# CHAPTER-I

## INTRODUCTION

### 1.0 INTRODUCTION

The Singrauli Coalfield, comprising of 2 separate sedimentary domains, covering an area of about 2202 sq.kms. is bounded by Lat 23°47'00" & 24°12'00"N, Long. 81°48'00" & 82°52'00"E. The north-eastern part of the coalfield, called Moher Half Basin has no well defined southern boundary. However, the post Talchir formations cover an area of 312 sq. kms. The main basin has approximately 1890 sq. kms. but again southern and eastern boundaries are yet to be demarcated. The Moher Half Basin lies in Sidhi district of Madhya Pradesh and about 80 sq. kms. lies in Sonebhadra district of Uttar Pradesh. Main Basin is spread over Sidhi, Surguja and Shahdol districts of Madhya Pradesh.

A Feasibility Study of Singrauli coalfield prepared by CMPDI in collaboration with the then Soviet Experts in 1974 identified Nigahi Opencast Project with a rated capacity of 10 Mtpa.

### 1.1 FR FOR NIGAHI OENCAST MINE (4.2 Mtpa)

Based on the Feasibility Report of Nigahi OCM (14 Mtpa) prepared by erstwhile Soviet Experts with the participation of Indian specialists, FR for 4.2 Mtpa was prepared and sanctioned by Govt in Nov 1987 for a capital investment of Rs 462.39 crores.

### 1.2 EPR FOR NIGAHI OCP (10.0 Mtpa)

Expansion Project Report for 10.00 Mtpa capacity was prepared in November, 1994 by CMPDI, RI-VI and submitted to the Govt. for its sanctioning. The above EPR had been sanctioned by the Govt. in July, 1997 for a capital investment of Rs.1846.49 crores.

### 1.3 EPR for Nigahi OCP (15.0 Mtpa)

With the sanction of additional two units of 500 MW each for VSTPS-III, there is additional coal demand for 2006-07. To meet the above demand, it is proposed to expand the existing Nigahi Project from 10 Mtpa to 15 Mtpa.

The EPR for Nigahi OCP with an incremental rated capacity of 5 Mtpa (Expansion from existing 10 Mtpa to 15 Mtpa) had been prepared and submitted (Vol.-I, Executive Summary) in the month of March'2005 for total capital investment of Rs. 2648.87 crores and approved by NCL Board in the same month.

The Detailed Project Report with the following two options:

Option – I , Total Departmental Variant

Option – II, Additional Shovel-Dumper OB Outsourcing

had been submitted in the month of January'2006 along with Draft PIB Note.

Since then the EPR had been updated in the month of June'2006 for total capital investment of Rs. 2806.33 crores and again in the month of January'2007 for total capital investment of Rs. 2843.43 crores on incremental basis for both the options. The cash-flow analysis with and without expansion has been worked out and presented in the EPR for both the options(Base Date-January'2007). The PIB Note had also been updated and submitted accordingly.

As Nigahi is an existing mine and linked with Vindhyachal STPS (3260 MW) of NTPC, there will be mixed working with outsourcing options, which may create operational problems. Considering the large volume of works, large size of equipment, litigation problems etc. with outsourcing options, Option – I, total departmental variant was recommended for Nigahi Expansion Project although, the project is not viable with departmental option. As the financial IRR at 85 % production level is less than 12% (9.33% for incremental coal production of 5 Mtpa and 11.38% for total production of 15 Mtpa), FSA with NTPC will be required to pay the desired selling price to yield 12 % IRR at 85 % production level for departmental operation. As the project is financially viable with Option-II with incremental additional capital of Rs. 259.40 crores only, the PIB held on 16th January'2007 recommended Option-II for total capital investment of Rs. 2078.01 crores (Partial OBR Outsourcing) i.e. additional shovel-dumper OBR to the tune of 18.00 Mm3 required for incremental coal production of 5 Mtpa by outsourcing for whole life of the mine.

# CHAPTER-II

## MARKETABILITY

Nigahi Opencast Mine is linked to Vindhyachal Super Thermal Power Station which will ultimately have a generation capacity of 3260 MW. In the first stage 4.20 Mtpa was sanctioned to cater the needs of existing 6 units of 210 MW each. With the installation of 2 additional units (2x500 MW), the existing demand of coal for Vindhyachal Stage-I & II (6x210 + 2x500 MW) is about 10.20 Mt. for which EPR for 10 Mtpa had been sanctioned in July, 1997. With the sanction of additional 21 units (2x500 MW), with the commissioning schedule of March, 2007, the additional demand is projected as 4.75 Mtpa for which it is proposed to expand existing Nigahi Project from 10 Mtpa to 15 Mtpa. Considering the projected demand of VSTPS, EPR for Nigahi OCP (15 Mtpa) is fully justified. The demand projection consumer-wise and coal production programme of NCL is given in Table No.2.1 and Table No.2.2 respectively.

Table No.- 2.1

## Demand Projection Consumerwise of NCL

| Sl. No. | Name of Consumer | Capacity (MW) | 2006-07 | 2011-12 |
|---|---|---|---|---|
| A.0 | NTPC | | | |
| A.1 | Existing | | | |
| 1 | SSTPS | 2000 | 9.60 | 9.80 |
| 2 | VSTPP-I | 1260 | 6.25 | 6.50 |
| 3 | Rh. STPS-I | 1000 | 4.80 | 4.80 |
| A.2 | New | | | |
| 1 | VSTPP-II | 1000 | 4.35 | 4.50 |
| 2 | VSTPP-III | 1000 | 1.00 | 4.41 |
| 3 | Rh. STPS-II | 1000 | 4.48 | 4.48 |
| | **Total NTPC (A)** | **7260** | **30.48** | **34.49** |
| B.0 | UPRVUNL | | | |
| B.1 | Existing | | | |
| 1 | Obra TPS | 1482 | 4.80 | 4.80 |
| 2 | Anapara (A+B) | 1630 | 8.00 | 8.00 |
| B.2 | New | | | |
| 1 | Anapara-C | 1000 | | 4.50 |
| 2 | Anapara-D (JV with NCL) | 1000 | | 5.80 |
| | **Sub-Total UPRVUNL** | **5112** | **12.80** | **23.10** |
| C.0 | ITPS (DVB) | 383 | 1.56 | 1.56 |
| D.0 | OTHERS TPS | | | |
| 1 | RVUNL | 1250 | 1.12 | 1.20 |
| 2 | TDL,TPS,Panipat (HSEB) | 880 | 1.80 | 1.49 |
| 3 | ISN International | 2000 | | 6.00 |
| 4 | Neyveli Lignite Corp.(JV with NCL) | 1000 | | 4.50 |
| | **Sub-Total (Others)** | **5130** | **2.92** | **13.19** |
| | **Total Power Utility** | **17885** | **47.76** | **72.34** |
| E.0 | Power Captive | | | |
| 1 | RPD upto 8th unit | 574.8 | 3.45 | 3.45 |
| 2 | RPD (9th & 10th unit) | 160 | | 0.75 |
| 3 | HIL (Co.Gen.) | 30.6 | 0.21 | 0.21 |
| 4 | HIL (Co.Gen. Expansion) | 40 | | 0.19 |
| 5 | KCl (PGD) | 25 | 0.16 | 0.17 |
| 6 | KCl (PGD Expansion) | 25 | | 0.14 |
| | **Sub-Total (Power Captive)** | **855.4** | **3.82** | **4.91** |
| | **TOTAL (POWER)** | **18740.4** | **51.58** | **77.25** |
| | **Total(Others)** | | **1.72** | **1.19** |
| | **TOTAL DEMAND** | | **53.30** | **78.44** |
| | **TOTAL PRODUCTION** | | **52.00** | **78.00** |
| | **SURPLUS(+)/DEFICIT(-)** | | **-1.30** | **-0.44** |

Table No.- 2.2

## Coal Production Programme of NCL

| Sl. No. | Projects | Ultimate Capacity | 2006-07 | 2011-12 |
|---|---|---|---|---|
| A. | **Existing & Completed Mines** | | | |
| 1 | Jhingurdah OCM | 3.00 | 4.30 | - |
| 2 | Amlohri OCM | 4.00 | 4.30 | 4.00 |
| 3 | Bina OCM | 4.50 | 1.45 | - |
| 4 | Jayant OCM | 10.00 | 10.50 | 10.00 |
| 5 | Kakri OCM | 3.00 | 3.60 | 3.00 |
| 6 | Khadia OCM | 4.00 | 3.30 | 4.00 |
| 7 | Dudhichua Expn. | 10.00 | 10.50 | 10.00 |
| 8 | Nigahi Expn. | 10.00 | 11.00 | 10.00 |
| | **Sub-Total (A)** | **48.50** | **48.95** | **41.00** |
| B. | **New Projects to be taken up** | | | |
| 1 | Krishnashila OCP | 4.00 | 0.00 | 4.00 |
| 2 | Bina Extn.OCP | 1.50 | 3.05 | 6.00 |
| 3 | Block- B OCP | 3.50 | | 3.50 |
| 4 | Khadia Expn. | 6.00 | | 4.00 |
| 5 | Amlohri Expn. | 6.00 | | 4.50 |
| 6 | Nigahi Expn. | 5.00 | | 5.00 |
| 7 | Jayant Expn. | 5.00 | | 5.00 |
| 8 | Dudhichua Expn. | 5.00 | | 5.00 |
| | **Sub-Total (B)** | **36.00** | **3.05** | **37.00** |
| | **Grand Total (A+B)** | **84.50** | **52.00** | **78.00** |

# CHAPTER-III

# PROJECT SITE INFORMATION

## 3.1 LOCATION & ACCESSIBILITY

Nigahi Opencast mine is situated in Sidhi district of Madhya Pradesh and forms a part of Singrauli Coalfield.

Singrauli Railway Station on the Obra-Katni branch line is located at a distance of about 12 kms. in the north from the centre of the property.

Renukut-Waidhan highway passes E-W through the block. The nearest town Waidhan is about 12 kms. to the south, Renukut (45 kms.) in the east and Varanasi (225 kms.) in the north.

## 3.2 CLIMATE

Climate is tropical with severe summer. The temperature in summer goes as high as $48^0$C in May-June. In winter (Nov-Feb.), the temperature varies from $4^0$C to $21^0$C.

Predominant wind direction is south-west. The average monthly wind velocity varies from 2.5 to 4.5 km/hr.

The average annual rainfall is about 1000 mm of which 95% precipitation is during the rainy season (June-September). The details of the rainfall data obtained from the meteorological station Jhingurdah (1968-77) are given in Table No.3.1.

## 3.3 PHYSIOGRAPHY

Nigahi Block lies between Jayant Project on the east and Amlohri Project on the west. It stands out as a hilly plateau with elevations of about 400-450 m above mean sea level. Some relief elevations exceed 500 m.

In the western part of the block where Turra Seam incrops, as well as in the central and eastern parts to the south of the incrop, the plateau is pronounced by steep escarpment facing the south. The slope of the escarpment is traversed by drains and nallahs.The base of the plateau extends as a plain with elevations of around 300m.

The incrop of Purewa Bottom seam lies on the face of another small escarpment also facing the south. The general elevation of the plateau varies from 405 to 455m.

The drainage is controlled by many small seasonal nallas with southerly flow in the major portion of the opencast mine field and northern by flow in the northern part of the minefield.

### 3.4 Land Use

The vegetation on the top of the plateau is rather scanty and represented mainly by shrubs. The slope of the escarpment facing the south is thickly forested. Cultivation is limited in patches on the plateau.

The total and requirement for Nigahi Opencast Project has been estimated as 3036.4 Ha. Out of 3036.4 Ha., 1260 Ha. is forest land and 1776.4 Ha. is non-forest land. Out of the 1776.4 Ha. of non-forest land, 209 Ha. is Govt. land and 1567.40 is tenancy land.

The head-wise breakup of the land is given below:

(Fig. in Ha.)

| | |
|---|---|
| Mine Area | 1875.00 |
| Dump Area | 418.00 |
| Other Infrastructure facilities | 497.50 |
| Colony, Greenbelt etc. | 245.90 |
| **Total** | **3036.40** |

## EPR FOR NIGAHI OPENCAST PROJECT (15.0 Mtpa)

## MONTHLY & ANNAUL RAINFALL DATA OF JHINGURDAH RAINGAUGE STATION (IN MM)

Table No.-3.1

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEPT | OCT | NOV | DEC | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | 11.20 | 38.00 | | 1.60 | | 41.40 | 100.30 | | 313.20 | 136.80 | 62.90 | 38.90 | 744.30 |
| No. of Days | 1 | 5 | | 1 | | 3 | 8 | 0 | 9 | 15 | 6 | 2 | 50 |
| 1973 | 1.40 | 32.30 | | | 14.80 | 25.50 | 131.90 | 198.90 | 265.80 | 98.30 | | | 768.90 |
| No. of Days | 2 | 4 | | | 1 | 4 | 13 | 11 | 18 | 7 | | | 60 |
| 1974 | 2.40 | 7.50 | | 11.00 | 13.10 | 25.00 | 320.80 | 236.00 | 238.10 | 22.40 | 3.70 | 5.60 | 885.60 |
| No. of Days | 1 | 1 | | 2 | 2 | 4 | 20 | 14 | 4 | 2 | 1 | 1 | 52 |
| 1975 | 21.30 | | 17.60 | | | 107.10 | 400.00 | 739.20 | 137.30 | 118.30 | | | 1540.80 |
| No. of Days | 8 | | 5 | | | 9 | 18 | 23 | 13 | 9 | | | 85 |
| 1976 | 9.00 | 17.10 | 6.80 | 31.10 | | 64.00 | 369.60 | 421.80 | 319.90 | 0.00 | | | 1239.30 |
| No. of Days | 1 | 1 | 1 | 4 | | 4 | 21 | 21 | 11 | | | | 64 |
| 1977 | 7.20 | 5.50 | | 27.20 | 8.20 | 417.00 | 573.40 | 282.00 | 443.60 | 61.10 | 23.00 | | 1848.20 |
| No. of Days | 2 | 1 | | 3 | 3 | 12 | 23 | 14 | 15 | 3 | 4 | | 80 |
| 1978 | 20.10 | 190.50 | 63.20 | | | 299.10 | 455.90 | 336.00 | 765.60 | 36.00 | 14.00 | 12.70 | 2193.10 |
| No. of Days | 1 | 7 | 4 | | | 10 | 21 | 23 | 15 | 2 | 1 | 1 | 85 |
| 1979 | 47.00 | 88.40 | 1.50 | 4.80 | | 96.60 | 171.00 | 227.00 | 48.80 | | 26.80 | | 711.90 |
| No. of Days | 8 | 4 | 1 | 2 | | 5 | 16 | 12 | 8 | | 3 | | 59 |
| 1980 | 1.60 | 10.40 | 24.40 | | 2.20 | 568.60 | 323.40 | 417.80 | 233.70 | | | 19.00 | 1601.10 |
| No. of Days | 1 | 2 | 3 | | 1 | 12 | 23 | 28 | 13 | | | 2 | 85 |
| 1981 | 25.40 | | 27.10 | 57.60 | 6.40 | 180.60 | 321.00 | 178.50 | 145.90 | | 2.30 | | 944.80 |
| No. of Days | 1 | | 2 | 2 | 1 | 4 | 22 | 14 | 9 | | 1 | | 56 |
| 1982 | 69.30 | 14.20 | 55.40 | | | 90.20 | 236.50 | 456.50 | 43.20 | | 4.60 | 21.80 | 991.70 |
| No. of Days | 3 | 2 | 4 | | | 4 | 16 | 28 | 10 | | 2 | 1 | 70 |
| 1983 | 1.50 | | | | 49.90 | 66.80 | 268.30 | 203.00 | 324.60 | 46.20 | | | 960.30 |
| No. of Days | 1 | | | | 2 | 2 | 19 | 15 | 20 | 3 | | | 62 |
| 1984 | 50.10 | 81.20 | | | 16.70 | 156.20 | 324.60 | 533.30 | 119.00 | 27.50 | | 18.30 | 1326.90 |
| No. of Days | 4 | 7 | | | 2 | 11 | 14 | 21 | 10 | 5 | | 1 | 75 |
| 1985 | 69.50 | | 6.80 | 4.00 | 3.20 | 101.20 | 331.50 | 490.10 | 238.20 | 33.90 | | | 1278.40 |
| No. of Days | 2 | | 2 | 1 | 1 | 7 | 21 | 16 | 13 | 3 | | | 66 |
| 1986 | | 87.50 | 11.10 | 15.50 | 2.80 | 138.70 | 148.90 | 277.10 | 68.50 | 41.70 | | 74.20 | 866.00 |
| No. of Days | | 6 | 1 | 1 | 2 | 10 | 14 | 16 | 7 | 2 | | 4 | 63 |
| 1987 | 14.40 | | 25.40 | | | 10.80 | 311.90 | 456.80 | 550.80 | 97.00 | | | 1467.10 |
| No. of Days | 2 | | 1 | | | 3 | 10 | 10 | 15 | 4 | | | 45 |
| 1988 | | 27.70 | 4.80 | 4.00 | | 376.00 | 493.00 | 117.00 | 85.00 | 28.00 | | | 1135.50 |
| No. of Days | | 3 | 1 | 1 | | 10 | 10 | 13 | 4 | 1 | | | 43 |
| 1989 | | | 31.00 | | | 291.00 | 338.40 | 242.10 | 176.90 | | 33.80 | 8.80 | 1122.00 |
| No. of Days | | | 8 | | | 15 | 16 | 12 | 10 | | 1 | 2 | 64 |
| 1990 | | 64.90 | 29.40 | | 61.20 | 227.00 | 260.60 | 173.00 | 207.70 | 5.20 | | | 1029.00 |
| No. of Days | | 3 | 1 | | 3 | 18 | 18 | 18 | 15 | 1 | | | 77 |
| 1991 | 11.00 | 31.00 | 52.50 | | 26.00 | 141.50 | 141.00 | 666.00 | 258.00 | 17.00 | | | 1344.00 |
| No. of Days | 2 | 2 | 4 | | 2 | 5 | 7 | 22 | 15 | 3 | | | 62 |
| 1992 | | | | | | 26.70 | 270.40 | 573.40 | 91.50 | 59.60 | | | 1021.60 |
| No. of Days | | | | | | 4 | 17 | 19 | 10 | 3 | | | 53 |
| 1993 | | | | | 3.20 | 217.10 | 297.80 | 297.10 | 394.30 | | | | 1109.50 |
| No. of Days | | | | | 1 | 19 | 18 | 19 | 12 | | | | 59 |
| 1994 | | | | 6.80 | 12.60 | 306.80 | 220.40 | 340.60 | 220.30 | | | | 1107.50 |
| No. of Days | | | | 1 | 1 | 21 | 16 | 24 | 15 | | | | 78 |
| 1995 | | | | | 19.90 | 340.90 | 360.80 | 300.70 | 210.50 | | | | 1232.80 |
| No. of Days | | | | | 1 | 16 | 17 | 15 | 10 | | | | 59 |
| 1996 | | | | | 18.90 | 397.80 | 414.30 | 180.60 | 221.30 | | | | 1232.90 |
| No. of Days | | | | | 3 | 20 | 26 | 14 | 16 | | | | 79 |
| 1997 | 18.40 | 12.30 | | | | 195.70 | 221.90 | 265.30 | 205.60 | 81.40 | 23.20 | 10.30 | 1034.10 |
| No. of Days | 3 | 2 | | | | 14 | 14 | 20 | 16 | 10 | 4 | 2 | 85 |
| 1998 | 47.00 | 41.40 | 19.10 | 22.30 | 40.60 | 116.50 | 279.30 | 469.60 | 207.40 | | 38.20 | | 1281.40 |
| No. of Days | 3 | 4 | 3 | 2 | 2 | 7 | 11 | 18 | 11 | | 1 | | 62 |
| 1999 | | | | | 16.00 | 284.40 | 532.00 | 321.40 | 450.10 | 137.60 | | | 1741.50 |
| No. of Days | | | | | 2 | 13 | 17 | 21 | 16 | 5 | | | 74 |
| 2000 | | 7.20 | | | 10.30 | 156.80 | 373.00 | 77.20 | 346.10 | 59.60 | | 21.50 | 1051.70 |
| No. of Days | | 1 | | | 1 | 8 | 21 | 6 | 12 | 1 | | 1 | 51 |
| 2001 | 10.30 | | 11.20 | 12.80 | 48.50 | 303.20 | 505.10 | 17.50 | | | | | 908.60 |
| No. of Days | 1 | | 2 | 2 | 3 | 13 | 16 | 2 | | | | | 39 |
| 2002 | | 37.40 | | | 22.30 | 122.50 | 126.50 | 440.90 | 283.90 | 44.50 | | 3.20 | 1081.20 |
| No. of Days | | 3 | | | 3 | 6 | 7 | 21 | 12 | 2 | | 1 | 55 |
| 2003 | 3.20 | 93.90 | | 50.10 | | 161.70 | 264.30 | 301.30 | 501.70 | 92.40 | | 10.30 | 1478.90 |
| No. of Days | 1 | 6 | | 2 | | 14 | 18 | 22 | 23 | 7 | | 2 | 95 |
| 2004 | 13.90 | | 6.40 | 15.20 | 2.00 | 197.60 | 350.00 | 458.10 | 104.30 | 7.20 | | | 1154.70 |
| No. of Days | 3 | | 2 | 3 | 1 | 16 | 20 | 24 | 6 | 2 | | | 77 |

# CHAPTER-IV

# GEOLOGY

## 4.1 Regional Geology:

The Singrauli Coalfield, the northern most member of the Central Indian Coalfields, is composed of two techno-sedimentary domains viz. the western part, covering an area of 1890 sq.km known as Main Basin and the northeastern part, covering an area of 312 sq.km known as Moher sub-basin. These two basins are separated by a high basement trending NW-SE. Moher sub-basin is the most promising area and, at present, mining of coal is confined to it in Singrauli Coalfield. Nigahi OCP is located in the south central part of Moher sub-basin.

The general stratigraphic sequence of Singrauli Coalfield (as per GSI, 1977) is as follows:

Table 4.1

**General Stratigraphic Succession, Singrauli Coalfield**

| Age | Group | Formation | Lithology | Thickness (m) |
|---|---|---|---|---|
| Cretaceous | | Intrusive | Dolerite dykes and sills | Not estimated |
| Upper Triassic | Upper Gondwana | Mahadeva | Coarse grained, ferruginous sandstone with bands of shale, clay and conglomerate | Not estimated |
| Lower Triassic | Lower Gondwana | Panchet (?) | White, greenish white and pink micaceous, medium to coarse grained sandstones with red beds, greenish brown silty shales and conglomerates | Not estimated |
| Upper Permian | | Raniganj | Fine grained sandstones and shales with coal seams. | 215-403 |
| Middle Permian | | Barren Measures | Very coarse grained ferruginous sandstones, green clay and shales | 125-300 |
| Lower Permain | | Barakar | Medium to coarse grained sandstones, shales, clays and coal seams | 325-600 |
| Upper " Carboniferous (?) | | Talchir | Tillites, sandstones, siltstones, needle shales | 75-130 |
| ---------- Unconformity---------- | | | | |
| Precambrian | Phyllites, quartzites, schists and gneisses. | | | |

The general strike of the beds is more or less east-west except in Block-B in the west and Bina & Kakri blocks in the east where the strike is nearly north-south. The beds have a corresponding centripetal dip. The amount of dip in general is about 2 to 3 degree. However, higher dips of about 8°-10° have been observed in the eastern part of the basin.

## 4.2 Exploration:

The area was regionally explored by GSI in 1958. IBM also drilled 68 boreholes in this area. Later on, CMPDI carried out detailed drilling in phases in and adjacent to the mining block. Total number of boreholes drilled in Nigahi Block and meterage drilled (agency wise) are furnished at Table No. 4.2.

Table 4.2

**Agency wise number of boreholes drilled in the Block**

| Exploration Agency | Borehole series | Period of drilling | Number of Boreholes Drilled | Total Metreage |
|---|---|---|---|---|
| CMPDIL | CMSN | Aug'78 to Dec'79 | 76 | 6327.90 |
| | CMMH | April'88 to Dec'89 | 03 | 640.50 |
| | CSND | March'94 to Nov'94 & Sept'99 to March'02 | 48 | 6169.15 |
| | CSNE | June'97 to Nov'97 | 22 | 4681.00 |
| | CNDE | July'00 to May'02 | 06 | 1200.00 |
| GSI | SN | 1958-59 | 11 | 1180.90 |
| IBM | SGR | 1961-63 | 67 | 8370.19 |
| Total | | | **233** | **28569.64** |

Nigahi block measures an area of 14.42 sq.km having borehole density of 16 boreholes per sq.km.

## 4.3 Geology of the Block:

Entire block area is covered by the sediments of Barakar Formation with a thin cover of soil and alluvium at places. The stratigraphic sequence of rocks within Barakars based on data of drill holes is given in Table 4.3.

Table 4.3

**Stratigraphic sequence of rocks within Barakar Formation**
**Nigahi Block (15 mtpa)**

| Lithology | Thickness Range (m) | | Remarks |
|---|---|---|---|
| | From | To | |
| Sand and sub soil | Nil | 9.00 | In the western part of the area the Purewa Top and Purewa Bottom merge to from a 17.57 to 27.50 m thick composite seam. |
| Sandstone with 2 to 3 clay bands and 1 to 2 thin impersistent carbonaceous horizon. | 30.50 | 167.40 | |
| Coal Seam : Purewa Top | 4.00 | 10.94 | |
| Sandstone with thin shale bands | 1.00 | 29.35 | |
| Coal Seam : Purewa Bottom | 8.80 | 14.70 | |
| Sandstone with thin carb shale | 52.10 | 69.60 | |
| Coal Seam : Turra | 11.08 | 19.20 | |

The Barakar sequence mainly consists of fine to coarse grained, light grey, felspathic sandstone, shale, clay and coal seams. Kaolinised felsper is usually the cementing material. Two to three clay beds occur within the upper horizon of the Barakars. The shale bands generally occur as inter banded with coal and constitutes most of the dirt bands within the seams. Presence of thin shale bands has also been observed within sandstone at places.

The major lithofacies of the Barakar Formation, comprising the coal seams belong to the arenaceous facies of varying grain sizes, but predominantly of the coarse grained sandstone. Argillaceous facies amounts to about 5% of the total column of the rocks in a vertical section. The sandstones are felspathic, at times kaolinised and rarely micaceous. The coal, shaly coal and carb shales constitute the coal horizon

## 4.4 Geological Structure :

The sandstone exposures and the topography do not reveal much on the geological structure of the area. The entire structural set-up, therefore, have been worked out on sub-surface data generated from Nigahi and adjoining blocks.

The block is situated in the south central part of the crescent shaped Moher sub-basin. In conformity to the regional set-up, the beds have a general ENE-WSW trend with northerly dip. The amount of dip is generally about 2° to 3°. The area has been postulated free of faults.

## 4.5 Description of Coal seams :

### 4.5.1 Turra Seam :

Turra seam represents the most potential and bottom-most workable coal horizon. It occurs 52.10 m to 69.60 m below Purewa Bottom/ merged seam. The seam incrops in the area; and maximum depth of occurrence of the seam is 249 m. The full thickness of Turra seam including all dirt bands varies from 11.08 m to 19.20 m; the effective thickness variation is from 14 m to 19 metre.

The immediate roof and floor of the Turra seam is generally represented by fine to coarse grained sandstone and sandy shale, carbonaceous shale, alternate bands of snale & sandstone respectively.

The seam is less inter-banded in comparison to the younger seams. Generally the dirt bands are less than 1 m thick. Dirt bands of 1 m and above in thickness have been found in few boreholes only attaining maximum thickness of 1.57m. The bands are normally represented by carbonaceous shale and in very few cases by shale.

The details of dirt bands are given in Table 4.5.1.

Table 4.5.1

**Dirt bands in Turra seam**

| Particulars | Thickness range of seam (in m) | Dirt bands | | | | | |
|---|---|---|---|---|---|---|---|
| | | < 1m. thick | | | | >1m. thick | |
| | | Combustible | | Non-combustible | | No. | Cumulative Tthickness (in m) |
| | | No. | Cumulative Thickness (in m) | No. | Cumulative Thickness (in m) | | |
| Within incrop | 1.00-14.40 | Nil to 2 | Nil to 0.59 | Nil to 1 | Nil to 0.17 | Nil to 1 | 1.20-1.57 |
| Beyond incrop | 11.08-19.20 | Nil to 4 | Nil to 2.93 | Nil to 7 | Nil to 1.31 | | |

4.5.1.1 **Coal Quality :**

The seam in general contains grade D coals. An improvement in its quality to grade C has been observed in north-eastern part of the block. The quality parameters of Turra seam are given in the following tables.

Table 4.5.1.1A

**Proximate Analysis**

| Particulars of analysis | On 60% RH & 40°C | | | | | |
|---|---|---|---|---|---|---|
| | M% | A% | VM% | CV (k.cal/kg) | UHV* (k.cal/kg) | Grade |
| Bcs (Sample consisting of coal and shaly coal) | 5.0 - 10.1 | 15.2 - 33.6 | 26.0 - 31.3 | 4310 - 5970 | 3408 - 6030 | E - B |
| I100 Sample inclusive of dirt bands (A+M% >55) of upto 1 m thick | 5.0 - 9.4 | 15.2 - 35.0 | 25.4 - 31.3 | 4210 - 5970 | 3242 - 6030 | F - B |

* UHV = 8900 - 138 (A%+M%)

Table 4.5.1.1B

**Ultimate Analysis**

| C% | H% | N% | S% | Oxy% (by diff.) |
|---|---|---|---|---|
| 77.2 - 81.3 | 4.5 - 6.6 | 1.5 - 2.0 | 0.4 - 0.8 | 12.0 - 16.0 |

Table 4.5.1.1C

**Sulphur distribution%**

| Sample type | Sulphur distribution% | | |
|---|---|---|---|
| | Pyrite | Sulphate | Organic |
| I100 | 8.5 - 47.5 | 3.1 - 7.3 | 43.4 - 87.2 |

Table 4.5.1.1D

**Hardgrove Grindability Index**

| Sample type | Hardgrove Grindability Index |
|---|---|
| Bcs | 55 - 65 |
| I100 | 51 - 76 |

Table 4.5.1.1E

**Long flame parameters**

| On dmmf basis | | |
|---|---|---|
| VM% | Gross CV in k.cal/kg | Moisture% at 60% RH & 40°C |
| 35.4 - 41.4 | 7334 – 7806 | 6.7 - 13.1 |

Table 4.5.1.1F

**Ash fusion temperature range**

| Sample type | Ash fusion range (at MRA) ° C | | |
|---|---|---|---|
| | IDT | HT | FT |
| Bcs | 1180 - >1400 | 1320 - >1400 | >1400 |
| I100 | 1250 - >1400 | 1310 - >1400 | >1400 |

Table 4.5.1.1G

**Chemical Composition of coal ash**

| Sample type | SiO2% | Al2O3% | Fe2O3% | TiO2% | P2O5% | MnO% | CaO% | MgO% | SO3 % | Alkalies by diff. |
|---|---|---|---|---|---|---|---|---|---|---|
| Bcs | 60.31 - 62.67 | 25.42 - 29.14 | 2.77 - 5.99 | 1.79 - 1.92 | 0.39 - 0.52 | Trace | 0.2 - 2.17 | 0.14 - 1.27 | 0.09 - 0.52 | 0.92 - 2.29 |
| I100 | 59.88 - 62.67 | 25.42 - 29.14 | 2.77 - 8.98 | 1.70 - 1.96 | 0.39 - 0.86 | Trace - 0.02 | 0.2 - 2.17 | 0.14 - 1.27 | Trace - 0.52 | 0.67 - 2.60 |

4.5.1.1.1 **Observation :**

From above data, it is observed that the coals are of low rank, high volatile, non-coking and bituminous type. Also it is found that Turra seam satisfies the stipulated parameters of long flame coal. The seam is, therefore, expected to be more reactive towards ignition and combustion and burn faster with luminous long flame resulting in high heat transfer rate.

4.5.2 **Purewa Bottom Seam** :

Purewa Bottom seam represents the middle workable coal horizon in the area. The seam incrops in the area and maximum depth of occurrence is 139 m. The seam merges with Purewa Top seam in the north-western portion of the block. The full thickness of the Purewa Bottom seam including all dirt bands varies from 8.80 m to 14.70 m.

Roof of the seam is generally composed of medium to coarse grained sandstone with occasional shale/clay bands. Immediate floor is also marked by fine to coarse grained sandstone and at some places by grey shale.

The seam is highly interbanded in nature . These bands are generally represented by carbonaceous and grey shales. The details of dirt bands are given in Table 4.5.2.

Table 4.5.2

**Dirt bands in Purewa Bottom seam**

| Particulars | Thickness range of seam (in m) | Dirt bands | | | | | |
|---|---|---|---|---|---|---|---|
| | | < 1m. thick | | | | >1m. thick | |
| | | Combustible | | Non-combustible | | No. | Cumulative Tthickness (in m) |
| | | No. | Cumulative Thickness (in m) | No. | Cumulative Thickness (in m) | | |
| Within incrop | 1.50 - 8.60 | Nil - 2 | Nil - 1.75 | Nil - 4 | Nil - 1.65 | - | - |
| Beyond incrop | 8.80 - 14.70 | Nil - 7 | 0.48 - 3.00 | Nil - 6 | Nil - 2.35 | Nil - 2 | Nil - 3.39 |

4.5.2.1 **Coal quality :**

The seam varies in its quality from grade E to G. In general, the seam contains grade F coal. Summary of quality details of the seam is given in following tables.

Table 4.5.2.1A

**Proximate analysis**

| Particulars of analysis | On 60% RH & 40°C | | | | | |
|---|---|---|---|---|---|---|
| | M% | A% | VM% | CV (k.cal/kg) | UHV (k.cal/kg) | Grade |
| Bcs | 6.5 - 9.2 | 20.5 - 26.5 | 29.5 - 37.5 | 4630 - 4900 | 3766 - 4953 | E - C |
| 1100 | 5.5 - 7.9 | 27.6 - 42.0 | 24.2 - 30.2 | 3720 - 4610 | 2304 - 4001 | G - E |
| Ip | 5.0 - 9.9 | 33.2 - 49.2 | 23.3 - 30.7 | 3360 - 4550 | 1393 - 3380 | G - E |

Table 4.5.2.1B

**Ultimate analysis**

| C% | H% | N% | S% | Oxy% (by diff.) |
|---|---|---|---|---|
| 77.7 - 82.5 | 4.7 - 5.1 | 1.4 - 2.0 | 0.5 - 0.9 | 10.5 - 14.6 |

Table 4.5.2.1C

**Sulphur distribution**

| Sample type | Sulphur distribution% | | |
|---|---|---|---|
| | Pyrite | Sulphate | Organic |
| Bcs | 41 | 4 | 55 |
| 1100 | 10.0 - 19.3 | 3.3 - 7.0 | 73.7 - 86.7 |

Table 4.5.2.1D

**Hardgrove Grindability Index**

| Sample type | Hardgrove Grindability Index |
|---|---|
| Bcs | 56 - 57 |
| I100 | 51 - 72 |
| Ip | 87 |

Table 4.5.2.1E

**Long flame parameters**

| On dmmf basis | | |
|---|---|---|
| VM% | Gross CV in k.cal/kg | Moisture% at 60% RH & 40° C (on mineral free basis) |
| 38.9 - 57.2 | 7451 - 7897 | 7.3 - 13.3 |

Table 4.5.2.1F

**Ash fusion temperature range**

| Sample type | Ash fusion range (at MRA) °C | | |
|---|---|---|---|
| | IDT | HT | FT |
| Bcs | 1190 - >1400 | 1390 - >1400 | >1400 |
| I100 | 1200 - >1290 | 1260 - >1400 | >1400 |

Table 4.5.2.1G

**Chemical Composition of Coal Ash**

| Sample type | SiO2% | Al2O3% | Fe2O3% | TiO2% | P2O5 % | MnO% | CaO% | MgO% | SO3% | Alkalies by diff. |
|---|---|---|---|---|---|---|---|---|---|---|
| Bcs | 61.4 - 62.0 | 26.2 - 26.3 | 3.9 - 6.0 | 1.7 -1.9 | 0.4 – 0.4 | Trace | 1.2 - 2.3 | 0.9 - 0.9 | 0.2 - 0.3 | 1.7 – 2.2 |
| I100 | 60.36 - 63.7 | 25.42 - 29.23 | 2.02 -4.4 | 1.5 1.92 | 0.39 – 0.80 | Trace | 0.9 - 2.32 | 0.88 - 1.5 | Trace - 0.52 | 1.3 - 2.29 |

4.5.2.1.1 **Observation** :

Purewa Bottom coals are low rank, high volatile, non-coking, bituminous. This seam satisfies the stipulated parameters of long flame coal.

4.5.3 **Purewa Top seam :**

Purewa Top seam represents the top most workable coal horizon in the area. The seam incrops in the area and maximum depth of occurrence is 112 m. The full thickness of the seam including all dirt bands varies from 4.25 m to 10.94 m.

Roof of the the seam is generally composed of medium to coarse grained sandstone with occasional shale/clay bands. Immediate floor is also marked by fine to coarse grained sandstone; at places grey shale also constitutes immediate floor.

This seam is also inter-banded in nature The dirt bands are generally represented by carbonaceous and grey shale. Bands of >1m thickness are rare. The details of dirt bands are given in table 4.5.3.

Table 4.5.3

**Dirt bands in Purewa Top seam**

| Particulars | Thickness range of seam (in m) | Dirt bands | | | | | |
|---|---|---|---|---|---|---|---|
| | | < 1m. thick | | | >1m. thick | | |
| | | Combustible | | Non-Combustible | No. | | Cumulative Thickness (in m) |
| Within incrop | 0.82 - 8.45 | Nil - 3 | 0.85 | Nil -2 | Nil - 0.85 | Nil -1 | Nil - 2.15 |
| Beyond incrop | 4.00 - 10.94 | Nil - 3 | Nil - 1.09 | Nil - 4 | Nil - 1.74 | Nil - 1 | Nil - 2.55 |

4.5.3.1 **Coal Quality :**

In general, the seam is grade G in quality. Quality parameters of Purewa Top seam is summarized in following tables.

Table 4.5.3.1A

**Proximate analysis**

| Particulars of analysis | On 60% RH & 40°C | | | | | |
|---|---|---|---|---|---|---|
| | M% | A% | VM% | CV (k.cal/kg) | UHV (k.cal/kg) | Grade |
| Bcs | 6.2 - 10.1 | 23.7 - 37.3 | 24.8 - 32.5 | 4085 - 4920 | 2897 - 4512 | F - D |
| I100 | 5.3 - 9.5 | 23.7 - 47.9 | 23.3 - 31.4 | 3315 - 4920 | 1420 - 4374 | G - D |
| Ip | 4.8 - 8.0 | 31.5 - 57.8 | 21.4 - 26.8 | 2285 - 4520 | 234 - 3753 | Ungr.-E |

Table 4.5.3.1B

**Ultimate analysis**

| C% | H% | N% | S% | Oxy% (by diff.) |
|---|---|---|---|---|
| 78.4 - 80.6 | 4.8 - 5.5 | 1.4 – 1.7 | 0.4 - 0.5 | 11.8 - 14.9 |

Table 4.5.3.1C

**Sulphur distribution**

| Sample type | Sulphur distribution% | | |
|---|---|---|---|
| | Pyrite | Sulphate | Organic |
| I100 | 13.7 - 17.5 | 4.8 - 5.9 | 77.7 - 80.4 |

Table 4.5.3.1D

**Hardgrove Grindability Index**

| Sample type | Hardgrove Grindability Index |
|---|---|
| I100 | 63 |

Table 4.5.3.1E

**Long flame parameters**

| On dmmf basis | | |
|---|---|---|
| VM% | Gross CV in k.cal/kg | Moisture% at 60% RH & 40° C (on mineral free basis) |
| 39.6 - 50.9 | 7091 – 7617 | 9.5 - 14.5 |

Table 4.5.3.1F

**Ash fusion temperature range**

| Sample type | Ash fusion range (at MRA) °C | | |
|---|---|---|---|
| | IDT | HT | FT |
| Bcs | 1200 - 1210 | >1400 | >1400 |
| I100 | 1230 - >1400 | 1330 - >1400 | >1400 |

Table 4.5.3.1G

**Chemical Composition of Coal Ash**

| Sample type | SiO2% | Al2O3% | Fe2O3% | TiO2% | P2O5% | MnO% | CaO % | MgO% | SO3% | Alkalies by diff. |
|---|---|---|---|---|---|---|---|---|---|---|
| I100 | 59.9 - 61.14 | 20.7 - 28.24 | 2.84 - 12.2 | 1.8 - 1.88 | 0.2 - 0.44 | Trace - 0.04 | 1 - 2.03 | 0.84 - 1.4 | Trace - 0.43 | 2.02 - 2.8 |

4.5.3.1.1 **Observation:**

Like other seams, the coals of Purewa Top seam are low rank, high volatile, non-coking, bituminous type. It is seen that unit volatile matter and moisture content on mineral free basis conform to the laid down parameters for long flame coals. The average gross calorific value on dmmf basis, however, is lower than the stipulated range. Therefore, Purewa Top seam does not strictly conform to the stipulations for long flame coals.

4.5.4 **Purewa Merged seam :**

Purewa Top and Purewa Bottom seams have merged together in the western part of the area to form a thick combined Purewa Merged seam. For all practical purposes the parting line of 1 m between Purewa Top and Purewa Bottom seams has been taken as the line of merger. The parting mainly consists of medium to coarse grained sandstone with sandy shale, shale and carbonaceous shale at places. The parting between this seam and underlying Turra seam ranges from 55 m to 70 m.The seam does not incrop in this block. The maximum depth of occurrence of the seam is 168 m.

The thickness of Purewa Merged seam including all dirt bands varies from 17.57 m to 27.50 m. Its effective thickness, in general, varies from 18 to 22m.

Medium to coarse grained sandstone usually forms both roof and floor of the seam. However, in some cases carbonaceous sandy shale, alternating bands of shale and sandstone also constitute the roof of the seam.

The seam is interbanded in nature. The dirt bands are represented by carbonaceous shale, carbonaceous sandy shale, shale etc. The summary of dirt bands is given in table 4.5.4.

Table 4.5.4

**Dirt bands in Purewa Merged seam**

| Thickness range of seam (in m) | Dirt bands | | | | | |
|---|---|---|---|---|---|---|
| | < 1m. thick | | | | >1m. thick | |
| | Combustible | | Non-combustible | | No. | Cumulative Thickness (in m) |
| | No. | Cumulative Thickness (in m) | No. | Cumulative Thickness (in m) | | |
| 17.57 - 27.50 | Nil - 12 | Nil - 2.53 | Nil -8 | Nil -3.57 | Nil -4 | Nil - 8.40 |

4.5.4.1 **Coal Quality :**

The quality of Purewa Merged seam varies between G-E. The seam is largely grade F in quality. A summary of quality details of the seam is given in following tables.

Table 4.5.4.1A

**Proximate analysis**

| Particulars of analysis | On 60% RH & 40°C | | | | | |
|---|---|---|---|---|---|---|
| | M% | A% | VM% | CV (k.cal/kg) | UHV (k.cal/kg) | Grade |
| Bcs | 6.8 - 10.4 | 21.9 - 29.3 | 27.9 - 32.9 | 4565 - 4955 | 3628 - 4912 | E - D |
| I100 | 6.4 - 10.0 | 25.1 - 41.7 | 25.1 - 30.4 | 3590 - 4890 | 2097 - 4291 | G - E |
| Ip | 5.1 - 7.9 | 29.6 - 48.9 | 23.4 - 27.3 | 2925 - 4650 | 1338 - 3739 | G - E |

Table 4.5.4.1B

**Ultimate analysis**

| C% | H% | N% | S% | Oxy% (by diff.) |
|---|---|---|---|---|
| 78.1 - 80.8 | 4.9 - 5.3 | 1.4 - 1.9 | 0.4 - 0.6 | 11.6 - 13.2 |

Table 4.5.4.1C

**Sulphur distribution**

| Sample type | Sulphur distribution% | | |
|---|---|---|---|
| | Pyrite | Sulphate | Organic |
| I100 | 8.5 - 12.1 | 3.5 - 6.9 | 85.9 - 87.4 |

Table 4.5.4.1D

**Hardgrove Grindability Index**

| Sample type | Hardgrove Grindability Index |
|---|---|
| Bcs | 58 |
| I100 | 56 - 76 |
| Ip | 56 |

Table 4.5.4.1E

**Long flame parameters**

| On dmmf basis | | Moisture% at 60% RH & 40° C (on mineral free basis) |
|---|---|---|
| VM% | Gross CV in k.cal/kg | |
| 38.9 - 47.1 | 6634 – 7843 | 9.0 - 13.7 |

Table 4.5.4.1F

**Ash fusion temperature range**

| Sample type | Ash fusion range (at MRA) °C | | |
|---|---|---|---|
| | IDT | HT | FT |
| Bcs | 1170 - >1400 | >1400 | >1400 |
| 1100 | 1280 - >1400 | 1340 - >1400 | >1400 |

Table 4.5.4.1G

**Chemical Composition of Coal Ash**

| Sample type | SiO2% | Al2O3% | Fe2O3% | TiO2% | P2O5% | MnO% | CaO% | MgO% | SO3% | Alkalies by diff. |
|---|---|---|---|---|---|---|---|---|---|---|
| Bcs | 60.52 - 61.3 | 24.64 - 28.28 | 6.79 - 8.78 | 1.6 | 0.23 - 0.48 | Trace | 0.71 - 1 | 0.6 - 0.63 | 0.3 | 0.97 - 1.27 |
| 1100 | 59.93 - 61.84 | 25.64 - 29.32 | 2.79 - 8.78 | 1.4 - 1.89 | 0.4 - 0.48 | Trace | 0.1 - 2.14 | 0.15 - 0.84 | 0.09 - 0.44 | 1.12 - 2.21 |

4.5.4.1.1 **Observation:**

From above data, it may be observed that the coals are of low rank, high volatile, non-coking and bituminous type. The Purewa Merged seam nearly satisfies the stipulated parameters of long flame coal.

## 4.6 Geological Coal Reserves:

Coal seams for opencast mining have been defined considering 1 metre and above coal/ shaly coal bands at roof and floor, despite of thicker following or preceding dirt band respectively. Thickness and quality considered for preparation of isochore and isograde plans are inclusive of combustible, non-combustible and obvious dirt bands of less than 1 metre in thickness. Dirt bands of 1 metre and above in thickness have been added to the overburden.

On the basis of inter-spacing of drill hole data, the estimated coal reserves have been placed under proved category.

The coal volume has been ascertained by measuring the area between successive isochore lines, drawn at 1 metre interval. The specific gravity has been calculated for each seam using formula Sp. gra = 1.28 + 1% of ash content. The gross coal reserve has been estimated by multiplying effective coal thickness and specific gravity with the measured area. A deduction of 10% has been effected from the gross reserves for unforeseen geological variants to arrive at net proved reserves. Coal reserves have been estimated within vertical walls of the block boundary.

The seam-wise total net proved reserve of coal excluding dirt bands of > 1 m thickness in the area is summarized in Table 4.6.

Table 4.6

**Seam-wise net geological reserves**

| Coal Seam | Proved reserves as per GR on Nigahi block, July, 1981 (in Million Tonnes) | Proved reserves as per GR on Nigahi North Extn. block, March, 2003 (in Million Tonnes) | Total Proved reserves in Million Tonnes in the area, considered for Nigahi OCP (15 Mtpa) |
|---|---|---|---|
| Purewa Top | 31.64 | 12.63 | 44.27 |
| Purewa Bottom | 81.76 | 25.06 | 106.82 |
| Purewa Merged | 22.42 | 86.52 | 108.94 |
| Turra | 191.38 | 110.30 | 301.68 |
| Total | 327.20 | 234.51 | 561.71 |

## 4.7 Overburden:

### 4.7.1 Nature:

The Nigahi mining block is covered by rocks of Barakar Formation with a thin cover of soil and alluvium. The cover of soil and alluvium is underlain by weathered sandstone and clays. The rocks underlying weathered mantle consist mainly of sandstone of varying grain size. Kaolinised felspar is usually the cementing material. There are about two to three caly bands above Purewa Top seam. The strata between Purewa Top and Purewa Bottom, and Purewa Bottom/ Purewa Merged and Turra seams are largely composed of medium to coarse grained sandstone.

### 4.7.2 Inseam burden:

Dirt bands of 1 metre and above in thickness are mostly composed of shale and carbonaceous shale. In Turra seam, dirt bands of 1 metre and above in thickness are rarely present.

4.7.3 **Methodology for overburden estimate**:

The volume of overburden has been computed by deducting the total coal volume from total excavation volume. The total excavation volume has been computed by subtraction of the Turra seam floor grid from the topography grid and multiplying with area. Like coal reserves, the overburden volume has been estimated within vertical walls. The maximum depth of excavation is 275 m.

Summary of coal reserves and overburden estimate is given in Table 4.7.3.

Table 4.7.3

**Summary of coal reserves and overburden estimate**

| Area | Net coal reserves in Million tonnes (For coal excluding >1 m dirt band) | Volume of total overburden in $mm^3$ | Stripping ratio in $m^3/t$ of coal |
|---|---|---|---|
| A) Nigahi block | 327.20 | 984.18 | 3.01 |
| B) Nigahi North Extn. block | 234.51 | 831.44 | 3.55 |
| Total Nigahi OCP (15 mtpa) | 561.71 | 1815.62 | 3.23 |

4.7.4 **Depth of excavation:**

The maximum depth of excavation is around 275 m. Bulk of the coal reserves (about 95%) fall within 250 m line.

4.7.5 **Mining activity:**

All the three coal seams namely Turra, Purewa Bottom and Purewa Top are under extensive exploitation in the block. The coal reserves and volume of overburden mentioned above are for the entire Nigahi Block including the excavation carried out so far.

4.8 **Physico-mechanical properties:**

The physico-mechanical properties of the rocks were determined from the cores of borehole CMSN-42, 45 & 47 and the following properties were determined.

Uni-axial Compressive Strength:

The uni-axial strength ranges between 9.5 to 247 $kg/cm^2$. For the medium to coarse grained sandstone, and for fine grained sandstone and shaly sandstone, it ranges between 55.0 to 267 $kg/cm^2$.

The range of carbonaceous shale varies between 63.3 to 430.1 kg/cm² and for coal and shaly coal it is between 87.7 and 388.8 kg/cm².

Protodyakonov Strength:

The protodyakonov strength ranges between 0.09 to 2.5 for coarse and medium grained sandstone, 0.6 to 2.7 for fine grained to shaly sandstone, from 0.6 to 4.3 for carb shale and 0.5 to 3.8 kg/cm² for coal.

Shear Strength:

The shear strength of coarse to medium grained sandstone ranges between 2.7 to 56.5 kg/cm² and 2.0 to 20.0 kg/cm² for carb shale and 1.4 to 13.0 kg/cm² for coal.

Tensile Strength:

The tensile strength ranges between 2.87 to 41.79 kg/cm² for coarse and medium grained sandstone, 7.0 to 55.8 kg/cm² for carb shales and 0.22 to 40.7 kg/cm² for coal and shaly coal.

## 4.9 Hydrogeology:

The basic data for sub-surface hydrogeology is too little to venture any firm predictions. The water levels recorded from the borehole in the block and in the Jayant block, situated to the east of Nigahi block indicate that the water level fluctuates from 15 m to 65 m from summer to monsoon. The general water table slope is towards east in the north but near the escarpment the water table slope is towards the south. Boreholes for hydrogeological purposes were not drilled for pumping and other tests.

# CHAPTER-V

# MINING TECHNOLOGY

## 5.0 DESCRIPTION OF THE MINEFIELD

Nigahi Block is located in the North-eastern part of the Singrauli Coalfield and has the following dimensions (along Turra Seam floor):

- along the strike - 3.5 Km.
- along the dip - 3.4 Km.

Existing Jayant Opencast Mine lies to the east of the block and Amlohri to the west. The terrain of the opencast mine field represents the hilly plateau with RLs of 400m to 500m above MSL and which comes abruptly to a plain of +300m in the Turra seam incrop region.

The incrop of Purewa Bottom seam lies on the face of another small escarpment on top of this plateau. Top levels of the escarpment come to about 455m and lower ones vary from 405m to 415 m.

The drainage is controlled by many seasonal nallahs with southerly flow in a major portion at the minefield.

Three coal seams Turra (14 m – 18m), Purewa Bottom Seam (11m – 12m) and Purewa Top Seam (7m –9m) are proposed to be mined. In the northern part of the minefield, Purewa Bottom and Purewa Top seams merge together to form Purewa Merged Seam (22-24m thick). The seams are dipping $2^{\circ}$ to $3^{\circ}$ northwards.

The thickness of the overburden overlying the seams vary from 10m to 95-100m. The parting between Turra & Purewa Bottom seams is 55m-60m and Purewa Bottom and Purewa Top seam is 0-28m. The stripping ratios range from $3.0 m^3/t$ in the extreme western portion of the minefield in the region of Turra seam incrop to 5-6 $m^3/t$ along the northern boundary of the opencast minefield.

## 5.1 MINE BOUNDARIES:

### 5.1.1 Mine Boundary delineation

The boundaries of the Opencast minefield have been fixed as follows:

**Southern Boundary** has been fixed in the incrop zone of Turra seam taking into account the economic cut-off ratio as 10:1 (OB:Coal).

**Northern Boundary**: Boundary of reserves prospected;

**Eastern Boundary**: Boundary of existing Jayant Opencast Mine;

**Western Boundary**: Boundary of Amlohri Opencast Mine.

According to the adopted sequence of mining of opencast minefield, a temporary barrier 110 m wide on the surface is to be kept at the boundary with the existing Jayant OCM from the side of Nigahi Opencast Mine. This barrier is considered necessary for the proposed sequence of the coalfield development and will serve as passage for transport, communication and surface drainage. This barrier is proposed to be mined at the end of exhaustion of Nigahi Project.

### 5.1.2 Mining Losses and Contamination

The seamwise operational losses for Nigahi is summarized in the table given below :-

| Name of Losses | Operational Losses(%) | | | |
|---|---|---|---|---|
| | Turra | Purewa Bott. | Purewa Top | Purewa Merg. |
| Losses in the seam roof. | 1.3 | 1.4 | 2.3 | 0.7 |
| Losses in the seam floor | 1.0 | 1.4 | 2.3 | 0.7 |
| Losses during selective extraction of dirt bands. | - | 1.8 | 3.0 | 2.1 |
| Losses during trimming of coal bench slope for Turra Seam | 0.5 | - | - | - |
| Losses during trimming of coal sub-bench work-Ing ground for Purewa Merged Seam | - | - | - | - |
| Losses during blasting operations. | 0.7 | 0.7 | 0.7 | 0.7 |
| Loading & Transpor-tation of coal | - | - | - | - |
| Total | 3.5 | 5.3 | 8.3 | 4.2 |

The percentage of contamination with OB at seam floor and roof for different seam is given below:

| | |
|---|---|
| Turra Seam | 0.96% |
| Purewa Bottom Seam | 0.78% |
| Purewa Top Seam | 0.79% |
| Purewa Merged Seam | 0.76% |

5.1.3 **Mineable Reserves & Stripping Ratio**:

The mineable reserves of coal within the boundaries of opencast mine as well as volume of OB and stripping ratio is given in Table No.5.1.

Table No.5.1

SUMMARISED STATEMENT OF
MINEABLE RESERVES & VOLUME OF OB

| Section | Coal (Mt. | | | OB(Mm3) | | | SR ($m^3$/t) |
|---|---|---|---|---|---|---|---|
| | Turra | Purewa | Total | By D/L | By Trans. | Total | |
| West | 127.98 | 111.08 | 239.06. | 231.77 | 718.42 | 950.19 | 3.97 |
| East | 115.24 | 128.71 | 243.95 | 206.03 | 620.43 | 826.46 | 3.39 |
| Total | 243.22 | 239.79 | 483.01 | 437.80 | 1338.85 | 1776.65 | 3.68 |

In addition to 483.01 Mt. of mineable reserves, there is additional 76.70 Mt. of mineable coal reserves in the barrier between Nigahi and Jayant which will require about 496.20 $Mm^3$ of overburden removal. From the above reserves of 483.01 Mt. of coal, the project has produced 82.66 Mt. of coal along with estimated OBR of 329.90 $Mm^3$ till 31.3.2006.

## 5.1.4 PRODUCTION TARGET

The Feasibility Report submitted by Soviet Experts and Indian specialists in 1983-84, envisaged a production of 14 Mtpa of ROM coal from Nigahi block.

The FR for Nigahi OCP was sanctioned in Nov.'87 for a rated capacity of 4.2 Mt. of coal per year in the first phase. The report was expanded for 10 Mtpa capacity and was sanctioned by the Govt. of India in July, '97. Now, with the increased demand of coal from Vindhyachal Super Thermal Power Station , the PR for Nigahi Expansion for a rated capacity of 15 Mtpa of coal per annum has been prepared.

## 5.1.5 LIFE OF THE MINE

Considering:

a) The balance Mineable coal reserves of 400.35 Mt. of coal (excluding the reserves of Jayant/Nigahi barrier);

b) Rated capacity of 15 Mt. of coal per annum;

c) Period of slack in output during development period and at the end of mining operations;

the balance life of the mine has been estimated around 31 years.

## 5.2 MINING STRATEGY

### 5.2.1 Geo-Mining Characteristics:

The geological and mining characteristics of the block are given in Table No.5.2.

**GEO-MINING CHARACTERISTICS**

**Table No.5.2**

| S.No. | Indices | Unit | Coal Seams | | | |
|---|---|---|---|---|---|---|
| | | | Turra | Purewa Bottom | Purewa Top | Purewa Merged |
| I | COAL SEAMS: | | | | | |
| 1 | Seam Thickness<br>From – To<br>Prevailing | m | 11.0-19.4<br>14-18 | 8.8-14.7<br>11-12 | 4.2-10.9<br>7-9 | 18.9-25.7<br>22-24 |
| 2 | Content of dirt bands<br>From – To<br>Including dirt band upto 1 m thick prevailing | % | 0-21.6 | 5.3-43.4 | 4.0-48.7 | 23.1-28.5 |
| 3 | Ash content of coal with dirt bands of upto 1m thick - (From-To) | % | 15.3-24.1 | 31.2-41.2 | 32.5 | 36.9-37.1 |
| 4 | Volume density of coal with dirt bands of upto 1m thick | t/m3 | 1.48 | 1.64 | 1.61 | 1.65 |
| 5 | Hardness index proto-dyakonov Scale<br>From – To<br>Prevailing | | 0.5-4.3<br>1.1 | 0.5-4.3<br>1.1 | 0.5-4.3<br>1.1 | 0.5-4.3<br>1.1 |
| 6 | Drillability Category | | VIII | VIII | VIII | VIII |
| 7 | Category of Excvn. | | III | III | III | III |
| II | OB ROCKS | | | | | |
| 1 | Thickness overlying OB<br>From – To<br>Prevailing | m | 31.4-89.9<br>40-60 | 18.4-90.0<br>40-70 | 0.5-167.4<br>60-100 | 30.5-167.4<br>60-100 |
| 2 | Thickness of Turra-Purewa Bottom parting<br>From – To | m | | 52.1-69.6 | | |
| 3 | Thickness of Purewa Bottom-Purewa top parting ( From – To ) | m | | 0-28 | | |
| 4 | Volume density of Overburden Rocks | t/m$^3$ | 2.0 | | | |
| 5 | Hardness index after proto-dyakonov scale<br>From – To | | 0.1-4.5 | | | |
| 6 | Drillability Category | | VIII | | | |
| 7 | Category for Excvn. | | IV – 10%<br>III-90% | | | |

### 5.2.2 Selection of Mining Method

Considering the mining and geological conditions such as:

a) Flat gradient of 2°-3° of the coal seam;
b) Mining of multiple seams viz. Turra (14-18m), Purewa Bottom (11-12m), Purewa Top (7-9m) and Purewa Merged (22-24m);
c) Parting of 52m to 70m between Turra and Purewa Bottom;
d) Large scope of work including 15 Mt of ROM coal and about 54.31 $Mm^3$ of OB (peak) per annum;

the combined system of opencast mining with the use of dragline and shovel dumper combination has been proposed.

#### 5.2.2.1 Balancing diagrams for 20/90 & 24/96 Dragline combination

The dragline balancing diagrams for different bench heights for the above dragline combination for single bench blasting as well as separate bench blasting have been drawn and presented in the EPR. The required coal exposure, dragline load alongwith the quantity of re-handling for different bench heights for both the options are given in Table No.5.3 & 5.4 respectively

Table No.5.3

**Separate Bench Blasting**

| Bench Height (m) | Coal Exposure (Mt) | Dragline Load ($Mm^3$) | Rehandling ($Mm^3$) | %age of Rehandling |
|---|---|---|---|---|
| 35 (20+15) | 3.45 | 6.05 | 1.20 | 16 |
| 40(25+15) | 2.86 | 5.74 | 1.53 | 22 |
| 45(30+15) | 2.43 | 5.47 | 1.83 | 28 |
| 50(35+15) | 2.11 | 5.29 | 2.04 | 32 |
| 55(40+15) | 1.84 | 5.07 | 2.28 | 37 |
| 55(38+17) | 1.88 | 5.19 | 2.15 | 34 |
| 61(45+16) | 1.62 | 4.94 | 2.42 | 42 |

Table No.5.4

**Single Bench Blasting**

| Bench Height (m) | Coal Exposure (Mt) | Dragline Load ($Mm^3$) | Rehandling ($Mm^3$) | %age of Rehandling |
|---|---|---|---|---|
| 30 | 4.84 | 6.74+0.53* | 0.42 | 4 |
| 35 | 4.00 | 6.47+0.53* | 0.73 | 8 |
| 40 | 3.33 | 6.15+0.51* | 1.07 | 13 |
| 45 | 2.82 | 5.84+0.52* | 1.43 | 19 |
| 50 | 2.43 | 5.59+0.50* | 1.70 | 23 |
| 55 | 2.14 | 5.40+0.50* | 1.91 | 27 |

* Volume of OB obtained due to throw blast, which will not be handled by draglines

Dragline deployment scheme with separate bench blasting has been adopted in the EPR.

### 5.2.2.2 Elements of Mining System

Elements of mining system have been determined in accordance with the parameters of excavation and transport equipment and the parameters of drilling and blasting.

#### Stripping Operation

The height of main bench over Turra seam excavated by draglines varies according to the requirement of coal exposure from Turra Seam. 33-43 m bench height has been proposed for dragline working. The dragline cut width is adopted as 60m.

The overburden from the advance benches is proposed to be removed by 12.5 $m^3$, 10 m3 and additional proposed 20 m3 electric rope shovels working in conjunction with 120/85/170 T rear dumpers. **In the EPR (15 Mtpa), it is proposed to replace all the existing 10 m3 and 12.5 m3 electric rope shovels deployed in OBR with equivalent numbers of 20 m3 electric rope shovels after their survey off. Similarly, all the existing 85/120 T rear dumpers are proposed to be replaced by equivalent numbers of 170 T rear dumpers after their survey off.** The width of the cut for the shovel benches has been adopted as 20m. The maximum height of the shovel bench is 18m. With two way traffic along the bench, the width of the working bench is 60-66m which includes 20m cut width, 14 m throw, 22m haul road, 6m for power supply arrangement (on alternate benches and 4m safety berm).

#### Coal Production

Coal seams will be mined by 8 m3/10 m3 elect. rope shovels working in conjunction with 85 T rear dumpers (Coal Body). **It is proposed to replace the existing 2 Nos. of 8 m3 electric rope shovels by 2 Nos. of 10 m3 electric rope shovels after their survey off.**

Turra, Purewa Bottom and Purewa Top seams will be developed in one bench each whereas Purewa Merged will be worked out in two benches.

### 5.2.2.3 General Scheme of Operations

Considering the flat dip (2°-3°) of the seams, it is proposed to excavate the OB from advanced benches by inclined layers parallel to the seam floor. This system eliminates the need to cut new horizons from the side of seam roof.

The minefield is being developed in two sections - western section and eastern section.

Coal from Turra seam in both the sections is transported to receiving pits through existing mid-entries. Coal from Purewa seams in western section is transported through the western ramp to temporary coal receiving pit through zig-zag road till receiving pit is constructed on the central haul road, thereafter through central haul road. In the eastern section, coal from Purewa seams will be transported through eastern batters as well as through central haul road proposed on the floor level of Purewa Bottom/Merged Seam.

Overburden is transported to internal dumps and partially to external dumps along the western and eastern non-working sides of the opencast mine and also through central haul road.

### 5.2.3 Sequence of Mining

Considering the mining and geological conditions, the minefield is being developed towards the dip of the seams (from south to north) from Turra incrop region.

As the adjacent Jayant mine is in Operation, a temporary barrier of 110m is proposed to be left between Jayant and Nigahi so that the OB from both the mines can be transported along their respective side flanks independently to the internal dumps at the minimum lead of transportation.

The barrier will be mined after the mining operations within the main field are over.

The western portion of the minefield had been developed first as it was envisaged in the sanctioned FR/EPR due to favourable mining and geological conditions.

Purewa Bottom and Purewa Top seams will be opened by the working side of the opencast mine as the working face line approaches.

In the sanctioned EPR, it was envisaged to develop the minefield with a centrally located sump after commissioning the eastern section. Coal from Turra seam was proposed to be transported through central entry whereas overburden and coal from Purewa seams was proposed to be transported along the western and eastern non-working sides of the opencast mine.

The above sequence could not be adopted due to delay in procurement of HEMM and subsequent delay in development of box cut in east section. Now, it has been proposed to develop both the sections with flank entries and mid-entries for the transportation of coal from Turra seam. There is proposal to have a central haul road on the floor of Purewa Bottom seam for transportation of Purewa coal to centrally located receiving pit and also for transportation of OB to internal dumps. This revised sequence of mining ensures reduction in transportation lead for OB removal.

The adopted sequence of mining ensures:

- Independent operation of Nigahi and Jayant opencast Mines;
- Minimum volume of mining operations for putting the opencast mine into operation;
- Minimum stripping ratio for the initial period of the opencast mine operation;
- Minimum lead of coal and OB transportation.

### 5.2.3.1 Opening of the Minefield

The western section has been opened by the box-cut excavated along the southern contour of the Turra seam considering the economically feasible maximum cut off ratio 1:10 with a certain alignment of the working face line and the western coal ramp. Flank ramps will be arranged for OB transportation to external dumps whereas the drainage from the excavated areas will be from the western ramp.

The working face line of the western section will be extended with the advance of mining operations.

The eastern section has also been opened by the box-cut excavated along the southern contours of Turra seam by eastern flank entry and also with the help of mid-entry which will be used for transportation of coal from Turra seam.

## 5.2.4 Schedule of Quantities

The opencast mine is planned to achieve its target capacity of 15 Mtpa of ROM coal in 2011-12. The production progamme during the initial years of quarry operation is given below:

| Years | Coal Production (Mt) | OB Removal ($Mm^3$) | Stripping Ratio ($m^3/t$) |
|---|---|---|---|
| 2006-07 | 10.00 | 35.68 | 3.57 |
| 2007-08 | 10.00 | 37.50 | 3.75 |
| 2008-09 | 11.00 | 41.10 | 3.74 |
| 2009-10 | 12.00 | 49.41 | 4.12 |
| 2010-11 | 14.00 | 54.13 | 3.87 |
| 2011-12 | 15.00 | 54.00 | 3.60 |

## 5.2.5 Dumping Arrangements

The main OB bench overlying Turra seam is to be mined by the dragline system and backfilled in the de-coaled area of the previous cut. The advanced benches are to be developed by shovel-dumper system.

The total volume of OB to be handled is 1776.65 $Mm^3$. Out of this, 1138 Mm3 will be dumped internally and 143 Mm3 and 88 Mm3 will be dumped in the southern and western external dumps respectively. There is shortfall in the dumping area for about 407.65 $Mm^3$ of OB.

OB dumps will be formed in benches of 30 m height. The southern external and western external dumps will be filled to 5 decks each. The internal dump will have 9 decks. The area occupied by external dumps comes to 418 ha.

For the purpose of dumps and leveling of dumps, 850 HP dozers have been envisaged. A total of 7 dozers have been provided for this purposes.

## 5.3 MINING SYSTEM & EQUIPMENT

### 5.3.1 Design Criteria

The annual workload for coal and OB removal are determined by the number of working days spent on these works. Based on these, capacities of mining and transport equipment and other economic indices of the opencast mine have been determined.

The following design criteria has been adopted for mining operation:

Opencast mine is to be worked on the above three shifts per day of six days per week schedule.

| | |
|---|---|
| No. of annual working days | 330 |
| No. of daily shifts | 3 |
| Duration of each shift(Hrs.) | 8 |

### 5.3.2 Selection of Equipment

#### 5.3.2.1 OB Removal

In the sanctioned EPR, 24/88R draglines, 20 m3/83R draglines 12.5 m3 EKG Russian electric rope shovels, 10 m3 electric rope shovels and 8 m3 Russian elect. rope shovels had been envisaged for excavating overburden. 120/85T rear dumpers for transportation of OB and 85 T coal body rear dumpers for coal had been envisaged in the EPR (10 Mtpa).

Considering the performance of equipment in Singrauli Coalfield and also future trends in upgradation of the size of existing equipment, the following equipment options have been studied in the EPR of Nigahi OCP (15 Mtpa).

Almost all the equipment provided in the sanctioned EPR (10 Mtpa) have been procured and deployed. As envisaged in the sanctioned EPR, 2 draglines (1 No. 24m3/88R and 1 No. 20m3/83R) are proposed to be deployed in the each section and will remain common for all the proposed equipment options.

**Option-I** - In this option, additional 10 m3 electric rope shovels in conjunction with 120 T rear dumpers are envisaged to work for OB removal. All the 85 T rear dumpers in addition to that required in coal are proposed to be replaced by equivalent numbers of 120 T rear dumpers.

**Option-II** – In this option, additional 20 m3 electric rope shovels in conjunction with 170 T rear dumpers are envisaged to work for OB removal. In this option, all the 5 Nos. of 12.5 m3 and 2 Nos. of EKG Russian electric rope shovels and 8 Nos. of 10 m3 electric rope shovels are proposed to be replaced by 8 Nos. of 20 m3 electric rope shovels.

All the existing 85/120 T rear dumpers are proposed to be replaced by 170 T rear dumpers. In this option, out of 40 Nos. of 410 HP dozer sanctioned in the EPR (10 Mtpa), only 23 Nos. (17 Nos. for OB and 6 Nos. for coal)are proposed to be deployed in the EPR of 15 Mtpa. Balance 17 Nos. of sanctioned 410 HP dozers are proposed to be replaced by 7 Nos. of 850 HP dozers.

| S. No. | Equipment | Size/Cap. | Option-I | Option-II |
|---|---|---|---|---|
| 1 | Dragline | 24m3/88R | 2 | 2 |
| 2 | Dragline | 20m3/83R | 2 | 2 |
| 3 | Elect. Rope Shovel | 20m3 | - | 13 |
| 4 | Elect. Rope Shovel | 12.5 m3 | 5 | - |
| 5 | Elect. Rope Shovel | 10 m3 | 21 | - |
| 6 | RBH Drill | 311 mm | 4 | 4 |
| 7 | RBH Drill | 250 mm | 29 | 22 |
| 8 | Rear Dumper | 170/190T | - | 95 |
| 9 | Rear Dumper | 120T | 122 | - |
| 10 | Rear Dumper | 85T | 52 | - |
| 11 | Dozer | 850 HP | - | 7 |
| 12 | Dozer | 410 HP | 52 | 17 |

### 5.3.2.2 Coal Winning

It is proposed not to use too many varieties/sizes of shovels and dumpers. This creates problem in keeping different inventories for maintenance etc. It has been proposed to replace the existing 2 Nos. of 8 m3 elect. rope shovels deployed in coal with 2 Nos. of 10 m3 elect. rope shovels after their survey off. Considering the existing population of 85 T rear dumpers, 85 T coal body rear dumpers are envisaged in the EPR of 15 Mtpa also. Considering the population of 85 T coal body rear dumpers required in 15 Mtpa stage, it may be advisable to replace all the existing 85 T rear dumpers with equivalent Nos. of 120 T coal body rear dumpers. For this some modification in the existing CHP may be required.

### 5.3.2.3 Selection of the Option

Keeping in view the unmanageable fleet of HEMM specially in dumpers and dozers in Option-I, and also considering the existing infrastructural facilities and the numbers of working benches to be worked by shovel-dumper system, Option-II is the best possible option at this stage for Nigahi EPR (15 Mtpa) and hence has been selected in the EPR.

### 5.3.3 Excavating Equipment Productivity

Annual productivity of excavators has been calculated on the following basis :

- Excavation Category
  For Coal : Cat-II
  For OB : 90% Cat-III & 10% Cat-IV

- Average Overall Annual Standard Utilization of shift hours

  Dragline : 73%
  Elect.Rope Shovels : 58%

- Factors allowed for traveling and positioning etc.

  Dragline : 0.8
  Rope Shovels : 0.8

The main mining and transport equipment viz. Elect. Rope Shovels, draglines, Dumpers and Dozers will be operating on three shifts per days, seven days per week schedule. The number of working days per year has been adopted as 330. Based on the above operating conditions and norms, the estimated annual productivity of various excavators is given below:

| S. No. | Equipment | Annual Productivity (Mm3) |
|---|---|---|
| 1 | Dragline (24/96) | |
| | - 90° Swing | 4.10 |
| | - 120° Swing | 3.70 |
| | - 180° Swing | 3.09 |
| 2 | Dragline (20/90) | |
| | - 90° Swing | 3.37 |
| | - 120° Swing | 3.04 |
| | - 180° Swing | 2.54 |
| 3 | 20 m3 Elect. Rope Shovels with 170/190 T Rear Dumpes | 4.28 |
| 4 | 12 m3 Elect.Rope Shovel with | |
| | - 85 T Rear Dumpers | 2.50 |
| | - 120 T Rear Dumpers | 2.72 |
| 5 | 10m3 Elect.Rope Shovel with | |
| | - 85 T Rear Dumpers | 2.07 |
| | - 120 T Rear Dumpers | 2.18 |
| 6 | 8m3 Elect.Rope Shovel with | |
| | - 85 T (CB) Rear Dumpers | 1.78 |
| 7 | 10m3 Elect.Rope Shovel with | |
| | - 85 T (CB)Rear Dumpers | 2.20 |

### 5.3.4 Drilling & Blasting Operation

#### 5.3.4.1 Category of Rock for drilling and type of drilling rigs

Drilling and blasting operations for loosening of OB rocks and coal are considred necessary before any excavation can be made. Based upon the physico-mechanical properties of coal and OB rocks, the drilling category is VIII for coal and X for Overburden as per Soviet Norms.

RBH drill of 160 mm dia are proposed for drilling in coal benches. RBH Electric Drills of about 250 mm dia are envisaged for drilling in OB shovel benches and RBH Elect. Drill of 311 mm dia are envisaged for drilling in dragline benches.

Drilling is proposed to be done at 70° to the horizontal for dragline benches and 90° for other overburden benches.

### 5.3.4.2 Elements of Drilling & Blasting

The elements of drilling for OB would be decided during the actual course of mining operations. However, based on the available data from the existing Nigahi mine and the neighbouring mines, the burden and spacing would be 10m each for the shovel benches with a height of 18m. Considering the sub-grade drilling required the volume of OB for each running metre of hole drilled is estimated as 92m.

For dragline benches, the burden and spacing would be 10m and 10.5 m respectively for a bench height of 47m. It is estimated that 99m3 of OB would be available for each metre of hole drilled.

The elements of drilling in coal would also be decided during the actual course of mining. However, based on available data from Nigahi mine, a drilling pattern of 8m x 8m for Turra seam and 7 m x 7m for Purewa seam has been envisaged in the EPR. This will give the yield of about 64 m3 and 49m3 respectively.

### 5.3.4.3 Requirement of Drills

The requirement of drills as been assessed considering the following :

- Workload as per Calendar plan of excavation;
- Annual Productivity of the drills;
- Yield mass, per running metre of hole drilled;
- Physical location of the drills, within the operating section and
- Planned cycle of repair and maintenance.

For the annual workload of 15 Mtpa of ROM coal and 54.31 Mm3 of OB (Peak) for the project, 4 Nos. of 311 mm dia RBH Elect. Drills for draglines benches, 19 Nos. of 250 mm dia RBH Elect. Drills for shovel benches in OB and 8 Nos. of 160 mm RBH drills for coal benches have been envisaged.

The following specific consumption of explosives has been adopted for estimating the annual requirement of explosives:

| | | |
|---|---|---|
| a) | OB from Shovel benches | 0.3 Kg./m3 |
| b) | OB from Dragline benches | 0.6 Kg./m3 |
| c) | Coal Seams | 0.2 Kg./m3 |

The amount of secondary blasting is estimated as 4% of the total volume of OB.

## 5.4 MINING SCHEDULE

### 5.4.1 Calendar Plan of Mining Operations

The calendar plan of mining operations has been formulated based on the adopted sequence of opencast minefield development, optimum conditions of mining operations for the entire life of the opencast mine.

Plan showing the sectors on Turra seam floor are given vide Drg. No. RI-VI/MIN/NGH/04/177. The quantity of coal and OB in each sector has been determined by cross-sectional method. The total volume of coal and OB have been checked by the figures calculated from the plan showing the isopachytes of total excavation and partings.

The calendar plan of mining operations in the eastern and western section is given vide Drg. No. RI-VI/OCM/NIG/04/177A & 177B. A summarized calendar programme of excavation and equipment phasing is given in Table No.5.5. The calendar programme of excavation for the existing 10 Mtpa for incremental 5 Mtpa is given in Table No.5.6.

Till March 2006, 82.66 Mt. of coal and 329.90 $Mm^3$ of OB has been reported to be removed.

The target capacity of 15 Mt of ROM coal will be achieved in the year 2011-12. The height of the main dragline bench is given in the calendar plan (Table No.5.7). Out of the total parting of 52 to 69 m, the draglines are envisaged to remove upto a maximum height of 41 m in east section and 48 m in west section. The balance is to be removed by transport system.

The peak volume of OB (54.31 $Mm^3$) will be removed in 2013-14. Out of 54.31 $Mm^3$ of OB, 12.31 $Mm^3$ is envisaged to be removed by dragline system and the balance 42.00 $Mm^3$ to be removed by shovel-dumper system. The peak stripping ratio is 3.75 $m^3/t$ in the year of 2005-06 to 2008-09.

### 5.4.2 ROM Coal Quality

The coal from Nigahi Opencast Mine will be supplied to Vindhyachal Super Thermal Power Station.

EPR for Nigahi OCP envisages extraction of Turra and Purewa Seam coals. The average grade of Turra seam coal is C/D long flame and that of Purewa is Gr-F. It is proposed to dispatch Turra and Purewa seam coal separately for better sales realization.

On the basis of the calendar programme of mining operations and the yearly advance of Turra and Purewa seams, effect of contamination and losses, the yearwise quality of coal has been summarized in Table No.5.8.