge of central maintenance, repair shops, stores, power generation & distribution system, traffic services, water system, compressed air station, chilled water plant, air separation plant and fuel management.

Chief Metallurgist is responsible for overall quality assurance and laboratory services of the plant. He is in-charge of analysis and testing of incoming raw materials, samples at different stages of production, inspection of semi-finished and finished products and other laboratory testing services to ensure the quality standards of the products are as per customer requirement. He will co-ordinate investigation of material failures and will attend to customer complaints. He will also take care of the scientific and technical information services. He will co-ordinate with the outside agencies in regard to investigation, testing and inspection services to be carried out by them.

## 8.2 BASIS OF MANPOWER ESTIMATE

The manpower estimates have been made taking into consideration the following aspects:

a) Production processes involved, logistics, equipment with its degree of automation, jobs to be outsourced and mode of operation practice.

b) Additional manpower over and above the daily requirement has been envisaged for departments/ sections working seven days a week and six days a week respectively to cater weekly off, holidays, leave, absenteeism etc.

c) A separate maintenance section for each major department has been provided directly under the head of department to take care of preventive maintenance, running shift maintenance and minor repairs. During equipment shutdown for maintenance, the operation personnel will assist the maintenance personnel in carrying out the maintenance tasks to maximise the utilisation of manpower. However all repairs of capital nature and heavy maintenance jobs including civil maintenance, telecommunication maintenance etc. will be done by engaging specialised external agencies.

d) The maintenance personnel will have multi-disciplinary skills; for example, mechanic will be able to perform simple machining, welding and gas cutting. Implementation of such concept will optimise the utilisation of human resources and thereby will increase labour productivity of the plant which, in turn, will reduce the cost of production.

e) Implementation of computer systems including local area network (LAN) with standard user friendly software's in the field of financial management, personnel management, materials management, order scheduling, sales and marketing management, management information systems (MIS), production planning and control, maintenance and spares planning, utility and energy management etc. has been considered to increase work efficiency and to reduce manpower requirement.

f) Some of the services as given below have been considered to be out-sourced for which no manpower has been considered on pay-roll.

i) Canteen and catering services.

ii) Security services.

iii) Horticulture and landscaping services.

iv) Sanitary and house-keeping services.

v) All road transport services for materials and personnel movement.

vi) Disposal of plant wastes and effluents generated from various plant units.

vii) Metal recovery plant.

viii) Macroetching laboratory.

ix) Heavy maintenance and capital repair.

x) Plant civil maintenance.

xi) Plant telecommunication maintenance.

xii) Air-conditioning and ventilation maintenance.

xiii) Maintenance and repair of automation equipment, computers including its peripherals and any other related services.

xiv) Road and permanent way maintenance.

xv) Mobile equipment repair shop.

## 8.3 TOTAL MANPOWER REQUIREMENT

Based on the above, it is estimated that the total manpower requirement on pay roll for the project will be about 12,000 after Phase-III.

## 8.4 TRAINING

It is presumed that the personnel in the administration departments having requisite qualification and experience will be available from the local market and they do not normally require any specific training. It is expected that their recruitment will be progressive depending upon the requirement during the construction period and will be completed before commissioning of the plant.

For works departments, it is considered during HRD planning for this project that most of the key positions in manpower of the proposed plant at different categories will be manned by the qualified persons having experience in the similar field in iron and steel industries. However, depending on the type of equipment/facilities along with the degree of automation contemplated, the personnel of the plant so recruited will require specific need based training which is proposed to be carried out on-site by the respective equipment/technology supplier during equipment erection, start up and commissioning of different plant units. Besides, training can also be arranged in other JSW plants.

# 9 - PLANT CONSTRUCTION AND IMPLEMENTATION SCHEDULE

This chapter describes the volume and type of construction work, requirement and availability of various construction materials, deployment of various construction equipment and manpower, construction facilities such as water, power, construction and storage yards, offices, site fabrication yard, roads, drainage etc. required for construction work of integrated steel plant along with captive power plant of JSW Steel Ltd. at Paradeep, Jagatsingpur District, Odisha. The strategy to be adopted for implementation of the project has been described in this chapter.

## 9.1 VOLUME OF CONSTRUCTION WORK

The estimated volume of major items of work involved in the construction of the plant facilities are indicated in Table 9-1. The quantities are only indicative and the actual quantities may vary during engineering stage, depending upon the selected equipment, finalised building sizes, shop layouts, actual soil conditions etc.

**TABLE 9-1 – ESTIMATED VOLUME OF MAJOR ITEMS OF CONSTRUCTION**

| Sl. no. | Item | Unit | Quantity | Quantity | Quantity |
|---|---|---|---|---|---|
| | | | Phase-I | Phase-II (additional) | Phase-III (additional) |
| 1. | Piling work | | | | |
| | i) 600 mm dia, 27 m shaft | no. | 1,17,290 | 75,490 | 78,560 |
| 2. | Concrete of all grades including piling work(1) | cu m | 29,02,211 | 21,43,901 | 18,99,984 |
| 3. | Structural steel work(2) | tons | 4,62,500 | 3,39,200 | 3,55,200 |
| 4. | Roof and side sheeting | sq m | 5,241,300 | 3,844,300 | 4,025,600 |

**Notes:**

(1) Includes concreting for piling work.

(2) Inclusive of steel for inserts and embedment for civil work.

## 9.2 REQUIREMENT OF CONSTRUCTION MATERIALS

The approximate requirements of major construction materials have been estimated based on the volume of work and is indicated in Table 9-2.

**TABLE 9-2 – REQUIREMENT OF MAJOR CONSTRUCTION MATERIALS**

| Sl. no. | Item | Unit | Estimated quantity | Estimated quantity | Estimated quantity |
|---|---|---|---|---|---|
| | | | Phase-I | Phase-II (additional) | Phase-III (additional) |
| 1. | Cement | ton | 14,51,106 | 10,71,951 | 9,49,992 |
| 2. | Coarse aggregates | cu m | 26,11,990 | 19,29,511 | 17,09,986 |
| 3. | Fine aggregates | cu m | 19,15,459 | 14,14,975 | 12,53,989 |
| 4. | Reinforcing steel | ton | 2,75,710 | 2,03,671 | 1,80,498 |
| 5. | Structural steel | ton | 5,08,717 | 3,73,087 | 3,90,687 |
| 6. | Sheeting | sq m | 5,241,300 | 3,844,300 | 4,025,600 |

## 9.3 SOURCING OF CONSTRUCTION MATERIALS

It may be noted that all the major construction materials and suppliers are available locally.

It is envisaged that cement will be sourced from JSW Cement, reinforcing steel and structural steel materials from JSW Steel, roof and side sheets shall be procured from JSW Coated and issued to the contractors free of cost or at agreed recovery rates. An advance action may be initiated by JSW Steel Ltd., so that these materials are procured in adequate quantity before commencement of the work at site. In case of turnkey contractors, supply of these items will be decided on mutual agreements between JSW Steel Ltd. and concerned agencies. All other construction materials shall be procured by the contractors and stacked in respective construction yard/batching plant area with storage provision of at least fifteen days. Keeping in view large quantum of construction materials that will be needed during construction (monthly peak requirement) proper planning needs to be done by various executing agencies for arranging procurement of these materials including consumables in a phased manner.

### 9.3.1 Coarse Aggregates

Considering the total quantity of coarse aggregates (conforming to relevant IS Codes) requirement, the contractor shall carry out survey in the local areas for identification of sources and ascertaining the availability. During monsoons, there may be a crisis/shortfall for procurement of coarse aggregates. Civil contractors shall plan well in advance to procure and stack the coarse aggregates to tackle the situation during the execution of work.

### 9.3.2 Fine Aggregates

The contractors shall carry out survey to determine the sources of sand (conforming to relevant IS Codes) considering the material's quality and its suitability for construction work. They shall plan well in advance to procure and stack the sand for building buffer stock, especially for the rainy seasons, enabling to tackle any crisis during the execution of work.

### 9.3.3 Other Construction Materials

Considering other various on-going projects in the area, availability of other construction materials for this project will not be a problem.

## 9.4 PRE-CONSTRUCTION ACTIVITIES

Pre-construction activities/site preparatory work is a prerequisite before commencement of major construction work of any project.

The following pre-construction activities are envisaged for this project:

### 9.4.1 Survey and Soil Investigation Work

It is assumed that preliminary topographical survey and soil investigation data of the proposed sites are available with JSW Steel Ltd. which may be shared with the prospective contractors for their reference. However, it shall be the responsibility of the Contractor to verify the existing survey/soil investigation reports and carry out confirmatory and detailed survey and soil investigation before embarking on the construction work.

### 9.4.2 Construction Facilities

Preparatory work generally include site leveling and establishment of construction facilities. Also, some basic infrastructure has to be developed/augmented to prepare the area for construction work. This may include the following:

a) Construction of boundary wall.

b) Arrangement of water for construction and drinking.

c) Arrangement of construction power and lighting system.

d) Development of fabrication & construction yards and stores.

e) Development of construction office and field offices etc.

f) Development of construction roads and drainage system.

g) Construction of peripheral road inside plant boundary.

h) Dismantling and relocation work (if required).

i) External rail and road linkages.

### 9.4.3 Construction Water, Power and Lighting System

***Construction water:*** Continuous and reliable supply of water is essential for the project where large volume of construction activities envisaged like concreting, roads, drainages etc. Water supply facilities for both drinking and sanitary requirement of construction workers have to be arranged. Construction water for the project shall be made available by JSW Steel Ltd. at one point if there is an existing system at site. The contractors will make their own arrangements for connection, distribution and storage of construction water at their construction sites depending on their requirement. It is also envisaged that drinking water shall be made available by JSW Steel Ltd. from their existing facilities at site, if any. Contractors shall make special arrangements for dispensing and storing the drinking water for use of their workers during construction stage. However, if there is no existing drinking and construction water facility at site, the contractor will have to arrange their own source of construction water and drinking water during construction stage.

***Construction power:*** Construction power for the project shall be provided by JSW Steel Ltd. from a common take over point. Necessary construction power sub-station (CPSS) will be established in various construction zones as well as for construction yards. Silent DG sets may be kept at standby to provide emergency power during construction. For power distribution, 1100 V grade power cable may be used for connectivity between main 415 V, 3 phase 3 wire emergency DG distribution board to remote junction box at site. The construction power system shall be properly earthed. Contractors can avail power supply from these junction boxes.

**Area and road lighting during construction period:** The lighting requirement during construction period can be generally classified into the following three categories:

a) Actual construction site as well as contractors' storage and fabrication yard lighting.

b) Construction road and general area lighting including security purpose lighting.

c) Lighting of permanent auxiliary facilities and ancillary and buildings which will be constructed in advance to serve during the construction period.

For area and road lighting during construction phase it is assumed that construction power will be made available prior to commencement of foundation work for main plant construction.

***Construction and storage yards:*** Adequate construction and storage yards will be required during construction phase based on the present volume of construction work. Setting up of batching plants and storage of construction materials, structural steel, reinforcement, prefabricated structural materials and equipment etc. will be carried out in this area.

Due to space constraint for setting up of adequate construction, fabrication and storage yards, sequential construction planning may be adopted for better utilisation of available space. Also, it is envisaged that structural materials shall be primarily fabricated outside plant premises, adhering to the transportation logistics and limitations. Fabricated structural materials from the fabrication yard/shop fabrication will be received and stacked near respective construction zones, where areas will be specifically earmarked for such materials. This will minimise double handling.

***Construction roads and drainage:*** The permanent roads planned for the project will be used initially as construction roads. Initially, the road will be constructed upto Wet Mix Macadam (WMM) and will be used for the purpose of construction. The final topping course will be laid when the project is nearing completion. Thereafter, these roads will be used as the plant's permanent roads. Construction of the plant's storm water drainage system will be simultaneously taken up along with road construction.

## 9.5 CIVIL AND STRUCTURAL WORK

The land required for the project will be made available by JSW Steel Ltd. prior to construction. Considering the volume of construction work involved and availability of a limited construction period, it would be necessary to engage adequate number of experienced and resourceful contractors for carrying out the work at site in various plant facilities simultaneously. This can be achieved if the Further, it would be necessary to carry out the construction work in a mechanised manner by deployment of excavators, ready mix concrete plant, transit mixer, pump for concrete work; welding, drilling and grinding equipment etc. for structural work and high capacity mobile cranes for erection of structures so that civil and structural construction work can be completed within stipulated time.

### 9.5.1 Civil Work

Civil work will generally include building foundations, equipment foundations, shop flooring, auxiliary and ancillary buildings, roads, drainage, sewerage etc. Locally available resourceful contractors may be engaged for ancillary and other infrastructure work.

### 9.5.2 Structural Steel and Sheeting Work

Structural steelwork will cover fabrication, erection, painting, sheeting and cladding work for the plant building structures including auxiliary facilities and ancillary buildings, yard facilities etc. Owing to limitation of space for establishment of fabrication yard, it is envisaged that structural materials shall be primarily fabricated outside plant premises, adhering to the transportation logistics and limitations.

## 9.6 EQUIPMENT MANUFACTURE AND DELIVERY

It is envisaged that certified equipment data required for design of equipment foundations will be made available by equipment suppliers within a reasonable time from the date of placement of firm orders for plant and equipment on the respective suppliers. Prior to delivery of process equipment, appropriate facilities have to be constructed at site for transportation and secure storage of these equipment.

Delivery of equipment at site shall be according to the site execution sequence of the project. For various plant and equipment, necessary specifications will be prepared for selection of suppliers and erectors towards placement of orders to match the planned commissioning of the plant units. The placement of orders and delivery schedule of equipment for power, water and utility systems and other auxiliary facilities shall have to be planned so that these facilities can be erected and commissioned in time to match the schedule for commissioning of the plant. Prior to delivery of process equipment, appropriate facilities have to be constructed at site for secure storage of these equipment.

## 9.7 EQUIPMENT ERECTION

Erection of equipment for the plant facilities will commence after availability of civil and structural fronts as well as receipt of equipment at the site to match the sequence of erection. The installation of power, water and utility systems will also be taken up simultaneously.

Order for equipment erection will be placed on shortlisted resourceful and experienced contractors as far as possible to ensure quality of job and completion of work as scheduled.

Erection of the equipment for different plant facilities shall be completed in a sequential manner to match the commissioning schedule of plant.

## 9.8 EXTERNAL FACILITIES

Off-site facilities such as external water supply, power transmission line, railway and road linkage for transportation facilities etc., will have to be established to cater to the requirements of the plant matching with the overall implementation schedule. It is expected that these facilities will be installed prior to the commencement of trial run and commissioning of the plant facilities.

## 9.9 TRIAL RUN AND COMMISSIONING

After completion of equipment erection, cold trial activities of various units will be taken up sequentially. It is envisaged that the trial run and commissioning is to be conducted utilising the permanent plant power, water and utility systems. Hence power, water and utility system has to be established prior to trial run and commissioning of the respective production units. The trial run and commissioning will include cold run, hot run, followed by performance guarantee tests

(PGT). Commercial production shall start after completion of all commissioning activities.

## 9.10 IMPLEMENTATION STRATEGY

The modes of implementation strategy to be adopted for execution of the project is to be developed based on the following major considerations:

a) Volume and location of construction work.

b) Quantum of jobs available for other on-going/planned projects with prospective suppliers and executing agencies during actual awarding of various packages.

c) Availability of qualified equipment suppliers.

d) Availability of the suitable executing agencies for civil, structural and equipment erection work.

e) Availability of skilled and unskilled labourers.

f) Time frame envisaged for various works units, within the overall project schedule.

### 9.10.1 Possible Mode of Implementation

Taking into account the above considerations, the possible modes of implementation can broadly be divided in three categories namely:

a) Turnkey,
b) Discrete turnkey,
c) Non-turnkey.

The mode of implementation to be actually adopted for execution of the project will depend on the resource availability at that time, considering the various on-going and proposed projects in the region during the probable time schedule for implementation of this project. However, actual mode of implementation strategy to be followed against various packages will be at the discretion of JSW Steel Ltd. at the time of actual project execution.

## 9.11 SAFETY REQUIREMENTS DURING PROJECT CONSTRUCTION

The plant will require the involvement of a large number of construction workers, supervisory staff, managers, operators of construction machineries etc. The plant, during its construction, will need high in-built safety requirements to avoid injury to workers involved in various activities. It will be of utmost importance that safety of all personnel be ensured, during construction and erection work of the plant.

### 9.11.1 Health and Safety Policy

A health and safety policy, outlining vision, purpose and goals in consonance with international safety norms along with JSW Steel Ltd.'s own safety policy, will need to be drawn up at the beginning itself. This will include personal protective equipment, transportation, storage, usage and disposal of hazardous materials, construction traffic, etc. This policy will address and safeguard the health and safety concerns of personnel associated with construction of the plant, as well as operators and maintenance personnel, associated with the running of the various construction equipment and commissioning of the production units.

The health and safety policy will also frame 'safety rules' for construction work that will be undertaken at site, prior to commencement of any work related to the project. These rules will have to be finalised considering international practice; and in cognisance of the prevalent local laws and statutory regulations as provided for in the various industrial acts.

## 9.12 IMPLEMENTATION SCHEDULE

The preliminary overall implementation schedule for the project is shown in the form of a bar chart. The schedule has been developed on the basis of the estimated quantum of work, expected delivery and installation periods of plant and equipment, and the need to commission the plant facilities in the shortest possible time. The total time period for implementation has been taken as seven (7) years including three phases, where Phase-I to be commissioned by three years, Phase-II work to be started in 3rd year and to be commissioned after three years, i.e. on 5th year from "Go ahead" and Phase-III work to be started in 5th year and to be commissioned after three years i.e. after 7 years from "Go ahead". Scheduled commissioning of the plant can only be achieved if construction, delivery and erection periods can be met by the respective suppliers and contractors.

The `Go-ahead' date for the project implementation has been considered as a date of `Go-ahead' given to the CONSULTING ENGINEERS by JSW for basic engineering. The schedule has been prepared based on the assumption that the following activities will be completed prior to the date of `Go-ahead'.

a) Freezing of adequate project details to enable preparatory site activities to commence on `Go-ahead'.

b) Finalising the arrangement for requisite finance as per projections matching with implementation schedule.

c) Acquiring all relevant statutory government clearances.

d) Creation of nucleus project organisation.

Commissioning of various major facilities has been scheduled in a progressive manner in order to ensure integrated operation of the plant. Implementation schedule for various units from the 'Go-ahead' for three phases is as given in Appendix 9-1.

# 10 - COST AND PROFITABILITY

This Chapter deals with estimated capital cost, annual manufacturing expenses, income from sales and profitability of green field expansion plan of 13.2 mtpy integrated steel plant by Client in three phases (Phase-I, Phase-II, Phase-III) in Jagatsinghpur, Paradip, Odisha. The estimates are based on price levels, taxes & duties and exchange rates prevailing during 4$^{th}$ quarter of FY 2020-21.

The cost estimates are based on the data/information available with the CONSULTING ENGINEERS for similar projects.

Based on the capital cost, annual manufacturing expense and the income from sales the profitability of the project has been estimated for 20 yrs of plant operation from the start of operation of Phase-I.

The following exchange rates have been considered for the estimate:

1 Euro = Rs. 89.3
1 USD = Rs. 73.8

## 10.1 CAPITAL COST ESTIMATE

The capital cost estimate of the expansion project is presented under the following heads:

a) Plant cost,
b) Margin money for working capital,
c) Pre-operative expenses,
d) Interest during construction (IDC).

### 10.1.1 Plant Cost

The plant cost for the project includes cost of land, land development, civil and structural steelwork, in plant roads & rails, plant and equipment as erected. Cost towards design, engineering, administration during construction, project management and consultancy services (DE and ADC) and provision for contingency are also included in the plant cost. Taxes and duties have been calculated based on prevailing rates.

***Land and land development*:** The expenses towards land and land development after Phase-III have been estimated at about Rs. 515.6 crore.

***Civil and structural steelwork*:** The civil work includes foundation for building and equipment, masonry and reinforced concrete for buildings, trenches, basement etc. with necessary waterproofing treatment and ancillary buildings.

Structural steelwork includes structural steelwork, cladding with translucent sheets and their erection. Technological structure integral with the equipment is included with the equipment cost.

Estimated costs for internal roads and railway track work are also included.

Applicable taxes and duties have been considered in the estimated cost. The cost of civil, structural steelwork, internal roads and railway track work after Phase-III is estimated at about Rs. 16,797.3 crore.

***Plant and equipment:*** The cost estimates for major packages are as per the information available with CONSULTING ENGINEERS for similar projects. Applicable taxes and duties have been considered in the estimated cost.

***Erection:*** Charges for erection of plant and equipment including foreign supervision of erection have been provided at normative basis.

***Design, engineering, project management and consultancy services and administration during construction, (DE and ADC)*****:** Cost towards the same is estimated at 5 per cent on the supply price of plant and equipment including civil work, structural steelwork and erection and cost for land development.

***Contingency*****:** A contingency provision is made at 5 per cent of plant cost to cover the cost of unforeseen items. This contingency provision does not provide for any forward escalation, exchange rate variation and changes in statutory levies.

### 10.1.2 Margin Money for Working Capital

Twenty-five per cent of the estimated working capital for the first year of operation has been included in capital cost as margin money for working capital.

### 10.1.3 Pre-operative Expenses

The pre-operative expenses comprise of upfront fee for long term loan and start up expenses.

### 10.1.4 Interest during Construction

Interest during construction has been calculated on Gross of Cenvat basis and based on the following assumptions:

a) Debt-equity ratio of 1:1

b) Cost of debt (pre-tax) has been considered as at 9.5 per cent per year.

c) Year wise allocation of expenditure as per implementation schedule.

d) Drawal of fund in the ratio of Debt: Equity.

Based on the above considerations estimated capital cost of the project is given in Table 10-1.

**TABLE 10-1 – PHASEWISE INCREMENTAL CAPITAL COST**

| Sl. no. | Description | Phase-I, Rs. crore | Phase-II, Rs. crore | Phase-III, Rs. crore | Total, Rs. crore |
|---|---|---|---|---|---|
| A. | **Plant Cost** | | | | |
| | Land and land development | 487.2 | 16.2 | 12.3 | 515.6 |
| | Civil and structural steelwork | 6,920.5 | 4,650.2 | 5,226.6 | 16,797.3 |
| | Plant & Equipment as erected | 19,161.2 | 13,317.8 | 13,249.9 | 45,728.9 |
| | Infrastructure facilities | 150.1 | - | - | 150.1 |
| | DE&ADC | 1,176.3 | 798.4 | 811.0 | 2,785.8 |
| | Contingency | 1,382.4 | 939.1 | 965.0 | 3,286.5 |
| | **Total (A)** | **29,277.7** | **19,721.7** | **20,264.8** | **69,264.3** |
| | | | | | |
| B. | **Other Costs** | | | | |
| | Margin money | 1,165.6 | - | - | 1,165.6 |
| | Preliminary and Pre-operative Expenses | 162.1 | 105.2 | 108.1 | 375.3 |
| | Interest during construction (IDC) | 1,807.3 | 1,207.7 | 1,245.4 | 4,260.4 |
| | **Total (B)** | **3,135.0** | **1,312.9** | **1,353.5** | **5,801.4** |
| | | | | | |
| C. | **Capital Cost (Gross of Input Tax)** | **32,412.8** | **21,034.5** | **21,618.3** | **75,065.6** |
| | | | | | |
| D. | Input Tax Credit | 4,257.3 | 2,861.9 | 2,946.5 | 10,065.7 |
| | | | | | |
| E. | **Capital Cost (Net of Input Tax)** | **28,155.5** | **18,172.7** | **18,671.8** | **65,000.0** |

## 10.2 ANNUAL MANUFACTURING EXPENSES

The cumulative annual manufacturing expenses after each phase in the first year of rated operation of each phase have been worked out under the following four heads:

a) Input materials,
b) Manpower,
c) Other conversion costs,
d) Overheads.

The production build-up for the facilities for expansion project has been considered as below:

| | Comm. period | Duration | Production Build up | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (months) | (months) | 1st yr | 2nd yr | 3rd yr | 4th yr | 5th yr | 6th yr | 7th yr | 8th yr | 9th yr |
| **Phase-I** | 0-36 | 36 | 80% | 90% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Phase-II** | 25-60 | 36 | | | 80% | 90% | 100% | 100% | 100% | 100% | 100% |
| **Phase-III** | 49-84 | 36 | | | | | 80% | 90% | 100% | 100% | 100% |

### 10.2.1 Input Materials

The annual costs of input materials have been computed taking into account the annual gross requirements and their corresponding unit prices

### 10.2.2 Manpower

The incremental manpower requirement for works and administration has been estimated at 12,000 persons. Provision has also been kept for outsourced manpower.

### 10.2.3 Other Conversion Cost

Other conversion cost includes cost of power and energy, industrial gas, fuel, make-up water and repair & maintenance.

The annual cost of electrical energy is estimated considering estimated quantity of purchased energy from state grid at an average unit price of Rs. 6.32 per kWh. The cost of contract demand charge with state grid is estimated at unit price of Rs. 250/KVA/month.

The annual requirement of industrial gases like oxygen, nitrogen and argon will be met from Captive Air Separation Plant. The unit rates

Make-up water cost is based on estimated quantities and unit price of Rs. 15 per cu m.

Annual provision towards repair and maintenance has been considered at 2.5 per cent of the as-built cost of plant and equipment.

### 10.2.4 Overheads

This includes cost towards insurance on fixed assets, office expenses and sales expenses.

Based on the above considerations, the cumulative annual manufacturing expenses in the year of stabilised operation after each phase are given in Table 10-2.

**TABLE 10-2 – CUMULATIVE ANNUAL MANUFACTURING EXPENSES AT STABILISED YEAR OF OPERATION AFTER EACH PHASE**

| Sl. no. | Item | Phase-I, Rs. crore | Phase-II, Rs. crore | Phase-III, Rs. crore |
|---|---|---|---|---|
| A. | Input material | 21,355.9 | 27,902.4 | 34,184.0 |
| B. | Salaries and wages | 841.8 | 1,434.0 | 2,035.7 |
| C. | Other conversion cost | | | |
| | - Power | 1,390.2 | 2,383.7 | 2,914.6 |
| | - Purchased Fuel (Propane) | 314.4 | 628.8 | 1,127.8 |

| Sl. no. | Item | Phase-I, Rs. crore | Phase-II, Rs. crore | Phase-III, Rs. crore |
|---|---|---|---|---|
| | - Consumables | 3,395.6 | 6,624.2 | 7,464.9 |
| | - Refractories | 187.0 | 372.4 | 580.8 |
| | - Water | 120.9 | 120.9 | 122.2 |
| | - Repair & Maintenance | 526.4 | 891.7 | 1,255.2 |
| D. | Overheads | 294.3 | 508.0 | 701.9 |
| | **Total** | **28,426.5** | **40,866.3** | **50,387.1** |

## 10.3 ANNUAL SALES REALISATION

The net sales realisations, cumulative annual sales quantity and amount of annual sales realisations of salable finished products in the year of stabilised operation after each phase have been indicated in Table 10-3.

### TABLE 10-3 – ANNUAL SALES REALISATION AFTER EACH PHASE

| Sl. no. | Salable products | NSR, Rs./ton | Salable qty | | | Amount | | |
|---|---|---|---|---|---|---|---|---|
| | | | Phase-I, ton p.a. | Phase-II, ton p.a. | Phase-III, ton p.a. | Phase-I, Rs. crore | Phase-II, Rs. crore | Phase-III, Rs. crore |
| 1 | HRC | 37,427 | 1,494,000 | 2,988,100 | 3,610,100 | 5,591.5 | 11,183.4 | 13,511.4 |
| 2 | Tinplate coil | 47,173 | 227,760 | 455,520 | 455,520 | 1,074.4 | 2,148.8 | 2,148.8 |
| 3 | CRCA coils | 42,779 | 972,500 | 1,944,000 | 1,944,000 | 4,160.3 | 8,316.3 | 8,316.3 |
| 4 | Colour coated | 49,173 | 497,500 | 995,000 | 995,000 | 2,446.4 | 4,892.8 | 4,892.8 |
| 5 | Galvanized | 47,173 | 522,625 | 1,044,250 | 1,044,250 | 2,465.4 | 4,926.1 | 4,926.1 |
| 6 | Silicon steel | 47,173 | 247,500 | 495,000 | 495,000 | 1,167.5 | 2,335.1 | 2,335.1 |
| 7 | Plates | 37,193 | - | - | 1,183,000 | - | - | 4,399.9 |
| 9 | Rebar | 36,308 | - | - | 1,200,000 | - | - | 4,356.9 |
| 10 | Wire rod | 36,988 | - | - | 599,400 | - | - | 2,217.0 |
| 11 | Medium sections | 32,908 | - | - | 1,007,000 | - | - | 3,313.9 |
| 13 | Iron ore concentrate | 3,086 | 14,448,000 | 6,672,000 | - | 4,457.9 | 2,058.6 | - |
| 14 | Pellet | 5,801 | 14,011,700 | 15,220,400 | 14,811,200 | 8,128.6 | 8,829.8 | 8,592.4 |
| 15 | DRI | 17,234 | - | - | 378,000 | - | - | 651.4 |
| 17 | Cement | 3,740 | 5,000,000 | 10,000,000 | 10,000,000 | 1,870.0 | 3,740.0 | 3,740.0 |
| 18 | **Crude tar distillation** | | | | | | | |
| 19 | - DNO | 18,000 | - | - | 1,100 | - | - | 2.0 |
| 20 | - Napthalene | 29,400 | - | - | 8,100 | - | - | 23.8 |
| 21 | - Pitch | 18,000 | - | - | 72,800 | - | - | 131.0 |
| 22 | - PCM | 18,000 | - | - | 164,700 | - | - | 296.5 |
| 23 | - Creosote | 18,000 | - | - | 5,400 | - | - | 9.7 |

| Sl. no. | Salable products | NSR, Rs./ton | Salable qty | | | Amount | | |
|---|---|---|---|---|---|---|---|---|
| | | | Phase-I, ton p.a. | Phase-II, ton p.a. | Phase-III, ton p.a. | Phase-I, Rs. crore | Phase-II, Rs. crore | Phase-III, Rs. crore |
| 24 | - Anthracene Oil | 19,250 | - | - | 5,400 | - | - | 10.4 |
| 25 | - Road Tar | 17,500 | - | - | 12,200 | - | - | 21.4 |
| 26 | - Wash oil | 19,600 | - | - | 300 | - | - | 0.6 |
| 27 | - Crude Tar | 17,500 | 135,000 | 202,500 | - | 236.3 | 354.4 | - |
| 28 | Sulphur | 2,000 | 6,000 | 9,000 | 12,000 | 1.2 | 1.8 | 2.4 |
| 29 | **Benzole refining plant** | | | | | | | |
| 30 | - N G Benzene | 33,460 | - | - | 43,900 | - | - | 146.9 |
| 31 | - N G Toluene | 36,820 | - | - | 7,600 | - | - | 28.0 |
| 32 | - Xylene | 39,200 | - | - | 1,100 | - | - | 4.3 |
| 33 | - Crude benzol | 27,300 | 36,000 | 54,000 | - | 98.3 | 147.4 | - |
| 34 | LD slag | 200 | 591,400 | 1,231,900 | 2,023,500 | 11.8 | 24.6 | 40.5 |
| 37 | BF coke | 23,843 | 1,120,400 | 784,600 | 435,100 | 2,671.3 | 1,870.7 | 1,037.4 |
| 38 | Coke breeze | 10,950 | - | - | 13,815 | - | - | 15.1 |
| 39 | Iron scrap | 12,500 | 35,500 | 71,000 | 106,071 | 44.4 | 88.8 | 132.6 |
| 40 | Steel scrap | 24,000 | - | - | 12,511 | - | - | 30.0 |
| | **Total** | | | | | **34,425.3** | **50,918.6** | **65,334.5** |

## 10.4 FINANCIAL ANALYSIS

This Section presents the financial analysis of the project over a 20 yr operation period after start of operation of Phase-I. The estimate is based on cost and prices, and prevailing taxes and duties. The profitability analysis has been worked out based on the capital cost, annual manufacturing expense and sales realisations as discussed earlier in the Chapter.

The financial highlights in the stabilised year of production of the project after each phase are presented in the Table 10-4.

### TABLE 10-4 – FINANCIAL HIGHLIGHTS IN THE STABILISED YEAR OF OPERATION AFTER EACH PHASE

| Description | After Phase-I, Rs. crore | After Phase-II, Rs. crore | After Phase-III, Rs. crore |
|---|---|---|---|
| Annual sales realisation | 34,425.3 | 50,918.6 | 65,334.5 |
| Annual generating expenses | 28,426.5 | 40,866.3 | 50,387.1 |
| Gross profit before interest, depreciation & tax | 5,998.8 | 10,052.3 | 14,947.4 |

| Description | After Phase-I, Rs. crore | After Phase-II, Rs. crore | After Phase-III, Rs. crore |
|---|---|---|---|
| Interest | 1,710.4 | 2,047.0 | 1,873.8 |
| Depreciation & Amortisation | 1,167.9 | 2,004.0 | 2,901.7 |
| Profit before income tax | 3,120.5 | 6,001.3 | 10,171.9 |
| Provision for income tax | 672.4 | 1,293.2 | 2,191.9 |
| Profit after income tax | 2,448.0 | 4,708.1 | 7,979.9 |

### 10.4.1 Means of Financing

Considering a debt-equity ratio of 1:1, the means of financing for three phases is given in Table 10-5.

**TABLE 10-5 – MEANS OF FINANCING**

| Sl. no. | Sources of fund | | Incremental | Incremental | Total |
|---|---|---|---|---|---|
| | | Phase-I | Phase-II | Phase-III | After Phase-III |
| | | Amount, Rs. crore | Amount, Rs. crore | Amount, Rs. crore | Amount, Rs. crore |
| **A.** | **Loan** | | | | |
| A.1 | Rupee Term Loan | 16,206.4 | 10,517.3 | 10,809.2 | 37,532.8 |
| | **Total (A)** | **16,206.4** | **10,517.3** | **10,809.2** | **37,532.8** |
| | | | | | |
| **B.** | **Equity** | **16,206.4** | **10,517.3** | **10,809.2** | **37,532.8** |
| | | | | | |
| | **Total (A+B)** | **32,412.8** | **21,034.5** | **21,618.3** | **75,065.6** |

### 10.4.2 Normal Capital Expenditure

Normal capital expenditure, for addition/modification/ replacement of plant and machinery necessary for ensuring continued good health of the plant, has been provided on a normative basis in each year from the fourth year of plant operation.

### 10.4.3 Depreciation

Depreciation has been calculated on the basis of three-shift plant operation. Depreciation has been calculated on straight-line method for the purpose of profit and loss statement. For corporate tax calculation, depreciation has been calculated on written down value (WDV) method. The rates of depreciation considered for various facilities are indicated on the next page.

| Facilities | Depreciation | |
|---|---|---|
| | **Straight-line, %** | **WDV basis, %** |
| Buildings | 3.17 | 10 |
| Other plant and equipment | 4.75 | 15 + 20 (1st year) |

### 10.4.4 Repayment of Borrowings

Loans from financial institutions/banks are considered to be repaid in each phase in the following manner:

| | | |
|---|---|---|
| Year of repayment | .. | 8 |
| Mode of repayment | .. | 32 equal quarterly installments |
| Moratorium period | .. | One year |

### 10.4.5 Working Capital

The working capital required for the first year of operation and during subsequent years, will be met from bank borrowings and internal accruals. The bank borrowings have been considered at 75 per cent of the working capital requirement for each year.

### 10.4.6 Interest Charges

Interest charges on long-term loan has been considered as 9.5 per cent per year and on bank borrowings for working capital requirement has been calculated at 10 per cent per year.

### 10.4.7 Corporate Tax

Corporate tax has been computed at the prevailing rate. However, for initial years when taxable profit is not generated, minimum alternate tax (MAT) is considered to be paid on profit before tax. Refund of MAT in the subsequent years has been considered as per stipulation in the Income Tax Act.

## 10.5 FINANCIAL INDICATORS

The salient financial indicators for the three phases of the project are given in Table 10-6.

**TABLE 10-6 – FINANCIAL INDICATORS**

| Sl. no. | Item | After Phase-I | After Phase-II | After Phase-III |
|---|---|---|---|---|
| A. | Internal rate of return (post tax), % | 11.7% | 12.0% | 12.6% |
| B. | Payback period, years | 7.5 | 8.1 | 8.6 |
| C. | Debt Service Coverage Ratio (DSCR) | 1.9 | 2.1 | 2.4 |
| D. | Breakeven capacity utilisation, % | 57.9% | 54.4% | 48.9% |
| E. | Cash breakeven capacity utilisation, % | 42.1% | 38.5% | 33.4% |

## 10.6 SENSITIVITY ANALYSIS

Sensitivity analysis on internal rate of return (IRR, post-tax) and for the project have been carried out based on variations on capital cost, raw material price and sales realisation of finished products, and are indicated in Table 10-7.

**TABLE 10-7 – SENSITIVITY ANALYSIS**

| Sl. no. | Description | Escalation/ Reduction | IRR (post tax) | | |
|---|---|---|---|---|---|
| | | | Phase-I | Phase-II | Phase-III |
| **A.** | **Sensitivity Analysis** | | | | |
| A | Base case | | 11.7% | 12.0% | 12.6% |
| | | | | | |
| A.1 | Sensitivity to Capital cost | (+) 15% | 10.3% | 10.5% | 11.1% |
| | | | | | |
| **B.** | **Sensitivity to multiple variations (Scenario-1)** | | | | |
| B.1 | Sensitivity to Input material price | (+) 10% | 10.6% | 11.4% | 12.2% |
| | Sensitivity to NSR of finished product | (+) 5% | | | |
| | | | | | |
| B.2 | **Sensitivity to multiple variations (Scenario-2)** | | | | |
| | - Capital cost | (+) 15% | | | |
| | - Input material price | (+) 10% | 10.9% | 11.5% | 12.0% |
| | - Sales realisation of finished steel | (+) 7.5% | | | |

Based on the technical and financial review carried out in this Report, it is concluded that the expansion project is techno-economically viable and merits consideration for detailed study before implementation.

# APPENDICES

## APPENDIX-2-1 - PLANT CONFIGURATION AFTER PHASE-I

| Sl. no. | Description | Design capacity | Production, mtpy |
|---|---|---|---|
| | | | |
| 1. | Pellet plant | 2 x 8 | 16 |
| 2. | Coke oven | 4 x 62 ovens | 3 |
| 3. | Sinter plant | 1 x 500 sq m | 5.775 |
| 4. | Blast furnace | 1 x 5,350 cu m | 4.5 |
| 5. | DR plant | - | |
| 6. | Steelmaking | SMS-1 | |
| | - Basic oxygen furnace | 2 x 350 ton | 4.27 |
| | - Ladle furnace | 2 x 350 ton | 4.27 |
| | - RH degasser | 1 x 350 ton | 1.7 |
| | - Slab caster | 2 x 2 - Strand | 4.15 |
| 7. | HSM | 5.5 mtpy | 4.1 |
| 8. | Cold rolling complex consisting of | | |
| | - PLTCM | 1 x 2.3 mtpy | Cold rolled annealed coil - 0.972 mtpy<br>Colour coated steel - 0.497 mtpy<br>Cold rolled galvanised Steel - 0.522 mtpy<br>Tinplate coil - 0.227 mtpy |
| | - CGL | 2 x 0.5 mtpy | |
| | - CAL | 1 x 1.0 mtpy | |
| | - RCL | 2 x 0.25 mtpy | |
| | - CCL | 2 x 0.25 mtpy | |
| | - Tinplate | 1 x 0.25 mtpy | |
| 9. | Silicon steel CRNO | 1 x 0.25 mtpy | 0.247 |
| 10. | Calcined lime plant | 2 x 600 tpd | 0.307 |
| 11. | Calcined dolo plant | 1 x 600 tpd | 0.042 |
| 12. | Oxygen plant | 2 x 2100 tpd | |
| 13. | Power plant | 1 x 300 MW | |
| 14. | Portland slag cement plant | 1 x 3.75 mtpy | 3.75 mtpy |
| 15. | Pozzolona portland cement plant | 1 x 1.25 mtpy | 1.25 mtpy |

## APPENDIX-2-2 - PLANT CONFIGURATION AFTER PHASE-II

| Sl. no. | Description | Design capacity | | Production after Phase-II, mtpy |
|---|---|---|---|---|
| | | After Phase-I | Added in Phase-II | |
| 1. | Pellet plant | 2 x 8 mtpy | 1 x 8.0 mtpy | 24 |
| 2. | Coke oven | 4 x 62 ovens | 2 x 62 ovens E8 | 4.5 |
| 3. | Sinter plant | 1 x 500 sq m | | 5.775 |
| 4. | Blast furnace | 1 x 5350 cu m | 1 x 5350 cu m | 9 |
| 5. | Steelmaking | SMS -1 | | |
| | - Basic oxygen furnace | 2 x 350 ton | 1 x 350 ton | 8.54 |
| | - Ladle furnace | 2 x 350 ton | 1 x 350 ton | 8.54 |
| | - RH degasser | 1 x 350 ton | 1 x 350 ton | 3.4 |
| | - S lab caster | 2 x 2 – Strand | 1 x 2 - Strand | 8.37 |
| 6. | HSM | 5.5 mtpy | 5.5 mtpy | 8.2 |
| 7. | Cold rolling complex consisting of | | | |
| | - PLTCM | 1 x 2.3 mtpy | 1 x 2.3 mtpy | Cold rolled annealed coil - 1.944 mtpy<br>Colour coated steel - 0.995 mtpy<br>Cold rolled galvanised steel - 1.044 mtpy<br>Tinplate coil - 0.455 mtpy |
| | - CGL | 2 x 0.5 mtpy | 2 x 0.5 mtpy | |
| | - CAL | 1 X 1.0 mtpy | 1 x 1.0 mtpy | |
| | - RCL | 2 x 0.25 mtpy | 1 x 0.25 mtpy | |
| | - CCL | 2 x 0.25 mtpy | 2 x 0.25 mtpy | |
| | - Tinplate | 1 x 0.25 mtpy | 1 x 0.25 mtpy | |
| 8. | Silicon steel CRNO | 1 x 0.25 mtpy | 1 x 0.25 mtpy | 0.495 |
| 9. | Calcined lime plant | 2 x 600 tpd | 2 x 600 tpd | 0.614 |
| 10. | Calcined dolo plant | 1 x 600 tpd | | 0.084 |
| 11. | Oxygen plant | 2 x 2100 tpd | 2 x 2100 tpd | |
| 12. | Power plant | 1 x 300 MW | 1 x 300 MW | |
| 13. | Portland slag cement plant | 1 x 3.75 mtpy | 1 x 3.75 mtpy | 7.5 mtpy |
| 14. | Portland pozzolona cement | 1 x 1.25 mtpy | 1.25 mtpy | 2.5 mtpy |

## APPENDIX-2-3 - PLANT CONFIGURATION AFTER PHASE-III

| Sl. no. | Description | Design capacity | | Production after Phase-III, mtpy |
|---|---|---|---|---|
| | | After Phase-II | Added in Phase-III | |
| 1. | Pellet plant | 3 x 8.0 mtpy | 1 x 8.0 mtpy | 32 |
| 2. | Coke oven | 6 x 62 Ovens | 2 x 62 ovens | 6 |
| 3. | Sinter plant | 1 x 500 sq m | - | 5.775 |
| 4. | Blast furnace | 2 x 5350 cu m | 1 x 5350 cu m | 13.5 |
| 5. | COG based DR plant | - | 1 x 1.2 mtpy | 1.2 |
| 6. | Steelmaking | SMS#1 | SMS#2 | |
| | - Basic oxygen furnace | 3 x 350 ton | 2 x 180 ton | 13.49 |
| | - Ladle furnace | 3 x 350 ton | 2 x 180 ton | 13.49 |
| | - RH degasser | 2 x 350 ton | 1 x 180 ton | 4.01 |
| | - Slab caster | 3 x 2 - Strand | - | 10.29 |
| | - Billet caster | - | 1 x 8- Strand | 2.91 |
| | - Billet cum bloom caster/beam blank | - | 1 x 6- Strand | |
| 7. | HSM | 2 x 5.5 mtpy | - | 8.82 |
| 8. | Plate mill | | 1 x 1.5 mtpy | 1.18 |
| 9. | Cold rolling complex consisting of | | | |
| | - PLTCM | 2 x 2.3 mtpy | - | Cold rolled annealed coil - 1.944 mtpy<br><br>Colour coated steel - 0.995 mtpy<br><br>Cold rolled galvanised steel - 1.044 mtpy<br><br>Tinplate coil - 0.455 mtpy |
| | - CGL | 4 x 0.5 mtpy | - | |
| | - CAL | 2 x 1.0 mtpy | - | |
| | - RCL | 3 x 0.25 mtpy | - | |
| | - CCL | 4 x 0.25 mtpy | - | |
| | - Tinplate | 2 x 0.25 mtpy | - | |
| 10. | Silicon steel CRNO | 2 x 0.25 mtpy | - | 0.495 mtpy |
| 11. | Long mill | | | |
| | - Rebar mill | | 1.2 mtpy | 2.8 |
| | - Wire rod mill | | 0.6 mtpy | |
| | - Medium section mill | | 1.0 mtpy | |
| 12. | Calcined lime plant | 4 x 600 tpd | 2 x 600 tpd | 0.972 |
| 13. | Calcined dolo plant | 1 x 600 tpd | | 0.134 |
| 14. | Oxygen plant | 4 x 2100 tpd | 2 x 2100 tpd | |
| 15. | Tar distillation plant | - | 0.3 mtpy | |
| 16. | Benzole refining plant | - | 0.1 mtpy | |

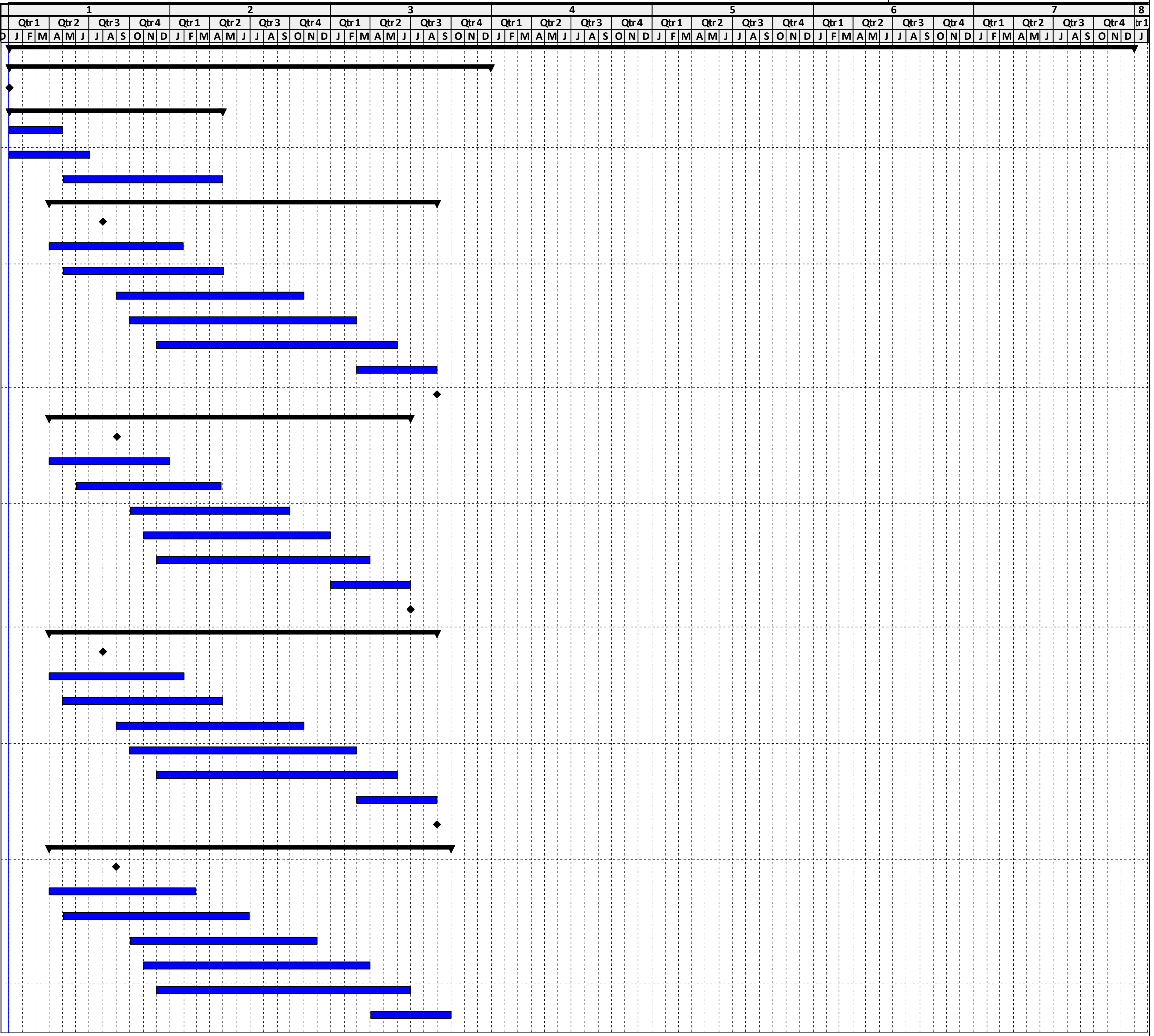
Appendix-2-3 - Plant Configuration After Phase-III (cont'd)

| Sl. no. | Description | Design capacity | | Production after Phase-III, mtpy |
|---|---|---|---|---|
| | | After Phase-II | Added in Phase-III | |
| 17. | Power plant | 2 x 300 MW | 1 x 300 MW | |
| 18. | Portland slag cement plant | 2 x 3.75 mtpy | - | 7.5 mtpy |
| 19. | Pozzolona Portland cement | 2 x 1.25 mtpy | - | 2.5 mtpy |

# 13.2 MTPY INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT ATJSW, ODISHA

## APPENDIX- 9-1: OVERALL PROJECT IMPLEMENTATION SCHEDULE

| Activity ID | Activity Name |
|---|---|
| **JSW-ODISHA- 13.2 MTPY INTEGRATED STEEL PLANT & CAPTIVE POWER PLANT** | |
| **PHASE # I** | |
| A2200 | Go Ahead for Phase # I (All Statutory Clearances obtained by JSW) |
| **GENERAL** | |
| A2210 | Site Survey, Soil Investigation report |
| A2215 | Plant layout finalisation |
| A2220 | Site Levelling & Construction Facilities (Power, Water etc) available |
| **PELLET PLANT (2 X 8.0 MTPY)** | |
| A1015 | Placement of order for technology equipment supplier |
| A1000 | Basic Engineering |
| A1010 | Procurement upto ordering of major packages |
| A1020 | Major detail Engineering |
| A1030 | Manufacturing and Delivery of major equipment |
| A1040 | Major construction and erection work |
| A1050 | Testing and Trial Run |
| A1060 | Pellet Plant Commissioning |
| **COKE OVEN (4 X 62 OVENS )** | |
| A3505 | Placement of order for technology equipment supplier |
| A3490 | Basic Engineering |
| A3500 | Procurement upto ordering of major packages |
| A3510 | Major detail Engineering |
| A3520 | Manufacturing and Delivery of major equipment |
| A3530 | Major construction and erection work |
| A3540 | Testing and Trial Run |
| A3550 | Coke oven plant commissioning |
| **SINTER PLANT (1 X 500 SQ. M. )** | |
| A3365 | Placement of order for technology equipment supplier |
| A3350 | Basic Engineering |
| A3360 | Procurement upto ordering of major packages |
| A3370 | Major detail Engineering |
| A3380 | Manufacturing and Delivery of major equipment |
| A3390 | Major construction and erection work |
| A3400 | Testing and Trial Run |
| A3410 | Sinter Plant Commissioning |
| **BLAST FURNACE (1 X 5350 M3 )** | |
| A3575 | Placement of order for technology equipment supplier |
| A3560 | Basic Engineering |
| A3570 | Procurement upto ordering of major packages |
| A3580 | Major detail Engineering |
| A3590 | Manufacturing and Delivery of major equipment |
| A3600 | Major construction and erection work |
| A3610 | Testing and Trial Run |

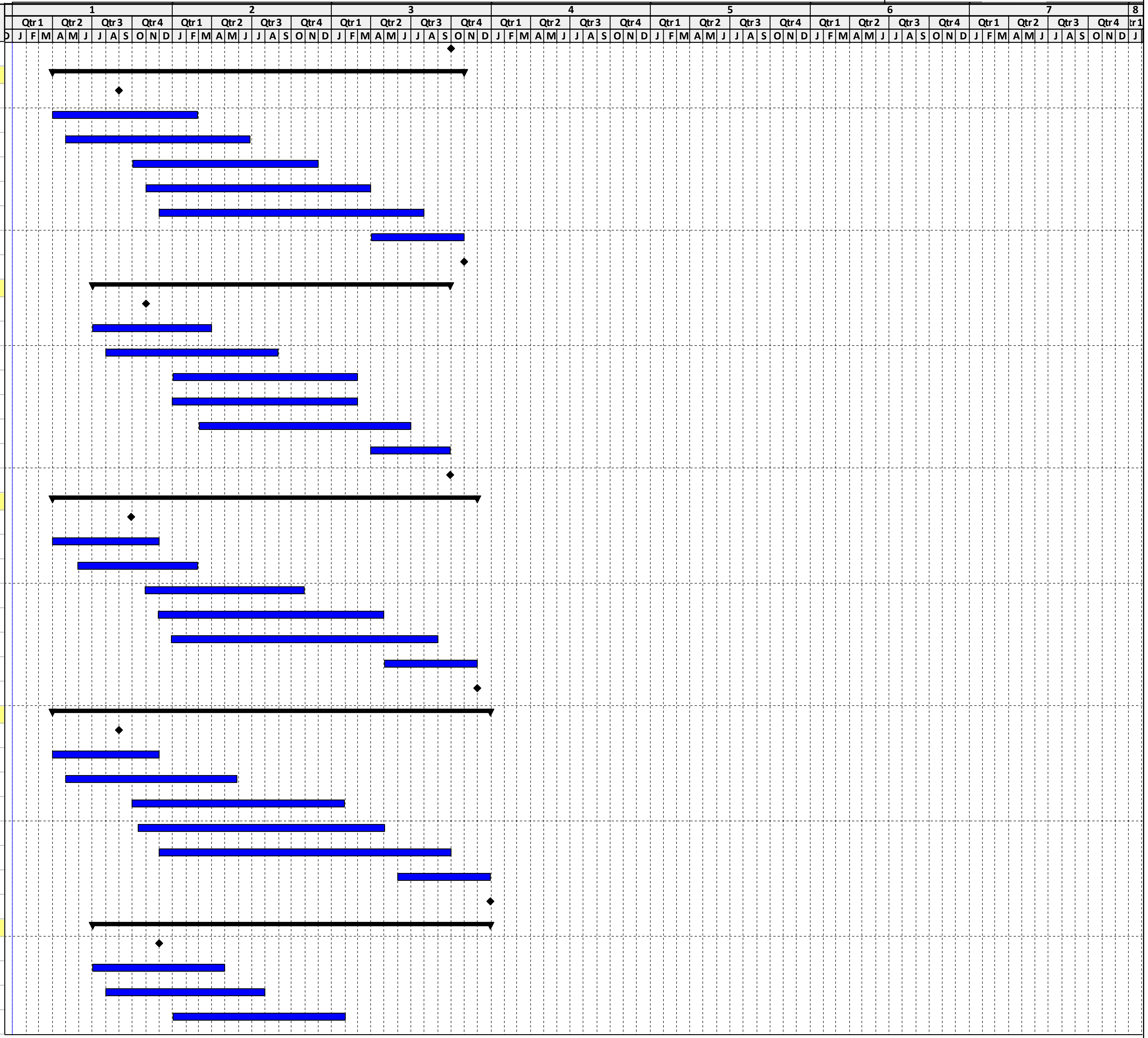


Activity — Summary — Milestone

## 13.2 MTPY INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT ATJSW, ODISHA

### APPENDIX- 9-1: OVERALL PROJECT IMPLEMENTATION SCHEDULE

| Activity ID | Activity Name |
|---|---|
| A3620 | Blast Furnace Blow In |
| **STEEL MAKING(SMS-1)** | |
| A3435 | Placement of order for technology equipment supplier |
| A3420 | Basic Engineering |
| A3430 | Procurement upto ordering of major packages |
| A3440 | Major detail Engineering |
| A3450 | Manufacturing and Delivery of major equipment |
| A3460 | Major construction and erection work |
| A3470 | Testing and Trial Run |
| A3480 | 1st Slab Out from SMS-1 |
| **CALCINING PLANT (2 X 200TPD LIME KILN, 1 X 200TPD DOLO KILN)** | |
| A3645 | Placement of order for technology equipment supplier |
| A3630 | Basic Engineering |
| A3640 | Procurement upto ordering of major packages |
| A3660 | Manufacturing and Delivery of major equipment |
| A3650 | Major detail Engineering |
| A3670 | Major construction and erection work |
| A3680 | Testing and Trial Run |
| A3690 | Calcining Plant Commissioning |
| **HSM(1 X 5.5 MTPY )** | |
| A4225 | Placement of order for technology equipment supplier |
| A4210 | Basic Engineering |
| A4220 | Procurement upto ordering of major packages |
| A4230 | Major detail Engineering |
| A4240 | Manufacturing and Delivery of major equipment |
| A4250 | Major construction and erection work |
| A4260 | Testing and Trial Run |
| A4270 | 1st Coil Out from Mill |
| **CRM-1** | |
| A4295 | Placement of order for technology equipment supplier |
| A4280 | Basic Engineering |
| A4290 | Procurement upto ordering of major packages |
| A4300 | Major detail Engineering |
| A4310 | Manufacturing and Delivery of major equipment |
| A4320 | Major construction and erection work |
| A4330 | Testing and Trial Run |
| A4340 | CRM-1 commissioning |
| **TIN PLATE-1 (0.23 MTPY)** | |
| A5905 | Placement of order for technology equipment supplier |
| A5890 | Basic Engineering |
| A5900 | Procurement upto ordering of major packages |
| A5910 | Major detail Engineering |

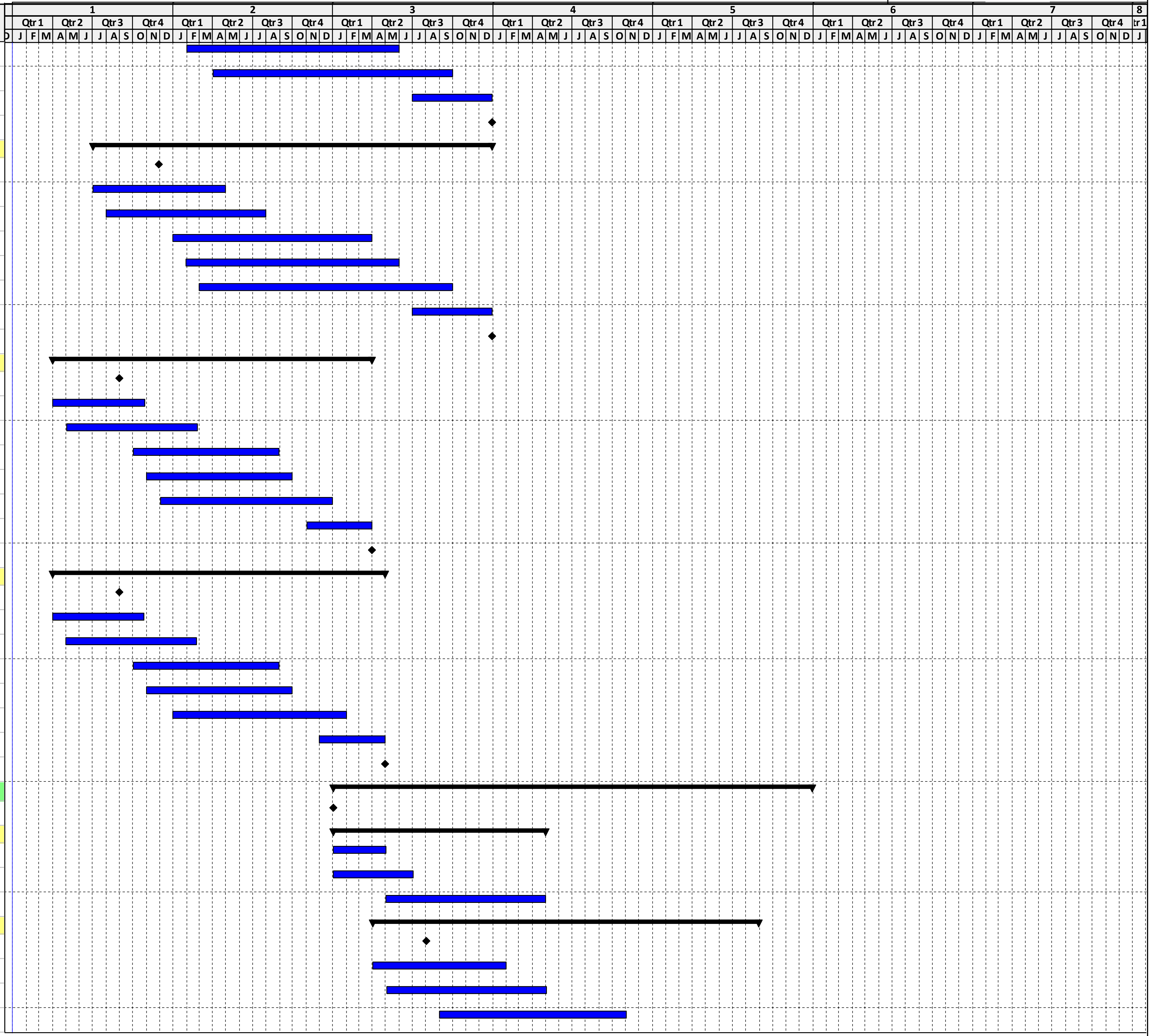



Activity
Summary
Milestone

13.2 MTPY INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT ATJSW, ODISHA

APPENDIX- 9-1: **OVERALL PROJECT IMPLEMENTATION SCHEDULE**

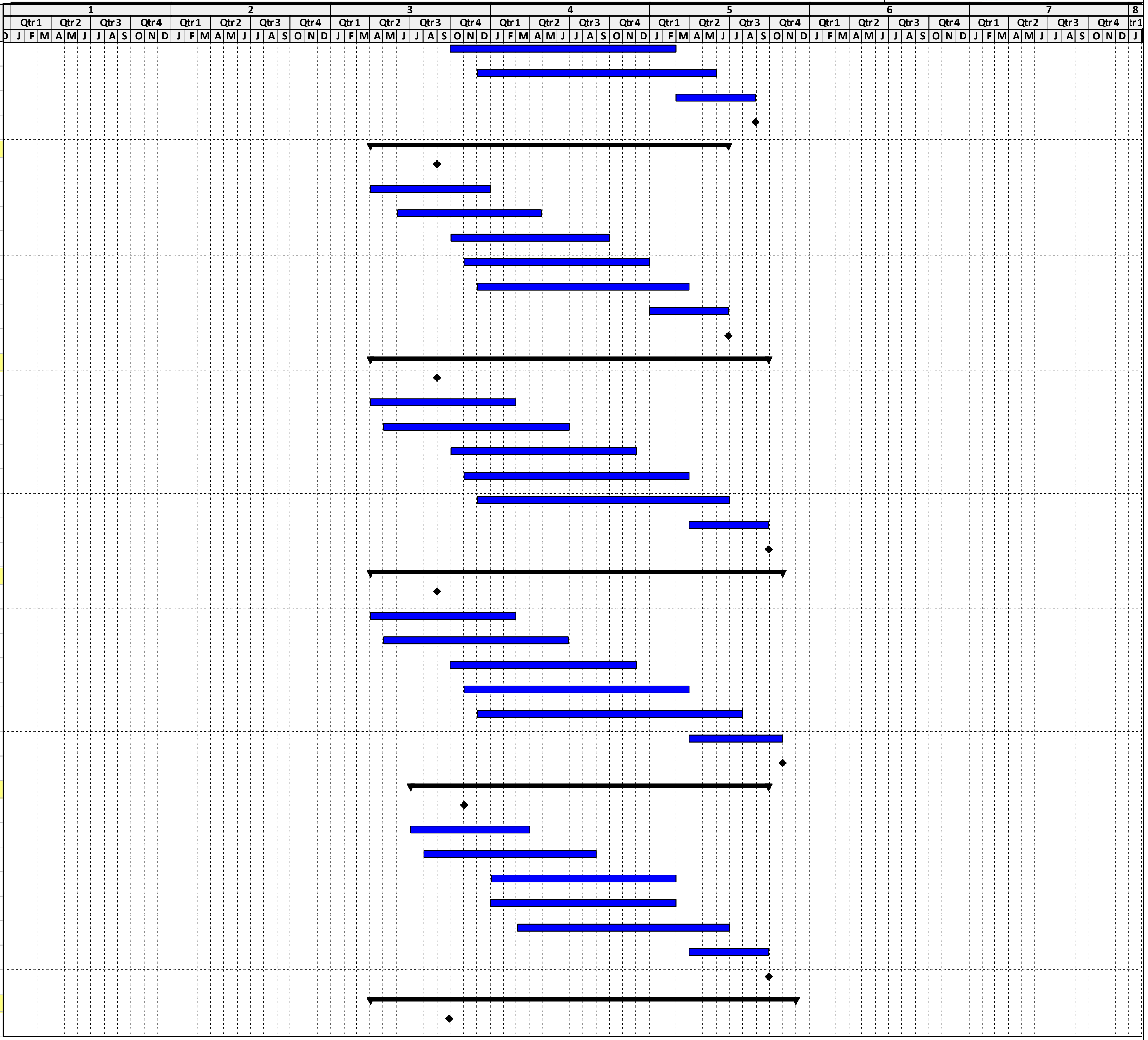
| Activity ID | Activity Name |
|---|---|
| A5920 | Manufacturing and Delivery of major equipment |
| A5930 | Major construction and erection work |
| A5940 | Testing and Trial Run |
| A5950 | Tin Plate mill commissioning |
| CEMENT PLANT | |
| A4365 | Placement of order for technology equipment supplier |
| A4350 | Basic Engineering |
| A4360 | Procurement upto ordering of major packages |
| A4370 | Major detail Engineering |
| A4380 | Manufacturing and Delivery of major equipment |
| A4390 | Major construction and erection work |
| A4400 | Testing and Trial Run |
| A4410 | Cement plant commissioning |
| POWER PLANT (1 X 300 MW ) | |
| A4575 | Placement of order for technology equipment supplier |
| A4560 | Basic Engineering |
| A4570 | Procurement upto ordering of major packages |
| A4580 | Major detail Engineering |
| A4590 | Manufacturing and Delivery of major equipment |
| A4600 | Major construction and erection work |
| A4610 | Testing and Trial Run |
| A4620 | Power plant commissioning |
| OXYGEN PLANT (2 X 2100 TPD ) | |
| A4645 | Placement of order for technology equipment supplier |
| A4630 | Basic Engineering |
| A4640 | Procurement upto ordering of major packages |
| A4650 | Major detail Engineering |
| A4660 | Manufacturing and Delivery of major equipment |
| A4670 | Major construction and erection work |
| A4680 | Testing and Trial Run |
| A4690 | Oxygen plant commissioning |
| PHASE # II | |
| A6090 | Go Ahead for Phase # II (All Statutory Clearances obtained by JSW) |
| GENERAL | |
| A6100 | Site Survey, Soil Investigation report |
| A6120 | Plant layout finalisation |
| A6110 | Site Levelling & Construction Facilities (Power, Water etc) available |
| PELLET PLANT (1X 8.0 MTPY ) | |
| A6910 | Placement of order for technology equipment supplier |
| A6030 | Basic Engineering |
| A6040 | Procurement upto ordering of major packages |
| A6050 | Major detail Engineering |




Activity
Summary
Milestone

APPENDIX- 9-1: OVERALL PROJECT IMPLEMENTATION SCHEDULE

| Activity ID | Activity Name |
|---|---|
| A6060 | Manufacturing and Delivery of major equipment |
| A6070 | Major construction and erection work |
| A6080 | Testing and Trial Run |
| A6130 | Pellet Plant Commissioning |
| COKE OVEN (2 X 62 OVENS E8) | |
| A6920 | Placement of order for technology equipment supplier |
| A6280 | Basic Engineering |
| A6290 | Procurement upto ordering of major packages |
| A6300 | Major detail Engineering |
| A6310 | Manufacturing and Delivery of major equipment |
| A6320 | Major construction and erection work |
| A6330 | Testing and Trial Run |
| A6340 | Coke oven plant commissioning |
| BLAST FURNACE (1 X 5350 M3 ) | |
| A6940 | Placement of order for technology equipment supplier |
| A6350 | Basic Engineering |
| A6360 | Procurement upto ordering of major packages |
| A6370 | Major detail Engineering |
| A6380 | Manufacturing and Delivery of major equipment |
| A6390 | Major construction and erection work |
| A6400 | Testing and Trial Run |
| A6410 | Blast Furnace Blow In |
| STEEL MAKING (SMS-1 AUGMENTATION) | |
| A6950 | Placement of order for technology equipment supplier |
| A6210 | Basic Engineering |
| A6220 | Procurement upto ordering of major packages |
| A6230 | Major detail Engineering |
| A6240 | Manufacturing and Delivery of major equipment |
| A6250 | Major construction and erection work |
| A6260 | Testing and Trial Run |
| A6270 | 1st Slab Out from SMS-1 |
| CALCINING PLANT (2 X 600 TPD LIME KILN ) | |
| A6960 | Placement of order for technology equipment supplier |
| A6420 | Basic Engineering |
| A6430 | Procurement upto ordering of major packages |
| A6450 | Manufacturing and Delivery of major equipment |
| A6440 | Major detail Engineering |
| A6460 | Major construction and erection work |
| A6470 | Testing and Trial Run |
| A6480 | Calcining Plant Commissioning |
| HSM(1 X 5.5 MTPY ) | |
| A6970 | Placement of order for technology equipment supplier |

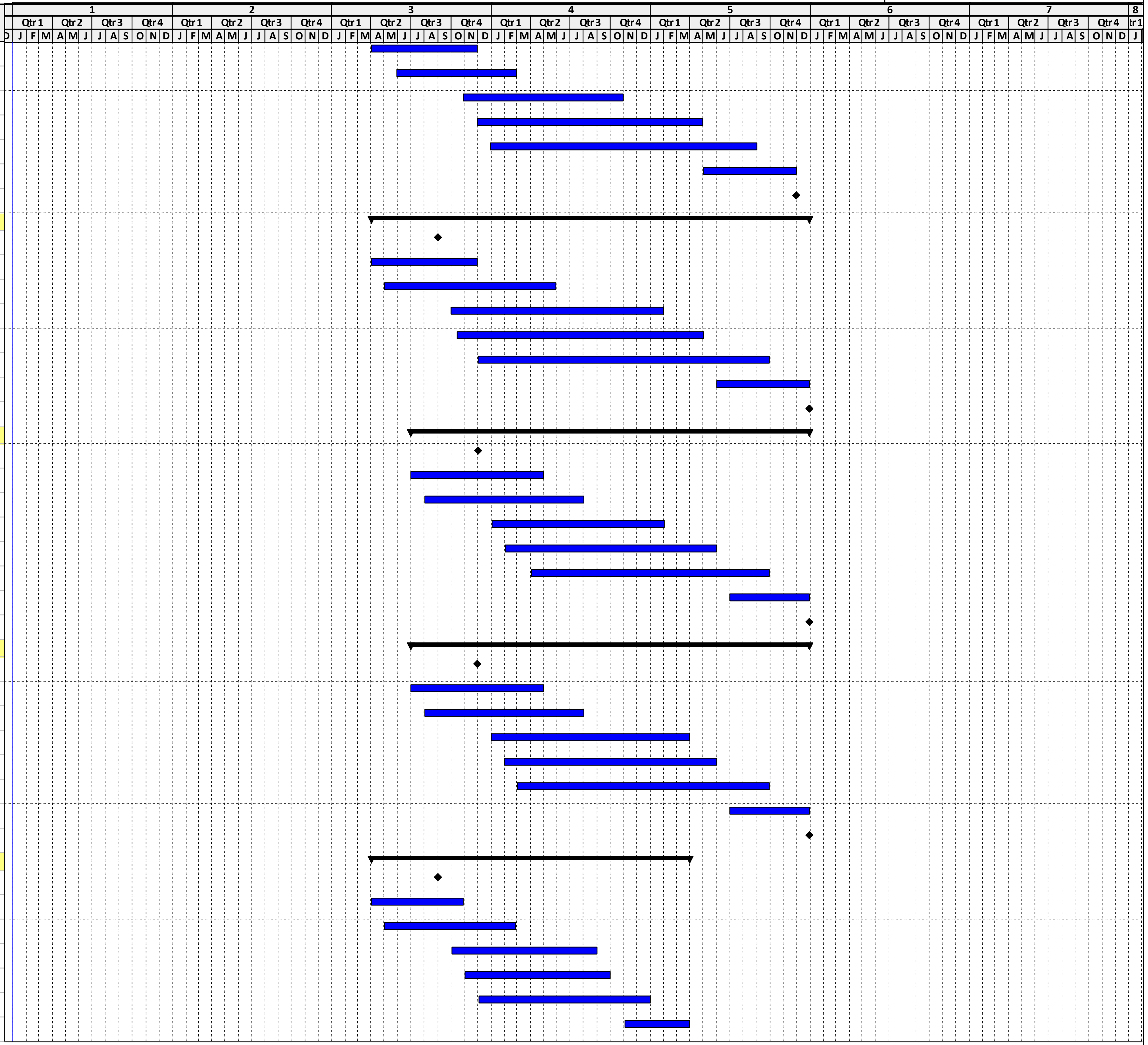



Activity — Summary — Milestone

**13.2 MTPY INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT ATJSW, ODISHA**

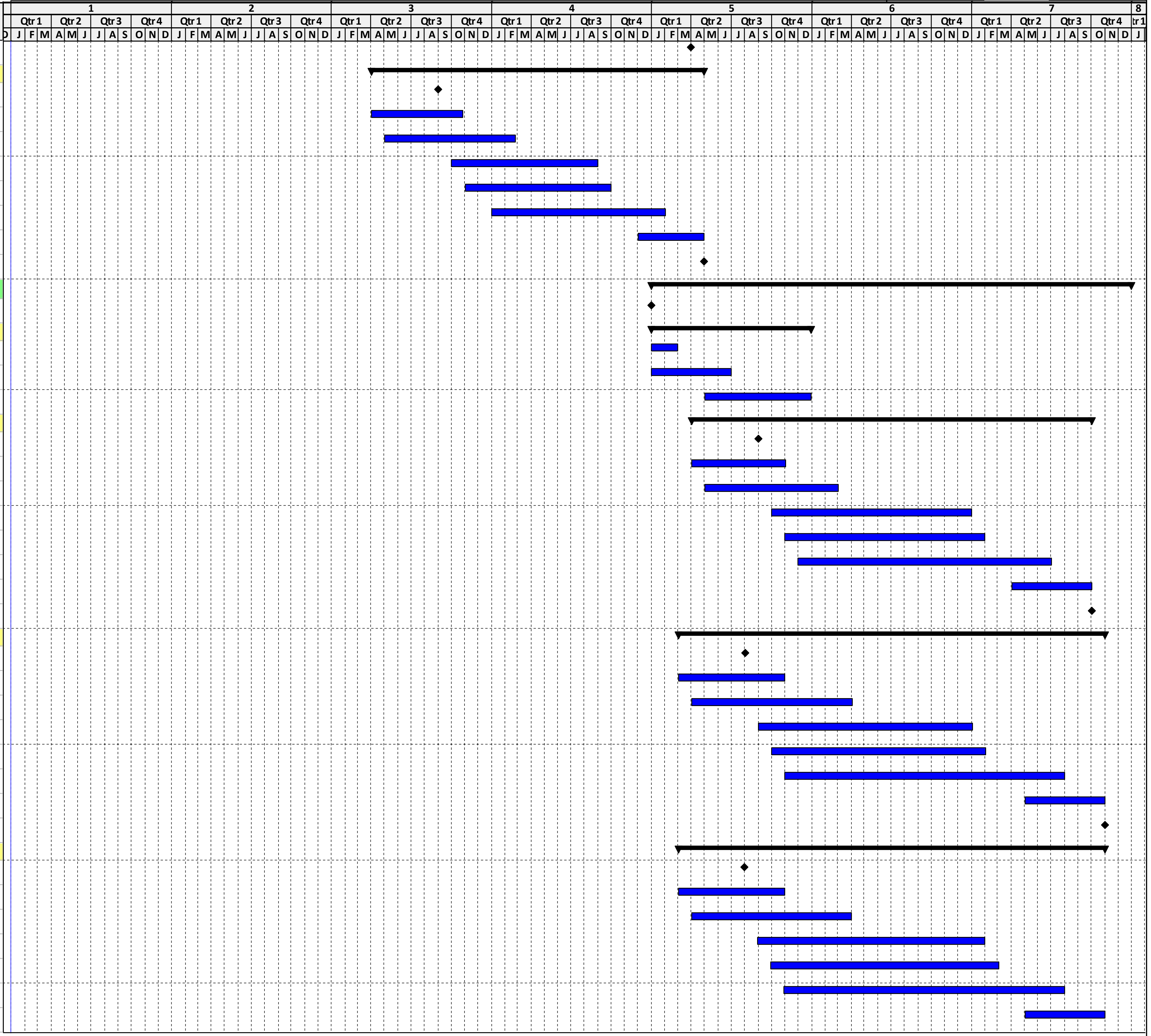
**APPENDIX- 9-1: OVERALL PROJECT IMPLEMENTATION SCHEDULE**

| Activity ID | Activity Name |
|---|---|
| A6490 | Basic Engineering |
| A6500 | Procurement upto ordering of major packages |
| A6510 | Major detail Engineering |
| A6520 | Manufacturing and Delivery of major equipment |
| A6530 | Major construction and erection work |
| A6540 | Testing and Trial Run |
| A6550 | 1st Coil Out from Mill |
| **CRM -2** | |
| A6980 | Placement of order for technology equipment supplier |
| A6560 | Basic Engineering |
| A6570 | Procurement upto ordering of major packages |
| A6580 | Major detail Engineering |
| A6590 | Manufacturing and Delivery of major equipment |
| A6600 | Major construction and erection work |
| A6610 | Testing and Trial Run |
| A6620 | CRM-1 commissioning |
| **TIN PLATE-2 (0.23 MTPY)** | |
| A6990 | Placement of order for technology equipment supplier |
| A6840 | Basic Engineering |
| A6850 | Procurement upto ordering of major packages |
| A6860 | Major detail Engineering |
| A6870 | Manufacturing and Delivery of major equipment |
| A6880 | Major construction and erection work |
| A6890 | Testing and Trial Run |
| A6900 | Tin Plate mill commissioning |
| **CEMENT PLANT- AUGMENTATION** | |
| A7000 | Placement of order for technology equipment supplier |
| A6630 | Basic Engineering |
| A6640 | Procurement upto ordering of major packages |
| A6650 | Major detail Engineering |
| A6660 | Manufacturing and Delivery of major equipment |
| A6670 | Major construction and erection work |
| A6680 | Testing and Trial Run |
| A6690 | Cement plant commissioning |
| **POWER PLANT (1 X 300 MW )** | |
| A7010 | Placement of order for technology equipment supplier |
| A6700 | Basic Engineering |
| A6710 | Procurement upto ordering of major packages |
| A6720 | Major detail Engineering |
| A6730 | Manufacturing and Delivery of major equipment |
| A6740 | Major construction and erection work |
| A6750 | Testing and Trial Run |




Activity — Summary — Milestone

| Activity ID | Activity Name |
|---|---|
| A6760 | Power plant commissioning |
| OXYGEN PLANT (2 X 2100 TPD ) | |
| A7020 | Placement of order for technology equipment supplier |
| A6770 | Basic Engineering |
| A6780 | Procurement upto ordering of major packages |
| A6790 | Major detail Engineering |
| A6800 | Manufacturing and Delivery of major equipment |
| A6810 | Major construction and erection work |
| A6820 | Testing and Trial Run |
| A6830 | Oxygen plant commissioning |
| PHASE # III | |
| A3750 | Go Ahead for Phase # III (All Statutory Clearances obtained by JSW) |
| GENERAL | |
| A3760 | Site Survey, Soil Investigation report |
| A3780 | Plant layout finalisation |
| A3785 | Site Levelling & Construction Facilities (Power, Water etc) available |
| PELLET PLANT (1 X 8.0 MTPY) | |
| A5765 | Placement of order for technology equipment supplier |
| A5750 | Basic Engineering |
| A5760 | Procurement upto ordering of major packages |
| A5770 | Major detail Engineering |
| A5780 | Manufacturing and Delivery of major equipment |
| A5790 | Major construction and erection work |
| A5800 | Testing and Trial Run |
| A5810 | Pellet Plant Commissioning |
| COKE OVEN (2 X 62 OVENS ) | |
| A4995 | Placement of order for technology equipment supplier |
| A4980 | Basic Engineering |
| A4990 | Procurement upto ordering of major packages |
| A5000 | Major detail Engineering |
| A5010 | Manufacturing and Delivery of major equipment |
| A5020 | Major construction and erection work |
| A5030 | Testing and Trial Run |
| A5040 | Coke oven plant commissioning |
| BLAST FURNACE (1 X 5350 M3 ) | |
| A5065 | Placement of order for technology equipment supplier |
| A5050 | Basic Engineering |
| A5060 | Procurement upto ordering of major packages |
| A5070 | Major detail Engineering |
| A5080 | Manufacturing and Delivery of major equipment |
| A5090 | Major construction and erection work |
| A5100 | Testing and Trial Run |

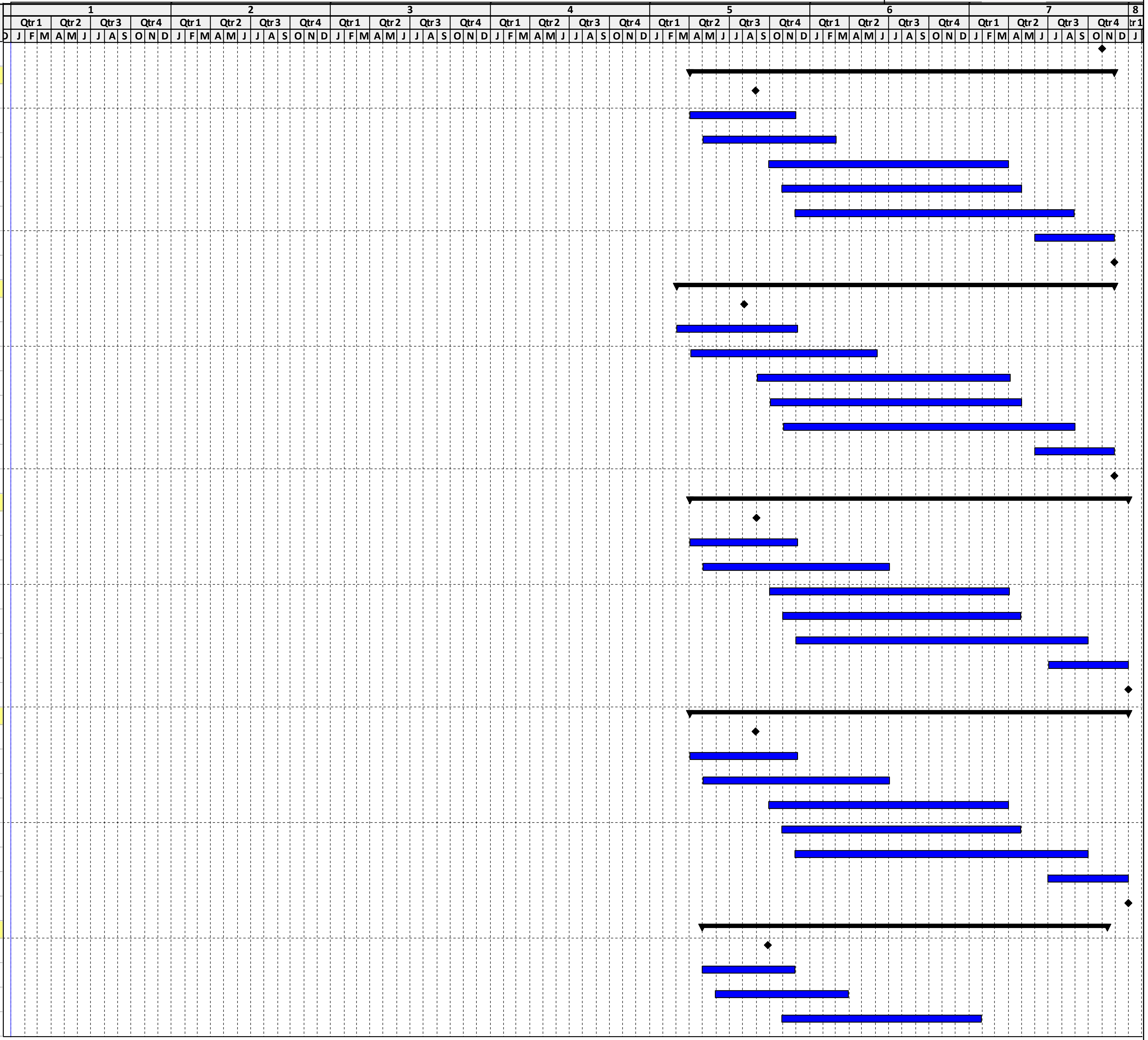


Activity — Summary — Milestone

**13.2 MTPY INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT ATJSW, ODISHA**

**APPENDIX- 9-1: OVERALL PROJECT IMPLEMENTATION SCHEDULE**

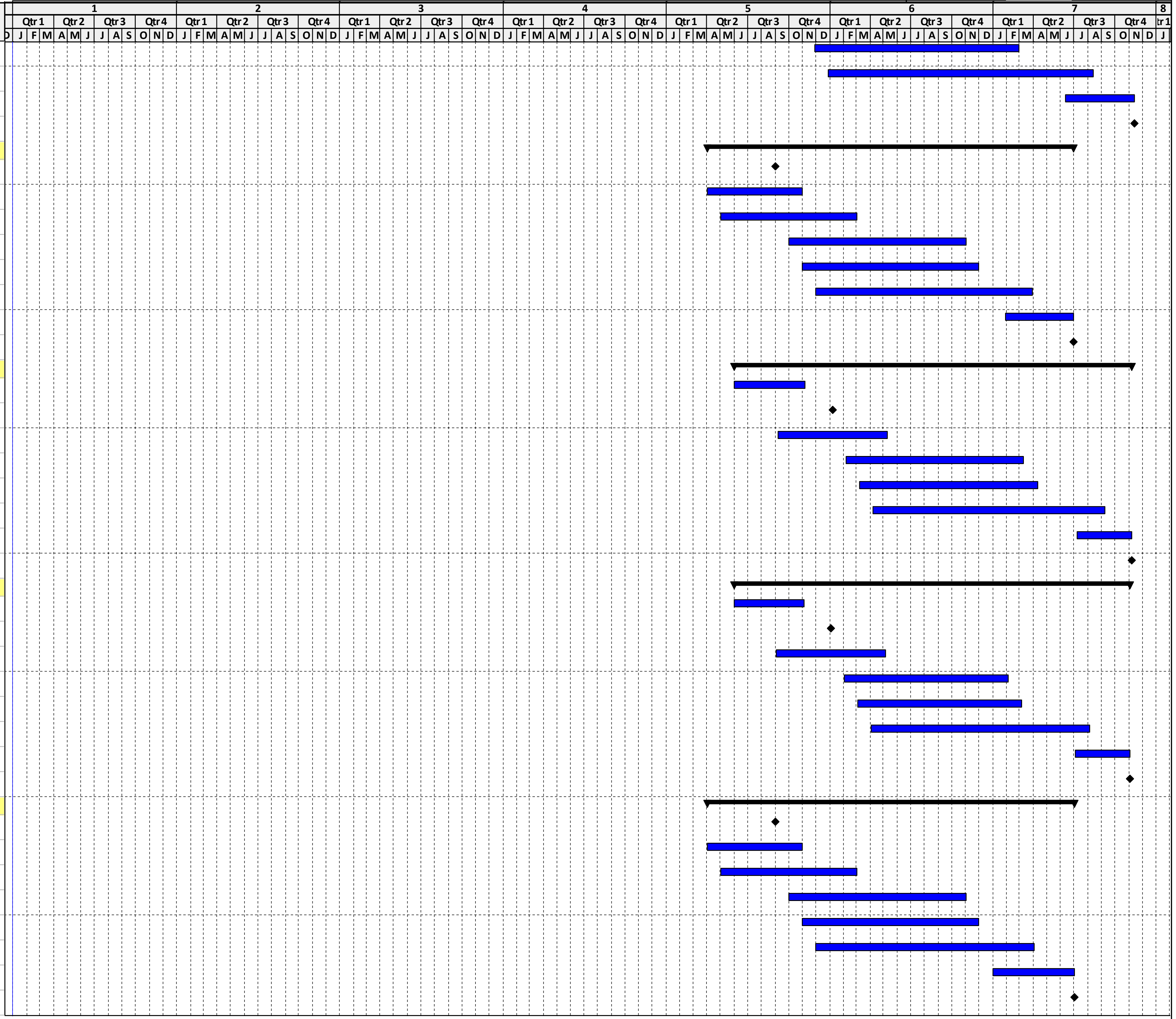
| Activity ID | Activity Name |
|---|---|
| A5110 | Blast Furnace Blow In |
| **DR PLANT (1 X 1.2 MTPY )** | |
| A5135 | Placement of order for technology equipment supplier |
| A5120 | Basic Engineering |
| A5130 | Procurement upto ordering of major packages |
| A5140 | Major detail Engineering |
| A5150 | Manufacturing and Delivery of major equipment |
| A5160 | Major construction and erection work |
| A5170 | Testing and Trial Run |
| A5180 | DR plant commissioning |
| **STEEL MAKING (SMS#2)** | |
| A5205 | Placement of order for technology equipment supplier |
| A5190 | Basic Engineering |
| A5200 | Procurement upto ordering of major packages |
| A5210 | Major detail Engineering |
| A5220 | Manufacturing and Delivery of major equipment |
| A5230 | Major construction and erection work |
| A5240 | Testing and Trial Run |
| A5250 | Readiness of SMS-2 |
| **PLATE MILL(1 X 1.5 MTPY)** | |
| A5415 | Placement of order for technology equipment supplier |
| A5400 | Basic Engineering |
| A5410 | Procurement upto ordering of major packages |
| A5420 | Major detail Engineering |
| A5430 | Manufacturing and Delivery of major equipment |
| A5440 | Major construction and erection work |
| A5450 | Testing and Trial Run |
| A5460 | Plate mill commissioning |
| **LONG MILL (1.2MTPY RM, 0.6 MTPY WRM, 1MTPY MSM)** | |
| A5555 | Placement of order for technology equipment supplier |
| A5540 | Basic Engineering |
| A5550 | Procurement upto ordering of major packages |
| A5560 | Major detail Engineering |
| A5570 | Manufacturing and Delivery of major equipment |
| A5580 | Major construction and erection work |
| A5590 | Testing and Trial Run |
| A5600 | Long Mill commissioning |
| **CALCINED LIME PLANT (2 X 600 TPD )** | |
| A5485 | Placement of order for technology equipment supplier |
| A5470 | Basic Engineering |
| A5480 | Procurement upto ordering of major packages |
| A5490 | Major detail Engineering |



**13.2 MTPY INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT ATJSW, ODISHA**

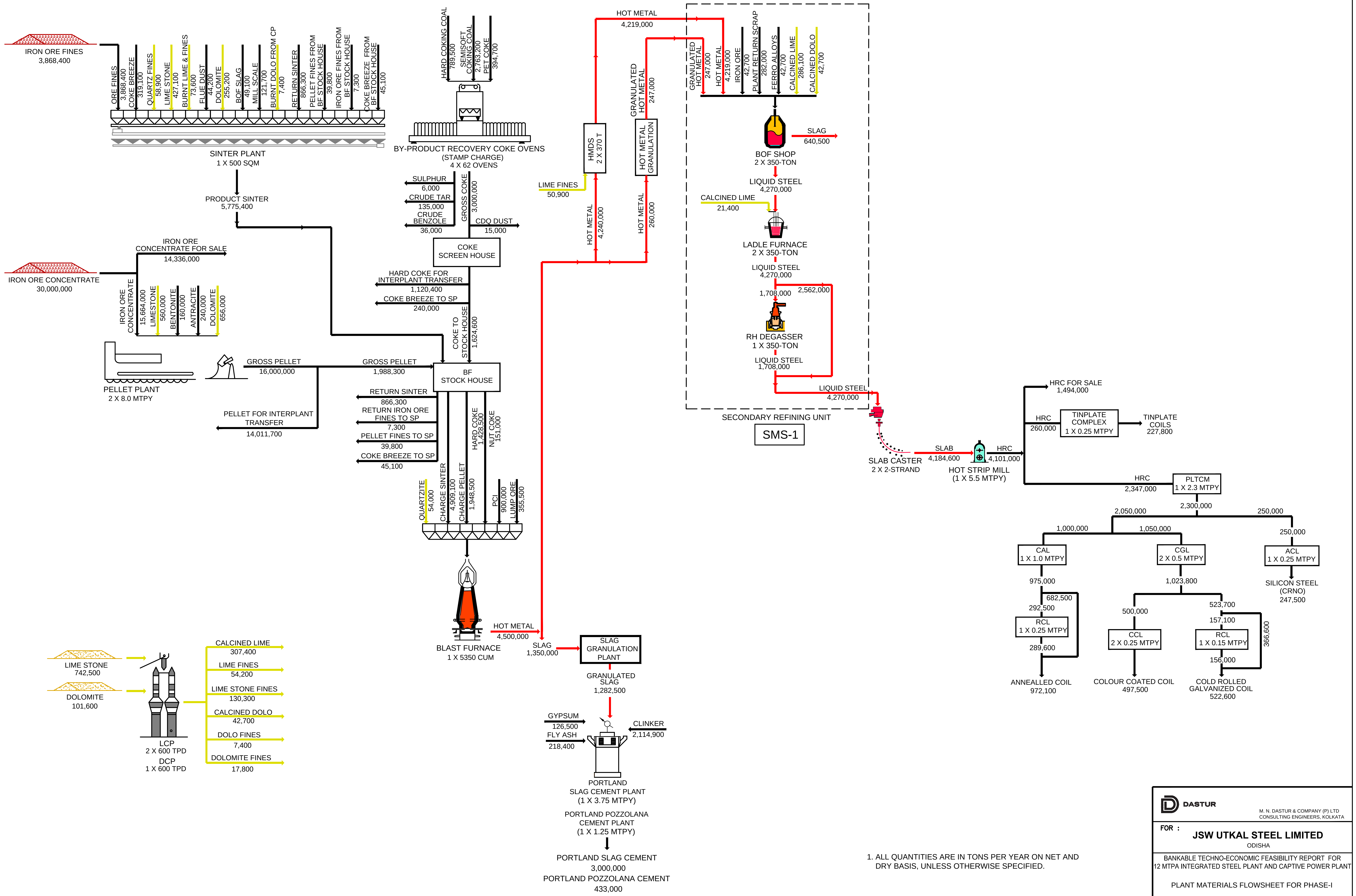
**APPENDIX- 9-1: OVERALL PROJECT IMPLEMENTATION SCHEDULE**

| Activity ID | Activity Name |
|---|---|
| A5500 | Manufacturing and Delivery of major equipment |
| A5510 | Major construction and erection work |
| A5520 | Testing and Trial Run |
| A5530 | Calcining Plant Commissioning |
| **OXYGEN PLANT (2 X 1700 TPD )** | |
| A5275 | Placement of order for technology equipment supplier |
| A5260 | Basic Engineering |
| A5270 | Procurement upto ordering of major packages |
| A5280 | Major detail Engineering |
| A5290 | Manufacturing and Delivery of major equipment |
| A5300 | Major construction and erection work |
| A5310 | Testing and Trial Run |
| A5320 | Oxygen plant commissioning |
| **TAR DISTILLATION PLANT (0.3 MTPY )** | |
| A5610 | Basic Engineering |
| A5625 | Placement of order for technology equipment supplier |
| A5620 | Procurement upto ordering of major packages |
| A5630 | Major detail Engineering |
| A5640 | Manufacturing and Delivery of major equipment |
| A5650 | Major construction and erection work |
| A5660 | Testing and Trial Run |
| A5670 | Tar Distillation Plant commissioning |
| **BENZOLE REFINING PLANT (0.1 MTPY )** | |
| A5680 | Basic Engineering |
| A5695 | Placement of order for technology equipment supplier |
| A5690 | Procurement upto ordering of major packages |
| A5700 | Major detail Engineering |
| A5710 | Manufacturing and Delivery of major equipment |
| A5720 | Major construction and erection work |
| A5730 | Testing and Trial Run |
| A5740 | Benzole refining plant commissioning |
| **POWER PANT (1 X 300 MW )** | |
| A5345 | Placement of order for technology equipment supplier |
| A5330 | Basic Engineering |
| A5340 | Procurement upto ordering of major packages |
| A5350 | Major detail Engineering |
| A5360 | Manufacturing and Delivery of major equipment |
| A5370 | Major construction and erection work |
| A5380 | Testing and Trial Run |
| A5390 | Power plant commissioning |




Activity
Summary
Milestone

# DRAWINGS




1. ALL QUANTITIES ARE IN TONS PER YEAR ON NET AND DRY BASIS, UNLESS OTHERWISE SPECIFIED.

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FOR :

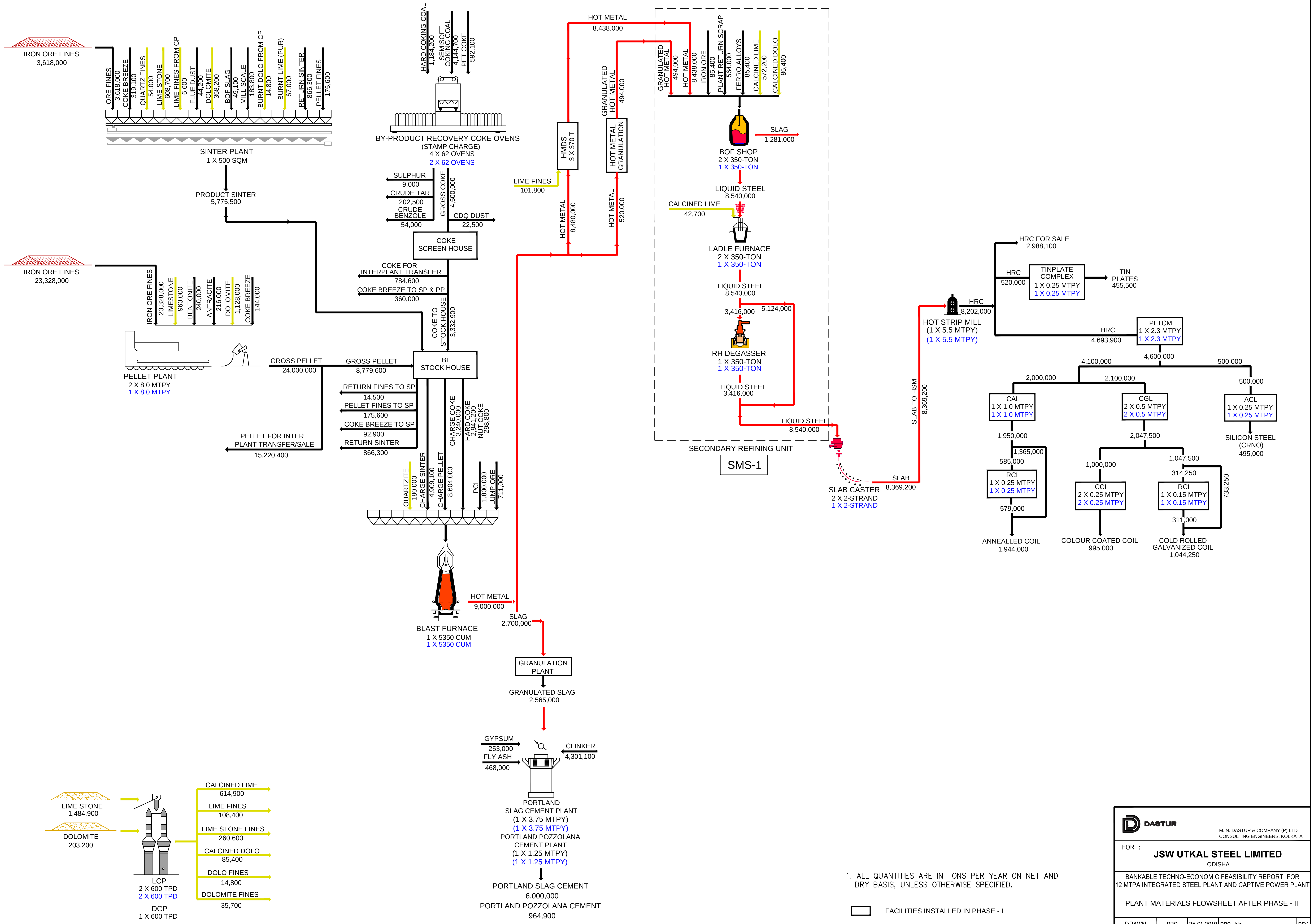
**JSW UTKAL STEEL LIMITED**

ODISHA

BANKABLE TECHNO-ECONOMIC FEASIBILITY REPORT FOR 12 MTPA INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT

PLANT MATERIALS FLOWSHEET FOR PHASE-I

| DRAWN | DBO | 25.01.2019 | DRG. No. | REV. |
|---|---|---|---|---|
| APPROVED | ADT | 25.01.2019 | 11467-02-0001 | 0 |




1. ALL QUANTITIES ARE IN TONS PER YEAR ON NET AND DRY BASIS, UNLESS OTHERWISE SPECIFIED.

FACILITIES INSTALLED IN PHASE - I

FACILITIES INSTALLED IN PHASE - II ADDITIONALLY

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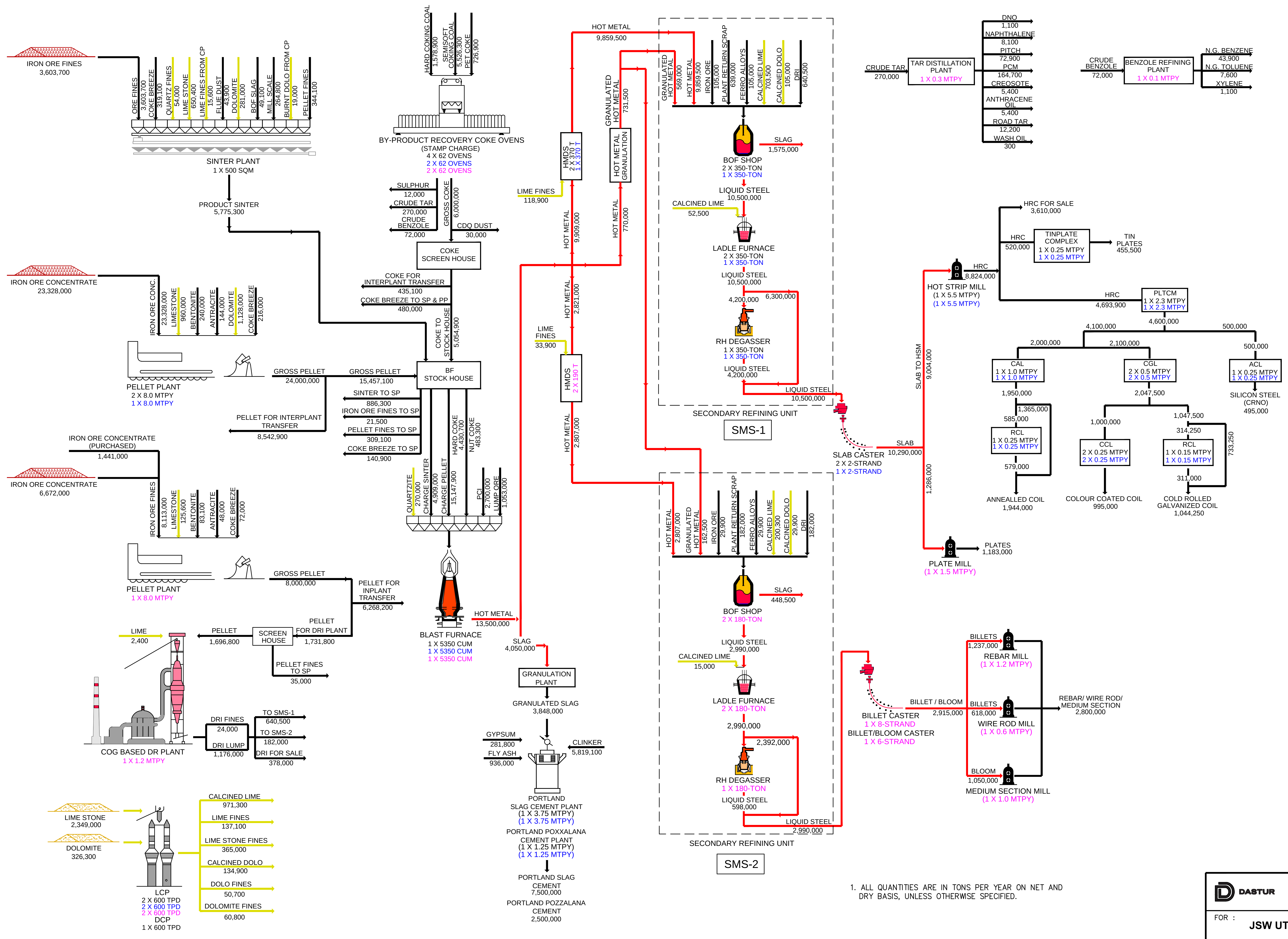
BANKABLE TECHNO-ECONOMIC FEASIBILITY REPORT FOR 12 MTPA INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT

PLANT MATERIALS FLOWSHEET AFTER PHASE - II

| DRAWN | DBO | 25.01.2019 | DRG. No. | REV. |
|---|---|---|---|---|
| APPROVED | ADT | 25.01.2019 | 11467-02-0002 | 0 |




1. ALL QUANTITIES ARE IN TONS PER YEAR ON NET AND DRY BASIS, UNLESS OTHERWISE SPECIFIED.

| | |
|---|---|
| (black box) | FACILITIES INSTALLED IN PHASE - I |
| (blue box) | FACILITIES INSTALLED IN PHASE - II ADDITIONALLY |
| (magenta box) | FACILITIES INSTALLED IN PHASE - III ADDITIONALLY |

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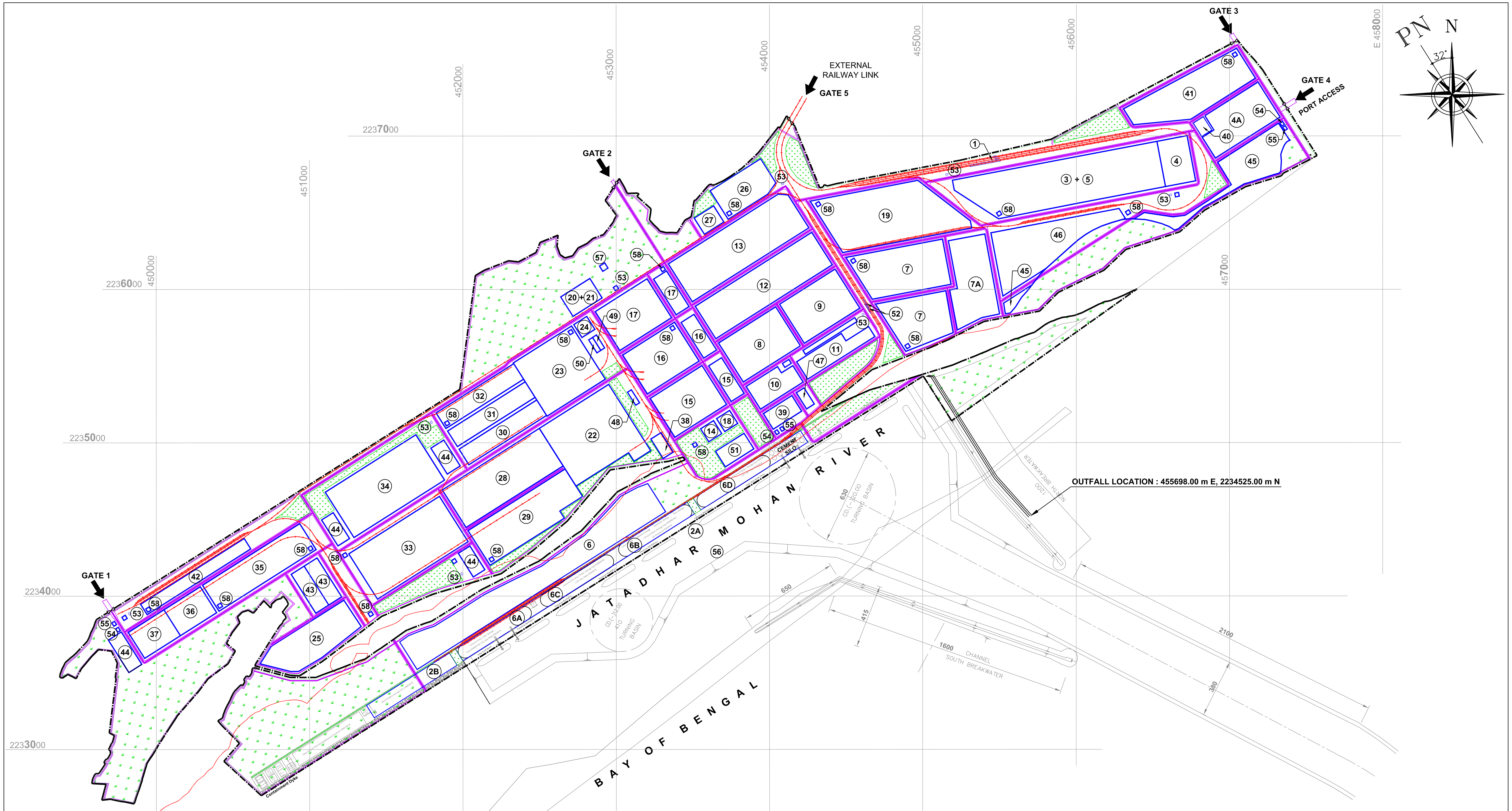
BANKABLE TECHNO-ECONOMIC FEASIBILITY REPORT FOR 12 MTPA INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT

PLANT MATERIALS FLOWSHEET AFTER PHASE-III

| | | | | |
|---|---|---|---|---|
| DRAWN | DBO | 27.06.2018 | DRG. No. | REV. |
| APPROVED | ADT | 27.06.2018 | 11467-02-0003 | 0 |




LEGEND

1. RAW MATERIAL UNLOADING YARD
2A. JETTY FOR RECEIPT OF IMPORTED RAW MATERIALS AND DESPATCH OF PELLET.
2B. JETTY FOR DESPATCH OF FINISHED PRODUCTS
3. ORE AND FLUX YARD
4. TERMINAL FACILITIES FOR I/O SLURRY
4A. EMERGENCY DUMP POND
5. THERMAL COAL, ANTHRACITE & IRON ORE CONCENTRATE YARD
6. IMPORTED COAL, PCI, LIME STONE (SMS), PELLET STORAGE
7. 3 X 300 MW CAPTIVE POWER PLANT
7A. ASH POND
8. PELLET PLANT 1,2.
9. PELLET PLANT 3,4.
10. SINTER PLANT
11. DR PLANT
12. COKE OVEN AND BY PRODUCT PLANT 1*
13. COKE OVEN AND BY PRODUCT PLANT 2*
14. COKE OVEN GAS HOLDER
15. BLAST FURNACE 1
16. BLAST FURNACE 2
17. BLAST FURNACE 3
18. BLAST FURNACE GAS HOLDER
19. GRANULATED SLAG STORAGE & CEMENT PLANT
20. LIME & DOLO PLANT 1
21. LIME & DOLO PLANT 2
22. STEEL MELT SHOP 1
23. STEEL MELT SHOP 2
24. LD GAS HOLDER
25. AIR SEPERATION PLANT & BUFFER VESSEL
26. MRSS (GIS) & MPDS
27. ADMINISTRATIVE BUILDING / OFFICE / LABORATORY DATA CENTRE / TELEPHONE EXCHANGE / TRAINING / PARKING
28. HOT STRIP MILL 1
29. HOT STRIP MILL 2
30. WIRE ROD MILL
31. MEDIUM SECTION MILL
32. BAR MILL
33. COLD ROLLING MILL 1 WITH ACL FOR ELECTRICAL STEEL
34. COLD ROLLING MILL 2 WITH ACL FOR ELECTRICAL STEEL
35. PLATE MILL
36. TIN PLATE MILL 1
37. TIN PLATE MILL 2
38. HOT METAL GRANULATION UNIT
39. COMPRESSED AIR STATION
40. CLARIFIED WATER STORAGE
41. METAL RECOVERY PLANT & DEBRIS DUMP
42. PRODUCT DESPATCH YARD
43. STORES AND REPAIR SHOP
44. PARKING AREA
45. RAW WATER RESERVOIR
46. RAW WATER, EFFLUENT & SEWAGE TREATMENT PLANT
47. CHILLED WATER PLANT
48. HOT METAL POOLING PIT
49. LADLE REPAIR SHOP
50. LOCO REPAIR SHOP
51. FUEL STORAGE FOR PELLET PLANT
52. WAGON LOADING STATION FOR PELLET
53. REST ROOM WITH TOILET
54. MEDICAL CENTER WITH AMBULANCE
55. FIRE BRIGADE / CENTRAL FIRE MONITORING STATION
56. CAPTIVE JETTY LAYOUT
57. TSDF – HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITIES
58. ASSEMBLY POINTS

* INCLUDING TAR DISTILLATION & BENZOL REFINING PLANT

LEGEND:–

1. PLANT BOUNDARY SHOWN THUS..............................
2. PROPOSED UNITS SHOWN THUS..............................
3. PROPOSED ROAD SHOWN THUS..............................
4. PROPOSED RAILWAY TRACK SHOWN THUS............
5. PROPOSED GREEN BELT SHOWN THUS...................

1. GATE 1 – PERSONNEL AND DESPATCH GATE
2. GATE 2 – PERSONNEL GATE
3. GATE 3 – MATERIAL GATE
4. GATE 4 – MATERIAL AND PORT ACCESS GATE
5. GATE 5 – RAIL GATE

0 100 300 500 750 1000

SCALE : METER

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BANKABLE TECHNO-ECONOMIC FEASIBILITY REPORT FOR 13.2 MTPY INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT

PLANT GENERAL LAYOUT

| | | | | | |
|---|---|---|---|---|---|
| DRAWN | ANBC | 16.03.2019 | DRG. No. | | REV. |
| APPROVED | AS | 28.03.2019 | 11467-03-0001 | | B |


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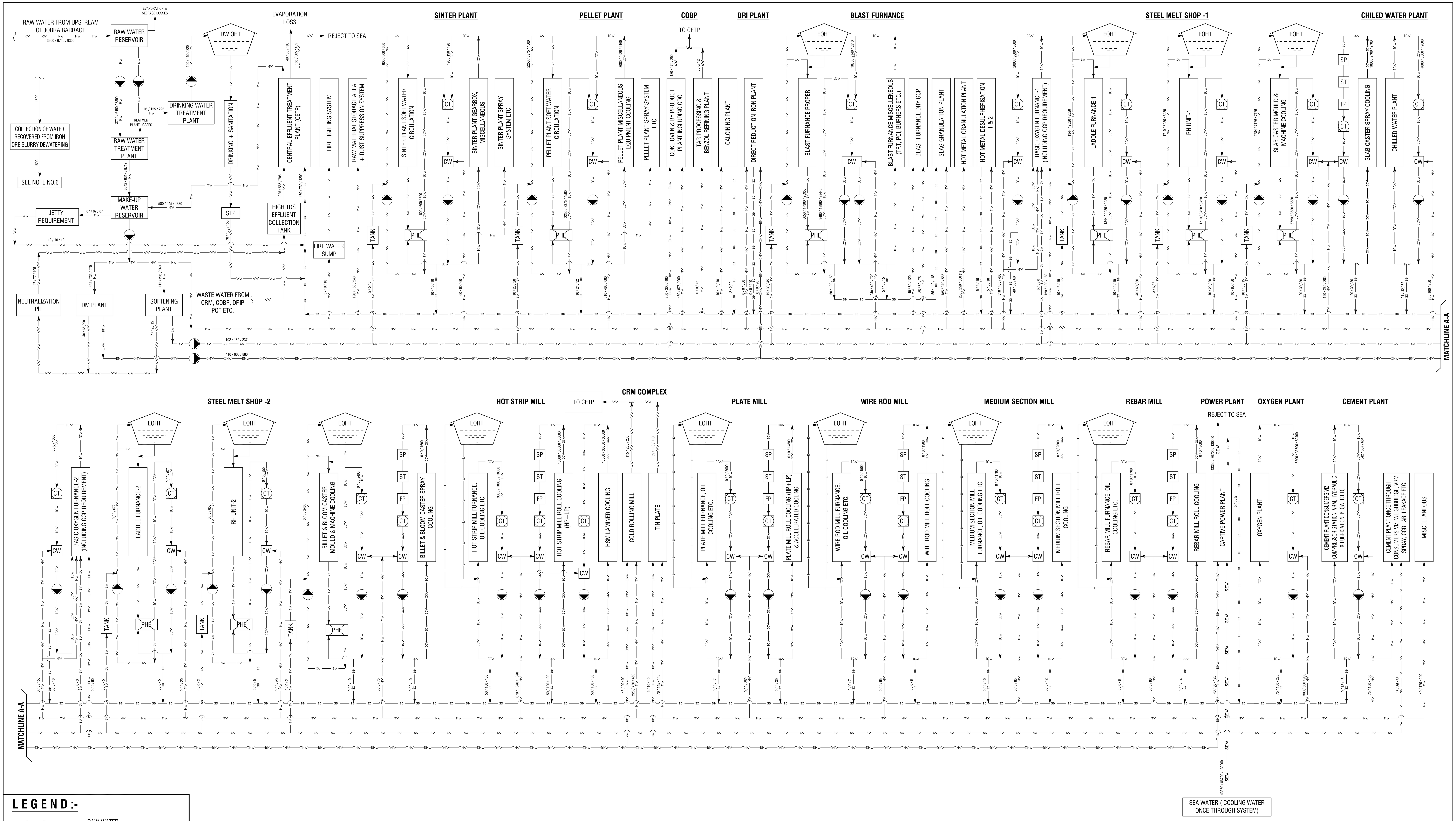
BANKABLE TECHNO-ECONOMIC FEASIBILITY REPORT FOR
12 MTPA INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT

SINGLE LINE DIAGRAM FOR
OVERALL POWER DISTRIBUTION SYSTEM

| | | | | |
|---|---|---|---|---|
| DRAWN | TNA | 15.12.2017 | DRG. No. | REV. |
| APPROVED | SJD | 15.12.2017 | **11467-06-0001** | **0** |




## LEGEND :-

| | |
|---|---|
| RW | RAW WATER |
| MW | MAKE-UP WATER |
| DMW | DE-MINERALISED WATER |
| SV | SOFT WATER |
| DW | DRINKING WATER |
| ICW | INDIRECT COOLING WATER |
| DCW | DIRECT COOLING WATER |
| E | EMERGENCY WATER |
| BD | BLOWDOWN WATER |
| WW | WASTE WATER |
| FW | FIRE WATER |
| SEW | SEA WATER |
| | PUMP |
| PHE | PLATE HEAT EXCHANGER |
| CT | COOLING TOWER |
| CW | COLD WELL |
| EOHT | EMERGENCY OVERHEAD TANK |
| SP | SCALE PIT |
| ST | SETTLING TANK |
| FP | FILTRATION PLANT |
| STP | SEWAGE TREATMENT PLANT |
| CETP | CENTRAL EFFLUENT TREATMENT PLANT |

## NOTES :-

1. FIGURES INDICATED ARE IN $M^3$/Hr.
2. FIGURES SHOWN THUS xxxx / xxxx / xxxx INDICATE FLOW REQUIREMENT IN PHASE-I / PHASE-II / PHASE-III.
3. (*) FIGURES INDICATE THAT FLOW IS INTERMITTENT.
4. TREATED WATER FROM PRIMARY TREATMENT AT CETP SHALL BE USED IN LOW END APPLICATION LIKE RAW MATERIAL HANDLING, FIRE FIGHTING, SLAG GRANULATION ETC.
5. WASTE BACKWASH OF FILTRATION PLANTS OF VARIOUS CONTAMINATED RECIRCULATING SYSTEM SHALL BE TREATED AND REUSED WITHIN RESPECTIVE SYSTEM.
6. DISCHARGE OF RECOVERED WATER FROM SLURRY TO BE DONE DURING INITIAL STAGES AND CONTINUALLY REDUCED DURING COMMISSIONING OF PLANT FACILITIES. AFTER COMMISSIONING OF PLANT FACILITIES WITHDRAWAL FROM JOBRA BARRAGE WILL FURTHER DECREASE BY 1500 CUM / HR.
7. SEA WATER WOULD BE USED IN CPP FOR ONCE-THROUGH COOLING SYSTEM

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BANKABLE TECHNO-ECONOMIC FEASIBILITY REPORT FOR
13.2 MTPY INTEGRATED STEEL PLANT AND CAPTIVE POWER PLANT

SCHEMATIC WATER FLOW DIAGRAM

| | | | | |
|---|---|---|---|---|
| DRAWN | MAMZ | 18.03.2019 | DRG. No. | REV. |
| APPROVED | GK | 18.03.2019 | 11467-06-0002 | A |